June 3, 2011

Ms. Kirsten Walli
Board Secretary
Ontario Energy Board
2300 Yonge Street, 27th Floor
Toronto, ON M4P 1E4

Dear Ms. Walli:

RE: EB-2010-0055– Union Gas – 2011 Demand Side Management Plan
- 2011 New and Updated DSM Measures

Union requests the Ontario Energy Board's (the "Board") approval for new and updated DSM measures for its 2011 program year.

On August 25, 2006 the Board issued its EB-2006-0021 Decision which outlined a process allowing for updates to the DSM input assumptions (page 57). Union followed the approved process to establish the 2011 DSM input assumptions. Union initiated consultation in 2010 with the 2010 Evaluation and Audit Committee ("EAC") on all the measures and, having worked extensively with the EAC, achieved complete consensus on all the input assumptions.

Attachment A contains substantiation documents for new and revised 2011 DSM measures. Free ridership rates were established for the two new programs, Commercial Drain Water Heat Recovery and Food Service Program which are provided in Attachment B.

Union followed the Board's process established in EB-2006-0021 and achieved consensus from its EAC for all the enclosed 2011 measures. Union requests the Board's approval of these 2011 DSM measures.

If you have any questions, please contact me at 519-436-4521

Sincerely,

[Original signed by]

Marian Redford
Manager, Regulatory Initiatives

c.c: Crawford Smith (Torys)
EB-2009-0166 Intervenors

P. O. Box 2001, 50 Keil Drive North, Chatham, ON, N7M 5M1 www.uniongas.com
Union Gas Limited

Attachment A

New / Updated 2011 DSM Measures

Drain Water Heat Recovery Units

Food Service Program

Low-Flow Showerheads

Drain Water Heat Recovery (DWHR) Units – Arena, Showering

New Construction

Description/Comment
Showering. Savings and Costs are shown per Showerhead.

Efficient Equipment and Technologies Description
Drain Water Heat Recovery (DWHR) pre-heats incoming domestic cold water with the available drain water heat that would otherwise be lost.
Base Equipment and Technologies Description
None

Decision Type	Target Market	End Use
New Construction.	Recreation Facility/ Arena. Showering.	Water Heating

Codes, Standards and Regulations

None.

Resource Savings Table

	Electricity and other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3 /showerhead)	Electricity (KWh /showerhead)	Water (L /showerhead)	($/showerhead)	($/showerhead)
1	394	0	0	$776	$0.00
2	394	0	0	$0.00	$0.00
3	394	0	0	$0.00	$0.00
4	394	0	0	$0.00	$0.00
5	394	0	0	$0.00	$0.00
6	394	0	0	$0.00	$0.00
7	394	0	0	$0.00	$0.00
8	394	0	0	$0.00	$0.00
9	394	0	0	$0.00	$0.00
10	394	0	0	$0.00	$0.00
11	394	0	0	$0.00	$0.00
12	394	0	0	$0.00	$0.00
13	394	0	0	$0.00	$0.00
14	394	0	0	$0.00	$0.00

15	394	0	0	$0.00	$0.00
16	394	0	0	$0.00	$0.00
17	394	0	0	$0.00	$0.00
18	394	0	0	$0.00	$0.00
19	394	0	0	$0.00	$0.00
20	394	0	0	$0.00	$0.00
21	394	0	0	$0.00	$0.00
22	394	0	0	$0.00	$0.00
23	394	0	0	$0.00	$0.00
24	394	0	0	$0.00	$0.00
25	394	0	0	$0.00	$0.00
Total	**9,855**	**0**	**0**	**$776**	**$0.00**

Resource Savings Assumptions

Annual Natural Gas Savings	**394**	m^3/showerhead

The savings associated with installing a DWHR system is calculated below. The value was calculated for an average facility and then divided by the average number of showerheads, resulting in savings per showerhead. This will allow for different system sizes. See below for details.

One DWHR assembly (with 2 pipes) is connected to the showers in the change rooms of the facility.

The following are the characteristics used to estimate the drain water from showers :
Showerhead flow rate: 4.7 L/min (1.25 GPM) [1]
Shower Usage Rate: 10% [2] Amount of time shower is in use.
Facility Hours of Operation: 16 hours per day [3]
Showers per Facility: 12 showers/facility [4]

$$Yearly\ Concurrent\ Drainwater\ Flow$$

$$= 4.7\ (L/min) \times 16\ (hours/day) \times 60\ (min/hour) \times 365\ (days/year) \times 10\% \times 12\ (showers/facility)$$

$$= 1{,}976{,}256\ (L/year)$$

The energy that can be recovered and therefore natural gas saved is calculated based on the following factors:
Yearly concurrent drain water flow: see above calculation
Drain water temperature for showers: 37°C [5]
Domestic Cold Water Temperature: 9.33 °C [6]
DWHR unit effectiveness for noted piping configuration: 60% [7]
Standard Natural gas water heater efficiency: 78%

$$Natural\ Gas\ Saving\ (m^3) = \frac{1{,}976{,}256\ (L/year/facility) \times 4.187\ (KJ/(Kg\ °C)) \times [37\ (^\circ C) - 9.33\ (^\circ C)] \times 60\ (\%)}{78\ (\%) \times 37230\ (KJ/m^3)}$$

$$= 4{,}731 (m^3/year)$$

394 m3/yr per showerhead = 4731 m3/yr / 12 showers per facility

Annual Electricity Savings	**0**	KWh/showerhead
N/A		
Annual Water Savings	**0**	L/showerhead
N/A		

Other Input Assumptions

Effective Useful Life (EUL)	**25**	Years
The DWHR units have a useful life in excess of 25 years. [7]		
Base & Incremental Conservation Measure Equipment and O&M Cost	**776**	$/showerhead
The cost associated with installing a DWHR system is calculated below. The value was calculated for an average facility and then divided by the average number of showerheads, resulting in costs per showerhead. DWHR assembly cost: $5,510. One assembly with 2 DWHR units (pipes) is required in this case.[8][9][10] Installation: $3,800 (total). This is calculated based on the materials, equipment and labour needed to install a unit, as estimated from RS Means $9,310 = $3,800 + $5,510 $776 per showerhead = $9,310/12 showerheads per facility. Maintenance: $0. DWHR is a passive technology and requires no maintenance similar to the piping systems that it is connected to.		
Customer Payback Period (Natural Gas Only)	**6.6**	Years
Simple payback period, based on a natural gas price of $0.30/m^3.		
Free Ridership	**5**	%
Free Ridership is approximated using market penetration, which is estimated as being low since most DWHR units are currently installed in residential markets and very little use in commercial markets, based on Enermodal's conversations with suppliers and manufacturers.		

$$Simple\ Payback\ Period\ = \frac{Incremental\ Cost}{Natural\ Gas\ Savings\ \times\ Natural\ Gas\ Cost}$$

$$= \frac{776(\$)}{394\ (m^3) \times 0.3\ (\$/m^3)} = 6.6\ (years)$$

References

[1] 1.25 GPM showerheads were used based on the likelihood of the facility participating in the low-flow showerhead program. This was agreed to by UG and their Evaluation and Audit Committee in November-December 2010.

[2] Ontario Recreation Facility Association (ORFA) indicated half of the showers are "on" 10-15 minutes/hr on average. This value will be higher for weekends and primetime periods.   10% = 12.5 minutes "on" / 60 minutes * 50% of showers

[3] Based on survey of typical rinks by Enermodal, corroborated with a web search of five rinks by UG.

[4] The typical maximum number of showers that can be ganged is 12. This is based on Enermodal's discussions with DWHR suppliers.

[5] ASHRAE Handbook 2007, HVAC Applications, Section 49 - Service Water Heating

[6] Cited in the following as personal communication with City of Toronto Works Dept. VEIC, Comments on Navigant's Draft Gas Measure Characterizations, March 2009.

[7] RenewABILITY Energy Inc., RenewABILITY Inc. Product Presentation, Delivered at Enermodal Engineering on November 2, 2009

[8] The number of assemblies required is based on the supplier RenewABILITY Energy Inc. and modified to account for the installation of low flow showerheads (1.25 GPM) instead of typical showerheads in agreement with the research contractor, Enermodal. Low flow showerheads are expected to be half the flow rate of typical showerheads.

[9] Enermodal Engineering, Development of DSM Measures and Market Information on Commercial Drain Water Heat Recovery, Rev 1., March 31, 2010

[10] The original report from Enermodal required two assemblies to service 12 typical flow showerheads. However, after the report, the showerhead flow rates were reduced by 50% (to 1.25 GPM). DWHR systems are sized according to flow rate, so if the flow rate is half of the original, the number of DWHR assemblies required will be half as well. Enermodal agreed to reduce the number of DWHR assemblies from two to one, which reduces the cost of the equipment by 50%.

Drain Water Heat Recovery (DWHR) Units – Arena, Showering

Retrofit

Description/Comment
Showering. Savings and Costs are shown per Showerhead.

Efficient Equipment and Technologies Description
Drain Water Heat Recovery (DWHR) pre-heats incoming domestic cold water with the available drain water heat that would otherwise be lost.
Base Equipment and Technologies Description
None

Decision Type	Target Market	End Use
Retrofit	Existing Recreation Facility/ Arena. Showering.	Water Heating

Codes, Standards and Regulations

None.

Resource Savings Table

	Electricity and other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3/ showerhead)	Electricity (KWh/ showerhead)	Water (L/ showerhead)	($/showerhead)	($/showerhead)
1	394	0	0	$1,209	$0.00
2	394	0	0	$0.00	$0.00
3	394	0	0	$0.00	$0.00
4	394	0	0	$0.00	$0.00
5	394	0	0	$0.00	$0.00
6	394	0	0	$0.00	$0.00
7	394	0	0	$0.00	$0.00
8	394	0	0	$0.00	$0.00
9	394	0	0	$0.00	$0.00
10	394	0	0	$0.00	$0.00
11	394	0	0	$0.00	$0.00
12	394	0	0	$0.00	$0.00
13	394	0	0	$0.00	$0.00
14	394	0	0	$0.00	$0.00

15	394	0	0	$0.00	$0.00
16	394	0	0	$0.00	$0.00
17	394	0	0	$0.00	$0.00
18	394	0	0	$0.00	$0.00
19	394	0	0	$0.00	$0.00
20	394	0	0	$0.00	$0.00
21	394	0	0	$0.00	$0.00
22	394	0	0	$0.00	$0.00
23	394	0	0	$0.00	$0.00
24	394	0	0	$0.00	$0.00
25	394	0	0	$0.00	$0.00
Total	**9,848**	**0**	**0**	**$1,209**	**$0.00**

Resource Savings Assumptions

Annual Natural Gas Savings	**394**	m^3/showerhead

The savings associated with installing a DWHR system is calculated below. The value was calculated for an average facility and then divided by the average number of showerheads, resulting in savings per showerhead. This will allow for different system sizes. See below for details.

One DWHR assembly (with 2 pipes) is connected to the showers in the change rooms of the facility.

The following are the characteristics used to estimate the drain water from showers :
Showerhead flow rate: 4.7 L/min (1.25 GPM)[1]
Shower Usage Rate: 10% [2] Amount of time shower is in use.
Facility Hours of Operation: 16 hours per day [3]
Showers per Facility: 12 showers/facility [4]

$$Yearly\ Concurrent\ Drainwater\ Flow = 4.7\ (L/min) \times 16\ (hours/day) \times 60\ (min/hour) \times 365\ (days/year) \times 10\% \times 12\ (showers/facility) = 1{,}976{,}256\ (L/year)$$

The energy that can be recovered and therefore natural gas saved is calculated based on the following factors:
Yearly concurrent drain water flow: see above calculation
Drain water temperature for showers: 37°C [5]
Domestic Cold Water Temperature: 9.33 °C [6]
DWHR unit effectiveness for noted piping configuration: 60% [7]
Standard Natural gas water heater efficiency: 78%

$$Natural\ Gas\ Saving\ (m^3) = \frac{1{,}976{,}256\ (L/year/facility) \times 4.184\ (KJ/(Kg\ °C)) \times [37\ (°C) - 9.33\ (°C)] \times 60\ (\%)}{78\ (\%) \times 37230\ (KJ/m^3)}$$

$$= 4{,}727\ (m^3/year)$$

394 m3/yr per showerhead = 4,727 m3 / 12 showers/facility

Annual Electricity Savings	**0**	KWh/showerhead

N/A

Annual Water Savings	**0**	L/showerhead

N/A

Other Input Assumptions

Effective Useful Life (EUL)	**25**	Years
The DWHR units have a useful life in excess of 25 years. [7]		
Base & Incremental Conservation Measure Equipment and O&M Cost	**1,209**	$/showerhead
The costs associated with installing a DWHR system is calculated below. The value was calculated for an average facility and then divided by the average number of showerheads, resulting in costs per showerhead. DWHR assembly cost: $5,510. One assembly with 2 DWHR units (pipes) is required in this case.[8][9][10] Installation: $9,000 (total). This is calculated based on the materials, equipment and labour needed to install a unit, in an existing building, as estimated from RS Means. $1,209 per showerhead = ($5,510 + $9,000)/12 showers/facility Maintenance: $0. DWHR is a passive technology and requires no maintenance similar to the piping systems that it is connected to.		
Customer Payback Period (Natural Gas Only)	**10.2**	Years
Simple payback period, based on a natural gas price of $0.30/m³.		
Free Ridership	**5**	%
Free Ridership is approximated using market penetration, which is estimated as being low since most DWHR units are currently installed in residential markets and very little use in commercial markets, based on Enermodal's conversations with suppliers and manufacturers.		

Simple payback period, based on a natural gas price of $\$0.30/m^3$.

$$Simple\ Payback\ Period\ =\ \frac{Incremental\ Cost}{Natural\ Gas\ Savings\ \times\ Natural\ Gas\ Cost}$$

$$=\frac{1{,}209(\$)}{394\ (m^3)\times 0.3\ (\$/m^3)}=10.2\ (years)$$

References

[1] 1.25 GPM showerheads were used based on the likelihood of the facility participating in the low-flow showerhead program. This was agreed to by UG and their Evaluation and Audit Committee in November-December 2010.

[2] Ontario Recreation Facility Association (ORFA) indicated half of the showers are "on" 10-15 minutes/hr on average. This value will be higher for weekends and primetime periods. 10% = 12.5 minutes "on" / 60 minutes * 50% of showers

[3] Based on survey of typical rinks by Enermodal, corroborated with a web search of five rinks by UG.

[4] The typical maximum number of showers that can be ganged is 12. This is based on Enermodal's discussions with DWHR suppliers.

[5] ASHRAE Handbook 2007, HVAC Applications, Section 49 - Service Water Heating

[6] Cited in the following as personal communication with City of Toronto Works Dept. VEIC, Comments on Navigant's Draft Gas Measure Characterizations, March 2009.

[7] RenewABILITY Energy Inc., RenewABILITY Inc. Product Presentation, Delivered at Enermodal Engineering on November 2, 2009

[8] The number of assemblies required is based on the DWHR supplier RenewABILITY Energy Inc. and modified to account for the installation of low flow showerheads (1.25 GPM) instead of typical showerheads in agreement with the research contractor, Enermodal. Low flow showerheads are expected to be half the flow rate of typical showerheads.

[9] Enermodal Engineering, Development of DSM Measures and Market Information on Commercial Drain Water Heat Recovery, Rev 1., March 31, 2010

[10] The original report from Enermodal required two assemblies to service 12 typical flow showerheads. However, after the report, the showerhead flow rates were reduced by 50% (to 1.25 GPM). DWHR systems are sized according to flow rate, so if the flow rate is half of the original, the number of DWHR assemblies required will be half as well. Enermodal agreed to reduce the number of DWHR assemblies from two to one, which reduces the cost of the equipment by 50%.

Drain Water Heat Recovery (DWHR) Units – Hospital, Dishwashing

New Construction

Description/Comment
Continuous Flow Dishwasher. Savings and Costs are shown per Bed.

Efficient Equipment and Technologies Description
Drain Water Heat Recovery (DWHR) pre-heats incoming domestic cold water with the available drain water heat that would otherwise be lost. This measure applies only to DWHR systems installed with Continuous Flow Dishwashers where there is concurrent hot water flow in and drain water flow out of the DWHR system.
Base Equipment and Technologies Description
None

Decision Type	Target Market	End Use
New Construction.	Hospital. Kitchen Dishwashing. Continuous Flow Dishwasher.	Water Heating

Codes, Standards and Regulations

None.

Resource Savings Table

	Electricity and other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3 / Bed)	Electricity (KWh / Bed)	Water (L / Bed)	($ / Bed)	($ / Bed)
1	12	0	0	$11.88	$0.00
2	12	0	0	$0.00	$0.00
3	12	0	0	$0.00	$0.00
4	12	0	0	$0.00	$0.00
5	12	0	0	$0.00	$0.00
6	12	0	0	$0.00	$0.00
7	12	0	0	$0.00	$0.00
8	12	0	0	$0.00	$0.00
9	12	0	0	$0.00	$0.00
10	12	0	0	$0.00	$0.00
11	12	0	0	$0.00	$0.00
12	12	0	0	$0.00	$0.00
13	12	0	0	$0.00	$0.00

14	12	0	0	$0.00	$0.00
15	12	0	0	$0.00	$0.00
16	12	0	0	$0.00	$0.00
17	12	0	0	$0.00	$0.00
18	12	0	0	$0.00	$0.00
19	12	0	0	$0.00	$0.00
20	12	0	0	$0.00	$0.00
21	12	0	0	$0.00	$0.00
22	12	0	0	$0.00	$0.00
23	12	0	0	$0.00	$0.00
24	12	0	0	$0.00	$0.00
25	12	0	0	$0.00	$0.00
Total	**311**	**0**	**0**	**$11.88**	**$0.00**

Resource Savings Assumptions

Annual Natural Gas Savings	**12**	m^3/Bed

The savings associated with installing a DWHR system is calculated below. The value was calculated for an average facility and then divided by the average number of beds in a hospital, resulting in savings per bed. See below for details.

One DWHR unit is connected to the dishwasher drain and used to preheat the water before the dishwasher water heater. A continuous flow dishwasher is used for the calculations.

The following are the characteristics used to estimate the drain water from the dishwashers:
Water Use per Meal:
= 9.1 (L/meal) * (1-70%)) [1]
= 2.7 (L/meal)
Average hospital size: 149 beds [2]
Percentage of beds requiring meals: 75% [3]
Additional meals for staff: 20% [3]
Percentage of water use per meal for dishwashers: 80% [4]

$$Yearly\ Concurrent\ Drainwater\ Flow$$

$$= 2.7\ (L/meal) \times 3\ (meals/day) \times 365\ (days/year) \times 149\ (beds/hospital) \times 75\%\ (beds\ requiring\ meals) \times 120\%\ (staff\ meals) \times 80\%$$

$$= 317{,}173\ (L/year)$$

The energy that can be recovered and therefore natural gas saved is calculated based on the following factors:
Yearly concurrent drain water flow: see above calculation
Drain water temperature for dishwasher: 77°C [1]
Domestic Cold Water Temperature: 9.33 °C [5]
DWHR unit effectiveness for noted piping configuration: 60% [6]
Standard Natural gas water heater efficiency: 78%

$Natural\ Gas\ Saving\ (m^3) = \frac{317{,}173\ (L/year)\ \times\ 4.184\ (KJ/(Kg\ ^\circ C))\ \times\ [77\ (^\circ C) - 9.33\ (^\circ C)]\ \times\ 60\ (\%)}{78\ (\%)\ \times\ 37230\ (KJ/m^3)}$ $= 1{,}856\ (m^3/year)$ 12 m3/yr per bed = 1,856m3/yr / 149 beds		
Annual Electricity Savings	**0**	KWh/Bed
N/A		
Annual Water Savings	**0**	L/Bed
N/A		

Other Input Assumptions

Effective Useful Life (EUL)	**25**	Years
The DWHR units have a useful life in excess of 25 years. [6]		
Base & Incremental Conservation Measure Equipment and O&M Cost	**11.88**	$/Bed
The costs associated with installing a DWHR system is calculated below. The value was calculated for an average facility and then divided by the average number of beds per facility, resulting in a cost per bed. DWHR unit cost: $1,030 [7] Installation: $740. This is calculated based on the materials, equipment and labour needed to install a unit, as estimated from RS Means. $11.88 = ($1,030 + $740)/149 beds/facility Maintenance: $0. DWHR is a passive technology and requires no maintenance similar to the piping systems that it is connected to.[8]		
Customer Payback Period (Natural Gas Only)	**3.3**	Years
Simple payback period, based on a natural gas price of $0.30/m^3. $Simple\ Payback\ Period = \frac{Incremental\ Cost}{Natural\ Gas\ Savings\ \times\ Natural\ Gas\ Cost}$ $= \frac{11.88(\$)}{12\ (m^3) \times 0.3\ (\$/m^3)} = 3.3\ (years)$		
Free Ridership	**5**	%
Free Ridership is approximated using market penetration, which is estimated as being low since most DWHR units are currently installed in residential markets and very little use in commercial markets, based on Enermodal's conversations with suppliers and manufacturers.		

References

[1] The 9.1 (L/meal) value originates from ASHRAE Handbook 2007, HVAC Applications, Section 49 - Service Water Heating and is associated with a study from the 70's. This value was updated by multiplying it by one minus the % reduction in water use by Conveyor and Flight-Type machines since then, gathered from a manufacturer (Suzanne Supplee - Champion Industries/BiLine) and Genevieve Bussieres from Natural Gas Technology Centre (NGTC) quoting an NSF study and conversations with Hobart (another manufacturer). The 70% reduction in water use value was chosen for this calculation based on the above sources (68% from Champion and 70-72% from NGTC's findings).

[2] Ontario Hospital Association, Health System Facts and Figures- Beds Staffed and in Operation, Ontario, 2009. Available at http://www.healthsystemfacts.com

[3] Grand River Hospital - Diet Office of the Nutrition/Food Service Department

[4] Wexiodisk, Rack Conveyor Dishwasher, 2006. Available at www.wexiodisk.com

[5] Cited in the following as personal communication with City of Toronto Works Dept. VEIC, Comments on Navigant's Draft Gas Measure Characterizations, March 2009.

[6] RenewABILITY Energy Inc., RenewABILITY Inc. Product Presentation, Delivered at Enermodal Engineering on November 2, 2009

[7] RenewABILITY Energy Inc.

[8] Enermodal Engineering, Development of DSM Measures and Market Information on Commercial Drain Water Heat Recovery, Rev 1., March 31, 2010

Drain Water Heat Recovery (DWHR) Units – Hospital, Dishwashing

Retrofit

Description/Comment
Continuous Flow Dishwasher. Savings and Costs are shown per Bed.

Efficient Equipment and Technologies Description
Drain Water Heat Recovery (DWHR) pre-heats incoming domestic cold water with the available drain water heat that would otherwise be lost. This measure applies only to DWHR systems installed with Continuous Flow Dishwashers where there is concurrent hot water flow in and drain water flow out of the DWHR system.
Base Equipment and Technologies Description
None

Decision Type	Target Market	End Use
Retrofit	Existing Hospital. Kitchen Dishwashing. Continuous Flow Dishwashers.	Water Heating

Codes, Standards and Regulations

None.

Resource Savings Table

	Electricity and other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3 / Bed)	Electricity (KWh / Bed)	Water (L / Bed)	($ / Bed)	($ / Bed)
1	31	0	0	$18.19	$0.00
2	31	0	0	$0.00	$0.00
3	31	0	0	$0.00	$0.00
4	31	0	0	$0.00	$0.00
5	31	0	0	$0.00	$0.00
6	31	0	0	$0.00	$0.00
7	31	0	0	$0.00	$0.00
8	31	0	0	$0.00	$0.00
9	31	0	0	$0.00	$0.00
10	31	0	0	$0.00	$0.00
11	31	0	0	$0.00	$0.00
12	31	0	0	$0.00	$0.00
13	31	0	0	$0.00	$0.00

14	31	0	0	$0.00	$0.00
15	31	0	0	$0.00	$0.00
16	31	0	0	$0.00	$0.00
17	31	0	0	$0.00	$0.00
18	31	0	0	$0.00	$0.00
19	31	0	0	$0.00	$0.00
20	31	0	0	$0.00	$0.00
21	31	0	0	$0.00	$0.00
22	31	0	0	$0.00	$0.00
23	31	0	0	$0.00	$0.00
24	31	0	0	$0.00	$0.00
25	31	0	0	$0.00	$0.00
Total	**775**	**0**	**0**	**$18.19**	**$0.00**

Resource Savings Assumptions

Annual Natural Gas Savings	**31**	m^3/Bed

The savings associated with installing a DWHR system is calculated below. The value was calculated for an average facility and then divided by the average number of beds in a hospital, resulting in savings per bed. See below for details.

One DWHR unit is connected to the dishwasher drain and used to preheat the water before the dishwasher water heater. A continuous flow dishwasher is used for the calculations.

The following are the characteristics used to estimate the drain water from the dishwashers:
Water Use per Meal
= 9.1 (L/meal) * (1-70%)/(1-60%) [1]
= 6.8 (L/meal)
Average hospital size: 149 beds [2]
Percentage of beds requiring meals: 75% [3]
Additional meals for staff: 20% [3]
Percentage of water use per meal for dishwashers: 80% [4]

$$Yearly\ Concurrent\ Drainwater\ Flow = 6.8\ (L/meal) \times 3\ (meals/day) \times 365\ (days/year) \times 149\ (beds/hospital) \times 75\%\ (beds\ requiring\ meals) \times 120\%\ (staff\ meals) \times 80\% = 798{,}807\ (L/year)$$

The energy that can be recovered and therefore natural gas saved is calculated based on the following factors:
Yearly concurrent drain water flow: see above calculation
Drain water temperature for dishwasher: 77°C [1]
Domestic Cold Water Temperature: 9.33 °C [5]
DWHR unit effectiveness for noted piping configuration: 60% [6]
Standard Natural gas water heater efficiency: 78%

$$Natural\ Gas\ Saving\ (m^3) = \frac{798{,}807\ (L/year) \times 4.184\ (KJ/(Kg\ ^\circ C)) \times [77\ (^\circ C) - 9.33\ (^\circ C)] \times 60\ (\%)}{78\ (\%) \times 37230\ (KJ/m^3)} = 4{,}673\ (m^3/year)$$

$31m^3$ per bed = 4,673 m^3 / 149 beds per facility		
Annual Electricity Savings	**0**	KWh/Bed
N/A		
Annual Water Savings	**0**	L/Bed
N/A		

Other Input Assumptions

Effective Useful Life (EUL)	**25**	Years
The DWHR units have a useful life in excess of 25 years. [6]		
Base & Incremental Conservation Measure Equipment and O&M Cost	**18.19**	$/Bed
The costs associated with installing a DWHR system is calculated below. The value was calculated for an average facility and then divided by the average number of beds per facility, resulting in a cost per bed. DWHR unit cost: $1,030 [7] Installation: $1,680. This is calculated based on the materials, equipment and labour needed to install a unit, in an existing building, as estimated from RS Means. Maintenance: $0. DWHR is a passive technology and requires no maintenance similar to the piping systems that it is connected to.[8] $18.19 per bed = ($1,030 + $1,680) / 149 beds per facility		
Customer Payback Period (Natural Gas Only)	**1.9**	Years
Simple payback period, based on a natural gas price of $0.30/m^3$. $$Simple\ Payback\ Period\ = \frac{Incremental\ Cost}{Natural\ Gas\ Savings\ \times\ Natural\ Gas\ Cost}$$ $$= \frac{18.19(\$)}{31\ (m^3) \times 0.3\ (\$/m^3)} = 1.9\ (years)$$		
Free Ridership	**5**	%
Free Ridership is approximated using market penetration, which is estimated as being low since most DWHR units are currently installed in residential markets and very little use in commercial markets, based on Enermodal's conversations with suppliers and manufacturers.		

References

[1] The 9.1 (L/meal) value originates from the ASHRAE Handbook 2007, HVAC Applications, Section 49 - Service Water Heating and is associated with a study from the 70's. This value was updated to reflect water use from middle-aged equipment as expected in existing buildings. Machines in existing buildings are expected to be typically 10 years old based on the equipment life of 20 years, which in-turn came from the Food Service Technology Center (FSTC) as cited in NGTC, DSM OPPORTUNITIES ASSOCIATED WITH COMMERCIAL DISHWASHERS, Final Report, April 27, 2009, pg 17.).

In order to take this into account, the 9.1 value was multiplied by one minus the 70% reduction in water use by Conveyor and Flight-Type machines since the 70's, then divided by one minus the 60% reduction in water-use of new machines vs. machines built 10 years ago. This data was gathered from a manufacturer (Suzanne Supplee - Champion Industries/BiLine) and Genevieve Bussieres from the Natural Gas Technology Centre (NGTC) quoting an NSF study and conversations with Hobart (another manufacturer). The 70% reduction in water use value was chosen for this calculation based on the above sources (68% from Champion and 70-72% from NGTC's findings). The 60% reduction value was chosen based on the same sources (61% from Champion and 58% from NGTC's findings).[2] Ontario Hospital Association, Health System Facts and Figures- Beds Staffed and in Operation, Ontario, 2009. Available at http://www.healthsystemfacts.com

[3] Grand River Hospital - Diet Office of the Nutrition/Food Service Department

[4] Wexiodisk, Rack Conveyor Dishwasher, 2006. Available at www.wexiodisk.com

[5] Cited in the following as personal communication with City of Toronto Works Dept. VEIC, Comments on Navigant's Draft Gas Measure Characterizations, March 2009.

[6] RenewABILITY Energy Inc., RenewABILITY Inc. Product Presentation, Delivered at Enermodal Engineering on November 2, 2009

[7] RenewABILITY Energy Inc.

[8] Enermodal Engineering, Development of DSM Measures and Market Information on Commercial Drain Water Heat Recovery, Rev 1., March 31, 2010

Drain Water Heat Recovery (DWHR) Units – Hospital, Laundry

New Construction

Description/Comment
Laundry - with storage tank and pumping equipment. Savings and Costs are shown per Bed.

Efficient Equipment and Technologies Description
Drain Water Heat Recovery (DWHR) pre-heats incoming domestic cold water with the available drain water heat that would otherwise be lost. A storage tank and pumping equipment is needed for batch-style (ie. front load or top load) Laundry equipment to ensure cold water flows into the DWHR system and warm drain water flows out concurrently.
Base Equipment and Technologies Description
None

Decision Type	Target Market	End Use
New Construction	Hospital. On-premise Laundry. Laundry Equipment	Water Heating

Codes, Standards and Regulations

None.

Resource Savings Table

	Electricity and other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3/Bed)	Electricity (KWh/Bed)	Water (L/Bed)	($/Bed)	($/Bed)
1	295	0	0	$213.56	$0.00
2	295	0	0	$3.66	$0.00
3	295	0	0	$3.33	$0.00
4	295	0	0	$3.03	$0.00
5	295	0	0	$2.75	$0.00
6	295	0	0	$2.50	$0.00
7	295	0	0	$2.27	$0.00
8	295	0	0	$2.07	$0.00
9	295	0	0	$1.88	$0.00
10	295	0	0	$1.71	$0.00
11	295	0	0	$1.55	$0.00
12	295	0	0	$1.41	$0.00
13	295	0	0	$1.28	$0.00

14	295	0	0	$1.17	$0.00
15	295	0	0	$1.06	$0.00
16	295	0	0	$0.96	$0.00
17	295	0	0	$0.88	$0.00
18	295	0	0	$0.80	$0.00
19	295	0	0	$0.72	$0.00
20	295	0	0	$0.66	$0.00
21	295	0	0	$0.60	$0.00
22	295	0	0	$0.54	$0.00
23	295	0	0	$0.49	$0.00
24	295	0	0	$0.45	$0.00
25	295	0	0	$0.41	$0.00
Total	**7,365**	**0**	**0**	**$250**	**$0.00**

Resource Savings Assumptions

Annual Natural Gas Savings	**295**	m^3/Bed

The savings associated with installing a DWHR system is calculated below. The value was calculated for an average facility and then divided by the average number of beds in a hospital, resulting in savings per bed. See below for details.

One manifolded DWHR assembly (made of (4) units or pipes) is connected, with storage and pumping equipment to the on-premise laundry equipment in the hospital.

The following are the characteristics used to estimate the drain water from the laundry equipment:
Water Usage Rate: 9.5 L/lb [1]
Average hospital size: 149 beds [2]
Quantity of Laundry: 18 Lbs/Room/day [3]

$$Yearly\ Concurrent\ Drainwater\ Flow$$
$$= 9.5\ (L/lb) \times 18\ (lbs/room/day) \times 149\ (beds) \times 365\ (days)$$
$$= 9{,}299{,}835\ (L/year)$$

The energy that can be recovered and therefore natural gas saved is calculated based on the following factors:
Yearly concurrent drain water flow: see above calculation
Drain water temperature for laundry equipment: 70°C [4]
Domestic Cold Water Temperature: 9.33 °C [5]
DWHR unit effectiveness for noted piping configuration: 60% [6]
Storage losses derating factor: 90% [7]
Standard Natural gas water heater efficiency: 78%

$$Natural\ Gas\ Saving\ (m^3)$$
$$= \frac{9{,}299{,}835\ \left(\frac{L}{year}\right) \times 4.184\ \left(\frac{KJ}{Kg\ °C}\right) \times [70\ (°C) - 9.33\ (°C)] \times 60\ (\%) \times 90\ (\%)}{78\ (\%) \times 37230\ \left(\frac{KJ}{m^3}\right)}$$

$= 43{,}898\ (m^3/year)$ 295 m^3 per Bed = 43,898 m^3 / 149 Beds per facility		
Annual Electricity Savings	**0**	KWh/Bed
N/A		
Annual Water Savings	**0**	L/Bed
N/A		

Other Input Assumptions

Effective Useful Life (EUL)	**25**	Years
The DWHR units have a useful life in excess of 25 years. [6]		
Base & Incremental Conservation Measure Equipment and O&M Cost	**250**	$/Bed
The costs associated with installing a DWHR system is calculated below. The value was calculated for an average facility and then divided by the average number of beds per facility, resulting in a cost per bed. DWHR assembly cost: $12,920.[8] One assembly made up of (4) units (pipes) is required. Accessories cost: $13,500. Includes costs for pumps, storage tank, controls and other necessary equipment for non-concurrent flow applications. Installation: $4,800. This is calculated based on the materials, equipment and labour needed to install a unit, as estimated from RS Means. Maintenance: $600. DWHR is a passive technology and requires no maintenance similar to the piping systems that it is connected to.[9] However, the storage tank and pump will require yearly maintenance and the pump requires some energy to operate. A discount rate of 10%, consistent with the TRC calculation, is applied to the yearly O&M cost, to calculate the NPV ($5991). $250 per Bed = ($12,920 + $13,500 + $4,800 + $5,991)/ 149 Beds		
Customer Payback Period (Natural Gas Only)	**2.5**	Years
Simple payback period, based on a natural gas price of $0.30/m^3$. $Simple\ Payback\ Period\ = \frac{Incremental\ Cost}{Natural\ Gas\ Savings\ \times\ Natural\ Gas\ Cost - Yearly\ Cost}$ $= \frac{(\frac{31{,}220}{149\ Beds})(\$)}{295\ (m^3) \times 0.3\ \left(\frac{\$}{m^3}\right) - (\frac{600}{149\ Beds})\ (\$)} = 2.5\ (years)$		
Free Ridership	**5**	%
Free Ridership is approximated using market penetration, which is estimated as being low since most DWHR units are currently installed in residential markets and very little use in commercial markets, based on Enermodal's conversations with suppliers and manufacturers.		

References

[1] Alliance for Water Efficiency, Commercial Laundry Facilities Introduction, 2009. Available at http://www.allianceforwaterefficiency.org/commercial_laundry.aspx

[2] Ontario Hospital Association, Health System Facts and Figures- Beds Staffed and in Operation, Ontario, 2009. Available at http://www.healthsystemfacts.com

[3] Department of Veteran Affairs, Veterans Health Administration: Environmental Management Service Laundry and Linen Operations, March 2008. Available at http://www.wbdg.org/ccb/VA/VASPACE/7610-408.pdf

[4] ASHRAE Handbook 2007, HVAC Applications, Section 49- Service Water Heating

[5] Cited in the following as personal communication with City of Toronto Works Dept. VEIC, Comments on Navigant's Draft Gas Measure Characterizations, March 2009.

[6] RenewABILITY Energy Inc., RenewABILITY Inc. Product Presentation, Delivered at Enermodal Engineering on November 2, 2009

[7] Value is from common industry practice, communication with Enermodal Engineering, November 2010.

[8] RenewABILITY Energy Inc.

[9] Enermodal Engineering, Development of DSM Measures and Market Information on Commercial Drain Water Heat Recovery, Rev 1., March 31, 2010

Drain Water Heat Recovery (DWHR) Units – Hospital, Laundry

Retrofit

Description/Comment
Laundry - with storage tank and pumping equipment. Savings and Costs are shown per Bed.

Efficient Equipment and Technologies Description
Drain Water Heat Recovery (DWHR) pre-heats incoming domestic cold water with the available drain water heat that would otherwise be lost. A storage tank and pumping equipment is needed for batch-style (ie. front load or top load) Laundry equipment to ensure cold water flows into the DWHR system and warm drain water flows out concurrently.
Base Equipment and Technologies Description
None

Decision Type	Target Market	End Use
Retrofit	Existing Hospital. On-premise Laundry. Laundry Equipment.	Water Heating

Codes, Standards and Regulations

None.

Resource Savings Table

	Electricity and other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3/Bed)	Electricity (KWh/Bed)	Water (L/Bed)	($/Bed)	($/Bed)
1	295	0	0	$237.72	$0.00
2	295	0	0	$3.66	$0.00
3	295	0	0	$3.33	$0.00
4	295	0	0	$3.03	$0.00
5	295	0	0	$2.75	$0.00
6	295	0	0	$2.50	$0.00
7	295	0	0	$2.27	$0.00
8	295	0	0	$2.07	$0.00
9	295	0	0	$1.88	$0.00
10	295	0	0	$1.71	$0.00
11	295	0	0	$1.55	$0.00
12	295	0	0	$1.41	$0.00
13	295	0	0	$1.28	$0.00

14	295	0	0	$1.17	$0.00
15	295	0	0	$1.06	$0.00
16	295	0	0	$0.96	$0.00
17	295	0	0	$0.88	$0.00
18	295	0	0	$0.80	$0.00
19	295	0	0	$0.72	$0.00
20	295	0	0	$0.66	$0.00
21	295	0	0	$0.60	$0.00
22	295	0	0	$0.54	$0.00
23	295	0	0	$0.49	$0.00
24	295	0	0	$0.45	$0.00
25	295	0	0	$0.41	$0.00
Total	**7,365**	**0**	**0**	**$274**	**$0.00**

Resource Savings Assumptions

Annual Natural Gas Savings	**295**	m^3/Bed

The savings associated with installing a DWHR system is calculated below. The value was calculated for an average facility and then divided by the average number of beds in a hospital, resulting in savings per bed. See below for details.

One manifolded DWHR assembly (made of (4) units or pipes) is connected with storage and pumping equipment to the on-premise laundry equipment in the hospital.

The following are the characteristics used to estimate the drain water from the laundry equipment:
Water Usage Rate: 9.5 L/lb [1]
Average hospital size: 149 beds [2]
Quantity of Laundry: 18 Lbs/Room/day [3]

$$Yearly\ Concurrent\ Drainwater\ Flow$$
$$= 9.5\ (L/lb)\ \times\ 18\ (lbs/room/day)\ \times 149\ (beds)\ \times\ 365\ (days)$$
$$= 9{,}299{,}835\ (L/year)$$

The energy that can be recovered and therefore natural gas saved is calculated based on the following factors:
Yearly concurrent drain water flow: see above calculation
Drain water temperature for laundry equipment: 70°C [4]
Domestic Cold Water Temperature: 9.33 °C [5]
DWHR unit effectiveness for noted piping configuration: 60% [6]
Storage losses derating factor: 90% [7]
Standard Natural gas water heater efficiency: 78%

$$Natural\ Gas\ Saving\ (m^3)$$
$$= \frac{9{,}299{,}835\ \left(\frac{L}{year}\right) \times\ 4.184\ \left(\frac{KJ}{Kg\ °C}\right) \times\ [70\ (°C) - \ 9.33\ (°C)] \times\ 60\ (\%) \times\ 90\ (\%)}{78\ (\%) \times\ 37230\ \left(\frac{KJ}{m^3}\right)}$$
$$= 43{,}898\ (m^3/year)$$

295 m3 per Bed = 43,898 m3 / 149 Beds per facility

Annual Electricity Savings	**0**	KWh/Bed

N/A

Annual Water Savings	**0**	L/Bed
N/A		

Other Input Assumptions

Effective Useful Life (EUL)	**25**	Years
The DWHR units have a useful life in excess of 25 years. [6]		
Base & Incremental Conservation Measure Equipment and O&M Cost	**274**	$/Bed
The costs associated with installing a DWHR system is calculated below. The value was calculated for an average facility and then divided by the average number of beds per facility, resulting in a cost per bed. DWHR assembly cost: $12,920.[8] One assembly made up of (4) units (pipes) is required. Accessories cost: $13,500. Includes costs for pumps, storage tank, controls and other necessary equipment for non-concurrent flow applications. Installation: $8,400. This is calculated based on the materials, equipment and labour needed to install a unit, in an existing building, as estimated from RS Means. Maintenance: $600. DWHR is a passive technology and requires no maintenance similar to the piping systems that it is connected to. [9] However, the storage tank and pump will require yearly maintenance and the pump requires some energy to operate. A discount rate of 10%, consistent with the TRC calculation, is applied to the yearly O&M cost, to calculate the NPV ($5991). $274 per Bed = ($12,920 + $13,500 + $8,400 + $5,991)/ 149 Beds per Facility		
Customer Payback Period (Natural Gas Only)	**2.8**	Years
Simple payback period, based on a natural gas price of $0.30/m^3. $$Simple\ Payback\ Period = \frac{Incremental\ Cost}{Natural\ Gas\ Savings \times Natural\ Gas\ Cost - Yearly\ Cost}$$ $$= \frac{(\frac{34{,}820}{149\ Beds})(\$)}{295\ (m^3) \times 0.3\ \left(\frac{\$}{m^3}\right) - (\frac{600}{149\ Beds})\ (\$)} = 2.8\ (years)$$		
Free Ridership	**5**	%
Free Ridership is approximated using market penetration, which is estimated as being low since most DWHR units are currently installed in residential markets and very little use in commercial markets, based on Enermodal's conversations with suppliers and manufacturers.		

References

[1] Alliance for Water Efficiency, Commercial Laundry Facilities Introduction, 2009. Available at http://www.allianceforwaterefficiency.org/commercial_laundry.aspx

[2] Ontario Hospital Association, Health System Facts and Figures- Beds Staffed and in Operation, Ontario, 2009.

Available at http://www.healthsystemfacts.com

[3] Department of Veteran Affairs, Veterans Health Administration: Environmental Management Service Laundry and Linen Operations, March 2008. Available at http://www.wbdg.org/ccb/VA/VASPACE/7610-408.pdf

[4] ASHRAE Handbook 2007, HVAC Applications, Section 49- Service Water Heating

[5] Cited in the following as personal communication with City of Toronto Works Dept. VEIC, Comments on Navigant's Draft Gas Measure Characterizations, March 2009.[6] RenewABILITY Energy Inc., RenewABILITY Inc. Product Presentation, Delivered at Enermodal Engineering on November 2, 2009

[7] Value is from common industry practice, communication with Enermodal Engineering, November 2010.

[8] RenewABILITY Energy Inc.

[9] Enermodal Engineering, Development of DSM Measures and Market Information on Commercial Drain Water Heat Recovery, Rev 1., March 31, 2010

Drain Water Heat Recovery (DWHR) Units – Nursing Home, Dishwashing

New Construction

Description/Comment
Continuous Flow Dishwasher. Saving and Costs are shown per Bed.

Efficient Equipment and Technologies Description
Drain Water Heat Recovery (DWHR) pre-heats incoming domestic cold water with the available drain water heat that would otherwise be lost. This measure applies only to DWHR systems installed with Continuous Flow Dishwashers where there is concurrent hot water flow in and drain water flow out of the DWHR system.
Base Equipment and Technologies Description
None

Decision Type	Target Market	End Use
New Construction.	Nursing Home. Kitchen Dishwashing. Continuous Flow Dishwasher.	Water Heating

Codes, Standards and Regulations

None.

Resource Savings Table

	Electricity and other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3/Bed)	Electricity (KWh/Bed)	Water (L/Bed)	($/Bed)	($/Bed)
1	12	0	0	$16.54	$0.00
2	12	0	0	$0.00	$0.00
3	12	0	0	$0.00	$0.00
4	12	0	0	$0.00	$0.00
5	12	0	0	$0.00	$0.00
6	12	0	0	$0.00	$0.00
7	12	0	0	$0.00	$0.00
8	12	0	0	$0.00	$0.00
9	12	0	0	$0.00	$0.00
10	12	0	0	$0.00	$0.00
11	12	0	0	$0.00	$0.00
12	12	0	0	$0.00	$0.00
13	12	0	0	$0.00	$0.00

14	12	0	0	$0.00	$0.00
15	12	0	0	$0.00	$0.00
16	12	0	0	$0.00	$0.00
17	12	0	0	$0.00	$0.00
18	12	0	0	$0.00	$0.00
19	12	0	0	$0.00	$0.00
20	12	0	0	$0.00	$0.00
21	12	0	0	$0.00	$0.00
22	12	0	0	$0.00	$0.00
23	12	0	0	$0.00	$0.00
24	12	0	0	$0.00	$0.00
25	12	0	0	$0.00	$0.00
Total	**311**	**0**	**0**	**$16.54**	**$0.00**

Resource Savings Assumptions

Annual Natural Gas Savings	**12**	m^3/Bed

The savings associated with installing a DWHR system is calculated below. The value was calculated for an average facility and then divided by the average number of beds in a Nursing Home, resulting in savings per bed. See below for details.

One DWHR unit is connected to the dishwasher drain and used to preheat the water before the dishwasher water heater. A continuous flow dishwasher is used for the calculations.

The following are the characteristics used to estimate the drain water from the dishwashers:
Water Use per Meal:
= 9.1 (L/meal) * (1-70%) [1]
= 2.7 (L/meal)Average Nursing Home size: 107 beds [2]
Percentage of beds requiring meals: 75% [3]
Additional meals for staff: 20% [3]
Percentage of water use per meal for dishwashers: 80% [4]

$$Yearly\ Concurrent\ Drainwater\ Flow$$
$$= 2.7\ (L/meal)\ \times\ 3\ (meals/day)\ \times\ 365\ (days/year)\ \times 107\ \left(\frac{beds}{Nursing\ Home}\right) \times\ 75\%\ \ (beds\ requiring\ meals) \times 120\%\ (staff\ meals)\ \times 80\%$$
$$=\ 227{,}769 (L/year)$$

The energy that can be recovered and therefore natural gas saved is calculated based on the following factors:
Yearly concurrent drain water flow: see above calculation
Drain water temperature for dishwasher: 77°C [1]
Domestic Cold Water Temperature: 9.33 °C [5]
DWHR unit effectiveness for noted piping configuration: 60% [6]
Standard Natural gas water heater efficiency: 78%

$$Natural\ Gas\ Saving\ (m^3) = \frac{227{,}769\ (L/year)\ \times\ 4.184\ (KJ/(Kg\ °C))\ \times\ [77\ (°C) - 9.33\ (°C)]\ \times\ 60\ (\%)}{78\ (\%)\ \times\ 37230\ (KJ/m^3)}$$
$$= 1{,}332 (m^3/year)$$

12 m3/yr = 1,332 m3 / 107 Beds per facility

Annual Electricity Savings	**0**	KWh/Bed
N/A		
Annual Water Savings	**0**	L/Bed
N/A		

Other Input Assumptions

Effective Useful Life (EUL)	**25**	Years
The DWHR units have a useful life in excess of 25 years. [6]		
Base & Incremental Conservation Measure Equipment and O&M Cost	**16.54**	$/Bed
The costs associated with installing a DWHR system is calculated below. The value was calculated for an average facility and then divided by the average number of beds per facility, resulting in a cost per bed. DWHR unit cost: $1,030 [7] Installation: $740. This is calculated based on the materials, equipment and labour needed to install a unit, as estimated from RS Means. Maintenance: $0. DWHR is a passive technology and requires no maintenance similar to the piping systems that it is connected to.[8] $16.54 / Bed = $1,030 + $740)/107 Beds per facility		
Customer Payback Period (Natural Gas Only)	**4.6**	Years
Simple payback period, based on a natural gas price of $0.30/m^3. $$Simple\ Payback\ Period\ = \frac{Incremental\ Cost}{Natural\ Gas\ Savings\ \times\ Natural\ Gas\ Cost}$$ $$= \frac{16.54(\$)}{12\ (m^3) \times 0.3\ (\$/m^3)} = 4.6\ (years)$$		
Free Ridership	**5**	%
Free Ridership is approximated using market penetration, which is estimated as being low since most DWHR units are currently installed in residential markets and very little use in commercial markets, based on Enermodal's conversations with suppliers and manufacturers.		

References

[1] The 9.1 (L/meal) value originates from ASHRAE Handbook 2007, HVAC Applications, Section 49 - Service Water Heating and is associated with a study from the 70's. This value was updated by multiplying it by one minus the % reduction in water use by Conveyor and Flight-Type machines since then, gathered from a manufacturer (Suzanne Supplee - Champion Industries/BiLine) and Genevieve Bussieres from Natural Gas Technology Centre (NGTC) quoting an NSF study and conversations with Hobart (another manufacturer). The 70% reduction in water use value was

chosen for this calculation based on the above sources (68% from Champion and 70-72% from NGTC's findings).

[2] American Health Care Association, Trends in Nursing Facility Characteristics, December 2009. Available at http://www.ahcancal.org/Pages/Default.aspx

[3] Grand River Hospital - Diet Office of the Nutrition/Food Service Department.

[4] Wexiodisk, Rack Conveyor Dishwasher, 2006. Available at www.wexiodisk.com

[5] Cited in the following as personal communication with City of Toronto Works Dept. VEIC, Comments on Navigant's Draft Gas Measure Characterizations, March 2009.

[6] RenewABILITY Energy Inc., RenewABILITY Inc. Product Presentation, Delivered at Enermodal Engineering on November 2, 2009

[7] RenewABILITY Energy Inc.

[8] Enermodal Engineering, Development of DSM Measures and Market Information on Commercial Drain Water Heat Recovery, Rev 1., March 31, 2010

Drain Water Heat Recovery (DWHR) Units – Nursing Home, Dishwashing

Retrofit

Description/Comment
Continuous Flow Dishwasher. Savings and Costs are shown per Bed.

Efficient Equipment and Technologies Description
Drain Water Heat Recovery (DWHR) pre-heats incoming domestic cold water with the available drain water heat that would otherwise be lost. This measure applies only to DWHR systems installed with Continuous Flow Dishwashers where there is concurrent hot water flow in and drain water flow out of the DWHR system.
Base Equipment and Technologies Description
None

Decision Type	Target Market	End Use
Retrofit	Existing Nursing Home. Kitchen Dishwashing. Continuous Flow Dishwasher.	Water Heating

Codes, Standards and Regulations

None.

Resource Savings Table

	Electricity and other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3/Bed)	Electricity (KWh/Bed)	Water (L)	($/Bed)	($/Bed)
1	31	0	0	$25.33	$0.00
2	31	0	0	$0.00	$0.00
3	31	0	0	$0.00	$0.00
4	31	0	0	$0.00	$0.00
5	31	0	0	$0.00	$0.00
6	31	0	0	$0.00	$0.00
7	31	0	0	$0.00	$0.00
8	31	0	0	$0.00	$0.00
9	31	0	0	$0.00	$0.00
10	31	0	0	$0.00	$0.00
11	31	0	0	$0.00	$0.00
12	31	0	0	$0.00	$0.00
13	31	0	0	$0.00	$0.00
14	31	0	0	$0.00	$0.00

15	31	0	0	$0.00	$0.00
16	31	0	0	$0.00	$0.00
17	31	0	0	$0.00	$0.00
18	31	0	0	$0.00	$0.00
19	31	0	0	$0.00	$0.00
20	31	0	0	$0.00	$0.00
21	31	0	0	$0.00	$0.00
22	31	0	0	$0.00	$0.00
23	31	0	0	$0.00	$0.00
24	31	0	0	$0.00	$0.00
25	31	0	0	$0.00	$0.00
Total	**775**	**0**	**0**	**$25.33**	**$0.00**

Resource Savings Assumptions

Annual Natural Gas Savings	**31**	m^3/Bed

The savings associated with installing a DWHR system is calculated below. The value was calculated for an average facility and then divided by the average number of beds in a Nursing Home, resulting in savings per bed. See below for details.

One DWHR unit is connected to the dishwasher drain and used to preheat the water before the dishwasher water heater. A continuous flow dishwasher is used for the calculations.

The following are the characteristics used to estimate the drain water from the dishwashers:
Water Use per Meal:
= 9.1 (L/meal) * (1-70%) / (1-60%) [1]
= 6.8 (L/meal)
Average Nursing Home size: 107 beds [2]
Percentage of beds requiring meals: 75% [3]
Additional meals for staff: 20% [3]
Percentage of water use per meal for dishwashers: 80% [4]

$$Yearly\ Concurrent\ Drainwater\ Flow$$
$$= 6.8\ (L/meal) \times 3\ (meals/day) \times 365\ (days/year) \times 107\ (\frac{beds}{Nursing\ Home})$$
$$\times 75\%\ (beds\ requiring\ meals) \times 120\%\ (staff\ meals) \times 80\%$$
$$= 573{,}640\ (L/year)$$

The energy that can be recovered and therefore natural gas saved is calculated based on the following factors:
Yearly concurrent drain water flow: see above calculation
Drain water temperature for dishwasher: 77°C [1]
Domestic Cold Water Temperature: 9.33 °C [5]
DWHR unit effectiveness for noted piping configuration: 60% [6]
Standard Natural gas water heater efficiency: 78%

$$Natural\ Gas\ Saving\ (m^3)$$
$$= \frac{573{,}640\ (L/year) \times 4.184\ (KJ/(Kg\ °C)) \times [77\ (°C) - 9.33\ (°C)] \times 60\ (\%)}{78\ (\%) \times 37230\ (KJ/m^3)}$$
$$= 3{,}356 (m^3/year)$$

31 m^3/yr = 3,356 m^3 / 107 Beds per facility

Annual Electricity Savings	**0**	KWh/Bed
N/A		
Annual Water Savings	**0**	L/Bed
N/A		

Other Input Assumptions

Effective Useful Life (EUL)	**25**	Years
The DWHR units have a useful life in excess of 25 years. [6]		
Base & Incremental Conservation Measure Equipment and O&M Cost	**25.33**	$/Bed
The costs associated with installing a DWHR system is calculated below. The value was calculated for an average facility and then divided by the average number of beds per facility, resulting in a cost per bed. DWHR unit cost: $1,030 [7] Installation: $1,680. This is calculated based on the materials, equipment and labour needed to install a unit, in an existing building, as estimated from RS Means. Maintenance: $0. DWHR is a passive technology and requires no maintenance similar to the piping systems that it is connected to.[8] $25.33 per Bed = ($1,030 + $1,680)/107 Beds per facility		
Customer Payback Period (Natural Gas Only)	**2.7**	Years
Simple payback period, based on a natural gas price of $0.30/m³. $Simple\ Payback\ Period = \frac{Incremental\ Cost}{Natural\ Gas\ Savings \times Natural\ Gas\ Cost} = \frac{25.33(\$)}{31\ (m^3) \times 0.3\ (\$/m^3)} = 2.7\ (years)$		
Free Ridership	**5**	%
Free Ridership is approximated using market penetration, which is estimated as being low since most DWHR units are currently installed in residential markets and very little use in commercial markets, based on Enermodal's conversations with suppliers and manufacturers.		

References

[1] The 9.1 (L/meal) value originates from the ASHRAE Handbook 2007, HVAC Applications, Section 49 - Service Water Heating and is associated with a study from the 70's. This value was updated to reflect water use from middle-aged equipment as expected in existing buildings. Machines in existing buildings are expected to be typically 10 years old based on the equipment life of 20 years, which in-turn came from the Food Service Technology Center (FSTC) as cited in NGTC, DSM OPPORTUNITIES ASSOCIATED WITH COMMERCIAL DISHWASHERS, Final Report, April 27, 2009, pg

17.).

In order to take this into account, the 9.1 value was multiplied by one minus the 70% reduction in water use by Conveyor and Flight-Type machines since the 70's, then divided by one minus the 60% reduction in water-use of new machines vs. machines built 10 years ago. This data was gathered from a manufacturer (Suzanne Supplee - Champion Industries/BiLine) and Genevieve Bussieres from the Natural Gas Technology Centre (NGTC) quoting an NSF study and conversations with Hobart (another manufacturer). The 70% reduction in water use value was chosen for this calculation based on the above sources (68% from Champion and 70-72% from NGTC's findings). The 60% reduction value was chosen based on the same sources (61% from Champion and 58% from NGTC's findings).

[2] American Health Care Association, Trends in Nursing Facility Characteristics, December 2009. Available at http://www.ahcancal.org/Pages/Default.aspx

[3] Grand River Hospital - Diet Office of the Nutrition/Food Service Department.

[4] Wexiodisk, Rack Conveyor Dishwasher, 2006. Available at www.wexiodisk.com

[5] Cited in the following as personal communication with City of Toronto Works Dept. VEIC, Comments on Navigant's Draft Gas Measure Characterizations, March 2009.

[6] RenewABILITY Energy Inc., RenewABILITY Inc. Product Presentation, Delivered at Enermodal Engineering on November 2, 2009

[7] RenewABILITY Energy Inc.

[8] Enermodal Engineering, Development of DSM Measures and Market Information on Commercial Drain Water Heat Recovery, Rev 1., March 31, 2010

Drain Water Heat Recovery (DWHR) Units – University/College Cafeterias, Dishwashing

New Construction

Description/Comment
Continuous Flow Dishwasher. Savings and Costs are shown per Meal Served per Day.

Efficient Equipment and Technologies Description
Drain Water Heat Recovery (DWHR) pre-heats incoming domestic cold water with the available drain water heat that would otherwise be lost. This measure applies only to DWHR systems installed with Continuous Flow Dishwashers where there is concurrent hot water flow in and drain water flow out of the DWHR system.
Base Equipment and Technologies Description
None

Decision Type	Target Market	End Use
New Construction.	University/College Cafeterias. Kitchen Dishwashing. Continuous Flow Dishwashers	Water Heating

Codes, Standards and Regulations

None.

Resource Savings Table

	Electricity and other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3/Meal per Day)	Electricity (KWh/Meal per Day)	Water (L/Meal per Day)	($/Meal per Day)	($/Meal per Day)
1	4.6	0	0	$3.41	$0.00
2	4.6	0	0	$0.00	$0.00
3	4.6	0	0	$0.00	$0.00
4	4.6	0	0	$0.00	$0.00
5	4.6	0	0	$0.00	$0.00
6	4.6	0	0	$0.00	$0.00
7	4.6	0	0	$0.00	$0.00
8	4.6	0	0	$0.00	$0.00
9	4.6	0	0	$0.00	$0.00
10	4.6	0	0	$0.00	$0.00
11	4.6	0	0	$0.00	$0.00

12	4.6	0	0	$0.00	$0.00
13	4.6	0	0	$0.00	$0.00
14	4.6	0	0	$0.00	$0.00
15	4.6	0	0	$0.00	$0.00
16	4.6	0	0	$0.00	$0.00
17	4.6	0	0	$0.00	$0.00
18	4.6	0	0	$0.00	$0.00
19	4.6	0	0	$0.00	$0.00
20	4.6	0	0	$0.00	$0.00
21	4.6	0	0	$0.00	$0.00
22	4.6	0	0	$0.00	$0.00
23	4.6	0	0	$0.00	$0.00
24	4.6	0	0	$0.00	$0.00
25	4.6	0	0	$0.00	$0.00
Total	**115**	**0**	**0**	**$3.41**	**$0.00**

Resource Savings Assumptions

Annual Natural Gas Savings	**4.6**	m^3/Meal per Day

The savings associated with installing a DWHR system is calculated below. The value was calculated for an average facility and then divided by the average number of meals served per day, resulting in savings per meals served per day. See below for details.

One DWHR unit is connected to the dishwasher drain and used to preheat the water before the dishwasher water heater. A continuous flow dishwasher is used for the calculations.

The following are the characteristics used to estimate the drain water from the dishwashers:
Water Use per Meal:
= 9.1 (L/meal) 0* (1-70%) [1]
= 2.7 (L/meal)

Average restaurant size: 519 meals/day [2][3] Calculate based on the number of establishments in the area, market share and number of meals eaten out per day.
Percentage of water use per meal for dishwashers: 80% [4]

$$Yearly\ Concurrent\ Drainwater\ Flow$$
$$= 2.7\ (L/meal) \times 519\ (meals/day) \times 365\ (days/year) \times 80\%$$
$$= 408{,}893\ (L/year)$$

The energy that can be recovered and therefore natural gas saved is calculated based on the following factors:
Yearly concurrent drain water flow: see above calculation
Drain water temperature for dishwasher: 77°C [1]
Domestic Cold Water Temperature: 9.33 °C [5]
DWHR unit effectiveness for noted piping configuration: 60% [6]
Standard Natural gas water heater efficiency: 78%

$$Natural\ Gas\ Saving\ (m^3)$$
$$= \frac{408{,}893\ (L/year) \times 4.184\ (KJ/(Kg\ °C)) \times [77\ (°C) - 9.33\ (°C)] \times 60\ (\%)}{78\ (\%) \times 37230\ (KJ/m^3)}$$

$= 2{,}392 (m^3/year)$ 4.6 m^3/meal served per day = 2,392 m^3/year / 519 meals served per day per facility		
Annual Electricity Savings	**0**	KWh/Meal per Day
N/A		
Annual Water Savings	**0**	L/Meal per Day
N/A		

Other Input Assumptions

Effective Useful Life (EUL)	**25**	Years
The DWHR units have a useful life in excess of 25 years. [6]		
Base & Incremental Conservation Measure Equipment and O&M Cost	**3.41**	$/Meal per Day
The costs associated with installing a DWHR system is calculated below. The value was calculated for an average facility and then divided by the average cost per meals served per day, resulting in a cost per meals served per day. DWHR unit cost: $1,030 [7] Installation: $740. This is calculated based on the materials, equipment and labour needed to install a unit, as estimated from RS Means. Maintenance: $0. DWHR is a passive technology and requires no maintenance similar to the piping systems that it is connected to. [8] $3.41 per meal served per day = ($1,030 + $740) / 519 meals served per day per facility		
Customer Payback Period (Natural Gas Only)	**2.5**	Years
Simple payback period, based on a natural gas price of $0.30/m^3$. $Simple\ Payback\ Period = \frac{Incremental\ Cost}{Natural\ Gas\ Savings \times Natural\ Gas\ Cost}$ $= \frac{3.41(\$)}{4.6\ (m^3) \times 0.3\ (\$/m^3)} = 2.5\ (years)$		
Free Ridership	**5**	%
Free Ridership is approximated using market penetration, which is estimated as being low since most DWHR units are currently installed in residential markets and very little use in commercial markets, based on Enermodal's conversations with suppliers and manufacturers.		

References

[1] The 9.1 (L/meal) value originates from ASHRAE Handbook 2007, HVAC Applications, Section 49 - Service Water Heating and is associated with a study from the 70's. This value was updated by multiplying it by one minus the %

reduction in water use by Conveyor and Flight-Type machines since then, gathered from a manufacturer (Suzanne Supplee - Champion Industries/BiLine) and Genevieve Bussieres from Natural Gas Technology Centre (NGTC) quoting an NSF study and conversations with Hobart (another manufacturer). The 70% reduction in water use value was chosen for this calculation based on the above sources (68% from Champion and 70-72% from NGTC's findings).[2] Natural Gas Technologies Centre, DSM Opportunities associated with Commercial Dishwashers, April 27 2009.

[3] Ebbin, J, Americans' Dining-Out Habits, Restaurant USA, November 2000. Available at http://www.restaurant.org/tools/magazines/rusa/magArchive/year/article/?ArticleID=138

[4] Wexiodisk, Rack Conveyor Dishwasher, 2006. Available at www.wexiodisk.com

[5] Cited in the following as personal communication with City of Toronto Works Dept. VEIC, Comments on Navigant's Draft Gas Measure Characterizations, March 2009.

[6] RenewABILITY Energy Inc., RenewABILITY Inc. Product Presentation, Delivered at Enermodal Engineering on November 2, 2009

[7] RenewABILITY Energy Inc.

[8] Enermodal Engineering, Development of DSM Measures and Market Information on Commercial Drain Water Heat Recovery, Rev 1., March 31, 2010

Drain Water Heat Recovery (DWHR) Units – University/College Cafeterias, Dishwashing

Retrofit

Description/Comment
Continuous Flow Dishwasher. Savings and Costs are shown per Meal Served per Day.

Efficient Equipment and Technologies Description
Drain Water Heat Recovery (DWHR) pre-heats incoming domestic cold water with the available drain water heat that would otherwise be lost. This measure applies only to DWHR systems installed with Continuous Flow Dishwashers where there is concurrent hot water flow in and drain water flow out of the DWHR system.
Base Equipment and Technologies Description
None

Decision Type	Target Market	End Use
Retrofit	University/College Cafeterias. Kitchen Dishwashing. Continuous Flow Dishwashers	Water Heating

Codes, Standards and Regulations

None.

Resource Savings Table

	Electricity and other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3/Meal per Day)	Electricity (KWh/Meal per Day)	Water (L/Meal per Day)	($/Meal per Day)	($/Meal per Day)
1	11.6	0	0	$6.26	$0.00
2	11.6	0	0	$0.00	$0.00
3	11.6	0	0	$0.00	$0.00
4	11.6	0	0	$0.00	$0.00
5	11.6	0	0	$0.00	$0.00
6	11.6	0	0	$0.00	$0.00
7	11.6	0	0	$0.00	$0.00
8	11.6	0	0	$0.00	$0.00
9	11.6	0	0	$0.00	$0.00
10	11.6	0	0	$0.00	$0.00
11	11.6	0	0	$0.00	$0.00

12	11.6	0	0	$0.00	$0.00
13	11.6	0	0	$0.00	$0.00
14	11.6	0	0	$0.00	$0.00
15	11.6	0	0	$0.00	$0.00
16	11.6	0	0	$0.00	$0.00
17	11.6	0	0	$0.00	$0.00
18	11.6	0	0	$0.00	$0.00
19	11.6	0	0	$0.00	$0.00
20	11.6	0	0	$0.00	$0.00
21	11.6	0	0	$0.00	$0.00
22	11.6	0	0	$0.00	$0.00
23	11.6	0	0	$0.00	$0.00
24	11.6	0	0	$0.00	$0.00
25	11.6	0	0	$0.00	$0.00
Total	**290**	**0**	**0**	**$6.26**	**$0.00**

Resource Savings Assumptions

Annual Natural Gas Savings	**11.6**	m^3/Meal per Day

The savings associated with installing a DWHR system is calculated below. The value was calculated for an average facility and then divided by the average number of meals served per day, resulting in savings per meals served per day. See below for details.

One DWHR unit is connected to the dishwasher drain and used to preheat the water before the dishwasher water heater. A continuous flow dishwasher is used for the calculations.The following are the characteristics used to estimate the drain water from the dishwashers:
Water Use per Meal:
= 9.1 (L/meal) * (1-70%)/(1-60%) [1]
= 6.8 (L/meal)
Average restaurant size: 519 meals/day [2][3] Calculate based on the number of establishments in the area, market share and number of meals eaten out per day.
Percentage of water use per meal for dishwashers: 80% [4]

$$Yearly\ Concurrent\ Drainwater\ Flow$$
$$= 6.8\ (L/meal) \times 519\ (meals/day) \times 365\ (days/year) \times 80\%$$
$$= 1{,}029{,}805\ (L/year)$$

The energy that can be recovered and therefore natural gas saved is calculated based on the following factors:
Yearly concurrent drain water flow: see above calculation
Drain water temperature for dishwasher: 77°C [1]
Domestic Cold Water Temperature: 9.33 °C [5]
DWHR unit effectiveness for noted piping configuration: 60% [6]
Standard Natural gas water heater efficiency: 78%

$$Natural\ Gas\ Saving\ (m^3) = \frac{1{,}029{,}805\ (L/year) \times 4.184\ (KJ/(Kg\ °C)) \times [77\ (°C) - 9.33\ (°C)] \times 60\ (\%)}{78\ (\%) \times 37230\ (KJ/m^3)}$$
$$= 6{,}024 (m^3/year)$$

11.6 m3/meal served per day = 6,024m3/year / 519 meals served per day per facility		
Annual Electricity Savings	**0**	KWh/Meal per Day
N/A		
Annual Water Savings	**0**	L/Meal per Day
N/A		

Other Input Assumptions

Effective Useful Life (EUL)	**25**	Years
The DWHR units have a useful life in excess of 25 years. [6]		
Base & Incremental Conservation Measure Equipment and O&M Cost	**6.26**	$/Meal per Day
The costs associated with installing a DWHR system is calculated below. The value was calculated for an average facility and then divided by the average cost per meals served per day, resulting in a cost per meals served per day. DWHR unit cost: $1,030 [7] Installation: $2,220. This is calculated based on the materials, equipment and labour needed to install a unit, in an existing building, as estimated from RS Means. Maintenance: $0. DWHR is a passive technology and requires no maintenance similar to the piping systems that it is connected to.[8] $6.26 per meal served per day = ($1,030 + $2,220)/519 meals served per day per facility		
Customer Payback Period (Natural Gas Only)	**1.8**	Years
Simple payback period, based on a natural gas price of $0.30/m^3. $Simple\ Payback\ Period = \frac{Incremental\ Cost}{Natural\ Gas\ Savings \times Natural\ Gas\ Cost}$ $= \frac{6.26(\$)}{11.6\ (m^3) \times 0.3\ (\$/m^3)} = 1.8\ (years)$		
Free Ridership	**5**	%
Free Ridership is approximated using market penetration, which is estimated as being low since most DWHR units are currently installed in residential markets and very little use in commercial markets, based on Enermodal's conversations with suppliers and manufacturers.		

References

[1] The 9.1 (L/meal) value originates from the ASHRAE Handbook 2007, HVAC Applications, Section 49 - Service Water Heating and is associated with a study from the 70's. This value was updated to reflect water use from middle-

aged equipment as expected in existing buildings. Machines in existing buildings are expected to be typically 10 years old based on the equipment life of 20 years, which in-turn came from the Food Service Technology Center (FSTC) as cited in NGTC, DSM OPPORTUNITIES ASSOCIATED WITH COMMERCIAL DISHWASHERS, Final Report, April 27, 2009, pg 17.).

In order to take this into account, the 9.1 value was multiplied by one minus the 70% reduction in water use by Conveyor and Flight-Type machines since the 70's, then divided by one minus the 60% reduction in water-use of new machines vs. machines built 10 years ago. This data was gathered from a manufacturer (Suzanne Supplee - Champion Industries/BiLine) and Genevieve Bussieres from the Natural Gas Technology Centre (NGTC) quoting an NSF study and conversations with Hobart (another manufacturer). The 70% reduction in water use value was chosen for this calculation based on the above sources (68% from Champion and 70-72% from NGTC's findings). The 60% reduction value was chosen based on the same sources (61% from Champion and 58% from NGTC's findings).

[2] Natural Gas Technologies Centre, DSM Opportunities associated with Commercial Dishwashers, April 27 2009.

[3] Ebbin, J, Americans' Dining-Out Habits, Restaurant USA, November 2000. Available at http://www.restaurant.org/tools/magazines/rusa/magArchive/year/article/?ArticleID=138

[4] Wexiodisk, Rack Conveyor Dishwasher, 2006. Available at www.wexiodisk.com

[5] Cited in the following as personal communication with City of Toronto Works Dept. VEIC, Comments on Navigant's Draft Gas Measure Characterizations, March 2009.

[6] RenewABILITY Energy Inc., RenewABILITY Inc. Product Presentation, Delivered at Enermodal Engineering on November 2, 2009

[7] RenewABILITY Energy Inc.

[8] Enermodal Engineering, Development of DSM Measures and Market Information on Commercial Drain Water Heat Recovery, Rev 1., March 31, 2010

Drain Water Heat Recovery (DWHR) Units – Laundromat

New Construction

Description/Comment
Laundry - with storage tank and pumping equipment. Savings and Costs are Shown per Laundromat.

Efficient Equipment and Technologies Description
Drain Water Heat Recovery (DWHR) pre-heats incoming domestic cold water with the available drain water heat that would otherwise be lost. A storage tank and pumping equipment is needed for batch-style (i.e., front load or top load) Laundry equipment to ensure cold water flows into the DWHR system and warm drain water flows out concurrently.
Base Equipment and Technologies Description
None

Decision Type	Target Market	End Use
New Construction.	Laundromats. Laundry Equipment.	Water Heating

Codes, Standards and Regulations

None.

Resource Savings Table

	Electricity and other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (KWh)	Water (L)	($)	($)
1	49,735	0	0	$31,820.00	$0.00
2	49,735	0	0	$545.45	$0.00
3	49,735	0	0	$495.87	$0.00
4	49,735	0	0	$450.79	$0.00
5	49,735	0	0	$409.81	$0.00
6	49,735	0	0	$372.55	$0.00
7	49,735	0	0	$338.68	$0.00
8	49,735	0	0	$307.89	$0.00
9	49,735	0	0	$279.90	$0.00
10	49,735	0	0	$254.46	$0.00
11	49,735	0	0	$231.33	$0.00
12	49,735	0	0	$210.30	$0.00
13	49,735	0	0	$191.18	$0.00
14	49,735	0	0	$173.80	$0.00

15	49,735	0	0	$158.00	$0.00
16	49,735	0	0	$143.64	$0.00
17	49,735	0	0	$130.58	$0.00
18	49,735	0	0	$118.71	$0.00
19	49,735	0	0	$107.92	$0.00
20	49,735	0	0	$98.10	$0.00
21	49,735	0	0	$89.19	$0.00
22	49,735	0	0	$81.08	$0.00
23	49,735	0	0	$73.71	$0.00
24	49,735	0	0	$67.01	$0.00
25	49,735	0	0	$60.92	$0.00
Total	**1,243,364**	**0**	**0**	**$37,211**	**$0.00**

Resource Savings Assumptions

Annual Natural Gas Savings	**49,735**	m^3

One manifolded DWHR assembly (made of (4) units or pipes) is connected, with storage and pumping equipment to the laundry equipment.

The following are the characteristics used to estimate the drain water from the laundry equipment:
Laundry Rate: 0.37 Loads/person/day [1]
Water Usage Rate: 60 L/load[2]
Consumer base for Laundromat: 1303 [3][4][5] Based on the number of Laundromats in the service area and the number of persons who use Laundromats.

$$Yearly\ Concurrent\ Drainwater\ Flow = 0.37\ (Loads/person/day) \times 60\ (L/load) \times 1303\ (persons) \times 365\ (days) = 10{,}536{,}258\ (L/year)$$

The energy that can be recovered and therefore natural gas saved is calculated based on the following factors:
Yearly concurrent drain water flow: see above calculation
Drain water temperature for laundry equipment: 70°C [6]
Domestic Cold Water Temperature: 9.33 °C [7]
DWHR unit effectiveness for noted piping configuration: 60% [8]
Storage losses derating factor: 90% [9]
Standard Natural gas water heater efficiency: 78%

$$Natural\ Gas\ Saving\ (m^3) = \frac{10{,}536{,}258\ \left(\frac{L}{year}\right) \times\ 4.184\ \left(\frac{KJ}{Kg\ °C}\right) \times\ [70\ (°C) - 9.33\ (°C)] \times\ 60\ (\%) \times\ 90\ (\%)}{78\ (\%) \times\ 37230\ \left(\frac{KJ}{m^3}\right)}$$

$$= 49{,}735\ (m^3/year)$$

Annual Electricity Savings	**0**	KWh

N/A

Annual Water Savings	**0**	L

N/A

Other Input Assumptions

Effective Useful Life (EUL)	**25**	Years
The DWHR units have a useful life in excess of 25 years. [8]		
Base & Incremental Conservation Measure Equipment and O&M Cost	**37,211**	$
DWHR assembly cost: $12,920.[10] One assembly made up of (4) units (pipes) is required in this case.. Accessories cost: $13,500. Includes costs for pumps, storage tank, controls and other necessary equipment for non-concurrent flow applications. Installation: $4,800. This is calculated based on the materials, equipment and labour needed to install a unit, as estimated from RS Means. Maintenance: $600. DWHR is a passive technology and requires no maintenance similar to the piping systems that it is connected to. However, the storage tank and pump will require yearly maintenance and the pump requires some energy to operate.[11] A discount rate of 10%, consistent with the TRC calculation, is applied to the yearly O&M cost, to calculate the NPV ($5991). $37,211 = $12,920 + $13,500 + $4,800 + $5991		
Number of DWHR Units for Reported Savings	**4**	Units
One manifolded DWHR assembly is required to handle the high flow rates for the laundry equipment. There are 4 DWHR units per assembly. The savings and payback are based on this configuration, which is representative of an average laundromat.		
Customer Payback Period (Natural Gas Only)	**2.2**	Years
Simple payback period, based on a natural gas price of $0.30/m^3. $\text{Simple Payback Period} = \frac{\text{Incremental Cost}}{\text{Natural Gas Savings} \times \text{Natural Gas Cost} - \text{Yearly Cost}}$ $= \frac{31{,}220(\$)}{49{,}735(m^3) \times 0.3\ (\$/m^3) - 600\ (\$)} = 2.2\ (years)$		
Free Ridership	**5**	%
Free Ridership is approximated using market penetration, which is estimated as being low since most DWHR units are currently installed in residential markets and very little use in commercial markets, based on Enermodal's conversations with suppliers and manufacturers.		

References

[1] Gleick, P.H., et al. Waste Not, Want Not: The Potential for Urban Water Conservation in California. Pacific Institute: Oakland, California, 2003.

[2] Speed Queen, Front Load Washer Horizon Line Product Brochure, 2010. Available at www.speedqueen.com

[3] Buertime, Industry Overview- Coin Operated Laundry, 2010. Available at http://buyertime.com/Laundry.html

[4] Coin Laundry Association, Industry Overview, 2006. Available at http://coinlaundry.org/resources/industryoverview.cfm

[5] Statistics Canada, Study: Changes and Challenges for Canada's Residential Real Estate Landlords, The Daily, May 25 2007. Available at http://www.statcan.gc.ca/daily-quotidien/070525/dq070525b-eng.htm

[6] ASHRAE Handbook 2007, HVAC Applications, Section 49 - Service Water Heating

[7] Cited in the following as personal communication with City of Toronto Works Dept. VEIC, Comments on Navigant's Draft Gas Measure Characterizations, March 2009.

[8] RenewABILITY Energy Inc., RenewABILITY Inc. Product Presentation, Delivered at Enermodal Engineering on November 2, 2009

[9] Value is from common industry practice, communication with Enermodal Engineering, November 2010.

[10] RenewABILITY Energy Inc.

[11] Enermodal Engineering, Development of DSM Measures and Market Information on Commercial Drain Water Heat Recovery, Rev 1., March 31, 2010

Drain Water Heat Recovery (DWHR) Units – Laundromat

Retrofit

Description/Comment
Laundry – with storage tank and pumping equipment. Savings and Costs are Shown per Laundromat.

Efficient Equipment and Technologies Description
Drain Water Heat Recovery (DWHR) pre-heats incoming domestic cold water with the available drain water heat that would otherwise be lost. A storage tank and pumping equipment is needed for batch-style (i.e., front load or top load) Laundry equipment to ensure cold water flows into the DWHR system and warm drain water flows out concurrently.
Base Equipment and Technologies Description
None

Decision Type	Target Market	End Use
Retrofit	Laundromat. Laundry Equipment	Water Heating

Codes, Standards and Regulations

None.

Resource Savings Table

	Electricity and other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (KWh)	Water (L)	($)	($)
1	49,735	0	0	$35,420.00	$0.00
2	49,735	0	0	$545.45	$0.00
3	49,735	0	0	$495.87	$0.00
4	49,735	0	0	$450.79	$0.00
5	49,735	0	0	$409.81	$0.00
6	49,735	0	0	$372.55	$0.00
7	49,735	0	0	$338.68	$0.00
8	49,735	0	0	$307.89	$0.00
9	49,735	0	0	$279.90	$0.00
10	49,735	0	0	$254.46	$0.00
11	49,735	0	0	$231.33	$0.00
12	49,735	0	0	$210.30	$0.00
13	49,735	0	0	$191.18	$0.00
14	49,735	0	0	$173.80	$0.00

15	49,735	0	0	$158.00	$0.00
16	49,735	0	0	$143.64	$0.00
17	49,735	0	0	$130.58	$0.00
18	49,735	0	0	$118.71	$0.00
19	49,735	0	0	$107.92	$0.00
20	49,735	0	0	$98.10	$0.00
21	49,735	0	0	$89.19	$0.00
22	49,735	0	0	$81.08	$0.00
23	49,735	0	0	$73.71	$0.00
24	49,735	0	0	$67.01	$0.00
25	49,735	0	0	$60.92	$0.00
Total	**1,243,364**	**0**	**0**	**$40,811**	**$0.00**

Resource Savings Assumptions

Annual Natural Gas Savings	**49,735**	m^3

One manifolded DWHR assembly (made of (4) units or pipes) is connected, with storage and pumping equipment to the laundry equipment.

The following are the characteristics used to estimate the drain water from the laundry equipment:
Laundry Rate: 0.37 Loads/person/day [1]
Water Usage Rate: 60 L/load[2]
Consumer base for Laundromat: 1303 [3][4][5] Based on the number of Laundromats in the service area and the number of persons who use Laundromats.

$$Yearly\ Concurrent\ Drainwater\ Flow = 0.37\ (Loads/person/day) \times 60\ (L/load) \times 1303\ (persons) \times 365\ (days) = 10{,}536{,}258\ (L/year)$$

The energy that can be recovered and therefore natural gas saved is calculated based on the following factors:
Yearly concurrent drain water flow: see above calculation
Drain water temperature for laundry equipment: 70°C [6]
Domestic Cold Water Temperature: 9.33 °C [7]
DWHR unit effectiveness for noted piping configuration: 60% [8]
Storage losses derating factor: 90% [9]
Standard Natural gas water heater efficiency: 78%

$$Natural\ Gas\ Saving\ (m^3) = \frac{10{,}536{,}258\ \left(\frac{L}{year}\right) \times 4.184\ \left(\frac{KJ}{Kg\ °C}\right) \times [70\ (°C) - 9.33\ (°C)] \times 60\ (\%) \times 90\ (\%)}{78\ (\%) \times 37230\ \left(\frac{KJ}{m^3}\right)} = 49{,}735\ (m^3/year)$$

Annual Electricity Savings	**0**	KWh
N/A		
Annual Water Savings	**0**	L
N/A		

Other Input Assumptions

Effective Useful Life (EUL)	**25**	Years
The DWHR units have a useful life in excess of 25 years. [8]		
Base & Incremental Conservation Measure Equipment and O&M Cost	**40,811**	$
DWHR assembly cost: $12,920.[10] One assembly made up of (4) units (pipes) is required in this case. Accessories cost: $13,500. Includes costs for pumps, storage tank, controls and other necessary equipment for non-concurrent flow applications. Installation: $8,400. This is calculated based on the materials, equipment and labour needed to install a unit, in an existing building, as estimated from RS Means. Maintenance: $600. DWHR is a passive technology and requires no maintenance similar to the piping systems that it is connected to.[8] However, the storage tank and pump will require yearly maintenance and the pump requires some energy to operate.[11] A discount rate of 10%, consistent with the TRC calculation, is applied to the yearly O&M cost, to calculate the NPV ($5991). $40,811 = $12,920 + $13,500 + $8,400 + $5991.		
Number of DWHR Units for Reported Savings	**4**	Units
One manifolded DWHR assembly is required to handle the high flow rates for the laundry equipment. There are 4 DWHR units per assembly. The savings and payback are based on this configuration, which is representative of an average laundromat..		
Customer Payback Period (Natural Gas Only)	**2.4**	Years
Simple payback period, based on a natural gas price of $0.30/m^3. $Simple\ Payback\ Period = \frac{Incremental\ Cost}{Natural\ Gas\ Savings \times Natural\ Gas\ Cost - Yearly\ Cost}$ $= \frac{34{,}820(\$)}{49{,}735\ (m^3) \times 0.3\ (\$/m^3) - 600\ (\$)} = 2.4\ (years)$		
Free Ridership	**5**	%
Free Ridership is approximated using market penetration, which is estimated as being low since most DWHR units are currently installed in residential markets and very little use in commercial markets, based on Enermodal's conversations with suppliers and manufacturers.		

References

[1] Gleick, P.H., et al. Waste Not, Want Not: The Potential for Urban Water Conservation in California. Pacific Institute: Oakland, California, 2003.

[2] Speed Queen, Front Load Washer Horizon Line Product Brochure, 2010. Available at www.speedqueen.com

[3] Buertime, Industry Overview- Coin Operated Laundry, 2010. Available at http://buyertime.com/Laundry.html

[4] Coin Laundry Association, Industry Overview, 2006. Available at http://coinlaundry.org/resources/industryoverview.cfm

[5] Statistics Canada, Study: Changes and Challenges for Canada's Residential Real Estate Landlords, The Daily, May

25 2007. Available at http://www.statcan.gc.ca/daily-quotidien/070525/dq070525b-eng.htm

[6] ASHRAE Handbook 2007, HVAC Applications, Section 49- Service Water Heating

[7] Cited in the following as personal communication with City of Toronto Works Dept. VEIC, Comments on Navigant's Draft Gas Measure Characterizations, March 2009.

[8] RenewABILITY Energy Inc., RenewABILITY Inc. Product Presentation, Delivered at Enermodal Engineering on November 2, 2009

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[10] RenewABILITY Energy Inc.

[11] Enermodal Engineering, Development of DSM Measures and Market Information on Commercial Drain Water Heat Recovery, Rev 1., March 31, 2010

Energy Star Fryers

Commercial – New/Existing

Efficient Technology & Equipment Description
Energy Star Fryer
Qualifier/Restriction
No restriction
Base Technology & Equipment Description
Standard-efficiency fryer:

Resource Savings Assumptions

Natural Gas	1,083 m^3

The gas savings were based on FSTC's calculator,[1] updated by studies conducted by NGTC including a survey of facilities in UG territory, using the inputs below. [2,3,4]

	Fryers	Inputs		Source
	Definitions	Base	HE	
Nb_{days}	Number of operating days per year	365	365	FSTC Life cycle calculator
Er_i	Idle energy rate (Btu/hr)	14,000	9,000	
N_p	Number of preheats per day	1	1	
E_p	Preheat energy (Btu)	16,000	15,500	
E_{food}	Energy transferred to food (Btu/lb)	565	565	
P_{hr}	Production capacity (lbs/hr)	60	65	
Eff	Cooking efficiency	35%	50%	

[1] Food Service Technology Center – Life-Cycle and Energy Cost Calculators - http://www.fishnick.com/saveenergy/tools/calculators/, visited in the fall of 2010

[2] NGTC, DSM Opportunities Associated with Gas-Fired Food Service Equipment, Final Report, Ver 2, June 22, 2010

[3] NGTC, Phase 3-jan14 2011 steamer corrected.xlsx

[4] NGTC,Characterizing the Demand-Side Management Potential of Gas-Fired Commercial Food Service Equipment. 2006

Prod	Daily production (lbs/day)	100	100	NGTC 2006 report, corroborated by fryer load data in UG territory (FSTC calculator has 150 lbs/day).
$Elec_p$	Electricity consumption for preheat (kWh)	0.07	0.07	Average values from technical specifications from various manufacturers
P_i	Electric power in idle mode (kW)	0.13	0.13	
P_h	Electric power in heavy load mode (kW)	0.41	0.41	
n%	Used to calculate time in idle mode on UG territory	84%	85%	% of time in idle mode based on results of NGTC telephone survey of full service restaurants, limited service restaurants and institutional establishments (schools, colleges, universities and hospitals) on UG territory
t_{daily}	Number of operating hours per day (hrs)	12	12	Based on NGTC telephone survey
t_p	Preheat time (hrs)	0.175	0.175	Based on FSTC appliance test reports for fryers
t_i	Hours per day in idle mode (hrs)	9.933	10.099	Calculated from $t_i = n\% * (t_{daily} - t_p)$
t_h	Time in heavy load mode, i.e. cooking time (hrs)	1.892	1.726	Calculated from $t_h = t_{daily} - (t_p + t_i)$
E_h	Daily heavy-load natural gas consumption (Btu)			Calculated
E_i	Daily idle natural gas consumption (Btu)			Calculated
E_{annual}	Annual natural gas consumption (Btu/year)			Calculated

$Savings = Nb_{days} * \left[E_{food} * \left(\frac{P_{hr_{base}} * t_{h_{base}}}{Eff_{base}} - \frac{P_{hr_{HE}} * t_{h_{HE}}}{Eff_{HE}}\right) + \left(Er_{i_{base}} * t_{i_{base}} - Er_{i_{HE}} * t_{i_{HE}}\right) + N_p * \left(E_{p_{base}} - E_{p_{HE}}\right)\right]$	
Electricity	**17 kWh**
$Elec_{savings} = Nb_{days} * \left[\left(t_{i_{base}} - t_{i_{HE}}\right) * P_i + \left(t_{h_{base}} - t_{h_{HE}}\right) * P_h\right]$ Electrical savings are based on the inputs above.	
Water	**0 L**
None	

Other Input Assumptions

Equipment Life	**12 Years**
Savings attributed to the measures are expected to last the life expectancy of the equipment. Source of effective useful life: FSTC savings calculator as referenced in NGTC, DSM OPPORTUNITIES ASSOCIATED WITH GAS-FIRED FOOD SERVICE EQUIPMENT, Final Report Ver 2, April 20, 2010.	
Incremental Cost	**$ 1,028**
High-efficiency and standard-efficiency equipment (base case) purchase prices were obtained from list prices in Canadian dollars obtained from Ontarian distributors. High-efficiency price and base case prices are for Pitco comparables (Source for list prices: W.D. College). Base Case cost - $6,400 Upgrade cost - $7,428 Installation costs of high-efficiency and standard-efficiency equipment are considered to be identical. Similarly, maintenance costs of high-efficiency and standard-efficiency equipment are considered to be identical (Source: W.D. College). Hence, the installation and maintenance costs were not taken into account in the resource savings table[5].	

[5] NGTC, "DSM Opportunities Associated with Gas-Fired Food Service Equipment", Final Report, Ver 2, June 22, 2010, pg 9

High Efficiency Under-Fired Broilers

Commercial – New/Existing

Efficient Technology & Equipment Description
High-efficiency broiler: Minimum 34% efficiency. In case of the 36" versions: Maximum Idle energy rate: 65,000 Btu/hr
Qualifier/Restriction
No restriction
Base Technology & Equipment Description
Standard-efficiency broiler: (FSTC calculator default broiler type)

Resource Savings Assumptions

Natural Gas	1,677 m^3

The gas savings were based on FSTC's calculator, [6] updated by studies conducted by NGTC including a survey of facilities in UG territory, using the inputs below. [7,8,9]

	Broilers	Inputs		Source
	Definitions	**Base**	**HE**	
Nb_{days}	Number of operating days per year	365	365	FSTC Life cycle calculators
N_p	Number of preheats per day	1	1	
E_p	Preheat energy (Btu)	32,000	27,000	
Er_i	Idle energy rate (Btu/hr)	80,000	65,000	
Eff	Cooking efficiency	30%	34%	
P	Electric power (kW)	0.00028	0.00028	Average values from technical specifications from various manufacturers
E_{food}	Energy transferred to food (Btu/lb)	374	374	From FSTC appliance test
P_{hr}	Production	47	47	Based on validation with FSTC

[6] Food Service Technology Center – Life-Cycle and Energy Cost Calculators - http://www.fishnick.com/saveenergy/tools/calculators/, visited in the fall of 2010

[7] NGTC, DSM Opportunities Associated with Gas-Fired Food Service Equipment, Final Report, Ver 2, June 22, 2010

[8] NGTC, Phase 3-jan14 2011 steamer corrected.xlsx

[9] NGTC,Characterizing the Demand-Side Management Potential of Gas-Fired Commercial Food Service Equipment. 2006

	capacity (lbs/hr)			calculator
$n\%$	Used to calculate time in idle mode on UG territory	82%	82%	% of time in idle mode based on results of NGTC telephone survey of full service restaurants, limited service restaurants and institutional establishments (schools, colleges, universities and hospitals) on UG territory
t_{daily}	Number of operating hours per day (hrs)	12	12	Based on NGTC telephone survey
t_p	Preheat time (hours)	0.333	0.333	Alto Shaam representative on UG territory
t_i	Hours per day in idle mode (hrs)	9.532	9.532	Calculated from $t_i = n\% * (t_{daily} - t_p)$
t_h	Time in heavy load mode, i.e. cooking time (hrs)	2.135	2.135	Calculated from $t_h = t_{daily} - (t_p + t_i)$
E_h	Daily heavy-load natural gas consumption (Btu)	Calculated		
E_i	Daily idle natural gas consumption (Btu)			
E_{annual}	Annual natural gas consumption (Btu/year)			

$$Savings = Nb_{days} * \left[E_{food} * \left(\frac{P_{hr_{base}} * t_{h_{base}}}{Eff_{base}} - \frac{P_{hr_{HE}} * t_{h_{HE}}}{Eff_{HE}}\right) + \left(Er_{i_{base}} * t_{i_{base}} - Er_{i_{HE}} * t_{i_{HE}}\right) + N_p * (E_{p_{base}} - E_{p_{HE}})\right]$$

Electricity	**0 kWh**
None	

Water	**0 L**

None

Other Input Assumptions

Equipment Life	**12 Years**
Savings attributed to the measures are expected to last the life expectancy of the equipment. Source of effective useful life: FSTC savings calculator as referenced in NGTC, DSM OPPORTUNITIES ASSOCIATED WITH GAS-FIRED FOOD SERVICE EQUIPMENT, Final Report Ver 2, April 20, 2010.	
Incremental Cost	**$ 1,270**
Incremental cost were calculated from list prices in Canadian dollars obtained from Ontarian distributors for 36 inch broilers. Base case and high-efficiency are Garland comparables. Installation and maintenance costs of high-efficiency and standard-efficiency equipment are considered to be identical. (Source: W.D. College representative). Hence, the installation and maintenance costs were not taken into account[10].	

[10] NGTC, "DSM Opportunities Associated with Gas-Fired Food Service Equipment", Final Report, Ver 2, June 22, 2010, pg 9

Energy Star Convection Ovens (Full Size)

Commercial – New/Existing

Efficient Technology & Equipment Description
Energy Star convection oven.
Qualifier/Restriction
No restriction
Base Technology & Equipment Description
Standard-efficiency convection oven. Model used for savings calculation corresponds to default FSTC calculator full size standard-efficiency convection oven

Resource Savings Assumptions

Natural Gas	**847 m^3**

The gas savings were based on FSTC's calculator, [11] updated by studies conducted by NGTC including a survey of facilities in UG territory, using the inputs below. [12,13,14]

	Convection ovens (full size)	**Inputs**		**Source**
	Definitions	**Base**	**HE**	
Nb_{days}	Number of operating days per year	365	365	FSTC Life cycle calculator
Er_i	Idle energy rate (Btu/hr)	18,000	13,000	
N_p	Number of preheats per day	1	1	
E_p	Preheat energy (Btu)	19,000	11,000	
E_{food}	Energy transferred to food (Btu/lb)	250	250	
P_{hr}	Production capacity (lbs/hr)	70	80	
Eff	Cooking efficiency	30%	44%	
Prod	Daily	100	100	

[11] Food Service Technology Center – Life-Cycle and Energy Cost Calculators - http://www.fishnick.com/saveenergy/tools/calculators/, visited in the fall of 2010

[12] NGTC, DSM Opportunities Associated with Gas-Fired Food Service Equipment, Final Report, Ver 2, June 22, 2010

[13] NGTC, Phase 3-jan14 2011 steamer corrected.xlsx

[14] NGTC,Characterizing the Demand-Side Management Potential of Gas-Fired Commercial Food Service Equipment. 2006

	production (lbs/day)			
$Elec_p$	Electricity consumption for preheat (kWh)	0.41	0.41	Average values from technical specifications from various manufacturers
P_i	Electric power in idle mode (kW)	0.54	0.54	
P_h	Electric power in heavy load mode (kW)	0.55	0.55	
$n\%$	Used to calculate time in idle mode on UG territory	88%	89%	% of time in idle mode based on results of NGTC telephone survey of full service restaurants, limited service restaurants and institutional establishments (schools, colleges, universities and hospitals) on UG territory
t_{daily}	Number of operating hours per day (hrs)	12	12	Based on NGTC telephone survey
t_p	Preheat time (hrs)	0.4	0.4	Based on FSTC appliance test reports for convection ovens
t_i	Hours per day in idle mode (hrs)	10.171	10.324	Calculated from $t_i = n\% * (t_{daily} - t_p)$
t_h	Time in heavy load mode, i.e. cooking time (hrs)	1.429	1.276	Calculated from $t_h = t_{daily} - (t_p + t_i)$
E_h	Daily heavy-load natural gas consumption (Btu)	Calculated values		
E_i	Daily idle natural gas consumption (Btu)	Calculated values		
E_{annual}	Annual natural gas consumption (Btu/year)	Calculated		

$$Savings = Nb_{days} * \left[E_{food} * \left(\frac{P_{hr_{base}} * t_{h_{base}}}{Eff_{base}} - \frac{P_{hr_{HE}} * t_{h_{HE}}}{Eff_{HE}}\right) + \left(Er_{i_{base}} * t_{i_{base}} - Er_{i_{HE}} * t_{i_{HE}}\right) + N_p * (E_{p_{base}} - E_{p_{HE}})\right]$$

Electricity	**1 kWh**
$Elec_{savings} = Nb_{days} * \left[\left(t_{i_{base}} - t_{i_{HE}}\right) * P_i + \left(t_{h_{base}} - t_{h_{HE}}\right) * P_h\right]$	
Water	**0 L**
None	

Other Input Assumptions

Equipment Life	**12 Years**
Savings attributed to the measures are expected to last the life expectancy of the equipment. Source of effective useful life: FSTC savings calculator as referenced in NGTC, DSM OPPORTUNITIES ASSOCIATED WITH GAS-FIRED FOOD SERVICE EQUIPMENT, Final Report Ver. 2, April 20, 2010.	
Incremental Cost	**$ 875**
Incremental costs are estimated using US list prices divided by 1.3, based on ratio of US and Canadian list prices for comparable Vulcan and Lang models, respectively. Installation costs of high-efficiency and standard-efficiency equipment are considered to be identical. Similarly, maintenance costs of high-efficiency and standard-efficiency equipment are considered to be identical (Source: W.D. College). Hence, the installation and maintenance costs were not taken into account[15].	

[15] NGTC, "DSM Opportunities Associated with Gas-Fired Food Service Equipment", Final Report, Ver 2, June 22, 2010, pg 9

Energy Star Steam Cookers

Commercial – New/Existing

Efficient Technology & Equipment Description
Energy Star steam cooker.
Qualifier/Restriction
No restriction
Base Technology & Equipment Description
Standard-efficiency steam cooker: Model used for savings calculations corresponds to the FSTC default standard-efficiency 3-pan model.

Resource Savings Assumptions

Natural Gas	**3,224 m^3**
The gas savings were based on FSTC's calculator, [16] updated by studies conducted by NGTC including a survey of facilities in UG territory, using the inputs below. [17,18,19]	

	Steamers	**Inputs**		**Source**
	Definitions	**Base**	**HE**	
Nb_{days}	Number of operating days per year	365	365	FSTC Life cycle calculator
Er_i	Idle energy rate (Btu/hr)	11,000	6,250	
N_p	Number of preheats per day	1	1	
E_p	Preheat energy (Btu)	18,000	7,000	
E_{food}	Energy transferred to food (Btu/lb)	107	107	
P_{hr}	Production capacity (lbs/hr)	50	55	
Eff	Cooking efficiency	15%	38%	
Prod	Daily production (lbs/day)	100	100	

[16] Food Service Technology Center – Life-Cycle and Energy Cost Calculators - http://www.fishnick.com/saveenergy/tools/calculators/, visited in the fall of 2010

[17] NGTC, DSM Opportunities Associated with Gas-Fired Food Service Equipment, Final Report, Ver 2, June 22, 2010

[18] NGTC, Phase 3-jan14 2011 steamer corrected.xlsx

[19] NGTC,Characterizing the Demand-Side Management Potential of Gas-Fired Commercial Food Service Equipment. 2006

$Elec_p$	Electricity consumption for preheat (kWh)	0.03	0.03	Average values from technical specifications from various manufacturers
P_i	Electric power in idle mode (kW)	0.02	0.02	
P_h	Electric power in heavy load mode (kW)	0.07	0.07	
gph	Hourly water consumption (gal/hr)	40	3	FSTC Life cycle calculator
n%	Used to calculate time in idle mode in UG territory	--	85%	% of time in idle mode based on results of NGTC telephone survey of full service restaurants, limited service restaurants and institutional establishments (schools, colleges, universities and hospitals) on UG territory
t_{daily}	Number of operating hours per day (hrs)	12	12	Based on NGTC telephone survey
t_p	Preheat time (hrs)	0.17	0.17	Based on FSTC appliance test reports for steamers
t_i	Hours per day in idle mode (hrs)	1.183	9.996	Calculated from $t_i = \left(t_{daily} - t_p\right) * 0{,}1$ for LE, and from $t_i = n\% * (t_{daily} - t_p)$ for HE.
t_h	Time in heavy load mode, i.e. cooking time (hrs)	10.647	1.834	Calculated from $t_h = \left(t_{daily} - t_p\right) * 0{,}9$ for LE and from $t_h = t_{daily} - (t_p + t_i)$ for HE. Note: LE steamers operate in constant steam mode (energy consumption equivalent to heavy load mode), 90% of the time (Reference: FSTC).
lpg	Conversion factor: liter per gallon (3,785)			
E_h	Daily heavy-load natural gas consumption (Btu)	Calculated values		
E_i	Daily idle natural gas consumption	Calculated values		

	(Btu)	
E_{annual}	Annual natural gas consumption (Btu/year)	Calculated
W_{annual}	Annual water consumption (L/year)	Calculated
$W_{savings}$	Annual water savings (L/year)	Calculated

$$Savings = Nb_{days} * \left[E_{food} * \left(\frac{P_{hr_{base}} * (t_{daily} - t_p) * 0,9}{Eff_{base}} - \frac{P_{hr_{HE}} * t_{h_{HE}}}{Eff_{HE}} \right) + \left(Er_{i_{base}} * (t_{daily} - t_p) * 0,1 - Er_{i_{HE}} * t_{i_{HE}} \right) + N_p * (E_{p_{base}} - E_{p_{HE}}) \right]$$

Electricity	**162 kWh**

$$Elec_{savings} = Nb_{days} * \left[(t_{i_{base}} - t_{i_{HE}}) * P_i + (t_{h_{base}} - t_{h_{HE}}) * P_h \right]$$

Water	**42,812 L**

$$W_{savings} = Nb_{days} * t_{daily} * \frac{(gph_{base} - gph_{HE})}{lpg}$$

Other Input Assumptions

Equipment Life	**10 Years**

Savings attributed to the measures are expected to last the life expectancy of the equipment. Source of effective useful life: FSTC savings calculator as referenced in NGTC, DSM OPPORTUNITIES ASSOCIATED WITH GAS-FIRED FOOD SERVICE EQUIPMENT, Final Report Ver 2, April 20, 2010.

Incremental Cost	**$ 2,000**

Too many discrepancies between standard-efficiency and high-efficiency Canadian list prices were observed to be able to give price estimates. Instead, the estimated incremental cost from The Berkshire Gas Company, D.P.U. 09-124 Technical Reference Manual for GasNetworks Measures: NYSERDA Deemed Savings Data (June 2009) is used. Canadian and US price increments are assumed to be identical. Installation costs of high-efficiency and standard-efficiency equipment are considered to be identical. Similarly, maintenance costs of high-efficiency and standard-efficiency equipment are considered to be identical (Source: W.D. College). Hence, the installation and maintenance costs were not taken into account[20].

[20] NGTC, "DSM Opportunities Associated with Gas-Fired Food Service Equipment", Final Report, Ver 2, June 22, 2010, pg 9

Low-Flow Showerhead (1.25 GPM replacing 2.0 GPM, Residential, Distributed, per Household)

Revision #	Description/Comment	Date Revised

Efficient Equipment and Technologies Description
Low-flow Showerhead (1.25 GPM) – distributed to participants under Union Gas' ESK program. One showerhead distributed per ESK Kit.

Base Equipment and Technologies Description
2.0 GPM (Participants who previously received a 2.0gpm showerhead from Union)

Decision Type	Target Market(s)	End Use
Retrofit	Residential	Water heating

Resource Savings Table

	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (kWh)	Water (L)	($)	($)
1	33	0	11,584	3.69	0
2	33	0	11,584	0	0
3	33	0	11,584	0	0
4	33	0	11,584	0	0
5	33	0	11,584	0	0
6	33	0	11,584	0	0
7	33	0	11,584	0	0
8	33	0	11,584	0	0
9	33	0	11,584	0	0
10	33	0	11,584	0	0
TOTALS	330	**0**	**115,840**	**3.69**	**0**

Resource Savings Assumptions

Annual Natural Gas Savings	33 m^3

Enbridge Gas commissioned a study by the SAS Institute (Canada)[1] to estimate natural gas savings for low-flow showerheads in Enbridge territory. Data was collected August 31, 2007 until August 31, 2009 for both treatment and control groups. Low flow showerheads were installed in treatment households between August 13, 2008 and October 30, 2008. There were 54 households with low-flow showerheads and 124 households without low-flow showerheads.

To calculate the gas savings, three different models were used to analyze the gas consumption data

1) a comparison made during the same time frame (post-installation) between a control set of households[2] and households that had them installed
2) a Pre & Post installation analysis on the same households, and
3) a complex time trend model analysis that factored in many household characteristics over the whole Pre & Post time period.

All three analyses agreed well with each other.[3]

[1] Rothman, Lorne, SAS® PHASE II Analysis for Enbridge Gas Distribution Inc.: Estimating the Impact of Low-Flow Showerhead Installation; April 5, 2010

[2] where no low-flow showerheads were ever installed

[3] Model 1 – a blended rate of 71.3 m3/yr (only models II and II provided bucketed savings estimates)
Model 2 – a blended rate of 67.4 m3/yr (45.4 m3/yr for 2 to 2.5 GPM bucket and 87.8 m3/yr for over 2.5 GPM), and

Three buckets for pre-existing showerheads were originally proposed. However, the lowest flow bucket (2.0 GPM or less) had too few observations and are rare in the population of households. The natural gas savings for the other two buckets are estimated to be as follows:

Baseline Flow rate (GPM)	Energy Efficient Flow Rate (GPM)	Change in GPM	Annual Natural Gas Savings (m^3)	Annual Natural Gas Savings (m^3 per GPM)
2.25[4]	1.25	1.0	46	46
3[5]	1.25	1.75	88	50

For base flow/efficient flow showerhead types not explicitly tested in the SAS study, gas savings have been extrapolated in the following manner:

1. The results of the SAS institute study indicate that gas savings increase at an increasing rate as the difference between efficient and base GPM increases.
2. Fitting a polynomial function with no intercept (no change in GPM = no gas savings) delivers the following function (where ΔGPM = Base GPM – Efficient GPM):

$$\text{Annual Gas Savings } (m^3) = 40.29 * \Delta GPM + 5.71 * \Delta GPM^2$$
$$= 40.29*(2.0-1.25) + 5.71*(2.0-1.25)^2$$
$$= 33$$

These savings values assume that 100% of household showering is reduced to 1.25 gpm. A survey determining the percentage of showering affected by the program should be used to adjust the year end program results.

Annual Electricity Savings	**0 kWh**

N/A

Annual Water Savings	**11,584 L**

Since the SAS report did not look at water savings, Navigant Consulting proposes the following method for calculating resulting water savings:

Assumptions and inputs:

- As-used flow rate with base equipment: 1.78 GPM[6]
- Average household size: 3.1 persons[7]
- Showers per capita per day: 0.75[8]
- Average showering time per capita per day with base equipment: 7.37 minutes
- Average showering time per capita per day with new technology: 7.61 minutes[9]

Model 3 – a blended rate of 77.2 m3/yr (46.4 m3/yr for 2 to 2.5 GPM bucket and 87.9 m3/yr for over 2.5 GPM).

[4] Average of 2.0 GPM and 2.5 GPM

[5] Assumed average low flow showerhead which is greater than 2.5 GPM.

[6] As-used flow is calculated as a function of "full-on" or label flow: as-used flow = min{ 0.691+0.542*full-on flow, full-on flow}. Proctor, J. Gavelis, B. and Miller, B. *Savings and Showers: It's All in the Head*, (PGE) Home Energy Magazine, July/Aug 1994. Cited in Summit Blue (2008). .

[7] Summit Blue (2008).

[8] Ibid, based on data from: Resource Management Strategies, Inc., Regional Municipality of York Water Efficiency Master Plan Update, April 2007

[9] Relationship modeled as: Average shower length = 8.17 – 0.448 * as-used GPM. From Energy Center of Wisconsin Analysis of data from Resource Management Strategies, Inc., *Regional Municipality of York Water Efficiency Master Plan Update,* April 2007. Cited in Summit Blue (2008)

Annual water savings calculated as follows:

$$Savings = Ppl * Sh * 365 * (T_{base} * Fl_{base} - T_{eff} * Fl_{eff})$$

Where:

Ppl = Number of people per household
Sh = Showers per capita per day
365 = Days per year
T_{base} = Showering time with base equipment (minutes)
T_{eff} = Showering time with efficient equipment (minutes)
Fl_{base} = As-used flow rate with base equipment (GPM)
Fl_{eff} = As-used flow rate with efficient equipment (GPM)

Savings = 3,060 gallons or 11,584 litres

Other Input Assumptions

Effective Useful Life (EUL)	10 Years
Summit Blue (2008) suggests an EUL of 10 years based on a survey of five studies of showerheads in other jurisdictions (California – two studies, New England, Vermont, Arkansas).	
Incremental Costs	**$3.69**
As per utility program costs, bulk purchase of showerheads.	
Free-Ridership	**10%**
Free Ridership rate recommended by Summit Blue Consulting.[10]	

[10] "Residential Measure Free Ridership And Inside Spillover Study - Final Report", Summit Blue Consulting, June 2008.

57. Low-Flow Showerhead (1.25 GPM, Multi-Family, per Household)

Revision #	Description/Comment	Date Revised
		October 28, 2010

Efficient Equipment and Technologies Description

One Low-flow Showerhead (1.25 Gpm) – distributed to participants under Union Gas' HWC program.

Base Equipment and Technologies Description

2.0 GPM (Participants who previously received a 2.0gpm showerhead from Union)

Decision Type	Target Market(s)	End Use
New/Retrofit	Multi-Family	Water heating

Codes, Standards, and Regulations

Ontario Building Code (2006)[1] requires showerheads to have a maximum flow of 2.5 GPM (9.5 L/min)

Resource Savings Table

	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (kWh)	Water (L)	($)	($)
1	24	0	7933	3.69	0
2	24	0	7933	0	0
3	24	0	7933	0	0
4	24	0	7933	0	0
5	24	0	7933	0	0
6	24	0	7933	0	0
7	24	0	7933	0	0
8	24	0	7933	0	0
9	24	0	7933	0	0
10	24	0	7933	0	0
TOTALS	**240**	**0**	**79,330**	**3.69**	0

Resource Savings Assumptions

Annual Natural Gas Savings	24 m^3

Enbridge Gas commissioned a study by the SAS Institute (Canada)[2] to estimate natural gas savings for low-flow showerheads in Enbridge territory. Data was collected August 31, 2007 until

[1] Ontario Regulations 350/06, 2006 Building Code

August 31, 2009 for both treatment and control groups. Low flow showerheads were installed in treatment households between August 13, 2008 and October 30, 2008. There were 54 households with low-flow showerheads and 124 households without low-flow showerheads.

To calculate the gas savings, three different models were used to analyze the gas consumption data

1) a comparison made during the same time frame (post-installation) between a control set of households[3] and households that had them installed
2) a Pre & Post installation analysis on the same households, and
3) a complex time trend model analysis that factored in many household characteristics over the whole Pre & Post time period.

All three analyses agreed well with each other.[4]

Three buckets for pre-existing showerheads were originally proposed. However, the lowest flow bucket (2.0 GPM or less) had too few observations and are rare in the population of households. The natural gas savings for the other two buckets are estimated to be as follows:

Baseline Flow rate (GPM)	Energy Efficient Flow Rate (GPM)	Change in GPM	Annual Natural Gas Savings (m^3)	Annual Natural Gas Savings (m^3 per GPM)
2.25[5]	1.25	1.0	46	46
3[6]	1.25	1.75	88	50

For base flow/efficient flow showerhead types not explicitly tested in the SAS study, gas savings have been extrapolated in the following manner:

1. The results of the SAS institute study indicate that gas savings increase at an increasing rate as the difference between efficient and base GPM increases.
2. Fitting a polynomial function with no intercept (no change in GPM = no gas savings) delivers the following function (where ΔGPM = Base GPM – Efficient GPM):

$$\text{Annual Gas Savings } (m^3) = 40.29 * \Delta GPM + 5.71 * \Delta GPM^2$$
$$= 40.29*(2.0-1.25) + 5.71*(2.0-1.25)^2$$
$$= 33$$

However, to reflect the fact that there are fewer occupants in apartments than in single family homes (average of 2.1 persons for apartments vs. 2.9 persons for fully detached homes)[7] the savings will be adjusted as follows:

[2] Rothman, Lorne, SAS® PHASE II Analysis for Enbridge Gas Distribution Inc.: Estimating the Impact of Low-Flow Showerhead Installation; April 5, 2010

[3] where no low-flow showerheads were ever installed

[4] Model 1 – a blended rate of 71.3 m3/yr (only models II and II provided bucketed savings estimates)
Model 2 – a blended rate of 67.4 m3/yr (45.4 m3/yr for 2 to 2.5 GPM bucket and 87.8 m3/yr for over 2.5 GPM), and
Model 3 – a blended rate of 77.2 m3/yr (46.4 m3/yr for 2 to 2.5 GPM bucket and 87.9 m3/yr for over 2.5 GPM).

[5] Average of 2.0 GPM and 2.5 GPM

[6] Assumed average low flow showerhead which is greater than 2.5 GPM.

[7] Statistics Canada. *Structural Type of Dwelling (10) and Household Size (9) for Occupied Private Dwellings of Canada, Provinces, Territories, Census Metropolitan Areas and Census Agglomerations, 2006 Census - 100% Data* (Table) *Census 2006.* Last updated Dec 6, 2008.
http://www12.statcan.ca/english/census06/data/topics/RetrieveProductTable.cfm?ALEVEL=3&APATH=3&CATNO=&DETAIL=0&DIM=&DS=99&FL=0&FREE=0&GAL=0&GC=99&GID=837983&GK=NA&GRP=1&IPS=&METH=0&ORDER=1&PID=89071&PTYPE=88971&RL=0&S=1&SUB=0&ShowAll=No&StartRow=1&Temporal=2006&Theme=69&VID=0&VNAMEE=&VNAMEF=

$$33\ m^3 \times (2.1 \text{ persons per household}/2.9 \text{ persons per household}) = 33 \times 72\% = 24\ m^3/yr$$

These savings values assume that 100% of household showering is reduced to 1.25 gpm. A survey determining the percentage of showering affected by the program should be used to adjust the year end program results.

Annual Electricity Savings	0 kWh
N/A	

Annual Water Savings	7,933 L

Since the SAS report did not look at water savings, Navigant Consulting proposes the following method for calculating resulting water savings:

Assumptions and inputs:

- As-used flow rate with base equipment: 1.78 GPM[8]
- Average household size: 2.14 persons[9]
- Showers per capita per day: 0.75[10]
- Average showering time per capita per day with base equipment: 7.37 minutes [12]
- Average showering time per capita per day with new technology: 7.61 minutes[11]

Annual water savings calculated as follows:

$$Savings = Ppl * Sh * 365 * (T_{base} * Fl_{base} - T_{eff} * Fl_{eff})$$

Where:

Ppl = Number of people per household.
Sh = Showers per capita per day.
365 = Days per year.
T_{base} = Showering time with base equipment (minutes)
T_{eff} = Showering time with efficient equipment (minutes).
Fl_{base} = As-used flow rate with base equipment (GPM)
Fl_{eff} = As-used flow rate with efficient equipment (GPM)

Savings = 2,096 gallons or 7933 litres

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[8] As-used flow is calculated as a function of "full-on" or label flow: as-used flow = min{ 0.691+0.542*full-on flow, full-on flow}. Proctor, J. Gavelis, B. and Miller, B. *Savings and Showers: It's All in the Head*, (PGE) Home Energy Magazine, July/Aug 1994. Cited in Summit Blue (2008). Summit Blue uses the equation without assuming that it is a min function, implicitly assuming that participants will have the expertise or desire to make minor adjustments to the house water pressure to compensate for reduced shower flow.

[9] To maintain consistency with Summit Blue number but to reflect the fact that apartments are generally occupied by fewer people than houses, the Summit Blue number was degraded by the ratio of the average number of inhabitants per apartment in an Ontario building over five stories (2) to the average number of inhabitants of a fully detached house in Ontario (2.9). Statistics Canada. No date. *Structural Type of Dwelling (10) and Household Size (9) for Occupied Private Dwellings of Canada, Provinces, Territories, Census Metropolitan Areas and Census Agglomerations, 2006 Census - 100% Data* (Table) *Census 2006.* Last updated Dec 6, 2008. http://www12.statcan.ca/english/census06/data/topics/RetrieveProductTable.cfm?ALEVEL=3&APATH=3&CATNO=&DETAIL=0&DIM=&DS=99&FL=0&FREE=0&GAL=0&GC=99&GID=837983&GK=NA&GRP=1&IPS=&METH=0&ORDER=1&PID=89071&PTYPE=88971&RL=0&S=1&SUB=0&ShowAll=No&StartRow=1&Temporal=2006&Theme=69&VID=0&VNAMEE=&VNAMEF=

[10] Ibid, based on data from: Resource Management Strategies, Inc., Regional Municipality of York Water Efficiency Master Plan Update, April 2007

[11] Relationship modeled as: Average shower length = 8.17 – 0.448 * as-used GPM. From Energy Center of Wisconsin Analysis of data from Resource Management Strategies, Inc., *Regional Municipality of York Water Efficiency Master Plan Update,* April 2007. Cited in Summit Blue (2008)

Other Input Assumptions

Effective Useful Life (EUL)	10 Years
Summit Blue (2008) suggests an EUL of 10 years based on a survey of five studies of showerheads in other jurisdictions (California – two studies, New England, Vermont, Arkansas).	
Incremental Costs	**$3.69**
As per utility program costs, bulk purchase of showerheads.	
Free-Ridership	**10%**
Free Ridership rate recommended by Summit Blue Consulting.[12]	

[12] "Residential Measure Free Ridership And Inside Spillover Study - Final Report", Summit Blue Consulting, June 2008.

57. Low-Flow Showerhead (1.25 GPM, Multi-Family, per Household)

Revision #	Description/Comment	Date Revised
		October 28, 2010

Efficient Equipment and Technologies Description
One Low-flow Showerhead (1.25 Gpm) – distributed to participants under Union Gas' HWC program.
Base Equipment and Technologies Description
Average existing stock (2.21 GPM)[1].

Decision Type	Target Market(s)	End Use
New/Retrofit	Multi-Family	Water heating

Codes, Standards, and Regulations

Ontario Building Code (2006)[2] requires showerheads to have a maximum flow of 2.5 GPM (9.5 L/min)

Resource Savings Table

	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (kWh)	Water (L)	($)	($)
1	32	0	9,585	3.69	0
2	32	0	9,585	0	0
3	32	0	9,585	0	0
4	32	0	9,585	0	0
5	32	0	9,585	0	0
6	32	0	9,585	0	0
7	32	0	9,585	0	0
8	32	0	9,585	0	0
9	32	0	9,585	0	0
10	32	0	9,585	0	0
TOTALS	**320**	**0**	**95,850**	**3.69**	0

[1] Shower-heads distributed under Union Gas's ESK program are installed by homeowners rather than Union contractors. No observation is made of the base equipment's GPM. It is therefore assumed to be the full-on flow rate corresponding to the as-used flow from York Region monitoring study calculated using the equation cited below. Resource Management Strategies, Inc., Regional Municipality of York Water Efficiency Master Plan Update, April 2007. Cited by: Summit Blue, *Resource Savings Values in Selected Residential DSM Prescriptive Programs*, June 2008.

[2] Ontario Regulations 350/06, 2006 Building Code

Resource Savings Assumptions

Annual Natural Gas Savings	$32\ m^3$

Enbridge Gas commissioned a study by the SAS Institute (Canada)[3] to estimate natural gas savings for low-flow showerheads in Enbridge territory. Data was collected August 31, 2007 until August 31, 2009 for both treatment and control groups. Low flow showerheads were installed in treatment households between August 13, 2008 and October 30, 2008. There were 54 households with low-flow showerheads and 124 households without low-flow showerheads.

To calculate the gas savings, three different models were used to analyze the gas consumption data

1) a comparison made during the same time frame (post-installation) between a control set of households[4] and households that had them installed
2) a Pre & Post installation analysis on the same households, and
3) a complex time trend model analysis that factored in many household characteristics over the whole Pre & Post time period.

All three analyses agreed well with each other.[5]

Three buckets for pre-existing showerheads were originally proposed. However, the lowest flow bucket (2.0 GPM or less) had too few observations and are rare in the population of households. The natural gas savings for the other two buckets are estimated to be as follows:

Baseline Flow rate (GPM)	Energy Efficient Flow Rate (GPM)	Change in GPM	Annual Natural Gas Savings (m^3)	Annual Natural Gas Savings (m^3 per GPM)
2.25[6]	1.25	1.0	46	46
3[7]	1.25	1.75	88	50

For base flow/efficient flow showerhead types not explicitly tested in the SAS study, gas savings have been extrapolated in the following manner:

1. The results of the SAS institute study indicate that gas savings increase at an increasing rate as the difference between efficient and base GPM increases.
2. Fitting a polynomial function with no intercept (no change in GPM = no gas savings) delivers the following function (where ΔGPM = Base GPM – Efficient GPM):

$$\text{Annual Gas Savings } (m^3) = 40.29 * \Delta GPM + 5.71 * \Delta GPM^2$$
$$= 40.29*(2.21-1.25) + 5.71*(2.21-1.25)^2$$
$$= 44$$

[3] Rothman, Lorne, SAS® PHASE II Analysis for Enbridge Gas Distribution Inc.: Estimating the Impact of Low-Flow Showerhead Installation; April 5, 2010
[4] where no low-flow showerheads were ever installed
[5] Model 1 – a blended rate of 71.3 m3/yr (only models II and II provided bucketed savings estimates)
Model 2 – a blended rate of 67.4 m3/yr (45.4 m3/yr for 2 to 2.5 GPM bucket and 87.8 m3/yr for over 2.5 GPM), and
Model 3 – a blended rate of 77.2 m3/yr (46.4 m3/yr for 2 to 2.5 GPM bucket and 87.9 m3/yr for over 2.5 GPM).
[6] Average of 2.0 GPM and 2.5 GPM
[7] Assumed average low flow showerhead which is greater than 2.5 GPM.

However, to reflect the fact that there are fewer occupants in apartments than in single family homes (average of 2.1 persons for apartments vs. 2.9 persons for fully detached homes)[8] the savings will be adjusted as follows: 44 m^3 x (2.1 persons per household/2.9 persons per household) = 44 x 72% = 32 m^3/yr These savings values assume that 100% of household showering is reduced to 1.25 gpm. A survey determining the percentage of showering affected by the program should be used to adjust the year end program results.

Annual Electricity Savings	**0 kWh**
N/A	
Annual Water Savings	**9,585 L**

Since the SAS report did not look at water savings, Navigant Consulting proposes the following method for calculating resulting water savings:

Assumptions and inputs:

- As-used flow rate with base equipment: 1.89 GPM[9]
- Average household size: 2.14 persons[10]
- Showers per capita per day: 0.75[11]
- Average showering time per capita per day with base equipment: 7.32 minutes
- Average showering time per capita per day with new technology: 7.61 minutes[12]

Annual water savings calculated as follows:

$$Savings = Ppl * Sh * 365 * \left(T_{base} * Fl_{base} - T_{eff} * Fl_{eff}\right)$$

Where:

Ppl = Number of people per household.
Sh = Showers per capita per day.

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[8] Statistics Canada. *Structural Type of Dwelling (10) and Household Size (9) for Occupied Private Dwellings of Canada, Provinces, Territories, Census Metropolitan Areas and Census Agglomerations, 2006 Census - 100% Data* (Table) *Census 2006.* Last updated Dec 6, 2008. http://www12.statcan.ca/english/census06/data/topics/RetrieveProductTable.cfm?ALEVEL=3&APATH=3&CATNO=&DETAIL=0&DIM=&DS=99&FL=0&FREE=0&GAL=0&GC=99&GID=837983&GK=NA&GRP=1&IPS=&METH=0&ORDER=1&PID=89071&PTYPE=88971&RL=0&S=1&SUB=0&ShowAll=No&StartRow=1&Temporal=2006&Theme=69&VID=0&VNAMEE=&VNAMEF=

[9] As-used flow is calculated as a function of "full-on" or label flow: as-used flow = min{ 0.691+0.542*full-on flow, full-on flow}. Proctor, J. Gavelis, B. and Miller, B. *Savings and Showers: It's All in the Head*, (PGE) Home Energy Magazine, July/Aug 1994. Cited in Summit Blue (2008). Summit Blue uses the equation without assuming that it is a min function, implicitly assuming that participants will have the expertise or desire to make minor adjustments to the house water pressure to compensate for reduced shower flow.

[10] To maintain consistency with Summit Blue number but to reflect the fact that apartments are generally occupied by fewer people than houses, the Summit Blue number was degraded by the ratio of the average number of inhabitants per apartment in an Ontario building over five stories (2) to the average number of inhabitants of a fully detached house in Ontario (2.9). Statistics Canada. No date. *Structural Type of Dwelling (10) and Household Size (9) for Occupied Private Dwellings of Canada, Provinces, Territories, Census Metropolitan Areas and Census Agglomerations, 2006 Census - 100% Data* (Table) *Census 2006.* Last updated Dec 6, 2008. http://www12.statcan.ca/english/census06/data/topics/RetrieveProductTable.cfm?ALEVEL=3&APATH=3&CATNO=&DETAIL=0&DIM=&DS=99&FL=0&FREE=0&GAL=0&GC=99&GID=837983&GK=NA&GRP=1&IPS=&METH=0&ORDER=1&PID=89071&PTYPE=88971&RL=0&S=1&SUB=0&ShowAll=No&StartRow=1&Temporal=2006&Theme=69&VID=0&VNAMEE=&VNAMEF=

[11] Ibid, based on data from: Resource Management Strategies, Inc., Regional Municipality of York Water Efficiency Master Plan Update, April 2007

[12] Relationship modeled as: Average shower length = 8.17 – 0.448 * as-used GPM. From Energy Center of Wisconsin Analysis of data from Resource Management Strategies, Inc., *Regional Municipality of York Water Efficiency Master Plan Update,* April 2007. Cited in Summit Blue (2008)

	365 = Days per year. T_{base} = Showering time with base equipment (minutes) T_{eff} = Showering time with efficient equipment (minutes). Fl_{base} = As-used flow rate with base equipment (GPM) Fl_{eff} = As-used flow rate with efficient equipment (GPM)
Savings = 2,532 gallons or 9,585 litres	

Other Input Assumptions

Effective Useful Life (EUL)	10 Years
Summit Blue (2008) suggests an EUL of 10 years based on a survey of five studies of showerheads in other jurisdictions (California – two studies, New England, Vermont, Arkansas).	
Incremental Costs	**$3.69**
As per utility program costs, bulk purchase of showerheads.	
Free-Ridership	**10%**
Free Ridership rate recommended by Summit Blue Consulting.[13]	

[13] "Residential Measure Free Ridership And Inside Spillover Study - Final Report", Summit Blue Consulting, June 2008.

Free Ridership for New Measures

Establishing Free Ridership (FR) values for new measures and programs has required ongoing and detailed negotiations. For the purpose of filing these new measures with consensus and to bring new DSM programs to the market, Union Gas and the EAC have agreed to the following FR values:

Free Ridership for New Measures

Measure	**Building Segment**	**Value**
Commercial Drain Water Heat Recovery	New and Existing	5%
Food Service Program:		
Energy Star Fryers	New and Existing	20%
High Efficiency Under-fired Broilers	New and Existing	20%
Energy Star Convection Oven (Full Size)	New and Existing	20%
Energy Star Steam Cookers	New and Existing	20%

The parties' agreement on the FR values set out above shall not not prejudice any positions or decisions the parties may take on the methodology in determining FR values, or the FR values themselves, for any measures or programs in future years beyond 2011.