Opportunity Report for Gas and Unregulated Fuels Efficiency Savings in National Grid's Rhode Island Service Territory

Prepared for the Rhode Island Energy Efficiency and Resource Management Council

by the VEIC/Optimal Consultant Team

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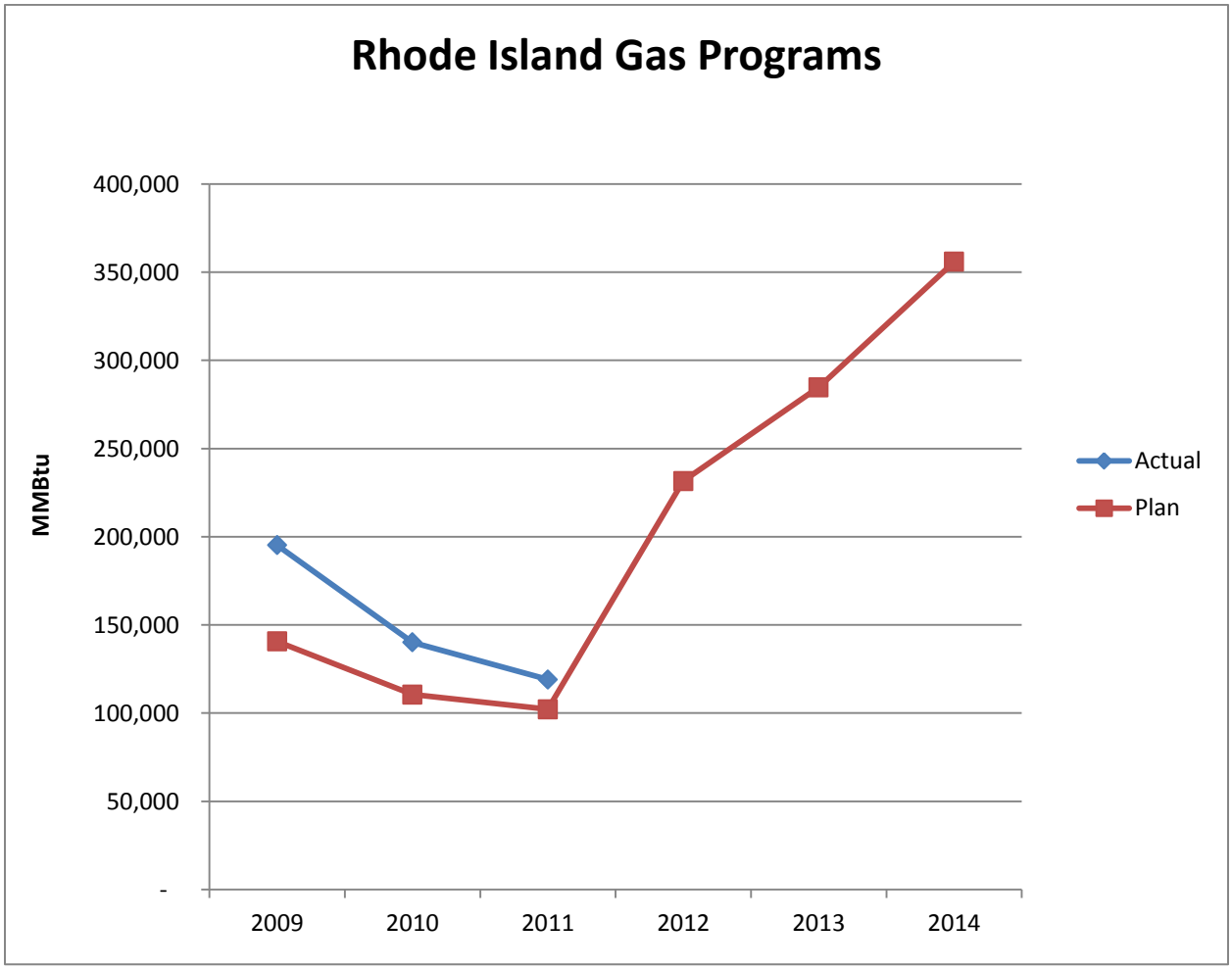
Background and Context

EERMC and National Grid have requested assistance in developing information to inform their natural gas, and to a lesser extent deliverable fuel, efficiency program planning for 2013 and 2014. In particular, the interest focuses on data and information regarding new technologies and additional efficiency measures and strategies that could be deployed to support achievement of savings goals established in the 2012 – 2014 Three-year Plan, which are dramatically higher than recent program activity.



This report summarizes the data collection and analytical activities used to prepare a list of promising opportunities and develop initial information on their potential magnitude and cost as well as factors relevant to acquiring savings from them.

The data and conclusions presented in this report are based on several sources.

- Interviews with knowledgeable and informed individuals with experience in gas and fossil fuel technologies and/or efficiency measures
- Research using readily available data sources and literature
- The professional knowledge and experience of the project team

The team's effort was focused on generating a small number of opportunities with the greatest likelihood of providing savings during the 2013 and 2014 program years. While the initial data collection effort generated over 100 ideas, the opportunities presented in this report are not intended to be an exhaustive or comprehensive listing of all potential means for additional gas and fossil fuel savings for Rhode Island's efficiency programs. Furthermore, the scale of the project precluded a detailed review of all of the initially identified opportunities. When possible, the team attempted to devote more effort to those opportunities that appeared to offer the greatest promise of substantial savings. This does not mean that other opportunities may not eventually turn out to also provide similar amounts of savings.

Summary of Findings

We identified several opportunities that could provide National Grid with substantial potential for additional savings. Of the 19 technology-based opportunities we characterized and included in this report, several have total market potentials in excess of 100,000 MMBtu each. Because many of these opportunities are based on retrofit measures, most of our estimates represent total available market sizes, rather than estimates of achievable savings in one year from natural replacement cycles. Regardless, all savings estimates are given in terms of annual first year, not lifetime, MMBtu savings. The table below presents the three technology opportunities and three program strategies that we feel represent the highest priority, based on total opportunity and, for the technology opportunities, expected cost.

Overall, the total potential represented by just the four opportunities expressed as total amounts (i.e., those that are largely retrofit type opportunities) is well in 1.3 million MMBtu, with over 100,000 MMBtu per program year from the remaining two opportunities (those that are based on annual replacement or current program delivery rates). The next table shows a sample set of penetrations that would achieve the 53,000 MMBtu increase from the 2012 to the 2013 savings goals. Reaching 2.5 percent of the 4 retrofit-type opportunities and 20 percent of the annual activity in the others would achieve slightly more than 54,000 MMBtu.

Opportunity	Estimated Total Opportunity (MMBtu)	Estimated Cost ($/annual MMBtu)	Sample penetrations to reach 2013 goal increase	Annual Savings (MMBtu)
Process Steam Retrofits	361,000	9	2.5%	9,025
DCV for Kitchen Exhaust	288,199	26	2.5%	7,205
Commercial Laundry	~200,000	22	2.5%	5,000
Upstream Heating & Kitchen Program	~100,000 per year	Not estimated	20%	20,000
Large Multifamily Building Initiative	493,000	Not estimated	2.5%	12,325
Additional Direct Install Measures	4,140	Not estimated	20%	828

Not included in this table are several other technology opportunities and five education opportunities. Details on these are included later in this report. Interviewers also provided suggestions for changes and improvements to National Grid's current programs and implementation processes. We are not characterizing these as new opportunities, but instead have conveyed these to National Grid in a separate memorandum so that they may be considered and addressed as part of on-going efforts to optimize program delivery and success.

Methodology

The analysis proceeded through several steps to successively identify and evaluate additional opportunities for gas and fossil fuel savings.

Summarize Existing Measures and Programs

We began our efforts by reviewing measure lists from the RI Technical Reference Manual (TRM), the RI Annual Plan, and the portfolio screening tool that supports the Annual Plan. We compiled these into one measure list and removed duplicates. We also used the screening tool to identify from which measures National Grid was forecasting to get most savings.

Data Collection

To collect data on potential savings opportunities, we pursued a set of interviews with individuals and organizations who have knowledge and an interest in this area. In preparation for these interviews, we developed a questionnaire to guide the interviewers and ensure consistent information collection. The questionnaire is included as Appendix A to this report.

Interviewees were identified through discussions with an advisory group consisting of Council members, National Grid staff, and other consultants. We conducted interviews both in person and via telephone conversations. In some cases, interviewees provided additional information via email. A list of the interviewees' organizational affiliations appears as Appendix B. Interview responses were collected electronically on the questionnaire, to ensure correlation of answers with questions.

In addition to the interviews, we briefly reviewed TRMs from other jurisdictions and program information from California and other leading states. This led to the addition of several measures not currently being offered in RI to the initial opportunity list.

Initial Screening

The information from the interviews and other research was used to prepare three tables listing opportunities in the areas of technologies, program strategies, and education opportunities. This list was shared with the advisory group in draft form and revised based on their feedback. In some cases, we combined technology opportunities from different sources based on their overlap or similarity. For example, several technologies related to boiler controls were combined into an overall boiler control measure, with the assumption that while individual technologies may only be applicable to certain systems or installations, some type of control improvement is likely available for most systems. For program strategies, we sometimes combined multiple suggestions because they addressed the same program or set of programs. For example, the "Upstream" program strategy combines suggestions specifically referring to upstream programs with others related to promoting commercial kitchen equipment, engaging kitchen equipment vendors, and improving rebate processing.

We next developed a set of criteria to apply to the initial opportunity list with the goal of selecting a smaller number of opportunities for further research. These criteria are listed and defined in Appendix C. These criteria were evaluated based on information provided by the interviewees, limited additional research, and professional judgment of the project team.

Technology opportunities were selected for the further characterization based on a qualitative review of the evaluated criteria. In general, measures selected for further characterization met the following criteria, although the professional judgment of the project team was also a factor.

- Applicable to Rhode Island (note: nearly all measures were)
- Not currently offered by National Grid in a program or a pilot
- Has verifiable savings

- Initial expectation of at least moderate savings potential

Program strategies and education opportunities were selected using similar criteria, although it was more likely that a particular opportunity was excluded based on one or more concerns or constraints.

A separate Excel workbook provided with this report presents a summary table of all opportunities considered during the initial screen. It includes an estimate of the anticipated scale of the opportunity relative to other opportunities and existing measures and programs, based on the team's initial understanding, ranked as high, medium, or low. No quantitative estimate of the potential size of the opportunity was made at this stage of the analysis. For excluded measures, the right-most column includes a brief explanation of the team's reasoning.

Opportunity Characterization

The project team pursued a second round of research and data collection to further characterize the 47 measures selected from the initial screening. We used a variety of sources to develop estimates of market size, savings potential and cost, including data provided by National Grid, the US Department of Energy's Energy Information Administration (EIA) and Energy Efficiency and Renewable Energy Department (EERE), evaluations of other programs, manufacturer data, and other published sources. For the program strategies, existing and planned program performance for relative markets provided a useful basis for future savings projections. We developed quantitative estimates of the potential opportunity savings for technologies and some of the program strategies; we did not prepare these estimates for any of the education opportunities, largely because attribution of savings to these types of program approaches has historically been difficult.

The sections that follow present the opportunity characterizations, still grouped into the three categories of technologies, program strategies, and education. They are arranged in decreasing order of the team's sense of priority, based on the combination of potential savings and projected cost and ease of deployment. Costs are expressed as dollars per first-year MMBtu and the total opportunity is expressed as total annual MMBtu.

We relied on a wide variety of data sources to develop the characterizations. Customer counts and gas sales data were developed from Energy Information Administration (EIA) and National Grid data sources. Sources and assumptions for all characterizations are included in an Excel workbook accompanying this report. The market sizes listed in the characterizations represent a maximum estimate based on high-level assumptions

regarding customer numbers and size and the distribution of gas consumption by end-use. We have not assessed the technical feasibility of each opportunity as a percentage of the overall market, but in some cases reduced the market size based on our professional judgment. Refined estimates of the potential savings from each opportunity will need to be based on more specific program design information and market data.

Note that some of the opportunities are partially or totally exclusive of one another. For example, moving HVAC equipment incentives and promotion upstream would negate the need or ability to pursue some of the other suggested program strategies. We have tried to note this where relevant.

Last, we note that most of our efforts were focused on understanding the potential for savings in gas-consuming equipment and applications. Nevertheless, many of the opportunities we identified would also apply to equipment and processes that rely on unregulated fuels. Any measure or program that addresses space conditioning loads through shell or operational improvements would be applicable to fuels other than natural gas, as would measures related to water heating. Therefore, potential savings from our top opportunities would be even greater if other fuels were considered.

Technology Opportunity Summaries

Process Steam Retrofits

Identification of Gap or Opportunity
Industrial facilities often use boilers to create steam that they use during product fabrication. A typical existing steam system can be improved in many ways, including:

- Minimizing excess combustion air for firing boilers
- Boiler controls
- Improved water treatment
- Ensure that the boiler, piping, valves, fittings, and vessels are well insulated
- Optimize condensate recovery
- Heat recovery
- Condensing economizers
- Pressure reduction
- Add steam traps and repair steam leaks
- Minimize vented steam
- Use backpressure turbines instead of pressure reducing valves
- Recover energy from boiler blowdown and wastewater streams

Since each industrial system is unique and in different condition, it is very difficult to separate and prioritize these measures. Further, the entire process steam system should ideally be looked as a whole for maximum savings, rather than trying to do one or two measures in isolation.

How This Approach or Measure Fills the Gap or Captures Opportunity
Currently, National Grid actively promotes steam trap surveys and repair. However, a comprehensive approach for industrial steam systems can achieve significant additional savings.

Target Market
Industrial facilities

Relationship with Existing Programs
Once National Grid opens a relationship with an industrial customer through its steam trap promotion, it could push additional, slightly more expensive retrofits for the overall steam system.

Type of Opportunity

This opportunity would best fit under a custom approach. National Grid does a fair amount of steam trap surveys – this is a good "in" with customers – but could aggressively promote more steam system retrofits at the same time or directly after a steam trap survey. The EERE and ITP case studies show that there are often inexpensive savings available from process steam retrofits.[1]

Baseline Technology and Efficient Technology Descriptions

Typical existing steam system

Metric/Characteristic	Value	Source
Energy Savings	20%	Savings range 15-30% from multiple sources. Use 20%.
Market Size	249 customers	Number of RI Industrial customers
Cost ($/MMBtu)	$9.00	From AEAA presentation. Consistent with DOE case studies
Estimated Total Opportunity (MMBtu)	361,000	Estimate 50% applicability

[1] See: http://www1.eere.energy.gov/manufacturing/tech_deployment/steam.html

Demand Control Ventilation for Kitchen Exhaust Hoods

Identification of Gap or Opportunity

Exhaust hoods in commercial kitchens are sized to the peak cooking usage of each appliance under the hood, and have a simple on or off control strategy. The exhaust is usually left at 100% during the operating hours of the facility.

How This Approach or Measure Fills the Gap or Captures Opportunity

This measure uses VFDs on the exhaust and make up air fans that vary the ventilation rates based on the actual use of the kitchen equipment. Further reductions in ventilation rates may be possible through retrofitting kitchen hoods with partial end panels. These retrofits enable a significant reduction in make-up air requirements, along with the associated energy requirements involved in heating the make-up air.

Target Market

Commercial kitchens

Relationship with Existing Programs

Cooking-based demand control ventilation may be included in the existing Custom Express Program, but the rate of uptake is unknown. Given the potentially large opportunity represented by this measure, it is included here as a potentially new measure.

Type of Opportunity

This measure could potentially be offered either custom or prescriptively. It is offered prescriptively in a few places such as Illinois and Canada.[2],[3]

Baseline Technology and Efficient Technology Descriptions

The baseline condition is a commercial kitchen with constant volume ventilation.

Metric/Characteristic	Value	Source
Savings	26%	Case studies in Ontario and California
Market Size (cfm)	10,121,912	Estimate based on total US cfm used for kitchen ventilation, and % of US population in RI
Cost ($/MMBtu)	$26.38	Average of case studies
Estimated Total Opportunity (MMBtu)	512,000	Calculated

[2] https://www.comed.com/Documents/business-savings/SIFYB_PY5_HVAC.pdf
[3] https://www.enbridgegas.com/businesses/assets/docs/Vertical_FixedCommercialIncentives.pdf

Commercial Laundry Initiative – Ozone Systems and High Efficiency Equipment

Identification of Gap or Opportunity

Commercial laundries use large amounts of hot water that is typically heated with natural gas. To date, very little has been done in Rhode Island to address savings potential in this market segment.

How This Approach or Measure Fills the Gap or Captures Opportunity

There are several efficient technology opportunities within commercial laundries that reduce the consumption of natural gas, propane, or other fuels. A targeted, integrated approach to addressing these opportunities could realize cost-effective savings.

Target Market

- Facilities with on-site laundry such as colleges and universities, hospitals, nursing homes, hotels, and prisons have opportunities for savings from a retrofit or new construction ozone system. Ozone systems have been proven to kill bacteria and viruses without the use of hot water, which is of particular interest to these customers for health reasons.
- All commercial laundry facilities and laundromats with daily water usage greater than 2,000 gallons are good candidates for high efficiency (HE) clothes washers and boilers or water heaters. Examples of customers may also include health clubs, schools, and restaurants.

Relationship with Existing Programs

While these technologies could be eligible for custom incentives through the existing custom C&I track, there is no comprehensive approach or outreach to customers with commercial laundry facilities, nor any program staff with specific knowledge regarding this opportunity. A focused effort to educate customers about the benefits and savings of ozone and high efficiency equipment would be necessary to transform the laundry market. A Commercial Laundry Initiative should cover Large C&I retrofit customers (hospitals, prisons, universities), new construction opportunities (and time of replacement), and Small DI customers (laundromats).

Type of Opportunity

A commercial laundry initiative would ideally have some prescriptive measures, such as high efficiency washers for small Laundromats, and some custom measures, such as for ozone laundry at large C&I retrofit customers.

Baseline Technology and Efficient Technology Descriptions

The baseline technology for this may include standard washers using hot water.

Efficient technology opportunities in commercial laundries include the following:

- Ozone laundry – uses ozone generated on-site to clean and disinfect laundry items, reducing the need for hot water. Sensors detect excess ozone in the ambient air and shut the system down to prevent a health hazard. Using ozone can reduce the use of hot water by more than 80%, reduce the overall volume of water used, and save electricity due to shorter wash cycles. The electrical use of the ozone generator is typically more than offset by electricity saved by reduced cycle times.
- High Efficiency (HE) single-load clothes washers (laundromats, restaurants, schools, etc)
- HE Boilers and boiler controls

Ozone Laundry

Metric/Characteristic	Value	Source
Unit of Measure	100 pounds of laundry	
Savings per unit (MMBtu/unit)	Ozone systems can save: 1.37 kWh per 100 lbs. laundry 138 gallons of water per 100 lbs. laundry .13 MMBtu of fuel per 100 lbs. laundry	WI Focus on Energy M&V report – Hampton Inn Ozone
Market Size (units)	1,483,500 units (100 lb units of laundry) 148, 350,000 estimated total annual pounds in RI	See spreadsheet for data
Cost ($/unit of measure)	$3.40 per 100 lb of laundry ($11,540 project cost) $2.38 per 100 lb of laundry ($15,843 project cost) $22.30/MMBtu	WI Focus PG&E PG&E sample
Estimated Total Opportunity (MMBtu)	192,000 MMBtu	See spreadsheet for calculations

High Efficiency Equipment

Metric/Characteristic	Value	Source
Unit of Measure	HE Clothes Washers	
Savings per unit (MMBtu/unit)	6-10 MMBtu per clothes washer per year	NYSERDA Deemed Savings Database v12
Market Size(units)	Assume 400 customers with 5 machines each = 2000	
Cost ($/unit of measure)	$300-600 per clothes washer $56 per MMBtu	NYSERDA Deemed Savings Database v12
Estimated Total Opportunity (MMBtu)	12,000 – 20,000 MMBtu	

Comments

Tunnel washers were also evaluated for inclusion in this proposed initiative. However, tunnel washers are suitable for a narrow range of customers and are very expensive. Ozone laundry is more widely applicable and beats a tunnel washer in such areas as water and energy savings.

Boiler Retrofits

Identification of Gap or Opportunity

Many existing boilers run inefficiently, due to lack of proper scheduling, temperature setpoints, and fuel-to-air ratios.

How This Approach or Measure Fills the Gap or Captures Opportunity

There are many potential retrofits that can cost-effectively improve the performance of an existing boiler without having to buy a completely new unit.

Target Market

Customers from all sectors with existing, inefficient boilers that are not ready for replacement.

Relationship with Existing Programs

National Grid does already do some of these measures, such as O2 trim and programmable thermostats. However, the interviews performed as part of this report indicated that there are still substantial opportunities for the proper control of existing boilers (such as with programmable thermostats, proper scheduling, and the controls mentioned below), and that even many new condensing boilers are not set up to take advantage of their condensing capability.

Type of Opportunity

For larger boilers, this would most likely be a custom opportunity, as each boiler can benefit from different retrofits. However, some of the measures applicable to smaller boilers could likely be done as a prescriptive or direct install measure.

Baseline Technology and Efficient Technology Descriptions

Low and high-pressure boilers of any size used for any application from space heat to process hot water. Typical boilers in a commercial application are low-pressure units in the 10 MMBtu size class and are used for space and hot water heating. Industrial boilers are usually much larger, in the 30 to 300 MMBtu size range and can be either low or high-pressure, depending on the application.

Efficient technology opportunities include the following:

- Steam boiler retrofits, such as condensing economizers, Ultramizers, blow-down heat recovery, and feedwater heat recovery. Cannon Boiler Works, for example, claims it can retrofit most existing firetube boilers to achieve 90% efficiency.
- Other retrofit add-ons like stack dampers, and oxygen trim controls.

- Multiple modular boilers as a replacement for one or two large boilers (in conjunction with a staging controller such as iWorx). This reduces jacket-losses and losses associated with short cycling.

Metric/Characteristic	Value	Source
Savings per MMBtuh of boiler capacity	Stack Economizer – 105 MMBtu Oxygen Trim Control – 82 MMBtu Blow-down Heat Recovery – 112 MMBtu Ultramizer (Large C&I only) – 300-1,000 MMBtu Vent Damper – 140 MMBtu	NYSERDA Deemed Savings Database v12; Cannon boilerworks; DOE
Market Size (units)		
Cost ($/MMBtu)	Stack economizer - $14 Oxygen Trim Control – $122 Blow-down Heat Recovery - $49 Ultramizer (Large C&I only) Vent Damper - $18	NYSERDA Deemed Savings Database v12; Cannon boilerworks; DOE
Estimated Total Opportunity (MMBtu)	Stack economizer – 107,120 Oxygen Trim Control – 111,002 Blow-down Heat Recovery – 114,168 Ultramizer (Large C&I only) – 510,094 Vent Damper – 351,245	

Comments

These measures assume that a new HE boiler is not being installed. If a new HE boiler is installed, stack dampers and oxygen trim controls should already be included in the installed unit. Blow-down heat recovery and Ultramizers or other condensers will improve even the efficiency of even new, high-pressure boilers, albeit in a smaller increment than existing high-pressure boilers. Further, this characterization is focused on the market for large hot water and steam boilers, as this market is less addressed than that for residential and small commercial boilers. However, significant savings opportunities for these retrofits (scheduling, programmable thermostats, outdoor reset, etc) still exists.

To the extent that other opportunities in this report are also pursued, savings from boiler retrofits could be reduced. For example, DCV for kitchen exhaust would lower the heat load of the building, reducing the savings from a more efficient system. This would also be true of laundry savings opportunities, multifamily retrofits, etc.,

Multifamily Heating and Envelope Retrofits

Identification of Gap or Opportunity

Many multi-family systems have old, inefficient heating systems, as well as old, leaky envelopes. Further, heating in multi-family buildings is centrally controlled, leading to rampant overheating. In fact, it is common for tenants to keep their windows open all through the winter, or even run their air conditioners, due to excessive space heat outside of their control.

How This Approach or Measure Fills the Gap or Captures Opportunity

Comprehensive retrofits that include individual radiator controls, combined with envelope and window upgrades, have the potential for very large savings in multi-family buildings.

Target Market

Multi-family buildings

Relationship with Existing Programs

Multi-family buildings are a relatively unaddressed segment of the market, and therefore represent a significant savings opportunity.

Type of Opportunity

Since this is a comprehensive project affecting multiple building systems, it best fits into a custom approach, or ideally an initiative targeting large multi-family buildings. For best results, National Grid should provide technical assistance and support begin early in the design phase.

Baseline Technology and Efficient Technology Descriptions

The baseline is a typical existing multi-family building.

Metric/Characteristic	Value	Source
Savings	14 MMBtu per multi-family unit	Assume 25% savings – average reduction from NYSERDA's MF program
Market Size	77,119 multi-family units in buildings with >5 units	Rhode Island Housing: http://www.rhodeislandhousing.org/filelibrary/Ch5_MarketAnalysis_FINAL.pdf
Cost ($/MMBtu)	$123	NYSERDA MF program experience. Assumes 40% of reported spending goes to gas upgrades
Estimated Total Opportunity (MMBtu)	571,528	Assumes 50% applicability

Comments

Actual evaluated data from NYSERDA's multi-family program shows an average 25% reduction of total fuel use, proving that this result is readily achievable for utility programs. Other multi-family retrofits have gone deeper – a recent retrofit at a Brown dormitory involving individual radiator controls and window sealing has achieved ~60% savings, a result replicated by other deep energy retrofits across the country, including one in Boston that achieved a 73% reduction in energy use.

Also, the high cost data should be taken with a grain of salt. It is very hard to get reliable cost data on comprehensive retrofits, as the project cost is highly variable, and not typically separated from either the electric measures or the non-efficiency measures that are part of a renovation.

Integrating Multiple Systems

Identification of Gap or Opportunity

Designers, engineers, and utility efficiency programs often look at widgets and systems in isolation. However, the deepest energy savings can come by taking a holistic approach to a new construction or retrofit project.

How This Approach or Measure Fills the Gap or Captures Opportunity

This could mean, for example, providing steep discounts on envelope upgrades when a furnace or boiler needs to be replaced, performing deep energy retrofits on residential or commercial boilers, or using waste heat to generate electricity or run a gas-fired heat pump.

Target Market

All sectors

Relationship with Existing Programs

Current rebate programs cover all end uses. However, program design could be modified to encourage customers to take a holistic, whole-building approach in their efficiency projects.

Type of Opportunity

Since this is such a broad opportunity, it is difficult to classify as prescriptive or custom. Comprehensive projects fall more naturally under a custom approach; however, there may be ways to encourage integration through prescriptive rebates. For example, the program could encourage envelope upgrades and indirect water heaters whenever someone gets a rebate for a boiler, or could send low-flow showerheads along with the prescriptive rebates.

Baseline Technology and Efficient Technology Descriptions

This is a very broad opportunity, and can be taken to mean many different things. For the estimated savings below, we assume that this is opportunity is defined as deep energy retrofits on residential and commercial buildings. The cost data assumes that the retrofit is being done as part of a renovation, and so is incremental to the cost of the standard renovation.

Metric/Characteristic	Value	Source
Energy Savings per building	Res: 40 MMBtu Comm: 196 MMBtu	NEEA Study: Examples of Deep Energy Savings in Existing Buildings
Market Size	11,002 buildings	RI Residential and commercial buildings with gas heat, assume buildings renovated every 20 years
Cost	Comm: $40/MMbtu Res: $149/MMBtu	http://www.peci.org/sites/default/files/aerg-office.pdf
Estimated Total Opportunity (MMBtu)	428,937	Assumes 70% applicability, retrofits happen during planned renovations

Comments

This measure covers too wide a range of possible projects to quantify all possible combinations. The table above assumes deep energy retrofits on residential and commercial gas heated buildings in RI, saving an average of 43% on fuel costs; There are also opportunities that may not go quite as far as a deep energy retrofit, such as encouraging envelope upgrades at the same time a new furnace or boiler is installed or encouraging gas fired heat pumps in facilities with a lot of unused waste heat.

Thermostatic Radiator Valves

Identification of Gap or Opportunity

Steam heating system savings will be maximized through a full conversion to hot water heat. However, there are cases where this is too costly or otherwise infeasible. These steam heating systems will often have problems such as uneven heating of the building and, in many cases, the steam pressure is set higher than necessary, causing unnecessary leakage and thus extra water and heat loss.

How This Approach or Measure Fills the Gap or Captures Opportunity

Thermostatic radiator valves (TRVs) allow heat to flow to individual radiators only when the room temperature is below an adjustable setpoint. TRVs are most effective with two-pipe systems, so that the valve on one radiator does not turn off the hot water to all other radiators. However, TRVs are also available for one-pipe system, where they replace the air valve, and do not let air out of the radiator unless the room temperature is below the setpoint. Temperature sensors for TRVs should not be placed directly next to the radiator, so they can pick up an accurate reading of the room temperature. TRVs are also applicable to parallel hydronic systems, though this characterization focuses on steam heating systems.

Many steam heating systems operate at higher pressure than necessary. This creates extra steam leakage which wastes both heat and water. Further, TRVs in one-pipe systems may not be effective if the steam pressure is too high, as the steam will force its way into the radiator despite the closed air valve. Steam pressure should be kept at the range of 1-2 psi.

Target Market

Commercial and residential buildings with steam heat

Relationship with Existing Programs

Not currently promoted by National Grid.

Type of Opportunity

This opportunity would work well as a direct install measure for buildings with steam heat. DI contractors would likely need additional training on TRV installation, and could check pressure setting on steam boilers to ensure that it is not set higher than necessary.

Baseline Technology and Efficient Technology Descriptions

A steam heat system without TRVs

Metric/Characteristic	Value	Source
Energy Savings	3-20%	http://www.edf.org/sites/default/files/10073_EDF_BottomBarrel_Ch5.pdf
Market Size		
Cost	$120-$200 per valve	See above. Installation cost assumed equal to measure cost.
Estimated Total Opportunity (MMBtu)		

Steam heat to hot water heat conversion

Identification of Gap or Opportunity

Rhode Island has many residential and commercial buildings using steam heat, especially multi-family and mixed use buildings in Providence. Steam heat is far less efficient than baseboard hot water, due to higher operating temperatures, increased leakage, increased venting losses, and difficulty to use controls such as zoning and outdoor reset.

How This Approach or Measure Fills the Gap or Captures Opportunity

A survey of steam-to-heat conversions in New York State showed an average of 40.5% heating savings. However, these projects can be quite complex. In general, these projects are cost-effective if the steam heating system either converts to hot water in the boiler room for distribution, or has a two pipe distribution system. Older steam systems with a one pipe distribution system are far more expensive to convert, but the high savings may still make it economic.

Target Market

Residential customers using steam space heating systems (likely largely multi-family)

Relationship with Existing Programs

National Grid does not currently do steam conversions. National Grid would ideally provide comprehensive guidance during the conversion, and promote concurrent envelope upgrades for further savings and to enable downsizing of the new hot water boiler. Note that although the payback is fairly high for conversions, the effective measure life is extremely long, as the hot water system will never be converted back to steam.

Type of Opportunity

Since the cost and complexity of the project depends heavily on the configuration of the existing distribution system, and since it is a fairly involved project, this falls best under a custom approach.

Baseline Technology and Efficient Technology Descriptions

The costs below assume that the existing condition is a two-pipe steam distribution system. Costs will be higher if there is a one pipe distribution system, and lower if the distribution system is already hydronic, and only the boiler needs replacement. However, the project should not be ruled out in one-pipe systems, as savings are high enough that it could still be cost-effective.

Metric/Characteristic	Value	Source
Energy Savings	40.5%	NYSERDA experience in NYS
Market Size (Multi-Family Apartment Units)	51,535	Estimated number of MF units in buildings with more than 5 units and steam heat without a one-pipe distribution
Cost ($/MMBtu)	$94	Calculated from NYSERDA survey
Estimated Total Opportunity (MMBtu)	903,325	Calculated

Comments

Savings estimate above is based only on the multi-family sector. Additional savings will be possible from single family and commercial steam heat conversions.

Dragon Fire Grill Heat Recovery

Identification of Gap or Opportunity

In most commercial kitchens, the waste heat from the grill is vented through the exhaust hood, where it escapes to the atmosphere unused.

How This Approach or Measure Fills the Gap or Captures Opportunity

The Dragon Fire Thermo Recovery Filter captures up to 60% of the heat lost in the exhaust stream and uses it to the heat hot water or make-up air. The dragon fire is largely a drop-in replacement for the conventional grease filter in a commercial kitchen, making installation easy.

Target Market

Commercial kitchens

Relationship with Existing Programs

No rebates currently exist for the dragon fire thermo recovery product.

Type of Opportunity

This is a very new product to the market, with very limited data available on costs and savings. The savings and cost data are adopted from the manufacturer literature and would ideally be confirmed by third-party testing before National Grid makes an aggressive push to bring this product to the market. As such, the product is probably not a candidate for immediate promotion by National Grid. However, it is a very promising idea, and so National Grid should keep a close eye on this product and any testing done by the Gas Technology Institute, FSTC, or other gas utilities. If testing and pilot installations confirm the savings and cost claims, this could be a very good prescriptive offering.

Baseline Technology and Efficient Technology Descriptions

The baseline condition is no heat recovery on the cooking line of a commercial kitchen

Metric/Characteristic	Value	Source
Unit of Measure	Commercial kitchen	
Savings per unit	288 MMBtu	Calculated from Dragon Fire literature
Market Size (units)	1,734 commercial kitchens	Estimates of kitchens in Rhode Island (restaurants, universities, and prisons)
Cost ($/MMbtu)	$72	Assume 2-year payback
Estimated Total Opportunity (MMBtu)	249,263	Assume 50% applicability

Demand Control Ventilation

Identification of Gap or Opportunity

Ventilation systems are sized for full design occupancy, even when the space may be well below full occupancy during most of the building operation. If more air than necessary is exhausted, both electric and fuel energy are wasted, as the ventilation fans run faster than necessary, and the excess make-up air has to be heated and cooled.

How This Approach or Measure Fills the Gap or Captures Opportunity

Demand control ventilation (DCV) uses CO sensors to sense how much outside air is necessary in a space, and adjusts ventilation rates accordingly. This in turn reduces the amount of make-up air that needs to be heated. DCV is appropriate for spaces with highly variable occupancy, such as classrooms, conference rooms, auditoriums, and parking garages.

Target Market

Commercial Spaces with high density but variable occupancy, such as schools, gyms, religious worship spaces, and public assembly.

Relationship with Existing Programs

Demand control ventilation is not currently offered on the gas side. However, it is promoted on the electric side. If gas savings are not claimed for electric DCV projects, there could be an opportunity to fund the projects partially out of the gas budget and claim the gas savings.

Type of Opportunity

Although costs may vary depending on the existing HVAC system, this could potentially be offered prescriptively. This is done, for example, in Oregon, Illinois, and New York[4][5][6].

[4] http://www.eweb.org/public/documents/energy/HVACcombined2.pdf
[5] https://www.comed.com/Documents/business-savings/SIFYB_PY5_HVAC.pdf
[6] http://www.nationalfuelforthought.com/commercial-large.html

Baseline Technology and Efficient Technology Descriptions

The baseline is a ventilation system with constant volume ventilation outside air.

Metric/Characteristic	Value	Source
Savings per unit	59 MMBtu per1,000 sf	Michigan deemed savings database
Market Size	4,312 buildings	Estimated number of schools, public assembly buildings, and places of worship in RI
Cost ($/MMBtu)	$7.60	NYSERDA deemed savings database
Estimated Total Opportunity (MMBtu)	933,600	Assumes a 25% applicability rate

Comments

This technology is already code for new construction (ASHRAE 90.1 2007, section 6.4.3.9) in spaces larger than 500 sf and with a design occupancy of greater than 40 people per 1,000 sf. However, there are likely significant cost-effective retrofits available, as well as spaces that do not meet the above criteria but could still benefit from DCV.

Turbopot

Identification of Gap or Opportunity

Traditional cooking pots have a flat bottom, thus minimal surface area to aid heat transfer.

How This Approach or Measure Fills the Gap or Captures Opportunity

Turbopots increase the surface area on the underside of the pot using a series of fins, which in turn increases the heat transfer to the contents of the pot and reduces cooking times.

Target Market

Commercial Kitchens

Relationship with Existing Programs

Turbopots are not currently rebated.

Type of Opportunity

Turbopots are well suited for a prescriptive rebate in the commercial kitchen market, alongside efficient cooking equipment such as fryers and ovens.

Baseline Technology and Efficient Technology Descriptions

The baseline is a traditional flat-bottomed pot.

Metric/Characteristic	Value	Source
Unit of Measure	Individual Turbo Pot	
Energy Savings (MMBtu)	6.7	Savings Value used by CA in 2010
Market Size (kitchens)	1,734	Estimate of kitchens in Rhode Island (restaurants, universities, and prisons)
Cost ($/MMBtu)	$29.85	CA experience
Estimated Total Opportunity (MMBtu)	46,471	Calculated; assumes 4 pots per kitchen

Warm Asphalt Mix

Identification of Gap or Opportunity

Conventional asphalt mix must be heated to and maintained at 300 degrees F or more, which requires substantial fossil fuels.

How This Approach or Measure Fills the Gap or Captures Opportunity

By adding certain additives to the asphalt mix, asphalt makers can reduce the temperatures by 50-100 degrees, while maintaining the same properties as conventional asphalt. Other benefits of warm asphalt mix include slower cooling, easier compaction, lower transportation costs, reduced worker exposure to fumes and emissions, and an extended paving season.

Target Market

There are at least two large asphalt manufacturers in Rhode Island, with potential for very large savings at each.

Relationship with Existing Programs

National Grid does not currently promote warm asphalt mix in Rhode Island.

Type of Opportunity

This measure would fall under the current C&I custom program. However, the savings are large enough from these types of projects that they may be worth specifically pursuing.

Comments

Due to the variable amount of asphalt made in each manufacturer, and the low availability of this data, we do not attempt to quantify the potential MMBtu savings from warm asphalt mix. According to the DOT, fuel is reduced by 20% on average across all technologies.[7]

Department of Transportation Approval can be a significant barrier to the adoption of warm asphalt mix (WMA). However, momentum towards WMA mix is picking up, and 40 state DOTs currently have specifications allowing WMA on federal-aid or federal lands projects. Further, one warm asphalt project has been completed in Rhode Island.[8]

[7] http://www.fhwa.dot.gov/everydaycounts/technology/asphalt/intro.cfm
[8] http://www.ri.gov/DOT/press/view.php?id=13870

Liquid Pool Cover

Identification of Gap or Opportunity
Heated water in swimming pools often shows a high rate of heat loss, especially if they are left uncovered when not in use.

How This Approach or Measure Fills the Gap or Captures Opportunity
Liquid pool covers are a chemical that forms a thin film on top of the pool water, greatly reducing evaporation and therefore heat loss from heated pools. To use correctly, one ounce per 400 square feet of pool surface area must be added every day.

Target Market
Residential and commercial swimming pools

Relationship with Existing Programs
No rebates currently exist for gas swimming pool technology.

Type of Opportunity
Solid or liquid pool covers are good candidates for a prescriptive offering.

Baseline Technology and Efficient Technology Descriptions
The baseline case is an uncovered pool

Metric/Characteristic	Value	Source
Energy Savings	106 MMBtu per short course pool	http://www.etcc-ca.com/images/stories/heatsavr_expr_workout_club_report_r2_4-12-10.pdf
Market Size (units)		
Cost ($/MMBtu)	$11	Calculated
Estimated Total Opportunity (MMBtu)		

Comments

The liquid pool cover saves 13% on heating costs compared to an uncovered pool. However, a traditional solid plastic pool covers is more effective at preventing evaporation than a liquid cover. A liquid pool cover can still supplement solid covers by preventing evaporation during periods of light pool usage and around the edges of pools with a solid cover. However this technology should not be promoted at the expense of solid covers.

Gas-fired Heat Pumps

Identification of Gap or Opportunity

Traditional combustion technology has a hard theoretical limit. On the electric side, by contrast, heat pumps can achieve coefficients of performance well in excess of 1.0, representing “efficiencies” of greater than 100%. Furthermore, the potential for CHP and waste heat recovery is often limited by the demand for natural gas, especially during the winter.

How This Approach or Measure Fills the Gap or Captures Opportunity

Gas-fired heat pumps can currently achieve heating efficiencies of around 140% by moving heat from the outside instead of directly heating the space. Further, they can provide cooling during the summer, thus providing a steady potential source of demand of recovered waste heat, or heat generated by CHP.

Target Market

Gas-driven absorption heat pumps are currently available in 5 tons or larger for the residential and commercial markets. This technology is a good replacement for a gas-fire boiler or furnace – it does not have to replace an electric heat pump.

Relationship with Existing Programs

There is no current program serving this market. Gas-fired heat pumps get efficiencies of 120%-140%, so could provide significant savings even after the federal baseline for boilers and furnaces changes to 90 AFUE.

Type of Opportunity

As this is a fairly new technology, it likely makes sense to pilot a few installations in the short-term to get a better sense of the costs and savings. However, in the medium-term, gas-fired heat pumps can be handled prescriptively, much like how furnaces and boilers are currently handled.

Baseline Technology and Efficient Technology Descriptions

The baseline technology is any gas fired furnace or boiler system greater than 60,000Btu/hr. Efficient technology opportunities currently exist in commercial and large residential space heating applications. Expect COP ratings of 1.2 or greater. While the generation absorber heat exchanger (GAX) technology is still being refined, there will be growing opportunities in cooling applications in the near future, with cooling COP around 0.7.

Metric/Characteristic	Value	Source
Energy Savings	31%	From federal baseline of 90 AFUE to 130 AFUE
Market Size	Potentially most space heating	
Cost ($/MMBtu)	$181	Goodman Catalogue
Estimated Total Opportunity (MMBtu)	1,477,487	Assume 25% applicability

Condensing Rooftop Units

Identification of Gap or Opportunity

Commercial space heating is a significant portion of nationwide gas usage, and packaged rooftop units make up around 25% of commercial space heating. However, with the exception of demand control ventilation and better thermostats, gas efficiency in RTUs has not been increasing, with typical seasonal efficiencies between 78% and 83%.

How This Approach or Measure Fills the Gap or Captures Opportunity

Recently there have been a few RTUs coming to market with condensing capabilities. This allows heating efficiencies to reach well above 90%.

Target Market

Commercial facilities that use rooftop units, or roughly 25% of commercial buildings.

Relationship with Existing Programs

No programs currently exist that promote this technology.

Type of Opportunity

Since this is an emerging opportunity, and most available units need to be custom ordered, this makes most sense as a custom measure. Further, National Grid would most likely want to pilot a few installations to get a better sense of the costs and savings before actively promoting to the broad market place. However, if there is significant interest and uptake, it could potentially be moved into the prescriptive program in the medium-term.

Baseline Technology and Efficient Technology Descriptions

Baseline is a rooftop unit with gas heat at 78-80% efficiency

Metric/Characteristic	Value	Source
Savings	18 MMbtu per rooftop unit, or 15% savings	MA TRM for condensing furnace
Market Size	1,850,037 MMBtu	25% of commercial space heating from RTUs: http://www.cee1.org/cee/mtg/06-10mtg/files/GasPACs_Anziano.pdf
Cost ($/MMBtu)		
Estimated Total Opportunity (MMBtu)	13,092	Assume market driven only, 15 year measure life and 7o0% applicability

Comments

This technology is not widely available in the marketplace, and so not ready for a large rebate program. Further, the addition of a secondary heat exchanger to allow the RTUs to condense increases the electrical energy of the fan, and so this technology will have to be evaluated in Rhode Island to make sure that it sees sufficient net energy savings. However, this could still be a large opportunity in a market that has not seen any significant improvement in efficiency for decades, and that utilities know how to address through their successful efforts promoting electrical efficiency in Rooftop Units. National Grid should keep an eye on the RTU market, and consider a pilot program as condensing units come online.

DOE Steam Super Boiler

Identification of Gap or Opportunity

DOE, GTI, and CleaverBrooks have partnered to create a super boiler, with fuel-to-steam efficiencies of 94-95%

How This Approach or Measure Fills the Gap or Captures Opportunity

It is typically harder to get high efficiencies out of steam boilers, and there is not much available on the market significantly higher than code requirements of 75-80% thermal efficiency. However, DOE, GTI, and Cleaver Brooks have recently brought to the market a steam super boiler with efficiencies of up to 95%, making the efficiency competitive with that of condensing hot water boilers.

Target Market

Industrial facilities or large commercial facilities with steam heat. Steam demand should be between 3,600 and 29,000 lb/h of 100 to 150 psig saturated steam, and there should be an annual capacity factor of at least 50%.

Relationship with Existing Programs

Steam super boilers are not currently promoted in Rhode Island; however, National Grid did do a demonstration project in New York. Due to the emerging nature of this technology, National Grid would likely want to investigate the results of the demo project in New York. National Grid would also likely want to find one or two manufacturers in need of boiler replacement, and work closely with the customer during the design and installation, in order to get more information on costs and savings for future projects, and to familiarize the market with this technology.

Type of Opportunity

Since this is a new technology, it would best start off under the custom program. However, if there is significant customer interest and uptake, it could potentially be moved into the prescriptive program in the medium term.

Baseline Technology and Efficient Technology Descriptions

Standard steam boiler with a thermal efficiency of 75-80%.

Metric/Characteristic	Value	Source
Energy Savings	13%	Super Boiler field test
Market Size	70% of RI Industrial use; 5% of commercial use	Estimated
Cost ($/MMBtu)	$4.39	Calculated from MIT Study
Estimated Total Opportunity (MMBtu)	17,023	Assumes 5% of steam boilers are replaced per year

Comments

The steam super boiler is a market driven measure, and likely not cost-effective as a retrofit. However, there are several cost-effective retrofits for steam boilers - such as feedwater economizers, condensing economizers, and ultramizers - that have the potential to bring efficiencies of existing steam boilers up to 90%. These retrofits are described in greater detail in the “Boiler Retrofit” section.

Advanced Burners

Identification of Gap or Opportunity

Burners are often a large heat consumer in industrial processes.

How This Approach or Measure Fills the Gap or Captures Opportunity

There are several new technologies for industrial burners that have the potential for large energy savings. Regenerative burners, for example, are a pair of burners which cycle on and off. When one of the burners is on, the other is absorbing heat from the exhaust gas, thereby creating less waste heat overall.

Target Market

Industrial process

Relationship with Existing Programs

Advance burner projects have highly variable savings and costs depending on the application, and so would naturally fall under the C&I custom program.

Type of Opportunity

Since this is an emerging opportunity for large industrial customers, it would be offered as part of the custom program.

Baseline Technology and Efficient Technology Descriptions

The baseline case is a single burner with no pre-heat of the incoming air

Metric/Characteristic	Value	Source
Unit of Measure	Regenerative Burner	
Savings per unit	12-50%	http://www.flox.com/documents/07_AFRC.pdf
Market Size (units)		
Cost ($/unit of measure)		
Estimated Total Opportunity (MMBtu)		

Comments

Since the implementation details for this measure are highly site specific, it requires a custom analysis in order to get a good estimate of costs and savings. Therefore, this report does not attempt to quantify the total opportunity. Further, it is unknown how many industrial burners there are in Rhode Island. However, since each burner project would give a very significant amount of savings, it may be worthwhile pursuing these projects in industrial consumers, even if only a small number are implemented.

Residential Zoning Controls

Identification of Gap or Opportunity

Typically a single family consists of one single HVAC zone, with one single thermostat. The temperature in the area immediately surrounding the thermostat will control the heating to the entire house, regardless of temperature variations between floors or rooms.

How This Approach or Measure Fills the Gap or Captures Opportunity

Creating multiple zones in a single-family house will allow each zone to be controlled by a separate thermostat, increasing occupant comfort and possibly producing energy savings. More importantly from a savings perspective, each zone can have its own occupancy schedule so that unoccupied are not heated to the same temperature as occupied rooms.

Some modeling studies have shown over 20% savings from residential zone control. However, these savings are highly dependent on aggressive use of occupancy schedules, and the overall body of literature has mixed results on the amount of savings from residential zoning, with some studies even showing an increase in energy use.

Target Market

Single family residential homes.

Relationship with Existing Programs

Not currently promoted by National Grid.

Type of Opportunity

This is best implemented as part of a new construction/renovation project in order to facilitate proper installation of the necessary duct work and dampers. However, given the mixed results of savings, and that other measures can get deeper savings during new construction, we do recommend actively promoting this measure.

Baseline Technology and Efficient Technology Descriptions

A single zone HVAC system

Metric/Characteristic	Value	Source
Energy Savings	7 MMBtu per home	Berkeley study
Market Size	197,556 homes	Res and LI gas heat accounts in RI
Cost ($/MMBtu)	$164	Calculated
Estimated Total Opportunity (MMBtu)	58,142	Assume 80% applicability, .05% res load growth, and average renovations once every 20 years

Automatic Steam Trap Monitoring Systems

Identification of Gap or Opportunity

Steam traps allow the discharge of condensate and non-condensable gases, without letting any of the steam escape. However, steam traps often fail, allowing useful steam to escape with the condensate. Depending on the O&M practices of the facilities, it can be a long time before the failed steam trap is noticed.

How This Approach or Measure Fills the Gap or Captures Opportunity

Automatic steam trap monitoring system is an automated system that can identify a failing steam trap as it is becomes ineffective and notifies a web-based system instantly. This allows a facility manager to proactively replace steam traps as they fail, thus minimizing the amount of useful heat lost through failed steam traps.

Target Market

Industrial

Relationship with Existing Programs

National Grid already does a lot of steam trap replacements as part of its industrial program. An automatic steam trap system could potentially be installed at the same time as a facility wide steam trap survey in order to ensure the persistence of the savings from the steam trap replacements.

Type of Opportunity

This could likely work as either a prescriptive or a custom measure. However, to make it work prescriptively, some metric (such as number of traps monitored) would have to be developed to properly scale the rebate size with the size of the facility.

Baseline Technology and Efficient Technology Descriptions

The baseline is a standard steam trap, with no notifications upon failure.

Comments

We did not estimate savings for this measure, because automatic steam trap notifications may not increase annual savings over a typical steam trap survey and replacement. Once the initial steam trap survey is completed, future audits are significantly cheaper, and so periodic surveys are likely a more cost-effective method of ensuring functioning steam traps than an automatic monitoring system. We therefore do not recommend that National Grid aggressively promote this measure.

Program Opportunity Summaries

In addition to new technologies, the interviews uncovered opportunities for increased savings through changes to existing programs or new programs. The way in which customers interact with the efficiency programs and what measures are offered can have a substantial impact on the amount of savings realized. How efficiency opportunities are offered is as important as what is offered. This section outlines some proposed changes and enhancements to existing programs.

- Moving some measures upstream instead of offering them prescriptively downstream is a way to reach more customers, both new and repeat, in a timely manner.
- Launching an initiative to focus on an underserved market segment is a way to engage new customers in a comprehensive, focused way.
- Offering more options as part of an existing Direct Install (DI) program can yield more savings from existing customers.

We note that there are interactive effects between what measures are offered and the means by which they are offered. For example the savings opportunity estimated as part of the Large Multifamily Building Initiative below should not be added to the Steam Heat to Hot Water Heat Conversion or the Multifamily heating and envelope retrofit measures discussed earlier or there would be the risk of double-counting. Rather, the measures mentioned above should be part of the initiative, and the initiative would be part of the Large C&I Retrofit program or of a stand-alone multifamily program.

Upstream Programs for Heating and Kitchen Equipment

Identification of Gap or Opportunity

Energy Efficiency programs have found that in many cases, running programs for equipment “upstream” captures more savings then running the program “downstream.” Upstream programs are typically designed to work with manufacturers and distributors. Midstream programs work with retailers and contractors to incentivize these vendors directly. Some programs include both mid and upstream participants. This approach minimizes the number of people directly involved in the program and provides an incentive for the vendors to stock and promote efficient equipment. It also better supports purchase of high efficiency equipment in the event of existing equipment failure, because the vendor is better positioned to promote efficiency at the time of sale than the utility, especially if they have efficient equipment in stock. We developed this opportunity by combining recommendations specifically referring to upstream programs

with others related to promoting commercial kitchen equipment, engaging kitchen equipment vendors, and improving rebate processing.

Running programs downstream requires more paperwork, a slower process, and misses time of sale opportunities. A 2006 KEMA study of the commercial HVAC equipment market in New England[9] found that the Cool Choice program, a downstream model used regionally in New England and New York, provided rebates for only 4.5% of the air conditioning equipment sold in 2005. About 20% of the equipment sold qualified for rebates. This illustrates two key points:

- downstream programs, even well-established regional ones like Cool Choice, have a limited impact because they do not reach many customers or do not reach them at the right time
- downstream programs have limited ability to persuade vendors to stock and promote more efficient equipment.

Efficiency programs have seen substantial increases in participation and savings by moving programs upstream. A paper written for the ACEEE 2010 Summer Study by NEEP, Efficiency Vermont and NYSERDA presents results comparing downstream and upstream programs for commercial HVAC equipment run simultaneously.[10] Data from this paper shown in the table below illustrates that the savings from the upstream program were ten to twenty-two times higher for the upstream program than for downstream. The upstream savings are over and above the normal downstream savings, so the upstream program was not cannibalizing the downstream program. All equipment was tracked using serial numbers to eliminate double counting.

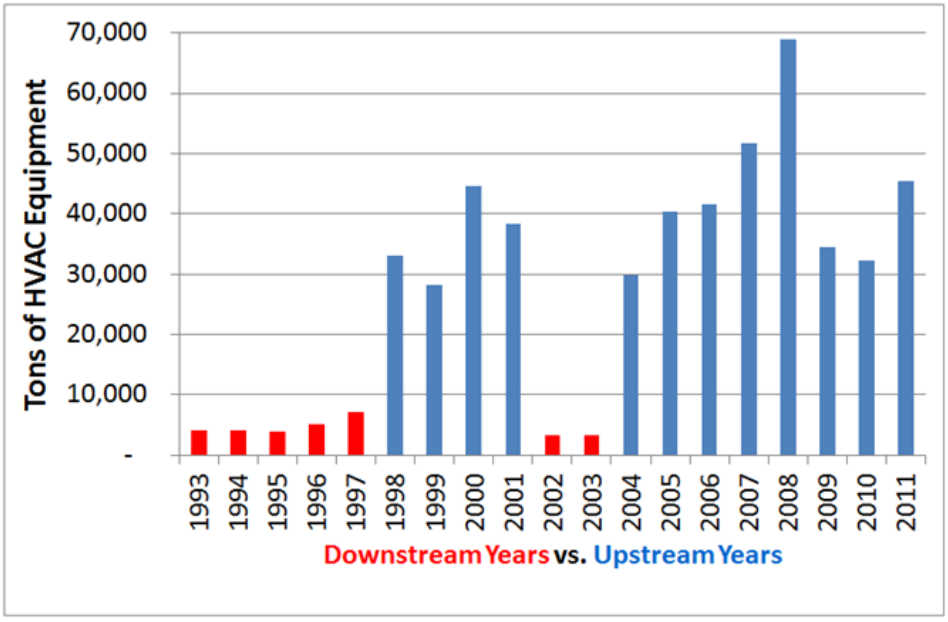
Efficiency Vermont Packaged HVAC Program Savings (MWh/year)

Year	End-User Program	Upstream Program
2008	18.5	195
2009	27.7	611

Pacific Gas & Electric (PG&E) in California has alternated between upstream and downstream programs for HVAC equipment. The results in the table below clearly show that the upstream years capture many times more equipment participation, as measured by the total cooling capacity of the equipment sold in tons (one ton of cooling equals 12,000 BTUs per hour).

[9] KEMA, Packaged HVAC Equipment Market Characterization Final Report, June 30, 2006 www.cee1.org/eval/db_pdf/539.pdf

[10] ACEEE, Swimming Upstream: Commercial HVAC Efficiency and Industry Allies www.aceee.org/proceedings-paper/ss10/panel06/paper26



Data courtesy of PG&E, graph created by Energy Solutions

How This Approach or Measure Fills the Gap or Captures Opportunity

Running programs upstream can realize the following benefits:

- saving increase by about a factor of ten over downstream programs
- reduced paperwork for the program administrator and for the customer
- reduced program costs due to reduced rebate processing time
- recruits the vendors to promote more efficiency
- provides vendors with motivation to stock qualifying efficient equipment
- takes advantage of existing relationships and market structures
- reaches customers who would otherwise be missed. For example: restaurant chains, which represent approximately half of all restaurants, typically work directly with the manufacturers for equipment purchases. An upstream program would have a better chance of capturing activity from these customers.

Target Market

Commercial and Industrial markets are the primary focuses. An upstream program that included residential heating equipment could also be effective.

Relationship with Existing Programs

National Grid already offers lighting equipment through upstream programs, so there is a precedent for this kind of program delivery in Rhode Island.

Potential market sectors that could benefit from an upstream approach include:

- Commercial kitchen equipment (gas and electric savings). This would include, but may not be limited to, equipment currently offered prescriptively on the RI Gas Commercial Kitchen Equipment form. Additional equipment could include demand controlled ventilation for ventilation hoods.
- Commercial (and residential) space and water heating equipment (gas savings). This would include the equipment currently offered prescriptively on the RI Natural high Efficiency Commercial Gas Equipment form.

Opportunity Characterization

Heating equipment: 2011 savings for commercial heating equipment with currently offered prescriptive rebates were approximately 1,381 MMBtu. Assuming that upstream programs increase savings by a factor of ten, the opportunity for increased annual savings in 2013 and 2014 is estimated to be 12,400 MMBtu (i.e., nine times the current savings).

Kitchen Equipment: 2011 savings for commercial kitchen equipment with prescriptive rebates were 10,323 MMBtu. Assuming that an upstream program would increase savings by a factor of ten, the opportunity for increased annual savings is estimated to be 92,900 MMBtu for future program years.

Large Multifamily Building Initiative or Program

Identification of Gap or Opportunity

While small multifamily buildings (with two to four units) can currently take advantage of the residential gas programs, larger buildings have not been a focus due to program budget constraints and the complex nature of large multifamily projects. We developed this opportunity by combining recommendations specifically referring to the multifamily building market with others related to steam heating and comprehensive approaches to savings in commercial buildings.

In addition, multifamily projects are currently handled by the residential group a National Grid whereas larger buildings may be better handled by the Commercial and Industrial Group. Residential program managers may not have the technical or business knowledge to adequately work with larger multifamily buildings, and splitting this sector by size may result in inconsistent program delivery.

How This Approach or Measure Fills the Gap or Captures Opportunity

Multifamily buildings were identified by multiple interviewees as an untapped market with a lot of opportunity. It is also believed that many of the larger multifamily buildings are heated with steam, which also represents a good opportunity for savings. An increased focus on multifamily buildings would capture more gas savings.

In order to provide seamless delivery to multifamily buildings of any size, many efficiency programs have established a dedicated multifamily program, like the separate Low Income Program, to deal with multifamily customers.

Target Market

Multifamily buildings with five or more units for the initiative, all multifamily for a dedicated program

Relationship with Existing Programs

Large multifamily buildings have typically represented a challenge for efficiency programs because of the dichotomy between the residential nature of the building and the commercial scale of energy usage. Large multifamily buildings do not nicely fit into normal commercial or residential programs. In addition, tenants and building owners often have different priorities, which can represent a significant barrier to making energy efficiency improvements. This barrier is often called the split incentive problem, in that tenants do not want to pay for capital improvements to a rental property they do not own, and landlords do not see any savings from efficiency projects because they do not

pay the utility bills. Dedicated multifamily programs are best suited to deal with these issues and challenges.

Opportunity Characterization

To estimate the gas savings opportunity in Rhode Island for large multifamily buildings, we look at two metrics: the estimated number of multifamily buildings in Rhode Island with five or more units, and the estimated savings per building. Using RI Housing data, we estimate that there are about 5,600 buildings of five or more units. MidAmerican Energy in Iowa has a good comprehensive multifamily program and publishes savings data by measure for non-residential multifamily projects. By estimating the number of buildings served, it is possible to calculate the average annual savings in MMBtu per building, which is 88 MMBtu. Multiplying these numbers yields an estimated 493,000 MMBtu in potential opportunity in this market sector.

Several of the technology opportunities discussed earlier in this report would be applicable in multifamily buildings. Therefore, there may be overlap between the potential expressed for this program strategy and that for particular technologies presented earlier.

Additional Direct Install Measures

Identification of Gap or Opportunity

The current Small Business Direct Install (DI) program is very successful with electric measures but is limited with respect to gas measures. Currently, gas measures are not mentioned as an option on the PowerOfAction website or in the small business promotional mailer. The six gas measures offered now through the DI program include pipe insulation, pre-rinse spray valves, steam traps, programmable thermostats, low flow faucet aerators and low flow shower heads. Gas measures that are not currently included in DI must be handled through the custom measure process.

For example, when a shell insulation opportunity is identified as part of the Small Business DI program, it must be processed as a custom project. This puts the project on a separate track, slows down the process, and presents more barriers to the customer. Making shell insulation a prescriptive measure will simplify the process and result in more projects.

Inclusion of other measures in the DI program such as boiler reset controls, hot water heaters, heat recovery ventilators, air sealing, and drain water heat recovery would provide more opportunities for savings without the complications resulting from going through the custom process.

How This Approach or Measure Fills the Gap or Captures Opportunity

Gas measures are currently limited to six measures. Steam traps have historically been the largest source of savings. Including more prescriptive measures, such as shell insulation, through the DI program would result in more savings. National Grid completed over 44,000 square feet of insulation projects in 2010, much less in 2011. Adding insulation as a measure to the Small DI program could increase the amount of insulation projects to previous levels or greater.

Target Market

Small Commercial DI customers

Relationship with Existing Programs

This represents an expansion of the measures available through the Small Business DI program.

Opportunity Characterization

Once National Grid has engaged a customer through the Direct Install program and has made the effort to persuade them to do a project, doing more measures to increase

savings comes at a lower incremental cost because the sales work has already been done. Characterizing the opportunity is difficult because of the diverse nature of small businesses and the range of suggested measures. Not all measures make sense for every customer, but adding insulation is likely a common additional measure.

Increasing the insulation in an attic space of a commercial building from an R value of 5 to 36 saves 0.033 MMBtu/square foot. The DI program worked with 1,670 customers in 2011. If 5 percent of those customers installed insulation, the 84 buildings treated at an average of 1,500 square feet (sf) per building would total of 125,000 sf. Estimated savings would be about 4,150 MMBtu at a cost $196 per MMBtu.

Adding more measures would increase the opportunity for savings even more, and some of the other measures are more cost-effective then insulation. .

Education Opportunity Summaries

Efficiency investments can be complicated because they often involve new technologies, controls, building science, process changes, human behavior, and changes to established knowledge and habits. Simply put, the two ways to change behaviors are through mandate or persuasion. Codes and standards are an example of a mandate, while education and incentives are means of persuasion.

While educational efforts are not easy to quantify with respect to direct energy savings, they are critical to transforming the market. Education is also cumulative so it should be thought of as an ongoing, continuous process. National Grid currently sponsors or offers a number of trainings such as Building Operator Certification and Compressed Air Challenge, but there is room for more. The suggestions below provide specific example of trainings requested or suggested by the people interviewed for this report.

Program Expeditor Trainings to Improve the Integration of Gas and Electric Programs

Identification of Gap or Opportunity

In the C&I programs, Program Expeditors (PEXs) theoretically identify both gas and electric efficiency opportunities during site visits. However, in practice, PEXs generally focus on electric programs, especially lighting. Program Expeditors should be trained to evaluate all gas efficiency opportunities when visiting customers. Program Expeditors should focus more gas measures, including insulation, and interactive gas and electric energy savings.

How This Approach or Measure Fills the Gap or Captures Opportunity

Natural gas efficiency opportunities are missed because they are not recognized by PEXs during site visits. Training PEXs to recognize more opportunities in the natural gas sector will address this issue and result in more gas efficiency measures being installed.

Target Market

Program Expeditors would be the direct targets of the trainings, but all C&I natural gas customers would ultimately benefit from this training and education initiative.

Relationship with Existing Programs

According to National Grid's website, PEXs currently offer the following:

- Lighting Upgrades
- HVAC efficiency improvements
- Energy Management Systems

- Variable Speed Drives
- Motor upgrades

Comments

Some training is currently offered to educate PEXs on gas measures. For example, RISE is doing some training to bring PEXs up to speed on gas efficiency opportunities. However, there is opportunity for National Grid to promote more PEXs trainings focused exclusively on natural gas opportunities.

Workforce Development, Trainings, and Certifications

Identification of Gap or Opportunity

Training and educational opportunities are essential to help develop a healthy building efficiency industry and create jobs in Rhode Island. There are still numerous opportunities for National Grid to participate in workforce development. More Certified Energy Managers (CEMs) are needed in the state, for example. When people take the time and invest the effort to learn new skills, they are motivated to capitalize on those skill and to promote themselves and their services. If the skills they learn are energy management and efficiency expertise, then they will help to promote efficiency projects in order to benefit themselves. This will also benefit National Grid and the efficiency market as a whole. The process of raising the level of knowledge about efficiency on a statewide level is known as market transformation.

How This Approach or Measure Fills the Gap or Captures Opportunity

Many engineers and architects need continuing education credits, in all subjects, to maintain their certification. Trainings and "lunch and learn" events, where credit is offered, are an opportunity for people to earn necessary credits. This is an excellent opportunity for National Grid to increase the level of knowledge in the marketplace. National Grid should regularly host, sponsor, and facilitate efficiency focused events on various topics for targeted groups. Some of these events could also provide certifications such as Building Operator Certification (BOC), Certified Energy Manager (CEM), and Building Commissioning (Cx) and RetroComissioning (RCx). There are enormous opportunities in the state for RCx, but trainings are needed to develop the workforce to do the work.

Increasing the knowledge base through training will also help to create jobs in Rhode Island. National Grid can help Rhode Island residents to achieve certifications through discounted tuition at trainings. If people from other states also want to attend the training, they can help subsidize Rhode Islanders by paying full cost.

Possible training subjects could include:

- Lighting - ncqlp.org/
- Commercial Kitchens - www.fishnick.com/
- Compressed Air - www.compressedairchallenge.org/
- Steam Systems, Process Heating, Motor Systems, and Fan Systems - www1.eere.energy.gov/manufacturing/tech_deployment/training.html
- Pump Systems - www.pumpsystemsmatter.org/
- Building Science - www.bpi.org/ http://www.aeecenter.org/

- Certified Energy Manager - www.aeecenter.org/i4a/pages/index.cfm?pageid=3351

Other program examples of training:

- WI Focus on Energy - www.focusonenergy.com/Business/Education-and-Training/
- Efficiency Maine - www.efficiencymaine.com/professional-training
- Efficiency Vermont - www.efficiencyvermont.com/for_our_partners/design_engineer_partners/lighting_exam.aspx
- NYSERDA - www.nyserda.ny.gov/Energy-Education-and-Workforce-Development.aspx

Target Market

The certification trainings would be targeted at CEMs, architects, designers, contractors, and engineers, but all customers in need of technical assistance would ultimately benefit. Efficiency programs have found success targeting specific types of customers with custom trainings. For example, a training about efficiency opportunities in custom kitchens should be of interest to the design community, equipment vendors, and the RI Hospitality Association.

Relationship with Existing Programs

National Grid offers some Building Operator (BOC) training, but there is the opportunity to do much more, and on a wide variety of subjects.

Residential Contractor and Plumber Trainings

Identification of Gap or Opportunity

Plumbers and HVAC contractors could be the ambassadors for efficiency. They should be comfortable with recommending efficiency improvements and be able to promise rebates. Interviewees have identified a need for additional trainings of plumbers and HVAC contractors, especially as it relates to residential furnace and boiler trainings. Residential plumbers need training to be better ambassadors and help National Grid manage the paperwork and the project process.

How This Approach or Measure Fills the Gap or Captures Opportunity

Customers may not currently implement efficiency measures because plumbers or contractors do not recommend them to their customers. Plumbers and HVAC contractors that are more aware and comfortable with the efficiency programs and the process will be better able to identify and market efficiency opportunities to their customers. Key components of the training would involve managing the process and documentation required by the program.

Target Market

Direct targets for trainings would be plumbers and HVAC contractors, but ultimate beneficiary would include all residential customers that may qualify for a boiler, furnace, or hot water system replacement.

Relationship with Existing Programs

RISE does work with vendors to provide training, including some classes on how to complete required paperwork. National Grid should provide or sponsor additional trainings open to all participating plumbers and HVAC contractors.

Programmable Thermostat Education for End-Users

Identification of Gap or Opportunity

Many programmable thermostats are not programmed properly to maximize savings and to ensure comfort. Most programmable thermostats units typically have two types of hold features: (a) hold/permanent/vacation; (b) temporary. Putting the thermostat on permanent hold or using it improperly reduces or cancels any energy savings that the thermostat may offer.

How This Approach or Measure Fills the Gap or Captures Opportunity

National Grid needs to educate end users on programmable thermostats to ensure that thermostats are used properly and that energy savings are maximized. There is currently insufficient education of residential end-users on thermostat installation and use.

Target Market

Residential end-users.

Relationship with Existing Programs

The existing information on the National Grid and GasNetworks websites do not provide easy-to-find educational materials on the use of programmable thermostats and essentially provide links and instructions on how to receive an incentive. Educational material on thermostat use needs to be more readily available. A bill insert may be one effective way to get to the end users.

Quality Installation of Heating Equipment Trainings

Identification of Gap or Opportunity

Many heating equipment installations are not done properly or to the best possible extent. Examples of poorly done installations include poor piping, improper sizing of boilers, poorly or incorrectly installed controls, heat recovery systems improperly installed, steam traps not maintained, economizers not working, absence of blowdown for boilers, absence of anode rod replacement on water heaters, heat recovery systems often disconnected or improperly installed, and poor maintenance practices in general.

More training for contractors and designers is necessary to remedy this quality installation issue, as well as code trainings for installers to ensure that installation meet code requirements.

How This Approach or Measure Fills the Gap or Captures Opportunity

Designers, contractors, and installers are more likely to install efficiency measures properly if they have followed trainings on quality installations. National Grid could address this quality installation issue through specific training, audits, and/or a Commissioning agent. National Grid could provide training or sponsor vendors/contractors to offer or participate in trainings.

Training needs were identified for the following topics:

- Proper installation, controls, and sequencing of heating equipment
- Specifying and installing condensing technology equipment so it condenses and is piped correctly
- Tankless water heater installed properly and end-users educated by installers on need to flush out every year to eliminate scale

Target Market

The trainings' targets would be designers, contractors, and installers, but the ultimate beneficiary would be all residential and C&I customers installing efficient heating and hot water technologies.

Relationship with Existing Programs

The 0% interest Heat Loan requires documentation of heat load calculations, which helps contractors learn proper sizing. Trainings could be modeled on this approach. National Grid is planning on using results from code compliance studies to identify initiatives to overcome barriers to code compliance. The trainings suggested here would be a step in the direction of code compliance, regardless of the results of the code compliance studies

Appendices

A – Questionnaire
B – List of Interviewees
C – Initial Screening Criteria

Appendix A – Questionnaire

Gas Opportunity Study Survey Questionnaire

Version 4-12-12

Section A: Background Questions

The purpose of this section is to gather background information on the person being interviewed to see if there are patterns in the responses regarding opportunities, based on who is answering the questions.

1. Who is being interviewed?
   a. Vendor ☐
   b. Distributor/Supplier ☐
   c. Contractor/Architect/Engineer
   d. Consultant/Industry Expert ☐
   e. Auditor/Rater ☐
   f. Insulation contractor ☐
   g. Trade association ☐
   h. Gas customer ☐
   i. Manufacturer representative ☐
   j. Other _____

2. What type of customers are they associated with? If more than one, then estimate the percentage of work in each area.
   a. Residential ☐
   b. Commercial ☐
   c. Industrial ☐
   d. Municipality ☐
   e. Multifamily ☐
   f. Institutional ☐

3. What kinds of gas equipment do they work with, and/or what kind of services offered? Write down all services and equipment mentioned, estimate volume by percentage.

Section B: Opportunity Questions

The purpose of this section is to learn what and where the subject thinks there are opportunities for increases savings, either through a technology, a service, or through the elimination of barriers Start by asking interviewee if they have knowledge of Grid's current program. If not, provide a quick overview of program features and delivery models of 1) new construction; 2) existing buildings; and, 3) products programs. For questions below, interviewer will refer back to the equipment and services they offer above to provide prompts.

1. Where do you see opportunities for new construction and major renovation gas efficiency measures? This includes potential design improvements and/or super-efficient equipment that may not be cost-effective as a retrofit.
2. Sometimes existing equipment works, but is not as efficient as newer equipment that is available on the market. Where do you see opportunities to retire this equipment before it the end of its life and replace it with more efficient equipment (early retirement retrofit)?
3. What new equipment or technologies represent the greatest opportunity for deep savings at a single site? (What are the big hitters). This includes any whole-system or whole-building approach for existing buildings.
4. Sometimes equipment saves a little energy, but there are a lot of opportunities which add up in aggregate. What do you think is the most underutilized currently available technology or opportunity? (What are the small but plentiful hitters)
5. What market segments or customer types represent the best opportunities? (Examples: restaurants, institutions, residences, factories, hotels, etc.)
6. Are there significant opportunities that could be captured by increasing code? If so, what technologies and sectors should code be raised for?
7. Do you see a lot of opportunities due to inefficient or improper use of existing equipment? (i.e. condensing boilers with too high return water temperatures)?
8. Are there any cutting-edge emerging opportunities with very low market acceptance? If so, what is the best way to accelerate adoption?

Are there opportunities for equipment that use propane or fuel oil that are substantially different from your answers for gas equipment?

Section C: Barrier Questions

Sometimes there are circumstances that are obstacles for people in doing an energy efficiency project or in purchasing efficient equipment. The purpose of this section is to find out what are real and perceived barriers to efficiency, and what could be solutions for overcoming or removing them.

1. What barriers do you see that make it difficult for people to take action and do gas efficiency projects? (Possible prompts: higher cost of equipment, lack of capital, lack of

knowledge/information, lack of choice or availability, reliability or performance concerns, no new construction projects, others?)
2. What are the biggest two or three barriers that you see?
3. How much impact does the cost of gas have in preventing people from doing efficiency projects?
4. If a large impact, at what price do you think efficiency will start to look attractive again?
5. How do the National Grid Programs help in overcoming barriers? (Possible prompts: financing, incentives, information, training, technical assistance, sales assistance in persuading decision makers to act, other)
6. What do you think could or should be done to remove barriers? And who should do them?

Section D: Equipment and Contractor Availability

The purpose of this section is to determine if efficient options are available and being promoted in the marketplace. Sometimes efficient equipment is not promoted because it is more expensive, is perceived negatively for some reason, or is simply not available locally.

1. To what extent are efficient equipment options available from distributors in the region?
2. To what extent are efficient equipment options available from vendors in the region?
3. To what extent are vendors promoting efficient equipment to customers?
4. To what extent does low bid typically win, which may prevent more efficient options from being offered?
5. How frequently are customers asking for efficient equipment? Are there specific customer sectors that tend to specify efficient equipment more than others?
6. Are engineers/architects specifying efficient equipment? If so, what?
7. What technologies or opportunities do your customers most often ask about? Are you able to help them?

Section E: Training and Labor Questions

The purpose of this section is to see if a lack of awareness or information is a barrier to more efficiency projects.

1. Would more training or education in your area about efficient gas products, services, or programs be helpful?
    a. If so, who should the training or education effort target? (possible prompt: vendors, installers, architects/engineers, or end use customers)
    b. If end use customers , then who? (prompts: restaurants, hotels, residential customers, manufacturers, etc)
2. Ask where the emphasis should be (who).What subjects should be emphasized?
    a. Insulation and air sealing?
    b. Kitchen equipment

c. Industrial process equipment
d. Residential furnaces and boilers
e. Commercial furnaces and boilers
f. Commercial ventilation
g. Water heating (inc. pool and spa heaters and solar hot water)
h. Other

3. Are there any other obstacles preventing an educated workforce that would identify and install efficiency measures?

Section F: Codes and Standards

The purpose of this section is to see how codes and standards can drive efficiency.

1. Do you think there an opportunity with respect to codes and standards?
2. If so, where do you think codes or standards could be changed? (possible prompts: appliances, equipment, building codes (insulation, windows, air sealing, residential, commercial), code enforcement)

Section G: Final Opportunity Question

Do you have any additional thoughts about opportunities now that we have gone through the all of the questions?

Appendix B – Organizational affiliations of interviewees

Disclaimer: The opinions expressed by the interviewees and used to develop the information and data in this report do not necessarily represent those of their employers.

National Grid
RISE
GEM Plumbing
Restivo's Heating and Air Conditioning
ACEEE
Food Service Technology Center
Gas Technology Institute (GTI)
Southern California Gas
Enbridge Gas
Energy Solutions Center
Frank Rounds Company
Hudson Technologies
Columbia Gas
Walsh Architects
Brown University

Appendix C – Initial Selection Criteria

Column Heading	Definition	Associated values	Reason for inclusion
Technology/ Strategy overview	Short description of the technology, program design, or educational opportunity that could offer additional energy savings.	Text	Description of the market that will be impacted
Technology/ Strategy details	Expanded description of the technology, program design, or educational opportunity that could offer additional savings. This field includes a short descirption of where savings would be coming from, as needed.	Text	
Type of opportunity (retrofit, TOS, conversion, etc.)	Whether the opportunity exists for retrofits, time of sale, new construction, commissioning, conversions, etc.	retrofits, time of sale, new construction, commissioning, conversions, all of the above, other (name)	
Market segment	What market segment does the opportunity apply to?	Residential, commercial, industrial, C&I, C&I- [name of specific C&I market]	
End use type	End uses that the opportunity will impact most. HVAC end uses include opportunities directly related to the heating system, whereas Shell end uses include opportunities indirectly relate to the heating system.	HVAC, Hot water, Cooking, Process steam, Shell, Whole building, other	
Scale of opportunity at the sector level	Estimation of the potential savings associated with each opportunity, relative to the market segment that this opportunity applies to.	High, medium, low	High level assesment of whether the opportunity is applicable, and savings are likely to be measurable and repeatable
Widespread market availability	Is the technology widely available in Rhode Island? If not, it does not disqualify the opportunity, but rather indicates that there will be additional challenges to overcome.	Yes/ no	
Widespread acceptance of the technology or program design by the customer	Is the opportunity likely to be readily accepted by the customers (vs. likely to encounter a strong opposition)? If not, it does not disqualify the opportunity but indicates that there will be additional challenges to overcome, or educational opportunities.	Yes/ no	
Applicability to RI	Is the technology applicable to Rhode Island's climate and industries? If not, this disqualifies the opportunity.	Yes/ no	
Offered by National Grid as a Pilot (Technology tab) Suggestions for an existing program implementation improvement (Program strategy and education tab)	Technology tab: Is the technology opportunity already included in a National Grid pilot in Rhode Island? If not, this does not disqualify the opportunity, and a more detailed analysis of the scale of the opportunity and potential for expanding the pilot will be helpful. Program strategy and education tab: Is the opportunity a suggestion for a program design improvement? If not, it does not disqualify the opportunity.	Yes/ no	

New Technology (Technology tab) New program design not currently offered by National Grid (Program strategy and education tab)	Technology tab: Is this a new technology that is not currently promoted through National Grid's current programs? If not and the technology is already offered as part of regular programs, this opportunity is disqualified. Program strategy and education tab: Is the the suggestion relative to a program design already offered by National Grid? If not and the program design is already offered as part of regular programs, this opportunity is disqualified.	Yes/ no	
Relative cost (Technology and Program design tabs)	What is the relative cost of the efficent measure compared to the baseline it is replacing. The relative cost of the opportunity provides a high level assesment of the level of interest this opportunity is likley to generate from the customer and National Grid's points of view.	High, medium, low	
Savings can be verified	Will this opportunity result in energy savings that can be calculated and verified? If not, this disqualifies the opportunity.	Yes/ no	
Qualified workforce is available	Is a qualified workforce currently available in Rhode Island to support this opportunity. If not, it does not disqualify the opportunity but indicates that there will be additional challenges to overcome.	Yes/ no	
Feasible in next 5 years	Can this opportunity be implemented in the next 5 years. If not, this disqualifies the opportunity.	Yes/ no	
Highlighted by inteviewee as big opportunity	Did an interviewee flag this opportunity as a large opportunity or did multiple interviewees mention this opportunity?	Yes, no, highlighted by many	
Currently offered by utility EE program in other state (name utility in notes)	Is the opportunity offered through energy efficiency programs in other jurisdictions? If so, it is an indication that the opportunity's savings may screen.	Yes/ no	
Notes	Clarifying notes for any of the criteria selection, including justifications for selecting "No" for any of the criteria, as needed.	Text	Selection of opportunities informed by prior criteria, and justification of the exclusion of any opportunity
Meets selection criteria	In light of the selection criteria above, is the opportunity likely to be a good candidate for a more detailed analysis of the potential savings in Rhode Island?	Yes, no, maybe	
Reasoning for selection/ rejection	Justification of why any of the measures were not selected.	Text	