Appendix E: Non-Energy Impacts

SECTION 1:

CLOTHES WASHERS - INDUSTRIAL

Continuous batch washers (also called "tunnel washers") utilize a method of constant volume washing to achieve water and natural gas savings. A continuous batch washer is comprised of a long chamber made up of several compartments, or "pockets", through which a large central auger slowly turns to move the laundry from one pocket to another [TW1][1]. When laundry first enters a continuous batch washer, it is soaked and treated with detergent and chemicals in the first few pockets. As the auger advances the laundry to subsequent pockets, it is agitated and rinsed with cleaner water. Water moves in a counter flow direction to the laundry so that the cleanest water is used for the final rinse pocket at the end of the washing chamber, and the most heavily used water soaks the dirtiest laundry at the beginning of the washing chamber. A continuous batch washer is most efficient when every laundry pocket is full because water and energy usage is not variable.

The mechanism for natural gas energy savings for clothes washer measures is a function of the reduction in water usage per pound of fabric cleaned. This reduction translates to a lower volume of water that must be heated, thereby reducing the heating load. This measure also directly impacts the volume of water purchased and related sewer charges. In addition, a lower volume of water reduces the need for detergent. Impacts on maintenance and production are also considered.

1.1 METHODS OF SAVINGS (OR INCREASE)

- Natural gas savings (MMBtu): Reduction in hot water per pound of laundry reduces the heating load
- Electricity Savings: Requires less energy than similarly sized washer extractors; reduction in the dryer load due to more effective water removal at the end of the wash cycle
- Water savings: Less water required per pound of laundry (1.8 gal/lb laundry [TW1], 0.7-1.0 gal/lb laundry [TW2])
- Waste water: About 50% of the water used in clothes washing goes to the drain and the balance gets evaporated. If sewer usage is separately metered, the sewer savings will be 50% of the water usage. If not separately metered, the savings will differ by municipal agency. In New York City, for example, unmetered wet laundry sewer discharge is assumed to be 80% of water usage. We have used 50% in these calculations based on site assessment results.
- Detergent: The lower water volume requires approximately 20% less detergent [TW3]
- O&M impact: There is no quantifiable difference in the continuous batch washer maintenance requirement; because continuous batch washers are more complicated than stand alone washers or washer extractors, technicians require some electrical/computer experience [TW3]
- Production: Continuous batch washers have a higher throughput per hour with less required labor because laundry is automatically moved from the washer to the dryer [TW3]; 3,120 lb/hr – 5,200 lb/hr for 130 lb chamber [TW2]
- Footprint: Reduced production area required by washer

[1] Within this appendix annotation such as "TW1" in this section and later "L1," "CB1," etc., are similar to chapter-level endnotes and provide links to a correspondingly annotated references listed within the section for each technology.

1.2 TABLE OF RESULTS

Table 1.2-1 Continuous Batch Washer NEI Summary

Non-Energy Savings	Per lb Laundry	Per MMBtu Saved
Water Reduction (gallons)	1.5000	1252.81
Detergent Reduction (lbs)	0.0020	1.670
Labor Reduction (hrs)	0.0006	0.464
Footprint Reduction (sq ft)	0.0001	0.101

1.3 RESEARCH AND REFERENCE SOURCES

[TW1] "Commercial Laundry Facilities Introduction", http://www.allianceforwaterefficiency.org/commercial_laundry.aspx, 2009.

[TW2] "SmoothFlow Automated Batch Tunnel Washing System", GA Braun, Inc., www.gabraun.com, 2006.

[TW3] Chase, Jay. Lead Sales Representative for Jensen USA, Tunnel Washer Division. (source has over 20 years of experience in the industry)

[TW4] "Dazzle" Commercial Strength Powdered All Fabric Laundry Detergent, Coastwide Laboratories, Albany Branch.

[TW5] "PBMP – Commercial Laundry Facilities", James Riesenberger, Koeller and Company, 4 November 2005.

[TW6]"Other Water Intensive Processes", US Department of Energy Federal Energy Management Program, http://femptraining.labworks.org/mod/resource/view.php?id=70.

1.4 CASE STUDY

Continuous batch washers reduce energy and water usage at high volume laundry facilities. Because water and energy use does not vary according to the amount of laundry, the efficiency of continuous batch washers is only realized if there is a constant flow of clothes being washed. Introducing continuous batch washers to a facility with a large volume of laundry will result in reduced natural gas and water use. Washer extractors are the most common baseline systems at large volume laundry facilities.

ERS evaluated Site SEC C7234, a high volume contract laundry service, after installing two continuous batch washers (referred to as the "Laundry Company"). The three main sources of non energy benefits experienced by the Laundry Company are reduced water consumption, reduced labor costs, and reduced footprint in the industrial space. A summary of natural gas, electricity, and non energy savings can be found in Table 1.6-1. The savings values are calculated for a single continuous batch washer.

Table 1.4-1: Laundry Company Summary of Savings

Project ID	Natural Gas Savings (therms/lb laundry)	Energy Savings (kWh/lb laundry)	Demand Savings (kW/yr)	Water Savings (gal/lb laundry)	Labor Savings (hrs/lb laundry)	Footprint Savings (sq ft/lb laundry)
SEC7234	0.0054	0.0207	55.9	1.5	0.0010	0.0001

Water savings is a result of the continuous batch washer's counter-flow design. Because water is reused during a typical washing cycle, less clean water is required. The Laundry Company saved an average of approximately 22,831,000 gallons of water annually by installing one continuous batch washer. Production also increased due to the automated transfer from washer to dryer. Employees were no longer required to move clean wet laundry from the washer to the dryer, making the process faster and less expensive. Additionally, installing a continuous batch washer saves space in a facility due to its small footprint. The Laundry Company saved 800 square feet of production area by replacing washer extractors with one continuous batch washer.

1.5 GENERALIZING TYPICAL RESULTS

Non-energy savings were ultimately normalized to per vendor estimated or reported MMBtu saved in the results table of the main report.

The impact evaluation quantified NEIs on three continuous batch washer projects. The results of these three studies were utilized as described in Table 1.5-1 as a basis for typical results and were used to calculate expected normalized NEIs per actual natural gas MMBtu saved. The evaluation determined that the tunnel washers saved about 45% of the original vendor estimated or reported energy savings. Thus, non-energy impacts also were multiplied by that 45% factor so that the NEI can be expressed as savings normalized per MMBtu of reported natural gas savings.

Table 1.5-1: Generalized Typical Results Development

Generalized Case			**Basis**
Average baseline water use	2.5	gal/lb laundry	Average of three site surveys
Average post installation water use	1.00	gal/lb laundry	Average of three site surveys
Average water reduction	1.50	gal/lb laundry	Average of three site surveys
Average water reduction	0.7	gal/lb laundry	[TW1]
Average water reduction	1.6	gal/lb laundry	[TW2]
Average thermal savings	**0.0054**	therms/lb laundry	Average of three site
Electricity Impact			
Average kWh reduction	0.04	kWh/lb laundry	site survey SEC7234
Average kWh reduction	7.21	kWh/therm	site survey SEC7235
Water Impact			
Average water reduction/therm	277.78	gallons/therm	calculation
Average amount of water to drain	50%	percent	per study
Average sewer reduction	138.89	gallons/therm	calculation
Detergent Impact			
Average detergent use/lb	0.01	lbs dtrgnt/lb laundry	[TW4]
Average detergent savings	20%	percent	[TW3]
Average detergent savings	0.002	lbs dtrgnt/lb laundry	calculation
Production Impact			
Labor Savings	6900	labor hrs/year	site survey SEC7234
Labor Savings	0.0006	labor hrs/lb laundry	site survey SEC7234
Production Area Impact			
Footprint Savings	0.0001	sq ft/lb laundry	site survey SEC7234

SECTION 2:

CLOTHES WASHERS – COMMERCIAL BATCH

The commercial batch clothes washers typically used in hotels and hospitals are referred to as washer-extractors. Washer-extractors are single load clothes washers with very large capacities [WE1]. Washer-extractors are vertical-axis font loading clothes washers that can be likened to large versions of front-loading residential washers. Typical washer-extractors require 3 to 4 gallons of water per pound of laundry [WE1]. However, the most efficient washer-extractors have water recycling capabilities that allow them to store the rinse water from the previous load to supply as wash water in the subsequent load. These units use less than 2.5 gallons per pound of laundry, leading to savings in heating energy, water, and water discharge costs [WE1].

2.1 METHODS OF SAVINGS (OR INCREASE)

- Natural gas savings (MMBtu): Reduction in hot water required by clothes washer leads to lower DHW heating load
- Water savings: Reduction in water drawn by clothes washer leads to lower city water consumption
- Waste water: A lower quantity of water purchased correlates proportionally with lower water discharge costs
- Detergent: Use of a high-efficiency washer allows for the use of high efficiency detergent, though it is more expensive and no significant monetary savings are realized

2.2 TABLE OF RESULTS

Table 2.4-1: Washer-Extractor with Water Recycling NEI Summary

Non-Energy Savings	Per lb Laundry	Per MMBtu Saved	
Water Reduction (gallons)	1.00	1474.81	
	55	F city water temperature	[General 1]
	120	F DHW temperature	[General 3]
Baseline water use	3.5	gal/lb laundry	[WE1]
Water use w/ recycling	2.5	gal/lb laundry	[WE1]
Water reduction	1	gal/lb laundry	calculation
	80%	boiler water heating eff%	[General 2]

2.3 RESEARCH AND REFERENCE SOURCES

[WE1] "Commercial Laundry Facilities Introduction", http://www.allianceforwaterefficiency.org/commercial_laundry.aspx, 2009.

[WE2] "Clothes Washers Key Product Criteria," ENERGY STAR, http://www.energystar.gov/index.cfm?c=clotheswash.pr_crit_clothes_washers

[General 1] Typical New York state city water temperature

http://www.gfxtechnology.com/WaterTemp.pdf

[General 2] US Dept of Energy; standard efficiency commercial natural gas fired boiler thermal efficiency http://www1.eere.energy.gov/femp/procurement/eep_boilers.html

[General 3] Maytag Commercial Laundry hot water temperature recommendation

http://maytagcommerciallaundry.com/content.jsp?pageName=Maintenance-Washers-Advice3

2.4 CASE STUDY

None available.

2.5 GENERALIZING TYPICAL RESULTS

Secondary research provided industry typical reductions for water usage per pound of laundry cleaned. Additional sources were found for typical values for city water temperature, hot water temperature and hot water heating efficiency. It was assumed that a commercial natural gas-fired boiler would provide hot water heating for a laundry.

SECTION 3:

CLOTHES WASHERS – LAUNDROMAT

The commercial clothes washers typically used in Laundromats are very similar to residential clothes washers. Though they may vary in capacity, commercial coin-operated clothes washers are single load washers with no water recycling capabilities. Clothes washers can either be horizontal-axis top loading, or vertical-axis font loading. High efficiency clothes washers can reduce water usage in a Laundromat by more than 35% [L1]. The energy and non-energy savings of coin-operated clothes washers are equivalent to the savings that result from installing ENERGY STAR® rated washers. ENERGY STAR-rated clothes washers require less water per cubic foot per cycle than standard models; this leads to savings in heating energy, water, and water discharge costs. For example, an ENERGY STAR-rated washer consumes 7.5 gallons per cycle per cubic foot, whereas the federal standard consumes 9.5 gallons per cycle per cubic foot [L2]. Common area laundromat washers complete an average of six loads per day, thus the energy and non-energy savings is significant when high efficiency clothes washers are installed for commercial use in Laundromats [L1].

3.1 METHODS OF SAVINGS (OR INCREASE)

- Natural gas savings (MMBtu): reduction in hot water required by clothes washer leads to lower DHW heating load.
- Water savings: reduction in water drawn by clothes washer leads to lower city water consumption.
- Waste water: a lower quantity of water purchased correlates proportionally with lower water discharge costs.
- Detergent: Use of a high-efficiency washer allows for the use of high efficiency detergent, though it is more expensive and no significant monetary savings are realized.

3.2 TABLE OF RESULTS

Table 3.4-1: Commercial Clothes Washer NEI Summary

Clothes Washer					
Capacity	Standard Water Usage	Energy Star-Rated Usage	Water Savings	Gas Savings	Water Savings
cu ft	gal/cycle	gal/cycle	gal/cycle	MMBtu/year	gal/MMBtu
2	19	15	4	5.9	1,475
3	28.5	22.5	6	8.9	1,475
4	38	30	8	11.9	1,475
Assumed:	9.5	gal/cf/cycle, standard		[L2]	
	7.5	gal/cf/cycle, Energy Star		[L2]	
	2,190	cycles per year		[L1]	
	55	F city water temperature		[General 1]	
	80%	boiler water heating eff%		[General 2]	
	120	F DHW temperature		[General 3]	

3.3 RESEARCH AND REFERENCE SOURCES

[L1] "Laundromats and Common Area Laundry Facilities", http://www.a4we.org/laundromats.aspx, 2009.

[L2] "Clothes Washers Key Product Criteria," ENERGY STAR, http://www.energystar.gov/index.cfm?c=clotheswash.pr_crit_clothes_washers

[L3] "Commercial Laundry Facilities Introduction", http://www.allianceforwaterefficiency.org/commercial_laundry.aspx, 2009.

[L4] ENERGY STAR Savings Calculator: Clothes Washer, ENERGY STAR, http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorConsumerClothesWasher.xls

3.4 CASE STUDY

None available at this time.

3.5 GENERALIZING TYPICAL RESULTS

Secondary research provided industry typical reductions for water usage per pound of laundry cleaned. Additional sources were found for typical values for city water temperature, hot water temperature and hot water heating efficiency. It was assumed that a commercial natural gas-fired boiler would provide hot water heating for a laundry.

SECTION 4:

CONDENSING BOILER

Installing a high efficiency or condensing boiler reduces natural gas consumption. Typical non-condensing boilers operate with an efficiency of around 75%, while condensing boilers can operate at efficiencies over 87%. The increased efficiency is due to the recovery of heat from the normally wasted exhaust gases.

Most condensing boilers have an extra heat exchanger for preheating return water. They also tend to have more complex controls and are more likely than non-condensing boilers to employ use of a variable speed drive (VSD) forced air fan and are more likely to use exhaust fans. This additional complexity would tend to increase operations and maintenance costs, however, service providers contacted are not adding a service premium for condensing boilers.

4.1 METHODS OF SAVINGS (OR INCREASE)

- Natural gas savings (MMBtu): Natural gas savings is realized as a result of the increased efficiency of a condensing boiler versus a non-condensing boiler
- O&M Impact: No significant maintenance changes were identified
- Installation: Depending upon the application, the installation costs of a condensing boiler can vary
- Electrical Impact: A minimal electrical impact for operating a forced air draft fan for condensing boilers is possible. However, this impact is not consistent across all instances of condensing boiler installations and is therefore difficult to quantify in general terms.

4.2 TABLE OF RESULTS

There are no quantifiable NEI results.

4.3 RESEARCH AND REFERENCE SOURCES

[CB1] Consortium for Energy Efficiency, "A Market Assessment for Condensing Boilers in Commercial Heating Applications" http://www.cee1.org/gas/gs-blrs/Boiler_assess.pdf

[CB2] IMPO: "Is a High-Efficiency Boiler Right for Your Facility", Thomas Neill

http://www.impomag.com/scripts/default.asp

[CB3] Service manual for the Prestige Solo 110 boiler http://www.triangletube.com/documents/1/Prestige%20SOLO%20110%20Manual.pdf

[CB4] Service charge calculator for boiler maintenance

https://www.britishgas.co.uk/ViewQuoteDetails/coverBoiler/

Conversations with representatives from:

- National Grid Service Department, Customer Service Representative
- Dunkirk Boilers (http://www.dunkirk.com/)

- Lochinvar Boilers (http://www.lochinvar.com/products/Default.aspx?type=category&categoryid=12)

4.4 CASE STUDY

A condensing boiler system was assessed at site NCP4012, a multi-family condominium building in Manhattan. The site is a 14,000 square foot building with five above ground floors and a below grade cellar. The boiler measure being discussed is labeled as new construction project which also included energy recovery ventilation, improved SEER air conditioners, kitchen and laundry exhaust fan switching sensors, lighting efficiency, air sealing of building envelope, and building integrated solar PV measures.

A condensing boiler with a rated output of 279,000 Btuh was installed at the facility to provide hot water to panel radiators throughout the facility. The supply water temperature of the boiler varied with outside air temperature. At 32°F the supple water temperature was 135°F while at 60°F the supply temperature was 90°F. The boiler does not operate when the outside air temperature is above 70°F.

Since the measure was reported as a new construction, the baseline efficiency for the facility was taken from New York State Energy Conservation Code for boilers of comparable size and was found to be 75%. The reported boiler efficiency of 94% was taken from the manufacturer's published product data. The maximum possible spot measured efficiency with the condensing taken into account was determined to be between 92.4% and 92.8%. The average annual total efficiency of the boiler was determined to be 88.6%, which corresponds to a 548 MMBtu/yr savings over the baseline boiler using an annual full load hour value of 993 hours.

No non-energy impacts were reported for this measure. The system operates as a closed loop and therefore there are no substantial savings from reduced water usage.

4.5 GENERALIZING TYPICAL RESULTS

Through the research conducted which included phone calls to boiler manufacturers and service providers, internet research, and surveys of existing measures, no consistent NEIs were found.

Due to the increased acidity of the exhaust of a condensing boiler, the standard venting materials cannot be used. The options for venting materials include stainless steel and polyvinyl chloride (PVC). Stainless steel venting usually represents a higher installation cost over a conventional boiler while PVC venting normally represents a lower installation cost. It can also be argued that the lower flue gas temperatures characteristic of a condensing boiler requires a simpler venting system. The high quality materials required to resist acidic corrosion may make the boiler more reliable.

No specific information on maintenance costs of condensing versus conventional boilers was obtained. Conversations with a boiler manufacturer indicated that a specialist trained in condensing boilers is required to perform maintenance on these systems. It was claimed, however, that the condensing boilers require less maintenance. In a sample of areas where service contracts are offered and condensing boilers are not uncommon (British Gas), the monthly plan fee is not a function of boiler type.

After consulting the manual for a specific condensing boiler it was noted that inspections of condensate traps and heat exchanger surfaces should be included in the regular maintenance programs for the system. Such inspections are unnecessary with conventional boiler systems.

Conversations with the service department of a utility service provider indicated that there no distinction between the maintenance plans for condensing boiler systems versus conventional boiler systems. Due to the varied responses about required maintenance, the impact cannot be deemed universal to all condensing boiler projects.

The general view is that condensing boiler systems represent a 2 to 3 times higher initial cost versus conventional boiler systems. This view was verified through the conversation with the boiler manufacturer who also noted that these types of systems typically have longer paybacks. Research on the website of Industrial Maintenance & Plant Operations (IMPO) magazine mirrored the views of the boiler manufacturer that condensing boiler systems are 2 to 3 times more costly to install.

Review of two case studies from the Consortium for Energy Efficiency (CEE) market assessment of condensing boilers demonstrated increased installation and maintenance costs associated with the installation of a condensing boiler.

The electrical impact of a condensing boiler arises from the fact that its flue gas temperature is lower than that of a conventional boiler. The lower exhaust temperatures make natural drafting more difficult and require the use of a fan or a blower. However, it is not possible to generalize this effect over all instances of this measure’s implementation. It should also be noted that the magnitude of this impact is negligible compared to the other savings associated with the measure.

SECTION 5:

STACK HEAT RECOVERY TO PREHEAT BOILER WATER

Installing a heat exchanger in a boiler exhaust stack allows for some of the waste heat to be recovered to raise the boiler makeup water intake temperature. This reduces the makeup water heating load, resulting in a lower natural gas requirement.

5.1 METHODS OF SAVINGS (OR INCREASE)

- Natural gas savings (MMBtu): A reduction in natural gas usage is seen as a result of this measure. By increasing the temperature of the boiler intake water, the difference between the intake and the supply water temperatures is reduced which leads to a reduction in the amount energy required to reach the desired supply water temperature.
- Reduction in cost of capital equipment: Reusing waste heat allows for smaller energy conversion equipment.
- Reduction in Air treatment costs: Cost to treat air pollutants can be reduced by recovery of waste heat in facilities that use incinerators to break down gaseous air pollutants.
- Electrical Impact: A minimal electrical impact due to the additional drafting considerations associated with the installation of a boiler economizer. However, this impact is not consistent across all instances of boiler economizer installations and is, therefore, difficult to quantify in general terms.

5.2 TABLE OF RESULTS

There are no quantifiable NEI results.

5.3 RESEARCH AND REFERENCE SOURCES

[SHR1] ACEEE. Industrial Waste-Heat Recovery: Benefits and Recent Advancements in Technology and Applications by Arzbaecher, Fouche, Parmenter of Global Energy Partners 2007.

[SHR2] Industrial Boiler & Mechanical Company, http://www.industrialboiler.com

5.4 CASE STUDY

The boiler stack heat recovery project installed at Site SEC7234, ("Laundry Company") was used as a basis for this NEI impact evaluation. At this site a direct contact boiler stack economizer was installed to recover waste heat from the exhaust flue and preheat boiler make-up water.

Through conversations with facility management it was determined that the system is no longer in use. Process requirements made a direct contact heat exchanger unsuitable for the facility. As the feed water was passed through the boiler exhaust gases it collected incomplete combustion carbon products which led to carbon stains in the laundry process. Damages caused by this system forced the site to discontinue using the economizer.

No NEIs were reported for this measure. This measure would have resulted in additional electrical usage at the site due to the forced draft requirements associated with boiler stack heat recovery. However, since the economizer system was no longer in operation these calculations were not conducted.

5.5 GENERALIZING TYPICAL RESULTS

Secondary research included phone calls to boiler stack economizer manufacturers and service providers, internet research, and surveys of existing measures. The research conducted yielded no quantifiable non-energy benefits.

From a phone conversation with a representative from a boiler supplier and service provider it was determined that there is no significant increase in the cost of maintaining an economized boiler system versus a system without an economizer. The cost of a quarterly service plan for both types of systems was identical. The representative also mentioned that there is very little additional required for boiler systems employing economizers. One supplier said that installing a boiler stack heat recovery unit could result in serious damage if the proper considerations are not made; venting of flue gas being the main concern. Using exhaust gas heat to preheat intake water lowers the flue gas temperature. Therefore natural convection cannot take place and a forced draft system needs to be implemented. Also, if the temperature of the exhaust gases drops too low, condensation will occur. The resulting condensate is acidic and can have damaging effects on certain venting materials.

The electrical impact of installing a boiler economizer arises from the fact that the flue gas temperature is lower than that of a boiler with no economizing. The lower exhaust temperatures make natural drafting more difficult and require the use of a fan or a blower. However, it is not possible to generalize this effect over all instances of this measure’s implementation. It should also be noted that the magnitude of this impact is negligible compared to the other savings associated with the measure.

SECTION 6:

CHILLER TECHNOLOGY IMPACTS ON COOLING TOWERS

A chiller extracts heat from the chilled water loop and rejects it to the condenser water loop along with the waste heat generated by the chiller equipment itself. Replacement of an existing chiller with an alternate technology can have a significant impact on the heat of rejection thereby impacting the load on the cooling tower. A change in chiller efficiency directly impacts the cooling tower load because inefficiency creates heat which must be rejected by the tower. An increases or decreases of the cooling tower load, impacts the condenser water pumping, cycling of the cooling tower fans, the amount of water evaporated from the tower, and the chemical treatment requirement of the cooling tower water. These technology changes typically either increase or decrease the tower load as follows:

- Single-stage with 2-stage absorption chiller — 25% decrease in load
- Single-stage with direct fired absorption chiller — 25% decrease in load
- Single-stage absorption with natural gas driven turbine chiller — 40% decrease in load
- Electric chiller with natural gas driven turbine chiller — 10% *increase* in load

6.1 METHODS OF SAVINGS (OR INCREASE)

- Natural gas savings (MMBtu): due to low energy input and low heat rejection from the cooling tower, the replacement of a single absorption chiller with either a 2-stage absorption chiller or a natural gas-powered chiller will result in natural gas savings.
- Electricity savings: the natural gas engine chiller application can result in electricity savings, particularly in the case of a single stage steam absorption chiller being replaced by a two-stage absorption chiller because of lower fan cycling and a reduction of condenser water pumping
- Water savings: less make-up water is required for a decrease in tower load
- Sewer savings: while most of the water usage is evaporated and is not sent to drain, most buildings do not have separately metered sewer lines so the sewer savings are equivalent to the water usage.
- Chemical treatment: chemical treatment costs are based on quantity of water used, thus the reduction of makeup water consumption will reduce chemical treatment costs

6.2 TABLE OF RESULTS

Table 6.2-1: Natural gas fired chiller improvement

Tower impact with chiller improvement		per mmBTU saved
Single to 2-stage absorber to turbine chiller		
Water Reduction (gallons)	184	gallons/MMBtu saved
Pump and fan electricity consumption reduction (kWh)	3.98	kWh/MMBtu saved
Chemical treatment costs reduction ($)	0.73	$/MMBtu saved
Single stage absorber to turbine chiller		
Water Reduction (gallons)	276	gallons/MMBtu saved
Pump and fan electricity consumption reduction (kWh)	7.99	kWh/MMBtu saved
Chemical treatment costs reduction ($)	1.10	$/MMBtu saved

6.3 RESEARCH AND REFERENCE SOURCES

[C1] "Site-Specific Measurement and Verification Report - PO9918"

[C2] Cooling System Alternatives, http://tristate.apogee.net/cool/cfsc.asp

[C3]J. LoBuglio, HVAC Guide - Cooling Systems, JD Supply HVAC Heating & Cooling Outlet**;** **http://www.boiler-outlet.com/Cooling-System-Guide-4.asp**

[C4] S. Osgood, Ozonation of Cooling Tower Water: A Case Study, Water Conservation Unit East Bay Municipal Utility District, 1991; http://www.p2pays.org/ref/02/01270.pdf

[C5] Gas Air Conditioning, Resource Smart Business, Sustainable Manufacturing, http://svc010.wic048p.server-web.com/manufacturing/sustainable_manufacturing/resource.asp?action=show_resource&resourcetype=2&resourceid=26

[C6] 100 ton absorption chiller/heat pump demonstrates the real cost of saving energy; The Free Library by Farlex, http://www.thefreelibrary.com/100+ton+absorption+chiller%2Fheat+pump+demonstrates+the+real+cost+of+...-a0172688609

6.4 CASE STUDY

The measure involves replacing a 350 ton single effect absorption chiller with a 300 ton natural gas powered centrifugal chiller at site PO9918. The chiller system serves a hospital located in New York City. The new chiller is a high performance centrifugal chiller directly powered by a natural gas fed internal combustion engine. The unit full load COP for the baseline system was 0.6-0.7 while for the as-built new system was1.7. As a result 22,827 therms/year are saved with the new chiller.

There were no non-energy benefits reported for this measure.

6.5 GENERALIZING TYPICAL RESULTS

The values of heat rejection by the cooling tower for different types of chillers are provided in Table 6.5-1 (reference [C2])..

Table 6.5-1: Higher heating value (HHV) input and heat rejection by the cooling tower for different types of chillers

#	Chiller type	HHV Input	Heat rejection by the cooling tower
		Btu/ton-hr	Btu/ton-hr
1	Single stage steam absorption chiller	22,000	29,000
2	Two-stage steam absorption chiller	12,200	22,300
3	Direct fired absorption chiller	12,000	22,900
4	Natural gas engine chiller (average of rows # 4.1;4.1; and 4.3)	~ 8,600	~ 16,600
4.1	*Reciprocating*	*9,300*	*16,900*
4.2	*Rotary screw*	*8,600*	*16,500*
4.3	*Centrifugal*	*7,760*	*16,300*
5	New Electric chiller	-	14.355
5.1	*Reciprocating**	-	*14,560*
5.2	*Screw**	-	*14,150*
6	Existing Electric chiller	-	14,905
6.1	*Reciprocating**	-	*15,300*
6.2	*Screw**	-	*14,510*

* The typical BTU per ton heat rejection for electric chillers is calculated:

= (kW/ton- hr x 3,413 Btuh/kW x 0.92) + 12,000 Btuh/ton,

where the 0.92 factor makes an 8% allowance for the losses to ambient.

All chillers require electricity to operate their auxiliary equipment like pumps, controls, etc. These savings should be included in the economic comparison. The electric consumption of the chilled water pump supplying the space is primarily a function of the space requirements and not the chiller, so this power input can be either included or omitted since it almost never affects the outcome of the analysis.

The electricity capacities of the cooling tower fans and condenser water pumps for few water-cooled chillers are provided in Table 6.5-2, reference [C2].

Table 6.5-2: Cooling tower fans and condenser water pump capacities

#	Chiller type	Cooling tower fans	Cond water pump*	Total
		kW/ton	kW/ton	kW/ton
1	Single stage steam absorption chiller	0.138	0.11	0.248
2	Two-stage absorption chiller	0.113	0.096	0.209
3	Natural gas engine chiller	0.087	0.054	0.141

* These numbers are based on efficiencies of pump of 0.7 and motor – 0.9

As is obvious from the table, in the case of a natural gas engine chiller application the electric capacity is the lowest and can result in electricity savings. In the case of a single stage steam absorption chiller replaced by a two-stage absorption chiller, some electricity savings can be obtained.

Furthermore, water consumption savings can be received from the chiller replacement measures. The typical chiller system makeup water consumption data for some of the chillers are as follows:

Electric chiller – 4.0 gallons/ton-hr;

Single stage absorption chiller – 8.0 gallons/ton-hr;

Two-stage absorption chiller – 6.2 gallons/ton-hr;

Natural gas driven chillers – 4.3 gallons/ton-hr.

Additionally, make-up water consumption savings will result in reduced costs associated with chemical treatment. Typical costs for chemically treating incoming water and disposing tower bleed-off (blowdown) is $4 per 1,000 gallons. Summary calculations are shown in Table 6.5-3a and b.

Table 6.5-3a: Summary Calculations for single to 2-stage absorption chiller

Generalized Case - single to 2-stage absorption chiller				
				Basis
	Average baseline input per ton-hour	22,000		Cooling System Alternatives,
	Average 2-stage absorption chiller input per ton-hour	12,200		http://tristate.apogee.net/cool/cfsc.asp
	Average reduction in energy input	9,800	Btu/ton-hour	Calculation
	Average full load hours	1,200	hours/yr	Assumption for an office
	Average annual savings in gas input to chiller	11,760,000	Btu/ton	Calculation
	Average heat rejection by the cooling tower - baseline	29,000	Btu/ton-hour	Cooling System Alternatives,
	Average heat rejection by the cooling tower - installed	22,300	Btu/ton-hour	http://tristate.apogee.net/cool/cfsc.asp
	Average annual reduction in tower loading	8,040,000	Btu/ton	Calculation
Make-Up Water Consumption Reduction (includes also evaporation losses)				
	Average usage of make-up water - baseline	8.0	gallons/ton-hour	Cooling System Alternatives,
	Average usage of make-up water - installed	6.2	gallons/ton-hour	http://tristate.apogee.net/cool/cfsc.asp
	Averge annual water consumption savings	2160.0	gallons/ton	Calculation
Condenser water pump and cooling tower fan				
	Average usage baseline	0.248	kW/ton	Cooling System Alternatives,
	Average usage installed	0.209	kW/ton	http://tristate.apogee.net/cool/cfsc.asp
	Average annual electric savings	46.8	kWh/ton	calculation
Chemical Treatment				
	Typical costs for chemically treating incoming water and disposing tower bleed-off (blowdown)	0.004	$/gallon	
	Chemical treatment costs savings	8.64	$	

Table 6.5-3b: Summary Calculations for single effect absorption to engine-driven chiller upgrade

Generalized Case - single to gas fired engine			
			Basis
Average baseline input per ton-hour	22,000		Cooling System Alternatives,
Average 2-stage absorption chiller input per ton-hour	8,600		http://tristate.apogee.net/cool/cfsc.asp
Average reduction in energy input	13,400	Btu/ton-hour	Calculation
Average full load hours	1,200	hours/yr	Assumption for an office
Average annual savings in gas input to chiller	16,080,000	Btu/ton	Calculation
Average heat rejection by the cooling tower - baseline	29,000	Btu/ton-hour	Cooling System Alternatives,
Average heat rejection by the cooling tower - installed	16,600	Btu/ton-hour	http://tristate.apogee.net/cool/cfsc.asp
Average annual reduction in tower loading	14,880,000	Btu/ton	Calculation
Make-Up Water Consumption Reduction (includes also evaporation losses)			
Average usage of make-up water - baseline	8.0	gallons/ton-hour	Cooling System Alternatives,
Average usage of make-up water - installed	4.3	gallons/ton-hour	http://tristate.apogee.net/cool/cfsc.asp
Averge annual water consumption savings	4440.0	gallons/ton	Calculation
Condenser water pump and cooling tower fan			
Average usage baseline	0.248	kW/ton	Cooling System Alternatives,
Average usage installed	0.141	kW/ton	http://tristate.apogee.net/cool/cfsc.asp
Average annual electric savings	128.4	kWh/ton	calculation
Chemical Treatment			
Typical costs for chemically treating incoming water and disposing tower bleed-off (blowdown)	0.004	$/gallon	
Chemical treatment costs savings	17.76	$	

SECTION 7:

COMMERCIAL DISHWASHER

More efficient dishwashers use less water per cycle. The water consumption reduction results in reduced water heating requirements, thereby reducing the heating load. This measure involves installing an ENERGY STAR rated dishwasher instead of a federal-standard counterpart of similar size. Advanced technology has improved dramatically over the last decade through advanced soil sensors, improved water filtration, more efficient jets and innovative dish racks.

Commercial dishwashers are defined under two categories:

- High Temperature Efficiency - apply potable hot water to achieve sanitization
- Low Temperature Efficiency - apply potable hot water and a chemical solution to achieve sanitization

ENERGY STAR has further defined a set of criteria and testing for equipment to qualify as energy efficient which includes four categories:

- Under Counter Dishwasher
- Stationary Single Door Dishwasher
- Single Tank Conveyor Dishwasher
- Multiple Tank Conveyor Dishwasher

ENERGY STAR dishwashers require fewer gallons per cycle than standard models, therefore saving heating energy, potable water, and water discharge costs. The average restaurant runs the dishwasher 6 hours per day, resulting in significant energy and non-energy impacts each year.

7.1 METHODS OF SAVING (OR INCREASE)

- Natural gas savings (MMBtu): reduction in hot water required by dishwasher leads to lower DHW heating load.
- Electricity savings: ENERGY STAR rated models use less energy than the federal standard
- Water savings: reduction in water drawn by dishwasher leads to lower city water consumption.
- Waste water: a lower quantity of water purchased correlates proportionally with lower water discharge costs.
- Detergent: because detergent usage is dictated by the quantity and cleanliness level of dishes, no significant monetary savings are realized when using high efficiency dishwashers

7.2 TABLE OF RESULTS

Table 7.5-1: High Temperature Efficiency Dishwasher NEI Summary

Machine Type	Water Consumption		Number of racks / hour	Non-Eff	EnergyStar	Use	Savings			
	EnergyStar - High Temp	Non-Efficiency Model								
	gal/rack	gal/rack		gal/hour	gal/hour	hrs / day	gal/hour	gal/year	MMBtu/yr	gal/MMBtu
Under Counter	1	1.4	30	42	30	6	12	26,280	39.16	671
Stationary Single Tank Door	0.95	1.7	45	76.5	42.75	6	33.75	73,913	110.15	671
Single Tank Conveyor	0.7	1	100	100	70	6	30	65,700	97.91	671
Multiple Tank Conveyor	0.54	1	200	200	108	6	92	201,480	300.25	671
	Assumptions		City Water		55 F		[General 1]			
			Dish water temp		180 F		[CD1] Required temp for sanitizing			
			Days of use per year		365		Assumed			
			DHW heating equipment		70% efficiency		[CD1]			

Table 7.5-2: Low Temperature Efficiency Dishwasher NEI Summary

Machine Type	Water Consumption		Number of racks / hour	Non-Eff	EnergyStar	Use	Savings			
	EnergyStar - High Temp	Non-Efficiency Model								
	gal/rack	gal/rack		gal	gal/hour	hrs / day	gal/hour	gal/year	MMBtu/yr	gal/MMBtu
Under Counter	1.7	2	30	60	51	6	9	19,710	19.97	987
Stationary Single Tank Door	1.18	1.7	45	76.5	53.1	6	23.4	51,246	51.93	987
Single Tank Conveyor	0.79	1	100	100	79	6	21	45,990	46.60	987
Multiple Tank Conveyor	0.54	1	200	200	108	6	92	201,480	204.17	987
			City Water		55 F		[General 1]			
			Dish water temp		140 F		[CD1] Required temp for sanitizing			
			Days of use per year		365		Assumed			
			DHW heating equipment		70% efficiency		[CD1]			

7.3 RESEARCH AND REFERENCE SOURCES

[CD1] ENERGY STAR
http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COH

[CD2] NSF International http://www.nsf.org/

[CD3] Natural Resources Canada
http://oee.nrcan.gc.ca/residential/business/energystar/procurement/commercial-dishwashers.cfm?attr=24

[CD4] NC Division of Pollution Prevention and Environmental Assistance
http://www.p2pays.org/ref/04/03103.pdf

[CD5] Insinger Dishwasher Equipment

http://www.insingermachine.com/index.html

7.4 CASE STUDY NONE

None available at this time.

7.5 GENERALIZING TYPICAL RESULTS

Secondary research provided industry typical reductions for water usage per rack of dishware cleaned. Additional sources were found for typical values for city water temperature, hot water temperature and hot water heating efficiency. It was assumed that a commercial natural gas-fired boiler would provide hot water heating for a commercial kitchen.

SECTION 8:

COMMERCIAL POOL COVER

The evaporation rate from an outdoor pool varies depending on the pool's temperature, air temperature and humidity, and the wind speed at the pool surface. It only takes 1 Btu (British thermal unit) to raise 1 pound of water 1 degree, but each pound of 80ºF water that evaporates requires 1,048 Btu of heat out of the pool. Pool covers reduce the amount of water that is evaporated, thereby saving water and reducing the heating load. Evaporation accounts for up to 70% of a pool's energy losses.

Outdoor Pools:

Evaporation rate depends on the pool's temperature, air temperature and humidity, and the wind speed at the pool surface. The higher the pool temperature and wind speed, and the lower the humidity, the greater the evaporation rate. Using trees/shrubs/fences as windbreaks will help to reduce losses.

Indoor Pools:

Although they are not subjected to the environment they require controlled room ventilation and humidity, which in turn requires additional mechanical equipment.

A pool cover is the single greatest means of saving energy for both indoor and outdoor pools. Reduced evaporation impacts potable water purchases and related sewer charges. Pool chemical treatment is also reduced and the latent heat load is substantially reduced in indoor pools with a pool cover.

8.1 METHODS OF SAVINGS (OR INCREASE)

- Natural gas Savings (MMBtu): Reducing heat loss lowers the natural gas usage required for heating.
- Water Savings: Minimizing water losses reduces the need for additional makeup water and heating.
- Waste Water: Sewer charges are based on quantity of water purchased, therefore sewer charges are less, although there may be little actual difference in water sent to drain, since it is mostly evaporated.
- Chemical Savings: Reducing water loss reduces the amount of chemical water treatment required. It also extends the life of the chemical in the pool.
- O&M Impact: Proper equipment size and reduction of heat and water losses results in an extended life of the pool

8.2 TABLE OF RESULTS

Table 8.4-1: Commercial Pool Cover NEI Summary

Parameter	Value	Units	Source
Pool size	13448	sqft	case study
Annual hours	1127	hours	case study
Heating savings	0.3	MMBtu/hour	case study
Boiler Efficiency	65%		Assumed
Annual savings	520	MMBTtu/year	case study
Water savings	256	lbm/hour	case study
	31	gal/hour	calculation
	34937	Gal/year	calculation
Water saving/mmbtu	67	gal/MMBtu	calculation

8.3 RESEARCH AND REFERENCE SOURCES

[P1] Department of Energy – Energy Efficiency & Renewable Energy
http://www.energysavers.gov/your_home/water_heating/index.cfm/mytopic=13130

[P2] Reduce Swimming Pool Energy Costs (RSPEC)
http://www.rlmartin.com/rspec/whatis/index.html

8.4 CASE STUDY

A pool cover was assessed at a Massachusetts public high school. The school owns an Olympic size indoor swimming pool, 50 meters by 25 meters (164 feet by 82 feet) in dimension. The pool is heated year round by hot water supplied by one of three boilers. The pool water temperature is maintained at approximately 80 F. The pool space temperature varies widely based on outdoor temperature. However, during the winter the space temperature drops to approximately 72 F. During the winter, as the pool water is warmer than the space temperature; heat is lost to the space. Additionally, water is constantly being evaporated to the drier air. The school requested that ERS evaluate the natural gas and water savings from covering the pool with an automatic cover when not in use. We estimated that the pool is in use from 7 AM to 8 PM, Monday through Friday.

ERS calculated savings for using an automatic pool cover using HeatSim software. According to the DOE Energy Smart Pools program, insulated pool covers have a 2.0 R-value. Also according to the Energy Smart Pools program, automatically deployed covers cost approximately \$7.00 /ft^2, while manually deployed covers cost approximately \$2.00 /ft^2. Table 8.6-1 presents the energy and cost savings, implementation cost and simple payback for installing both manual and automatic pool covers.

Table 8.6-1: Energy and Cost Savings, Implementation Cost and Simple Payback for Pool Cover Installation Case Study

Pool Operating Hours	7 AM - 8 PM, M - F, 4 winter months
Annual Hours	1,127
Heat Savings (mmBtu/hour)	0.3
Boiler Efficiency	65%
Gas Savings (mmBtu/hour)	0.46
Gas Savings (mmBtu/year)	520
Gas Cost ($/mmBtu)	$17.86
Gas Savings ($/year)	$9,286
Water Savings (lbm/hour)	256
Water Savings (gal/hour)	31
Water Savings (ccf/hour)	0.041
Water Savings (ccf/year)	46
Water Cost ($/ccf)	$3
Water Savings ($/year)	$139
Total Savings ($/year)	$9,425
Automatic Cover Implementation Cost ($)	$94,136
Automatic Cover Simple Payback (years)	**10.0**
Manual Cover Implementation Cost ($)	$26,896
Manual Cover Simple Payback (years)	**2.9**

8.5 GENERALIZING TYPICAL RESULTS

Results were developed from the case study and normalized on a per MMBtu saved basis.

SECTION 9:

CLOTHES WASHERS – HOME

This measure involves the installation of an ENERGY STAR-rated clothes washer over a federal-standard counterpart of equivalent size. Residential clothes washers vary in capacity, but are all single load washers with no water recycling capabilities. ENERGY STAR-rated models require less water per cubic foot per cycle than standard models; this leads to savings in heating energy, water, and water discharge costs. For example, an ENERGY STAR-rated washer consumes 7.5 gallons per cycle per cubic foot, whereas the federal standard consumes 9.5 gallons per cycle per cubic foot. Only front and top load clothes washers more voluminous than 1.6 cubic feet are eligible for the ENERGY STAR rating.

9.1 METHODS OF SAVINGS (OR INCREASE)

- Natural gas savings (MMBtus): reduction in hot water required by clothes washer leads to lower DHW heating load.
- Water savings: reduction in water drawn by clothes washer leads to lower city water consumption.
- Waste water: a lower quantity of water purchased correlates proportionally with lower water discharge costs.
- Detergent: Use of a high-efficiency washer allows for the use of high efficiency detergent, though it is more expensive so no significant monetary savings are realized.

9.2 TABLE OF RESULTS

Table 9.4-1: Residential Clothes Washer NEI Summary

Clothes Washer					
Capacity	Standard Water Usage	Energy Star-Rated Usage	Water Savings	Therm Savings	Normalized Savings
cu ft	gal/cycle	gal/cycle	gal/cycle	MMBtu/year	gal/year
2	19	15	4	0.940	1040
3	28.5	22.5	6	1.410	1560
4	38	30	8	1.880	2080
Assumed:	9.5	gal/cf/cycle, standard		[CW1]	
	7.5	gal/cf/cycle, Energy Star		[CW1]	
	260	cycles per year		[CW1]	
	55	F city w ater temperature		[General 1]	
	120	F DHW temperature		[General 3]	
	60%	Hot w ater heater efficiency		[General 4]	

9.3 RESEARCH AND REFERENCE SOURCES

[CW1] "Clothes Washers Key Product Criteria," ENERGY STAR, http://www.energystar.gov/index.cfm?c=clotheswash.pr_crit_clothes_washers

ENERGY STAR Savings Calculator: Clothes Washer, ENERGY STAR, http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorConsumerClothesWasher.xls

[General 4] Residential hot water efficiency http://www.aceee.org/consumerguide/waterheating.htm

9.4 CASE STUDY

None available at this time.

9.5 GENERALIZING TYPICAL RESULTS

Secondary research provided industry typical reductions for water usage for different capacity clothes washers. Additional sources were found for typical values for city water temperature, hot water temperature and hot water heating efficiency. It was assumed that a residential direct fired heater would provide hot water heating.

SECTION 10:

DISHWASHER

This measure involves the installation of an ENERGY STAR rated dishwasher over a federal-standard counterpart of similar size. ENERGY STAR dishwashers require fewer gallons per cycle than standard models, and therefore save heating energy, water, and water discharge costs. For example, an ENERGY STAR dishwasher of standard size uses 5.8 gallons per cycle on average, whereas the federal standard uses 6.5 gallons per cycle [DW1]. ENERGY STAR dishwashers also save electricity, rated to use 324 kWh/year instead of the federal standard of 355 kWh/year [DW1]. An average usage of 215 cycles per year per residence was cited and used for annual savings calculations [DW1].

10.1 METHODS OF SAVINGS (OR INCREASE)

- Natural gas savings (MMBtu): reduction in hot water required by dishwasher leads to lower DHW heating load
- Electricity savings: ENERGY STAR rated models use less energy than the federal standard
- Water savings: reduction in water drawn by dishwasher leads to lower city water consumption
- Waste water: a lower quantity of water purchased correlates proportionally with lower water discharge costs
- Detergent: because detergent usage is dictated by the quantity and cleanliness level of dishes, no significant monetary savings are realized when using high efficiency dishwashers

10.2 TABLE OF RESULTS

Table 10.4-1: Residential Dishwasher NEI Summary

Dishwasher					
Size	Federal Standard	Energy Star	Savings		Normalized
	gal/cycle	gal/cycle	gal/year	MMBtu/year	gal/MMBtu
Compact	4.5	4	107	0.097	1106
Standard	6.5	5.8	149.8	0.135	1106
		31	kWh/year savings		[DW1]
		214	cycles per year		[DW1]
		120	F, dishwasher temp		[General 4]
		55	F, city water		[General 1]
		60%	DHW water efficiency		[General 4]

10.3 RESEARCH AND REFERENCE SOURCES

[DW1] "Dishwashers Key Product Criteria," ENERGY STAR, http://www.energystar.gov/index.cfm?c=dishwash.pr_crit_dishwashers

10.4 CASE STUDY

None available at this time.

10.5 GENERALIZING TYPICAL RESULTS

Non-energy savings were classified into two tiers of dishwasher size: standard and compact. However it is assumed that standard dishwashers predominate the market and the standard results were used for reporting.

Secondary research provided industry typical reductions for water usage for different capacity clothes washers. Additional sources were found for typical values for city water temperature, hot water temperature and hot water heating efficiency. It was assumed that a residential direct fired heater would provide hot water heating.

SECTION 11:

LOW FLOW SHOWERHEADS

This measure involves the installation of a low-flow showerhead. Savings are realized both from the reduction of domestic hot water heating energy, as well as a reduction in city water used and discharged. According to [SH1], the Federal Energy Policy Act of 1992 sets a maximum flow rate of 2.5 gpm for all fixtures manufactured in the U.S. From [SH2], a flow rate of 2.0 gpm is recommended for WaterSense-labeled showerheads. An estimate of 122 annual hours has also been used in the savings calculation [SH3]. It was assumed that the typical shower uses a mix of 73%/27% hot/cold water on average [SH1].

11.1 METHODS OF SAVINGS (OR INCREASE)

- Natural gas savings (MMBtu): reduction in hot water required per shower leads to lower DHW heating load.
- Water savings: reduction in water drawn by showerhead leads to lower city water consumption.
- Waste water: a lower quantity of water purchased correlates proportionally with lower water discharge costs.

11.2 TABLE OF RESULTS

Table 11.4-1: Low Flow Showerhead NEI Summary

Showerhead					
Efficient Case	Baseline Case	Annual Savings			Normalized
gpm	gpm	gpm	gal	MMBtu	gal/MMBtu
1.5	2.5	1	7320	6.62	1106
1.7	2.5	0.8	5856	5.29	1106
2	2.5	0.5	3660	3.31	1106
Assumed:	122	hrs/year			[SH3]
	120	F, DHW temperature			[General 4]
	55	F, city w ater temp			[General 1]
	73%	mix of hot w ater to cold			[SH1]
	60%	DHW w ater efficiency			[General 4]

11.3 RESEARCH AND REFERENCE SOURCES

[SH1] Flex Your Power Showerheads Study, http://www.fypower.org/res/tools/products_results.html?id=100160

[SH2] "WaterSense Labeled Showerheads," http://www.epa.gov/watersense/docs/showerhead_factsheet508.pdf

[SH3] "Reduce Hot Water Use for Energy Savings," U.S. Dept. of Energy, http://www.energysavers.gov/your_home/water_heating/index.cfm/mytopic=13050

11.4 CASE STUDY

None available at this time.

11.5 GENERALIZING TYPICAL RESULTS

Non-energy savings were normalized by reduction in nameplate gpm between baseline and installed. This ensures a fair savings estimate, no matter the rated gpm of the installed showerhead. Secondary research provided typical values for city water temperature, hot water temperature and hot water heating efficiency. It was assumed that a residential direct fired heater would provide hot water heating.

The same calculations were also used for the commercial sector, however these results are normalized per MMBtu saved permitting a reasonable estimate of non-energy benefits given vendor estimates of energy savings for a particular commercial setting, assuming a similar water heater efficiency to the residential case.

SECTION 12:

AERATORS

Aerators limit the flow of water through kitchen and bathroom faucets, thereby saving heating energy and water consumption. The baseline for this measure is a faucet head without an aerator, which consumes no more than 2.2 gpm, as mandated by federal regulations [A1]. The aerator case is estimated to consume 1.6 gpm based on an average of 106 aerator installs on Long Island in 2009 [A2]. A typical faucet is expected to run for 130 hours per year, resulting in significant potable water savings, water heating savings, and wastewater savings. [A3].

12.1 METHODS OF SAVINGS (OR INCREASE)

- Natural gas savings (MMBtu): reduction in hot water drawn at faucet leads to lower DHW heating load.
- Water savings: reduction in water drawn at faucet leads to lower city water consumption.
- Waste water: a lower quantity of water purchased correlates proportionally with lower water discharge costs.

12.2 TABLE OF RESULTS

Table 12.4-1: Aerator NEI Summary

Aerator				
Standard	Energy Star	Savings		Normalized
gpm	gpm	gal/year	MMBtu/year	gal/MMBtu
2.2	1.5	5460	3.60	1515
2.2	1.6	4680	3.09	1515
2.2	1.7	3900	2.57	1515

Assumed:	130	hrs/year	[A3]
	120	F, DHW temperature	[General 4]
	55	F, city water	[General 1]
	73%	DHW used on average	[SH1]
	60%	DHW water efficiency	[General 4]

12.3 RESEARCH AND REFERENCE SOURCES

[A1] "Reduce Hot Water Use for Energy Savings," U.S. Department of Energy, http://www.energysavers.gov/your_home/water_heating/index.cfm/mytopic=13050

[A2] 2009 Long Island Power Authority Residential Energy Affordability Partnership install statistics

[A3] Federal Energy Management Program, http://www1.eere.energy.gov/femp/technologies/eep_faucets.html

12.4 CASE STUDY

None available at this time.

12.5 GENERALIZING TYPICAL RESULTS

Non-energy savings were normalized by reduction in nameplate gpm between baseline and installed. This ensures a fair savings estimate, no matter the rated gpm of the installed faucet. Secondary research provided typical values for city water temperature, hot water temperature and hot water heating efficiency. It was assumed that a residential direct fired heater would provide hot water heating.

The same calculations were also used for the commercial sector, however these results are normalized per MMBtu saved permitting a reasonable estimate of non-energy benefits given vendor estimates of energy savings for a particular commercial setting, assuming a similar water heater efficiency to the residential case.

SECTION 13:

INSTANT HIGH EFFICIENCY HOT WATER HEATER

This measure involves the installation of an efficient, instantaneous hot water heater. An instantaneous (or tankless) water heater reduces standby losses common to standard tank water heaters, providing natural gas savings. Additionally, the reduced volume of the tankless water heater as compared to a tank equivalent provides a non-energy benefit. A typical 39 ft^3 reduction in volume was determined when switching from a 41.5 ft^3 standard unit [HW1] to a 2.5 ft^3 tankless unit [HW2] that provides up to 7.4 gpm of heated water.

13.1 METHODS OF SAVINGS (OR INCREASE)

- Natural gas savings (MMBtu): Reduction in standby losses common to tank water heaters
- Volume (cu ft): Reduction in volume (cu ft) occupied by water heater when replacing a tank unit with a tankless unit

13.2 TABLE OF RESULTS

There are no quantifiable NEI results.

13.3 RESEARCH AND REFERENCE SOURCES

[HW1] Lochinvar Water Heater Product Guide, http://www.foxwater.com/includes/lochinvarrg.pdf

[HW2] Paloma Tankless Water Heater Product Specifications, http://www.palomastore.com/paloma-ph-28r-7.4-gpm-tankless-water-heater.html

[HW3] American Council for an Energy Efficient Economy, Consumer Guide to Home Energy Savings: Water Heating, http://www.aceee.org/consumerguide/waterheating.htm

13.4 CASE STUDY

None available at this time.

13.5 GENERALIZING TYPICAL RESULTS

Although installing an instant high efficiency hot water heater does result in vertical space savings, the unit footprint is approximately the same size as a traditional water heater tank. Therefore, the vertical space is only usable if shelving allows items to be placed above the instant hot water heater and no building footprint reduction can take place. For this reason, the space savings is not typically beneficial to residences with instant high efficiency hot water heaters, and can therefore not be universally quantified.