uniongas
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December 19, 2012

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

Dear Ms. Walli:

RE: EB-2012-0441 – New and Updated DSM Measures
Joint Submission from Enbridge Gas Distribution Inc. and Union Gas Ltd.

Enbridge Gas Distribution Inc. ("Enbridge") and Union Gas Ltd. ("Union") request the approval of the Ontario Energy Board (the "Board") for the new and updated DSM measures.

In the DSM Guidelines for Natural Gas Utilities (EB-2008-0346), the Board directed the utilities to make an annual application to update approved input assumptions and encouraged the utilities to file a joint application.

Also, per the Joint Terms of Reference on Stakeholder Engagement for DSM Activities by Enbridge Gas Distribution and Union Gas Limited dated November 4, 2011, one of the Technical Evaluation Committee ("TEC") major tasks is the development of a Technical Reference Manual for natural gas DSM activities. It is envisioned that the Technical Reference Manual will eventually replace the common Table of Measure Assumptions and Substantiation Documents which the utilities filed with their 2012-2014 Plans. Until the Technical Reference Manual is completed and filed with the Board, the common Table of Measure Assumptions and Substantiation Documents will continue to document the Board approved measure assumptions.

This joint application is made, in consultation with the TEC, to update the common Table of Measure Assumptions and Substantiation Documents. The TEC supports the updates to the specific measure assumptions per this application.

The application includes updated assumptions to existing measures as per 2010 and 2011 Audit recommendations, corrections to clerical errors or omissions in the 2012 Plan submission, new measures, updated measures based on new information and additional notes of clarification for Effective Useful Life ("EUL") Tables.

The application contains the following exhibits:

Exhibit A, Tab 1, Schedule 1	Table of Contents
Exhibit B, Tab 1, Schedule 1	Background and Introduction
Exhibit B, Tab 1, Schedule 2	Updated Table of Measure Assumptions
Exhibit B, Tab 1, Schedule 3	Notes for EUL Tables
Exhibit B, Tab 1, Schedule 4	New and Updated Substantiation Documents

This application was prepared jointly by Enbridge and Union. Please direct correspondence on this file to both Enbridge and Union representatives:

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Enbridge and Union requests the Board's approval of new and updated DSM measures.

Sincerely,

[Original signed by]

Marian Redford
Manager, Regulatory Initiatives

c.c: Alexander Smith (Torys)
EB-2012-0337 Intervenors

Dennis M. O'Leary
EB-2011-0295 Intervenors

TEC Members:
Ted Kesik – Independent Member
Bob Wirtshafter – Independent Member
Jay Shepherd – School Energy Coalition
Julie Girvan – Consumers Council of Canada
Chris Neme – Green Energy Coalition
Ravi Sigurdson – Enbridge Gas Distribution
Melinda Clarke – Union Gas

APPLICATION FOR NEW AND UPDATED DSM MEASURES

Exhibit	Tab	Schedule	Contents of Schedule	Witnesses
B	1	1	Background and Introduction	L. Kulperger/R.Sigurdson
B	1	2	Updated Table of Measure Assumptions	L. Kulperger/R.Sigurdson
B	1	3	Notes for EUL Tables	L. Kulperger/R.Sigurdson
B	1	4	New and Updated Substantiation Documents	L. Kulperger/R.Sigurdson

BACKGROUND AND INTRODUCTION

1. In June of 2011 the Ontario Energy Board released the *"Demand Side Management Guidelines for Natural Gas Utilities"* ("DSM Guidelines").

2. In response to the Guidelines, Union Gas Limited ("Union") and Enbridge Gas Distribution ("Enbridge") submitted DSM plans for the period 2012 to 2014. In preparing their DSM plan submissions, Union and Enbridge worked together to develop a common set of reference documents for the prescriptive measure assumptions to be included in their respective DSM plans. As a result, both utilities filed a common Table of Measure Assumptions together with a common set of Substantiation Documents providing detailed information and savings calculations for each of the measures listed.

3. In preparing their 2012-2014 Plans, Union and Enbridge consulted extensively with members of the DSM Consultative. One result was an agreement with the utilities and intervenors on the Terms of Reference for Stakeholder Engagement for the Multi-year plan period. Both utilities filed this Agreement with their 2012-2014 Plan submission.

4. The Terms of Reference for Stakeholder Engagement called for the establishment of a Technical Evaluation Committee.

Witnesses: L. Kulperger
R. Sigurdson

"There will be one Technical Evaluation Committee for both natural gas utilities which will act as an independent body. …The goal of the TEC is to establish DSM technical and evaluation standards for natural gas utilities in Ontario."[1]

5. In the first few months of 2012 the utilities have worked with members of the DSM Consultative to establish the Technical Evaluation Committee. The Committee consists of three representatives of the DSM Consultative, two independent technical experts and a representative from each of the utilities.

6. As noted in the Terms of Reference for the Technical Evaluation Committee, one of the Committee's major tasks is the development of a Technical Reference Manual for natural gas DSM activities. It is envisioned that the Technical Reference Manual will eventually replace the common Table of Measure Assumptions and Substantiation Documents which the utilities filed with their 2012-2014 Plans. Until the Technical Reference Manual is completed and filed with the Board, the common Table of Measure Assumptions and Substantiation Documents will continue to document the Board approved measure assumptions. With respect to this Update to the measure assumptions, the TEC comments speak only to the new measures and to specific changes to the individual assumptions as noted for existing measures as described in the attached substantiation documents. The TEC has not reviewed the remaining assumptions for existing measures in the Update or the assumptions for other measures listed on the Measure Assumption Table.

[1] Joint Terms of Reference on Stakeholder Engagement for DSM Activities by Enbridge Gas Distribution and Union Gas Limited, EB-2011-0295, Exhibit B, Tab 2, Schedule 9, Appendix A, November 4, 2011, page 9.

Witnesses: L. Kulperger
R. Sigurdson

7. The Guidelines also provided for updates to the measure assumptions and directed the utilities to work together in preparing the required annual Update submissions.

> "The input assumptions may change over time based on more accurate and up-to-date information, resulting from the annual evaluation and audit process and other research undertaken as required. … The natural gas utilities should cooperate in preparing their individual applications for updates and/or additions to the set of approved input assumptions, and are encouraged to file a joint application. The application should be made as soon as practical after, but not prior to, the completion of the auditor's final report (i.e., the Audit Report) on the natural gas utilities' Draft Evaluation Report." The application should be made annually, whether or not the natural gas utilities are requesting any changes to their set of input assumptions. The natural gas utilities' annual application will provide a Board forum for stakeholders that will allow them to, among other things, request updates and/or additions to the set of input assumptions that may not have been identified by the natural gas utilities."[2]

8. Following the Board Guidelines and the Terms of Reference for the Technical Evaluation Committee, the utilities and the Committee have worked together to prepare this Update submission to the Measure Assumptions for the Union and Enbridge 2012-2014 DSM Plans. This Update is submitted with the full endorsement of the Technical Evaluation Committee.

9. The Update includes the following elements:

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[2] Demand Side Management Guidelines for Natural Gas Utilities, EB-2008-0346, Ontario Energy Board, June 30, 2011, page 19.

Witnesses: L. Kulperger
R. Sigurdson

Update Element	Measure(s)	Utility
Updated assumptions to existing measures as per 2010 and 2011 Audit recommendations	- Infrared Heaters - Condensing Make Up Air Units - Prescriptive High Efficiency Boilers over 300 MBTU - Prescriptive Boilers: Elementary Schools - Prescriptive Boilers: Secondary Schools	Both
Corrections to clerical errors or omissions in the 2012 Plan submission	- Table of Measure Assumptions re: Low-Income Measures free ridership	Both
	Low-Income Showerheads in Multi-residential buildings	Enbridge
	Low-Income Multi-Family Space Heating Measures	Both
New Measures	Low-Income Multi and Single Family Measures - Showerheads - Aerators	Union
Updates to Measures based on new information	- High Efficiency Boilers under 300 MBTU - Condensing Boilers under 300 MBTU	Both
Additional Notes of Clarification	- Note added to Table of EUL for Custom Project Technologies	Both

10. This submission is comprised of the following Exhibits

Witnesses: L. Kulperger
R. Sigurdson

- Exhibit B, Tab 1, Schedule 2 presents the Updated Table of Measure Assumptions.
- Exhibit B, Tab 1, Schedule 3 presents the Notes to be added to the Union Table of Effective Useful Life (EUL) for Custom Project Measures and the Enbridge Table of Measure Life for Custom Project Measures.
- Exhibit B, Tab 1, Schedule 4 presents the New and Updated Substantiation Documents as listed below.

MEASURE	Utility	Assumption Update Endorsed by TEC
Infrared Heaters	Both	Two-stage infrared heater savings presented separate from the high-intensity and single-stage
Condensing Make Up Air Units	Both	Electricity savings have been updated for units that have variable frequency drives
Prescriptive High Efficiency Boilers	Both	Updated savings calculation based on results of Boiler Baseline Study.
Prescriptive Boilers: Elementary Schools	Both	Updated savings calculation based on results of Boiler Baseline Study.
Prescriptive Boilers: Secondary Schools	Both	Updated savings calculation based on results of Boiler Baseline Study.

Witnesses: L. Kulperger
R. Sigurdson

Low Flow Showerheads (Residential, Multi-residential, Low-Income Residential and Low-Income Multi-residential)	Enbridge	Addition of line in substantiation document to record application of multi-residential savings calculation to low-income multi-residential buildings
Low-Income Multi-Family Bath Aerator	Union	Existing measure added to the Low-Income Multi-Family segment.
Low-Income Multi-Family Kitchen Aerator	Union	Existing measure added to the Low Income Multi-Family segment.
Low-Income Multi-Family Showerhead (distributed)	Union	Existing measure added to the Low-Income Multi-Family segment.
Low-Income Multi-Family Showerhead (replacing 2.0-2.5GPM)	Union	Existing measure added to the Low-Income Multi-Family segment.
Low-Income Multi-Family Showerhead (replacing 2.6+GPM)	Union	Existing measure added to the Low-Income Multi-Family segment.
Low-Income Multi-Family Showerhead (replacing 1.5GPM)	Union	Existing measure added to the Low-Income Multi-Family segment.
Low-Income Multi-Family Showerhead (replacing 2.0GPM)	Union	Existing measure added to the Low-Income Multi-Family

Witnesses: L. Kulperger
R. Sigurdson

		segment.
Low-Income Showerhead (replacing 2.0GPM)	Both	Existing measure added to the Low Income Multi-family segment.
High Efficiency Boilers under 300 MBTU	Both	Update savings calculation to reflect new federal standards in boiler baseline efficiency
High Efficiency Condensing Boilers under 300 MBTU	Both	Update savings calculation to reflect new federal standards in boiler baseline efficiency
OTHER		
Free Ridership for all Low-Income Measures	Both	Documenting in the Measure Assumption Table low-income free ridership for prescriptive and custom measures resulting from 2012 plan negotiations
Low-Income Multi-Family Space Heating	Both	Documenting in the Measure Assumption Table existing space heating measures applicable to the Low-Income Multi-Family segment.

Witnesses: L. Kulperger
R. Sigurdson

Indicates an update (December 2012) from the Board approved list of input assumptions

Target Market		Equipment Details				Annual Resource Savings			Other				
Sector	New/Existing	Efficient Equipment	Details of Efficient Equipment	Base Equipment	Details of Base Equipment	Natural Gas (m3)	Electricity (kWh)	Water (L)	EUL	Incremental Cost ($)	Free Rider (%)	Utility Measure Applies to	Decision Type
Residential Space Heating													
Residential	Existing	Attic Insulation	upgrade to R-40	R-10		105	105	0	20	$580	33%	UG	Retrofit
Residential	Existing	Basement Wall Insulation	upgrade to R-12	R-1		261	145	0	25	$1654	33%	UG	Retrofit
Residential	Existing	Draft Proofing Kit	(1) Spray Foam, can (1) Caulk, tube (30 ft) Foam Tape (4) Energy Saver Gasket with 2 child safety inserts	No Draft Proofing Kit		236	27	0	1	$20	55%	UG	Retrofit
Residential	New	Energy Star Home	version 3	Home built to OBC 2006		1018	1450	0	25	$3200	48%	EGD	New
Residential	Existing	Fireplace intermittent ignition control retrofit		Natural gas fireplace with a pilot		104	-31	0	8	$150	1%	UG	Retrofit
Residential	Existing	High Efficiency Condensing Furnace	AFUE 96	High-Efficiency Furnace	AFUE 90	129	0	0	18	$1767	0%	EGD	Replacement
Residential	New	High Efficiency Fireplace with Pilotless Ignition	Freestanding, Minimum 70% EnerGuide Rating	Freestanding fireplace	65% median efficiency	110	-31	0	20	$135	17%	EGD	New
Residential	New	High Efficiency Fireplace with Pilotless Ignition	Insert, Minimum 60% EnerGuide Rating	Insert	55% median efficiency	109	-31	0	20	$135	17%	EGD	New
Residential	New	High Efficiency Fireplace with Pilotless Ignition	Zero Clearance, >= 40 kBtu.h =Minimum 60% EnerGuide Rating	Zero Clearance		122	-31	0	20	$135	17%	EGD	New
Residential	New	High Efficiency Fireplace with Pilotless Ignition	Zero Clearance, < 40 kBtu.h =Minimum 70% EnerGuide Rating	Zero Clearance		108	-31	0	20	$135	17%	EGD	New
Residential	Existing	High Efficiency Fireplace with Pilotless Ignition	Freestanding, Minimum 70% EnerGuide Rating	Freestanding fireplace	65% median efficiency	110	-31	0	20	$135	17%	EGD	Replacement
Residential	Existing	High Efficiency Fireplace with Pilotless Ignition	Insert, Minimum 60% EnerGuide Rating	Insert	55% median efficiency	109	-31	0	20	$135	17%	EGD	Replacement
Residential	Existing	High Efficiency Fireplace with Pilotless Ignition	Zero Clearance, >= 40 kBtu.h =Minimum 60% EnerGuide Rating	Zero Clearance		122	-31	0	20	$135	17%	EGD	Replacement
Residential	Existing	High Efficiency Fireplace with Pilotless Ignition	Zero Clearance, < 40 kBtu.h =Minimum 70% EnerGuide Rating	Zero Clearance		108	-31	0	20	$135	17%	EGD	Replacement
Residential	New	Programmable Thermostat		Standard Thermostat		53	54	0	15	$25	10%	UG	New
Residential	Existing	Programmable Thermostat		Standard Thermostat		53	54	0	15	$25	43%	UG	Retrofit
Residential	New	Programmable Thermostat		Standard Thermostat		53	54	0	15	$53.22	10%	EGD	New
Residential	Existing	Programmable Thermostat		Standard Thermostat		53	54	0	15	$50	43%	EGD	Retrofit
Residential	Existing	Reflector Panels		No reflector panels		143	0	0	18	$229	0%	UG	Retrofit
Residential	Existing	Reflector Panels		Radiant heat w/o reflector panels		143	0	0	18	$238	0%	EGD	Retrofit
Residential Water Heating													
Residential	New	Faucet Aerator	Bathroom, 1.5 GPM, (3) aerators	Average Existing Stock	2.2 GPM	18	0	6012	10	$2.72	31%	EGD	New
Residential	New	Faucet Aerator	Bathroom, 1.0 GPM	Ontario Building Code 2006	2.2 GPM	10	0	3,435	10	$0.59	33%	UG	New
Residential	Existing	Faucet Aerator	Bathroom, 1.0 GPM	Average existing stock	2.2 GPM	10	0	3,435	10	$0.59	33%	UG	Retrofit
Residential	Existing	Faucet Aerator	Bathroom, 1.0 GPM	Replace existing 1.5 GPM	1.5 GPM	4		1,432	10	$0.59	33%	UG	Retrofit
Residential	New/Existing	Faucet Aerator	Bathroom, 1.5 GPM	Average existing stock	2.2 GPM	6	0	2,004	10	$0.49	33%	UG	New/Retrofit
Residential	New	Faucet Aerator	Kitchen, 1.0 GPM	Ontario Building Code 2006	2.2 GPM	32	0	10,631	10	$1.59	33%	UG	New

Indicates an update (December 2012) from the Board approved list of input assumptions

Target Market		Equipment Details				Annual Resource Savings			Other				
Sector	New/Existing	Efficient Equipment	Details of Efficient Equipment	Base Equipment	Details of Base Equipment	Natural Gas (m3)	Electricity (kWh)	Water (L)	EUL	Incremental Cost ($)	Free Rider (%)	Utility Measure Applies to	Decision Type
Residential	Existing	Faucet Aerator	Kitchen, 1.0 GPM	Average existing stock	2.5 GPM	35	0	11,694	10	$1.59	33%	UG	Retrofit
Residential	Existing	Faucet Aerator	Kitchen, 1.5 GPM	Average existing stock	2.5 GPM	23	0	7,797	10	$1.29	33%	UG	Retrofit
Residential	New	Faucet Aerator	Kitchen, 1.5 GPM	Ontario Building Code 2006	2.2 GPM	19	0	6,201	10	$1.29	33%	UG	New
Residential	New	Faucet Aerator (Distributed)	Bathroom, 1.0 GPM	Ontario Building Code 2006	2.2 GPM	10	0	3435	10	$0.55	31%	EGD	New
Residential	Existing	Faucet Aerator (Distributed)	Bathroom, 1.0 GPM	Average Existing Stock	2.2 GPM	10	0	3435	10	$0.55	31%	EGD	Retrofit
Residential	Existing	Faucet Aerator (Distributed)	Bathroom, 1.5 GPM	Average Existing Stock	2.2 GPM	6	0	2004	10	$1	31%	EGD	Retrofit
Residential	New	Faucet Aerator (Distributed)	Kitchen, 1.0 GPM	Ontario Building Code 2006	2.2 GPM	32	0	10631	10	$1	31%	EGD	New
Residential	Existing	Faucet Aerator (Distributed)	Kitchen, 1.0 GPM	Average Existing Stock	2.5 GPM	35	0	11694	10	$1	31%	EGD	Retrofit
Residential	New	Faucet Aerator (Distributed)	Kitchen, 1.5 GPM	Average Existing Stock	2.5 GPM	23	0	7797	10	$1.65	31%	EGD	New
Residential	Existing	Faucet Aerator (Distributed)	Kitchen, 1.5 GPM	Average Existing Stock	2.5 GPM	23	0	7797	10	$1	31%	EGD	Retrofit
Residential	New	Low-flow showerhead	1.25 & 1.5 GPM (Per Household)	Average Existing Stock	2.5 GPM	48	0	14391	10	$16.76	10%	EGD	New
Residential	Existing	Low-flow showerhead	1.25 GPM	Replace existing 2.0 GPM	2.0 GPM	33		11,584	10	$3.79	10%	UG	Retrofit
Residential	New	Low-flow showerhead	1.25 GPM (Per household)	Average Existing Stock	2.5 GPM	53	0	17187	10	$4.26	10%	EGD	New
Residential	New	Low-flow showerhead	1.5 GPM (Per Household)	Average Existing Stock	2.5 GPM	43	0	11596	10	$12.5	10%	EGD	New
Residential	Existing	Low-flow showerhead (Contractor Installed)	1.25 GPM	2.0 -2.5 GPM Showerhead	2.25 GPM	46	0	14294	10	$3.79	10%	UG	Retrofit
Residential	Existing	Low-flow showerhead (Contractor Installed)	1.25 GPM	2.6 + GPM Showerhead	3.0 GPM	88	0	22580	10	$3.79	10%	UG	Retrofit
Residential	Existing	Low-flow showerhead (Distributed)	1.25 GPM	2.6 + GPM Showerhead	3.07 GPM	82	0	23374	10	$4.26	10%	EGD	Retrofit
Residential	Existing	Low-flow showerhead (Distributed)	1.25 GPM	2.0 -2.5 GPM Showerhead	2.45 GPM	50	0	16631	10	$4.26	10%	EGD	Retrofit
Residential	New/Existing	Low-flow showerhead (Distributed)	1.25 GPM	Average existing stock	2.2 GPM	44	0	13,885	10	$3.79	10%	UG	New/Retrofit
Residential	Existing	Low-flow showerhead (Installed)	1.25 GPM	2.0 -2.5 GPM Showerhead	2.45 GPM	50	0	16631	10	$19	10%	EGD	Retrofit
Residential	Existing	Low-flow showerhead (Installed)	1.25 GPM	2.6 + GPM Showerhead	3.07 GPM	82	0	23374	10	$19	10%	EGD	Retrofit
Residential	Existing	Pipe Insulation		Water Heater w/o pipe insulation		18	0	0	10	$2/$4	4%	EGD	Retrofit

Indicates an update (December 2012) from the Board approved list of input assumptions

Target Market		Equipment Details				Annual Resource Savings			Other				
Sector	New/Existing	Efficient Equipment	Details of Efficient Equipment	Base Equipment	Details of Base Equipment	Natural Gas (m3)	Electricity (kWh)	Water (L)	EUL	Incremental Cost ($)	Free Rider (%)	Utility Measure Applies to	Decision Type
Residential	Existing	Pipe Wrap (R-4)	Insulation for DWH outlet pipe	Uninsulated DHW outlet pipes	R-1	18	0	0	10	$0.98	4%	UG	Retrofit
Residential	Existing	Solar Pool Heaters		Natural gas pool heater		1,116	-57	0	20	$1,450	10%	Both	Retrofit
Residential	New/Existing	Tankless Water Heater	EF 0.82	Storage Tank Water Heater		142	0	0	18	$750	2%	UG	New/Replacement
Residential	Existing	Tankless Water Heater		Storage Tank Water Heater		130	0	0	18	$750	2%	EGD	Replacement
Low-Income Space Heating													
Low-Income	Existing	Early Furnace Replacement - 60% AFUE	90% AFUE Furnace	60% AFUE Furnace		781			3	$518	0%	UG	Retrofit
Low-Income	Existing	Early Furnace Replacement - 70% AFUE	90% AFUE Furnace	70% AFUE Furnace		466			3	$518	0%	UG	Retrofit
Low-Income	Existing	Programmable Thermostat		Standard manual thermostat		53	54	0	15	$26.95	1%	UG	Retrofit
Low Income	Existing	Programmable Thermostat		Standard Thermostat		53	54	0	15	$69.18	0%	EGD	Retrofit
Low-Income Water Heating													
Low-Income	Existing	Early Hot Water Heater Replacement (0.575 to 0.62 EF)	0.62 EF Water Heater	0.575 EF Water Heater		80			3	$168.00	0%	UG	Retrofit
Low-Income	Existing	Faucet Aerator	Bathroom, 1.0 GPM	Average existing stock	2.2 GPM	10	0	3,435	10	$0.59	1%	UG	Retrofit
Low-Income	Existing	Faucet Aerator	Bathroom, 1.0 GPM	Replace existing 1.5 GPM	1.5 GPM	4	0	1,432	11	$0.59	1%	UG	Retrofit
Low-Income	Existing	Faucet Aerator	Bathroom, 1.5 GPM	Average existing stock	2.2 GPM	6	0	2,004	10	$0.49	1%	UG	Retrofit
Low-Income	Existing	Faucet Aerator	Kitchen, 1.0 GPM	Average existing stock	2.5 GPM	35	0	11,694	10	$1.59	1%	UG	Retrofit
Low-Income	Existing	Faucet Aerator	Kitchen, 1.5 GPM	Average existing stock	2.5 GPM	23	0	7,797	10	$1.29	1%	UG	Retrofit
Low Income	Existing	Faucet Aerator	Bathroom, 1.0 GPM	Average Existing Stock	2.2 GPM	10	0	3435	10	$0.55	0%	EGD	Retrofit
Low Income	Existing	Faucet Aerator	Bathroom, 1.5 GPM	Average Existing Stock	2.2 GPM	6	0	2004	10	$0.46	0%	EGD	Retrofit
Low Income	Existing	Faucet Aerator	Kitchen, 1.0 GPM	Average Existing Stock	2.5 GPM	35	0	11694	10	$1	0%	EGD	Retrofit
Low Income	Existing	Faucet Aerator	Kitchen, 1.5 GPM	Average Existing Stock	2.5 GPM	23	0	7797	10	$0.94	0%	EGD	Retrofit
Low Income	Existing	Low-flow showerhead	1.25 GPM (Installed)	2.0 -2.5 GPM Showerhead	2.45 GPM	50	0	16631	10	$18.71	0%	EGD	Retrofit
Low Income	Existing	Low-flow showerhead	1.25 GPM (Installed)	2.6 + GPM Showerhead	3.07 GPM	82	0	23374	10	$18.71	0%	EGD	Retrofit
Low-Income	Existing	Low-flow showerhead (Contractor installed)	1.25 GPM	Average existing stock	2.25 GPM	46	0	14,294	10	$3.79	1%	UG	Retrofit
Low-Income	Existing	Low-flow showerhead (Contractor installed)	1.25 GPM	Average existing stock	3.0 GPM	88	0	22,580	10	$3.79	1%	UG	Retrofit
Low-Income	Existing	Pipe insulation for DHW outlet pipe	R-4 insulation	Uninsulated DHW outlet pipes (R-1)	R-1	18	0	0	10	$0.98	1%	UG	Retrofit
Low-Income	Existing	Low-flow showerhead	1.25 GPM	Replace existing 2.0 GPM	2.0 GPM	33	0	11,584	10	$3.79	1%	UG	Retrofit
Low-Income Multi-Family Water Heating													
Low-Income	Existing	Faucet Aerator	Kitchen, 1.5 GPM	Average existing stock	2.5 GPM	16	0	5,377	10	$1.14	1%	UG	Retrofit
Low-Income	Existing	Faucet Aerator	Bathroon, 1.0 GPM	Average existing stock	2.2 GPM	7		2,371	10	$0.56	1%	UG	Retrofit
Low-Income	Existing	Low-flow showerhead (Distributed)	1.25 GPM	Average existing stock	2.21 GPM	32	0	9,585	10	$3.79	1%	UG	Retrofit
Low-Income	Existing	Low-flow showerhead	1.25 GPM	2.0-2.5 GPM showerhead	2.25 GPM	33	0	9,892	10	$3.79	1%	UG	Retrofit
Low-Income	Existing	Low-flow showerhead	1.25 GPM	> 2.6 GPM showerhead	3.0 GPM	64	0	15,549	10	$3.79	1%	UG	Retrofit
Low-Income	Existing	Low-flow showerhead	1.25 GPM	Replace existing 1.5 GPM	1.5 GPM	8	0	3,846	10	$3.79	1%	UG	Retrofit
Low-Income	Existing	Low-flow showerhead	1.25 GPM	Replace existing 2.0 GPM	2.0 GPM	24	0	7,933	10	$3.79	1%	UG	Retrofit
Low Income	Existing	Low-Flow Showerhead (Per household, Installed)	1.5 GPM	2.0 -2.5 GPM showerhead	2.25 GPM	21	0	5931	10	$12.5	0%	EGD	Retrofit
Low Income	Existing	Low-Flow Showerhead (Per household, Installed)	1.5 GPM	2.6 -3.0 GPM GPM showerhead	2.8 GPM	40	0	10036	10	$12.5	0%	EGD	Retrofit
Low Income	Existing	Low-Flow Showerhead (Per household, Installed)	1.5 GPM	3.1 - 3.5 GPM showerhead	3.3 GPM	58	0	13621	10	$12.5	0%	EGD	Retrofit
Low Income	Existing	Low-Flow Showerhead (Per household, Installed)	1.5 GPM	3.6 GPM and above	3.6 GPM	69	0	15705	10	$12.5	0%	EGD	Retrofit
Low-Income Multi-Family Space Heating													
Low income	New	Condensing Boiler - Space Heating (<100 Mbtu/h)	90% AFUE	Non-condensing Boiler	82% AFUE	0.01019 /Btu/hr	0	0	25	$1,475	Union 5%, EDG 0%	Both	New
Low income	New	Condensing Boiler - Space Heating (100 to 199 Mbtu/h)	90% AFUE	Non-condensing Boiler	82% AFUE	0.01019 /Btu/hr	0	0	25	$2,414	Union 5%, EDG 0%	Both	New
Low income	New	Condensing Boiler - Space Heating (200 to 299 Mbtu/h)	90% AFUE	Non-condensing Boiler	82% AFUE	0.01019 /Btu/hr	0	0	25	$3,227	Union 5%, EDG 0%	Both	New
Low income	Existing	Condensing Boiler - Space Heating (<100 Mbtu/h)	90% AFUE	Non-condensing Boiler	82% AFUE	0.01019 /Btu/hr	0	0	25	$2,045	Union 5%, EDG 0%	Both	Replacement
Low income	Existing	Condensing Boiler - Space Heating (100 to 199 Mbtu/h)	90% AFUE	Non-condensing Boiler	82% AFUE	0.01019 /Btu/hr	0	0	25	$2,984	Union 5%, EDG 0%	Both	Replacement
Low income	Existing	Condensing Boiler - Space Heating (200 to 299 Mbtu/h)	90% AFUE	Non-condensing Boiler	82% AFUE	0.01019 /Btu/hr	0	0	25	$3,797	Union 5%, EDG 0%	Both	Replacement

Indicates an update (December 2012) from the Board approved list of input assumptions

Target Market		Equipment Details				Annual Resource Savings			Other				
Sector	New/Existing	Efficient Equipment	Details of Efficient Equipment	Base Equipment	Details of Base Equipment	Natural Gas (m3)	Electricity (kWh)	Water (L)	EUL	Incremental Cost ($)	Free Rider (%)	Utility Measure Applies to	Decision Type
Low income	New/Existing	Condensing Boilers - Space Heating, 300 and above MBTUH	88% seasonal efficiency	Non-condensing boiler	76% estimated seasonal efficiency	0.0104 m3/Btu/hr	0	0	25	$12/Kbtu/hr	5%	UG	New/Replacement
Low income	New	High Efficiency Boiler - Space Heating (<100 Mbtu/h)	85% AFUE	Non-condensing Boiler	82% AFUE	0.00318 /Btu/hr	0	0	25	$1,238	Union 5%, EDG 0%	Both	New
Low income	New	High Efficiency Boiler - Space Heating (100 to 199 Mbtu/h)	85% AFUE	Non-condensing Boiler	82% AFUE	0.00318 /Btu/hr	0	0	25	$1,544	Union 5%, EDG 0%	Both	New
Low income	New	High Efficiency Boiler - Space Heating (200 to 299 Mbtu/h)	85% AFUE	Non-condensing Boiler	82% AFUE	0.00318 /Btu/hr	0	0	25	$1,388	Union 5%, EDG 0%	Both	New
Low income	Existing	High Efficiency Boiler - Space Heating (<100 Mbtu/h)	85% AFUE	Non-condensing Boiler	82% AFUE	0.00318 /Btu/hr	0	0	25	$1,808	Union 5%, EDG 0%	Both	Replacement
Low income	Existing	High Efficiency Boiler - Space Heating (100 to 199 Mbtu/h)	85% AFUE	Non-condensing Boiler	82% AFUE	0.00318 /Btu/hr	0	0	25	$2,114	Union 5%, EDG 0%	Both	Replacement
Low income	Existing	High Efficiency Boiler - Space Heating (200 to 299 Mbtu/h)	85% AFUE	Non-condensing Boiler	82% AFUE	0.00318 /Btu/hr	0	0	25	$1,958	Union 5%, EDG 0%	Both	Replacement
Low income	Existing	Prescriptive Higher Efficiency Boiler - Space Heating	83-84% Efficient, 300-2000 MBH	Space Heating Boiler	80.5% Thermal Efficiency	2,474-19,340	0	0	25	$3900-$4950	Union 5%, EDG 0%	Both	Replacement
Low income	Existing	Prescriptive Higher Efficiency Boiler - Space Heating	85-88% Efficient, 300-2000 MBH	Space Heating Boiler	80.5% Thermal Efficiency	3,496-27,325	0	0	25	$4,500-$7,050	Union 5%, EDG 0%	Both	Replacement
Low income	New	Prescriptive Higher Efficiency Boiler - Space Heating	83-84% Efficient, 300-2000 MBH	Space Heating Boiler	80.5% Thermal Efficiency	2,474-19,340	0	0	25	$3900-$4950	Union 5%, EDG 0%	Both	New
Low income	New	Prescriptive Higher Efficiency Boiler - Space Heating	85-88% Efficient, 300-2000 MBH	Space Heating Boiler	80.5% Thermal Efficiency	3,496-27,325	0	0	25	$4,500-$7,050	Union 5%, EDG 0%	Both	New

Commercial Cooking

Commercial	New/Existing	Energy Star Fryer	Energy Star	Standard fryer		1083	17	0	12	$1,028	20%	Both	New/Replacement
Commercial	New/Existing	Energy Star Convection Ovens - Full Size	Energy Star	Standard Convection Oven		847	1		12	$875	20%	Both	New/Replacement
Commercial	New/Existing	Energy Star Steam Cookers	Energy Star	Standard Efficiency Steam Cooker		3224	162	42812	10	$2,000.00	20%	Both	New/Replacement
Commercial	New/Existing	High Efficiency Under-Fired Broilers		Standard Efficiency Broiler		1677			12	$1,270	20%	Both	New/Replacement

Commercial Space Heating

Commercial	Existing	Air Curtains	Double door	Non-air curtain doors		1,529	1,023	0	15	$2,500	5%	Both	Retrofit
Commercial	New/Existing	Air Curtains	Shipping and Receiving Doors (10 x 10)	Non-air curtain doors		20605	-936		15	$10,170	5%	Both	New/Retrofit
Commercial	New/Existing	Air Curtains	Shipping and Receiving Doors (8 x 10)	Non-air curtain doors		9457	-5220		15	$8,242	5%	Both	New/Retrofit
Commercial	New/Existing	Air Curtains	Shipping and Receiving Doors (8 x 8)	Non-air curtain doors		7565	-5380		15	$8,242	5%	Both	New/Retrofit
Commercial	Existing	Air Curtains	Single door	Non-air curtain doors		667	172	0	15	$1,650	5%	Both	Retrofit
Commercial	New	Condensing Boiler - Space Heating (<100 Mbtu/h)	90% AFUE	Non-condensing Boiler	82% AFUE	0.01019 /Btu/hr	0	0	25	$1,475	5%	Both	New
Commercial	New	Condensing Boiler - Space Heating (100 to 199 Mbtu/h)	90% AFUE	Non-condensing Boiler	82% AFUE	0.01019 /Btu/hr	0	0	25	$2,414	5%	Both	New
Commercial	New	Condensing Boiler - Space Heating (200 to 299 Mbtu/h)	90% AFUE	Non-condensing Boiler	82% AFUE	0.01019 /Btu/hr	0	0	25	$3,227	5%	Both	New
Commercial	Existing	Condensing Boiler - Space Heating (<100 Mbtu/h)	90% AFUE	Non-condensing Boiler	82% AFUE	0.01019 /Btu/hr	0	0	25	$2,045	5%	Both	Replacement
Commercial	Existing	Condensing Boiler - Space Heating (100 to 199 Mbtu/h)	90% AFUE	Non-condensing Boiler	82% AFUE	0.01019 /Btu/hr	0	0	25	$2,984	5%	Both	Replacement
Commercial	Existing	Condensing Boiler - Space Heating (200 to 299 Mbtu/h)	90% AFUE	Non-condensing Boiler	82% AFUE	0.01019 /Btu/hr	0	0	25	$3,797	5%	Both	Replacement
Commercial	New/Existing	Condensing Boilers - Space Heating, 300 and above MBTUH	88% seasonal efficiency	Non-condensing boiler	76% estimated seasonal efficiency	0.0104 m3/Btu/hr	0	0	25	$12/Kbtu/hr	5%	UG	New/Replacement
Commercial	New/Existing	Condensing Make Up Air Unit - MR and LTC		Conventional MUA with constant speed drive		.84 m3/cfm - 2.92 m3/cfm	(0.00-1.48) kwh/cfm		15	$870 + (.66 - 1.02) per cfm	5%	Both	New/Replacement
Commercial	New/Existing	Condensing Make Up Air Unit - Retail and Comm		Conventional MUA with constant speed drive		.41 m3/cfm - 2.07 m3/cfm	(0.00-1.09) kwh/cfm		15	$870 + (.66 - 1.02) per cfm	5%	Both	New/Replacement
Commercial	New/Existing	Condensing Unit Heater		% Sales Weighted Average model	78% Annually Efficient	0.00631 m3/Btu/hr	(-)0.00186 kwh/Btu/hr	0	18	$0.0129 /Btu/hr	0%	Both	New/Replacement
Commercial	New/Existing	Demand Control Kitchen Ventilation	0 - 4,999 CFM	Kitchen ventilation without DCKV		4,801	13,521	0	15	$10,000	5%	Both	New/Replacement
Commercial	New/Existing	Demand Control Kitchen Ventilation	10,000 - 15,000 CFM	Kitchen ventilation without DCKV		18,924	49,102	0	15	$20,000	5%	Both	New/Replacement
Commercial	New/Existing	Demand Control Kitchen Ventilation	5,000 - 9,999 CFM	Kitchen ventilation without DCKV		11,486	30,901	0	15	$15,000	5%	Both	New/Replacement
Commercial	New/Existing	Destratification Fans		No destratification fans		0.5 $m3/ft^2$	(-)0.0034 kwh/ft^2	0	15	$7,021	10%	Both	New/Retrofit

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Exhibit B
Tab 1
Schedule 2

Indicates an update (December 2012) from the Board approved list of input assumptions

Target Market		Equipment Details				Annual Resource Savings			Other				
Sector	New/Existing	Efficient Equipment	Details of Efficient Equipment	Base Equipment	Details of Base Equipment	Natural Gas (m3)	Electricity (kWh)	Water (L)	EUL	Incremental Cost ($)	Free Rider (%)	Utility Measure Applies to	Decision Type
Commercial	New	Energy Recovery Ventilation (Multi-Family, Health Care, Nursing Home)	Ventilation with ERV	Ventilation without ERV		5.77 m3/CFM	0	0	14	$3.18/CFM	5%	Both	New
Commercial	Existing	Energy Recovery Ventilation (Multi-Family, Health Care, Nursing Home)	Ventilation with ERV	Ventilation without ERV		6.12 m3/CFM	0	0	14	$3.18/CFM	5%	Both	Retrofit
Commercial	New	Energy Recovery Ventilation (Hotel, Restaurant, Retail)	Ventilation with ERV	Ventilation without ERV		3.21 m3/CFM	0	0	14	$3.18/CFM	5%	Both	New
Commercial	Existing	Energy Recovery Ventilation (Hotel, Restaurant, Retail)	Ventilation with ERV	Ventilation without ERV		3.4 m3/CFM	0	0	14	$3.18/CFM	5%	Both	Retrofit
Commercial	New	Energy Recovery Ventilation (Office, Warehouse, School)	Ventilation with ERV	Ventilation without ERV		2.05 m3/CFM	0	0	14	$3.18/CFM	5%	Both	New
Commercial	Existing	Energy Recovery Ventilation (Office, Warehouse, School)	Ventilation with ERV	Ventilation without ERV		2.17 m3/CFM	0	0	14	$3.18/CFM	5%	Both	Retrofit
Commercial	New	Heat Recovery Ventilation (Multi-Family, Health Care, Nursing Home)	Ventilation with HRV	Ventilation without HRV		4.28 m3/CFM	0	0	14	$3.61/CFM	5%	Both	New
Commercial	Existing	Heat Recovery Ventilation (Multi-Family, Health Care, Nursing Home)	Ventilation with HRV	Ventilation without HRV		4.70 m3/CFM	0	0	14	$3.61/CFM	5%	Both	Retrofit
Commercial	New	Heat Recovery Ventilation (Hotel, Restaurant, Retail)	Ventilation with HRV	Ventilation without HRV		2.38 m3/CFM	0	0	14	$3.61/CFM	5%	Both	New
Commercial	Existing	Heat Recovery Ventilation (Hotel, Restaurant, Retail)	Ventilation with HRV	Ventilation without HRV		2.61 m3/CFM	0	0	14	$3.61/CFM	5%	Both	Retrofit
Commercial	New	Heat Recovery Ventilation (Office, Warehouse, School)	Ventilation with HRV	Ventilation without HRV		1.52 m3/CFM	0	0	14	$3.61/CFM	5%	Both	New
Commercial	Existing	Heat Recovery Ventilation (Office, Warehouse, School)	Ventilation with HRV	Ventilation without HRV		1.67 m3/CFM	0	0	14	$3.61/CFM	5%	Both	Retrofit
Commercial	New	High Efficiency Boiler - Space Heating (<100 Mbtu/h)	85% AFUE	Non-condensing Boiler	82% AFUE	0.00318 /Btu/hr	0	0	25	$1,238	5%	Both	New
Commercial	New	High Efficiency Boiler - Space Heating (100 to 199 Mbtu/h)	85% AFUE	Non-condensing Boiler	82% AFUE	0.00318 /Btu/hr	0	0	25	$1,544	5%	Both	New
Commercial	New	High Efficiency Boiler - Space Heating (200 to 299 Mbtu/h)	85% AFUE	Non-condensing Boiler	82% AFUE	0.00318 /Btu/hr	0	0	25	$1,388	5%	Both	New
Commercial	Existing	High Efficiency Boiler - Space Heating (<100 Mbtu/h)	85% AFUE	Non-condensing Boiler	82% AFUE	0.00318 /Btu/hr	0	0	25	$1,808	5%	Both	Replacement
Commercial	Existing	High Efficiency Boiler - Space Heating (100 to 199 Mbtu/h)	85% AFUE	Non-condensing Boiler	82% AFUE	0.00318 /Btu/hr	0	0	25	$2,114	5%	Both	Replacement
Commercial	Existing	High Efficiency Boiler - Space Heating (200 to 299 Mbtu/h)	85% AFUE	Non-condensing Boiler	82% AFUE	0.00318 /Btu/hr	0	0	25	$1,958	5%	Both	Replacement
Commercial	Existing	High Efficiency Condensing Furnace	96% AFUE	AFUE 90%		1.7/kBtu/hr	0	0	18	$8.4/kBtu/hr	17.5%	Both	Replacement
Commercial	New/Existing	Single Stage & High Intensity Infrared Heaters	0 - 49,999 BTU/hr	Regular Unit Heater		0.0144 /Btu/hr	16	0	20	$0.0122 /BTUh	33%	Both	New/Replacement
Commercial	New/Existing	2-Stage Infrared Heaters	0 - 49,999 BTU/hr	Regular Unit Heater		0.0242 /Btu/hr	16	0	20	$0.0122 /BTUh	33%	Both	New/Replacement
Commercial	New/Existing	Single Stage & High Intensity Infrared Heaters	165,000 - 300,000 BTU/hr	Regular Unit Heater		0.0144 /Btu/hr	873	0	20	$0.0122 /BTUh	33%	Both	New/Replacement
Commercial	New/Existing	2-Stage Infrared Heaters	165,000 - 300,000 BTU/hr	Regular Unit Heater		0.0242 /Btu/hr	873	0	20	$0.0122 /BTUh	33%	Both	New/Replacement
Commercial	New/Existing	Single Stage & High Intensity Infrared Heaters	50,000 - 164,999 BTU/hr	Regular Unit Heater		0.0144 /Btu/hr	409	0	20	$0.0122 /BTUh	33%	Both	New/Replacement
Commercial	New/Existing	2-Stage Infrared Heaters	50,000 - 164,999 BTU/hr	Regular Unit Heater		0.0242 /Btu/hr	409	0	20	$0.0122 /BTUh	33%	Both	New/Replacement
Commercial	Existing	Prescriptive High Efficiency Boiler - Space Heating	83-84% Efficient, 300-2000 MBH	Space Heating Boiler	80.5% Thermal Efficiency	2,474-19,340	0	0	25	$3900-$4950	10/12/20%	Both	Replacement
Commercial	Existing	Prescriptive High Efficiency Boiler - Space Heating	85-88% Efficient, 300-2000 MBH	Space Heating Boiler	80.5% Thermal Efficiency	3,496-27,325	0	0	25	$4,500-$7,050	10/12/20%	Both	Replacement
Commercial	New	Prescriptive High Efficiency Boiler - Space Heating	83-84% Efficient, 300-2000 MBH	Space Heating Boiler	80.5% Thermal Efficiency	2,474-19,340	0	0	25	$3900-$4950	10/12/20%	Both	New
Commercial	New	Prescriptive High Efficiency Boiler - Space Heating	85-88% Efficient, 300-2000 MBH	Space Heating Boiler	80.5% Thermal Efficiency	3,496-27,325	0	0	25	$4,500-$7,050	10/12/20%	Both	New
Commercial	Existing	Prescriptive Schools - Elementary	hydronic boiler with 83%+ thermal efficiency	hydronic boiler with 80.5% thermal efficiency		12,217	0	0	25	$8,646	27%	UG	Replacement
Commercial	Existing	Prescriptive Schools - Elementary	hydronic boiler with 83%+ thermal efficiency	hydronic boiler with 80.5% thermal efficiency		12,217	0	0	25	$8,646	12%	EGD	Replacement
Commercial	Existing	Prescriptive Schools - Secondary	hydronic boiler with 83%+ thermal efficiency	hydronic boiler with 80.5% thermal efficiency		49,476	0	0	25	$14,470	27%	UG	Replacement
Commercial	Existing	Prescriptive Schools - Secondary	hydronic boiler with 83%+ thermal efficiency	hydronic boiler with 80.5% thermal efficiency		49,476	0	0	25	$14,470	12%	EGD	Replacement
Commercial	Existing	Programmable Thermostat		Standard thermostat		13 - 108**	15 - 77**	0	15	$110	20%	UG	Retrofit
Commercial	Existing	Programmable Thermostat	Educational - School	Standard thermostat		65	8	0	15	$110	20%	EGD	Retrofit

Indicates an update (December 2012) from the Board approved list of input assumptions

Target Market		Equipment Details				Annual Resource Savings			Other				
Sector	New/Existing	Efficient Equipment	Details of Efficient Equipment	Base Equipment	Details of Base Equipment	Natural Gas (m3)	Electricity (kWh)	Water (L)	EUL	Incremental Cost ($)	Free Rider (%)	Utility Measure Applies to	Decision Type
Commercial	Existing	Programmable Thermostat	Educational - University/College	Standard thermostat		58	57	0	0	$110	20%	EGD	Retrofit
Commercial	Existing	Programmable Thermostat	Food Service - Restaurant/Tavern	Standard thermostat		69	77	0	15	$110	20%	EGD	Retrofit
Commercial	Existing	Programmable Thermostat	Hotel/Motel	Standard thermostat		10	11	0	0	$110	20%	EGD	Retrofit
Commercial	Existing	Programmable Thermostat	Large Hotel	Standard thermostat		10	14	0	0	$110	20%	EGD	Retrofit
MultiFamily	Existing	Programmable Thermostat	Multi Family	Standard thermostat		15	13	0	15	$80	20%	Both	Retrofit
Commercial	Existing	Programmable Thermostat	Recreation - Small Fitness / Spa	Standard thermostat		35	87	0	15	$110	20%	EGD	Retrofit
Commercial	Existing	Programmable Thermostat	Retail - Food	Standard thermostat		22	16	0	15	$110	20%	EGD	Retrofit
Commercial	Existing	Programmable Thermostat	Retail - Mall	Standard thermostat		14	19	0	15	$110	20%	EGD	Retrofit
Commercial	Existing	Programmable Thermostat	Retail - Strip Mall	Standard thermostat		11	19	0	15	$110	20%	EGD	Retrofit
Commercial	Existing	Programmable Thermostat	Small Office	Standard thermostat		39	43	0	0	$110	20%	EGD	Retrofit
Commercial	Existing	Programmable Thermostat	Warehouse / Wholesale	Standard thermostat		132	9	0	15	$110	20%	EGD	Retrofit
Commercial	New/Existing	Rooftop Unit	Two-stage rooftop unit	Single stage rooftop unit		255	0	0	15	$375	5%	Both	New/Replacement

Commercial Water Heating

Sector	New/Existing	Efficient Equipment	Details of Efficient Equipment	Base Equipment	Details of Base Equipment	Natural Gas (m3)	Electricity (kWh)	Water (L)	EUL	Incremental Cost ($)	Free Rider (%)	Utility Measure Applies to	Decision Type
Commercial	New/Existing	Commercial Laundry Washing Equipment with Ozone	Washer extractor – 60 lbs	Commercial Laundry Washing Equipment without Ozone		0.0328 m3/lbs/yr	0.00219 kwh/lbs/yr	2.01 L/lbs/yr	15	$10,970	8%	Both	New/Retrofit
Commercial	New/Existing	Commercial Laundry Washing Equipment with Ozone	Washer extractor – 500 lbs	Commercial Laundry Washing Equipment without Ozone		0.0328 m3/lbs/yr	0.00219 kwh/lbs/yr	2.01 L/lbs/yr	15	$30,270	8%	Both	New/Retrofit
Commercial	New/Existing	Commercial Laundry Washing Equipment with Ozone	Tunnel Washer – 120 lbs	Commercial Laundry Washing Equipment without Ozone		0.0240 m3/lbs/yr	0.00152 kwh/lbs/yr	1.22 L/lbs/yr	15	$49,667	8%	Both	New/Retrofit
Commercial	New/Existing	Commercial Laundry Washing Equipment with Ozone	Tunnel Washer – 500 lbs	Commercial Laundry Washing Equipment without Ozone		0.0240 m3/lbs/yr	0.00152 kwh/lbs/yr	1.22 L/lbs/yr	15	$160,065	8%	Both	New/Retrofit
Commercial	Existing	Condensing Boiler - DHW (<100 Mbtu/h)	90% or greater AFUE	Non-condensing Boiler	82% AFUE	0.02170 /Btu/hr	0	0	25	$2,045	5%	Both	Replacement
Commercial	Existing	Condensing Boiler - DHW (100 to 199 Mbtu/h)	90% or greater AFUE	Non-condensing Boiler	82% AFUE	0.01332 /Btu/hr	0	0	25	$2,984	5%	Both	Replacement
Commercial	Existing	Condensing Boiler - DHW (200 to 299 Mbtu/h)	90% or greater AFUE	Non-condensing Boiler	82% AFUE	0.00996 /Btu/hr	0	0	25	$3,797	5%	Both	Replacement
Commercial	New	Condensing Boiler - DHW (<100 Mbtu/h)	90% or greater AFUE	Non-condensing Boiler	82% AFUE	0.02170 /Btu/hr	0	0	25	$1,475	5%	Both	New
Commercial	New	Condensing Boiler - DHW (100 to 199 Mbtu/h)	90% or greater AFUE	Non-condensing Boiler	82% AFUE	0.01332 /Btu/hr	0	0	25	$2,414	5%	Both	New
Commercial	New	Condensing Boiler - DHW (200 to 299 Mbtu/h)	90% or greater AFUE	Non-condensing Boiler	82% AFUE	0.00996 /Btu/hr	0	0	25	$3,227	5%	Both	New
Commercial	New/Existing	Condensing Gas Water Heater (1,000gal/day)	95% thermal efficiency	Conventional storage tank water heater	80% efficiency, 91 gal. tank.	1,551	0	0	13	$2,230	5%	Both	New/Replacement
Commercial	New/Existing	Condensing Gas Water Heater (100gal/day)	95% thermal efficiency	Conventional storage tank water heater	80% efficiency, 91 gal. tank.	332	0	0	13	$2,230	5%	Both	New/Replacement
Commercial	New/Existing	Condensing Gas Water Heater (500gal/day)	95% thermal efficiency	Conventional storage tank water heater	80% efficiency, 91 gal. tank.	873	0	0	13	$2,230	5%	Both	New/Replacement
Commercial	New	Drain Water Heat Recovery (DWHR)	Laundromat	No DWHR		49735	0	0	25	$37,211.00	5%	Both	New
Commercial	New	Drain Water Heat Recovery (DWHR)	Entertainment, Arena	No DWHR		394 per Showerhead	0	0	25	$776 per Showerhead	5%	Both	New
Commercial	New	Drain Water Heat Recovery (DWHR)	University/College Cafeterias - Dishwashing	No DWHR		4.6 per Meal Served/Day	0	0	25	$3.41 per Meal Served/Day	5%	Both	New
Commercial	New	Drain Water Heat Recovery (DWHR)	Hospital - Dishwashing	No DWHR		12 per Bed	0	0	25	$11.88 per Bed	5%	Both	New
Commercial	New	Drain Water Heat Recovery (DWHR)	Hospital - Laundry	No DWHR		295 Per Bed	0	0	25	$250 per Bed	5%	Both	New
Commercial	New	Drain Water Heat Recovery (DWHR)	Nursing Home - Dishwashing	No DWHR		12 per Bed	0	0	25	$16.54 per Bed	5%	Both	New
Commercial	Existing	Drain Water Heat Recovery (DWHR)	Laundromat	No DWHR		49735	0	0	25	$40,811.00	5%	Both	Retrofit
Commercial	Existing	Drain Water Heat Recovery (DWHR)	Entertainment, Arena	No DWHR		394 per Showerhead	0	0	25	$1209 per Showerhead	5%	Both	Retrofit
Commercial	Existing	Drain Water Heat Recovery (DWHR)	University/College Cafeterias - Dishwashing	No DWHR		11.6 Meal Served per Day	0	0	25	$6.26 per Meal Served per day	5%	Both	Retrofit

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Target Market		Equipment Details				Annual Resource Savings			Other				
Sector	New/Existing	Efficient Equipment	Details of Efficient Equipment	Base Equipment	Details of Base Equipment	Natural Gas (m3)	Electricity (kWh)	Water (L)	EUL	Incremental Cost ($)	Free Rider (%)	Utility Measure Applies to	Decision Type
Commercial	Existing	Drain Water Heat Recovery (DWHR)	Hospital - Dishwashing	No DWHR		31 per Bed	0	0	25	$18.19 per Bed	5%	Both	Retrofit
Commercial	Existing	Drain Water Heat Recovery (DWHR)	Hospital - Laundry	No DWHR		295 per Bed	0	0	25	$274 per Bed	5%	Both	Retrofit
Commercial	Existing	Drain Water Heat Recovery (DWHR)	Nursing Home - Dishwashing	No DWHR		31 per Bed	0	0	25	$25.33 per Bed	5%	Both	Retrofit
Commercial	New/Existing	Energy Star Dishwasher	Undercounter – High Temperature	Non-Energy Star Dishwasher		801	3,754	112,795	10	(-)$13	40%	Both	New/Replacement
Commercial	New/Existing	Energy Star Dishwasher	Undercounter – Low Temperature	Non-Energy Star Dishwasher		326	559	45,891	10	(-)$13	40%	Both	New/Replacement
Commercial	New/Existing	Energy Star Dishwasher	Stationary Rack, (Door type, or Single rack) – High Temperature	Non-Energy Star Dishwasher		619	3,553	87,119	15	(-)$350	20%	Both	New/Replacement
Commercial	New/Existing	Energy Star Dishwasher	Stationary Rack, (Door type, or Single rack) – Low Temperature	Non-Energy Star Dishwasher		841	855	118,369	15	(-)$350	20%	Both	New/Replacement
Commercial	New/Existing	Energy Star Dishwasher	Rack Conveyor, Single (Tank) – High Temperature	Non-Energy Star Dishwasher		2,203	9,811	310,271	20	$2,375	27%	Both	New/Replacement
Commercial	New/Existing	Energy Star Dishwasher	Rack Conveyor, Multi (Tank) – High Temperature	Non-Energy Star Dishwasher		3,708	15,822	522,192	20	$288	27%	Both	New/Replacement
Commercial	Existing	High Efficiency Boiler - DHW (<100 Mbtu/h)	85% or greater AFUE	Non-Condensing Boiler	82% AFUE	0.00468 /Btu/hr	0	0	25	$1,808.00	5%	Both	Replacement
Commercial	Existing	High Efficiency Boiler - DHW (100 to 199 Mbtu/h)	85% or greater AFUE	Non-Condensing Boiler	82% AFUE	0.00287 /Btu/hr	0	0	25	$2,114.00	5%	Both	Replacement
Commercial	Existing	High Efficiency Boiler - DHW (200 to 299 Mbtu/h)	85% or greater AFUE	Non-Condensing Boiler	82% AFUE	0.00215 /Btu/hr	0	0	25	$1,958.00	5%	Both	Replacement
Commercial	New	High Efficiency Boiler - DHW (<100 Mbtu/h)	85% or greater AFUE	Non-Condensing Boiler	82% AFUE	0.00468 /Btu/hr	0	0	25	$1,238.00	5%	Both	New
Commercial	New	High Efficiency Boiler - DHW (100 to 199 Mbtu/h)	85% or greater AFUE	Non-Condensing Boiler	82% AFUE	0.00287 /Btu/hr	0	0	25	$1,544.00	5%	Both	New
Commercial	New	High Efficiency Boiler - DHW (200 to 299 Mbtu/h)	85% or greater AFUE	Non-Condensing Boiler	82% AFUE	0.00215 /Btu/hr	0	0	25	$1,388.00	5%	Both	New
Commercial	Existing	Pre-Rinse Spray Nozzle	1.24 GPM	Standard pre-rinse spray nozzle	3.0 GPM	190 - 886**	0	36,484 - 170,326**	5	$60	12.40%	UG	Retrofit
Commercial	New	Pre-Rinse Spray Nozzle (Full Service)	0.64 GPM	Pre-rinse spray nozzle	3.0 GPM	1286	0	252000	5	$150	0%	EGD	New
Commercial	Existing	Pre-Rinse Spray Nozzle (Full Service)	0.64 GPM	Pre-rinse spray nozzle	3.0 GPM	1286	0	252000	5	$150	0%	Both	Retrofit
Commercial	Existing	Pre-Rinse Spray Nozzle (Full Service)	0.64 GPM	Pre-rinse spray nozzle	1.6 GPM	457	0	97,292	5	$150	0%	Both	Retrofit
Commercial	New	Pre-Rinse Spray Nozzle (Limited)	0.64 GPM	Pre-rinse spray nozzle	3.0 GPM	339	0	66400	5	$150	0%	EGD	New
Commercial	Existing	Pre-Rinse Spray Nozzle (Limited)	0.64 GPM	Pre-rinse spray nozzle	3.0 GPM	339	0	66400	5	$150	0%	Both	Retrofit
Commercial	Existing	Pre-Rinse Spray Nozzle (Limited)	0.64 GPM	Pre-rinse spray nozzle	1.6 GPM	90	0	19,197	5	$150	0%	Both	Retrofit
Commercial	New	Pre-Rinse Spray Nozzle (Other)	0.64 GPM	Pre-rinse spray nozzle	3.0 GPM	318	0	62200	5	$150	0%	EGD	New
Commercial	Existing	Pre-Rinse Spray Nozzle (Other)	0.64 GPM	Pre-rinse spray nozzle	3.0 GPM	318	0	62200	5	$150	0%	Both	Retrofit
Commercial	Existing	Pre-Rinse Spray Nozzle (Other)	0.64 GPM	Pre-rinse spray nozzle	1.6 GPM	109	0	23,166	5	$150	0%	Both	Retrofit
Commercial	New	Prescriptive Higher Efficiency Boiler - DWH	83-84% Efficient, 300-1500 MBH	DWH Boiler	80.5% Thermal Efficiency	1,168-4,693	0	0	25	$3900 -$5900	10/12/20%	Both	New
Commercial	New	Prescriptive Higher Efficiency Boiler - DWH	85-88% Efficient, 300-1500 MBH	DWH Boiler	80.5% Thermal Efficiency	1,861-7,475	0	0	25	$4500-$7400	10/12/20%	Both	New
Commercial	Existing	Prescriptive Higher Efficiency Boiler - DWH	83-84% Efficient, 300-1500 MBH	DWH Boiler	80.5% Thermal Efficiency	1,168-4,693	0	0	25	$3900 -$5900	10/12/20%	Both	Replacement
Commercial	Existing	Prescriptive Higher Efficiency Boiler - DWH	85-88% Efficient, 300-1500 MBH	DWH Boiler	80.5% Thermal Efficiency	1,861-7,475	0	0	25	$4500-$7400	10/12/20%	Both	Replacement
Commercial	New	Tankless Water Heater	100 USG/day, 84% thermal efficiency	Conventional Storage Tank Water Heater	80% thermal efficiency	154	0	0	18	(-)$1,102	2%	Both	New
Commercial	Existing	Tankless Water Heater	100 USG/day, 84% thermal efficiency	Conventional Storage Tank Water Heater	80% thermal efficiency	154	0	0	18	(-)$1,102	2%	Both	Replacement

Multi-Family Water Heating

Multi-Family	New/Existing	CEE Tier 2 Front-Loading Clothes Washer	MEF=2.20, WF=5.1	Conventional top-loading, vertical axis clothes washer	MEF=1.26, WF=9.5	117	396	58,121	11	$600	10%	Both	New/Replacement
Multi-Family	New/Existing	Energy Star Front-Loading Clothes Washer	MEF=1.72 ,WF=8.0	Conventional top loading vertical axis washers	MEF = 1.26, WF=9.5	76	201	19,814	11	$150	48%	UG	New/Replacement

Indicates an update (December 2012) from the Board approved list of input assumptions

Target Market		Equipment Details				Annual Resource Savings			Other				
Sector	New/Existing	Efficient Equipment	Details of Efficient Equipment	Base Equipment	Details of Base Equipment	Natural Gas (m3)	Electricity (kWh)	Water (L)	EUL	Incremental Cost ($)	Free Rider (%)	Utility Measure Applies to	Decision Type
MultiFamily	Existing	Faucet Aerator	Bathroom, 1.0 GPM	Average Existing Stock		7	0	2371	10	$1.5	10%	EGD	Retrofit
MultiFamily	Existing	Faucet Aerator	Bathroom, 1.5 GPM	Average Existing Stock		4	0	1382	10	$2.	10%	EGD	Retrofit
MultiFamily	Existing	Faucet Aerator	Kitchen, 1.0 GPM	Average Existing Stock		24	0	8072	10	$2.	10%	EGD	Retrofit
Multi-Family	New	Faucet Aerator	Kitchen, 1.0 GPM	Ontario Building Code 2006	2.2 GPM	22	0	7,337	10	$1.59	10%	UG	New
MultiFamily	Existing	Faucet Aerator	Kitchen, 1.5 GPM	Average Existing Stock		16	0	5377	10	$2.	10%	EGD	Retrofit
Multi-Family	New	Faucet Aerator	Bathroom, 1.0 GPM	Ontario Building Code 2006	2.2 GPM	7	0	2,371	10	$0.59	10%	UG	New
Multi-Family	Existing	Faucet Aerator	Bathroom, 1.0 GPM	Average existing stock	2.2 GPM	7	0	2,371	10	$0.59	10%	UG	Retrofit
Multi-Family	New	Faucet Aerator	Bathroom, 1.5 GPM	Ontario Building Code 2006	2.2 GPM	4	0	1,382	10	$0.49	10%	UG	New
Multi-Family	Existing	Faucet Aerator	Bathroom, 1.5 GPM	Average existing stock	2.2 GPM	4	0	1,382	10	$0.49	10%	UG	Retrofit
Multi-Family	New	Faucet Aerator	Kitchen, 1.5 GPM	Ontario Building Code 2006	2.2 GPM	13	0	4,280	10	$1.29	10%	UG	New
Multi-Family	Existing	Faucet Aerator	Kitchen, 1.0 GPM	Average existing stock	2.5 GPM	24	0	8,072	10	$1.59	10%	UG	Retrofit
Multi-Family	Existing	Faucet Aerator	Kitchen, 1.5 GPM	Average existing stock	2.5 GPM	16	0	5,377	10	$1.29	10%	UG	Retrofit
Multi-Family	New/Existing	Low-Flow Showerhead - (MF ONLY)	1.25 GPM	Replace existing 2.0 GPM	2.0 GPM	24	0	7,933	10	$3.79	10%	UG	New/Retrofit
Multi-Family	New	Low-flow showerhead (Distributed)	1.25 GPM	Average existing stock	2.2 GPM	32	0	9,585	10	$3.79	10%	UG	New
Multi-Family	Existing	Low-flow showerhead (Distributed)	1.25 GPM	Average existing stock	2.2 GPM	32	0	9,585	10	$3.79	10%	UG	Retrofit
Multi-Family	New	Low-flow showerhead (Distributed)	1.5 GPM		2.2 GPM	33	0	5,228	10	$6	10%	UG	New
Multi-Family	Existing	Low-flow showerhead (Distributed)	1.5 GPM	Average existing stock	2.2 GPM	33	0	5,228	10	$6	10%	UG	Retrofit
MultiFamily	New	Low-Flow Showerhead (Per household, Installed)	1.25 GPM		2.5 GPM	36	-	11587	10	$12.5	10%	EGD	New
MultiFamily	New	Low-Flow Showerhead (Per household, Installed)	1.5 GPM		2.5 GPM	29	-	7818	10	$12.5	10%	EGD	New
MultiFamily	Existing	Low-Flow Showerhead (Per household, Installed)	1.5 GPM	2.0 -2.5 GPM showerhead	2.25 GPM	21	0	5931	10	$12.5	10%	EGD	Retrofit
MultiFamily	Existing	Low-Flow Showerhead (Per household, Installed)	1.5 GPM	2.6 -3.0 GPM GPM showerhead	2.8 GPM	40	0	10036	10	$12.5	10%	EGD	Retrofit
MultiFamily	Existing	Low-Flow Showerhead (Per household, Installed)	1.5 GPM	3.1 - 3.5 GPM showerhead	3.3 GPM	58	0	13621	10	$12.5	10%	EGD	Retrofit
MultiFamily	Existing	Low-Flow Showerhead (Per household, Installed)	1.5 GPM	3.6 GPM and above	3.6 GPM	69	0	15705	10	$12.5	10%	EGD	Retrofit

* Efficiency ratings and natural gas savings will vary by fireplace type. Please see substantiation sheet for type specific efficiency ratings and savings.

** Savings will vary for different segments. Please see substantiation sheet for segment specific savings.

	Indicates an update (December 2012) from the Board approved list of input assumptions

Target Market		Equipment Details				Annual Resource Savings			Other				
Sector	New/Existing	Efficient Equipment	Details of Efficient Equipment	Base Equipment	Details of Base Equipment	Natural Gas (m3)	Electricity (kWh)	Water (L)	EUL	Incremental Cost ($)	Free Rider (%)	Utility Measure Applies to	Decision Type

Union Gas Custom Projects

Sector	Free Rider (%)
Agriculture	54%
Industrial	54%
Commercial	54%
Multi-Residential	54%
New Construction	54%
Low-Income - Weatherization	0%
Low-Income - Custom	5%

Enbridge Custom Projects

Sector	Free Rider (%)
Agriculture	40%
Industrial	50%
Commercial	12%
Multi-Residential	20%
New construction	26%
Low-Income - Weatherization	0%
Low-Income - Custom	0%

NOTE FOR EUL TABLES

1. The following note will be added to the Union Table of Effective Useful Life (EUL) for Custom Project Measures and the Enbridge Measure Life Table for Custom Project Measures.

   “Where site specific information or a relevant prescriptive EUL is available to support an alternate EUL value for a specific custom project (Union / Enbridge) will use the alternate value for that custom project.”

2. The purpose of the note is to clarify that the EUL values listed in the tables are provided as guidelines for the utilities in calculating energy savings and project benefits. As stated in the note, the utilities may use an alternate EUL value for specific custom projects where the alternate value is supported by information specific to that custom project or where the alternate value has been approved for a prescriptive technology.

Witnesses: L. Kulperger
R. Sigurdson

NEW AND UPDATED SUBSTANTIATION DOCUMENTS

Infrared Heaters, UG & EGD

Revision #	Description/Comment	Date Revised
		December 2012

Efficient Equipment and Technologies Description
Infrared heater (up to 255,000 Btu/hour)
Base Equipment and Technologies Description
Regular unit heater

Decision Type	Target Market(s)	End Use
New/Retrofit	New/Existing Commercial buildings	Space Heating

Codes, Standards, and Regulations

The old code CAN 1-2.16-M81 (R1996) has been withdrawn.

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/Btu/hour)	Electricity (kWh)	Water (L)	($/Btu/hour)	($)
1	0.0144 - 0.0242	16 - 873	0	0.0122	0
2	0.0144 - 0.0242	16 - 873	0	0	0
3	0.0144 - 0.0242	16 - 873	0	0	0
4	0.0144 - 0.0242	16 - 873	0	0	0
5	0.0144 - 0.0242	16 - 873	0	0	0
6	0.0144 - 0.0242	16 - 873	0	0	0
7	0.0144 - 0.0242	16 - 873	0	0	0
8	0.0144 - 0.0242	16 - 873	0	0	0
9	0.0144 - 0.0242	16 - 873	0	0	0
10	0.0144 - 0.0242	16 - 873	0	0	0
11	0.0144 - 0.0242	16 - 873	0	0	0
12	0.0144 - 0.0242	16 - 873	0	0	0
13	0.0144 - 0.0242	16 - 873	0	0	0
14	0.0144 - 0.0242	16 - 873	0	0	0
15	0.0144 - 0.0242	16 - 873	0	0	0
16	0.0144 - 0.0242	16 - 873	0	0	0
17	0.0144 - 0.0242	16 - 873	0	0	0
18	0.0144 - 0.0242	16 - 873	0	0	0
19	0.0144 - 0.0242	16 - 873	0	0	0
20	0.0144 - 0.0242	16 - 873	0	0	0
TOTALS	**0.288 – 0.484**	**326 – 17,469**	**0**	**0.0122**	**0**

Resource Savings Assumptions

Annual Natural Gas Savings	Single Stage & High Intensity	0.0144 m^3/Btu/h
	2-Stage Heaters	0.0242 m^3/Btu/h

The infrared heater gas savings were based on the analysis procedures previously created by Agviro Inc. for Union Gas.[1]

Savings in the Agviro report are provided in three bins, corresponding to the input rating (Btu/hour) of the 0% over-sized conventional draft hood unit heater to be replaced. Agviro explicitly notes that over-sizing was not taken into account in the calculation of savings.

Agviro also notes that the efficient technology, the infrared heater "has been downsized by the infrared adjustment factor" and that "[when/if] the conventional system is 75,000 btu/h input... the infrared heater is [approximately] 64,000 Btu/h input...."

Put another way, an IR heater replacing a 0% over-sized conventional draft hood heater will have an input in btu/h that is 85% (the IR adjustment factor) that of the conventional unit.

Rather than using input range bins for the conventional draft hood heater, Navigant recommends using the corresponding input range bins for the efficient technology. This is for two reasons:

1. It will likely be much simpler to determine the input (btu/h) of the replacement/efficient technology than of the old conventional heater to be replaced.
2. The savings will not be overstated regardless of whether or not the conventional unit is over-sized, so long as the IR heater is appropriately sized for the heating load to be served. If in fact the conventional unit is over-sized the savings estimated will likely be understated given that an oversized draft hood heater operating at partial capacity is likely to consume more gas for a given heating load than a 0% oversized draft hood heater operating at optimal capacity.

In summary: the input heater range bins (and the attendant savings) shown below correspond to the input of *the efficient measure*.

Location	Heater Range (Btu/h)	Annual Gas Savings (m^3/year)		
		Single Stage	2-Stage	High Intensity
London	0 – 63,750	898	1,508	898
	64,600 – 127,500	1,786	3,017	1,786
	128,350 - 255,000	3,591	6,033	3,591
Sudbury	0 – 63,750	971	1,631	971
	64,600 – 127,500	1,942	3,262	1,942
	128,350 - 255,000	3,883	6,524	3,883

Annual gas savings were determined by taking the difference in the annual natural gas consumption of a conventional system and the annual natural gas consumption of the efficient technology as in equation (1) below.

[1] Assessment of Average Infrared Heater Savings, Agviro, December 1, 2004

$$\Delta GasUse = \left(\frac{AnnualHeatLoss_{Conv}}{Eff_{Conv}} - \frac{AnnuaHeatLoss_{EE}}{Eff_{EE}} \right) \times \frac{1}{35,300} \quad (1)$$

Where:

$AnnualHeatLoss$ = Annual heat loss of conventional heater and EE infrared heater (as defined by subscript).

Eff = The combustion efficiency of the heater (%).

35,300 = The energy value of natural gas (Btu/m^3)

The annual heat loss is calculated by Agviro as the sum of unit heat losses in a variety of outdoor temperature bins each of which is multiplied by the number of hours in which the temperature, on average falls into a given bin[2].

An average rate of savings of 0.0159 m^3/Btu/hour was determined by taking a weighted average of the savings from both locations: 70% of Union Gas South (London) and 30% of Union Gas North (Sudbury) based on customer population distribution in Union Gas service territories. Navigant, in determining the average rate of savings from the information in the Agviro report has conservatively assumed that the Btu/h is the highest possible for a given range. For example, a single-stage infrared heater saves on average 920 m^3 of natural gas per year (see table directly below) for Infrared heaters in the 0 – 63,750 Btu/h range – the weighted average between Union's two territories. Assuming that the average Btu/h within this range is in fact the highest possible value in this range (in this case 63,750 Btu/h) this results in savings of 0.0144 m^3/Btu/hr/year as shown in the table below.

Capacity (Btu/h)	Single stage	2 Stage	High Intensity
63,750	920	1,545	920
127,500	1,833	3,091	1,833
250,000	3,679	6,180	3,679
Infrared Tier	Revised Calculation		
63,750	0.0144	0.0242	0.0144
127,500	0.0144	0.0242	0.0144
255,000	0.0144	0.0242	0.0144

The savings for 2-stage units will be accounted for separately as per the 2011 Union Gas DSM Audit[2]

Annual Electricity Savings — 16 - 873 kWh

Both infrared heaters and conventional draft-hood unit heaters require an electrically powered circulating fan. Infrared heaters typically use a fan of a much lower horse-power than those used by a conventional draft-hood heater.

Navigant has estimated the base measure's fan load by converting the average fan horse-power of a representative sample of conventional draft-hood heaters into kilowatts.[3] Fan loads for infrared heaters were obtained by Navigant by contacting several manufacturers by and requesting the horse-power of the fan/blower on the most popular units in a given btu/hr input range[5].

[2] ECONorthwest, "Audit Report on Union Gas Draft DSM 2011 Annual Report – Final Report", June 15, 2012, pg 10-11

[3] Horse-power values were drawn from Trane's specifications sheet for that company's line of conventional draft-hood heaters: http://www.trane.com/Commercial/Uploads/Pdf/1024/uh-ts-1.pdf

As with the natural gas savings shown above, the electricity savings correspond to the input range bin in which the input (btu/h) of the efficient technology falls, not the base technology.

	Fan load (kW)		Operating Hours per Year		
Heater Range (Btu/h)	Conventional draft-hood heater	Infrared Heater	Conventional draft-hood heater	Infrared Heater	**Electricity Savings**
< 50,000	0.02	0.02	2509	2133	**16**
50,000 - 165,000	0.19	0.04	2509	2133	**409**
> 165,000	0.43	0.09	2509	2133	**873**

Annual Water Savings	0 L
N/A	

Other Input Assumptions

Effective Useful Life (EUL)	20 Years
Infrared heaters have an estimated service life of 20 years[6].	
Base & Incremental Conservation Measure Equipment and O&M Costs	**$ 0.0122 / Btu / h**
An incremental cost of $350 was used based on past input assumptions filed by Union[7]. Local retailers reported an average of $0.009 / Btu/hr incremental cost. Navigant Consulting therefore is estimating an average of $0.0122 / Btu/hour.	

Measure Assumptions Used by Other Jurisdictions

Source	Annual Natural Gas Savings (m3)	Effective Useful Life (Years)	Incremental Cost ($)	Penetration/Market Share
Questar Gas[8]	32.64	17	1,391	N/A
Comments Specifications for infrared heaters are not provided in the report or the baseline assumptions.				

[5] Navigant contacted Spaceray (www.spaceray.com) , Schwank (www.schwankgroup.com) and Calcana (www.Calcana.com) and also consulted the online specifications published by Solaronics (http://solaronics.thomasnet.com/Asset/SSTG-SSTU-GB_200010_Spec_Sheet.pdf). The infrared heaters produced by Solaronics, Schwank and Spaceray all use the same horse-power fan, regardless of btu/hr input, whereas the Calcana heater fan horse-power varies by input range. Navigant has conservatively assumed that the fan load of the 0 – 75,000 btu/hr range will be the average of all those reported to Navigant, whereas the fan-load for the other two buckets will be those reported by Calcana.

[6] "Prescriptive Incentives for Selected Natural Gas Technologies", Prepared for Enbridge Consumers Gas and Union Gas Ltd., Prepared by: Jacques Whitford Environment Limited, Agviro Inc., and Engineering Interface Ltd., September 27, 2000.

[7] EB-2005-0211, Union Gas Settlement Agreement, April 7, 2005

[8] Questar Gas, DSM Market Characterization Report, by Nexant, August 9, 2006

Condensing Make-Up Air (MUA) Unit, UG & EGD

Revision #	Description/Comment	Date Revised
		December 2012

Efficient Equipment and Technologies Description
Condensing Make-up air unit (MUA) with: a. Improved Efficiency (91%) b. Improved Efficiency (91%) and 2 speed motor c. Improved Efficiency (91%) and a variable frequency drive (VFD)
Base Equipment and Technologies Description
Conventional MUA unit with constant speed drive

Decision Type	Target Market(s)	End Use
New, Existing	Commercial	Space heating

Codes, Standards, and Regulations

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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/cfm)	Electricity (kWh/cfm)	Water (L)	($)	($)
1	0.41-2.92	0.54-1.48			
2	0.41-2.92	0.54-1.48			
3	0.41-2.92	0.54-1.48			
4	0.41-2.92	0.54-1.48			
5	0.41-2.92	0.54-1.48			
6	0.41-2.92	0.54-1.48			
7	0.41-2.92	0.54-1.48			
8	0.41-2.92	0.54-1.48			
9	0.41-2.92	0.54-1.48			
10	0.41-2.92	0.54-1.48			
11	0.41-2.92	0.54-1.48			
12	0.41-2.92	0.54-1.48			
13	0.41-2.92	0.54-1.48			
14	0.41-2.92	0.54-1.48			
15	0.41-2.92	0.54-1.48			
TOTALS	**6.15-43.8**	**8.1-22.2**	**0**	**$(0.66-1.02) per cfm +$870**	

Resource Savings Assumptions

Annual Natural Gas Savings	MR & LTC 0.84 m^3/cfm – 2.92 m^3/cfm Retail & Comm 0.41 m^3/cfm– 2.07 m^3/cfm

To estimate the gas savings for this measure, Navigant relied on the results of evaluations, completed by Agviro Inc., of 18 projects in which condensing MUA with improved efficiencies and in some cases 2 speed or variable frequency drives were installed in commercial applications[1]. 14 of these projects were multi-residential, 1 for long term care, 2 for retail and 1 for other commercial.

The analysis considered several heating input ranges based on the available Make-up air (MUA) models.

The efficiency for the base case and for condensing MUA's is provided by manufacturers[1] for the various heating input ranges as shown below:

	Combustion Efficiency (%)	
Input Range (MBH)	Base Case (@ High Fire)	Condensing
100-200	82	91
200-400	82	91
450-600	80.5	91
600-1,000	80	91
1,100-1,400	80	91

Gas savings for each of the 18 projects were estimated by Agviro by applying project-specific inputs (e.g., air-flow, indoor set-point temperature, hours of operation, etc.) to the proprietary Enbridge ETools calculator[2].

The ETools calculator estimates gas savings in the following manner:

The annual heat requirement to maintain the set-point air temperature is the sum of the annual heat requirement to maintain the set-point temperature between midnight and 8am, 8am and 4pm and 4pm and midnight:

$$q_{vent} = q_{vent\,00-08} + q_{vent\,08-16} + q_{vent\,16-24} \tag{1}$$

Where:

- q_{vent} = Annual heat requirement (Btu)
- $q_{vent00-08}$ = Annual heat requirement (Btu) between midnight and 8am
- $q_{vent09-16}$ = Annual heat requirement (Btu) between 8am and 4pm
- $q_{vent16-24}$ = Annual heat requirement (Btu) between 4pm and midnight

Note that in the base case, when the circulating fan runs at a constant speed the above equation is equivalent to:

$$q_{vent} = q_{vent\,00-24} \tag{2}$$

The savings for three types of condensing MUA units have been evaluated:

1. A unit with improved efficiency (91%)
2. A unit with improved efficiency (91%) and a 2 speed motor
3. A unit with improved efficiency (91%) and a VFD.

1 Prescriptive Condensing MUA Program Prescriptive Savings Analysis, Agviro Inc., Oct. 25, 2010 (Rev. 21-Jan-11).

2 An external review of Enbridge's program processes, data tracking, and oversight activities has indicated that the development and continual improvement of the ETools custom project screening tool is reflective of industry best practices.
The Cadmus Group, *Independent Audit of 2008 DSM Program Results*, June 2009. Report filed with the OEB in connection with Enbridge's application to clear DSM deferral accounts for 2008, EB-2009-0341.

The condensing MUAs with 2 speed motors and VFDs do not run at a constant speed. Schedules of the percent airflow for Multi-Res, LTC and Other Commercial applications are included in Appendix A of this document.

The annual heating requirement, q_{vent}, is calculated as shown below:

$$q_{vent} = \sum_{-5}^{T_i} 1.08QH(T_i - T_o) \qquad (3)$$

Where:

q_{vent} =	Annual heat requirement (Btu)
Q =	Ventilation rate (cfm)
1.08 =	Energy required to raise the temperature of 1 ft^3 of air 1°F (Btu/°F/hour)
T_i =	Desired supply air temperature (°F)
T_o =	Outside temperature (°F)
H =	Total number of hours in a year which occur inside a specific 5° temperature range (as determined by average of 30 years)

The summation indicates that the equation above is calculated for a number of different outdoor temperature buckets each of five degrees C (e.g., -5 to 0, 0 to 5, etc.)

T_o and H vary with each term of the summation, where T_o is the mid-point of the given temperature bucket (e.g., for -5 to 0, T_o would be -2.5) and where H is the average number of hours in the year in which the temperature falls in the given bucket.

Gas savings are driven by the change in the annual heating requirement and the change in efficiency of the condensing MUA. The annual heating requirement for a condensing MUA with a VFD or with a 2 Speed motor can be calculated as follows:

$$q_{vent,VFD/2Speed} = (\%AirFlow_{VFD/2speed}) \times q_{vent} \qquad (4)$$

Where:

$\%AirFlow_{VFD/2speed}$

= The average airflow following the installation of the VFD or 2 speed motor expressed as a percentage of the airflow when the base technology was in place found in Appendix A.

It should be noted that when a conventional MUA is replaced with a condensing MUA that has neither a 2 speed or VFD-controlled motor, there will not be a change in airflow. In this case equation 4 will not be required in order to estimate the annual heat requirements.

Gas savings for the condensing MUA are then determined using the following equation:

$$NG_E = \left(\frac{q_{vent}}{NG_{cal}(Eff_{Base}/100)} - \frac{q_{vent,VFD/2speed}}{NG_{cal}(Eff_{VFD/2speed}/100)} \right) \times \%FA \qquad (1)$$

Where:

NG_E = Annual gas consumption (m^3)
q_{vent} = Annual heat requirement of the ventilation system (Btu)
NG_{cal} = Calorific value of Natural Gas (35,000 Btu/m^3)
Eff = Equipment efficiency (%)
%FA = % of Fresh Air (for make-up air units this value will always be 100%)

Note that for the condensing MUA without a VFD or 2 speed fan, q_{vent} = $q_{vent,VFD/2speed}$, and gas saving are driven only by the increase in efficiency.

The savings obtained by Agviro[1] from the ETools calculator for the various cases are given below:

MUA Inputs		NG Savings m^3		
Airflow (cfm)	**MBH**	**Improved Efficiency**	**2 Speed Motor**	**VFD**
Multi-Residential				
1,700	150	1,249	3,124	4,791
3,300	300	2,424	6,064	9,300
6,000	525	5,238	11,855	17,740
9,000	800	8,282	18,208	27,036
14,000	1,250	12,884	28,324	42,055
Long Term Care				
1,700	150	1,269	3,167	4,868
3,300	300	2,539	6,335	9,735
6,000	525	5,229	11,810	17,704
9,000	800	8,269	18,139	26,980
14,000	1,250	12,934	28,372	42,200
Retail/Other Commercial				
1,700	150	616	2,047	3,425
3,300	300	1,197	3,974	6,649
6,000	525	2,586	7,635	12,499
9,000	800	4,089	11,663	18,958
14,000	1,250	6,361	18,143	29,491

MUA Inputs		Annual NG Savings m^3/cfm		
Airflow (cfm)	**MBH**	**Improved Efficiency**	**2 Speed Motor**	**VFD**
Multi-Residential				
1,700	150	0.73	1.84	2.82
3,300	300	0.73	1.84	2.82
6,000	525	0.87	1.98	2.96
9,000	800	0.92	2.02	3.00
14,000	1,250	0.92	2.02	3.00
Long Term Care				
1,700	150	0.75	1.86	2.86
3,300	300	0.77	1.92	2.95
6,000	525	0.87	1.97	2.95
9,000	800	0.92	2.02	3.00
14,000	1,250	0.92	2.03	3.01
MR & LTC Average				
1,700	150	0.74	1.84	2.82
3,300	300	0.74	1.84	2.83
6,000	525	0.87	1.98	2.96
9,000	800	0.92	2.02	3.00
14,000	1,250	0.92	2.02	3.00
MR & LTC Annual Gas Savings m^3/cfm		**0.84**	**1.94**	**2.92**
Retail/Other Commercial				
1,700	150	0.36	1.20	2.01
3,300	300	0.36	1.20	2.01
6,000	525	0.43	1.27	2.08
9,000	800	0.45	1.30	2.11
14,000	1,250	0.45	1.30	2.11
Retail/Commercial Annual Gas Savings m^3/cfm		**0.41**	**1.25**	**2.07**

In the case of the multi-residential and long term care sectors, the savings were averaged based on the number of cases in each sector to obtain the final gas savings in m^3/(cfm) for each type of condensing MUA. Enbridge has informed Navigant that the distribution of projects by sector is anticipated to be the same going forward as it has been in the past. Following program implementation if Enbridge finds the distribution of projects has changed in any significant way the savings should be re-calculated to reflect the actual distribution.

Annual Electricity Savings	
	MR & LTC (0.54-1.48) kWh per cfm **Retail & Comm (0.54-1.09) kWh per cfm**

The electricity savings for each of the 18 projects were estimated by Agviro[1] by applying project-specific inputs (e.g., air-flow, indoor set-point temperature, hours of operation, etc.) to the proprietary Enbridge ETools calculator.

No electricity savings are achieved by replacing a conventional MUA with a condensing MUA of improved efficiency. The annual electricity savings attained from installing a condensing MUA with a 2 speed motor or with a VFD is simply the difference between the electricity consumed by the constant speed drive and the 2 speed motor or the VFD.

The annual electricity consumed by the MUA motor is calculated in the following manner:

$$MotorkWh = \sum_{\%Flow_{Partial}}^{\%Flow_{Peak}} kW_{Peak,Partial} \times Operation_{Peak,Partial}(hrs/yr) \qquad (6)$$

Where:

The annual electricity consumed by the motor is calculated in the following manner:

Where:

$kW_{Peak,Partial}$= The electrical demand (kW) of the motor at peak or partial air-flow. This is itself a function of the motor's horse-power, percent motor loading, motor efficiency and control factor.

$Operation_{Peak,Partial}$= The number of hours per year at which the motor/VFD operates at peak or partial airflow.

The summation indicates that the equation above is calculated for peak and partial airflow. Appendix 1 includes scheduling of the Base Case, 2-Stage and VFD motors for Multi-Res, LTC and Commercial applications.

The annual energy savings may then be calculated as the difference in motor energy use between the Base Case and 2-Stage or VFD.

The electricity savings achieved by either a condensing MUA with a 2 speed motor or a condensing MUA with a VFD as reported by Agviro presented below. The Commercial savings were updated to take into account the fan law as recommended in the Union Gas ECONorthwest 2011 Audit.

MUA Inputs			Annual Electricity Savings by Condensing MUA Type (kWh)		
Airflow (cfm)	**Motor HP**	**Input (MBH)**	**Improved Efficiency**	**2 Speed Motor**	**VFD**
Multi-Residential					
1,700	1	150	-	953	2,597
3,300	2	300	-	1,906	5,195
6,000	3	525	-	2,859	7,792
9,000	5	800	-	4,765	12,987
14,000	8.5	1,250	-	8,101	22,077
Long Term Care					
1,700	1	150	-	953	2,597
3,330	2	300	-	1,906	5,195
6,000	3	525	-	2,859	7,792
9,000	5	800	-	4,765	12,987
14,000	8.5	1,250	-	8,101	22,077
MR & LTC Average					
1,700	1	150	-	953	2,597
3,330	2	300	-	1,906	5,195
6,000	3	525	-	2,859	7,792
9,000	5	800	-	4,765	12,987
14,000	8.5	1,250	-	8,101	22,077
MR & LTC Annual Electricity Savings kWh/cfm			**-**	**0.54**	**1.48**
Retail/Other Commercial					
1,700	1	150	-	1,035	2,069
3,300	2	300	-	1,938	3,877
6,000	3	525	-	2,822	5,644
9,000	5	800	-	4,564	9,128
14,000	8.5	1,250	-	7,561	15,121
Retail/Comm Annual Electricity Savings kWh/cfm			**-**	**0.54**	**1.09**

These savings were averaged based on the number of cases in each sector to obtain the final electricity savings in kWh for each type of condensing MUA. Enbridge has informed Navigant that the distribution of projects by sector is anticipated to be the same going forward as it has been in the past. Following program implementation if Enbridge finds the distribution of projects has changed in any significant way the savings should be re-calculated to reflect the actual distribution.

Annual Water Savings	0 L
N/A	

Other Input Assumptions

Effective Useful Life (EUL)	15 Years

Measure life estimates for condensing MUAs are not currently available. It is expected that these units may last longer than conventional MUAs, but until robust estimates of condensing MUA EULs are available, the EUL of a conventional MUA will be used. The Iowa Utility association[3] and Puget Sound Energy[4] estimated the EUL for a conventional gas MUA to be 15 years.

Incremental Costs	$870 + ($0.66 to $1.02) per cfm

The total incremental costs versus the base case for the different units are included in the table below as given in the Agviro Inc. report[1]. The condensing MUA requires a neutralizer tank to adjust the pH of the condensate before going to the drain. The condensate must then have access to a drain. Drainage can be accomplished by a number of methods including plumbing to a roof drain or plumbing through the roof and into an interior drain. Costs for the neutralizer and plumbing to drain the condensate have also been included.

cfm	Incremental Costs vs. Base Case				
	Neutralizer	Drain	Improved Efficiency	Improved Efficiency & 2 Speed Motor	Improved Efficiency & VFD
1,700	$ 120	$ 750	$ 2,007	$ 3,060	$ 3,102
3,300	$ 120	$ 750	$ 2,250	$ 3,734	$ 3,793
6,000	$ 120	$ 750	$ 3,167	$ 4,615	$ 4,673
9,000	$ 120	$ 750	$ 4,196	$ 6,325	$ 6,410
14,000	$ 120	$ 750	$ 6,418	$ 8,764	$ 8,858
Average $/cfm			**$ 0.66**	**$ 1.01**	**$ 1.02**
Incremental Cost			**$870 + $0.66*cfm**	**$870 + $1.01*cfm**	**$870 + $1.02*cfm**

[3] Summit Blue Consulting et al, Prepared for the Iowa Utility Association, *Assessment of Energy and Capacity Savings Potential in Iowa*, February, 2008.
[4] Quantec, Prepared for Pudget Sound Energy, *Comprehensive Assessment of Demand Side Resource Potentials,* May, 2007.

Appendix A:
(Taken from the Prescriptive Condensing MUA Program Prescriptive Savings Analysis, Agviro Inc., Oct.25, 2010(Rev. 21-Jan-11)

Base Case, 2 Speed, VFD

These inputs calculate the energy and electrical savings comparing the base case unit having a single speed motor to a condensing MUA having a 2-speed motor for multi-residential, long term care, and retail/other commercial facility types. Tables of the inputs are included in Appendix B & C of the Agviro report. A schedule of hourly percent of airflow for Multi-Res and LTC are shown in Table 6.

Table 7 shows the modeled airflow schedules for Retail and Other Commercial applications. This type of facility is considered to require MUA for 12 hrs/day, 6 days/week at 72F. The Base Case unit provides 100% airflow during this period. The 2-Speed Condensing unit is considered to operate on high-speed for half the time and low-speed for the remaining; resulting in an average of 75% of the airflow over the entire operational period versus the base case. The VFD calculation assumes 50% airflow versus the Base Case.

The fan law states that when an electric motor is powering a fan under ideal conditions, the fractional power use is equal to the fractional fan speed, raised to the third power. However, due to inefficiencies, savings are more accurately modeled by raising the fractional fan speed to the 2.7 power.

$$\frac{Power_{New}}{Power_{Baseline}} = \left(\frac{Fan\ Speed_{New}}{Fan\ Speed_{Baseline}}\right)^{2.7}$$

The fan law was used to calculate power requirements for each of the flow rate values from the tables below. ECONorthwest/Cascades Energy also applied a motor load of 65%[1], and motor efficiencies of 0.742, 0.792, 0.816, 0.841, 0.863 for the 1, 2, 3, 5, and 8.5 hp motors, respectively.[2] The Multi-Res and LTC savings were not in need of adjustment because the values were already very similar (within ~3%).

Table 6: Schedule of Multi-Res & LTC Applications

	Multi-Res & LTC		
Hr of Day	**Base Case**	**2 Stage**	**VFD***
0	100	50	50
1	100	50	50
2	100	50	50
3	100	50	50
4	100	50	50
5	100	50	50
6	100	100	100
7	100	100	100
8	100	100	70
9	100	100	70
10	100	100	70
11	100	100	100
12	100	100	100
13	100	100	70
14	100	100	70
15	100	100	70
16	100	100	100
17	100	100	100
18	100	100	100
19	100	100	100
20	100	50	50
21	100	50	50
22	100	50	50
23	100	50	50
Weighted Ave (%):	**100.0**	**79.2**	**71.7**

[1] a conservative value based on Cascade Energy's experience with MUA systems (Craig Phillips, Aug 2, 2012)
[2]Calculated from data from NEMA motor selection tool - U.S. Department of Energy
http://www1.eere.energy.gov/manufacturing/tech_deployment/software_motormaster.html

Table 7: Schedule of Commercial Applications

	Commercial		
Hr of Day	**Base Case**	**2 Stage**	**VFD**
0	0	0	0
1	0	0	0
2	0	0	0
3	0	0	0
4	0	0	0
5	0	0	0
6	0	0	0
7	0	0	0
8	100	75	50
9	100	75	50
10	100	75	50
11	100	75	50
12	100	75	50
13	100	75	50
14	100	75	50
15	100	75	50
16	100	75	50
17	100	75	50
18	100	75	50
19	100	75	50
20	0	0	0
21	0	0	0
22	0	0	0
23	0	0	0

HIGHER EFFICIENCY BOILERS –SPACE HEATING

Existing and New Commercial and Multi- Residential
(Updated December 2012)

Efficient Technology & Equipment Description
Hydronic Boilers for space (Seasonal)
Base Technology & Equipment Description
80.5% Thermal Efficiency Space Heating Boiler

Resource Savings Assumptions

Natural Gas (Updated)

Boiler Size	Space Heating (Seasonal) M3 Savings by Thermal Efficiency 83-84%	85-88%
300 MBH	2,474	3,496
600 MBH	4,695	6,633
1,000 MBH	8,594	12,141
1,500 MBH	13,582	19,189
2,000 MBH	19,340	27,325

Source: Prescriptive Commercial Boiler Program – Prescriptive Savings Analysis – AMEC Environmental & Infrastructure dated November 7, 2012. The original report dated Sep 10th, 2012 has been updated as per recommendations from the Commercial Hydronic Boiler System Baseline Study by ICF Marbek dated Sep 16th, 2011.

An iterative approach was used to determine the annual savings in the commercial sector. The following steps were taken:
a. The Rate 6 accounts were subdivided into bins of annual gas use. This provided the annual average gas use, number of accounts, seasonal, non-seasonal and total gas use.
b. The seasonal portion of the annual gas use was normalized to 30 year weather data. This normalized gas use was correlated to a seasonal boiler size required for gas consumption.
c. Categories of boiler sizes were selected to provide a suitable range of boilers available within the sector.
d. The Rate 6 accounts were subdivided using the normalized average seasonal gas use for the respective categories of boilers selected. This provided the annual average gas use, number of accounts, and total gas use per seasonal boiler size category.
e. Seasonal annual gas use normalization of the boiler size category accounts was completed.
f. Annual seasonal efficiency of the boiler size categories for each of the thermal efficiency ranges was determined.
g. Boiler costs for the boiler size categories was compiled.
h. A TRC/CCM analysis was completed for each of the boiler size categories.
i. A similar approached was used for the non-seasonal gas use with the exception of normalizing the data.
j. The new base case boiler efficiency changed from 81% combustion efficiency to 80.5% Thermal Efficiency. This reduced the seasonal efficiency from 62.6% to 60.9% for seasonal boilers and 65.6% to 64.9% for non-seasonal boilers. All other conditions remain the same as original.

Electricity (Updated)	kWh
Water	**L**

Other Input Assumptions

Equipment Life	25 years
As per EB 2008-0384 & 0385	
Incremental Cost (Contr. Install)	**Space Heating (Seasonal) Incremental Cost by Thermal Efficiency**

Boiler Size	83-84%	85-88%
300 MBH	$3,900	$ 4,500
600 MBH	$5,800	$ 6,000
1,000 MBH	$7,400	$10,300
1,500 MBH	$5,900	$ 7,400
2,000 MBH	$4,950	$ 7,050

Source: Prescriptive Commercial Boiler Program – Prescriptive Savings Analysis – Agviro Report Sept 10, 2008.

PRESCRIPTIVE SCHOOL BOILERS - ELEMENTARY

Commercial Existing Buildings
(Updated December 2012)

Efficient Technology & Equipment Description
Space Heating, Hydronic Boiler with Thermal Efficiency of 83% or higher
Base Technology & Equipment Description
Space Heating, Hydronic Boiler with Thermal Efficiency of 80.5%.

Resource Savings Assumptions

Natural Gas	**12,217 m^3**
Source: Updated "Elementary Schools Prescriptive Savings Analysis Report", AMEC Environmental & Infrastructure dated November 5, 2012 from original report by Agviro Inc., dated November 23, 2007. The new base case boiler efficiency changed from 81% combustion efficiency to 80.5% Thermal Efficiency. This reduced the base case seasonal efficiency from 63.89% to 62.21% thus the increase in gas savings. All other conditions remain the same as original.	
Electricity	**N/A kWh**
Water	**N/A L**

Other Input Assumptions

Equipment Life	**25 years**
As recommended by Navigant and approved in EB-2008-0384 / 0385.	
Incremental Cost (Contractor Install)	**$8,646**
Incremental costs are based on the weighted average of boiler types as noted above. As approved in EB-2008-0384 & 0385.	

PRESCRIPTIVE SCHOOL BOILERS - SECONDARY

Commercial Existing Buildings
(Updated December 2012)

Efficient Technology & Equipment Description -
Space Heating, Hydronic Boiler with Thermal Efficiency of 83% or higher
Base Technology & Equipment Description
Space Heating, Hydronic Boiler with Thermal Efficiency of 80.5%

Resource Savings Assumptions

Natural Gas	**49,476 m^3**
Source: Updated “Secondary Schools Prescriptive Savings Analysis Report”, AMEC Environmental & Infrastructure dated November 5, 2012 from original report by Agviro Inc., dated November 23, 2007. The new base case boiler efficiency changed from 81% combustion efficiency to 80.5% Thermal Efficiency. This reduced the base case seasonal efficiency from 63.89% to 62.21% thus the increase in gas savings. All other conditions remain the same as original.	
Electricity	**N/A kWh**
Water	**N/A L**

Other Input Assumptions

Equipment Life	**25 years**
As recommended by Navigant and approved in EB-2008-0384 / 0385.	
Incremental Cost (Contractor Install)	**$14,470**
Incremental costs are based on the weighted average of boiler types as noted above. As approved in EB-2008-0384 & 0385.	

Low-Flow Showerhead (Various GPM, Enbridge TAPS, ESK and Multi-Family)

Revision #	Description/Comment	Date Revised
		December 2012

Efficient Equipment and Technologies Description	
Low-flow Showerhead (1.25 or 1.5 GPM) – distributed to participants under Enbridge's TAPS program, Enbridge's ESK program, Enbridge's Multi-Family program and Enbridge's Low-Income program.	
Base Equipment and Technologies Description	
Enbridge TAPS (existing only)	– 2.45 GPM or – 3.07 GPM[1]
Enbridge ESK (new only)	– Maximum allowable by OBC (2.5 GPM)
Enbridge Multi-Family (MF) (existing only)	– 2.25 GPM – 2.8 GPM – 3.3 GPM – 3.6 GPM[2]
Enbridge Multi-Family (MF) (new only)	– Maximum allowable by OBC (2.5 GPM)
Enbridge Low-Income	– 2.45 GPM or – 3.07[3]
Enbridge Multi-Family (MF) Low Income (existing only)	– 2.25 GPM – 2.8 GPM – 3.3 GPM – 3.6 GPM[4]

Decision Type	Target Market(s)	End Use
Enbridge TAPS - Existing, Enbridge ESK – New Only, Enbridge MF – New and Existing and Low Income	Residential, Low-Income, Multi-family	Water heating

[1] Enbridge load research indicates that that the average bag-tested flow rate for showerheads that fall within the 2.0 – 2.5 GPM bucket is 2.45 GPM and that the average bag-tested flow rate for showerheads that fall within the >2.5 GPM bucket is 3.07.

[2] Enbridge contractors install the showerheads as part of the Enbridge Multi-Family program. The base measure is reported as falling in one of four buckets, 2.0 – 2.5 GPM, 2.6 – 3.0 GPM, 3.1 – 3.5 GPM and greater than 3.6 GPM. Navigant has assumed that in each case the average base technology GPM for each of the first three buckets is the mid-point and that the average GPM for the fourth bucket is the lowest possible value; 3.6 GPM

[3] The average GPM of low-income households' showerheads is assumed by Navigant to be no different than that of standard single family households'.

[4] Enbridge contractors install the showerheads as part of the Enbridge Multi-Family program. The base measure is reported as falling in one of four buckets, 2.0 – 2.5 GPM, 2.6 – 3.0 GPM, 3.1 – 3.5 GPM and greater than 3.6 GPM. Navigant has assumed that in each case the average base technology GPM for each of the first three buckets is the mid-point and that the average GPM for the fourth bucket is the lowest possible value; 3.6 GPM

Codes, Standards, and Regulations

Ontario Building Code (2006)[5] requires shower heads to have a maximum flow of 2.5 GPM (9.5 L/min).

Resource Savings Table

Year (EUL=)	Electricity and Other Resource Savings: Natural Gas (m^3)	Electricity (kWh)	Water (L)	Equipment & O&M Costs of Conservation Measure ($)	Equipment & O&M Costs of Base Measure ($)
1	21 – 82	0	5,931 – 23,374	6	0
2	21 – 82	0	5,931 – 23,374	0	0
3	21 – 82	0	5,931 – 23,374	0	0
4	21 – 82	0	5,931 – 23,374	0	0
5	21 – 82	0	5,931 – 23,374	0	0
6	21 – 82	0	5,931 – 23,374	0	0
7	21 – 82	0	5,931 – 23,374	0	0
8	21 – 82	0	5,931 – 23,374	0	0
9	21 – 82	0	5,931 – 23,374	0	0
10	21 – 82	0	5,931 – 23,374	0	0
TOTALS	**215 - 815**	**0**	**59,307 – 233,744**	**EG TAPS 1.25 GPM = $19.00** **EG LI 1.25 GPM = $18.71** **EG ESK 1.25 GPM = $4.26** **EG ESK 1.5 GPM = $12.50** **EG ESK 1.5 & 1.25 GPM = $16.76** **EG Multi-Fam 1.5 GPM = $12.50** **EG Multi-Fam 1.25 GPM = $12.50** **EG Multi-Fam LI 1.5 GPM = $15.50**	**0**

Resource Savings Assumptions

Annual Natural Gas Savings	21 – 82 m^3

Enbridge Gas commissioned a study by the SAS Institute (Canada)[6] 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[7] 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.[8]

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:

[5] Ontario Regulations 350/06, 2006 Building Code
[6] Rothman, Lorne, SAS® PHASE II Analysis for Enbridge Gas Distribution Inc.: Estimating the Impact of Low-Flow Showerhead Installation; April 5, 2010
[7] Where no low-flow showerheads were ever installed
[8] 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).

Table 1 - SAS Study Results

Bucket for Base Showerhead	Average Flow Rate of SAS Sample (GPM)	Annual Natural Gas Savings (m3)
2.0 to 2.5 GPM	2.36	46
> 2.5 GPM	3.19	88

To extrapolate the savings estimates reported in the SAS study to the base technologies under consideration several steps are required.

1. **Estimate the "as-used" flow of the base and efficient technologies.**

In its report on showerhead savings, Summit Blue[9], notes that the actual flow-rate as used in showers has been found to differ somewhat from the nominal flow-rate. Citing a 1994 California study, they provide an equation for calculating the "as-used" flow:

As-used flow rate (GPM) = 0.691 + 0.542*Nominal flow rate (GPM)

Navigant notes that applying this equation to a showerhead with a 1.25 GPM flow rate would result in an as-used flow rate that is greater than the nominal flow rate. Navigant has therefore applied a somewhat modified version of the equation above to determine the as-used flow rate. The as-used flow rate is estimated to be the minimum of either the result of the equation above or the nominal flow rate.

Applying the modified equation to Table 1, above, we obtain the following:

Table 2 - As-Used Flow

Nominal Flow (GPM)		As-Used Flow (GPM)		Delta As-Used Flow (GPM)	Observed Savings (m^3)
Base Technology	Efficient Measure	Base Technology	Efficient Measure		
2.36	1.25	1.97	1.25	0.72	46
3.19	1.25	2.42	1.25	1.17	88

2. **Estimate the average annual natural gas consumption of a 1.25 GPM showerhead.**

Based on the values above, Navigant has estimated that the annual natural gas consumption of the 1.25 GPM showerhead is 87 m^3 per year.

Table 3 - Annual Natural Gas Consumption of a 1.25 GPM Showerhead

Delta As-Used Flow (GPM)	Observed Savings (m^3)	Efficient Technology As-Used Flow (GPM)	Implied Annual Gas Consumption of Efficient Technology (m^3)	Average (m^3)
A	B	C	D = (C/A)*B	E = Average(D)
0.72	46	1.25	80	87
1.17	88	1.25	94	

[9] Summit Blue, *Resource Savings Values in Selected Residential DSM Prescriptive Programs*, prepared for Union Gas and Enbridge Gas Distribution, June 2008

3. **Extrapolate the implied annual natural gas consumption of showerheads in both buckets identified by the SAS Institute.**

Extrapolating these values is simply a matter of adding the estimated savings by bucket to the estimated annual consumption of the 1.25 GPM showerhead.

Table 4 - Implied Annual Natural Gas Consumption by Showerhead Flow Rate

Nominal Flow Rate (GPM)	Implied Annual Natural Gas Consumption (m3)
1.25	87
2.36	133
3.19	175

4. Estimate an equation from which the annual natural gas consumption of showerheads with flow rates different to those above may be extrapolated.

Fitting a polynomial equation to the three data-points in Table 4 above delivers the following equation which may be used to extrapolate the annual natural gas consumption of a given showerhead:

$$y = 49.06 + 24.39x + 4.72x^2$$

Where:

y = Annual natural gas consumption (m^3)
x = Nominal GPM of showerhead

Navigant notes that given the manner in which this equation was derived, and the values of the parameters, it may be inappropriate to use this equation to extrapolate the annual natural gas consumption of showerheads with a nominal flow rate that is less than 1.25 GPM.

In multi-family homes, Navigant has adjusted savings based on number of occupants per household to reflect differences in patterns of use. The adjustment factor is the fraction of average number of occupants per household in an apartment building over the average number of occupants per household in a single-detached house[10]. This factor is (2/2.9) = 69% for buildings over 5 stories and (1.9/2.9) = 66% for buildings of five stories or less. The average of these two factors, weighted by the number of each type of household is 68%.

It should be noted that the savings below are per household and predicated on the assumption that all showers taken in that household are taken using a shower with the low-flow showerhead. In the program measurement and verification stage, Enbridge will undertake to determine what proportion of showers per household were taken with the efficient measure and apply this factor to previously calculated savings.

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[10] 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=

Table 5 - Natural Gas Savings

Program	Applicable Customer Group	Base Flow Rate	Efficient Measure Flow Rate	Annual Gas Savings(m3)	Lifetime Gas Savings (m3)
EG TAPS	Standard Res	2.45	1.25	50	502
EG TAPS	Standard Res	3.07	1.25	82	815
EG Low-Income	LI	2.45	1.25	50	502
EG Low -Income	LI	3.07	1.25	82	815
EG ESK (New Only)	Standard Res	2.50	1.25	53	526
EG ESK (New Only)	Standard Res	2.50	1.50	43	433
EG ESK (New Only)	Standard Res	2.50	1.25 & 1.5	48	480
EG ESK (New Only)	Multi-Family	2.50	1.25	36	358
EG ESK (New Only)	Multi-Family	2.50	1.50	29	294
EG MF & MF Low Income	Multi-Family & LI	2.25	1.50	21	215
EG MF & MF Low Income	Multi-Family & LI	2.80	1.50	40	395
EG MF & MF Low Income	Multi-Family & LI	3.30	1.50	58	576
EG MF & MF Low Income	Multi-Family & LI	3.60	1.50	69	692

**Participants in Enbridge's ESK program receive both a 1.25 and 1.5 GPM showerhead. Navigant has assumed that both are used equally and that resultant household savings are equivalent to the average savings of a household that receives only 1.5 GPM showerheads and a household that receives only 1.25 GPM showerheads. Enbridge has indicated that in the future new households may receive either only 1.5 or 1.25 FPM showerheads. These households would attain the corresponding savings shown above.*

Annual Electricity Savings	**0 kWh**

N/A

Annual Water Savings	**5,931 – 23,374 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 and efficient equipment:

Base Technology	
Nominal GPM	As-Used GPM
2.45	2.02
3.07	2.35
2.5	2.05
2.25	1.91
2.8	2.21
3.3	2.48
3.6	2.64

Efficient Technology	
Nominal GPM	As-Used GPM
1.25	1.25
1.5	1.50

- Average household size: 3.1 persons (Standard Res and LIA)[11], 2.09 persons (Multi-family)[12]
- Showers per capita per day: 0.75[13]
- Average showering time per capita per day with base and efficient equipment[14]:

Base Technology	
As-Used GPM	Showering Time
2.02	7.28
2.35	7.13
2.05	7.27
1.91	7.33
2.21	7.20
2.48	7.08
2.64	7.01

Efficient Technology	
As-Used GPM	Showering Time
1.25	7.62
1.5	7.51

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
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)

[11] Summit Blue (2008).

[12] 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 (1.96) 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=

[13] Summit Blue (2008), based on data from: Resource Management Strategies, Inc., Regional Municipality of York Water Efficiency Master Plan Update, April 2007

[14] 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)

Table 6 - Annual Water Savings

Program	Applicable Customer Group	Base Flow Rate	Efficient Measure Flow Rate	Base Flow Rate (as used)	Efficient Measure Flow Rate (as used)	Annual Water Savings (L)	Lifetime water Savings (L)
EG TAPS	Standard Res	2.45	1.25	2.02	1.25	16,631	166,309
EG TAPS	Standard Res	3.07	1.25	2.35	1.25	23,374	233,744
EG Low-Income	LI	2.45	1.25	2.02	1.25	16,631	166,309
EG Low -Income	LI	3.07	1.25	2.35	1.25	23,374	233,744
EG ESK (New Only)	Standard Res	2.50	1.25	2.05	1.25	17,187	171,866
EG ESK (New Only)	Standard Res	2.50	1.50	2.05	1.50	11,596	115,958
EG ESK (New Only)	Standard Res	2.50	1.25 & 1.5	2.05	1.38	14,391	143,912
EG ESK (New Only)	Multi-Family	2.50	1.25	2.05	1.25	11,587	115,871
EG ESK (New Only)	Multi-Family	2.50	1.50	2.05	1.50	7,818	78,178
EG MF & MF Low Income	Multi-Family & LI	2.25	1.50	1.91	1.50	5,931	59,307
EG MF & MF Low Income	Multi-Family & LI	2.80	1.50	2.21	1.50	10,036	100,362
EG MF & MF Low Income	Multi-Family & LI	3.30	1.50	2.48	1.50	13,621	136,214
EG MF & MF Low Income	Multi-Family & LI	3.60	1.50	2.64	1.50	15,705	157,054

**Participants in Enbridge's ESK program receive both a 1.25 and 1.5 GPM showerhead. Navigant has assumed that both are used equally and that resultant household savings are equivalent to the average savings of a household that receives only 1.5 GPM showerheads and a household that receives only 1.25 GPM showerheads. Enbridge has indicated that in the future new households may receive either only 1.5 or 1.25 FPM showerheads. These households would attain the corresponding savings shown above.*

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	**EG TAPS 1.25 GPM = $19.00** **EG LI 1.25 GPM = $18.71** **EG ESK 1.25 GPM = $4.26** **EG ESK 1.5 GPM = $12.50** **EG ESK 1.5 & 1.25 GPM = $16.76** **EG Multi-Fam 1.5 GPM = $12.50** **EG Multi-Fam 1.25 GPM = $12.50** **EG Multi-Fam LI 1.5 GPM = $15.50**
Incremental cost for EG TAPS, ESK, Low Income, Multi-Family, and Multi-Family Low Income based on utility bulk purchase costs and installation costs where applicable.	

1.0 GAL/MIN FAUCET AERATOR (BATHROOM)

Low-Income Multi-Family, UG (Updated December 2012)

Efficient Technology & Equipment Description
1.0 GPM Faucet Aerator
Base Technology & Equipment Description
Average existing stock / 2.2 GPM Faucet Aerator

Resource Savings Assumptions

Natural Gas (Updated)	**7 m^3**
Based on Navigant savings calculation adjusted for a 1.0 GPM unit.	
Electricity	**n/a kWh**
Water (Updated)	**2,371 L**
Based on Navigant savings calculation adjusted for a 1.0 GPM unit.	

Other Input Assumptions

Equipment Life	**10 years**
As recommended by Navigant.	
Incremental Cost (Contractor Install)	**$0.56**
As per utility program costs.	

Faucet Aerator (Low-Income Multi-Family Kitchen), UG

Revision #	Description/Comment	Date Revised
		December 2012

Efficient Equipment and Technologies Description
Faucet Aerator (kitchen) (1.5 GPM)
Base Equipment and Technologies Description
Average existing stock (2.5 GPM)[1]

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

Codes, Standards, and Regulations

Ontario Building Code (2006)[2] requires bathroom and kitchen faucets to have a maximum flow of 2.2 GPM (8.35 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	16	0	5,377	1.14	
2	16	0	5,377	0	0
3	16	0	5,377	0	0
4	16	0	5,377	0	0
5	16	0	5,377	0	0
6	16	0	5,377	0	0
7	16	0	5,377	0	0
8	16	0	5,377	0	0
9	16	0	5,377	0	0
10	16	0	5,377	0	0
TOTALS	**160**	**0**	**53,770**	**1.14**	

[1] From on-site audit data. Resource Management Strategies, Inc. *Regional Municipality of York Water Efficiency Master Plan Update,* 2007. Cited in: 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	16 m^3

Assumptions and inputs:

- Average faucet water temperature: 30 °C (86 F)[3]
- Average water inlet temperature: 9.33 °C (48.8 F)[4]
- Average water heater energy factor: 0.76[5]

Annual gas savings calculated as follows:

$$Savings = W * 8.33 * (T_{out} - T_{in}) * \frac{1}{EF} * 10^{-6} * 27.8$$

Where:

W = Water savings (gallons)
8.33 = Energy content of water (Btu/gallon/°F)
T_{out} = Faucet water temperature (°F)
T_{in} = Water inlet temperature (°F)
EF = Water heater recovery efficiency
10^{-6} = Factor to convert Btu to MMBtu
27.8 = Factor to convert MMBtu to m^3

Gas savings were determined to be 20% over base case:

$$Percent\ Savings = \frac{(G_{base} - G_{new})}{G_{base}}$$

Where:

G_{eff} = Annual natural gas use with efficient equipment, 64 m^3
G_{base} = Annual natural gas use with base equipment, 80 m^3

Annual Electricity Savings	0 kWh

N/A

Annual Water Savings	5,377 L

Assumptions and inputs:

- Average household size: 2.14 persons[6]
- Baseline faucet use (all faucets) per capita per day: 53 litres (14 gallons)[7]

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[3] Average of findings in two studies, adjusted for Toronto water inlet temperature. Mayer, P. W. et al, *Residential Indoor Water Conservation Study: Evaluation of High Efficiency Indoor Plumbing Fixture Retrofits in Single-Family Homes in East Bay Municipal Utility District Service Area,* 2003 and Skeel, T. and Hill, S. *Evaluation of Savings from Seattle's "Home Water Saver" Apartment/Condominium Program*, 1994. Both cited in: Summit Blue (2008).

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

[5] Assumption used by Energy Center of Wisconsin, citing GAMA, www.doa.state.wi.us/docs_view2.asp?docid=2249

[6] Summit Blue (2008) and Census 2006. 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=

[7] Ibid.

- Kitchen faucet use as a percentage of total faucet use: 65%[8]
- Point estimate of quantity of water that goes straight down the drain: 50%[9]

Annual water savings calculated as follows:

$$Savings = Fu * Ppl * 365 * Ba * \left(\frac{Fl_{base} - Fl_{eff}}{Fl_{base}} \right) * Dr$$

Where:

Fu = Faucet use per capita (gallons)
Ppl = Number of people per household
365 = Days per year
Dr = Percentage of water that goes straight down the drain
Ki = Kitchen faucet use as a percentage of total faucet use
Fl_{base} = Flow rate of base equipment (GPM)
Fl_{eff} = Flow rate of efficient equipment (GPM)

Water savings was determined to be 20% over base case:

$$PercentSavings = \frac{(W_{base} - W_{eff})}{W_{base}}$$

Where:

W_{eff} = Annual water use with efficient equipment: 21,509 litres (5,681gallons)
W_{base}= Annual water use with base equipment: 26,887litres (7,101 gallons)

Other Input Assumptions

Effective Useful Life (EUL)	10 Years
The U.S. DOE assumes a 10 year life for faucet aerators[10].	
Base & Incremental Conservation Measure Equipment and O&M Costs	**$1.14**
Average equipment cost based on utility bulk purchase order costs. This does not include installation costs.	

[8] DeOreo, W. and P. Mayer, *The End Uses of Hot Water in Snigle Family Homes from Flow Trace Analysis*, 1999 cited in Summit Blue (2008).
[9] Summit Blue (2008).
[10] U.S. Department of Energy, Federal Energy Management Program, *FEMP Designated Product: Lavatory Faucets* http://www1.eere.energy.gov/femp/procurement/eep_faucets.html

Low-Flow Showerhead (1.25 GPM, Low-Income Multi-Family, per Household), UG

Revision #	Description/Comment	Date Revised
		December 2012

Efficient Equipment and Technologies Description
One Low-flow Showerhead (1.25 Gpm) – distributed to participants

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	3.79	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**	**3.79**	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):

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

[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: $44\ m^3 \times (2.1 \text{ persons per household}/2.9 \text{ persons per household}) = 44 \times 72\% = 32\ m^3/yr$ 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.	

[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	**$3.79**
As per utility program costs, bulk purchase of showerheads.	

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

Low-Flow Showerhead (1.25 GPM Installed, Replacing 2.0-2.5GPM, Low-Income Multi-Family, per Household), UG

	Updated December 2012	

Efficient Equipment and Technologies Description
One Low-flow Showerhead (1.25 Gpm) - Installed
Base Equipment and Technologies Description
Existing showerhead between 2.0GPM and 2.5GPM (avg 2.25GPM)

Decision Type	Target Market(s)	End Use
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	33	0	9892	3.79	0
2	33	0	9892	0	0
3	33	0	9892	0	0
4	33	0	9892	0	0
5	33	0	9892	0	0
6	33	0	9892	0	0
7	33	0	9892	0	0
8	33	0	9892	0	0
9	33	0	9892	0	0
10	33	0	9892	0	0
TOTALS	**330**	**0**	**98,920**	**3.79**	0

Resource Savings Assumptions

Annual Natural Gas Savings	33 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):

$$\text{Annual Gas Savings } (m^3) = 40.29 * \Delta GPM + 5.71 * \Delta GPM^2$$
$$= 40.29*(2.25-1.25) + 5.71*(2.25-1.25)^2$$
$$= 46$$

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:

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[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=

$46 \ m^3 \times (2.1 \text{ persons per household}/2.9 \text{ persons per household}) = 46 \times 72\% = 33 \ m^3$

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	**9,892 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: 1.91 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: 7.31 minutes [12]
- Average showering time per capita per day with new technology: 7.61 minutes[11]

Annual water savings calculated as follows:

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

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 = 2,613 gallons or 9,892 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	**$3.79**
As per utility program costs, bulk purchase of showerheads.	

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

Low-Flow Showerhead (1.25 GPM Installed, Replacing 2.6+GPM, Low-Income Multi-Family, per Household), UG

	Updated December 2012	

Efficient Equipment and Technologies Description
One Low-flow Showerhead (1.25 Gpm) - Installed
Base Equipment and Technologies Description
Existing showerhead greater than 2.6GPM (avg 3.0GPM)

Decision Type	Target Market(s)	End Use
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	64	0	15549	3.79	0
2	64	0	15549	0	0
3	64	0	15549	0	0
4	64	0	15549	0	0
5	64	0	15549	0	0
6	64	0	15549	0	0
7	64	0	15549	0	0
8	64	0	15549	0	0
9	64	0	15549	0	0
10	64	0	15549	0	0
TOTALS	**640**	**0**	**155,490**	**3.79**	0

Resource Savings Assumptions

Annual Natural Gas Savings	64 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):

$$\text{Annual Gas Savings } (m^3) = 40.29 * \Delta GPM + 5.71 * \Delta GPM^2$$
$$= 40.29*(3.0-1.25) + 5.71*(3.0-1.25)^2$$
$$= 88$$

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:

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[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=

88 m^3 x (2.1 persons per household/2.9 persons per household) = 88 x 72% = 64 m^3

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	**15,549 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: 2.32 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: 7.13 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 = 4,108 gallons or 15,549 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	**$3.79**
As per utility program costs, bulk purchase of showerheads.	

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

Low-Flow Showerhead (1.25 GPM, Low-Income Multi-Family, per Household), UG

Revision #	Description/Comment	Date Revised
		December 2012

Efficient Equipment and Technologies Description
One Low-flow Showerhead (1.25 Gpm)

Base Equipment and Technologies Description
1.5 GPM (Participants who previously received a 1.5gpm showerhead from Union)

Decision Type	Target Market(s)	End Use
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	8	0	3846	3.79	0
2	8	0	3846	0	0
3	8	0	3846	0	0
4	8	0	3846	0	0
5	8	0	3846	0	0
6	8	0	3846	0	0
7	8	0	3846	0	0
8	8	0	3846	0	0
9	8	0	3846	0	0
10	8	0	3846	0	0
TOTALS	**80**	**0**	**38,460**	**3.79**	0

Resource Savings Assumptions

Annual Natural Gas Savings	**8 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):

$$\text{Annual Gas Savings } (m^3) = 40.29 * \Delta GPM + 5.71 * \Delta GPM^2$$
$$= 40.29*(1.5-1.25) + 5.71*(1.5-1.25)^2$$
$$= 10.4$$

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:

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[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=

$10.4\ m^3 \times$ (2.1 persons per household/2.9 persons per household) $= 10.4 \times 72\% = 8\ m^3$ 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	**3,846 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: 1.5 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: 7.50 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 = 1,016 gallons or 3846 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	**$3.79**
As per utility program costs, bulk purchase of showerheads.	

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

Low-Flow Showerhead (1.25 GPM replacing 2.0 GPM, Low-Income, per Household), UG

Revision #	Description/Comment	Date Revised
		December 2012

Efficient Equipment and Technologies Description
Low-flow Showerhead (1.25 GPM)
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	3.79	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**	**3.79**	**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]

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[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):

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

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	**$3.79**
As per utility program costs, bulk purchase of showerheads.	

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

Low-Flow Showerhead (1.25 GPM, Low-Income Multi-Family, per Household), UG

Revision #	Description/Comment	Date Revised
		December 2012

Efficient Equipment and Technologies Description
One Low-flow Showerhead (1.25 Gpm)
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	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	3.79	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**	**3.79**	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

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[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):

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

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:

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[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 persons per household/2.9 persons per household) = 33 x 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:

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

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	**$3.79**
As per utility program costs, bulk purchase of showerheads.	

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

CONDENSING BOILERS UNDER 300 MBH

Small Commercial – New/Existing, EGD & UG
(Updated December 2012)

Efficient Technology & Equipment Description
Condensing boilers having annual fuel utilization efficiency (AFUE) of 90% or greater. Boiler input size is under 300,000 Btu/hr. Application is for seasonal or non-seasonal use. MBH is defined throughout this document as 1,000 Btu/hr.
Base Technology & Equipment Description
Non-condensing boiler having an AFUE of 82% for either seasonal or non-seasonal use. Boiler input size is under 300,000 Btu/hr.

Resource Savings Assumptions

Natural Gas Annual Savings	**<u>Seasonal</u>** **0.01019 m^3 /(Btu/hr Boiler Input)** **<u>Non-Seasonal</u>** **Boiler Input Under 100 MBH = 0.02170 m^3 /(Btu/hr Boiler Input)** **Boiler Input 100 To Under 200 MBH =0.01332 m^3 /(Btu/hr Boiler Input)** **Boiler Input 200 To Under 300 MBH =0.00996 m^3 /(Btu/hr Boiler Input)**

<u>Estimation Based on AMEC Study for Enbridge</u>

- Based on AMEC's report[1], the energy analysis compares use of a condensing boiler having an average AFUE of 94.4%[2] versus a base case non-condensing boiler having an AFUE of 82%[3].
- The normalized gas use for a seasonal base case boiler is determined by the relationship[4]:

    Seasonal Normalized Gas Use = 77.575 x *BoilerIP*where:

        BoilerIP = seasonal boiler input size (MBH)
        Normalized Gas Use = normalized annual seasonal gas use (m3/yr)

- The gas savings for a non-seasonal base case boiler is determined by the

[1] AMEC, Prescriptive Savings Analysis – Condensing Boilers Under 300MBH, Oct 19, 2012
[2] Average Condensing Boiler AFUE from AHRI Certification Directory as of September 2012
[3] Canada Gazette - Minimum Boiler Efficiency - http://canadagazette.gc.ca/rp-pr/p2/2011/2011-10-12/pdf/g2-14521.pdf, PDF pg 94
[4] Trend equation from billing data analysis (AMEC, Prescriptive Savings Analysis – Condensing Boilers Under 300MBH, Oct 19 2012, pg 3)

relationship[5]:

$$NonSeasonal\,GasUse = 36.282 \times BoilerIP + 9256.9$$

where:

BoilerIP = seasonal boiler input size (MBH)
Non Seasonal Gas Use = annual non-seasonal gas use (m3/yr)

- The gas savings of the condensing versus the base case boiler is determined by the relationship:

<u>Seasonal</u>:

$$GasSavings = GasUse \times (1 - \frac{\%AFUE_{BC}}{\%AFUE_{CE}})$$

where:

GasUse = seasonal gas use (m3)
$\%AFUE_{BC}$[6] = AFUE of the Base Case boiler at 82%
$\%AFUE_{CE}$ = AFUE of the Condensing boiler at 94.4%
GasSavings = annual gas savings (m3/yr)

<u>Non-Seasonal</u>:

$$GasSavings = GasUse \times (1 - \frac{\%ASE_{BC}}{\%ASE_{CE}})$$

where:

GasUse = non-seasonal gas use (m3)
$\%ASE_{BC}$[7] = ASE of the Base Case boiler at 72.88%
$\%ASE_{CE}$ = ASE of the Condensing boiler at 84.34%
GasSavings = annual gas savings (m3/yr)

- For Non-Seasonal loads, boiler sizes were selected to provide a reasonable range of categories for energy and costing analysis purposes.
  - Under 100 MBH uses a 75 MBH boiler size for analysis. This is used to provide average values for boilers ranging in size between 50 to under 100 MBH. Although there are boilers available under 50 MBH they are considered to make up a negligible part of the market.
  - 100 to under 200 MBH uses 150 MBH as the boiler size for analysis.
  - 200 to under 300 MBH uses 250 MBH.

[5] Non-Seasonal trend equation from consumption data analysis of boilers from NYSERDA, EGD, and EP&G (AMEC, Prescriptive Savings Analysis – Condensing Boilers Under 300MBH, Oct 19 2012, pg 9)
[6] AFUE is the Annual Fuel Utilization Efficiency as outlined in CSA P2 Standard with minimum requirements from NRCan
[7] ASE is the Annual Seasonal Efficiency calculated using eTools and based on rated boiler thermal efficiency

▪	
Electricity	**0 kWh**
Water	**0 L**

Other Input Assumptions

Equipment Life	**25 yrs**
•	

Incremental Cost	**<u>Existing Construction</u>**	
	Boiler Input (MBH)	**Incremental Cost ($)**
	Under 100	**$2,045**
	100 To Under 200	**$2,984**
	200 To Under 300	**$3,797**
	<u>New Construction</u>	
	Boiler Input (MBH)	**Incremental Cost ($)**
	Under 100	**$1,475**
	100 To Under 200	**$2,414**
	200 To Under 300	**$3,227**

Incremental costs account for differences in venting, controls and labour.

<u>Incremental Cost – Existing Construction</u>

- Boiler Input Under 100 MBH = $2,045
- Boiler Input 100 To Under 200 MBH = $2,984
- Boiler Input 200 To Under 300 MBH = $3,797

<u>Incremental Cost – New Construction</u>

- Boiler Input Under 100 MBH = $1,475
- Boiler Input 100 To Under 200 MBH = $2,414
- Boiler Input 200 To Under 300 MBH = $3,227

HIGH EFFICIENCY BOILERS UNDER 300 MBH

Small Commercial – New/Existing, EGD & UG
(Update December 2012)

Efficient Technology & Equipment Description
High Efficiency non-condensing boilers having annual fuel utilization efficiency (AFUE) of 85% or greater. Boiler input size is under 300,000 Btu/hr. Application is for seasonal or non-seasonal use. MBH is defined throughout this document as 1,000 Btu/hr.
Base Technology & Equipment Description
Non-condensing boiler having an AFUE of 82% for either seasonal or non-seasonal use. Boiler input size is under 300,000 Btu/hr.

Resource Savings Assumptions

Natural Gas Annual Savings	**<u>Seasonal</u>** **0.00318 m^3 /(Btu/hr Boiler Input)** **<u>Non-Seasonal</u>** **Boiler Input Under 100 MBH = 0.00468 m^3 /(Btu/hr Boiler Input)** **Boiler Input 100 To Under 200 MBH =0.00287 m^3 /(Btu/hr Boiler Input)** **Boiler Input 200 To Under 300 MBH =0.00215 m^3 /(Btu/hr Boiler Input)**

<u>Estimation Based on AMEC Study for Enbridge</u>

- Based on AMEC's report[1], the energy analysis compares use of a high efficiency boiler having an average AFUE of 85.5%[2] versus a base case non-condensing boiler having an AFUE of 82%[3].
- The normalized gas use for a seasonal base case boiler is determined by the relationship[4]:

  Seasonal Normalized Gas Use = 77.575 x *BoilerIP*

  where:

  BoilerIP = seasonal boiler input size (MBH)
  Normalized Gas Use = normalized annual seasonal gas use (m3/yr)

- The gas savings for a non-seasonal base case boiler is determined by the relationship[5]:

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[1] AMEC, Prescriptive Savings Analysis – High Efficiency Boilers Under 300MBH, , Oct 19, 2012
[2] Average High Efficiency Boiler AFUE from AHRI Certification Directory as of September 2012
[3] Canada Gazette - Minimum Boiler Efficiency - http://canadagazette.gc.ca/rp-pr/p2/2011/2011-10-12/pdf/g2-14521.pdf, PDF pg 94
[4] Trend equation from billing data analysis (AMEC, Prescriptive Savings Analysis – HE Boilers Under 300MBH, Oct 19 2012, pg 4)

$$NonSeasonal\,GasUse = 36.282 \times BoilerIP + 9256.9$$

where:

BoilerIP = seasonal boiler input size (MBH)
Non Seasonal Gas Use = annual non-seasonal gas use (m3/yr)

- The gas savings of the high efficiency boiler versus the base case boiler is determined by the relationship:
- Seasonal:

$$GasSavings = GasUse \times (1 - \frac{\%AFUE_{BC}}{\%AFUE_{CE}})$$

where:

GasUse = seasonal gas use (m3)
$\%AFUE_{BC}$[6] = AFUE of the Base Case boiler of 82%
$\%AFUE_{HE}$ = AFUE of the High Efficiency boiler of 85.5%
GasSavings = annual gas savings (m3/yr)

Non-Seasonal

$$GasSavings = GasUse \times (1 - \frac{\%ASE_{BC}}{\%ASE_{CE}})$$

where:

GasUse = non-seasonal gas use (m3)
%ASE[7] = ASE of the Base Case boiler of 72.88%
%ASE = ASE of the High Efficiency boiler of 75.08%
GasSavings = annual gas savings (m3/yr)

- For Non-Seasonal loads, boiler sizes were selected to provide a reasonable range of categories for energy and costing analysis purposes.
  - Under 100 MBH uses a 75 MBH boiler size for analysis. This is used to provide average values for boilers ranging in size between 50 to under 100 MBH. Although there are boilers available under 50 MBH they are considered to make up a negligible part of the market.
  - 100 to under 200 MBH uses 150 MBH as the boiler size for analysis.
  - 200 to under 300 MBH uses 250 MBH.

▪

[5] Non-Seasonal trend equation from consumption data analysis of boilers from NYSERDA, EGD, and EP&G (AMEC, Prescriptive Savings Analysis – High Efficiency Boilers Under 300MBH, Oct 19 2012, pg 9)
6 AFUE is the Annual Fuel Utilization Efficiency as outlined in CSA P2 Standard with minimum requirements from NRCan
[7] ASE is the Annual Seasonal Efficiency calculated using eTools and based on rated boiler thermal efficiency

Electricity	**0 kWh**
Water	**0 L**

Other Input Assumptions

Equipment Life	**25 yrs**
•	
Incremental Cost	**Existing Construction** / **Incremental Cost ($)** **Boiler Input (MBH)** **Under 100** — **$1,808** **100 To Under 200** — **$2,114** **200 To Under 300** — **$1,958** **New Construction** / **Incremental Cost ($)** **Boiler Input (MBH)** **Under 100** — **$1,238** **100 To Under 200** — **$1,544** **200 To Under 300** — **$1,388**

Incremental costs account for differences in venting, controls and labour.

Incremental Cost – Existing Construction

- Boiler Input Under 100 MBH = $1,808
- Boiler Input 100 To Under 200 MBH = $2,114
- Boiler Input 200 To Under 300 MBH = $1,958

Incremental Cost – New Construction

- Boiler Input Under 100 MBH = $1,238
- Boiler Input 100 To Under 200 MBH = $1,544
- Boiler Input 200 To Under 300 MBH = $1,388

HIGHER EFFICIENCY BOILERS – DOMESTIC WATER HEATING

Existing and New Commercial and Multi- Residential
Updated December 2012

Efficient Technology & Equipment Description
Hydronic Boilers for water heating (Non Seasonal)
Base Technology & Equipment Description
80.5% Thermal Efficiency Domestic Water Heating Boiler

Resource Savings Assumptions

Natural Gas (Updated)

Boiler Size	Domestic Water Heating (Non Seasonal) M3 Savings by Thermal Efficiency 83-84%	85-88%
300 MBH	1,168	1,861
600 MBH	1,931	3,076
1,000 MBH	3,409	5,431
1,500 MBH	4,693	7,475

Source: Prescriptive Commercial Boiler Program – Prescriptive Savings Analysis – AMEC Environmental & Infrastructure dated November 5, 2012. The original report dated Sep 10th, 2012 has been updated as per recommendations from the Commercial Hydronic Boiler System Baseline Study by ICF Marbek dated Sep 16th, 2011.

An iterative approach was used to determine the annual savings in the commercial sector. The following steps were taken:
a. The Rate 6 accounts were subdivided into bins of annual gas use. This provided the annual average gas use, number of accounts, seasonal, non-seasonal and total gas use.
b. The seasonal portion of the annual gas use was normalized to 30 year weather data. This normalized gas use was correlated to a seasonal boiler size required for gas consumption.
c. Categories of boiler sizes were selected to provide a suitable range of boilers available within the sector.
d. The Rate 6 accounts were subdivided using the normalized average seasonal gas use for the respective categories of boilers selected. This provided the annual average gas use, number of accounts, and total gas use per seasonal boiler size category.
e. Seasonal annual gas use normalization of the boiler size category accounts was completed.
f. Annual seasonal efficiency of the boiler size categories for each of the thermal efficiency ranges was determined.
g. Boiler costs for the boiler size categories was compiled.
h. A TRC/CCM analysis was completed for each of the boiler size categories.
i. A similar approached was used for the non-seasonal gas use with the exception of normalizing the data.
j. The new base case boiler efficiency changed from 81% combustion efficiency to 80.5% Thermal Efficiency. This reduced the seasonal efficiency from 62.6% to 60.9% for seasonal boilers and 65.6% to 64.9% for non-seasonal boilers. All other conditions remain the same as original.

Electricity (Updated)	**kWh**
Water	**L**

Other Input Assumptions

Equipment Life	**25**	**years**
As per EB 2008-0384 & 0385		
Incremental Cost (Contr. Install)		**Domestic Water Heating (Non Seasonal) Incremental Cost by Thermal Efficiency**
	Boiler Size	**83-84%** / **85-88%**
	300 MBH	**$3,900** / **$ 4,500**
	600 MBH	**$5,800** / **$ 6,000**
	1,000 MBH	**$7,400** / **$10,300**
	1,500 MBH	**$5,900** / **$ 7,400**
Source: Prescriptive Commercial Boiler Program – Prescriptive Savings Analysis – Agviro Report Sept 10, 2008.		