uniongas
An Enbridge Company

February 16, 2018

BY COURIER & RESS

Ms. Kirsten Walli
Board Secretary
Ontario Energy Board
Suite 2700, 2300 Yonge Street
Toronto, Ontario
M4P 1E4

**RE: EB-2017-0255 – Union Gas Limited - 2018 Cap-and-Trade Compliance Plan - Interrogatory Responses**

Dear Ms. Walli,

On November 9, 2017 Union filed its 2018 Cap-and-Trade Compliance Plan application with the Ontario Energy Board (the "OEB" or the "Board"). On January 8, 2018, at the request of OEB Staff, Union filed an Update to its application to reflect changes to redactions. Union's filings are in compliance with the Board's EB-2015-0363 Regulatory Framework for the Assessment of Costs of Natural Gas Utilities' Cap-and-Trade Activities (the "Framework").

In accordance with the Framework, there are three categories of information which may be included within a natural gas utility's Compliance Plan: public information, confidential information, and Strictly Confidential information. Further, certain aspects of Union's Compliance Plan were deemed as "Strictly Confidential", specifically areas of Auction Confidential and Market Sensitive content. This content is to be reviewed only by Board Staff and the Board panel assigned to review and decide this Application.

In this context and pursuant to Procedural Order No.1 (dated December 28, 2017), please find attached Union's responses to interrogatories on non-confidential "public information". These responses will be filed on the Board's RESS and copies will be sent to the Board.

As stated in its response to Exhibit B.GEC.2 a live Excel spreadsheet has been provided to the requesting party via email, copying the Board. Other parties who wish to receive a copy of the document can contact Union directly.

If you have any questions with respect to this submission please contact me at 519-436-4558.

Yours truly,

*[original signed by]*

Adam Stiers
Manager, Regulatory Initiatives

Encl.

cc: C. Smith, Torys
M. Seers, Torys
Valerie Bennett, OEB Case Manager
Ljuba Djurdjevic, OEB Counsel
Lawren Murray, OEB Counsel
EB-2017-0255 Intervenors

UNION GAS LIMITED

Answer to Interrogatory from
Ontario Energy Board Staff ("Staff")

Reference: Exhibit 3, Tab 5, pp. 4-13
Exhibit 3, Tab 5, Schedule 2, p. 1

Preamble: Union Gas states its 2018 forecast of GGEIDA costs total $6.0 million, including forecast administration costs of $4.0 million (which represents approximately 1.4% of the total forecast cost of compliance) and the forecast Low Carbon Initiative Fund costs of up to $2.0 million.

Union Gas also states that it made changes to its methodology when calculating its 2018 bad debt forecast.

Question:

a) Please complete the table below. For the 2017 Actual column, please provide year-to-date actuals and the remainder of the 2017 year as a forecast.

| **Administrative Cost Item** | **2017 Forecast** | **2017 Actual** | **2018 Forecast** |
|---|---|---|---|
| Staffing Resources (Salaries and Wages) | $2,542,000 | | $2,598,000 |
| Customer Care Centre (Salaries and Wages) | $275,000 | | |
| Consulting | $670,000 | | $670,000 |
| Bad debt related to cap and trade | $600,000 | | $425,000 |
| IT Billing System Updates | $68,000 | | |
| OEB Costs (OEB LTCPF[1] and related working group) | | | $50,000 |
| Revenue Requirement on Capital Costs (related to billing system changes) | | | $193,000 |
| Other (travel expenses, market research and communications) | $68,000 | | $68,000 |
| **SUB-TOTAL** | **$4,223,000** | | **$4,004,000** |
| Low Carbon Initiative Fund | n/a | | $2,000,000 |
| **TOTAL** | **$4,223,000** | | **$6,000,000** |

b) Please explain why Union Gas' customer care centre costs went from $275,000 in 2017 to $0 in 2018.

[1] EB-2016-0359, OEB Long Term Carbon Price Forecast

c) Please discuss the rationale and appropriateness of the difference in consulting costs proposed by Union Gas ($670,000 in 2018) and Enbridge Gas ($400,000 in 2018).
d) Enbridge Gas and Union Gas filed a MAAD application[2] with the OEB. Please explain whether, and if so how, Union Gas will realize any economies of scale in relation to the FTEs that are working on Cap-and-Trade.
e) For the table in a), please provide an explanation for any line item where:
   i. The cost difference between 2017 Forecast and 2017 Actual is greater than 10 percent.
   ii. The cost difference between 2017 Actual and 2018 Forecast is greater than 10 percent.

---

Response:

a)

| **Administrative Cost Item** | **2017 Forecast** | **2017 Actual** | **2018 Forecast** |
|---|---|---|---|
| Staffing Resources (Salaries and Wages) | $2,542,000 | $2,357,000 | $2,598,000 |
| Customer Contact Centre (Salaries and Wages) | $275,000 | $80,300 | - |
| Consulting | $670,000 | $340,000 | $670,000 |
| Bad Debt Related to Cap & Trade | $600,000 | $141,400 | $425,000 |
| IT Billing System Updates | $68,000 | (see Revenue Requirement below) | (see Revenue Requirement below) |
| OEB Study Costs (OEB LTCPF[1] and related working group) | N/A | $112,300 | $50,000 |
| Revenue Requirements on Capital Costs (related to billing system changes) | N/A | $90,000 | $193,000 |
| Other (travel expenses, market research and communications) | $68,000 | $97,500 | $68,000 |
| **SUB-TOTAL** | **$4,223,000** | **$3,218,500** | **$4,004,000** |
| Low Carbon Initiative Fund | N/A | N/A | $2,000,000 |
| **TOTAL** | **$4,223,000** | **$3,218,500** | **$6,004,000** |

b) Consistent with Union's response at EB-2016-0296 Exhibit B.Staff.2, Union staffs its call centre appropriately to meet the Service Quality Requirement ("SQR") for Call Answering Service Level of 75% of calls answered in 30 seconds. Customer Care costs in 2017 were related to incremental staff hired and trained to assist in meeting the SQR based on a forecast of increased call volumes associated with Cap-and-Trade. When call volumes decreased to a normal level in Q1 2017 these call centre staff were released from the Cap-and-Trade program. Cap-and-Trade related calls are currently being addressed with existing staff and therefore are not captured in the GGEIDA.

[2] EB-2017-0306

c) Of the total variance of $270,000 in consulting costs, $250,000 is due to a difference in how Union and EGD categorize GHG Reporting and Forecasting and external legal counsel fees. Union has included these costs in consulting, whereas EGD reflects these items as separate line items. Please also see the response at Exhibit B.SEC.15 where Union and EGD have jointly provided a more detailed breakdown of administrative costs by common component.

Union's total 2018 consulting forecast was completed early in 2017 to align with the corporate budgeting process. At this time, Union had very little experience in the live Cap-and-Trade market. Costs were therefore estimated to be similar in magnitude to the 2017 consulting forecast. Union's 2017 forecasted costs are not being recovered in this proceeding; only actual costs will be captured in the GGEIDA for disposal in a future proceeding.

d) Please see the response at Exhibit B.Staff.14 a).

e)

i. The variances in Union's 2017 forecast and 2017 actual costs are reflected in the table below. An explanation is provided for each line item with a percent difference greater than 10%.

| **Administrative Cost Item** | **2017 Forecast** | **2017 Actual** | **±% Δ** |
|---|---|---|---|
| Staffing Resources (Salaries and Wages) | $2,542,000 | $2,357,000 | -7% |
| Customer Contact Centre (Salaries and Wages) | $275,000 | $80,300 | -71% |
| Consulting | $670,000 | $340,000 | -49% |
| Bad Debt Related to Cap & Trade | $600,000 | $141,400 | -76% |
| IT Billing System Updates | $68,000 | (see revenue requirement) | N/A |
| OEB Costs (OEB LTCPF[1] and related working group) | $0 | $112,300 | N/A |
| Revenue Requirements on Capital Costs | $0 | $90,000 | N/A |
| Other (travel expenses, market research and communications) | $68,000 | $97,500 | +43% |
| **SUB-TOTAL** | **$4,223,000** | **$3,218,500** | **-24%** |
| Low Carbon Initiative Fund | N/A | N/A | N/A |
| **TOTAL** | **$4,223,000** | **3,218,500** | **-24%** |

Union's forecast for 2017 was completed in early 2016, well before the Cap-and-Trade program was live. As a result, there remained significant uncertainties about the program and how it would be administered. This is an underlying factor which contributes to most of the variances identified in the above chart. Actual costs are recorded in the GGEIDA for future disposition.

Detailed explanations specific to each line item are provided below.

**Customer Contact Centre**

- Union forecasted the requirement of seven temporary employees to meet the SQR identified above in part b) above due to expected increases in calls to the customer contact centre as a result of Cap-and-Trade implementation and billing beginning January 1, 2017. Due to lower than anticipated call volumes, Union required only two additional temporary employees to meet increased call demands.

**Consulting Costs**

- Union's 2017 consulting costs were less than anticipated for services related to GHG reporting, offset scoping and investigation, legal interpretation of regulations, and implementation support. At the time of Union's 2017 forecast development Union had minimal experience in engaging consulting services for Cap-and-Trade related activities. In addition, delays in legislation and protocols (e.g. offsets) also contributed to lower costs than expected.

**Bad Debt**

- As explained in Union's application at Exhibit 3, Tab 5, Union used a simplified method to estimate Cap-and-Trade related bad debts for 2017, assuming that a 10% increase in customer bills as a result of Cap-and-Trade costs would result in a 10% increase in bad debt. This simplified method was employed because Union had no previous experience with bad debt in a Cap-and-Trade environment.
- Union would like to clarify that there has been no change in methodology applied in the calculation of the bad debt forecast for 2018. The reduction to the forecast from 2017 to 2018 is a direct result of actual Cap-and-Trade effects on overall customer bills experienced during 2017. These effects combined with Union's current account write-off level result in the forecast of $425,000 for 2018 for applicable Cap-and-Trade amounts.
- As outlined in Union's response at EB-2016-0296, Exhibit B.FRPO.1, the actual incremental bad debt amount directly related to Cap-and-Trade in 2017 was expected to be lower than the estimate in 2017 due to the implementation of Cap-and-Trade commencing January 1, 2017 and the lag time before Cap-and-Trade amounts would be included in customer accounts that were written off. Only the actual costs will be captured in a deferral account for future disposition; the forecast for 2017 of $0.6 million was not in rates and was not in a deferral account. The amount of bad debt recognized in actuals is included in the Greenhouse Gas Emissions Impact Deferral Account ("GGEIDA"). For 2017 the actual amount of bad debt included in the GGEIDA is approximately $141,000. Union's actual bad debt write-offs are lower in 2017 due to the time lag

described above, which results in only partial year impacts in 2017. For 2018, Union will realize a full year of bad debt write-offs in the GGEIDA.

**OEB Study Costs**

- At the time the 2017 Forecast was completed, it was not yet known that the OEB would publish a LTCPF and MACC; therefore, these costs were not included in the forecast.

**Revenue Requirement (IT Billing)**

- Union's revenue requirement on capital costs increased in 2017 as these capital assets became available for use and were placed into service.

**Other**

- Union's employee expenses were higher than forecast due to activities related to knowledge building in support of the Cap-and-Trade program. As noted in Union's application at Exhibit 3, Tab 2, p. 10, Union attends conferences and carbon market training events to aid in the development of its knowledge and understanding of Cap-and-Trade and the regulatory events impacting North American carbon markets. Knowledge of these events was minimal at the time of 2017 forecast development.

ii. The variances in Union's 2017 actual costs and 2018 forecasts are reflected in the table below. An explanation is provided for each line item with a percent difference greater than 10%.

| **Administrative Cost Item** | **2017 Actual** | **2018 Forecast** | **±% Δ** |
|---|---|---|---|
| Staffing Resources (Salaries and Wages) | $2,357,000 | $2,598,000 | +10% |
| Customer Contact Centre (Salaries and Wages) | $80,300 | $0 | -100% |
| Consulting | $340,000 | $670,000 | +97% |
| Bad Debt Related to Cap & Trade | $141,400 | $425,000 | +301% |
| IT Billing System Updates | (see revenue requirement) | (see revenue requirement) | N/A |
| OEB Costs (OEB LTCPF[1] and related working group) | $112,300 | $50,000 | -55% |
| Revenue Requirements on Capital Costs | $90,000 | $193,000 | +214% |
| Other (travel expenses, market research and communications) | $97,500 | $68,000 | -30% |
| **SUB-TOTAL** | **$3,218,500** | **$4,004,000** | **+24%** |
| Low Carbon Initiative Fund | $0 | $2,000,000 | N/A |
| **TOTAL** | **3,218,500** | **$6,004,000** | **+87%** |

It should also be noted that Union completes its annual budget forecast in the second quarter of each year. At the time of 2018 forecast was developed, Union had not yet incurred two full quarters of expenses related to the Cap-and-Trade program. Therefore, the 2018 forecast was based largely on the 2017 forecast. This is an underlying factor which contributes to most of the variances identified in the above table. Actual costs for 2018 will be recorded in the GGEIDA for future disposition.

Detailed explanations specific to each item are provided below:

**Customer Contact Centre**

- Please see the response in part b) above.

**Consulting**

- The 2018 forecast is consistent with Union's 2017 consulting forecast as it was developed in the second quarter of 2017 to align with annual budget timelines. In addition, 2017 consulting costs were lower than expected due to the delay in the release of some regulations and protocols (e.g. offsets). Union plans to continue to engage consulting services in the areas of procurement, offsets, carbon market dynamics, legal, and GHG reporting and forecasting. However, in some cases specific vendor arrangements have not yet been defined and scopes of work have not yet been completed.

**Bad Debt**

- An explanation of Union's 2017 actuals is provided in the response to part e) i) above. For 2018, Union's forecast reflects that it will realize a full year of bad debt write-offs in the GGEIDA.

**OEB Study Costs**

- The 2018 forecast represent expectations for the annual LTCPF and related Working Group. Union has forecast its portion of OEB costs to be $50,000 for 2018, which is approximately half of the cost Union was charged for this work in 2017. Costs to complete the MACC in 2017 are not expected to be repeated in 2018 since the OEB has identified that the MACC will be completed for each compliance period rather than annually.

**Revenue Requirements on Capital Costs**

- Union has included the 2018 revenue requirement of $193,000 related to capital costs of approximately $673,000 as forecast at December 31, 2018 for billing system changes as a result of Cap-and-Trade.

**Other**

- Employee travel expenses, market research, and internal and external communications for 2018 were based on Union's 2017 forecast.

**Low Carbon Initiative Fund**

- The Low Carbon Initiative Fund is a new fund proposed for 2018 in order to support the advancement of new technologies that contribute to future customer and facilities abatement initiatives. Please see Union's application at Exhibit 3, Tab 5, p. 12 for further detail.

UNION GAS LIMITED

Answer to Interrogatory from
Ontario Energy Board Staff ("Staff")

Reference: Exhibit 3, Tab 5, pp. 8-9
Exhibit 3, Tab 2, pp. 8-9

Preamble: Union Gas states that in 2018, it will continue to use external consulting to support the development of its Compliance Plans and the ongoing sustainment of the cap-and-trade program. Union Gas also states that these consulting services "are forecast to cost $670,000 in 2018 for work supporting the development and execution of Union Gas' Compliance Plan, in a similar manner to 2017.

Union Gas indicates that it will continue to retain ClearBlue and it has also engaged other consultants for various other Cap-and-Trade related services, including BlueSource, ICF and Ortech Environmental.

Question:

a) Please complete the table below:

| **Consultant** | **2018 Costs** |
|---|---|
| ClearBlue | |
| BlueSource | |
| ICF | |
| Ortech Environmental | |
| Other | |
| **Total** | **$670,000** |

b) Has Union Gas engaged additional consultants than the ones listed above? Please explain.
   i. If so, please provide the 2018 costs.
c) Please explain whether Union Gas used a competitive procurement process when selecting BlueSource, ICF and Ortech Environmental?
d) Please explain the scope of work for each of the consultants listed in a). Please compare their scope of work with ClearBlue's scope of work.
e) Enbridge Gas and Union Gas filed a MAAD application[1] with the OEB. Please explain whether, and if so how, Union Gas will realize any economies of scale in relation to external consultants working on issues related to cap and trade.

---

Response:

[1] EB-2017-0306

a) & b)

The table provided in part a) above presumes that Union will use all previous consultants in 2018. While that is possible, it has not been confirmed. Union has provided below the 2018 forecast cost by type of consulting,[2] and identified consultants that have previously completed such work. Actual costs for 2018 will be recorded in the GGEIDA for future disposition.

| Particulars | 2018 Cost Forecast ($000) | Previous Consultant |
|---|---|---|
| Compliance Planning/Implementation | 200 | ClearBlue Markets |
| Carbon Strategy and Analysis | 120 | ICF, Torys LLP |
| GHG Reporting and Forecasting | 100 | ORTECH Environmental, GHD |
| Offset Consulting | 100 | BlueSource |
| Legal Interpretation and Review | 150 | Torys LLP |
| Total | 670 | |

c) Union used a competitive procurement process when selecting BlueSource and ClearBlue Markets. Due to tight timelines, unique requirements and proven pre-existing service agreements, Union did not use a competitive procurement process for ICF or ORTECH Environmental. Additionally, ORTECH Environmental has been completing emissions-related work for a number of years and is uniquely familiar with Union's specific operations and emission sources.

d) The following table lists the scope of work for each consultant listed in part b) above.

| Consultant | Scope of Work |
|---|---|
| GHD | Completion of Verification Audits in accordance with GHG Reporting Regulation. |
| ORTECH Environmental | Provide technical support for GHG emission measurements and calculations in order meet GHG Reporting compliance requirements. |
| BlueSource | Provide expertise on the offsets market, interpretation of offset protocols and regulations, and insights with respect to the developing offset market in Ontario and WCI. |
| Torys LLP | Legal support to interpret climate regulations and ensure Union's compliance with regulatory requirements and legislation. |
| ClearBlue Markets | Advise on procurement strategy including analysis of instruments, risks, and benefits. |
| ICF | Provide analytics on supply, demand, and pricing as well as electrification impacts and customer cost impacts. |

[2] Exhibit 3, Tab 5, Table 2

ClearBlue costs relate directly to the ongoing development of Union's Cap-and-Trade strategy with direct input to Union's Compliance Plans. Union hired ClearBlue in late 2016 to aid in the development of its compliance instrument procurement strategy for 2017. ClearBlue has supported Union through 2017 by providing ongoing regulatory and market updates, assessment of Ontario public auction results, assessment of Union's 2017 Compliance Plan (including recommendations to adapt to changing market conditions) and assistance with the development of the 2018 compliance instrument procurement strategies.

e) Please see the response at Exhibit B.Staff.14 a).

UNION GAS LIMITED

Answer to Interrogatory from
Ontario Energy Board Staff ("Staff")

Reference: Exhibit 2, p. 5
Exhibit 2, Schedule 1, p. 1
Exhibit 3, Tab 4, Appendix A, p. 2

Preamble: In Exhibit 2, p. 5, Union Gas indicates that the DSM volume impact corresponds to the 2016-2020 DSM plan approved by the OEB (EB-2015-0029) and amounts to 98,317,116 $m^3$.

In the 2018 Volume Forecast table in Schedule 1, Union Gas includes a DSM volume reduction of 323,134,370 $m^3$.

In Evaluation of Customer Abatement via Energy Conservation Programs Incremental to DSM, Union Gas indicates that their C/I annual savings in their DSM Plan for 2020 (including savings persisting from 2018 and 2019 programs) are 193 million $m^3$ for C/I programs and 20 million $m^3$ for residential programs.

Question:

a) Please explain why the DSM volume impacts in Exhibit 2 and Exhibit 2 / Schedule 1 are not consistent. If revisions are required, please update all necessary tables.
b) Please explain whether the annual savings for Union Gas' DSM plan shown in Appendix A of Exhibit 3 / Tab 4 reflect the 2018 DSM volume impact estimated in Exhibit 2. If not, why not.

---

Response:

a) There are no inconsistencies between the DSM Volume impacts in Union's application at Exhibit 2 and at Exhibit 2, Schedule 1. See below for the DSM volume impacts included in Union's application at Exhibit 2, and their corresponding reference to Union's application at Exhibit 2, Schedule 1.

| **DSM Volume Impact** | **Reference: Exhibit 2** | **Reference: Exhibit 2, Schedule 1** |
|---|---|---|
| 98,317,116 $m^3$ | p. 5, Line 12 | Column A, Line 2 |
| 224,817,254 $m^3$ | p. 6, Line 20 | Column B, Line 2 |

b) No. The savings shown in Tables 2 and 3 of Union's application at Exhibit 3, Tab 4, Appendix A reflect the forecasted annual savings from 2018, 2019, and 2020 and do not include Union's DSM Large Volume Program. The savings were used to compare to the MACC Report's savings opportunity, which consists of annual savings from 2018, 2019, and 2020 and does not include savings opportunity from large volume customers.

The DSM volumes shown in Union's application at Exhibit 2, p. 5, Line 12 and at Exhibit 2, p. 6, Line 20 reflect annual savings from 2017 and 2018 only and include Union's DSM Large Volume Program. The volumes were used to forecast Union's net throughput for 2018.

UNION GAS LIMITED

Answer to Interrogatory from
Ontario Energy Board Staff ("Staff")

Reference: Exhibit 3, Tab 6, pp. 12-13

Preamble: In the WCI linked market, Union Gas is considered a related person with two entities: Enbridge Gas and Gazifère Inc.

Enbridge Gas and Union Gas also filed a MAAD application[1] with the OEB.

Question:

a) For 2018, please explain whether, and if so how, Union Gas will realize any economies of scale in relation to the following cap and trade activities:
   i. Research and development, including RNG research and development
   ii. Back office functions
   iii. FTEs related to cap and trade
   iv. Cap and trade consultants
   v. Abatement activities
b) Do Enbridge Gas and Union Gas intend to file individual and separate compliance plans for 2019-2020? Please explain

---

Response:

a) Union and EGD have requested the OEB's approval to amalgamate effective January 1, 2019. Union and EGD will continue to operate as separate entities until they have received all necessary approvals. Only after the decision is made to proceed with the amalgamation will a detailed integration plan be developed.

b) Under the Framework, Union and EGD are required to file the 2019-2020 Compliance Plans by August 1, 2018. No determination has been made as to the structure of the 2019-2020 Compliance Plan.

[1] EB-2017-0306

UNION GAS LIMITED

Answer to Interrogatory from
Ontario Energy Board Staff ("Staff")

Reference: Exhibit 3, Tab 2, p. 12

Preamble: Union Gas states that its CITSS accounts are managed within its compliance instrument procurement function in the Gas Supply department. Union Gas also has CITSS Account Viewing Agents in the cap-and-trade and Finance departments.

Question:

a) How may CITSS accounts does Union Gas have?
    i. Please describe each of Union Gas' CITSS accounts
b) Do Union Gas, Enbridge Gas and Gazifère share a CITSS account? Please explain.
c) Please explain how Union Gas, Enbridge Gas and Gazifère will coordinate and report their accumulated compliance instruments to demonstrate compliance.

---

Response:

a) Union, as a capped emitter, has two CITSS accounts as described below.
    1. General Account (referred to as a 'holding account' in Ontario's Regulation) – this account is used for holding emission allowances and performing transfers of emission allowances between participants.
    2. Compliance Account – this account is used to surrender emissions allowances and credits to satisfy a compliance obligation under Ontario's Cap-and-Trade Program. Emissions allowances transferred to this account cannot be withdrawn.

b) & c)

Union, EGD, and Gazifère are separate entities and therefore do not share CITSS accounts or compliance obligations. Per Cap-and-Trade Regulations, Union, EGD, and Gazifère must share general holding and auction purchase limits since they are related entities.

UNION GAS LIMITED

Answer to Interrogatory from
Ontario Energy Board Staff ("Staff")

Reference: Exhibit 3, Tab 2, p. 11

Preamble: Union Gas states that it intends to apply to the MOECC for a holding limit exemption in the fall of 2017 under Section 41 of the cap and trade regulation.

Question:

a) Has Union Gas applied to the MOECC for a holding limit exemption? Please explain.
    i. If yes, has Union Gas been granted an exemption? Is there a time limit on the exemption? Please explain.

---

Response:

a) Union applied to the Ministry of the Environment and Climate Change under Section 41 of the Regulation for a holding limit exemption. Union's holding limit exemption was approved in December 2017 and is applicable from January 1, 2018 to December 31, 2018.

UNION GAS LIMITED

Answer to Interrogatory from
Ontario Energy Board Staff ("Staff")

Reference: Exhibit 3, Tab 1, p. 9
Exhibit 3, Tab 4, p. 13, Table 1

Preamble: Union Gas states that Union Gas and Enbridge Gas have developed an Abatement Construct, including an Initiative Funnel, to support development of new technologies over the long-term, including "abatement initiatives that may not be cost-effective and that will require alternative funding models… to proceed." Union Gas provides Table 1, which lists the abatement initiatives in Union Gas' Initiative Funnel (by Funnel stage):

Table 1
Projects and 2018 Requests

| Stage | Measure | Applicability |
|---|---|---|
| **Stage 1: Conceptual** | Residential-scale Carbon Capture and Utilization | Customer Abatement |
| | Building skins | Customer Abatement |
| | Biomass Conversion (Thermochemical) to renewable natural gas | Customer Abatement |
| | Automatic meter reading | Customer Abatement |
| | Portable Blowdown Recovery | Facilities Abatement |
| | Federal Methane Regulations (possible projects) | Facilities Abatement |
| **Stage 2: Formulate** | Integrated Air-Source Heat Pump/Natural Gas Solution | Customer Abatement |
| | Ground Source Heat Pump | Customer Abatement |
| | Net Zero Energy and Net Zero Energy Ready Homes | Customer Abatement |
| | Hydrogen and Power to Gas | Customer Abatement |
| | Micro Generation | Customer Abatement |
| | Fugitive Emissions Management | Facilities Abatement |
| | Station Heating Equipment (London North Gate Station) | Facilities Abatement |
| **Stage 3: Propose** | Renewable natural gas | Customer Abatement |
| | Process integration | Facilities Abatement |
| **Implementation** | Existing DSM Programs | Customer Abatement |
| | Existing GIF Program | Customer Abatement |
| | CNG for Fleet | Facilities Abatement* |
| | Other Existing Facility Abatement Initiatives | Facilities Abatement |

Question:

a) Please provide Table 1 (above) with the following columns added on:
   i. The cost per tonne of $CO_2e$ ($/tonne $CO_2e$) for each abatement opportunity.
   ii. A description of the funding that Union Gas has requested or will request for each opportunity.
   iii. An explanation of why these abatement opportunities require government funding.
b) Please provide all supporting documentation, including data and analysis used to calculate the $/tonne $CO_2e$ for each abatement activity in a).
c) Please provide the cost-effectiveness threshold (in $/tonne) that Union Gas used to determine that the abatement activities may not be cost-effective.

d) For any abatement activity in Table 1 that is more expensive per tonne of $CO_2e$ than the abatement activities on the OEB's Marginal Abatement Cost Curve[1] (OEB MACC), please explain why Union Gas selected these activities instead of the less expensive abatement activities on the OEB MACC. In Union Gas' response, please provide all supporting documentation, including data, assumptions and analysis.

---

Response:

a) See Table 1 below for cost per tonne references and 2018 approvals requested as part of Union's 2018 Compliance Plan.

Union has requested LCIF funding as part of its 2018 Compliance Plan to support development of new technologies aimed at facilitating future abatement opportunities. At this time, only government funding to support Union's RNG mechanism and costs has been specifically requested; see Union's application at Exhibit 3, Tab 4 for detail. As identified in the response at Exhibit B.Staff.1 e), Union has advocated government in relation to other abatement alternatives; those measures may also require government funding to proceed if they are not cost-effective on a stand-alone basis.

[1] EB-2016-0359

**Table 1**

| Projects and 2018 Stages | Measure | Applicability | $/tonne $CO_2e$ | 2018 OEB Approval Requested |
|---|---|---|---|---|
| **Stage 1: Conceptual** | Residential-scale Carbon Capture and Utilization | Customer Abatement | Stage 1 initiatives have not been evaluated for magnitude of potential emissions reductions or costs. | Approval of LCIF funding (up to $2M) starting in 2018 to support development of new technologies aimed at facilitating future abatement opportunities. |
| | Building skins | Customer Abatement | | |
| | Biomass Conversion (Thermochemical) to renewable natural gas | Customer Abatement | | |
| | Automatic meter reading | Customer Abatement | | |
| | Portable Blowdown Recovery | Facilities Abatement | See Exhibit 3, Tab 4, Appendix B | |
| | Federal Methane Regulations (possible projects) | Facilities Abatement | | |
| **Stage 2: Formulate** | Integrated Air-Source Heat Pump/Natural Gas Solution | Customer Abatement | OEB MACC, Appendix A | Approval of LCIF funding (up to $2M) starting in 2018 to support development of new technologies aimed at facilitating future abatement opportunities. |
| | Ground Source Heat Pump | Customer Abatement | | |
| | Net Zero Energy and Net Zero Energy Ready Homes | Customer Abatement | Detailed analysis has not been completed. Requires further study and/or data collection. | |
| | Hydrogen and Power to Gas | Customer Abatement | | |
| | Micro Generation | Customer Abatement | | |
| | Fugitive Emissions Management | Facilities Abatement | See Exhibit 3, Tab 4, Appendix B | |
| | Station Heating Equipment (London North Gate Station) | Facilities Abatement | | |
| **Stage 3: Propose** | Renewable natural gas | Customer Abatement | See Exhibit 3, Tab 4 and Exhibit B.Staff.1 f) | Approval of Union's RNG mechanism and costs, see Exhibit 3, Tab 4[2] |
| | Process integration | Facilities Abatement | See Exhibit 3, Tab 4, Appendix B | N/A |
| **Implementation** | Existing DSM Programs | Customer Abatement | N/A | N/A |
| | Existing GIF Program | Customer Abatement | N/A | |
| | CNG (fleet) | Facilities Abatement | N/A | |
| | Other Existing Facility Abatement Initiatives | Facilities Abatement | See Exhibit 3, Tab 4, Appendix B | |

b) Please refer to the above chart for references to supporting documentation and analysis.

[2] As per EB-2017-0255, OEB Procedural Order No. 2, p. 4, "The OEB has determined that the RNG Procurement and Funding model does not require approval."

c) For the 2018 Compliance Plan, Union's methodology used to evaluate cost-effectiveness is dependent on the nature of the measure being evaluated.

Incremental Energy Efficiencies – As outlined in Union's application at Exhibit 3, Tab 4, evaluation of cost-effective incremental energy efficiency utilizes the CPS, OEB MACC and the OEB LTCPF.

RNG – The cost-effectiveness of Union's RNG proposal was premised on government funding made available through the CCAP. Union also referenced the MACC in the evaluation of its RNG proposal. Please see the response at Exhibit B.Staff.1 a).

New technologies – Union expects that cost effectiveness will be based on the cost of carbon per the OEB LTCPF. Detailed analysis of Union's new technology initiatives in Stage 1 and Stage 2 is not yet available as evaluation of these initiatives is in its infancy. Please also see the responses at Exhibit B.GEC.7 d), at Exhibit B.GEC.19, and at Exhibit B.APPrO.5.

Facilities Abatement – As outlined in Union's application at Exhibit 3, Tab 4, cost effectiveness was measured against the cost of carbon per the OEB LTCPF.

d) Union has utilized the OEB MACC as part of its evaluation of abatement measures. However, the MACC is largely based on existing energy efficiency alternatives, and analysis of new technology measures is limited to RNG and heat pumps. Documentation for the analysis related to these measures is referenced in Table 1 included in part a) above.

With the exception of Stage 3, the list of initiatives in Table 1 above has not been selected for proposal. Rather, it is a current list of new technology initiatives being evaluated for feasibility and further analysis. This analysis is subject to the guiding principles described in Union's response at Exhibit B.Staff.18 and the structured evaluation approach described in Union's responses at Exhibit B.BOMA.1 and at Exhibit B.Staff.21 a). The outcome of this analysis will help quantify the costs and benefits of abatement opportunities. This analysis, coupled with other evaluation criteria (including alignment with the Cap-and-Trade Framework and complementary Abatement Construct guiding principles) will determine if abatement opportunities are ultimately selected for proposal in future compliance plans.

UNION GAS LIMITED

Answer to Interrogatory from
Ontario Energy Board Staff ("Staff")

Reference: Exhibit 3, Tab 4, pp. 6-8

Preamble: Union Gas states that "abatement investments require guiding principles that are complementary to the guiding principles in the Cap-and-Trade Framework." Union Gas then outlines its abatement guiding principles, including:

- Funding
- Timely advancement of technology
- Support for government targets
- Efficient and rational development, and
- Respect for appropriately modified regulatory constructs.

Question:

a) In the OEB's Cap and Trade Framework[1], the OEB indicates that its assessment of the utility's Compliance Plan will be guided by six principles, the first of which is cost-effectiveness. Please explain why cost-effectiveness is not one of Union Gas' guiding principles for abatement.
    i. Please explain how each of Union Gas' abatement guiding principles upholds the Cap and Trade Framework's guiding principles of rate predictability, cost recovery, transparency, flexibility and continuous improvement.
b) Please explain how Union Gas used its abatement guiding principles in its decision to pursue RNG Procurement, RNG Enabling, and Geothermal Energy Services Program for its 2018 proposed customer abatement activities.
    i. Please explain whether Union Gas considered the cost-effectiveness of RNG Procurement, RNG Enabling, and Geothermal Energy Services.
c) In regards to the second principle, "timely advancement of technology", please explain what Union Gas believes its role is in advancing the adoption of new technology in Ontario.
d) In relation to the third principle, "support for government targets", please explain what Union Gas believes its role is in supporting government abatement targets.
e) In relation to the fourth principle, "efficient and rational development", Union Gas states that "abatement programs should balance customer cost impacts by leveraging existing infrastructure." Please provide one or more examples of how customer abatement programs would balance customer cost impacts by leveraging existing infrastructure.
    i. For the examples provided above, please explain why Union Gas did or did not propose any of these customer abatement programs as part of its 2018 Compliance Plan. Please provide analysis and supporting documentation.

---

[1] EB-2015-0393, pp. 7-8

Response:

a) Cost-effectiveness is one of the guiding principles of the Cap-and-Trade Framework and is applied in the evaluation of abatement. As an example, Union notes in its summary of the Compliance Plan at Exhibit 3, Tab 1, pp. 5-6, "From an abatement perspective, Union has considered cost-effectiveness in the application of the LTCPF, MACC, and economic evaluations when determining which measures are appropriate to fund within existing regulatory mechanisms. Union is also proactively addressing cost-effectiveness by working collaboratively with government to pursue funding that will allow customer abatement initiatives (such as RNG) to proceed."

   This is further discussed in the response at Exhibit B.Staff.1 a) and in Table 1 below.

   i. Union has presented the guiding principles in the Abatement Construct which are complementary to the guiding principles of the Cap-and-Trade Framework. Each of the guiding principles of the Abatement Construct uphold the guiding principles of the Framework as summarized in Table 1 below:

**Table 1**

| | |
|---|---|
| **Funding** | **Predictability:** Securing alternative means of funding for the duration of an initiative or project can assist in providing greater predictability of rates.<br><br>**Cost recovery**: By seeking alternative means of funding for initiatives that are not cost-effective, the utilities are potentially reducing the level of costs to be recovered from ratepayers.<br><br>**Transparency:** Utility compliance plans provide line-of-sight to abatement proposals, including how they are funded. In addition to utility reporting within the Framework, reporting by government regarding use of CCAP funding is also required by the Climate Change Act.<br><br>**Flexibility:** Providing for alternative means of funding allows the utilities to be flexible to pursue various available sources of funding to advance abatement alternatives.<br><br>**Continuous Improvement**: Considering alternative means of funding recognizes that there is not just one path to advancing abatement, and allows for multi-pronged approaches to achieving GHG reductions. This demonstrates the utilities' commitment to evolving from traditional means of funding. |
| **Timely Advancement of Technology** | **Predictability:** As proposed with the Low Carbon Initiative Fund, an established, predictable level of annual funding for new technologies can support these initiatives over the long-term. This provides stability in development of initiatives, and predictability for rate payers regarding the level |

| | |
|---|---|
| | of investment in new technologies.<br><br>**Cost recovery:** Establishing a program of technology development, consistent with guiding principles and demonstrated cost/benefit analyses, demonstrates prudency and supports cost recovery.<br><br>**Transparency:** The Initiative Funnel provides a clear line of sight for the Board and intervenors regarding the new technologies and innovations that the utility is investigating and developing. Through successive Compliance Plans, there is transparency to the progress and status of each initiative, as well as the continuous development of new ideas.<br><br>**Flexibility:** The steady, predictable level of investment of resources into new technologies allows the consistent investigation of new technologies, as well as developments in the market place, of customer preferences, and of public policy. A dedicated focus on these initiatives allows for adaptability when conditions change or new technologies emerge.<br><br>**Continuous Improvement**: Advancing innovations through dedicated resources constantly monitoring progress in technologies and seeking to understand how these can be applied to benefit customers is the embodiment of continuous improvement. |
| **Support Government Targets** | **Predictability:** Government targets, both at the federal and provincial level, are set for both medium term (e.g. 2020) out to the long-term (e.g. 2050). Establishing a program of abatement directed at longer time horizons provides predictability; it recognizes that sustainable GHG emission reductions are contributing to the pursuit of Ontario's low-carbon economy, a transition which will occur over the long-term.<br><br>**Cost recovery:** The Framework clearly states that the utilities are expected to comply with legislation and support government targets for GHG reductions. Prudent plans which align with these goals should be subject to cost recovery. Evaluating many forms of abatement (and how they are funded) through the Abatement Construct provides for the ability to support GHG reduction goals.<br><br>**Transparency:** Government targets are public and the utility Compliance Plans provide clear reporting with respect to GHG obligations and reductions achieved through abatement. In addition, as required by Ontario Regulation 143/16 Quantification, Reporting and Verification of Greenhouse Gas Emissions, Union is required to report GHG emissions to the Ontario Ministry of the Environment and Climate Change ("MOECC"). The total annual GHG emissions reported are made available to the public through the Ontario government's open data catalogue. |

| | |
|---|---|
| | **Flexibility:** By supporting the development of both cost-effective and cost-ineffective programing (through the use of alternative funding models), the Abatement Construct provides the flexibility to pursue programs that otherwise may not have been possible.<br><br>**Continuous Improvement**: The flexibility to pursue programs that may not be cost-effective (at least not at the outset of their development), allows the utility to seek new technologies and improved ways of reducing the GHG footprint of Union's facilities and customers. |
| **Efficient and Rational Development** | **Predictability**: Maximizing the investment in existing infrastructure and programs provides greater rate predictability.<br><br>**Cost recovery**: Leveraging existing infrastructure and efficient development assists in balancing ratepayer impacts, demonstrating prudence for cost recovery.<br><br>**Transparency**: As a regulated utility, there is transparency and oversight through OEB reviews and frameworks. Continuing to leverage this infrastructure for the development of abatement opportunities provides transparency and line-of-sight for customers.<br><br>**Flexibility and Continuous Improvement**: Seeking new and innovative means to optimize the utility infrastructure in the pursuit of GHG emission reductions demonstrates both flexibility and continuous improvement. |
| **Respect Applicable Regulatory Constructs** | **Predictability, Cost Recovery, and Transparency**: Existing regulatory constructs are rooted in providing predictable and reasonable rates for customers through a transparent regulatory process. Continuing to respect these constructs ensures these principles are valued as utilities seek to advance new abatement opportunities.<br><br>**Flexibility and Continuous Improvement**: By introducing the Abatement Construct as a complementary framework to existing regulatory constructs, the Utilities are providing greater flexibility to pursue abatement initiatives that otherwise may not have been feasible. |

b) In this application, Union is pursuing an RNG procurement and funding model.[2] Union is not pursuing RNG Enabling Services or a Geothermal Energy Services Program; these items have been proposed by EGD.

In terms of RNG procurement, Union has considered the abatement guiding principles as outlined in evidence as well as described in Table 1 above. Specifically:

[2] EB-2017-0255, Procedural Order No. 2, p. 4, "The OEB has determined that the RNG Procurement and Funding model does not require approval."

- **Funding:** The RNG procurement proposal leverages provincial government funding in order to advance. Government funding allows RNG to be introduced into the gas supply stream while keeping customers financially indifferent to the forecasted cost of conventional natural gas and the associated price of carbon.

- **Timeline advancement of technology:** The RNG procurement proposal allows the utilities, who serve the vast majority of customers in the province, to advance the commercialization of RNG in the province by providing a stable demand for RNG that project developers can rely on when assessing the business case for development.

- **Support government targets:** RNG is one measure recognized by the government, as identified the Climate Change Action Plan, Long Term Energy Plan (as well as other documentation from the Ministry of Energy and OEB), as a means of reducing GHG emissions in the province.

- **Efficient and rational development:** RNG can replace conventional natural gas supply in existing distribution, transmission and storage facilities. This allows existing natural gas infrastructure to remain used and useful, while at the same time delivering a carbon-neutral fuel to customers.

- **Respect applicable regulatory constructs:** The RNG proposal respects elements of both the Gas Supply planning framework and the Cap-and-Trade Framework. The RNG proposal also leverages existing rate, billing, and reporting processes for the operationalization of RNG.

i. Yes. Please see the response at Exhibit B.Staff.1 a).

c) – d)

Union supports Ontario's transition to a low-carbon economy, and believes that it plays an important role in supporting government GHG reduction targets. As outlined in Attachment 1 to Union's response at Exhibit B.Energy Probe.7 a), Union estimates that approximately 26% of Ontario GHG emissions are attributable to natural gas. Natural gas is the preferred choice by customers for home, building, and water heating due to its availability and affordability.

As the second largest natural gas utility in Ontario, Union is in a unique position to support government policies related to GHG reduction. Union can provide valuable expertise as a result of direct line-of-sight to the benefits and use of natural gas in Ontario. With Union's existing infrastructure, regulated business models, strong historic DSM results, track record of safety and reliability, as well as its own mandate to reduce facilities emissions, the utilities most certainly have a role to play in continuing to support customers in reducing GHG emissions. Leveraging existing assets and delivery systems, allows the pursuit of GHG reductions in a way that balances environmental and economic outcomes. This role of the

utilities in transitioning to the low-carbon economy is recognized by the Cap-and-Trade Framework which states that in addition to achieving compliance with regulations, the utilities are expected to also support the government's GHG reduction targets. However, it is neither reasonable or practical to assume homeowners are going to bear the cost of not only retrofitting their homes with electric heat and water heat, but of paying the high electricity costs that would result. Energy in a cold climate like Ontario is a necessity of life and therefore affordability is a key consideration. Union's role is then to ensure that it has the most efficient technologies to reduce building heat and water heating needs, resulting in reduced natural gas consumption.

Union believes that the utilities' size, proximity to large-scale markets, physical assets and established delivery systems can also be leveraged to successfully expedite the adoption of new technologies and energy applications. Complementary to the continued execution of energy efficiency programs in the province, Union believes that sustained, consistent and predictable focus on new technologies and innovations can deliver incremental GHG reductions over the long-term.

e) Two examples of how customer abatement programs can balance customer cost impacts by leveraging existing infrastructure are RNG and energy efficiency measures.

**RNG** – RNG is a carbon-neutral fuel, and can seamlessly be introduced in existing natural gas infrastructure (distribution, transmission and storage assets). By developing RNG as a GHG abatement initiative, Ontario can continue to leverage the economic, reliable, and safe natural gas infrastructure while reducing GHG emissions. This is a market-ready solution which requires no new investment or equipment on behalf of natural gas consumers.

Union has proposed RNG as an abatement measure in the 2018 Compliance Plan because it meets the guiding principles of the Framework and the Abatement Construct (as described in part b) above). With the use of provincial funding, RNG becomes a cost-effective abatement initiative to reduce GHG emissions in the province.

**Energy Efficiency Measures –** The introduction of new cost-effective energy efficiency measures should be managed through the DSM Framework. Opportunities to abate carbon such as those identified through the CPS and/or MACC analysis should be considered within the appropriate regulatory framework. The DSM framework is proven and offers best practices in delivery of cost-effective energy efficiency measures to the market.

Rather than duplicating the assessment and delivery of energy conservation programs within two OEB frameworks, the DSM Framework should be enhanced to ensure that any energy conservation opportunity that is cost-effective relative to the cost of carbon is included for assessment within the DSM Framework.

Enhancing the DSM Framework, rather than assessing and delivering energy conservation programs within two separate OEB frameworks, would facilitate leveraging the existing

DSM Framework, which is robust and effective, to assess and deliver any additional energy conservation programs that are deemed cost-effective relative to the cost of carbon. Further, ratepayers would avoid funding two regulatory processes for the assessment of energy conservation programs.

Please see the responses at Exhibit B.GEC.15 and at Exhibit B.GEC.22 for additional detail.

UNION GAS LIMITED

Answer to Interrogatory from
Ontario Energy Board Staff ("Staff")

Reference: Exhibit 3, Tab 1, p. 62
Exhibit B.Staff.1, Attachment 1, p.6 (p.15 of slide deck)

Preamble: Union Gas states that it "has evaluated incremental energy efficiency opportunities, facilities abatement initiatives, as well as new technologies. Generally, these opportunities cannot be advanced, because they are not cost-effective at this time. Given that cost recovery within the existing regulatory mechanisms (whether that be DSM, gas supply procurement, or carbon procurement) is largely predicated upon prudency and cost effectiveness, this represents a barrier to advancing these measures."

In the IRRs provided by Union Gas in response to Issue 1.1.10 (RNG), Board Staff IR #1, Attachment 1, Union Gas provides a slide deck. On page 15 of the slide deck, Union Gas states "conservation remains the lowest cost solution to reducing emissions and saving customers money." It also contains a graphic stating that "Residential Customers save $2.67 for each dollar spent on natural gas conservation (ECO, 2016)."

Question:

a) Given Union Gas' statement above and the statements contained in the slide deck, please explain:
   i. Union Gas' decision to prioritize RNG and not to pursue other abatement opportunities in its 2018 Compliance Plan.
   ii. Whether the abatement activities that Union Gas is seeking government funding for are cost-effective.
      1. Please provide all data and supporting analysis that Union Gas used to calculate cost-effectiveness in $/tonne $CO_2e$.

---

Response:

a)
   i. As stated in Union's response at Exhibit B.Staff.1 d), the advancement of other abatement activities is not dependent upon OEB approval of Union's RNG proposal[1]. Rather, Union's pursuit of DSM and other abatement initiatives is complementary to its RNG proposal, and Union is taking steps to advance different forms of abatement in parallel. As outlined in Union's response at Exhibit B.Staff.1 e), Union has met with provincial Ministries in relation to other applicable measures that can be effective in reducing GHG emissions, and may require funding. These include energy efficiencies,

[1] As per EB-2017-0255, OEB Procedural Order No. 2, February 7 2018, p. 4, "The OEB has determined that the RNG Procurement and Funding model does not require approval."

CNG and geothermal. Union has also had energy efficiency program discussions with government focused on Residential, Commercial/Industrial, Indigenous, and Market Transformation opportunities that complement existing DSM programs.

ii. As outlined in Union's application at Exhibit 3, Tab 4, pp. 41-42, "For opportunities that may not be cost-effective within the DSM Framework, Union will pursue these through CCAP and GreenON as this ensures that there is no duplication of program offerings. Any duplication in program offerings will not provide ratepayers or the programs with the most efficient means of reducing GHG emissions."

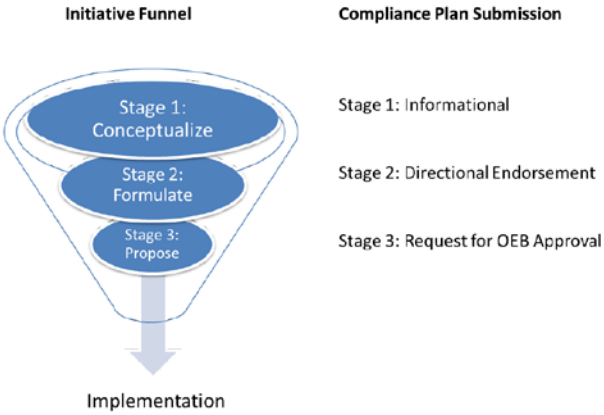
As noted in Union's response at Exhibit B.Staff.1 e), cost effectiveness of RNG procurement in terms of the utility impact on its ratepayers is subject to government funding. Please see the response at Exhibit B.Staff.1 f), for an evaluation of the cost-effectiveness of Union's RNG proposal.

UNION GAS LIMITED

Answer to Interrogatory from
Ontario Energy Board Staff ("Staff")

Reference: Exhibit 3, Tab 4, pp. 8-10

Preamble: Union Gas proposes that the following Initiative Funnel for its approach to investigating, planning and implementing abatement activities through its Compliance Plan.




Union Gas states that decisions about which initiatives move through the funnel stages will be informed by market signals, policy, OEB MACC, OEB LTCPF, customer acceptance, and technology development status, among other inputs.

Question:

a) Please explain how Union Gas' abatement guiding principles will be incorporated into its decision regarding which abatement activities move through the Funnel stages. Will they be different depending on the stage? Please explain.
   i. Are all the abatement guiding principles equally important or are some of the guiding principles more important than others? Please explain.
   ii. Will Union Gas consider the cost-effectiveness of different abatement initiatives as it moves projects through the Initiative Funnel?
      1. If yes, please describe how Union Gas will consider and compare the cost-effectiveness of all potential abatement initiatives.
      2. If no, please explain why not.

b) Please explain whether, and if so how, stakeholder input will be used by Union Gas to make decisions regarding which abatement initiatives to pursue.

---

Response:

a) Union views the guiding principles as constant, and will not change them depending on the project or the stage in the Initiative Funnel. The guiding principles are broadly framed, and

intended to guide the identification of which projects could be feasible for consideration by Union. While Union believes that all the principles should be considered and balanced in assessing projects, Union does not anticipate a formulaic weighting will be applied. It is Union's belief that the determination of abatement alternatives is not a mechanical process, but rather one that requires significant thought and judgement, and supporting analyses. An example of how Union has applied the guiding principles to an abatement initiative (RNG) can be found in the response at Exhibit B.Staff.18 b).

As described in Union's application at Exhibit 3, Tab 4, pp. 8-9, and in the response at Exhibit B.BOMA.1, there are several factors that will influence the movement of projects from one stage to another in the Initiative Funnel. These factors could include technical feasibility, market acceptance, public policy, as well as cost effectiveness. Factors may vary depending on whether it is a customer or facility abatement opportunity. These evaluation criteria may be both qualitative and quantitative, and may be subject to relative weighting depending on the project or initiative stage. For example, technical feasibility may be more important near the earlier stages of a project in order for it to proceed. Once this is proven, then cost and customer acceptance may carry greater weight in the later stages of the initiative.

Union will consider cost-effectiveness when evaluating abatement projects. Union will consider cost-effectiveness measures such as the OEB issued LTCPF and MACC; it will also consider the availability of alternative funding to support projects that may not be cost-effective on a stand-alone basis.

b) Union expects that both formal and informal means can be used as input to the evaluation of abatement initiatives. While it is not practical to conduct extensive stakeholder surveys or input for each idea or initiative, the following means may be employed:
   - Lessons learned and trends from actual DSM programing and customer response rates;
   - Insight from direct customer interaction from Union's commercial and industrial sales force;
   - Anecdotal feedback from stakeholders, industry, and customers through energy associations, conferences, and symposiums;
   - Customer feedback through pilot programs and surveys, where applicable;
   - Feedback from the OEB and intervenors through the compliance planning process and the Initiative Funnel projects by stage; and,

   Given Union's focus on continuous improvement, it is also possible that with the passage of time and experience, other means of gathering stakeholder input may be identified.

UNION GAS LIMITED

Answer to Interrogatory from
Ontario Energy Board Staff ("Staff")

Reference: Exhibit 3, Tab 4, pp. 10-12
Exhibit 3, Tab 4, p. 14

Preamble: Union Gas states that each stage of Initiative Funnel activity will have associated resourcing requirements.

Union Gas also states that a Low Carbon Initiative Fund (LCIF), consisting of available funds of up to $2 million per year, will provide funding to identify abatement ideas and move them through the stages of the Funnel, as well as enable the development of ideas that may require multiple years to reach commercialization. Union Gas indicates that the LCIF will be used for activities such as consulting, pilot programs, testing, data analysis, and measurement and verification.

Question:

a) How does Union Gas currently identify abatement activities to pursue? What would change if the LCIF is approved? Please explain.
    i. In 2017, did Union Gas undertake any activities that would, in 2018, fall within the ambit of the LCIF?
        1. If yes, please provide: a description of each activity; amounts spent on each activity in 2017; and whether those amounts are included in Union Gas' 2017 admin costs.
b) Please explain what work Union Gas intends to undertake in 2018 with the LCIF, if approved.
    i. Please explain how this work is related to the abatement activities proposed in the Initiative Funnel.
c) Please provide details of expected resourcing requirements and costs associated with each stage of the Funnel, including implementation, for 2018.
    i. Please explain whether these costs are incremental to Union Gas' forecast 2018 administrative costs.
    ii. Please explain whether these costs are included in the proposed $2M LCIF.
d) Enbridge Gas and Union Gas filed a MAAD application (EB-2017-0306) with the OEB. Please explain whether, and if so how, Union Gas will realize any economies of scale in relation to resourcing requirements for activities being undertaken in relation to GHG abatement and activities funded by the LCIF.
e) Please explain what will happen if the OEB does not approve the $2M LCIF that Union Gas is requesting.

f) Please provide references to specific cases and/or policy from the OEB and from any other authorities where research and development activities such as consulting, pilot programs, testing, market research, and data analysis is funded by ratepayers.
g) In the event that Union Gas' research undertaken through the LCIF leads to new technologies that could be marketed resulting in a financial value, would that financial value be shared with ratepayers?
   i. If yes, please explain how.
   ii. If no, please explain why not.

---

Response:

a) Union is committed to supporting Ontario's transition to a low-carbon economy by developing integrated energy solutions that balance emissions reductions with affordability at the customer level.

Consistent with this, Union has developed the Abatement Construct and the Initiative Funnel, as described in Union' application at Exhibit 3, Tab 4. In order to facilitate the development of ideas through the Initiative Funnel, Union has developed rigorous selection and project management approach. The selection approach applies to "Stage 1: Conceptual" of the Initiative Funnel and the project management phase applies to "Stage 2: Formulate". Steps within each phase may vary depending on whether it is a customer or facility abatement opportunity.

Selection starts with a market scan of emerging technologies enabling the identification of potential technologies and services aligned with the guiding principles. Selection is a stepped process which begins with pre-screening of technologies assessed against criteria such as environmental performance and GHG emissions, energy efficiency, market segments, economics and more. Potential technology providers are also assessed against established criteria including financial viability, design capability, management experience, etc. The selection concludes with a go/no-go decision regarding which technologies will be pursued for further development and implementation, initiating the project management phase for Stage 2 for each technology and/or abatement opportunity selected.

Project management begins with a project specific feasibility assessment during which a project execution plan is developed, which addresses the different phases of the project. Phases include planning, design and procurement through to construction and installation, measurement, verification, close-out and recommendation. This recommendation concludes the project management phase and constitutes the trigger that would move the opportunity to the Stage 3 of the funnel.

If the LCIF is approved, Union will be in a position to increase the number and the diversity of projects it pursues and accelerate the transition to a low-carbon economy.

Union undertook the following activities in 2017:

| Activity | Overview of 2017 Work | Approximate Spend | Included in GGEIDA Costs |
|---|---|---|---|
| Carbon Capture | Technology demonstrating GHG reduction, energy recovery and savings and overall performance of system. The work completed included a technology scan, pre-screening and assessment, initial risk assessment, lessons learned review and residential stakeholder identification. | N/A | No |
| Building Skins | Working with MaRS Advanced Energy Center to develop a workshop around creating a building envelope system for retrofit application on low-income housing. The work included planning of workshop, preliminary energy modeling and the execution of the workshop and the development of the RFP. | $90,000 | No |
| Integrated ASHP/NG Solution | Two pilot projects to demonstrate hybrid heating efficiencies and optimal switch-points for GHG savings and cost savings. Pilots will also include a study of home energy management system ("EMS") for integrated control. | $10,000 | No |
| Ground Source Heat Pump | Technology demonstrating GHG reduction, energy savings and overall performance of system. The work included a technology scan, pre-screening and an initial risk assessment. | $31,000 | No |
| Micro Generation | Pilot projects demonstrating hybrid heating efficiencies, GHG savings, system resilience, integration with net-zero homes and customer cost savings. Technology Scan, pre-screening, assessment and installation of 2 units at pilot sites M&V for both units. | $117,500 | No |

b) In 2017, Union was able to leverage a modest existing budget and incremental FTE in order to initiate work on new technologies.[1] Specifically, Union was able to initiate work advancing the Abatement Construct and Initiative Funnel. As such, Union established its selection and project management approach, developed relationships with key stakeholders

[1] 3.0 incremental roles for Technology and Innovation were identified in the Cap-and-Trade forecast administration costs for 2017 and 2018. Actual costs for these roles are captured in the GGEIDA.

(e.g. industry, technology partners, and academia) and began the identification of potential technologies and services aligned with the guiding principles. This budget allows for early and lower cost activities such as limited technology scans, early stage development of roadmaps, and identification of technology providers. However, the existing budget is not adequate to fully develop existing initiatives, to initiate new initiatives, or to pursue pilot projects at the level necessary, please also see Union's response at part e) below. Therefore, approval of the LCIF is needed to enable Union to advance new and existing initiatives in 2018 not limited to the following:

| **Union Gas Breakdown of Proposed 2018 LCIF Budget of up to $2 million** | | | |
|---|---|---|---|
| **Stage 1 - Conceptualize** | | | |
| **Initiative** | **Description of work** | **2018 Estimate** | **Reference to evidence** |
| Building Skins | Working with MaRS Advanced Energy Center to develop a workshop around creating a building envelope system for retrofit application on low-income housing.<br>Planned work: Pilot Project Initiation, execution, M&V* | $100,000 | Exhibit 3, Tab 4 Page 35-36 |
| Micro Generation | Pilot projects demonstrating hybrid heating efficiencies, GHG savings, system resilience, and customer cost savings.<br>Planned work: Pre-screening and Assessment of new technologies | $192,000 | Exhibit 3, Tab 4 Page 32-34 |
| Biomass Conversion (Thermochemical) to RNG | Understand technologies and feedstocks converting biomass to RNG, through the completion of a Technology Scan.<br>Planned work: Technology scan and feedstock studies | $110,000 | Exhibit 3, Tab 4 Page 36-37 |
| Automatic Meter Reading | Exploring integration with technologies to collect and utilize customer data in support of future developments which drive abatement opportunities | N/A | Exhibit 3, Tab 4 Page 37-38 |
| Portable Blowdown Recovery | Exploring applicability to Union's facilities and refining economic and GHG emissions reduction estimates | N/A | Exhibit 3, Tab 4 Page 53 |
| Federal Methane Regulations (possible projects) | Exploring possible projects to Union's facilities and refining economic and GHG emissions reduction estimates | N/A | Exhibit 3, Tab 4 Page 54-56 |

| **Union Gas Breakdown of Proposed 2018 LCIF Budget of up to $2 million** | | | |
|---|---|---|---|
| **Stage 2 - Formulate** | | | |
| Residential scale Carbon Capture | Pilot project demonstrating GHG reduction, energy recovery and savings and overall performance of system.<br>Planned work: Commercial pilot project initiation and execution | $51,000 | Exhibit 3, Tab 4 Page 35 |
| Ground Source Heat Pump | Pilot project demonstrating GHG reduction, energy savings and overall performance of system.<br>Planned work: Development of GSHP Roadmap and MURB Pilot Project Initiation (site selection and assessment) | $71,000 | Exhibit 3, Tab 4 Page 27-28 |
| Hydrogen and Power to Gas | Completion of P2G technology roadmap<br>Planned work: Monitoring of Enbridge's Power to Gas pilot project and a pre-feasibility assessment and studies of potential demonstration concepts | $100,000 | Exhibit 3, Tab 4 Page 30-31 |
| Micro Generation | Pilot projects demonstrating hybrid heating efficiencies, GHG savings, system resilience, integration with net zero homes and customer cost savings.<br>Planned work: Pilot Project Initiation and phased execution (9 sites) M&V | $535,000 | Exhibit 3, Tab 4 Page 32-34 |
| Fugitive Emissions Management | Exploring applicability to Union's facilities and refining economic and GHG emissions reduction estimates | N/A | Exhibit 3, Tab 4 Page 51-52 |
| Station Heating Equipment (London North Gate Station) | Evaluation of newer and more efficient technology improving fuel consumption on a cost effective basis. | N/A | Exhibit 3, Tab 4 Page 52-53 |

c) Please see the response to part b) above.

d) Please see the response at Exhibit B.Staff.14 a).

e) The existing budget is limited and does not adequately support next-level investigation or pilot demonstrations across a range of initiatives. For example, Union may be in a position to conduct a pilot at a single site, but not multiple pilots which are required to prove the technology for different applications and market segments (such as residential vs. commercial, new home vs. existing home, or multi-family vs. single family homes).

Union cannot commit to incurring costs to pursue new technologies without OEB approval. If the OEB does not approve Union's proposed LCIF, this will impact Union's ability to pursue new technologies and could result in certain initiatives not being pursued or taking longer to develop, depending on the availability of alternative funding. As outlined in the response at Exhibit B.Staff.18 c)-d), Union is in a unique position to leverage its expertise and relationships with customers to advance new technologies for abatement. Union feels that if the LCIF is not approved this will be a missed opportunity to align with other jurisdictional leaders (as outlined in the response at part f) below) in the interest of supporting the government's policies related to GHG reduction.

If the LCIF is approved, it will provide for a consistent, stable, and sufficient budget for Union to pursue a range of abatement initiatives and gather meaningful data to support deployment of such initiatives within its franchise.

f) Union is aware of the following instances where utilities are evaluating new technologies to support potential abatement initiatives:

- In the 2015-2020 DSM Plan proceeding (EB-2015-0029), the Collaboration and Innovation Fund was approved by the OEB to promote innovation or collaborative research and pilots within the realm of energy efficiency.

- In 2012, the California Public Utilities Commission approved the establishment of the Electric Program Investment Charge ("EPIC") to assist the development of non-commercialized new and clean emerging technologies in California. All EPIC activities are to provide ratepayer benefits for San Diego Gas & Electric, Pacific Gas & Electric and Southern California Edison customers.

- In its Energy Efficiency and Conservation Application (May 28, 2008), Terasen Gas and Terasen Gas Vancouver Island applied for spending related to Innovative Technologies, Natural Gas Vehicles ("NGV") and Measurement. Terasen was ultimately approved for Energy Efficiency and Conservation funding amounts for innovative technologies of $2.3 million for 2010 and $4.669 million for 2011. Terasen's Energy Efficiency and Conservation program is their energy conservation program.

- In 2008, the Louisiana Public Service Commission approved the development of a funding mechanism for natural gas utilities for research and development programs. The Louisiana Research and Development Committee ("RDC") was created and tasked with selecting and reviewing projects while determining which projects would have a reasonable chance to benefit Louisiana natural gas customers. The selected projects would be funded via a $0.90 per meter per year surcharge.

- Union is also aware of a discussion paper prepared by Concentric Energy Advisors that , based on analysis of utility innovation models from around the world, recommended that

Canadian utilities and regulators establish an innovation model for utilities that authorizes multi-year funding (at least three years), and is fully ratepayer funded.[2,3]

g) The purpose of Union's LCIF is to support the advancement of new technologies that contribute to future customer and facilities abatement initiatives. Currently, Union has no Initiative Funnel Stage 3 projects which represent a financial value. Union's RNG proposal, which is dependent on government funding, is a cost pass-through to ratepayers which leaves them indifferent.

Other initiatives at the earlier stages of the Initiative Funnel are still under development and it is too soon to determine if there is any financial value that will result. The treatment of any financial value associated with an initiative will be determined at the time the initiative is brought forward for OEB review.

[2] Stimulating Innovation on Behalf of Canada's Electricity and Natural Gas Consumers, August 21 2014, Concentric Energy Advisors Inc., p. 9, http://44f0gi3luy7z39sz523bbcjn.wpengine.netdna-cdn.com/wp-content/uploads/2015/10/CGA_CEA-Report.pdf

[3] Stimulating Innovation on Behalf of Canada's Electricity and Natural Gas Consumers, August 21 2014, Concentric Energy Advisors Inc., p. 16, http://44f0gi3luy7z39sz523bbcjn.wpengine.netdna-cdn.com/wp-content/uploads/2015/10/CGA_CEA-Report.pdf

UNION GAS LIMITED

Answer to Interrogatory from
Ontario Energy Board Staff ("Staff")

Reference: Exhibit 3, Tab 4, pp. 16

Preamble: Union Gas states that it engaged customers in 2017 to understand their needs and preferences, and that one of the topics it asked customers about was "the creation of an innovation and technology fund." Union Gas also states that over 70% of residential and commercial customers supported ratepayer-funded investments in new technologies.

Questions:

a) Please provide all relevant documentation of the customer engagement activities Union Gas carried out in 2017 that are related to the creation of an innovation and technology fund.
    i. Please provide documentation demonstrating customer responses and approval ratings in regards to the development of a new fund.

Response:

In 2017, as part of Union's customer engagement activities that were initiated in preparation for its 2019 Rebasing proceeding (that was subsequently deferred),[1] Union tested customer reactions to the prospect of creating an innovation and technology fund.

The question, as posed in the workbook for general service residential customers, can be seen in Figure 1 below.[2]

[1] EB-2017-0306
[2] Source Innovative Research Group

**Figure 1**

**Innovation and Technology Fund:**

As Ontario and the world look for new ways to provide reliable energy while lowering greenhouse gas emissions, natural gas distributors can play an important role in helping develop viable and useful new technologies. To that end, Union Gas is considering a fund of $10 million per year (about $3 per year for the average residential customer) in order to support research and development of new natural gas technologies. The funds would be spent on a mix of internal projects and partnerships with other companies and organizations. Some ideas include:

- A pilot project to use natural gas pipeline system as energy storage to shore up the reliability of the electrical system as it integrates more renewable fuels that may face interruptions due to weather.
- Biomass from landfills and hydrogen programs to provide "greener" natural gas.
- Technologies to help consumers be more energy efficient, such as combined heat and power units for residential applications.

39. Thinking about the potential to start investing in an innovation and technology fund, which statement is closest to your own view?

- ❑ Union Gas should invest in new technologies, and the proposed $10 million a year sounds like the right amount.
- ❑ Union Gas should invest in new technologies, and should spend more than $10 million a year even if that means higher rates.
- ❑ Union Gas should invest in new technologies, but $10 million a year is too much to spend.
- ❑ Union Gas shouldn't invest in new technologies.
- ❑ I'm not sure / don't have a strong opinion about this.

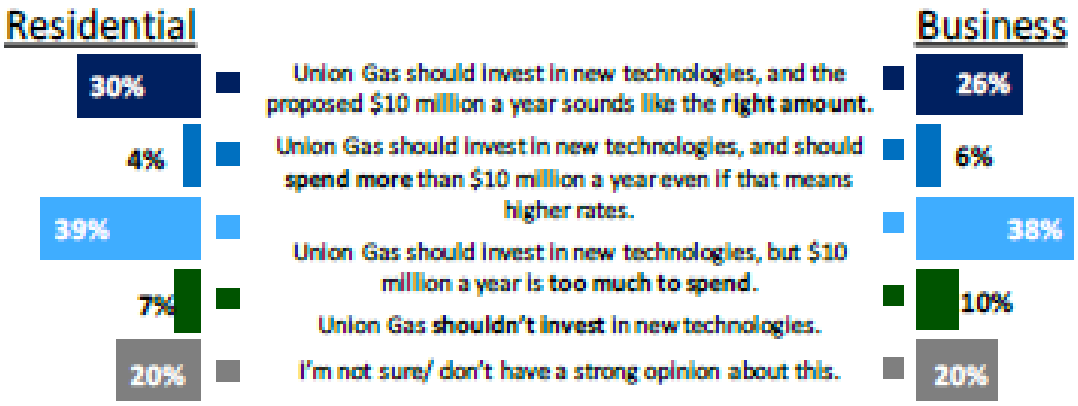
Comments:

The workbook for general service business customers included the same question with a rate impact of about $12 per year.

In response to this question, four in 10 participants (39% residential, 38% business) supported the implementation of a technology and innovation fund but believed that $10 million was too much to spend. Another 30% of residential participants and 26% of business participants supported the fund as proposed. One in five (20%) participants (both business and residential) didn't know or didn't have a strong opinion. Figure 2 below shows the number of customer responses and provides a breakdown of the responses: [3]

[3] Source Innovative Research Group

**Figure 2**


Residential
Business
30%
26%
Union Gas should invest in new technologies, and the proposed $10 million a year sounds like the right amount.
4%
6%
Union Gas should invest in new technologies, and should spend more than $10 million a year even if that means higher rates.
39%
38%
Union Gas should invest in new technologies, but $10 million a year is too much to spend.
7%
10%
Union Gas shouldn't invest in new technologies.
20%
20%
I'm not sure/ don't have a strong opinion about this.

UNION GAS LIMITED

Answer to Interrogatory from
Ontario Energy Board Staff ("Staff")

Reference: Exhibit 3, Tab 4, pp. 25-28

Preamble: Union Gas states that two of the project in Stage 2 of the Initiative Funnel are Integrated Air-Source Heat Pump/Natural Gas Solution and Ground Source Heat Pumps.

For Ground Source Heat Pumps (GSHP), Union Gas indicates that it intends to work with industry to establish an application roadmap for this technology. Union Gas states that it has and will continue to work with Enbridge Gas as part of its evaluation of GSHP technology, and it plans to monitor and build on Enbridge Gas' experience with GSHP and consider options to serve Union Gas customers. Union Gas also states that it expects to launch a pilot project in 2018 which will establish an implementation plan for its residential and commercial markets for GSHPs. It will evaluate next steps for GSHP following the pilot project in 2018.

Questions:

a) Given that the OEB MACC report indicates that heat pumps are currently high cost compared to other energy efficiency options for space heating, please explain why Union Gas is pursuing heat pumps at this point in time?
b) In regards to Union Gas' development of an application roadmap for GSHP, please describe:
    i. The industry experts that Union Gas has been working with and will work with in the future to establish the roadmap.
    ii. The work has been done on the GSHP roadmap to date.
    iii. What Union Gas expects to achieve from the development of the roadmap.
c) In regards to the work Union Gas has been undertaking on GSHP with Enbridge Gas, please explain:
    i. How Union Gas plans to monitor and build on Enbridge Gas' experience with GSHP.
    ii. The details of the pilot project that Union Gas expects to launch in 2018.
    iii. How Union Gas will evaluate the pilot to determine next steps for GSHP.
    iv. What type of "additional customer research" Union Gas is planning for GSHPs.

Response:

a) Please see the response at Exhibit B.Staff.17 d).

b)

i. Union has not yet engaged with outside parties. In 2018, Union plans to develop a GSHP application roadmap leveraging the experience of EGD. Industry experts and other relevant third parties will be identified in the roadmap development process.

ii. There has been no work done to date on a GSHP roadmap. However, a preliminary assessment has been completed to build an understanding of the potential GHG abatement opportunity.

iii. In developing a roadmap, Union expects to define industry experts and delivery agent partners, optimal target markets, as well as additional performance data needs. A pilot project will be defined to validate performance, economics and business model(s), which in turn will inform a potential GSHP program offering and implementation plan. The potential GSHP program offering (progression to Phase 3 of the initiative funnel), will also be considered according to analysis performed as part of the roadmap that will include: the size of the potential target market(s), range of system costs, and assessment of potential barriers and available funding mechanisms.

c)

i. Union plans to monitor the progress of EGD's pilot projects through participation in regular updates and review of issued reports. The results of EGD's pilot projects will inform Union's future pilot project, to avoid overlap and duplication of information.

ii. Union will develop the GSHP roadmap in 2018. Based upon the results of EGD's pilot projects and the completion of Union's roadmap, Union will define a pilot project. This pilot project may be deferred to 2019.

iii. Union's pilot project will confirm performance, economics and business models around GSHP's. With the results of the pilot project, Union will explore potential program offerings, if appropriate, for Union's customers.

iv. Additional customer research that is required as part of the establishment of any implementation plan includes forecasts of market demand, customer awareness and understanding of the technology, and the benefits and barriers to adoption.

UNION GAS LIMITED

Answer to Interrogatory from
Ontario Energy Board Staff ("Staff")

Reference: Exhibit 3, Tab 4, pp. 28-30

Preamble: Union Gas states that it currently administers the Optimum Home Program to encourage residential builders to construct new homes 20% more efficient than the Ontario Building Code 2017 standards. Union Gas also states that Enbridge Gas has a similar program and that Union Gas is aware that Enbridge Gas has proposed to the MOECC additional measures, such as expanding participating builders and geographic regions as well as builder incentives for NZER construction. Union Gas indicates that it is investigating similar measures for its franchise area and that specific measures are yet to be determined, but it is expected that they will not be cost-effective and would require government funding of $100 - $150 million to proceed.

Questions:

a) Please expand on the types of measures Union Gas is considering as part of its cap and trade customer GHG abatement.
b) Please explain why Union Gas has determined that it requires government funding to proceed with NZER.
    i. Please provide Union Gas' data and calculations used to determine that NZER will not be cost-effective and that $100-$150M would be required in provincial funding.
    ii. Has Union Gas entered into discussions, or will Union Gas enter into discussions, with the province regarding obtaining this funding? Please explain.

---

Response:

a) Specific measures and/or program design changes are yet to be determined, but could include:
    - Expanding participating builders
    - Expanding geographic regions
    - Addition of incentives for NZER construction

b) This abatement initiative is still in the early stages of scoping and investigation, and as such Union has not yet completed detailed data collection or analysis. However, based on preliminary understanding of net zero measures, and the reality that new technology measures are generally not cost-effective at the outset, Union expects that this initiative may require government support to proceed to implementation.

i. The estimated funding range of $100-$150 million is intended to represent a projected order of magnitude, and will be subject to refinement as the initiative moves through the various steps within the Initiative Funnel.

ii. Union has not been involved in discussions with the province related to obtaining funding for NZER programming, however Union is aware of EGD's preliminary proposal to the MOECC as noted in the response to part b) i) above. Union intends to support future proposals and discussions for NZER programming; however, no specific details have been established.

UNION GAS LIMITED

Answer to Interrogatory from
Ontario Energy Board Staff ("Staff")

Reference: Exhibit 3, Tab 4, pp. 32

Preamble: Union Gas states that it is planning to pilot various micro generation technologies in 2017 and 2018 in target markets and geographic locations, and that the results of the pilot projects will be monitored to confirm the effectiveness of micro generation systems.

Union Gas also states that it intends to pursue further steps to overcome the barriers to commercialization of micro generation, including proposing changes to legislation pertaining to Net Metering. Union Gas indicates that it expects that government funding in the range of $70 - $110 million is required over the next 5 years to commercialize micro generation technology.

Questions:
a) Please explain how micro generation solutions lead to GHG abatement.
b) Please explain why it is appropriate for Union Gas to have a role in the commercialization of micro generation technology.
c) Please explain whether ratepayers would be expected to support any of the costs of commercialization of micro generation.
    i. Is Union Gas requesting ratepayer support for its activities regarding proposing changes to Net Metering legislation? If yes, how much does Union Gas expect these activities to cost?
d) If ratepayers are expected to contribute to the cost of commercialization of micro generation, please describe the expected benefits, including:
    i. Qualitative benefits such as consumer choice.
    ii. Quantitative benefits in $/tonnes of $CO_2e$ savings.

---

Response:
a) Micro generation results in GHG abatement due to:

- Primarily, increased efficiency of electricity production at the home (site production) compared to the grid (source production), which mitigates line losses and heat losses;

- Depending on the electricity mix, there is a potential reduction in GHG emissions by replacing electricity that would have been generated by natural gas powered generators (particularly at peak times); and,

- Homes in Ontario require large amounts of heating energy and current systems in existing homes are less efficient than micro generation. The pilot projects are designed to confirm the effectiveness of the systems and inform optimal configuration for the province so that homes can be upgraded to micro generation with significant increased mechanical efficiencies of the heating systems and reduced GHG emissions.

b) It is appropriate for Union to have a role in the commercialization of micro generation technology because:
   - Union has strong and trusted existing community and customer relationships which enable in-home pilot project implementation;
   - Union has a deep understanding of the natural gas infrastructure in Ontario and is intimately familiar with the energy usage and profile of its residential customers which enables it to remove and barriers and accelerate the time to market of this technology;
   - Union has strong experience in measurement and verification of gas systems. This experience can be leveraged to remove risk and optimize the Measurement and Verification process.

c) Union anticipates that its activities regarding potential Net Metering Legislation changes could require additional funding. However, it is too early to estimate what costs could be required.

d) Qualitative benefits of micro generation systems include:
   - They can be a GHG emission neutral solution that provides increased reliability and resilience to a homeowner, due to the system's ability to act as a generator during electricity grid disruptions caused by winter ice storms, flooding, etc.
   - Ratepayers can also expect a reduced cost for electricity generated by the microgeneration system due to the price differential between electricity and natural gas, which is currently estimated at 3.5 cents KWH equivalent for natural gas compared to 14.5 cents for electricity from the grid.

   Given the development stage of micro generation projects, it is too early to provide detailed and validated quantitative benefits. Union expects that its proposal to conduct the pilot tests identified in Stage 2 of the Initiative Funnel will assist with assessment of quantitative benefits of micro generation systems in the future.

UNION GAS LIMITED

Answer to Interrogatory from
Ontario Energy Board Staff ("Staff")

Reference: Exhibit 3, Tab 4, pp. 35-38

Preamble: Union Gas states that its stage 1 (conceptualize) projects include Residential-Scale Carbon Capture and Utilization, Building Skins, Biomass Conversion (Thermochemical) to RNG, and Automatic Meter Reading.

Questions:

a) Please explain what activities (such as research and development, pilot projects, market research, etc.) Union Gas intends to do with regards to the stage 1 projects in 2018.
    i. Please indicate how much Union Gas expects these activities to cost in 2018.

---

Response:
Please see the response at Exhibit B.Staff.21 b).

UNION GAS LIMITED

Answer to Interrogatory from
Ontario Energy Board Staff ("Staff")

Reference: Exhibit 3, Tab 4, pp. 44-45
Exhibit 3, Tab 4, pp. 49-51

Preamble: Union Gas states it undertook a Facility Abatement Study to identify opportunities with the potential to reduce GHG emissions from its transmission, storage, and distribution operations. Union Gas further states that the Facility Abatement Study identified three applications where incorporating the GHG emissions impact has particular applicability: valve operators, pipeline looping, and blowdown recovery.

Union Gas indicates that for pipeline looping, the Abatement Study evaluated the cost and emissions of building a new compressor relative to the cost to install pipeline looping, and that "high level calculations for additional GHG emission costs suggest the higher capital cost of pipeline looping could be offset by cost savings related to the avoidance of GHG emissions."

Questions:
a) Please provide a copy of the study referenced above.
b) Did Union Gas complete a similar abatement study for customer abatement?
    i. If yes, please provide this study.
c) For pipeline looping, can Union Gas please provide the following:
    i. Supporting documentation, including data and analysis which demonstrate that the higher capital cost of pipeline looping could be offset by cost savings related to the avoidance of GHG emissions.

---

Response:
a) Union's Facilities Abatement Study, as described in its application at Exhibit 3, Tab 4, refers to a compilation of analyses and data conducted by the Facility GHG Emission Reduction Team in 2017. The summary evidence provided within Union's application at Exhibit 3, Tab 4, Section 3 reflects the culmination, and the most up-to-date capture, of these various analyses and data. The potential facility abatement measures which Union is pursuing are summarized in Union's application at Exhibit 3, Tab 4, Appendix B.

b) Yes, Union evaluated potential customer abatement opportunities as part of its 2018 Compliance Plan. This included the creation of an Abatement Construct to evaluate possible future abatement opportunities, a proposal to procure RNG, an overview of future customer abatement initiatives and evaluation of possible incremental DSM using the OEB LTCPF and MACC. See Union's application at Exhibit 3, Tab 4 for further detail.

c) A high level analysis was completed in order to determine the potential annual emission reductions if a pipeline loop is installed in place of building a new compressor facility. The purpose of this analysis was to get an indication of whether the GHG emissions from a typical new transmission compressor plant and the associated carbon emissions costs could be significant enough to offset the additional cost that may be required to build a loop of high pressure pipeline. This analysis was done on a cost per GJ of capacity basis as new pipeline looping and new compression did not provide the same incremental capacity. One of the conclusions of this high level analysis, as stated in Union's application at Exhibit 4, Tab 4 p. 51 was that "High level calculations for additional GHG emission costs suggest the higher capital cost of pipeline looping could be offset by cost savings related to the avoidance of GHG emissions. Moving forward, Union will consider the costs of GHG emissions when selecting future facilities."

Union notes that this high level analysis was completed based on one specific scenario, which took into consideration potential demand increases on Union's Dawn Parkway System. The analysis did not consider overall system operation costs or any GHG emissions costs associated with incremental compressor utilization across the Dawn Parkway System (i.e. increased existing compressor utilization). As noted above, the cost of carbon will be assessed, alongside other operational considerations, when evaluating Dawn Parkway System expansion options in the future. It is important to note that there are circumstances where a compressor plant or pipeline looping project may be a more expensive option but will be required in order to meet the operational requirements of the Dawn Parkway System.

UNION GAS LIMITED

Answer to Interrogatory from
Ontario Energy Board Staff ("Staff")

Reference: Exhibit 3, Tab 2, p. 4
Exhibit 3, Tab 4, p. 56

Preamble: Union Gas states that it initiated process changes to support the potential abatement opportunities, such as leveraging economic evaluation models and processes to incorporate the OEB LTCPF and OEB MACC into customer and facility abatement analyses.

Union Gas also states that it established a cross-functional project team to investigate and evaluate facility abatement ideas, and that this project team will evolve into a sustainment team which generates and evaluates new abatement ideas on an annual basis, and that this team also integrates its findings into Union Gas's broader planning processes.

Union Gas indicates that as part of the mandate of the Abatement Study project, a sustainment plan has been implemented to maintain ongoing focus on facility abatement projects. Union Gas proposes that the sustainment plan establishes the Facility GHG Emission Reduction program, which includes the formation of the Facilities Abatement Steering Committee.

Questions:

a) Please describe the roles and responsibilities of each team, Committee and the GHG Emission Reduction program [program] (as described in the exhibit above) as well as any other team or committee that Union Gas has that relates to facilities abatement.
    i. Please explain how the teams, Committees and program differ from each other.
    ii. Is there, or will there be, interaction and collaboration between the Committee and teams described above? Please explain.
b) Please describe all the work done to date by the teams, Committees and program discussed in a).
c) Please explain when the cross-functional project team will evolve into a sustainment team.
d) Please describe how the sustainment team will generate and evaluate new abatement ideas, and how this will work with Union Gas' Initiative Funnel.
    i. Will the Facilities Abatement Steering Committee also work with Union Gas' Initiative Funnel? Please explain.
e) Please describe whether, and if so how, the work of the Committee and teams will be integrated into Union Gas' broader planning processes (including, but not limited to, business planning, capital planning and investment management planning).
f) Will similar teams, programs and Committees be used for customer abatement activities? Please explain.

Response:

a) The overall purpose of the Facility GHG Emission Reduction Program is as follows:
   - Annually review potential emission reduction opportunities
   - Track progress on in flight opportunities ($CH_4$ & $CO_2e$)
   - Report on actual emission reductions
   - Present quarterly status update to governance

   The accountabilities of the Program Steering Committee are as follows:
   - Regular review of program status
   - Act in Steering Committee capacity for large projects as required
   - Endorsement of new opportunities at funnel stages
   - Funding recommendations
   - Support for compliance plan development

   The core program team is comprised of various functional subject matter experts. A summary of accountabilities is provided below:
   - Identify potential new initiatives
   - Complete analysis of initiatives through Stages 1 and 2 of the Initiative Funnel
   - Provide economic evaluation support
   - Provide emission reduction evaluation support
   - Track and report on emission reduction progress
   - Provide support for compliance plan development
   - Monitor potential sources of funding

   i. The Program serves as the framework to annually review GHG emission reduction opportunities from Union's facilities and is comprised of the Program Steering Committee and core team.
      - The Steering Committee provides overall direction for the program, and consideration and endorsement to identified opportunities as appropriate.
      - The core team is made up of functional leads and supporting SMEs from across the organization. The functional leads are responsible for brainstorming, designing, and in some cases implementing GHG emission reduction opportunities. The EHS, Finance, and Cap-and-Trade teams all provide specialist knowledge and perspective to the analysis and evaluation of opportunities.

   ii. The program lead coordinates all program activities and is responsible for the collaboration between the teams and the Program Steering Committee. The

program lead meets with the core team and the Program Steering Committee separately and shares meeting outcomes between both stakeholder groups.

Overall oversight of abatement and the compliance plan is provided through the Cap-and-Trade Advisory Team and the Cap-and-Trade Governance Committee.

b) The program has moved to a sustainment model and program resources have been identified. Currently Union is implementing procedural changes to integrate GHG emission reductions and the cost of carbon into design considerations for planned improvements and capital investments. Union is also continuing to refine costs and emission reductions estimates of opportunities identified in the 2018 Compliance Plan. Finally, Union is investigating the feasibility of new technologies and innovations. Please see the response at Exhibit B.Staff.27 a).

c) The program has transitioned into sustainment. The cross-functional team is now a part of the sustainment team. The sustainment of the program is the responsibility of the program lead in conjunction with the Program Steering Committee.

d) The sustainment team will continue to meet on a regular basis, in part to identify and evaluate new facility abatement ideas following the path outlined in the Initiative Funnel.

In the conceptual stage, ideas are brought forward for discussion and high level cost/benefit assessment to determine if the opportunity may be feasible considering the criteria outlined in Union's application at Exhibit 3, Tab 4, p. 46. Opportunities considered potentially feasible are reviewed with the Program Steering Committee and moved to Stage 2 of the Initiative Funnel for further investigation and a refined analysis.

If the opportunity, once refined, is confirmed to meet the evaluation criteria above, the opportunity is presented as the business case for the project to move forward. If endorsed by the Program Steering Committee, the opportunity moves to Stage 3, becoming either a project or department initiative, depending on the size and scope. Initiatives are then endorsed for implementation through either the established project structure, or through specific functional unit oversight. Line of sight to these initiatives is maintained through the GHG Emission Reduction Program. Initiatives are tracked and reported on a quarterly basis to the Program Steering Committee, which includes representation from the functional areas that have ownership for the endorsed initiatives.

e) The work of the Facility GHG Emission Reduction team is integrated into broader planning processes, such as asset management planning, capital planning, budgeting and business priority planning. This occurs through the intersection of these planning processes, and through the Program Steering Committee which includes representation from the functional areas who have ownership for these planning processes. In addition, the timing of Union's analysis of its facility abatement initiatives aligns with budgeting and planning cycles.

f) Yes, customer abatement does leverage similar teams and Committees to identify and evaluate initiatives. Functional accountability for DSM programming, Cap-and-Trade, Technology and Innovation and Business Development resides with the same Vice-President, In addition, cross-functional teams are established as needed to evaluate specific initiatives (e.g. RNG or Net Zero). Overall oversight of abatement and the Compliance Plan is provided through the Cap-and-Trade Advisory Team and the Cap-and-Trade Governance Committee.

UNION GAS LIMITED

Answer to Interrogatory from
Ontario Energy Board Staff ("Staff")

Reference: Exhibit 3, Tab 2, Appendix A, pp. 2-3 and Table 1

Preamble: Union Gas states that it conducted an analysis of the OEB's Conservation Potential Study (OEB CPS) and OEB LTCPF and determined that incremental abatement opportunities were not cost-effective over an average 15-year measure life once Ontario's cap and trade market is linked to WCI.

Questions:

a) Please provide all supporting data and analysis that Union Gas used to calculate the marginal costs of incremental abatement (in $/tonne) in Table 1.
    i. Please describe whether Union Gas' calculations include costs and benefits to the utilities only, or also includes costs and benefits to the ratepayer.
b) Please provide the cost-effectiveness threshold (in $/tonne) that Union Gas used to determine that the incremental abatement activities were not cost-effective.

---

Response:

a) The methodology used to determine the Marginal Cost ($/Tonne) figures in Union's application at Exhibit 3, Tab 4, Appendix A, p. 3, Table 1, can be found at Exhibit 3, Tab 4, Schedule 1. Specifically, the $60/Tonne figure can be found in Column m, line 4 and the $119/Tonne figure can be found in Column m, line 5. The costs and savings used in Union's application at Exhibit 3, Tab 4, Schedule 1 are informed by the CPS and are referenced in the notes below the table.

    i. Exhibit 3, Tab 4, Schedule 1 calculates the cost per $CO_2e$ tonne abated, based on the costs and savings provided in the CPS. The costs include all program costs (program delivery costs and customer incentive costs) as per the CPS, and the benefits include natural gas $m^3$ savings as per the CPS (converted to $CO_2e$ emissions saved).

b) Union utilized the Minimum LTCPF, Mid-Range LTCPF and Maximum LTCPF outlined in the LTCPF Report to determine the cost-effectiveness threshold for emission savings between 2018 and 2028.[1] For emission savings in years beyond 2028, Union assumed the 2028 figures.

[1] EB-2015-0363, Long Term Carbon Price Forecast Report, May 31, 2017, p.22.

UNION GAS LIMITED

Answer to Interrogatory from
Ontario Energy Board Staff ("Staff")

Reference: Exhibit 3, Tab 4, Appendix A, p. 4

Preamble: Union Gas indicates that it adjusted the savings potentials found in the CPS and the OEB MACC because it claims that they were gross, i.e., did not exclude efficiency upgrades that would occur in the absence of DSM programming.

The OEB's Natural Gas Conservation Potential Study explicitly gives special consideration to natural conservation, and notes that it gave special consideration to:

- Naturally-occurring improvements in equipment efficiency
- Expected penetration of more efficient equipment into the building stock
- Known, upcoming changes in building and equipment energy performance codes and standards

Questions:

a) Please indicate why Union Gas believes that the opportunities identified in the OEB MACC are gross savings.
b) Please confirm that Union Gas understands that the OEB MACC analysis is based on the data and analysis from the OEB CPS, which indicates that the reference case explicitly included natural conservation.
c) Please explain how the adjustment factors Union Gas used to reduce the OEB MACC potential are reasonable, given that the reference case included natural conservation.

---

Response:

a) – c)

Union understands that the opportunities identified in the MACC and CPS take into account some natural conservation; however, Union does not believe that this natural conservation takes into account all applicable factors. For example, as noted in the CPS "the reference case does not account for initiatives related to the Climate Change Action Plan, which was under development at the time the analysis was completed. It is anticipated that some of these initiatives would reduce gas consumption in the reference case forecast, which would reduce the achievable potential savings found in this study."[1] To account for all applicable factors including the significant amount of CCAP funding that is expected to continue Union applied a discount to each MACC within its incremental energy efficiency abatement opportunity analyses.

[1] ICF Natural Gas Conservation Potential Study, Updated July 7, 2016, p. ii.

UNION GAS LIMITED

Answer to Interrogatory from
Ontario Energy Board Staff ("Staff")

Reference: Exhibit 3, Tab 4, p. 43
Exhibit 1, p. 6
Exhibit 3, Tab 4, Appendix A, p 6, Table 2 and Table 3

Preamble: In Exhibit 3, Union Gas states that when assessing the OEB MACC for abatement opportunities, it "did not identify any cost-effective Commercial/Industrial (C/I) abatement opportunities incremental to its existing DSM programs." Union Gas LAO states that it "did, however, identify cost-effective abatement opportunities incremental to Union's existing DSM programs within the Residential sector in all carbon price forecast scenarios." Union Gas indicates that it will "assess the incremental opportunity and pursue it through the DSM Framework where possible."

Union Gas proposes that "through the CPS and OEB MACC analyses, Union has determined that it is not appropriate to include incremental DSM abatement opportunities in the 2018 Compliance Plan."

In Appendix A, Union Gas identifies its annual savings in 2020 (plus savings persisting from the 2018 and 2019 year) based on its analysis of the potential found in the OEB MACC, and compared them to the savings anticipated in the existing DSM plan for those years.

Questions:

a) Please explain why Union Gas states that is not appropriate to include incremental abatement in its 2018 Compliance Plan even though Union Gas identified cost-effective abatement opportunities in the residential sector in all carbon price forecast scenarios.
    i. Please explain why and how Union Gas proposes to pursue this opportunity through the DSM Framework instead (given that the DSM budgets for 2015-2020 were approved in the DSM Decision.[1]
b) For the Commercial/Industrial Analysis in Appendix A:
    i. Please provide Union Gas' calculation of the OEB MACC mid-range LTCPF savings potential of 66 million $m^3$, based on the results found in the OEB MACC.
    ii. Please provide Union Gas' data and analysis to calculate the annual savings realized in 2020 from Union's C/I prescriptive and custom DSM plan, including savings from 2018 and 2019 that persist into 2020. Please indicate the achievement of their targets (in %) assumed for 2017, 2018, 2019, and 2020 in this calculation.

[1] EB-2015-0029/0049

iii. Please indicate what commercial/industrial measures included in the OEB MACC are those that Union Gas does not currently incent, and provide rationale for excluding each.

c) For the Residential Analysis in Appendix A:
   i. Please provide Union Gas' calculation of the OEB MACC mid-range LTCPF savings potential of 35 million $m^3$, based on the results found in the OEB MACC (i.e., 144 million $m^3$ of 2018-2020 abatement potential in Ontario, as shown in Table 14 of the OEB MACC).
   ii. Please provide Union Gas' data and analysis to calculate the annual savings realized in 2020 from Union Gas' Residential DSM Plan, including savings from 2018 and 2019 that persist into 2020. Please explicitly indicate the achievement of their targets (in %) assumed for 2017, 2018, 2019, and 2020 in this calculation.
d) Please explain whether the annual savings from Union Gas' DSM Plan in Appendix A are consistent with the 2018 DSM volume reductions indicated in Exhibit 2.

---

Response:

a) The energy conservation measures that were identified within the MACC Report that are not currently included within Union's DSM programs can be grouped into the following three categories.

1. **Behavioural Measures**

   The MACC identified the following opportunities related to residential behavioural measures, which are not currently included within Union's DSM program.

   - Minimize Hot and Warm Clothes Wash;
   - Reduce Temperature of DHW;
   - Clothes lines and drying racks;
   - Close windows and blinds; and,
   - Maintain Weather-stripping.

   As part of Union's 2015-2020 DSM Plan application, the utility proposed a residential behavioural offering.[2] Within its Decision and Order, the OEB denied the offering stating "The OEB is not convinced, based on the evidence filed, that the proposed budgets are a good use of customer funds or that the programs provide value for money."[3] Union submits that it would not be appropriate to propose a behavioural program given the OEB's decision on Union's 2015-2020 DSM Plan. Union suggests that should a behavioural offering be revisited, it should be assessed within the DSM Framework, and

[2] EB-2015-0029, Union DSM 2015-2020 DSM Plan, Exhibit A, Tab 3, Appendix A, pp. 2-24.
[3] EB-2015-0029, Decision, p. 37.

that it is not appropriate to duplicate the DSM Framework within the Cap-and-Trade Framework. Please see the response at Exhibit B.GEC.22 for more detail.

2. **Adaptive Thermostats**

The MACC identified opportunity related to residential adaptive thermostats, which are not currently included in Union's DSM program.

In its Decision and Order on Union's 2015-2020 DSM Plan, the OEB directed Union to "propose a new, widespread residential program at the mid-term review".[4] Within its DSM Mid-Term Review submission for Part 2 Requirement 2, Union proposed a new Residential Adaptive Thermostat offering, requiring approval of incremental budget.[5] Union submits that this opportunity should continue to be assessed within the DSM Framework, and that it is not appropriate to duplicate the DSM Framework within the Cap-and-Trade Framework. Please see the response at Exhibit B.GEC.22.

3. **Assessed and Not Prioritized**

The MACC identified opportunity related to the following residential measures:

- Draft Proofing Kit;
- Heat Reflector Panels;
- Programmable Thermostat;
- Faucet Aerator;
- High-Efficiency (ENERGY STAR®) Dishwashers;
- Low-Flow Shower Head;
- Pipe Wrap;
- DHW Tank Insulation;
- Active Solar Water Heating Systems;
- DHW Recirculation Systems;
- Wastewater Heat Recovery Systems;
- High-Efficiency Gas Clothes Dryers;
- Sensor for Clothes Dryer;
- Insulating Pool Covers;
- High-Efficiency Gas-Fired Pool Heaters;
- Solar Pool Heaters;
- Fireplace Intermittent Ignition Control Retrofit; and,
- High Efficiency Fireplace with Pilotless Ignition.

[4] EB-2015-0029/EB-2015-0049, Decision and Order, January 20, 2016, p. 15.
[5] EB-2017-0127, Union Submission, January 15, 2018, pp. 4-6.

These measures have either been denied by the OEB within the current or previous DSM Frameworks, or have been assessed by Union within the DSM Framework and have been identified as low priority measures (either due to poor TRC-Plus cost effectiveness or limited market opportunity). Union submits that should these measures require reassessment, they should continue to be assessed within the DSM Framework, and that it is not appropriate to duplicate the DSM Framework within the Cap-and-Trade Framework. Please see the response at Exhibit B.GEC.22.

b)

i. Union used the following methodology to arrive at the commercial/industrial MACC (Mid-Range LTCPF) annual savings potential for 2018-2020 of 66 million $m^3$.

1. Union first identified the province wide cost-effective savings opportunity identified in the MACC Report (Mid-Range LTCPF) for commercial and industrial sectors respectively: 99 million $m^3$,[6] and 96 million $m^3$.[7]

2. Union then adjusted the savings opportunity identified in the MACC Report to align with Union's DSM savings results by applying Net-to-Gross adjustments. The Net-to-Gross adjustments used for each sector was based on Union's 2015-2020 DSM Plan. Specifically, Union assumed a 90% Net-to-Gross adjustment for the commercial sector (based on the typical range of Net-to-Gross adjustments for the Commercial/Industrial Prescriptive offering) and a 46% for the industrial sector (based on the Net-to-Gross adjustment for the Commercial/Industrial Custom offering).

3. Union then adjusted the savings to represent the opportunity within Union's franchise area, as opposed to province wide. Union attributed 42% of the commercial sector savings opportunity and 66% of the industrial sector savings opportunity to Union's franchise area. These figures are based on the savings identified in the CPS Constrained Scenario for the 2018-2020 years in Union's territory.

4. Union summed the savings opportunity for the Commercial and Industrial sectors. The calculation is as follows:

[6] EB-2015-0363, MACC Report, p. 35.
[7] EB-2015-0363, MACC Report, p. 28.

**Commercial + Industrial = 66 million $m^3$**
*Where:*
***Commercial*** *= 99 million $m^3$*
*× 0.90 Net-to-Gross adjustment*
*× 42% franchise area adjustment*
*= **37 million $m^3$***

***Industrial*** *= 96 million $m^3$*
*× 0.46 Net-to-Gross adjustment*
*× 66% franchise area adjustment*
*= **29 million $m^3$***

ii. 2017 has not been included in this response as Union only used 2018-2020 for this analysis. The "C/I Prescriptive and Custom DSM Plan" figure (193 million $m^3$) in Table 2 of Union's application at Exhibit 3, Tab 4, Appendix A is the sum Union's commercial/industrial 2018-2020 annual natural gas savings forecasts from its 2015-2020 DSM Plan. The figure includes:

- Low-Income Multi-Family offering;[8]
- Commercial/Industrial Prescriptive offering;[9]
- Commercial/Industrial Custom offering;[10] and,
- Performance-Based Conservation program.[11]

| M3 savings | 2018 | 2019 | 2020 | Total |
|---|---|---|---|---|
| Low Income (Multi-Family) | 1,039,617 | 1,203,334 | 1,191,633 | 3,434,584 |
| CI Prescriptive | 16,375,788 | 16,375,788 | 16,375,788 | 49,127,363 |
| CI Custom | 45,430,134 | 45,430,134 | 45,430,134 | 136,290,403 |
| Performance Based Conservation | 650,000 | 1,250,000 | 2,050,000 | 3,950,000 |
| **Total** | | | | **192,802,350** |

Savings from Union's Large Volume program were not included in order to estimate a comparable figure to the MACC Report's results, as Large Final Emitters were not included in the MACC Report.

Union assumed 100% achievement of these forecasts.

iii. There are three measures included in the MACC Report which Union does not currently include within its DSM Commercial/Industrial Program.[12] The measures represent routine maintenance projects.

- Boiler Tune-up
- Steam Leak Repairs

[8] EB-2015-0029, Union Application and Evidence, Exhibit A, Tab 3, Appendix A, p. 89.
[9] EB-2015-0029, Union Application and Evidence, Exhibit A, Tab 3, Appendix A, p. 42.
[10] EB-2015-0029, Union Application and Evidence, Exhibit A, Tab 3, Appendix A, p. 42.
[11] EB-2015-0029, Union Application and Evidence, Exhibit A, Tab 3, Appendix A, p. 60.
[12] EB-2015-0363, MACC Report, pp. 30-32.

- Steam Trap Survey and Repair

As per Union's DSM Mid-Term Review Submission on Part 2 Requirement 1:[13]

"In an effort to reduce free-ridership, beginning in 2016, Union stopped providing incentives for routine maintenance projects such as steam trap repairs, steam leak repairs and combustion tune ups. Steam traps, for example, are devices used within commercial/industrial facilities to discharge condensate with minimal steam loss, and should be repaired or replaced soon after failure to prevent excessive steam loss and inefficient energy use. In an effort to reduce free-rider participation, routine maintenance projects such as steam trap repairs are no longer eligible for financial incentives within Union's Commercial/Industrial Custom offering, and savings from routine maintenance projects are not claimed towards the offering's results. To ensure customers are aware of the benefits of performing routine maintenance activities, Union continues to provide information and education about routine maintenance projects as part of the offering."

c)

i. Union used the following methodology to arrive at the residential MACC (Mid-Range LTCPF) annual savings potential for 2018-2020 of 35 million $m^3$.

1. Union first identified the province wide cost-effective savings opportunity identified in the MACC Report (Mid-Range LTCPF) for the residential sector: 97 million $m^3$.[14] It should be noted that the 144 million $m^3$ figure referenced in the IR represents the total abatement over the 2018-2020 period, whereas the 97 million $m^3$ figure represents the abatement from cost-effective measures over the 2018-2020 period using the Mid-Range LTCPF. Both figures are presented in the MACC report.[15]

2. Union then adjusted the savings opportunity identified in the MACC to align with Union's DSM savings results by applying a Net-to-Gross adjustment. The Net-to-Gross adjustment used for the residential sector was based on Union's 2015-2020 DSM Plan. Specifically, Union assumed a 95% Net-to-Gross adjustment for the residential sector (based on the Net-to-Gross adjustment for the Residential Home Reno Rebate offering).

3. Union then adjusted the savings to the represent the opportunity within Union's franchise area, as opposed to province wide. Union attributed 38% of the

[13] EB-2017-0127, Union Submission, October 2 2017, p. 6.
[14] EB-2015-0363, MACC Report, p. 41.
[15] EB-2015-0363, MACC Report, p. 41.

residential sector savings opportunity to Union's franchise area. These figures are based on the savings identified in the CPS Constrained Scenario for the 2018-2020 years in Union's territory.

The calculation is as follows:

**Residential** *= 97 million $m^3$*
*× 0.95 Net-to-Gross adjustment*
*× 38% franchise area adjustment*
= **35 million $m^3$**

ii. 2017 has not been included in this response as Union only used 2018-2020 for this analysis. The "Residential DSM Plan" figure (20 million $m^3$) in Table 3 of Union's application at Exhibit 3, Tab 4, Appendix A is the sum Union's residential 2018-2020 annual natural gas savings forecasts from its 2015-2020 DSM Plan. The figure includes Union's:

- Low-Income offerings, not including the Low-Income Multi-Family offering;[16] and,
- Residential Home Reno Rebate offering.[17]

| M3 savings | 2018 | 2019 | 2020 | Total |
|---|---|---|---|---|
| Residential (HRR) | 5,196,700 | 5,196,700 | 5,196,700 | 15,590,100 |
| Low Income (Residential) | 1,528,909 | 1,625,149 | 1,669,642 | 4,823,699 |
| **Total** | | | | **20,413,799** |

Union assumed 100% achievement of these forecasts.

d) Please see the response at Exhibit B.Staff.13 b).

[16] EB-2015-0029, Union Application and Evidence, Exhibit A, Tab 3, Appendix A, p. 89.
[17] EB-2015-0029, Union Application and Evidence, Exhibit A, Tab 3, Appendix A, p. 15.

UNION GAS LIMITED

Answer to Interrogatory from
Ontario Energy Board Staff ("Staff")

Reference: Exhibit 5, pp. 1-9

Preamble: Union Gas states that based on customer feedback, it has transitioned cap-and-trade outreach from program awareness and general education to communications focused on cap-and-trade rates as a component of customers' bills.

Union Gas proposes that its cap-and-trade rate changes will be communicated with customers in the same way as other annual rate changes, including (but not limited to): bill inserts, bill messages, website, contact centre, customer FAQ's, Enerline newsletters, customer meetings and one-on-one discussions. Union Gas states that this will involve a strong focus on available energy saving programs (DSM) and associated incentives as a means to reduce customers' energy use and therefore to mitigate the impact of cap-and-trade.

Questions:

a) Please discuss Union Gas' experience to-date related to the information that it has provided to customers. Please discuss how this information generally been received by customers and the volume of inquiries/comments submitted to Union Gas' call centre.
b) Has Union Gas received feedback from customers on its cap and trade calculator? If so, please discuss the feedback Union Gas has received.

---

Response:

a) Union continues to provide Cap-and-Trade information for customers through sources such as on-bill messages, newsletters, Union's website, Union's call centre and account representatives. The purpose of this information is to ensure customers understand the provincial Cap-and-Trade program, the impact of the program on their bills, and how they can personally manage their greenhouse gas (GHG) emissions and resulting bill impacts.

   The volume of Cap-and-Trade related calls to Union's call centre has been low, and currently averages 1-2 calls per day (compared to approximately 3,500 total daily calls received by the call centre). The following summarize general customer comments received in relation to Cap-and-Trade:

   - Would like to see Cap-and-Trade charges identified separately on the bill
   - Concern over the added cost to their bill
   - General dissatisfaction with the charge

   Contract customers continue to be supported directly by their account manager. Anecdotal feedback received by Union from these customers can be found in Union's application at Exhibit 5.

Some customers/segments have specific concerns. Greenhouse customers, for example, are concerned that the program does not recognize the carbon that is captured and being used in the greenhouse for plant growth, that large final emitters who receive allowances have a cost advantage compared to those who are billed for allowances by the utility, and that the cost of Cap-and-Trade and minimum wage increases are a direct impact to their revenue with little to no means of recovering these costs through an increase in the products produced.

b) The Cap-and-Trade calculator was launched on Union's website November 23, 2016. To date, over 35,000 calculations have been made. A monthly high of 12,500 calculations was made in December 2016, followed by just over 10,000 calculations in January 2017. Since then use of the calculator has declined but it continues to be used at an average of 250 calculations per month.

Few customers have commented on the calculator specifically; however, those that were directed to it by an agent, or who found it on their own and commented, were very pleased with the calculator.

UNION GAS LIMITED

Answer to Interrogatory from
Ontario Energy Board Staff ("Staff")

Reference: Exhibit 6, p. 3
Exhibit 6, p. 3, Table 1

Preamble: Union Gas states that it is requesting approval of the disposition of the 2016 balance in its GGEIDA. The 2016 balance in Union Gas' GGEIDA is a debit from ratepayers of $2.225 million, plus interest of $0.007 million, for a total debit from ratepayers of $2.232 million. Union Gas provided the Table 1 as a line item summary of its 2016 GGEIDA.

Table 1
Total GGEIDA Costs for the year ending December 31, 2016

| Line No. | Particulars | 2016 Cost ($000) |
|---|---|---|
| 1 | Salaries and Wages | 1,682 |
| 2 | Consulting and Market Research | 484 |
| 3 | Other | 63 |
| 4 | Revenue Requirement on Capital Costs | (4) |
| 5 | Total | **2,225** |

In Exhibit D, Tab 1, Schedule 2, p 2 of Enbridge Gas' evidence, Enbridge Gas provided the following table:

Table 1: 2016 GGEIDA

| **Cost Element** | **Actual Amount** |
|---|---|
| IT billing system – revenue requirement | $ (99,500) |
| Staff Resources | $533,321 |
| Market Intelligence, and Consulting Support | $268,199 |
| Customer Outreach and Information | $44,783 |
| External Legal Counsel (Compliance Readiness and C&T Regulatory Proceeding Preparations) | $93,533 |
| **Total (exclusive of interest)** | **$840,336** |

Questions:

a) Please provide an explanation as to why Union Gas believes $1,682,000 is a reasonable amount for salaries and wages given that Enbridge Gas spent $533,321 in 2016.

b) Please provide an explanation as to why Union Gas believes $484,000 is a reasonable amount for consulting and market research given that Enbridge Gas spent $268,199 for consulting support and market intelligence in 2016.

Response:

a) Please see the response at Exhibit B.SEC.15 for a detailed comparison of the variances between Union and EGD.

b) Of the total variance of $215,800 in consulting support and market intelligence costs, $185,000 is due to a difference in how Union and EGD categorize external legal counsel fees and customer education and outreach costs. Union has included these costs in consulting,[1] where EGD reflects this as separate line items.

Additionally, in 2016 Union incurred incremental consulting costs of $35,000 directly attributed to the development of new reporting tools to facilitate reporting and forecasting of GHG emissions, critical review of calculation methodologies, and assistance with submissions, in response to the Greenhouse Gas Reporting Guideline.[2]

[11] Due to materiality, customer education and outreach costs were reflected in Union's "Other" line item in its 2017 and 2018 forecasts.
[2] Guideline for Quantification, Reporting And Verification Of Greenhouse Gas Emissions -2017, https://www.ontario.ca/page/report-greenhouse-gas-ghg-emissions

UNION GAS LIMITED

Answer to Interrogatory from
Ontario Energy Board Staff ("Staff")

Reference: Exhibit 7, Tab 2, p. 2
Exhibit 6, p. 3
Exhibit 6, p. 3, Table 1

Preamble: Union Gas proposes to dispose of the 2016 GGEIDA balance of $2.232 million related to administration costs and allocate the GGEIDA balance to rate classes in proportion to the 2013 OEB-approved Administrative and General O&M Expense per Exhibit G3, Tab 2, Schedule 2, updated for the EB-2011-0210 OEB Decision.
Union Gas also proposes to dispose of the approved 2016 GGEIDA balance with the disposition of the 2017 non-commodity deferral account balances. Union Gas anticipates its disposition of the 2017 non-commodity deferral accounts to be effective October 1, 2018 following OEB approval in that proceeding.

For General Service Rate M1, Rate M2, Rate 01 and Rate 10 customers, Union Gas proposes to dispose of the 2016 cap-and-trade deferral account balances prospectively, over the October 1, 2018 to March 31, 2019 time period. For in-franchise and ex-franchise rate classes, Union proposes to dispose of the 2016 cap-and-trade deferral account balances as a one-time adjustment with October 2018 bills customers receive in November 2018.
In Table 1, Union Gas provided the following administration cost line items for 2016.

Table 1
Total GGEIDA Costs for the year ending December 31, 2016

| Line No. | Particulars | 2016 Cost ($000) |
|---|---|---|
| 1 | Salaries and Wages | 1,682 |
| 2 | Consulting and Market Research | 484 |
| 3 | Other | 63 |
| 4 | Revenue Requirement on Capital Costs | (4) |
| 5 | Total | **2,225** |

Questions:
a) Please provide the proposed allocation factors by rate class for each of the cost line items outlined in Table 1 (above) and the amounts allocated by rate class.
b) Please provide an indication of the average monthly amount for general service customers associated with 2016 GGEIDA costs in Table 1.

Response:

a) Union is proposing to allocate all components of the 2016 GGEIDA balance to rate classes in proportion to the 2013 OEB-approved Administration and General O&M Expenses. Please see Attachment 1 for the proposed allocation by rate class for each component presented in Union's application at Exhibit 6, p. 6, Table 1, including deferral interest.

b) Union has provided the general service bill impacts of the proposed prospective recovery of the 2016 GGEIDA balance in its application at Exhibit 7, Tab 2, Schedule 3. Please see Table 1 for an estimated simple monthly average of 2016 GGEIDA bill impacts for general service customers.

Table 1
Estimated 2016 GGEIDA Average Monthly Bill Impacts for General Service Customers

| Line No. | Particulars ($) | Total Bill Impact (1) (a) | Average Monthly Bill Impact (b) = (a / 12) |
|---|---|---|---|
| | Union South | | |
| 1 | Rate M1 | 0.83 | 0.07 |
| 2 | Rate M2 | 6.75 | 0.56 |
| | Union North | | |
| 3 | Rate 01 | 1.02 | 0.09 |
| 4 | Rate 10 | 10.38 | 0.87 |

Notes:
(1) Exhibit 7, Tab 2, Schedule 3, Column (c).

UNION GAS LIMITED
Allocation of 2016 GGEIDA by Cost Item

| Line No. | Particulars ($000's) | Proposed Allocator Total 2013 A&G ($000's) (1) | 2016 GGEIDA Costs Salaries and Wages ($000's) (2) | Consulting and Market Research ($000's) (2) | Other ($000's) (2) | Revenue Requirement on Capital Costs ($000's) (2) | Interest ($000's) (2) | Total ($000's) |
|---|---|---|---|---|---|---|---|---|
| | | (a) | (b) | (c) | (d) | (e) | (f) | (g) = (b+c+d+e+f) |
| | Union South In-Franchise | | | | | | | |
| 1 | Rate M1 | 80,159 | 850 | 245 | 32 | (2) | 4 | 1,128 |
| 2 | Rate M2 | 7,513 | 80 | 23 | 3 | (0) | 0 | 106 |
| 3 | Rate M4 | 2,801 | 30 | 9 | 1 | (0) | 0 | 39 |
| 4 | Rate M5 | 3,131 | 33 | 10 | 1 | (0) | 0 | 44 |
| 5 | Rate M7 | 787 | 8 | 2 | 0 | (0) | 0 | 11 |
| 6 | Rate M9 | 108 | 1 | 0 | 0 | (0) | 0 | 2 |
| 7 | Rate M10 | 25 | 0 | 0 | 0 | (0) | 0 | 0 |
| 8 | Rate T1 | 2,036 | 22 | 6 | 1 | (0) | 0 | 29 |
| 9 | Rate T2 | 5,624 | 60 | 17 | 2 | (0) | 0 | 79 |
| 10 | Rate T3 | 627 | 7 | 2 | 0 | (0) | 0 | 9 |
| 11 | Total South In-Franchise | 102,812 | 1,090 | 314 | 41 | (3) | 5 | 1,446 |
| | Union North In-Franchise | | | | | | | |
| 12 | Rate 01 | 31,817 | 337 | 97 | 13 | (1) | 1 | 448 |
| 13 | Rate 10 | 2,759 | 29 | 8 | 1 | (0) | 0 | 39 |
| 14 | Rate 20 | 2,373 | 25 | 7 | 1 | (0) | 0 | 33 |
| 15 | Rate 25 | 953 | 10 | 3 | 0 | (0) | 0 | 13 |
| 16 | Rate 100 | 2,089 | 22 | 6 | 1 | (0) | 0 | 29 |
| 17 | Total North In-Franchise | 39,992 | 424 | 122 | 16 | (1) | 2 | 563 |
| | Ex-Franchise | | | | | | | |
| 18 | Rate M12 | 14,918 | 158 | 46 | 6 | (0) | 1 | 210 |
| 19 | Rate M13 | 0 | 0 | 0 | 0 | (0) | 0 | 0 |
| 20 | Rate M16 | 21 | 0 | 0 | 0 | (0) | 0 | 0 |
| 21 | Rate C1 | 323 | 3 | 1 | 0 | (0) | 0 | 5 |
| 22 | Excess Utility Storage Space | 597 | 6 | 2 | 0 | (0) | 0 | 8 |
| 23 | Total Ex-Franchise | 15,859 | 168 | 48 | 6 | (0) | 1 | 223 |
| 24 | Total In-Franchise & Ex-Franchise | 158,663 | 1,682 (3) | 484 (3) | 63 (3) | (4) (3) | 7 | 2,232 (4) |

Notes:
(1) 2013 OEB-approved Administrative and General O&M Expense per Exhibit G3, Tab 2, Schedule 2, updated for the EB-2011-0210 OEB Decision.
(2) Allocation in proportion to column (a).
(3) Exhibit 6, p. 6, Table 1
(4) Exhibit 6, Schedule 1, column (a), line 1.

UNION GAS LIMITED

Answer to Interrogatory from
Ontario Energy Board Staff ("Staff")

Preamble: In Enbridge Gas' Exhibit G, Tab 1, Schedule 1, p. 3, Enbridge Gas provides the following information:

> "12. As set out in Appendix A, Table A1, which is included at Exhibit G, Tab 1, Schedule 1, Enbridge's forecast customer-related obligation costs in 2018 total $377,052,654 (19,855,327t$CO_2e$ * $18.99 CAD/t $CO_2e$).
> 13. As set out in Appendix A, Table A2, which is included at Exhibit G, Tab 1, Schedule 1, Enbridge's forecast facility-related obligation costs in 2018 total $4,604,398 (242,464t$CO_2e$ * $18.99/t $CO_2e$)."

Enbridge Gas then provides the following Tables in Appendix A:

**TABLE A1**

TABLE 1: 2018 CUSTOMER-RELATED VOLUMES, EMISSIONS, COST OF EMISSIONS AND UNIT RATE

| | | Col. 1 | Col. 2 | Col. 3 | Col. 4 | Col. 5 | Col. 6 | Col. 7 |
|---|---|---|---|---|---|---|---|---|
| Line | Rate | Budget Forecast Volumes[1] | LFE, Customer Abatement, Capped Participants and Other Exempt Gas Volumes[2] | Net Volumes[3] | Net $CO_2e$ Emissions[4] | Assumed Cost of Allowances[5] | Cost of $CO_2e$ Emissions[6] | Unit Rate[7] |
| | | ($10^3m^3$) | ($10^3m^3$) | ($10^3m^3$) | (Tonnes $CO_2e$) | ($/tonne $CO_2e$) | ($) | (¢/$m^3$) |
| 1.1 | 1 | 4,760,546.5 | 5,922.6 | 4,754,623.9 | 8,913,146.3 | 18.99 | 169,260,649.0 | |
| 1.2 | 6 | 4,829,792.7 | 156,649.9 | 4,673,142.8 | 8,760,399.7 | 18.99 | 166,359,989.7 | |
| 1.3 | 9 | 0.0 | 0.0 | 0.0 | 0.0 | 18.99 | 0.0 | |
| 1.4 | 100 | 0.0 | 0.0 | 0.0 | 0.0 | 18.99 | 0.0 | |
| 1.5 | 110 | 789,035.8 | 367,138.0 | 421,897.8 | 790,901.0 | 18.99 | 15,019,210.1 | |
| 1.6 | 115 | 542,831.4 | 410,350.3 | 132,481.1 | 248,352.6 | 18.99 | 4,716,216.8 | |
| 1.7a | 125 | 319,562.5 | 0.0 | 319,562.5 | 599,060.5 | 18.99 | 11,376,158.7 | |
| 1.7b | 125D[8] | 124,896.5 | 0.0 | 124,896.5 | 234,134.4 | 18.99 | 4,446,211.3 | |
| 1.8 | 135 | 64,501.3 | 0.0 | 64,501.3 | 120,915.9 | 18.99 | 2,296,192.5 | |
| 1.9 | 145 | 50,136.2 | 3,670.7 | 46,465.5 | 87,105.5 | 18.99 | 1,654,133.1 | |
| 1.10 | 170 | 291,152.3 | 237,627.7 | 53,524.6 | 100,338.7 | 18.99 | 1,905,431.2 | |
| 1.11 | 200 | 169,764.4 | 169,764.4 | 0.0 | 0.0 | 18.99 | 0.0 | |
| 1.12 | 300 | 518.6 | 0.0 | 518.6 | 972.2 | 18.99 | 18,461.7 | |
| 1 | Total Customer-Related | 11,942,738.2 | 1,351,123.6 | 10,591,614.6 | 19,855,326.7 | 18.99 | 377,052,654.1 | 3.5599 |

Notes:
(1) Exhibit B, Tab 2, Schedule 1, Table 1, Col. 1 - Col. 2
(2) Exhibit B, Tab 2, Schedule 1, Table 1, Col. 3 + Col. 5 + Col. 6
(3) Col. 1 - Col. 2
(4) Exhibit B, Tab 3, Schedule 1, Table 1, Col. 5
(5) The carbon proxy price for rate setting purposes was based on the California Carbon Allowance ICE 21 day strip price for delivery from September 1 through to September 29, 2017.
(6) Col. 4 x Col. 5
(7) (Col. 6 / (Col. 3 x 1000)) x 100
(8) Dedicated unbundled customers

**Customer-Related Unit Rate Calculation**

Cap and Trade Customer Related Charge = Cost of $CO_2e$ Emissions / Net Volumes
= $ 377,052,654.1 / 10,591,614.6 $10^3m^3$
= 3.5599 ¢/$m^3$

**TABLE A2**

TABLE 2: 2018 FACILITY-RELATED VOLUMES, EMISSIONS, COST OF EMISSIONS AND UNIT RATES

| Line | | Col. 1 Volumes[1] ($10^3m^3$) | Col. 2 $CO_2e$ Emissions[2] (Tonnes $CO_2e$) | Col. 3 Assumed Cost of Allowances[3] ($/tonne $CO_2e$) | Col. 4 Cost of $CO_2e$ Emissions[4] ($) | Col. 5 Unit Rate (¢/$m^3$) | |
|---|---|---|---|---|---|---|---|
| 2.1 | Company Use | | | | | | |
| 2.1.1 | Fleet | 1,147.2 | 2,150.6 | 18.99 | 40,839.4 | | |
| 2.1.2 | Buildings | 1,388.8 | 2,603.5 | 18.99 | 49,440.1 | | |
| 2.1.3 | Boilers | 4,078.8 | 7,909.9 | 18.99 | 150,209.5 | | |
| 2.1 | Company Use | 6,614.8 | 12,664.0 | 18.99 | 240,489.0 | 0.0016 | 5 |
| 2.2 | Unaccounted For Gas (UAF) | 106,077.0 | 198,854.8 | 18.99 | 3,776,252.8 | 0.0320 | 6 |
| 2.3 | Compressor Fuel | 15,957.3 | 30,945.5 | 18.99 | 587,655.9 | 0.0050 | 7 |
| 2 | Total Facility-Related | 128,649.1 | 242,464.3 | 18.99 | 4,604,397.7 | 0.0386 | |

Notes:
(1) Exhibit B, Tab 2, Schedule 1, Table 2
(2) Exhibit B, Tab 3, Schedule 1, Table 3, Col. 5
(3) The carbon proxy price for rate setting purposes was based on the California Carbon Allowance ICE 21 day strip price for delivery in each month of 2018.
(4) Col. 2 x Col. 3
(5) Cost of $CO_2e$ emissions / (Total customer-related volume + Rate 332 Volume) = [Col. 4 / ((Exhibit A1, Table 1, Line 1, Col. 1 + 2,850,078 $10^3$ $m^3$) x 1000)] x 100
(6) Cost of $CO_2e$ emissions / (Total customer-related volume - Rate 125D customers - landfill gas volume) = [Col. 4 / ((Exhibit A1, Table 1, Line 1, Col. 1 - Line 1.7b, Col. 1 - Line 1.12, Col. 2) x 1000)] x 100
(7) Cost of $CO_2e$ emissions / (Total customer-related volume excluding unbundled customers (Rates 125 and 300) + Rate 325 Volume) = [Col. 4 / ((Exhibit A1, Table 1, Line 1, Col. 1 - Line 1.7a, Col. 1 - - Line 1.7b, Col. 1 - Line 1.12, Col. 1 + 190,328 $10^3$ $m^3$)) x 1000] x 100

**Facility-Related Unit Rate Calculations**

Company Use = Cost of $CO_2e$ Emissions for Company Use / (Total Customer-Related Volume + Rate 332 Volume)
= $ 240,489.0 / (11,942,738.2 + 2,850,078) $10^3m^3$
= 0.0016 ¢/$m^3$

Unaccounted For Gas Volumes = Cost of $CO_2e$ Emissions for Unaccounted For Gas / (Total Customer-Related Volume Excluding Rate 125D and Landfill Gas)
= $ 3,776,252.8 / (11,942,738.2 - 124,896.5 - 0) $10^3m^3$
= 0.0320 ¢/$m^3$

Compressor Fuel Volumes = Cost of $CO_2e$ Emissions for Compressor Fuel / (Total Customer-Related Volume Excluding Unbundled Customers + Rate 325 Volume)
= $ 587,655.9 / (11,942,738.2 - 319,562.5 - 124,896.5 - 518.6 + 190,328.0) $10^3m^3$
= 0.0050 ¢/$m^3$

Facility-Related Charge = 0.0016 + 0.0320 + 0.0050 ¢/$m^3$
= 0.0386 ¢/$m^3$

App
Page

Questions:

a) Similar to the evidence filed by Enbridge Gas (above) in Exhibit G, Tab 1, Schedule 1, p. 3, please provide the following, including calculations:
   i. Union Gas' total forecast customer-related obligation cost for 2018.
   ii. Union Gas' total forecast facility-related obligation cost for 2018.

b) Please provide tables for Union Gas that contain the information in Table A1 and A2 from Enbridge Gas' Exhibit G, Tab 1, Schedule 1, App. A, Table A1 and A1.
   i. Similar to the evidence filed by Enbridge Gas in the tables above, please provide the customer-related and facility-related unit rate calculations with each table.

---

Response:

a) The calculation of the 2018 customer-related and facility-related obligation costs are provided in Union's application at Exhibit 7, Tab 1, Schedule 1, Line 7, Columns (a) and (f), respectively.

   i. Union's forecast customer-related obligation costs for 2018 are $274.210 million (14,439,690 $tCO_2e$ x $18.99 CAD/$tCO_2e$).

ii. Union's forecast facility-related obligation costs for 2018 are $8.584 million (452,022 $tCO_2e$ x $18.99 CAD/$tCO_2e$).

b) Please see Attachment 1.

UNION GAS LIMITED
2018 Customer-Related Volumes, Emissions, Cost of Emissions and Unit Rate

| Line No. | Rate Class | Budget Forecast Volumes ($10^3m^3$) | Exempt Volumes (2) ($10^3m^3$) | Net Volumes (4) ($10^3m^3$) | Net $CO_2e$ Emissions (5) ($tCO_2e$) | Assumed Cost of Allowances (6) ($/$tCO_2e$) | Cost of $CO_2e$ Emissions ($) | Unit Rate (8) (cents/$m^3$) |
|---|---|---|---|---|---|---|---|---|
| | | (a) | (b) | (c) = (a - b) | (d) | (e) | (f) = (d x e) | (g) = (f/c/10) |
| | Union North | | | | | | | |
| 1 | Rate 01 | 957,267 | 29 | 957,238 | 1,794,465 | 18.99 | 34,076,890 | |
| 2 | Rate 10 | 360,125 | 1,559 | 358,566 | 672,177 | 18.99 | 12,764,634 | |
| 3 | Rate 20 | 723,234 | 345,282 | 377,952 | 708,519 | 18.99 | 13,454,782 | |
| 4 | Rate 25 | 70,079 | 51,162 | 18,917 | 35,463 | 18.99 | 673,440 | |
| 5 | Rate 100 | 976,171 | 704,896 | 271,275 | 508,540 | 18.99 | 9,657,177 | |
| | Union South | | | | | | | |
| 6 | Rate M1 | 2,941,675 | 1,524 | 2,940,151 | 5,511,686 | 18.99 | 104,666,922 | |
| 7 | Rate M2 | 1,199,552 | 34,955 | 1,164,597 | 2,183,185 | 18.99 | 41,458,685 | |
| 8 | Rate M4 | 656,436 | 115,074 | 541,362 | 1,014,852 | 18.99 | 19,272,036 | |
| 9 | Rate M5 | 80,780 | 13,047 | 67,733 | 126,973 | 18.99 | 2,411,225 | |
| 10 | Rate M7 | 483,679 | 445,113 | 38,566 | 72,297 | 18.99 | 1,372,917 | |
| 11 | Rate M9 | 81,243 | 81,243 | - | - | 18.99 | - | |
| 12 | Rate M10 | 277 | 277 | - | - | 18.99 | - | |
| 13 | Rate T1 | 452,041 | 420,222 | 31,819 | 59,649 | 18.99 | 1,132,730 | |
| 14 | Rate T2 | 3,938,686 | 3,004,162 | 934,524 | 1,751,884 | 18.99 | 33,268,276 | |
| 15 | Rate T3 | 278,023 | 278,023 | - | - | 18.99 | - | |
| 16 | Total Customer-Related | 13,199,270 (1) | 5,496,569 (3) | 7,702,700 | 14,439,690 | 18.99 | 274,209,714 (7) | 3.5599 |

Notes:
(1) Exhibit 2, Schedule 1, p. 1, column (c), line 4 / 1000.
(2) Includes large final emitter, voluntary participant, and wholesale customer volumes.
(3) Exhibit 2, Schedule 1, p. 1, column (c), line 5 + line 6 / 1000.
(4) Exhibit 2, Schedule 1, p. 2 / 1000.
(5) Exhibit 2, Schedule 1, p. 2.
(6) Exhibit 2, Schedule 2, line 3.
(7) Exhibit 7, Tab 1, Schedule 1, p. 1, column (a), line 7 * 1000.
(8) Exhibit 7, Tab 1, Schedule 1, p. 1, column (a), line 10.

**Customer-Related Unit Rate Calculation**

Cap-and-Trade Customer-Related Charge = Cost of $CO_2e$ Emissions / Net Volumes
= \$274,209,714 / 7,702,700 $10^3m^3$
= 3.5599 cents/$m^3$

UNION GAS LIMITED
2018 Facility-Related Volumes, Emissions, Cost of Emissions and Unit Rates

| Line No. | Description | Volumes (1) ($10^3m^3$) | $CO_2e$ Emissions ($tCO_2e$) | | Assumed Cost of Allowances (3) ($/$tCO_2e$) | Cost of $CO_2e$ Emissions ($) | | Unit Rate (5) (cents/$m^3$) |
|---|---|---|---|---|---|---|---|---|
| | | (a) | (b) | | (c) | (d) = (b x c) | | (e) |
| 1 | Unaccounted for Gas (UFG) | 70,890 | 132,892 | | 18.99 | 2,523,617 | | 0.0064 |
| 2 | Blowdowns | 4,623 | 8,667 | | 18.99 | 164,579 | | 0.0004 |
| 3 | Compressor Fuel | 145,404 | 285,868 | | 18.99 | 5,428,634 | | 0.0138 |
| 4 | Own Use Gas Buildings & Line Heaters | 12,510 | 24,595 | | 18.99 | 467,068 | | 0.0012 |
| 5 | Total Facility-Related | 233,427 | 452,022 | (2) | 18.99 | 8,583,899 | (4) | 0.0219 |

Notes:
(1) Exhibit 2, Schedule 1, p. 1, lines 8-12 / 1000.
(2) Exhibit 2, Schedule 1, p. 1, line 22.
(3) Exhibit 2, Schedule 2, line 3.
(4) Exhibit 7, Tab 1, Schedule 1, p. 1, column (f), line 7 * 1000.
(5) Unit Rate = Cost of $CO_2e$ Emissions / 2018 Forecast Delivery and Transportation Volumes of 39,242,095 $10^3m^3$

**Facility-Related Unit Rate Calculations**

Unaccounted for Gas (UFG) = Cost of $CO_2e$ Emissions / 2018 Forecast Delivery and Transportation Volumes
= \$2,523,617 / 39,242,095 $10^3m^3$
= 0.0064 cents/$m^3$

Blowdowns = Cost of $CO_2e$ Emissions / 2018 Forecast Delivery and Transportation Volumes
= \$164,579 / 39,242,095 $10^3m^3$
= 0.0004 cents/$m^3$

Compressor Fuel = Cost of $CO_2e$ Emissions / 2018 Forecast Delivery and Transportation Volumes
= \$5,428,634 / 39,242,095 $10^3m^3$
= 0.0138 cents/$m^3$

Own Use Gas Buildings & Line Heaters = Cost of $CO_2e$ Emissions / 2018 Forecast Delivery and Transportation Volumes
= \$467,068 / 39,242,095 $10^3m^3$
= 0.0012 cents/$m^3$

Cap-and-Trade Facility-Related Charge = 0.0064 + 0.0004 + 0.0138 + 0.0012 cents/$m^3$
= 0.0219 cents/$m^3$

UNION GAS LIMITED

Answer to Interrogatory from
Ontario Energy Board Staff ("Staff")

Preamble: In its application, in Exhibit G, Tab 1, Schedule 1, Appendix A, p. 4, Table A4, Enbridge Gas provided a table of 2018 cap and trade unit rate summary by rate class.

Questions:

a) As in the Enbridge Gas Exhibit described above, please provide a table that identifies 2018 Cap and Trade Unit Rate Summary by Rate Class, as follows:

| Rate Class | Non-LFE (cents/$m^3$) | LFE* (cents/$m^3$) |
|---|---|---|
| | | |
| | | |

* Includes Voluntary Participants and Other Exempt Gas Volumes

---

Response:

a) Please see Table 1 below.

Table 1
2018 Cap-and-Trade Unit Rate Summary by Rate Class

| Line No. | Rate Class | Non-Large Final Emitter | Large Final Emitter (1) |
|---|---|---|---|
| | Union South In-Franchise (cents/$m^3$) | | |
| 1 | Rate M1 | 3.5818 | 0.0219 |
| 2 | Rate M2 | 3.5818 | 0.0219 |
| 3 | Rate M4 | 3.5818 | 0.0219 |
| 4 | Rate M5 | 3.5818 | 0.0219 |
| 5 | Rate M7 | 3.5818 | 0.0219 |
| 6 | Rate M9 | N/A | 0.0219 |
| 7 | Rate M10 | N/A | 0.0219 |
| 8 | Rate T1 | 3.5818 | 0.0219 |
| 9 | Rate T2 | 3.5818 | 0.0219 |
| 10 | Rate T3 | N/A | 0.0219 |
| | Union North In-Franchise (cents/$m^3$) | | |
| 11 | Rate R01 | 3.5818 | 0.0219 |
| 12 | Rate R10 | 3.5818 | 0.0219 |
| 13 | Rate R20 | 3.5818 | 0.0219 |
| 14 | Rate R25 | 3.5818 | 0.0219 |
| 15 | Rate R100 | 3.5818 | 0.0219 |
| | Ex-Franchise ($/GJ) (2) | | |
| 16 | Rate M12 | N/A | 0.006 |
| 17 | Rate M13 | N/A | 0.006 |
| 18 | Rate M16 | N/A | 0.006 |
| 19 | Rate C1 | N/A | 0.006 |

Notes:
(1) Includes voluntary participants, other exempt gas volumes and ex-franchise customers.
(2) Ex-franchise unit rates converted to GJs based on 38.95 GJ/$10^3m^3$.

UNION GAS LIMITED

Answer to Interrogatory from
Ontario Energy Board Staff ("Staff")

Reference: Exhibit 1, p.10

Preamble: Union Gas states that it requested interim approval of their proposed 2018 cap and trade charges and interim approval was denied by the OEB. Therefore, the final 2017 OEB-approved cap and trade charges have been continued until such time as the OEB completes its review and the OEB makes a determination of the approved 2018 cap and trade charges.

Questions:

a) How does Union Gas propose to recover the difference between the final 2018 cap and trade charges and the amount Union Gas has recovered since January 1, 2018?

---

Response:

a) Union will record the impact of any differences between the interim rates and the final approved rates for the period of January 1, 2018 to the implementation date of the final rate order in the established Greenhouse Gas Emissions Compliance Obligation – Customer-Related and Greenhouse Gas Emissions Compliance Obligation – Facility-Related deferral accounts, as applicable. This approach to the difference between interim approvals and final approvals is consistent with the 2017 Cap-and-Trade Compliance Plan Decision.[1]

   Union proposes to implement final approved rates as part of the QRAM application that follows the OEB Decision and final rate order in this proceeding.

   Union will propose a disposition methodology for the 2018 deferral account balances at the time the deferral balances are proposed for disposition. Union's current practice is to dispose of non-commodity deferral account balances prospectively over a six month period for general service customers and as a one-time adjustment for contract rate customers.

[1] EB-2016-0296, Decision and Order, p. 41

UNION GAS LIMITED

Answer to Interrogatory from
Association of Power Producers of Ontario ("APPrO")

Reference: Exhibit 3, Tab 2, Section 2.3

Preamble: Union Gas Limited ("Union") is seeking an exemption to the holding limit from the Ministry of the Environment and Climate Change ("MOECC").

Question:

a) Has Union received a decision from the MOECC on its application for the exemption to the holding limit? If so, please indicate the outcome of the application.
b) Please describe financial or other consequences to customers of receiving or not receiving the exemption.

---

Response:

a) Please see the response at Exhibit B.Staff.16 a).

b) As described in Union's application, "Until 2019, Union's holding limit would be calculated on GHG reporting which does not yet reflect the addition of the customer emissions effective January 1, 2017. The exemption corrects for this timing lag, and is required in both 2017 and 2018."[1] Had the exemption not been granted, Union's holding limit would be too low to appropriately reflect Union's compliance obligation in 2018. This would impact Union's ability to execute its compliance instrument procurement strategy.

[1] Exhibit 3, Tab 2, p. 11.

UNION GAS LIMITED

Answer to Interrogatory from
Association of Power Producers of Ontario ("APPrO")

Reference: Exhibit 3, Tab 4

Preamble: Union is seeking approval for up to a $2 million amount that would be used to develop new technologies to reduce future emissions. The actual amounts spent would be recorded in the GGEIDA. APPrO would like to understand the nature of these technologies and who would be expected to pay for such technologies.

Question:

a) Has Union sought funding for these amounts from the provincial government in a similar fashion that the Renewable Natural Gas ("**RNG**") funds are being sought?
b) Please provide the current technologies that Union expects to investigate during 2018 if the fund were to be approved.
c) Please indicate the target customer groups for these technologies.
d) Please indicate how each of these technologies could be used by large gas-fired generators.
e) Please explain if the development of any of these technologies could be funded under Union's DSM budget.
f) Please indicate how these amounts in the GGEIDA would be cleared to each rate class.
g) Enbridge is also looking for money for a similar fund. In light of the merger between the two parent companies in 2017, and the movement towards a single distribution company (EB-2017-0306), if the Enbridge fund is approved, please explain why Union requires a separate fund of its own. Please also explain why it would be more efficient to identify potential opportunities, investigate such opportunities on a rational basis and administer two separate funds rather than a single fund.

---

Response:

a) With respect to Low Carbon Initiative Fund ("LCIF") activities, Union has not sought any funding from the provincial government. Please see the responses at Exhibit B.Staff.17 a) and at Exhibit B.Staff.19 for additional detail.

b) In 2018, contingent on receiving OEB approval for the LCIF, Union plans to investigate the following technologies:

Residential Carbon Capture – Equipment installed in homes that captures carbon from combustion equipment exhaust (e.g. furnaces, hot water tanks).

Building Skins – Workshop and RFP process to identify potential solutions for exterior building insulation and building skin retrofits.

Integrated ASHP/NG Solution – Metering existing projects to identify an optimal heating temperature switch point between ASHP and NG furnace to maximize efficiency, minimize costs, and minimize GHG emissions.

Micro Generation – Demonstrate the potential of a micro-generation residential system that provides natural gas heating, hot water and electricity, and back-up power for increased resiliency and reduced GHG emissions and energy costs.

c) The following is a list of the target markets for each of the technologies:
- Residential Carbon Capture - Residential and Small Industrial/Commercial
- Building Skins - Low-Income Residential
- Integrated ASHP/NG Solution - Residential
- Group Source Heat Pump - Residential
- Net Zero Energy and Net Zero Energy Ready Homes - Residential
- Micro Generation - Residential and Small Commercial

d) At this point, the only technology that could be used by an operator of a large gas-fired generator would be the commercial version of the carbon capture and utilization technology identified in the Stage 1 of the Initiative Funnel. This technology could be connected to carbon emitting equipment (for example a boiler) in a building of the operator in order to reduce the GHG emissions of the equipment.

e) Union's limited DSM research budget funds research into customer natural gas conservation measures that are commercially-available and could be included in a potential DSM program in the near-term. In addition, DSM is focused on energy efficiency measures, while the LCIF is broader in its scope (for example, considering measures to green the fuel supply and facilities abatement). As Union's proposed LCIF will fund research for customer and facilities carbon abatement measures that are in the early stages of development, a portion of the funding required to advance energy efficiency measures in later stages of development (i.e. progressing to commercialization/program design) could be provided by Union's DSM research budget.

f) Union has proposed to allocate the 2016 GGEIDA balance to rate classes in proportion to the 2013 OEB-approved Administrative and General O&M Expenses which is consistent with the allocation of existing administrative costs in accordance with the direction in the Framework. Union will propose an allocation methodology for the 2018 GGEIDA balance (including the LCIF) at the time the deferral balance is proposed for disposition.

g) Union supports a combined LCIF fund with a total amount of $4 million. This level of spending is reasonable given the number of customers served by both Union and EGD and the broad range of customer characteristics between the two utilities. For example**,** EGD has more residential customers while Union has a greater proportion of commercial and

industrial customers. In addition, there is geographic diversity across the two franchise areas, which can impact the application of some technologies.

UNION GAS LIMITED

Answer to Interrogatory from
Association of Power Producers of Ontario ("APPrO")

Reference: Exhibit 3, Tab 4

Preamble: Union is investigating the potential to use surplus electricity to produce hydrogen for storage and subsequent injection into its natural gas system. APPrO would like to understand the implications of injecting hydrogen into the natural gas system.

Question:
a) Please describe the status of this potential project.
b) Please indicate if Union has developed a maximum hydrogen content for its natural gas supply. If so, please specify the maximum percentage.
c) Please indicate if Union has had consultations with large volume customers, including gas-fired generators, on the potential changes to the natural gas composition.
d) Hydrogen has been known to migrate through steel and impact the integrity of steel pipelines. Has, or will Union investigate the risks of injecting hydrogen into pipelines to ensure that there are no unintended consequences from this initiative. If Union has completed a study, please provide a copy of the study.

---

Response:
a) Union is currently building further understanding of Power to Gas technologies and their potential application in Ontario, as well as understanding the long-term role that Power to Gas may play in providing services to the electric grid. Union will be evaluating and comparing the benefits and risks of the introduction of hydrogen into the natural gas pipeline system, to the benefits and risks of the introduction of synthetic natural gas derived from hydrogen. A variety of potential Power to Gas demonstration project concepts and opportunities will be investigated in 2018 including through Union's LCIF.

b) Union has developed maximum hydrogen content for natural gas supply of 4%, where the integrity of natural gas and end-user systems is not compromised.

c) Union has not yet engaged with customers on the potential changes to natural gas composition which may arise from the introduction of hydrogen or synthetic natural gas derived from hydrogen into the natural gas pipeline system.

   It is anticipated that Union's customer considerations will be identified through the joint AGA/CGA North American Hydrogen/Power to Gas Task group. Once customer considerations have been identified, Union will evaluate the feasibility of introducing hydrogen or synthetic natural gas derived from hydrogen into the natural gas system.

The integrity of the natural gas system and of its customers' facilities and processes are of upmost importance to Union. The primary deciding factor to the introduction of hydrogen or synthetic natural gas derived from hydrogen is the integrity of the natural gas system and of Union's customers' facilities and processes.

d) Union is currently a participant in the joint AGA/CGA North American Hydrogen/Power to Gas Task group. The purpose of this task group is to identify potential consequences of introducing hydrogen into the natural gas pipeline system. Union has not completed studies, nor has the Task group issued its findings.

Prior to contemplating the introduction of hydrogen into the natural gas system, site specific assessments of potential risks and consequences to both the natural gas system and customers' facilities would be undertaken. Engagement with customers is essential during this process.

UNION GAS LIMITED

Answer to Interrogatory from
Association of Power Producers of Ontario ("APPrO")

Reference: i) EB-2017-0224 Exhibit C Tab 5
ii) Exhibit 3, Tab 5

Preamble: Enbridge and Union each are proposing to use significant consulting resources to augment their internal expertise. In light of the common ownership of the two companies and the merger application that is underway, APPrO would like to understand if there are synergies in the consulting budgets between the two companies that could reduce the burden on ratepayers.

Question: In reference i) Enbridge notes that it has a $400,000 consulting budget for "support and Market Intelligence". Similarly, Union has proposed $670,000 for a variety of consulting work. Table 3 in reference i) outlines the specific consulting work that is proposed by Enbridge and there is a high degree of correlation with the consulting work proposed by Union in Table 2, reference ii). Please indicate why this consulting work between Enbridge and Union cannot be coordinated to reduce the ratepayer burden?

---

Response:

Please see the response at Exhibit B.Staff.11 c).

UNION GAS LIMITED

Answer to Interrogatory from
Association of Power Producers of Ontario ("APPrO")

Reference: Exhibit 3, Tab 4

Preamble: Union is currently evaluating automatic meter reading as a means to collect more granular usage data.

Question:

a) Is this program intended to be used on a targeted basis along with other technologies or implemented at all locations?
b) If such meters are installed on a wide scale basis, is Union considering time of use rates?
c) Please confirm that large volume accounts currently employ automated meter reading equipment.

---

Response:

a) Automatic Meter Reading is still under evaluation within Stage 1 "Conceptual" of the Initiative Funnel. The details of its implementation have not yet been determined. Please see the response at Exhibit B.Staff.21 b).

b) Please see the response to part a) above.

c) Confirmed. Certain large volume accounts currently employee automatic meter reading equipment.

UNION GAS LIMITED

Answer to Interrogatory from
Association of Power Producers of Ontario ("APPrO")

Reference: i) Exhibit 3, Tab 5
ii) Exhibit 3, Tab 5, Schedule 2

Preamble: Union is forecasting a $6 million balance for the GGEIDA for 2018, made up of $2 million of the Low Carbon Initiative Fund (LCIF) and $4 million for other administrative costs. In light of the common ownership of Union and Enbridge, APPrO would like to understand what synergies have been reflected in this proposed GGEIDA budget.

Question:

a) Please confirm that Union is coordinating Cap and Trade initiatives with Enbridge.
b) For the 'Salaries and Wages' and 'Consulting' cost categories, please explain why greater coordination with Enbridge is not possible in 2018 to reduce administration costs.

---

Response:

a) & b)

Please see the response at Exhibit B.Staff.14 a).

UNION GAS LIMITED

Answer to Interrogatory from
Association of Power Producers of Ontario ("APPrO")

Reference: Exhibit 7, Tab 2

Preamble: Disposition of the 2016 GGEIDA deferral balances.

Question:

a) Please confirm that Union is proposing to dispose of the balances in this deferral account for general service customers on a prospective basis?
b) Please confirm that Union is proposing to dispose of the balances in this account for non-general service customers on a one-time retroactive basis?
c) In schedule Exhibit 7 Tab 2 Schedule 2 page 3 of 3, Union identifies the deferral balances for storage and transportation services. Please indicate:
    i. The proposed disposition methodology for these services.
    ii. Please indicate why there are no balances associated with M13 and M16 services
d) Please explain why Union has used different rate disposition methodologies among the rate types in disposing of the GGEIDA balance.
e) In the event that the OEB determined that the appropriate disposition methodology of the GGEIDA balances for non-general service rate classes was to be completed on a prospective basis, please calculate all of the rate implications and provide the respective draft schedules and changes to tariffs.

---

Response:

a) Confirmed.

b) Not Confirmed. Union proposes to dispose of the 2016 GGEIDA balance to contract rate customers as a one-time adjustment based on 2016 actual volumes.

c)

i. Union is proposing to dispose of the ex-franchise services GGEIDA balance as a one-time adjustment with October 2018 bills, received by customers in November 2018.

ii. Union's proposed allocation of the 2016 GGEIDA balance of $2.232 million to Rate M13 and Rate M16 is $4 (or 0.0002%) and $291 (or 0.0131%), respectively, which rounds to zero in Union's application at Exhibit 7, Tab 2, Schedule 1, column (b).

d) Union's proposed disposition methodology for general service and contract and ex-franchise rate classes is consistent with Union's current practice and approved methodologies to dispose of non-commodity deferral accounts.

Recovery of deferral account balances as a one-time adjustment aligns cost incurrence with cost recovery by customer. The one-time adjustment avoids the material mismatch that could occur between cost incurrence and cost recovery due to customer switching between rate classes and changes in customer's consumption volumes from year to year. A one-time adjustment also eliminates the forecast variance which results from disposing of deferral account balances prospectively. Union is able to administer one-time adjustments for contract and ex-franchise customers through the system used to bill this group of customers.

Union is not able to administer one-time adjustments for general service customers because of limitations in the system used to bill this group of customers. Accordingly, Union's practice has been to recover deferral balances prospectively over a six-month period. A prospective recovery disposition methodology from general service customers works because of the consistency of consumption patterns throughout the year by customers in these rate classes.

Union is currently not able to administer prospective recovery from ex-franchise customers.

e) For the purposes of this response, Union has calculated the unit rates for prospective recovery of the 2016 GGEIDA balance over a twelve-month period from October 1, 2018 to September 30, 2019. If the deferral balance were collected prospectively from all customer rate classes, a twelve-month recovery period would be necessary to help mitigate the inequity by customer within the contract rate classes associated with differences in annual volume consumption patterns that occur throughout the year.

Please see Attachment 1 for the calculation of the unit rates for prospective recovery. As described in part d) above, Union is not currently able to administer prospective disposition to all customer rate classes. Accordingly, Union has not prepared a complete set of the rate schedules. Union will prepare a final rate order following the Board’s decision in this proceeding.

UNION GAS LIMITED
Contract and Ex-Franchise Unit Rates for One-Time Adjustment of the 2016 GGEIDA

| Line No. | Particulars | Rate Class | Deferral Balance for Disposition ($000's) (1) (a) | Forecast Volume ($10^3m^3$) (2) (b) | Forecast Volume (GJ) (2) (c) | Unit Rate for Prospective Recovery/(Refund) (cents/$m^3$) (d) = (a / b)*100 | Unit Rate for Prospective Recovery/(Refund) ($/GJ) (e) = ((a*1000) / c)) |
|---|---|---|---|---|---|---|---|
| | Union North | | | | | | |
| 1 | Medium Volume Firm Service | 20 | 33 | 917,913 | | 0.0036 | |
| 2 | Large Volume High Load Factor | 100 | 29 | 783,655 | | 0.0038 | |
| 3 | Large Volume Interruptible | 25 | 13 | 66,715 | | 0.0201 | |
| | Union South | | | | | | |
| 4 | Firm Com/Ind Contract | M4 | 39 | 658,546 | | 0.0060 | |
| 5 | Interruptible Com/Ind Contract | M5 | 44 | 78,185 | | 0.0563 | |
| 6 | Special Large Volume Contract | M7 | 11 | 488,490 | | 0.0023 | |
| 7 | Large Wholesale | M9 | 2 | 81,243 | | 0.0019 | |
| 8 | Small Wholesale | M10 | 0 | 277 | | 0.1290 | |
| 9 | Contract Carriage Service | T1 | 29 | 448,928 | | 0.0064 | |
| 10 | Contract Carriage Service | T2 | 79 | 3,972,167 | | 0.0020 | |
| 11 | Contract Carriage- Wholesale | T3 | 9 | 279,996 | | 0.0031 | |
| | Ex-franchise | | | | | | |
| 12 | Storage and Transportation | M12 | 210 | | 657,739,944 | | 0.000 |
| 13 | Local Production | M13 | 0 | | 3,851,861 | | 0.000 |
| 14 | Short-Term Cross Franchise | C1 | 5 | | 293,377,855 | | 0.000 |
| 15 | Storage Transportation Service | M16 | 0 | | 10,275,506 | | 0.000 |
| 16 | Total | | 504 | | | | |

Notes:
(1) Exhibit 7, Tab 2, Schedule 1, Column (b).
(2) Forecast volume for the period October 1, 2018 to September 30, 2019.

UNION GAS LIMITED

Answer to Interrogatory from
Building Owners and Managers Association ("BOMA")

Reference: Exhibit 3, Tab 1, p. 4

Preamble: "Union has applied the LTCPF and MACC to analyze incremental customer abatement with respect to energy efficiency measures. Union has completed analyses using the MACC report and the underlying Conservation Potential Study ("CPS") (see Exhibit 3, Tab 1) and has determined that within the existing DSM Framework and considering the cost-effectiveness filter for abatement within the (Cap-and-Trade) Framework, there is no incremental customer abatement that would be prudent to pursue at this time."

Question:
Given that allowable DSM is economic from a total resource cost perspective and from the participating customer cost perspective, shouldn't the MACC and an increase in the funding for existing DSM programs and initiatives reflect the negative cost of the programs and initiatives when compared to other initiatives on the MACC? Has Union considered using a baseline year, say 2016 and treat any additional DSM savings as incremental? Wouldn't this be consistent with the use of baselines with respect to emission reductions?

---

Response:
As per the Marginal Abatement Cost Curve for Assessment of Natural Gas Utilities' Cap and Trade Activities (EB-2016-0359), July 20 2017 (the "MACC Report"), "The zero dollars line (x-axis) represents the 'cost-effective' threshold, which includes the price of an allowance. Bars below the zero-line represent activities that are less costly than an allowance on a lifetime basis".[1] Union interprets the bars below the zero-line to represent "negative cost" energy conservation measures, meaning the benefits are greater than the costs to deliver the energy conservation measures.

Union assessed all energy conservation potential identified in the CPS and the MACC Report. The data sets in the CPS and the MACC Report do not include Union's existing DSM programs. Therefore, Union could not specifically assess the additional opportunity from its existing DSM programs. Please see the response at Exhibit B.GEC.7 a) for further details.

Union has not considered a separate analysis that contemplates setting a baseline year as Union was directed to use the MACC Report to assist in guiding its abatement activities.

[1] The MACC Report, p. 9.

UNION GAS LIMITED

Answer to Interrogatory from
Building Owners and Managers Association ("BOMA")

Reference: Exhibit 3, Tab 1, p. 4

Preamble: "Union has used the MACC to assess potential incremental cost-effective DSM and energy efficiency programs. Through analysis using this report and the underlying CPS (Exhibit 3, 4, Appendix A) Union has determined that there is no cost-effective incremental energy efficiency program that would be prudent to pursue at this time within the existing DSM Framework. There were a few incremental cost-effective measures that could be pursued for residential customers if the existing DSM Budget and DSM Framework were revised. Budget changes to the 2015 – 2020 DSM Plan could occur as a result of the DSM Mid-Term Review process, which is expected to be finalized December 1, 2018. This would not have any impact on Union's 2018 Compliance Plan; however, it could impact future Compliance Plans."

Question:
Has Union considered not providing DSM programs to Large Final Emitters and redirect its DSM budget to non-Final Emitters to deliver the DSM programs and initiatives that are cost effective to these customer groups?

---

Response:
DSM program design, eligibility, and budgets are more appropriately being addressed within the DSM Framework.

The issue of large volume customers and their relationship to utility DSM programs has been discussed within several OEB proceedings. Specifically, within its 2015-2020 DSM Plan, Union proposed a scaled-down DSM program for large volume customers. In the OEB's Decision and Order on Union's Plan, the OEB denied Union's proposal and reinstated the previous Large Volume program at a higher budget level than proposed by Union.[1]

[1] EB-2015-0029, Decision and Order, pp. 50-52.

UNION GAS LIMITED

Answer to Interrogatory from
Building Owners and Managers Association ("BOMA")

Reference: Exhibit 3, Tab 1, p. 20

Preamble: "However, the limitation of using the CPS is that it includes existing measures from OEB-approved DSM programs. Therefore, some of the potential energy efficiencies identified in the MACC are not incremental to energy efficiency measures that are already offered by Union and EGD."

Question:
Surely, incremental can be interpreted to mean taking existing programs to customers who have not yet been served rather than the specific energy efficient measure or program? Please explain Union's interpretation of incremental.

---

Response:
Please see the response at Exhibit B.GEC.7 a).

UNION GAS LIMITED

Answer to Interrogatory from
Canadian Manufacturers & Exporters ("CME")

Reference: Exhibit 3, Tab 1, p. 8

Preamble: At Exhibit 3, Tab 1, page 8, Union states that "Union has continued to monitor and incorporate, where appropriate, applicable learnings and observations from developments in the Ontario, California and Quebec carbon markets."

Question:

a) CME wishes to better understand Union's monitoring and incorporation. Please provide a reference in the evidence to the learnings and observations incorporated into the 2018 compliance plan from California and/or Quebec. If that is not available, please set out the developments, and how it has impacted the 2018 compliance plan.
b) What sort of developments or areas would it be inappropriate to incorporate applicable learnings and observations from WCI markets?

---

Response:

a) Union monitors the events in California and Quebec in order to understand actual and potential policy changes, legislative and regulatory updates, market developments, and supply and demand dynamics. Examples of references to such developments in Union's application include:
    - Exhibit 3, Tab 1, pp. 10-11 - Issuance of linkage Readiness Report by California Air Resources Board;
    - Exhibit 3, Tab 1, pp. 11-12 - Size of the WCI carbon market relative to Ontario;
    - Exhibit 3, Tab 1, pp. 12-14 and Exhibit 3, Tab 6, pp. 23-24 - California legislative changes and proposals;
    - Exhibit 3, Tab 2, pp. 12-13 - Secondary market contract examples;
    - Exhibit 3, Tab 3, pp. 9-10 and 11-13 - Offset invalidation risk in California and Québec; and,
    - Exhibit 3, Tab 5, p. 5 - Range of administrative costs by California utilities.

    Examples of references to such developments in Union's responses to interrogatories include:
    - Exhibit B.Staff.3;
    - Exhibit B.Staff.5; and,
    - Exhibit B.ED.19.

b) Union would not unilaterally categorize a development as applicable or inapplicable without analysing the context and related impacts of such an event. In some instances, differences between the jurisdictions may have contributed to the development and limit its applicability in Ontario. As an example, some differences include:

- Ontario's market size and maturity;
- Ontario's climate and use of energy;
- Differences in some Cap-and-Trade regulations (e.g. offset invalidation);
- Consignment of free allowances to California utilities; and,
- Differences in related regulations (e.g. building codes, fuel standards).

UNION GAS LIMITED

Answer to Interrogatory from
Canadian Manufacturers & Exporters ("CME")

Reference: Exhibit 3, Tab 2, p. 3

Preamble: At Exhibit 3, Tab 1, page 3, Union states "The pre-audit verification process is still in progress and is expected to be completed by the end of 2017."

Question:
a) Is the pre-audit verification process completed?
b) Will the results of this process be part of the evidence in this proceeding? Why or why not?

---

Response:
a) The pre-audit verification process for the 2016 GHG emissions reported under Standard Quantification Method ON.400 (Natural Gas Distribution) was completed on November 27, 2017. The accredited verification body determined that "the reported 2016 ON.400 emissions are free of misstatements, in all material aspects, and in accordance with O. Reg. 452/09 and associated guidance and relevant criteria."[1]

b) The ON.400 verification report prepared by the accredited verification body is included at Attachment A.

[1] GHD. Verification Report: 2016 Natural Gas Distribution Greenhouse Gas Emissions – ON.400, Union Gas, Chatham, Ontario. November 27, 2017, p. 21 (see Attachment A to this response)

November 27, 2017 Reference No. 078643-07

Mr. Peter Mussio
Environmental Manager
Union Gas Limited
P.O. Box 2001
Bloomfield Road
Chatham, Ontario
N7M 5M1

Dear Mr. Mussio:

**Re: Verification Report**
**2016 Natural Gas Distribution Greenhouse Gas Emissions - ON.400**
**Union Gas, Chatham, Ontario**

## 1. Introduction

Union Gas Limited (Union Gas) retained GHD Limited (GHD) to undertake a voluntary verification of Union Gas's reported greenhouse gas (GHG) emissions for natural gas distribution activities per section ON.400 (ON.400 emissions) of Ontario Regulation 452/09 (O. Reg. 452/09) for the compliance period of January 1 to December 31, 2016 (2016 Reporting Year). O. Reg. 452/09[1] applies to facilities that are listed under Section 5(1). Facilities listed under Section 5(1) that emit greater than 25,000 tonnes of carbon dioxide equivalent ($CO_2e$) per year must have their emissions verified by an accredited third party. Per O. Reg. 452/09, Union Gas is required to report ON.400 emissions for the 2016 Reporting Year; however, per section 26(1)(b) of O. Reg. 452/09, Union Gas is not required to have ON.400 emissions verified for the 2016 Reporting Year. For the 2017 Reporting Year, ON.400 emissions will be reported under O. Reg. 143/16 and verification will be mandatory. GHD understands that Union Gas voluntarily retained GHD to complete a verification of ON.400 emissions for the 2016 Reporting Year in preparation for mandatory verification in future.

GHD completed the voluntary verification in accordance with the requirements of O. Reg. 452/09 *Greenhouse Gas Emissions Reporting*, under the Environmental Protection Act, and O. Reg. 143/16 *Quantification, Reporting and Verification of Greenhouse Gas Emissions*, under the Climate Change Mitigation and Low-carbon Economy Act.

GHD has prepared this Verification Report in accordance with ISO Standard *ISO 14064 Greenhouse gases - Part 3: Specification with guidance for the validation and verification of greenhouse gas assertions* (ISO 14064-3) and with the requirements of O. Reg. 452/09.

[1] References to O. Reg. 452/09 Sections within this document correspond to O. Reg. 452/09 text as amended by O. Reg. 398/15, current as of January 1, 2016. https://www.ontario.ca/laws/regulation/090452

## 2. Verification Objective

The objective of the verification is to provide Union Gas with assurance that the Facility's 2016 ON.400 emissions contain no material discrepancy and are prepared in accordance with O. Reg. 452/09.

## 3. Level of Assurance

GHD has conducted the verification to a reasonable level of assurance as per Section 10(1)(b) of O. Reg. 452/09.

## 4. Verification Standards

GHD applied ISO 14064-3 as the verification standard.

## 5. Verification Criteria

GHD applied the following criteria for this verification:

- *ISO 14064 Greenhouse gases - Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals*, ISO, March 2006 (ISO 14064-1).
- *ISO 14064 Greenhouse gases - Part 3: Specification with guidance for the validation and verification of greenhouse gas assertions*, ISO, March 2006 (ISO 14064-3).
- O. Reg. 452/09, Section 10: Verification of Emissions Report and, by reference, Sections 4, 5, 6, and 7 of O. Reg. 452/09.
- Ontario Ministry of the Environment and Climate Change. *Guidelines for Greenhouse Gas Emissions Reporting, December 2015* (MOECC Guidelines).

## 6. Verification Scope

The following sections describe the scope of the Verification.

### 6.1 Facility Emission Sources and Reporting Requirements

ON.400 emissions include carbon dioxide ($CO_2$), methane ($CH_4$) and nitrous oxide ($N_2O$) from an entity's natural gas distribution activities. $CO_2$ emissions are calculated according to Equation 400-6 from the MOECC Guidelines, as follows:

$$CO_{2f} = CO_{2i} – CO_{2j} – CO_{2k} – CO_{2l}$$

Where,

$CO_{2f}$ = total annual CO2 emissions (calculated per Equation 400-1 or 400-2)

$CO_{2i}$ = annual CO2 emissions from the complete combustion or oxidation of the natural gas received by the distributor at its custody transfer stations (calculated per Equation 400-3)

$CO_{2j}$ = annual CO2 emissions from the complete combustion of the natural gas that is distributed to another distributor or exported out of Ontario (calculated per Equation 400-4)

$CO_{2k}$ = annual CO2 emissions that would result from the complete combustion of the natural gas that is distributed to other persons required to report and verify emissions under the regulation (calculated per Equation 400-4)

$CO_{2l}$ = annual CO2 emissions that would result from the complete combustion of natural gas that represents the net change in natural gas stored within the calendar year (calculated per Equation 400-5)

The individual components of Equation 400-6, per above, are calculated using Equations 400-1 through 400-5, which reference default emission factors in Tables 400-1 and 400-2 of the MOECC Guidelines. $CH_4$ and $N_2O$ emissions are calculated according to Equations 400-7 and 400-8, respectively, which apply default emission factors from Table 20-4 to calculate $CH_4$ and $N_2O$ emissions based on $CO_{2f}$.

### 6.2 Geographical and Organizational Boundaries

The verification included the emission from Union Gas' natural gas distribution activities in the province of Ontario.

### 6.3 Reporting Period

The reporting period is between January 1, 2016 and December 31, 2016.

### 6.4 Use of this Report

This report has been prepared for the use of Union Gas.

Statements from GHD's Verification Report, including the Verification Statement must reference the date of issuance of GHD's report, the applicable verification period and the associated programme for which the verification was conducted. The GHG assertion provided by GHD can be freely used by Union Gas for marketing or other purposes other than in a manner misleading to the reader. The GHD mark shall not be used by Union Gas in any way that might mislead the reader about the verification status of the organization. The GHD mark can only be used in relation to the specific time period verified by GHD.

# 7. Verification Plan

GHD developed a Verification Plan including a sampling plan based on a preliminary review of the data initially provided. GHD submitted the Verification Plan to Union Gas on May 24, 2017, prior to GHD's Site visits on July 24, 2017 and August 14, 2017. GHD's Verification Plan was revised, as required, throughout the course of the verification to address questions or initial concerns with data originally provided.

## 7.1 Facility Emissions Breakdown

A breakdown of Union Gas' ON.400 emissions is provided in the following table:

| Source Group | Approximate Emissions (tonnes $CO_2e$) | Percentage of Total Emissions (%) | Calculation Methodology |
|---|---|---|---|
| **$CO_{2i}$** – Natural gas received by Union Gas at custody transfer meters | 47,073,531 | n/a | Equation 400-2 |
| **$CO_{2j}$** – Natural gas distributed to another distributor or out of Ontario | 23,416,504 | n/a | Equation 400-3 |
| **$CO_{2k}$** – Natural gas distributed to capped participants that are not a petroleum product supplier or another distributor | 10,211,073 | n/a | Equation 400-4 |
| **$CO_{2l}$** – Natural gas that represents the net change in natural gas stored within the calendar year | -1,078,755 | n/a | Equation 400-5 |
| **$CO_{2f}$** – Total (net) annual $CO_2$ emissions | 14,524,709 | 99.38% | Equation 400-6 |
| **$CH_4$** – Total annual $CH_4$ emission | 6,057.8 | 0.04% | Equation 400-7 |
| **$N_2O$** – Total Annual $N_2O$ emissions | 84,591.1 | 0.58% | Equation 400-8 |

## 7.2 Assessment of Risk and Magnitude of Potential Errors, Omissions or Misrepresentations

Based on GHD's review of the Union Gas' operations, the following table summarizes the potential risk and magnitude of potential errors, omissions or misrepresentations, as currently known:

| Potential Risk Area | Approximate Percent of total Emissions (%) | Risk Type (Inherent, Control, Detection) | Risk Level (High, Medium, Low) | Justification |
|---|---|---|---|---|
| **Emissions from combustion of distributed natural gas** | | | | |
| Natural gas received by Union Gas at custody transfer meters | 100% | Inherent | Low | Low risk as calculation methodology is not complex. |
| | | Control | Low | Control risk is low as natural gas received by Union Gas are tracked via invoices/meters for accounting purposes. |

| Potential Risk Area | Approximate Percent of total Emissions (%) | Risk Type (Inherent, Control, Detection) | Risk Level (High, Medium, Low) | Justification |
|---|---|---|---|---|
| | | Detection | Low | The detection risk could be set at High; however, GHD reviewed a large sample of data/records with respect to received natural gas to maintain a low detection risk. |
| Natural gas distributed to another distributor or out of Ontario | | Inherent | Low | Low risk as calculation methodology is not complex. |
| | | Control | Medium | Natural gas delivered by Union Gas is tracked via invoices/meters for accounting purposes. As Union Gas must identify natural gas delivered to other suppliers or out of provide on a per account basis, the control risk is medium. |
| | | Detection | Low | The detection risk could be set at medium. To lower the detection risk, GHD reviewed a large sample of data/records, and thoroughly reviewed Union Gas's process for identifying natural gas delivered to other distributors and out of province. |
| Natural gas distributed to capped participants that are not a petroleum product supplier or another distributor | | Inherent | Low | Low risk as calculation methodology is not complex. |
| | | Control | High | Natural gas delivered by Union Gas is tracked via invoices/meters for accounting purposes. Union Gas must identify which customers/facilities constitute capped participants, and which accounts are held by each capped participant. As there is a high risk that facilities or accounts may be erroneously excluded or included, there is a high control risk. |
| | | Detection | Low | The detection risk could be set at High; however, GHD will review a large sample of data/records with respect to received natural gas to maintain a low detection risk. |
| Natural gas that represents the net change in natural gas stored within the calendar year | | Inherent | Low | Low risk as calculation methodology is not complex. |
| | | Control | Low | Control risk is low as natural gas placed into and removed from storage is metered for accounting purposes. |
| | | Detection | Low | The detection risk could be set at High; however, GHD reviewed a large sample of |

| Potential Risk Area | Approximate Percent of total Emissions (%) | Risk Type (Inherent, Control, Detection) | Risk Level (High, Medium, Low) | Justification |
|---|---|---|---|---|
| | | | | data/records with respect to natural gas storage to maintain a low detection risk. |
| **Data Management and Integrity** | | | | |
| Data Management Systems | N/A | Inherent | Low | All emissions are based on metering/invoicing used for accounting by Union Gas. |
| | | Control | Medium | There is a medium control risk as Union Gas's data management system does not specifically track which accounts are attributed to other suppliers, out of province deliveries, and capped participants. |
| | | Detection | Low | The detection risk could be set at medium. To lower the detection risk, GHD will review a large sample of data/records, and will thoroughly review Union Gas's process for identifying natural gas delivered to other distributors, out of province and to capped participants. |

### 7.3 Final Sampling Plan

GHD developed a sampling plan based on review of review of the objectives, criteria, scope, and level of assurance detailed above. The sampling plan is dynamic and was revised, as required, throughout the course of the verification process.

The following table summarizes the final sampling plan of material sources:

| Data/Information Description | Percentage of total Site Emissions[2] (%) | Data/Information Source | Collection Frequency | Sample size/Action |
|---|---|---|---|---|
| **Emissions from combustion of distributed natural gas** | | | | |
| Natural gas received by Union Gas at custody transfer stations | 100% | • List of custody transfer stations<br>• Monthly Net Gas Sendout Reports<br>• List of "locations" per Net Gas Sendout | • As collected for 2016 Reporting Year | • All data from January 1 to December 31, 2016. |

[2] Percentages estimated based on 2015 Emissions Report.

| Data/Information Description | Percentage of total Site Emissions[2] (%) | Data/Information Source | Collection Frequency | Sample size/Action |
|---|---|---|---|---|
| | | Reports<br>• Sample of meter data for Dawn compressor station | | |
| Natural gas distributed to another distributor or out of Ontario | | • Monthly Net Gas Sendout Reports<br>• List of "locations" per Monthly Net Gas Sendount Reports<br>- Markup of which locations correspond to natural gas distributors | • As collected/ published for 2016 Reporting Year | • All data from January 1 to December 31, 2016. |
| Natural gas that represents the net change in natural gas stored within the calendar year | | • List of storage facilities<br>• Sample of meter data for Dawn compressor station | • As collected for 2016 Reporting Year | • All data from January 1 to December 31, 2016. |
| Natural gas distributed to capped participants that are not a petroleum product supplier or another distributor | | • List of all capped participants in Ontario (published by MOECC)<br>• List of capped participants to which Union Gas supplies natural gas<br>- List of accounts per capped participants<br>- Explanation of how list was determined<br>• Sample of customer attestations | • As collected/ published for 2016 Reporting Year | • All data from January 1 to December 31, 2016 |
| **Data Management and Integrity** | | | | |
| Meter Calibration | N/A | • Meter calibration records<br>• Meter calibration program summary | As collected | • Discussed meter calibrations records and procedures with Union Gas<br>• Visited key metering locations |

| Data/Information Description | Percentage of total Site Emissions[2] (%) | Data/Information Source | Collection Frequency | Sample size/Action |
|---|---|---|---|---|
| Back up of data acquisition systems | N/A | • General Data Management System<br>• Controls and QA/QC procedures<br>• Document retention policy | N/A | • Reviewed frequency of data backup and interviewed Facility personnel |
| Data Acquisition and flow from meters to data collection/process monitoring system software to data historian | N/A | • Facility | N/A | • Reviewed data systems at Facility and interviewed Facility personnel |

### 7.4 Materiality

Facility quantitative materiality for this verification is set at plus or minus 5 percent of the reported 2016 ON.400 emissions as per Section 11(1) of O. Reg. 452/09. An individual error, omission, misstatement or the aggregate effect of discrete errors, omissions, or misstatements may be considered material.

## 8. Verification Procedures

### 8.1 Methodologies Used to Assess/Verify Emissions Data

GHD used the verification procedures detailed in the Verification Plan to assess the following:

1. Accuracy and completeness of 2016 ON.400 emissions
2. Uncertainty of external data sources used
3. Emission assumptions
4. Accuracy of emission calculations
5. Potential magnitude of errors and omissions

To sustain a risk-based assessment, the GHD Project Team identified and determined risks related to annual GHG emissions during both the desk reviews and the follow-up interviews. The GHD Project Team particularly focused on the accuracy and completeness of provided information. The components of the document review and follow-up interviews were:

- Document Review:
  - Review of data and information to confirm the correctness and completeness of presented information.
  - Cross-checks between information provided per the reported ON.400 emissions and information from independent background investigations.
  - Determine sensitivity and magnitude analysis for parameters that may be the largest sources of error.
- Follow-up Interviews:
  - On site
  - Via telephone
  - Via email

Through the document review GHD established to what degree the presented ON.400 emissions documentation met the verification standards and criteria.

The GHD Project Team's document review during the review process comprised an evaluation of whether or not:

- The documentation is complete and comprehensive and follows the structure and criteria given in O. Reg. 452/09 and its associated guidance.
- The methodologies are justified and appropriate.
- The assumptions behind the inventory are conservative and appropriate.
- The GHG emission calculations are appropriate and use conservative assumptions for estimating GHG emissions.
- The GHG information system and its controls are sufficiently robust to minimize the potential for errors, omissions, or misrepresentations.

The GHD Project Team interviewed Facility personnel to:

- Cross-check information provided
- Test the correctness of critical formulae and calculations
- Review data management and recording procedures

### 8.2 Details of Site Visit

Neil Risk of GHD visited Union Gas on July 24, 2017 during the verification of the 2016 ON.400 emissions. GHD met with Peter Mussio, Ainslie Murdock and Luna Ghose of Union Gas' Environment, Health and Safety group, who were responsible for the reporting of the ON.400 emissions.

During the head office visit, the Environment Health and Safety group first provided an initial walkthrough of the ON.400 emissions and the applicable data. Thereafter, meetings were held with Union Gas employees who possessed thorough knowledge of the data, and who answered GHD's questions concerning data sources, data checks, and data flow from source to use in the ON.400 emissions. Union Gas employees provided GHD explanation of the function of the BANNER, GMAS, CONTRAX, and CARE data management systems, and how and what data from each system was retrieved for use in calculating the ON.400 emissions.

On August 15, 2017, Neil Risk of GHD visited Union Gas' Dawn compressor station. GHD met with Ray Jump (Electronic Engineer) of Union Gas, as well as Peter Mussio, Ainslie Murdock and Luna Ghose. GHD verified the use of electronic meters and the data flow from meters to the Union Gas databases at several of Union Gas' largest receipt and distribution points. GHD verified that Union Gas' custody transfer meters are calibrated and tagged by Measurement Canada, and that Union Gas' internal meters are calibrated in-house according to manufacturer specifications (at a minimum).

## 9. Verification Findings

The following subsections provide details of GHD's findings as well as GHD's conclusions.

### 9.1 Verification Findings

The following present a summary of the independent quantifications from the document review:

| Emission Source Group | General |
|---|---|
| Scope Item Verified | Assessment of completeness of ON.400 emissions and inclusion of all sources |
| Verification Procedure | Review of Union Gas operations with respect to natural gas quantities per Equations 400-2 through 400-5 of the MOECC Guidelines |
| Verification Findings | GHD confirmed the boundary on Union Gas' operations with respect to ON.400 emissions independently for the natural gas quantities per Equations 400-2 through 400-5 of the MOECC Guidelines. GHD verified the following:<br>• Equation 400-2: Annual quantity of natural gas received at custody transfer stations<br>- Discussion with Gas Measurement Services group members<br>- Review of list of all receipt points in Union Gas network |

| Emission Source Group | General |
|---|---|
| | • Equation 400-3: Annual quantity of natural gas distributed to another distributor or out of Ontario<br>- Discussion with Gas Measurement Services group members who confirmed Union Gas does not export natural gas out of Ontario, but does sell natural gas to parties that do<br>- Online search of Union Gas operations to confirm Union Gas does not export natural gas<br>- Review of internal reports which detail bulk deliveries to natural gas distributors<br>- Review of delivery data for Union Gas clients who are municipal distributors (e.g. Kitchener Utilities)<br>• Equation 400-4: Annual quantity of Natural gas distributed to capped participants that are not a petroleum product supplier or another distributor<br>- Review of MOECC's published list of capped participants<br>- Review of Union Gas' approach to determining whether capped participants are their clients, including checks, and Union Gas' final markup of MOECC's list<br>• Equation 400-5: Annual quantity of natural gas that represents the net change in natural gas stored within the calendar year<br>- Discussion with Union Gas personnel concerning all of Union Gas' storage pool locations<br>- Review of Union Gas network map (high-level)<br>- Online research concerning Union Gas' operations<br>- Visit to Dawn compressor station, Union Gas' main natural gas storage facility<br>Additional details are provided in the following findings. GHD did not identify any emission sources that were excluded from the ON.400 emissions reported for 2016. |
| Conclusion | GHD verified that all relevant emission sources have been included in the ON.400 emissions reported for 2016. |

| Emission Source Group | Natural Gas Quantification |
|---|---|
| Scope Item Verified | Natural gas received by Union Gas at custody transfer meters |
| Verification Procedure | Review of MOECC Guidelines, discussion with members of Union Gas' Gas Measurement Services group, review of monthly Net Gas Send Out Reports (NGSO Reports), review of list of all receipt points within Union Gas' network, review of sample of data for two of the |

| Emission Source Group | Natural Gas Quantification |
|---|---|
| | largest receipt points by volume (and reconciliation with NGSO Reports), and site visit to Dawn compressor station. |
| Verification Findings | Union Gas reports total receipts of natural gas based on their internal NGSO Reports. The NGSO Reports are prepared monthly by Union Gas' Gas Measurement Services group based using the CARE data management system. The CARE data management system is used to reconcile transactional data (i.e. gas scheduling for deliveries/receipts) with gas measurement data pulled from the GMAS data measurement system. The NGSO Reports are validated monthly by the Union Gas' Gas Measurement Team, which involves checking to confirm measurement data are properly interfaced into CARE.<br>The NGSO Reports detail total natural gas receipts and deliveries on a per location basis, where the locations are receipt and delivery points on Union Gas' infrastructure. A receipt/delivery point as listed on the NGSO Reports may be a single meter, or a group of meters. For months where natural gas was both received and delivered from a given point, the receipts and deliveries are itemized separately. Receipts consist of natural gas imported into Union Gas' infrastructure, and deliveries consist of natural gas exported to other distributors. Only deliveries to other distributors (which are typically large deliveries) are detailed on the NGSO Reports. Natural gas supplied to Union Gas account and contract customers, such as industry and residences, are handled in separate billing systems.<br>The main purpose of the NGSO Reports is to compare the send out, the difference between receipts and bulk deliveries, to the total billed consumption per Union Gas' billing systems. The difference between these values is termed the Unaccounted For Gas (UFG). The American Gas Association (AGA) defines UFG as: "*The difference between the total gas available from all sources, and the total gas accounted for as sales, net interchange, and company use. This difference includes leakage or other actual losses, discrepancies due to meter inaccuracies, variations of temperature and/or pressure, and other variants, particularly due to measurements being made at different times*." For 2010 to 2014, the UFG ranged from 0.11% to 0.34% of gas throughput. Union Gas has indicated typical UFG is <1%, and if the UFG approaches of exceeds this threshold, it is an indication of an issue in the distribution system.<br>For 2016, the overall UFG was 134,148,123 $m^3$, where a positive value indicates that, per the metering, less natural gas was consumed (billed) than was measured to have been sent out. Union Gas conservatively included the UFG in their total received natural gas, as in, did not subtract out the UFG from the total receipts. The MOECC Guidelines do not stipulate how UFG is to be handled, and as such, by not adjusting for UFG, Union Gas' approach is correct.<br>For the purposes of quantifying natural gas received, only the receipts portion of the NGSO Reports is needed. Natural gas |

| Emission Source Group | Natural Gas Quantification |
|---|---|
| | received by Union Gas is invoiced, and can quantified in three ways: quantified by third-party metering and checked by Union Gas metering, quantified by third-party metering only, and quantified by Union Gas metering only (small suppliers only). For receipts where only third-party metering exists, Union Gas receives the meter data via email, and uploads said data to GMAS (which can pulled into CARE and populated into the NGSO Reports).<br>To verify the total received natural gas, GHD reviewed all monthly NGSO reports for 2016, reviewed a list (with locations) of all receipt points within Union Gas' network, and reviewed a sample of data for two of the largest receipt points by volume ("METALOR PROD" and "DAWN-TCPL"), confirming the data reconciled with the NGSO Reports. GHD interviewed Mr. Brad Blanchard of Union Gas' Gas Measurement Services team, who explained how the NGSO Reports are developed and checked, including a thorough explanation of the data flow. Additionally, GHD visited the Dawn compressor station, and confirmed the presence of Measurement Canada calibrated metering and audited data control systems at several receipt points. Based this review, GHD did not identify any issues concerning the reported total receipt of natural gas in 2016. |
| Conclusion | GHD did not identify any issues concerning the reported total receipt of natural gas in 2016. |

| Emission Source Group | Natural Gas Quantification |
|---|---|
| Scope Item Verified | Natural gas distributed to another distributor or out of Ontario |
| Verification Procedure | Review of MOECC Guidelines, discussion with members of Union Gas' Gas Measurement Services group, review of NGSO Reports, review of list of all locations per NGSO Reports, and review of BANNER summary of monthly deliveries to municipal distributors. |
| Verification Findings | Union Gas assert that they do not distribute natural gas out of Ontario. GHD confirmed this through discussion with members of the Gas Measurement Services group, who explained that while Union Gas has customers who export natural gas out of Ontario, no natural gas under Union Gas' custody is exported out of province.<br>To quantify natural gas distributed to another distributor, Union Gas first relies of the NGSO Reports. As discussed, the NGSO Reports detail total natural gas receipts and deliveries on a per location basis. These "locations" include Union Gas facilities, as well as natural gas distributors who receive large quantities of natural gas from Union Gas. These distributors are entered as locations in the NGSO Reports as the location is a physical location along the network (at which there may be several meters). One company may have multiple locations if they receive gas at multiple geographic points in Union Gas' network. For the purposes of the ON.400 emissions, Union Gas summed the natural gas sent to other distributors by identifying them by location in the NGSO (the location |

| Emission Source Group | Natural Gas Quantification |
|---|---|
| | generally have descriptive names which include the company name). The Gas Measurement Services group checked this summation.<br>In addition to large distributors, Union Gas supplies natural gas to the municipal distributor Kitchener Utilities. Kitchener Utilities is not itemized on the NGSO Reports, but is instead billed as a client through Union Gas' BANNER system.<br>To verify the natural gas distributed to other distributors GHD reviewed all monthly NGSO Reports. Additionally, GHD reviewed a list of all the locations that can appear on the NGSO reports which Union Gas had marked up to identify which were natural gas distributors (if there is no deliveries or receipts in a month at a location it is excluded from the NGSO Report). With respect to the municipal distributors, GHD reviewed a BANNER summary of the natural gas supplied to, and therefore billed to, Kitchener Utilities. GHD did not identify any issues. |
| Conclusion | GHD did not identify any issues concerning the reported total natural gas distributed to another distributor or out of Ontario in 2016. |

| Emission Source Group | Natural Gas Quantification |
|---|---|
| Scope Item Verified | Natural gas that represents the net change in natural gas stored within the calendar year |
| Verification Procedure | Review of MOECC Guidelines, discussion with Union Gas' Gas Measurement team, Site visit to Dawn compressors station and storage facility (include visit to metering points), review of NGSO reports, and review of sample of Dawn storage facility meter data. |
| Verification Findings | In Union Gas's NGSO Reports, Union Gas' own storage pools are treated as receipt/delivery points. Natural gas placed into storage is included under deliveries, while natural gas removed from storage is included under receipts. Receipts and deliveries (e.g. removals from and injections into storage) are separated on a per storage location basis. For months where natural gas was both received (removed) and delivered (injected) at a given point, the receipts and deliveries are itemized separately.<br>Initially, consistent with how the storage of natural gas is handled on the NGSO Reports, Union Gas included the annual change in storage of natural gas within the $CO_{2i}$ term of Equation 400-6. Per ON.402(a)(4) and (5) natural gas, the annual quantities of natural gas placed into and withdrawn from storage in the reporting year must be reported. After GHD identified this issue, Union Gas revised their ON.400 emissions detailing the total annual deposits and withdrawals of natural gas to and from Union Gas owned storage pools. In Union Gas' calculations natural gas that is received directly from a third party storage pools is treated as a receipt (i.e. $CO_{2i}$) not a withdrawal from storage. Conversely, natural gas that is transferred from Union Gas directly into a third party's storage pool |

| Emission Source Group | Natural Gas Quantification |
|---|---|
| | is treated as a delivery to another distributor (i.e. $CO_{2j}$). Both of these types of transactions are itemized on NGSO Reports. Union Gas confirmed with the MOECC that this is the correct approach, and provided GHD with records of the associated correspondence (email chain). Union Gas determined the total deposits and withdrawals into storage based on internal metering at the Dawn and Hagar facilities (Union Gas' only storage locations). To verify the annual change in storage, GHD reviewed the monthly NGSO Reports and a sample of meter data for storage pools at the Dawn facility. GHD did not identify any issues. |
| Conclusion | GHD did not identify any issues concerning the reported net change in natural gas stored within the calendar year. |

| Emission Source Group | Natural Gas Quantification |
|---|---|
| Scope Item Verified | Natural gas distributed to capped participants that are not a petroleum product supplier or another distributor |
| Verification Procedure | Review of MOECC Guidelines, review of MOECC's published list of facilities in the cap and trade program (capped participants), discussion with Union Gas' personnel concerning approach to identifying capped participants who are and aren't Union Gas clients, review/demonstration of CONTRAX and BANNER data management systems, review of sample of Union Gas customer attestations, and review of calculations. |
| Verification Findings | The MOECC publishes a list of all capped participants. The list provides the follows details for each participant:<br>• GHGID<br>• Organization Name<br>• Facility Name<br>• Address (Physical Address)<br>Based on this information, Union Gas are required to determine what capped participants are their customers, and what the total natural gas delivery was in 2016 for each of those customers. To do so, Union gas took the following approach<br>1. Based on the addresses Union Gas eliminated facilities that are outside of Union Gas' operational area<br>2. Union Gas compared the list of facilities within their operation area against their accounting records, and determined which facilities were known clients<br>3. Union Gas sent all known clients attestations. The attestations required the facilities to complete a form, and stipulated that failure to do so would result in the addition of cap-and-trade costs to their bill. The following information was requested:<br>  • Business Name<br>  • GHGID |

| Emission Source Group | Natural Gas Quantification |
|---|---|
| | • Facility Address<br>• All Union Gas contract service agreement numbers (SA#) associated with the facility<br>• All Union Gas general service account numbers associated with the facility<br>• All meter numbers associated with the facility<br>• Contact information for person(s) who completed form<br>4. For facilities within their operational area that were not known customers, Union Gas reached out to confirm the entities/facilities were not customers. If a customer was identified, they were sent an attestation per above.<br>5. For contract service agreements, Union Gas queried all accounts in their CONTRAX billing system, and manually extracted usage data for each SA# identified per above (CONTRAX cannot be queried for a list of specific SA#)<br>• This manual data retrieval was checked by two Union Gas personnel<br>6. Union Gas queried their BANNER billing system for the usage associated with the general service accounts identified per above<br>7. Union Gas reviewed the CONTRAX SA# output as well as their BANNER database to check for any missed accounts (e.g. accounts attributed to addresses or companies per attestations, but not listed on attestations)<br>Based on the above approach, each entity/facility on the MOECC's list was confirmed to be either outside Union Gas' operational area, within the operational area but not a customer, or a Union Gas customer. Union Gas confirmed they received attestations from all of the capped participants they identified to be Union Gas customers.<br>Per the above approach, and based on discussions with Union Gas, GHD determined that it would only be possible for an account to be missed if the account was a general service account not registered in the company's name (all contract service agreements are registered under company names). However, as Union Gas contacted all capped participants within their operational area to confirm which were their customers, and as their customers were incentivized to report all accounts lest they incur additional costs, the possibility an account was missed is very low. Furthermore, as contract service agreements account for >90% of all natural gas use by Union Gas customers who are capped participants, the risk a missed account would result in a material error overall is significantly lower.<br>GHD reviewed Union Gas' markup of the MOECC list, reviewed correspondence between Union Gas and the MOECC indicating the list was to be used to determine $CO_{2k}$, and reviewed Union Gas' natural gas use breakdown for their customers who are capped |

| Emission Source Group | Natural Gas Quantification |
|---|---|
| | participants. While reviewing the latter (breakdown), GHD confirmed that entities identified as natural gas distributors were not double counted. Additionally, GHD reviewed a sample of attestations for facilities whose 2016 emissions were verified by GHD, and cross-referenced the attested accounts against the accounts identified in GHD's verifications. GHD did not identify any issues associated with Union Gas' reported natural gas quantity distributed to capped participants that are not a petroleum product supplier or another distributor. |
| Conclusion | GHD did not identify any issues associated with Union Gas' reported natural gas quantity distributed to capped participants that are not a petroleum product supplier or another distributor. |

| Emission Source Group | General |
|---|---|
| Scope Item Verified | Emissions Calculations and Calculation Methodologies |
| Verification Procedure | Review of calculation methodology applied by Union Gas. Check that calculation methodology is applicable per O.Reg.452/09 and MOECC Guidelines. |
| Verification Findings | Per Section 7.1, Union Gas applies the following calculation methodologies from the MOECC Guidelines for emissions from all natural gas fuel use:<br>• Equation 400-2<br>• Equation 400-3<br>• Equation 400-4<br>• Equation 400-5<br>• Equation 400-6<br>• Equation 400-7<br>• Equation 400-8<br>Union Gas applies the following emission factors from the MOECC Guidelines:<br>• $CO_2$ emission factor from Table 400-2<br>• $CH_4$ and $N_2O$ emission factors from Table 20-4 for Residential, Construction, Commercial/Institutional, Agriculture (as stipulated in ON.404)<br>GHD reviewed the calculation methodologies and confirmed that Union Gas's use of equations and emissions factors are in accordance with MOECC Guidance. GHD completed a full recalculation of the emissions, using the natural gas quantities as outlined in previous findings, and did not identify any discrepancies. |

| Emission Source Group | General |
|---|---|
| Conclusion | GHD did not identify any issues with the calculation methodologies applied by Union Gas. |

### 9.2 Summary of Errors, Omissions, Misstatements or Non-compliances Identified

Quantitative materiality for this verification is set at plus or minus 5 percent of the reported emissions as per O. Reg. 452/09 Section 11(1). The quantitative aggregated magnitude of errors, omissions, and misstatements for the Union Gas' 2016 ON.400 emissions is 0.0 percent, which is less than the materiality threshold of 5 percent.

### 9.3 Corrections Made to GHG ON.400 emissions

Union Gas did not make changes to the 2016 ON.400 emissions during this verification.

### 9.4 Data Management Systems

Union Gas' Environmental Health and Safety group prepares the ON.400 emissions, including the consolidation of the requisite data. Union Gas' internal data is retrieved from four main data management systems: GMAS, BANNER, CONTRAX and CARE. GMAS obtains real time fuel usage data from fuel meters with associated web enabled communication devices. BANNER is Union Gas's billing system for customers without contract service agreements, while CONTRAX is Union Gas' billing system for accounts with contract service agreements. Finally, CARE is used to reconcile transactional data (i.e. gas transportation scheduling for deliveries/receipts). To retrieve data Union Gas' Environmental Health Safety group contacts the other Union Gas departments in charge of the given data management system (e.g. billing/accounting, gas measurement services). Union Gas' Environmental Health Safety group reviews the data, and has members of the applicable departments review the data to ensure accuracy and completeness. The processes for data querying and review, with respect to ON.400 emissions, are described in more detail in Section 9.1 above.

### 9.5 GHG Data and Information

As part of this verification, GHD reviewed the following information, as provided by Union Gas:

- attestations for 2016 verification.pdf
- DAWN-TCPL MEASUREMENT JULY 2016.xlsx
- GHD 078643_Information Request_2016.xlsx
- JULY 2016 STORAGE POOL MEASUREMENT.xlsx
- METALORE JULY 2016.xlsx
- NG Distribution Calcs 2017May16.xlsx

- NG Distribution Calcs 2017May19 - Exchange Update.xlsx
- North and South July 2016.xlsx

# 10. Verification Team

## 10.1 Roles and Responsibilities

***Lead Verifier*** – **Gordon Reusing, M.A.Sc., P.Eng** – Mr. Reusing led the verification and was responsible for development of the verification plan. Mr. Reusing reviewed the risk assessment, recalculation of raw data, data management and draft findings. Mr. Reusing prepared and signed the verification statement and verification report.

***Verifier*** **– Neil Risk, M.Sc.** – Mr. Risk developed and revised the verification plan and sample plan, developed a risk assessment, recalculated raw data, reviewed management of data quality and prepared draft findings. Mr. Risk conducted a visit to the Union Gas headquarters and a site visit to the Dawn compressor station.

***Peer Reviewer*** **– Brent Boss, P.Eng.** – Mr. Boss conducted a peer review of the verification plan, risk assessment, verification report, and findings.

## 10.2 Qualifications

**Lead Verifier - Gordon Reusing, M.A.Sc., P.E., P.Eng.** - Mr. Reusing is a Principal in charge of GHD's Greenhouse Gas Assurance Services Group. He is a Lead Verifier, Lead Validator and Peer Reviewer with extensive experience including GHG Programmes in Alberta, BC, Ontario, Quebec, Nova Scotia, California, Massachusetts, and Programmes operated by the United Nations Framework Convention on Climate Change (UNFCC) Clean Development Mechanism (CDM), The Gold Standard, The Climate Registry (TCR), the Carbon Disclosure Project (CDP), and the Verified Carbon Standard (VCS).

Mr. Reusing has extensive greenhouse gas (GHG) emissions inventory and verification experience in the oil and gas, chemical, cement, transportation, pulp & paper, general industrial, electronics, power generation and waste management sectors. He has completed dozens of bottom-up GHG emissions inventories. Mr. Reusing is very familiar with stationary combustion, manufacturing and reaction processes which generate GHG emissions. Mr. Reusing is identified as an air emissions expert for quantification of emissions reductions in accordance with GHD's role as a Designated Operational Entity (DOE) in the United Nations Framework Convention on Climate Change (UNFCCC).

Mr. Reusing has been the Lead Verifier, Peer Reviewer and Technical Expert for numerous GHG verification projects for the government of Alberta for GHG Compliance Reports, Baseline Reports and GHG offsets under the Alberta Specified Gas Emitters Regulation. In Alberta Mr. Reusing has experience with upstream oil and gas (in situ and mining oil sands), downstream oil and gas (refineries), chemical plants, pulp and paper, sawmills, coal fired power plants, co-generation systems, hydrogen plants and biomass power plants.

Mr. Reusing has completed two courses on GHG emissions conducted by the Canadian Standards Association (CSA) – ISO 14064 Part 1 "Specification with Guidance at the Organization Level for Quantification and Reporting of Greenhouse Gas Emissions and Removals" and ISO 14064 Part 2 "Specification with Guidance at the Project Level for Quantification, Monitoring and Reporting of Greenhouse Gas Emission Reductions or Removal Enhancements". Mr. Reusing is qualified by the Canadian Standards Association as a Lead Verifier for greenhouse gas verification and validation projects. He has obtained a certificate for completion of the exams associated with ISO 14064 Part 3 "Specification with Guidance for the Validation and Verification of Greenhouse Gas Assertions".

**Verifier – Neil Risk, M.Sc.** - Mr. Risk has a Bachelor of Science in Earth Surface Science, and a Master of Science in Environmental Science, both from the University of Guelph. Mr. Risk's graduate research focused on greenhouse gas emissions, and Mr. Risk has published two peer reviewed journal articles based on the results. Mr. Risk is currently working towards a professional geoscientist designation. Mr. Risk has experience completing GHG verifications under Ontario O. Reg. 452/09, Massachusetts Regulation 310 CMR 7.71, The Climate Registry, CDP, CSA, and Alberta's Specified Gas Emitters Regulation. Mr. Risk has completed verifications as a verifier for cement plants, automotive manufacturers, general manufacturing facilities, power generation facilities, pulp and paper mills, steel mills, and chemical manufacturing facilities, among others. Additionally, Mr. Risk has prepared GHG inventories for facilities and companies for reporting under O. Reg. 452/09 and CDP.

**Peer Reviewer – Brent Boss, P.Eng.** – Mr. Boss is a licensed Professional Engineer in Ontario and has a Bachelor of Engineering in Environmental Engineering from the University of Guelph. Mr. Boss has experience in solid waste engineering and a range of greenhouse gas (GHG) validation and verification activities. Mr. Boss works closely with the United Nations Framework Convention on Climate Change (UNFCCC) and the International Standards Organization (ISO) 14065 GHG accreditations. Mr. Boss assisted in leading the successful applications and approvals process in which GHD is now recognized as a Designated Operational Entity (DOE) with the UNFCCC and as a Validation/Verification Body under the ISO 14065 program. Mr. Boss has also led GHD to become registered to complete Validation and Verification Services with The Gold Standard, the Fair Recycling Foundation (formerly the Swiss Charter Foundation), and the Verified Carbon Standard (VCS).

Mr. Boss has completed over 30 GHG validation/verification projects as a lead auditor or peer reviewer on a wide range of sectoral scopes ranging from renewable power generation (wind power and hydroelectric), oil and gas, agricultural, and landfill gas/biogas combustion plants. Mr. Boss has also completed several methodology review processes under the VCS and the Fair Recycling Foundation.

Mr. Boss has accreditation as a Lead Verifier in Ozone Depleting Substances (ODS), and Livestock projects under the California Air Resources Board (CARB) GHG Offset Reporting System. Mr. Boss has assisted in the development of several agricultural manure digestion projects under the Climate Action Reserve (CAR) in California. Mr. Boss has also performed similar reporting under Environment Canada's PERRL Initiative for several landfills within Ontario. Mr. Boss has also created Project Information Notes (PIN) for several large scale aerobic composting facilities within Ontario as well as an

energy-from-bagasse plant in Brasil. Mr. Boss also works closely with the permitting, approvals, and annual reporting processes for a number of organics composting facilities operated in Ontario.

Mr. Boss is also experienced in Ontario Ministry of the Environment and Climate Change (MOECC) regulatory standards with respect to the development of landfill gas collection and control systems. Mr. Boss assisted in the preparation of Sample Application Packages for both the Certificate of Approval (Waste Disposal Site) and Certificate of Approval (Air and Noise). Subsequently Mr. Boss has performed Detailed Design Reports for two landfill operations within Ontario that have been captured through updated MOECC regulatory standards. Mr. Boss has also completed the construction administration and oversight for the landfill gas collection and control system at both the Stratford and Humberstone Landfill Sites including compliance assessments with the Technical Standards and Safety Authority (TSSA) and other applicable regulatory bodies.

## 11. Statement of Verification

Union Gas reported 14,615,357 tonnes $CO_2e$ as the total 2016 ON.400 emissions. This assertion includes the GHG emissions resulting from the distribution of natural gas from January 1 through December 31, 2016.

GHD's responsibility was to express a conclusion as to whether the assertions are fairly represented, in all material respects, in accordance with O. Reg. 452/09. GHD completed the verification in accordance with the *ISO 14064 Greenhouse gases - Part 3: Specification with guidance for the validation and verification of greenhouse gas assertions*, *ISO 14064* Greenhouse gases – *Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals,* and O. Reg. 452/09*.* GHD completed the work to provide a reasonable level of assurance. The work conducted is believed to provide an appropriate basis for this verification statement.

Based on GHD's verification, the reported 2016 ON.400 emissions are free of misstatements, in all material aspects, and in accordance with O. Reg. 452/09 and associated guidance and relevant criteria.

## 12. Limitation of Liability

Because of the inherent limitations in any internal control structure, it is possible that fraud, error, or non-compliance with laws and regulations may occur and not be detected. Further, the verification was not designed to detect all weakness or errors in internal controls so far as they relate to the requirements set out above as the verification has not been performed continuously throughout the period and the procedures performed on the relevant internal controls were on a test basis. Any projection of the evaluation of control procedures to future periods is subject to the risk that the procedures may become inadequate because of changes in conditions, or that the degree of compliance with them may deteriorate.

The verification opinion expressed in this report has been formed on the above basis.

GHD's review of the 2016 ON.400 emissions included only the information discussed above. While the review included observation of the systems used for determination of the 2016 ON.400 emissions, GHD did not conduct any direct field measurements and has relied on the primary measurement data and records provided by Union Gas as being reliable and accurate. No other information was provided to GHD or incorporated into this review. GHD assumes no responsibility or liability for the information with which it has been provided by others.

The information and opinions rendered in this report are exclusively for use by Union Gas. GHD will not distribute or publish this report without Union Gas' consent except as required by law or court order. The information and opinions expressed in this report are given in response to a limited assignment and should only be evaluated and implemented in connection with that assignment. GHD accepts responsibility for the competent performance of its duties in executing the assignment and preparing this report in accordance with the normal standards of the profession, but disclaims any responsibility for consequential damages.

All of Which is Respectfully Submitted,

GHD

Gordon Reusing, M.A.Sc., P.Eng

Brent Boss, P.Eng.

NR/jp/17

cc: Neil Risk (GHD)

UNION GAS LIMITED

Answer to Interrogatory from
Canadian Manufacturers & Exporters ("CME")

Reference: Exhibit 3, Tab 4, pp. 19-20

Preamble: At Exhibit 3, Tab 4, pages 19 and 20, Union states that "The second approach includes a quarterly review of Union's compliance instrument procurement activities by the Cap-and-Trade Compliance Governance Committee. This committee was established in early 2017 to provide an additional level of executive oversight on the compliance instrument procurement function, recognizing the newness of Cap-and-Trade and related processes. During 2017, the mandate of the committee was broadened to incorporate all aspects of compliance planning including abatement."

Question:

a) What caused Union to broaden the Cap-and-Trade Compliance Governance Committee's mandate during 2017?
b) Was there another body that previously oversaw all aspects of compliance planning, or is this an increase in overall oversight?

---

Response:

a) Union expanded the scope of the Cap-and-Trade Compliance Governance Committee in 2017 recognizing that over time compliance plans will become more sophisticated and complex. As an example, the 2018 Compliance Plan has an expanded scope including both customer and facility abatement.

b) The addition of this scope to the Cap-and-Trade Compliance Governance Committee increases overall oversight to provide a holistic view of Cap–and-Trade compliance. The functional accountabilities and oversight for other aspects of the compliance planning (such as customer and facility abatement) also remain in place.

UNION GAS LIMITED

Answer to Interrogatory from
Canadian Manufacturers & Exporters ("CME")

Reference: Exhibit 1, p. 5

Preamble: At Exhibit 1, page 5, Union states that "Union proposes to establish a Low Carbon Initiative Fund within the GGEIDA, as described at Exhibit 3, Tab 5, section 4.2. The Fund ensures a stable and predictable level of funding of up to $2 million per year (beginning in 2018) so that Union can proactively identify and develop abatement ideas to consistently feed and move through the development process, with the goal of realizing abatement over the longer term."

Question:

a) What threshold(s) will a project have to meet before being eligible for Low Carbon Initiative Fund funding?
b) Is the $2 million funding limit a hard limit? In other words, if the amount of eligible projects was larger than $2 million, would some projects be deferred? If so, on what basis would Union decide which projects to defer?
c) Has Union investigated whether the provincial government would be willing to fund novel abatement programs? If so, what was their response? If not, why not?

---

Response:

a) There is no monetary threshold for a project to be eligible for the Low Carbon Initiative Fund. Instead, Union will pursue projects that meet the selection criteria laid out in the technology and innovation selection approach, described in more detail in the response at Exhibit B.Staff.21 a). These criteria can range from environmental performance and GHG emissions and energy efficiency to financials and design capability and competency, enabling Union to increase the number and the diversity of projects it pursues and accelerate Ontario's transition to a low-carbon economy.

b) Yes, the $2 million funding limit is a hard limit. Depending on the nature of the projects, Union would work with a variety of partners such as other natural gas and electric LDCs, industry partners, technology providers, energy associations, academia, and others to complement the LCIF and increase the number and the diversity of projects it pursues and accelerate Ontario's transition to a low-carbon economy.

c) Please see the response at Exhibit B.Staff.19 a).

UNION GAS LIMITED

Answer to Interrogatory from
Canadian Manufacturers & Exporters ("CME")

Reference: EB-2017-0224 Exhibit C, Tab 5, Schedule 1, p. 11

Preamble: At Exhibit C, Tab 5, Schedule 1, page 11, EGD states that "Enbridge will require two additional full time equivalent ("FTE") employees to support the Company's efforts to identify, formulate and begin to implement on new or expanded abatement activities within the Initiative Funnel."

Question: Please confirm whether Union will also need to increase its employee complement to support the initiative fund or the Low Carbon Initiative Fund programs.

---

Response:
Confirmed. There will be no incremental FTE beyond what Union has already identified in its 2018 forecasted administration costs. Three roles for Technology, Innovation and Offsets were established in late 2016 and have been ramped up throughout 2017, continuing into 2018.

UNION GAS LIMITED

Answer to Interrogatory from
Environmental Defence ("ED")

Reference: Exhibit 3, Tab 4, Appendix A, pp. 1-7

Question: Please provide a copy of the report prepared by ICF entitled "Impacts of Ontario's Proposed Climate Policy" and dated July 7, 2015.

---

Response:
This study is not referenced in Union's application.

Union understands that EGD filed the above referenced presentation as part of the 2017 Compliance Plan proceeding. Please refer to EGD's response to Environmental Defence interrogatory number 1.

UNION GAS LIMITED

Answer to Interrogatory from
Environmental Defence ("ED")

Reference: Exhibit 3, Tab 4, Appendix A, pp. 1-7

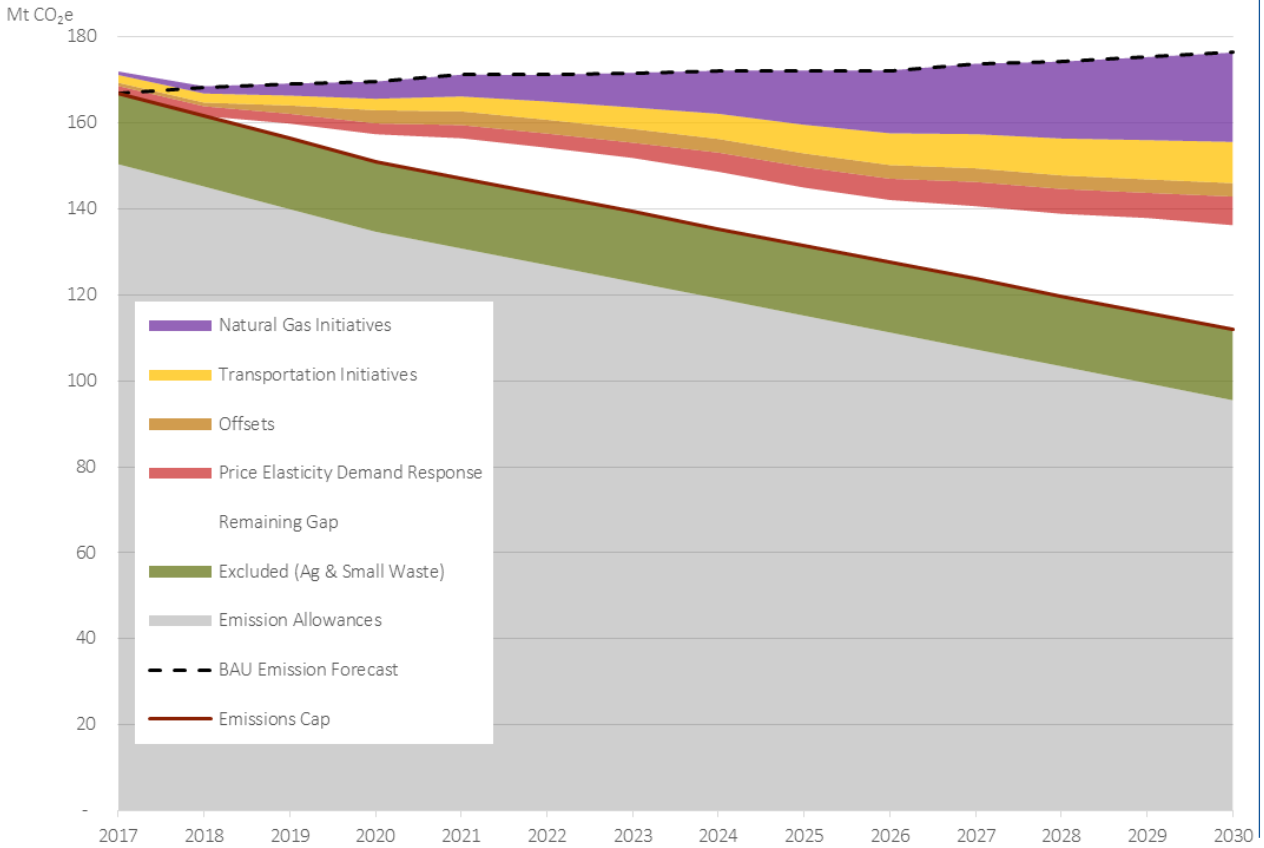
Question: Please provide a copy of any reports or presentations related to the same topics discussed in ICF, *Impacts of Ontario's Proposed Climate Policy*, dated July 7, 2015. Please include any reports or presentations by ICF providing updated or revised information following its July 7, 2015 report.

---

Response:
Please see updated information completed by ICF as follows:

- Attachment A – Completed November 2015 for Union and EGD jointly
- Attachment B – Completed April 2016 for Union, following the release of the draft Cap-and-Trade Regulations

# Ontario Emissions Reduction Forecast: With Free Allocation to Natural Gas Distributors



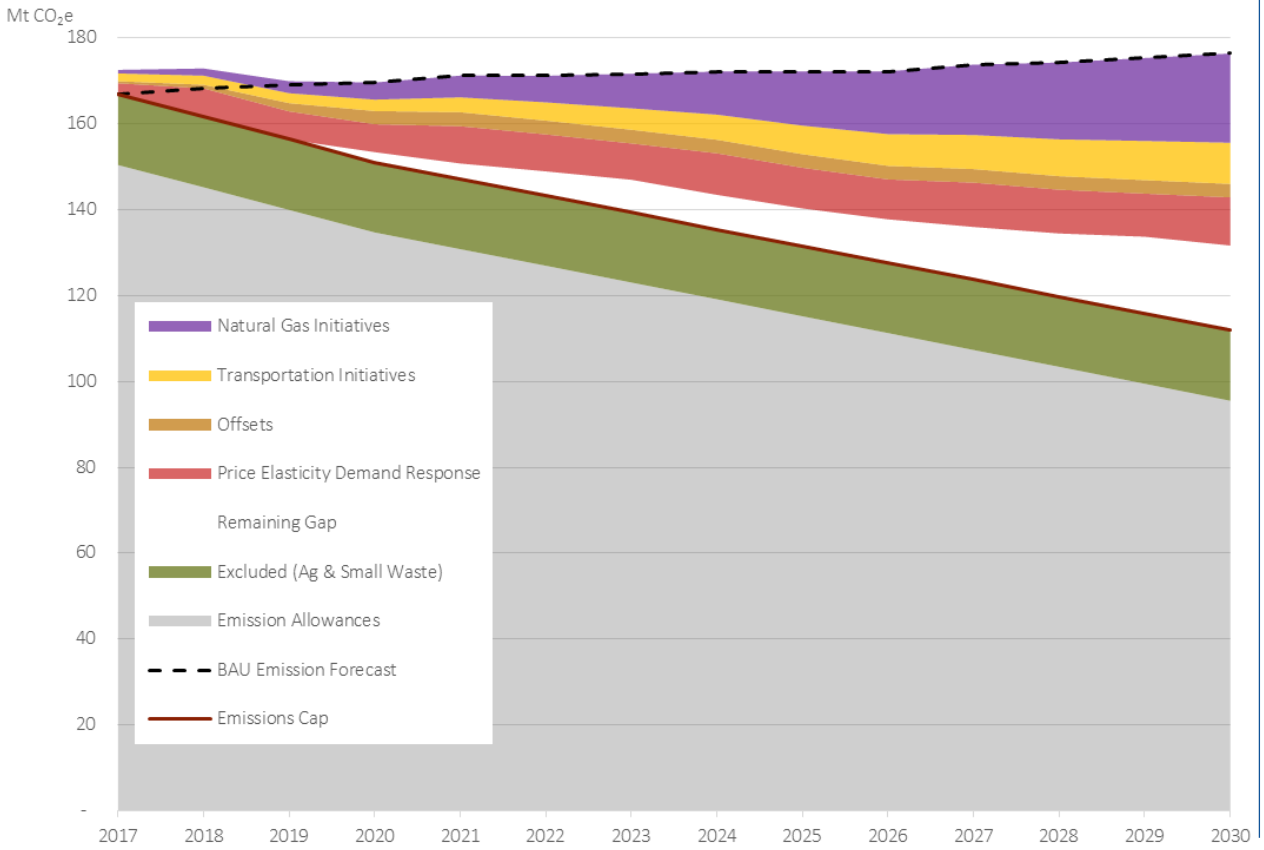

C&T scenario with free allocation informed by UG/EGD activity data and assumptions.

By 2030

- NG related initiatives **reduce emissions by 21 Mt $CO_2e$**, the largest GHG reduction potential in the study timeframe.
- Non-NG transport initiatives **reduce emissions by 10 Mt $CO_2e$**.
- Elasticity demand response to increasing fuel prices results in **reductions of 7 Mt $CO_2e$**.
- Gap of **24 Mt $CO_2e$**

Cumulative allowance shortage of **161 Mt $CO_2e$** from 2017-2030.

# Ontario Emissions Reduction Forecast: No Free Allocation to Natural Gas Distributors



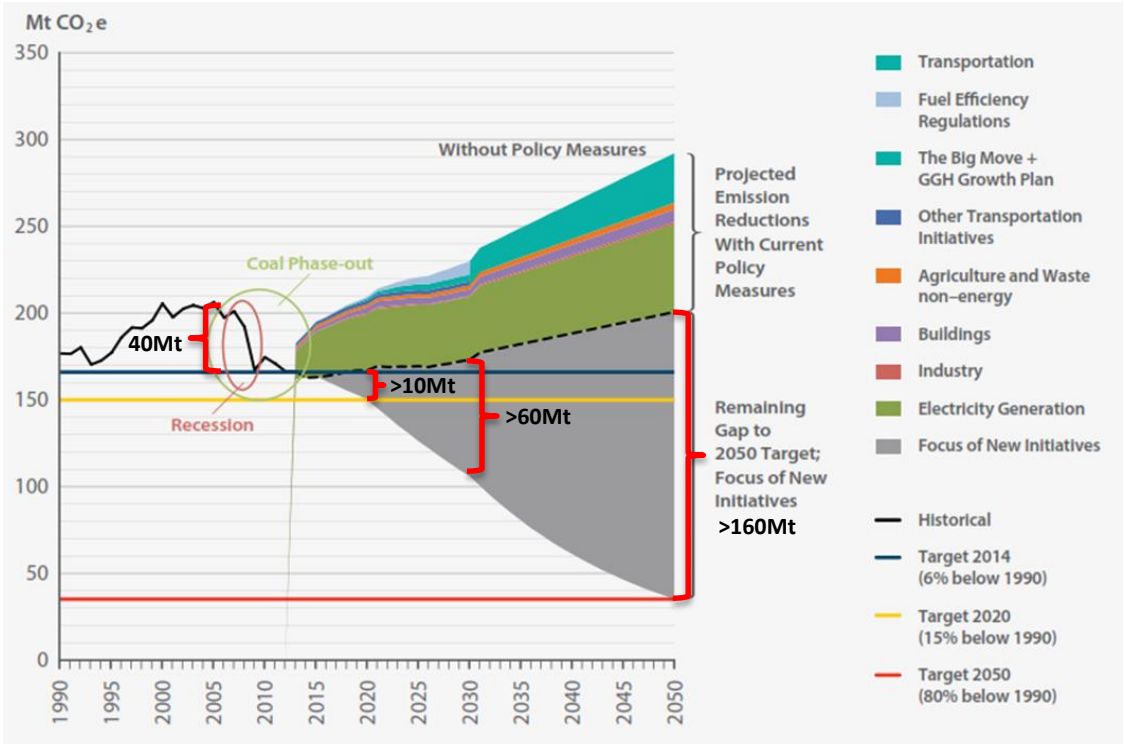

C&T scenario assuming no free allocation informed by UG/EGD activity data and assumptions.

By 2030

- NG related initiatives **reduce emissions by 21 Mt $CO_2e$**, the largest GHG reduction potential in the study timeframe
- Non-NG transport initiatives **reduce emissions by 10 Mt $CO_2e$**.
- Elasticity demand response to increasing fuel prices results in **reductions of 11 Mt $CO_2e$**.
- Gap of **20 Mt $CO_2e$**

Cumulative allowance shortage of **100 Mt $CO_2e$** from 2017-2030.

# Ontario has defined 2020 and 2030 targets and a linear path to de-carbonization by 2050



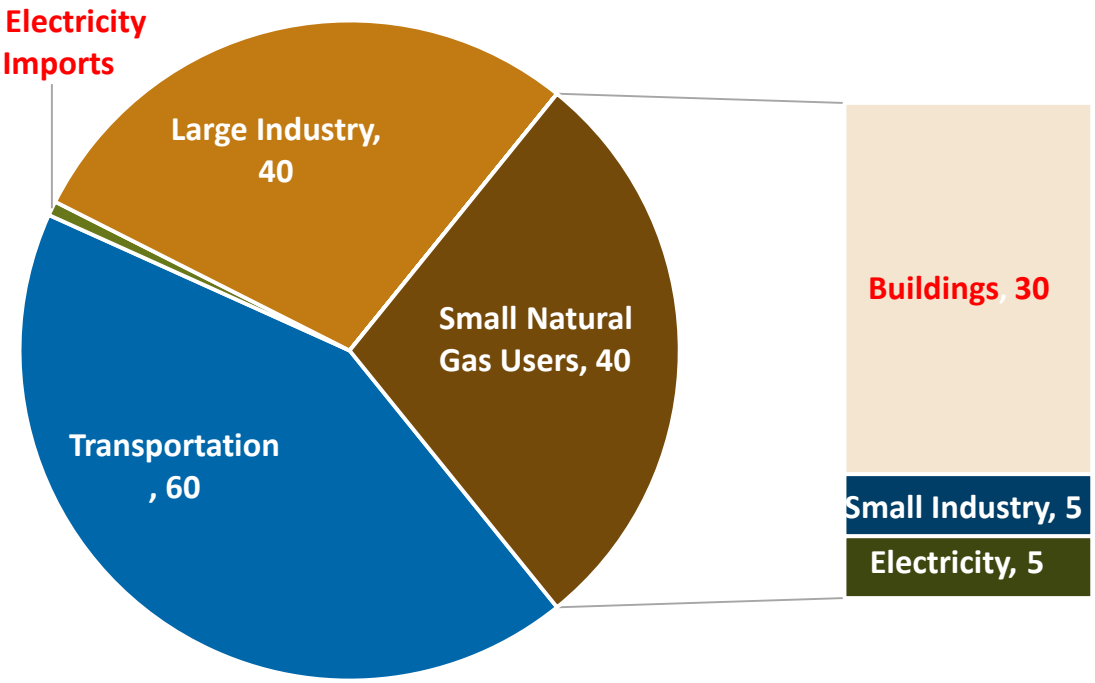

Significant reductions from 2005 to 2010. >40 Mt (20%).

Ontario's emission targets established versus 1990 baseline. 2020 (15%), 2030 (37%) and 2050 (80%).

Current measures identified for public transportation and energy efficiency.

Future reductions required to fill gap...

# Based on Ontario's emissions profile reductions needed from NG and transport fuel use




**Ontario Forecast 2017 GHG emissions for sectors / sources covered under proposed cap and trade ($MtCO_2e$)**

NG and transportation fuel each meet 33% of energy demand and electricity meets 25%.

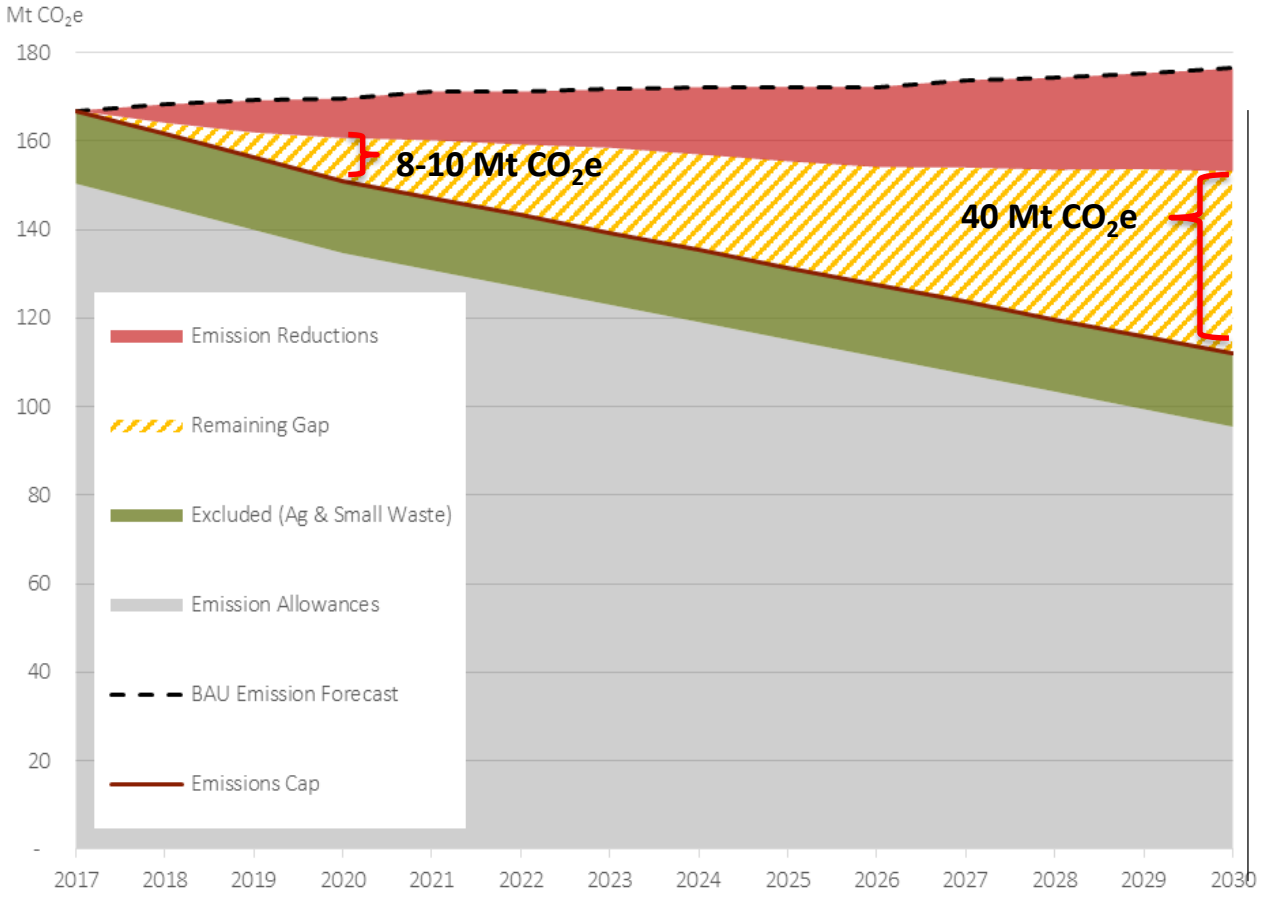
NG share of energy demand expected to grow over next 15 years.

**Cap declines from 142M in 2017 to 124M in 2020 = 532M (avg 133M/yr)**

To meet a 2030 target NG and transportation fuel use would need to decline by 50%.

Unlikely to influence consumer behavior – transport / NG use with a price on $CO_2$ alone.

# ICF Ontario Emission Reduction Forecast




Informed by ICF economy wide model.

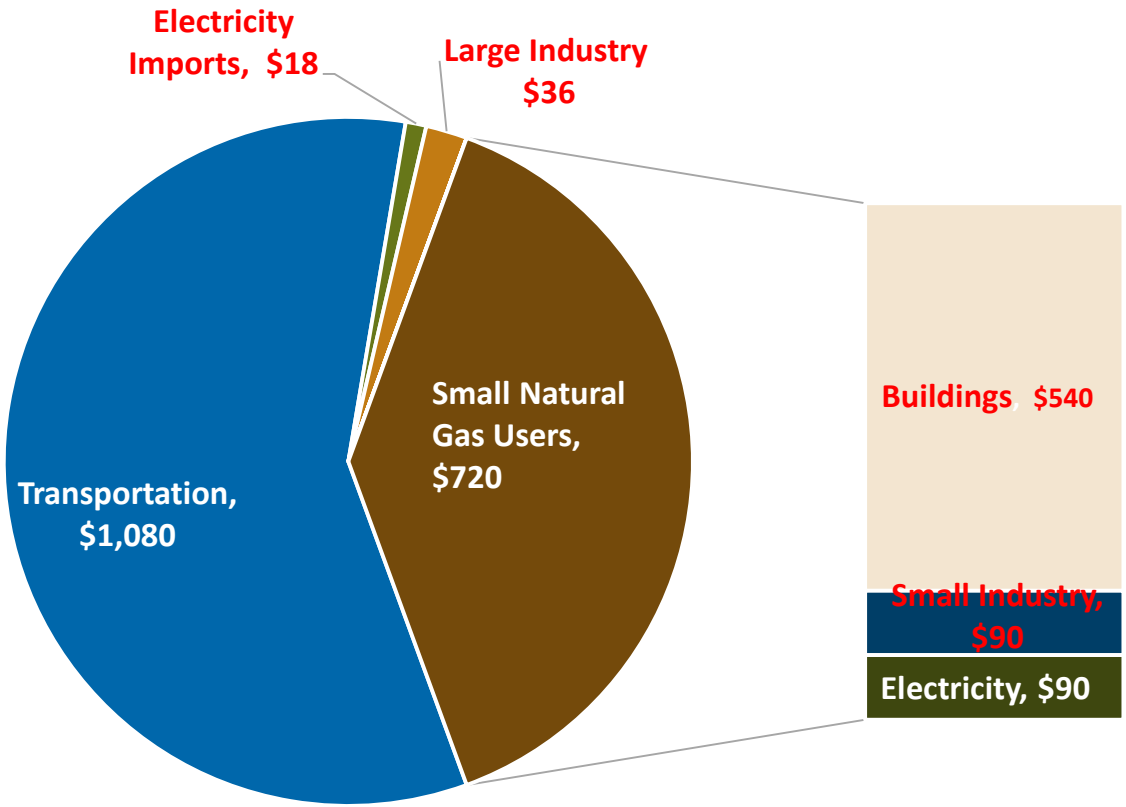
Identified reductions available at less than $100 / t $CO_2e$ and within 2030 timeframe.

By 2030

- NG related initiatives (RNG, EE, LNG/CNG, CHP) reduce emissions by 10-12 Mt $CO_2e$.
- Refined fuel initiatives reduce emissions by 5-8 Mt $CO_2e$.
- Response to increasing fuel prices reduce 3-5 Mt $CO_2e$.

- **As a result of the 40 Mt $CO_2e$ gap, Ontario is expected to enter the market short.**
- **This is NOT the "UG/EGD view" where the 2030 gap is closer to 25 Mt $CO_2e$.**
- **The 2017-2020 gap is NOT updated based on the "cap" defined in the Draft Reg**

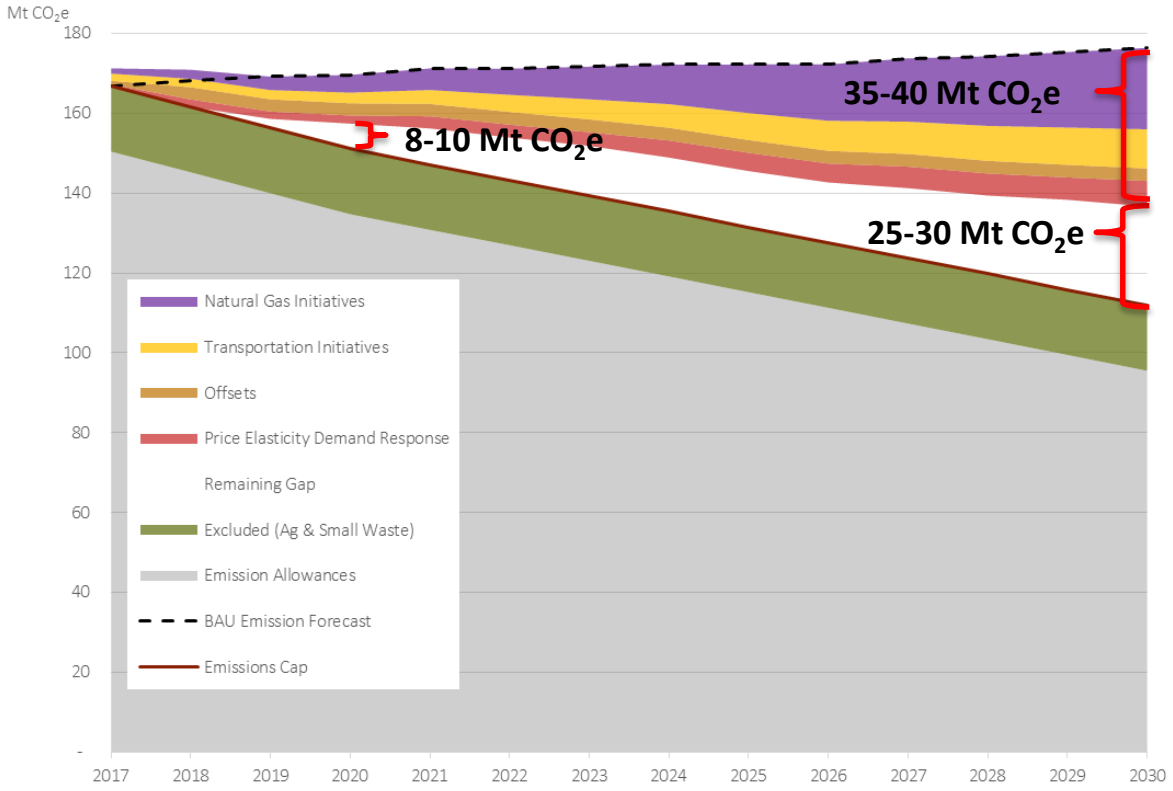
# Year 1: >$1.8B in revenue from sale of allowance via auction. Mostly from the small energy user.




**Ontario Forecast Year 1 (2017/18) proceeds of sale of allowance (Million $s) – assuming $18/tCO2e (WCI = $14US@0.77)**

- 142M+ total allowances in Year 1
- ~38M free allocated to large industry (95% of 40M) = $0
- ~104M allowances auctioned.
  - ~$1.1B (60M) for transport fuels (6-12 buyers).
  - >$700M (40M) for NG small end users and NG generators (2 buyers).
  - <40$M (2M) by 100 large industrials (for portion not free allocated).
  - <$20M (<1M) by electricity importers.
- @18$/tCO2 the average family will pay +$85/yr for NG and +$106/yr for transport fuel.

# UG/EGD Ontario Emission Reduction Forecast




Informed by ICF economy wide model and UG / EGD data.

By 2030

- NG related initiatives (RNG, EE, LNG/CNG,CHP) reduce emissions by 20 Mt $CO_2e$.
- Refined fuel initiatives reduce emissions by 10 Mt $CO_2e$.
- Response to increasing fuel prices reduce 5 Mt $CO_2e$.

- Gap of 25-30 Mt $CO_2e$.

**ASSESS IMPACT of 25-30 Mt $CO_2e$ gap?**

UNION GAS LIMITED

Answer to Interrogatory from
Environmental Defence ("ED")

Reference: Exhibit 3, Tab 4, Appendix A, pp. 1-7

Question: Please provide Union's cumulative TRC net benefits to date from all of its programs since the inception of its DSM program.

---

Response:
The Total Resource Cost ("TRC") net benefit resulting from Union's DSM programs (1997 to 2016) to date is $3,148,013,000. Please see Table 1 below for a detailed breakdown of annual TRC net benefits.

**Table 1**

| **Year** | **TRC Net Benefits ($000)** |
|---|---|
| 1997 | $76,300 |
| 1998 | $38,000 |
| 1999 | $41,900 |
| 2000 | $43,859 |
| 2001 | $47,776 |
| 2002 | $76,194 |
| 2003 | $47,364 |
| 2004 | $70,167 |
| 2005 | $97,106 |
| 2006 | $184,677 |
| 2007 | $215,896 |
| 2008 | $262,754 |
| 2009 | $308,256 |
| 2010 | $284,133 |
| 2011 | $325,657 |
| 2012 | $232,147 |
| 2013 | $326,341 |
| 2014 | $107,725 |
| 2015 (Pre-audit) | $161,193 |
| **Total (Pre-audit)** | **$2,947,446** |

UNION GAS LIMITED

Answer to Interrogatory from
Environmental Defence ("ED")

Reference: Exhibit 3, Tab 4, Appendix A, pp. 1-7

Question:

a) Please provide a forecast of the natural gas savings (cubic metres) and GHG emission reductions (tonnes) in 2018 for Union's 2018 DSM programs.
b) Please provide a forecast of the lifetime natural gas savings (cubic metres) and GHG emission reductions (tonnes) for Union's 2018 DSM programs.

Please use the methodology used to calculate the gas and emissions reductions for the 2017 programs in EB-2016-0296, Exhibit B.ED.1 (g) & (h), or explain why a different methodology would be appropriate.

---

Response:

a) Annual natural gas savings for 2018 DSM are expected to be 163,085,869 $m^3$ and as a result Greenhouse Gas reductions are expected to be 305,786 tonnes.

b) Lifetime natural gas savings for 2018 DSM are expected to be 2,391,624,849 $m^3$ and as a result Greenhouse Gas reductions are expected to be 4,484,297 tonnes.

Above values for 2018 were derived using the same methodology used to calculate the gas and emissions reductions for the 2017 programs as stated in Union's 2017 Compliance Plan proceeding (EB-2016-0296) in response to interrogatory Exhibit B.ED.1 g) & h).

UNION GAS LIMITED

Answer to Interrogatory from
Environmental Defence ("ED")

Reference: Exhibit 3, Tab 4, Appendix A, pp. 1-7

Question: Please provide an estimate of the value of the lifetime GHG emissions reductions from Union's 2018 DSM programs using forecast annual GHG reductions and the Board's Long-Term Carbon Price Forecast Report. The table below is an illustration of the required analysis. Please complete that table for the 2018 DSM program as a whole and for the 2018 DSM program each sector (residential, commercial, etc.). Please make, state, and discuss any assumptions as necessary, including any assumptions used to allocate the lifetime savings to each year. Please make best efforts to provide a response and include any caveats if necessary.

| **Value of Lifetime GHG Emissions Reductions from 2018 DSM Program** | | | | | |
|---|---|---|---|---|---|
| | 2018 | 2019 | … | Last year of lifetime savings | Total for all years |
| Forecast annual gas savings ($m^3$) | | | | | |
| Forecast annual GHG reduction (t co2e) | | | | | |
| Forecast carbon price | | | | | |
| Value of GHG reduction | | | | | |

---

Response:
Please see Attachment A for the above table in the following formats:

- 2018 DSM Residential Sector – Residential program and Low Income program (single family only)
- 2018 DSM Commercial/Industrial Sector – Commercial/Industrial program, Performance-Based program, and Low Income program (multi-family only)
- 2018 DSM Large Volume Sector – Large Volume program

*Notes:*

- *Not all DSM program participants are required to pay the price of carbon, as they may be managing their own compliance obligation.*
- *Union utilized the Mid-Range LTCPF for all tables. The LTCPF is available to 2028 only; for years beyond 2028 Union assumed the 2028 price.*

- *Union utilized the following measure lives, based on the typical measure life for the measures in the programs within each sector. These measure lives are estimates only.*
    - *Residential sector – 25 years*
    - *Commercial/Industrial sector – 17 years*
    - *Large Volume sector – 12 years*
- *The 2018 annual savings figures are based on the Excel spreadsheet provided in the response at Exhibit B.GEC.2 d).*

**Value of Lifetime GHG Emissions Reductions from 2018 DSM Residential Sector**

| | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | Total Lifetime Savings |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Forecast annual gas savings (m3)** | 7,398,170 | 7,398,170 | 7,398,170 | 7,398,170 | 7,398,170 | 7,398,170 | 7,398,170 | 7,398,170 | 7,398,170 | 7,398,170 | 7,398,170 | 7,398,170 | 7,398,170 | 7,398,170 | 7,398,170 | 7,398,170 | 7,398,170 | 7,398,170 | 7,398,170 | 7,398,170 | 7,398,170 | 7,398,170 | 7,398,170 | 7,398,170 | 7,398,170 | 184,954,250 |
| **Forecast annual GHG reduction (t co2e)** | 13,872 | 13,872 | 13,872 | 13,872 | 13,872 | 13,872 | 13,872 | 13,872 | 13,872 | 13,872 | 13,872 | 13,872 | 13,872 | 13,872 | 13,872 | 13,872 | 13,872 | 13,872 | 13,872 | 13,872 | 13,872 | 13,872 | 13,872 | 13,872 | 13,872 | 346,789 |
| **Forecast carbon price (Mid-Range LTCPF)** | $ 17 | $ 18 | $ 18 | $ 19 | $ 20 | $ 21 | $ 31 | $ 36 | $ 43 | $ 50 | $ 57 | $ 57 | $ 57 | $ 57 | $ 57 | $ 57 | $ 57 | $ 57 | $ 57 | $ 57 | $ 57 | $ 57 | $ 57 | $ 57 | $ 57 | Not Applicable |
| **Value of GHG reduction** | $ 235,817 | $ 249,688 | $ 249,688 | $ 263,560 | $ 277,431 | $ 291,303 | $ 430,019 | $ 499,376 | $ 596,477 | $ 693,578 | $ 790,679 | $ 790,679 | $ 790,679 | $ 790,679 | $ 790,679 | $ 790,679 | $ 790,679 | $ 790,679 | $ 790,679 | $ 790,679 | $ 790,679 | $ 790,679 | $ 790,679 | $ 790,679 | $ 790,679 | $ 15,647,130 |

**Value of Lifetime GHG Emissions Reductions from 2018 DSM Commercial/Industrial Sector**

| | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | Total Lifetime Savings |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Forecast annual gas savings (m3)** | 72,138,369 | 72,138,369 | 72,138,369 | 72,138,369 | 72,138,369 | 72,138,369 | 72,138,369 | 72,138,369 | 72,138,369 | 72,138,369 | 72,138,369 | 72,138,369 | 72,138,369 | 72,138,369 | 72,138,369 | 72,138,369 | 72,138,369 | | | | | | | | | 1,226,352,273 |
| **Forecast annual GHG reduction (t co2e)** | 135,259 | 135,259 | 135,259 | 135,259 | 135,259 | 135,259 | 135,259 | 135,259 | 135,259 | 135,259 | 135,259 | 135,259 | 135,259 | 135,259 | 135,259 | 135,259 | 135,259 | | | | | | | | | 2,299,411 |
| **Forecast carbon price (Mid-Range LTCPF)** | $ 17 | $ 18 | $ 18 | $ 19 | $ 20 | $ 21 | $ 31 | $ 36 | $ 43 | $ 50 | $ 57 | $ 57 | $ 57 | $ 57 | $ 57 | $ 57 | $ 57 | | | | | | | | | Not Applicable |
| **Value of GHG reduction** | $ 2,299,411 | $ 2,434,670 | $ 2,434,670 | $ 2,569,929 | $ 2,705,189 | $ 2,840,448 | $ 4,193,043 | $ 4,869,340 | $ 5,816,156 | $ 6,762,972 | $ 7,709,788 | $ 7,709,788 | $ 7,709,788 | $ 7,709,788 | $ 7,709,788 | $ 7,709,788 | $ 7,709,788 | | | | | | | | | $ 90,894,345 |

**Value of Lifetime GHG Emissions Reductions from 2018 DSM Large Volume Sector**

| | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | Total Lifetime Savings |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Forecast annual gas savings (m3)** | 83,549,330 | 83,549,330 | 83,549,330 | 83,549,330 | 83,549,330 | 83,549,330 | 83,549,330 | 83,549,330 | 83,549,330 | 83,549,330 | 83,549,330 | 83,549,330 | | | | | | | | | | | | | | 1,002,591,963 |
| **Forecast annual GHG reduction (t co2e)** | 156,655 | 156,655 | 156,655 | 156,655 | 156,655 | 156,655 | 156,655 | 156,655 | 156,655 | 156,655 | 156,655 | 156,655 | | | | | | | | | | | | | | 1,879,860 |
| **Forecast carbon price (Mid-Range LTCPF)** | $ 17 | $ 18 | $ 18 | $ 19 | $ 20 | $ 21 | $ 31 | $ 36 | $ 43 | $ 50 | $ 57 | $ 57 | | | | | | | | | | | | | | Not Applicable |
| **Value of GHG reduction** | $ 2,663,135 | $ 2,819,790 | $ 2,819,790 | $ 2,976,445 | $ 3,133,100 | $ 3,289,755 | $ 4,856,305 | $ 5,639,580 | $ 6,736,165 | $ 7,832,750 | $ 8,929,335 | $ 8,929,335 | | | | | | | | | | | | | | $ 60,625,483 |

**Value of Lifetime GHG Emissions Reductions from 2018 DSM Programs**

| | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | Total Lifetime Savings |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Forecast annual gas savings (m3)** | 163,085,869 | 163,085,869 | 163,085,869 | 163,085,869 | 163,085,869 | 163,085,869 | 163,085,869 | 163,085,869 | 163,085,869 | 163,085,869 | 163,085,869 | 163,085,869 | 79,536,539 | 79,536,539 | 79,536,539 | 79,536,539 | 79,536,539 | 7,398,170 | 7,398,170 | 7,398,170 | 7,398,170 | 7,398,170 | 7,398,170 | 7,398,170 | 7,398,170 | 2,413,898,486 |
| **Forecast annual GHG reduction (t co2e)** | 305,786 | 305,786 | 305,786 | 305,786 | 305,786 | 305,786 | 305,786 | 305,786 | 305,786 | 305,786 | 305,786 | 305,786 | 149,131 | 149,131 | 149,131 | 149,131 | 149,131 | 13,872 | 13,872 | 13,872 | 13,872 | 13,872 | 13,872 | 13,872 | 13,872 | 4,526,060 |
| **Forecast carbon price** | $ 17 | $ 18 | $ 18 | $ 19 | $ 20 | $ 21 | $ 31 | $ 36 | $ 43 | $ 50 | $ 57 | $ 57 | $ 57 | $ 57 | $ 57 | $ 57 | $ 57 | $ 57 | $ 57 | $ 57 | $ 57 | $ 57 | $ 57 | $ 57 | $ 57 | Not Applicable |
| **Value of GHG reduction** | $ 5,198,362 | $ 5,504,148 | $ 5,504,148 | $ 5,809,934 | $ 6,115,720 | $ 6,421,506 | $ 9,479,366 | $ 11,008,296 | $ 13,148,798 | $ 15,289,300 | $ 17,429,802 | $ 17,429,802 | $ 8,500,468 | $ 8,500,468 | $ 8,500,468 | $ 8,500,468 | $ 8,500,468 | $ 790,679 | $ 790,679 | $ 790,679 | $ 790,679 | $ 790,679 | $ 790,679 | $ 790,679 | $ 790,679 | $ 167,166,957 |

UNION GAS LIMITED

Answer to Interrogatory from
Environmental Defence ("ED")

Reference: Exhibit 3, Tab 4, Appendix A, pp. 1-7

Question: Although the benefits of conservation (e.g. reduced gas usage and reduced bills) stretch out over many years, the costs are often primarily borne in the first year. Please describe and assess options to match the benefits and the costs associated with conservation in time over the lifetime of the measures, including financing conservation by including it in rate base or with debt.

---

Response:
For the purpose of Union's 2018 Compliance Plan, the benefits of energy conservation programs was determined using the lifetime natural gas savings for energy conservation measures in conjunction with the LTCPF, and was matched to the upfront costs required to deliver the energy conservation measures. Union's assessment of benefits and costs of energy conservation programs was informed by the CPS and the MACC Report.

Union did not assess other methods of matching long-term benefits of energy conservation measures to the upfront costs to deliver the energy conservation measures. Such an exercise is outside the scope of the 2018 Compliance Plan proceedings and would warrant review and consideration by stakeholders and the OEB.

Further, Union submits that the assessment of benefits and costs for energy conservation programs is included within the DSM Framework, and that the Cap-and-Trade Framework should not duplicate the DSM Framework. Please see the response at Exhibit B.GEC.22.

UNION GAS LIMITED

Answer to Interrogatory from
Environmental Defence ("ED")

Reference: Exhibit 3, Tab 4, Appendix A, pp. 1-7

Question: Although the benefits of conservation (e.g. reduced gas usage and reduced bills) stretch out over many years, the costs are often borne primarily in the first year. If conservation were treated as a capital cost, and included in rate base, the costs would better match the benefits in time and the first year rate impact would decrease significantly.

What would the first year rate impact be of one dollar of conservation spending if it was (a) rate based instead of treated as an operating cost or (b) financed using the lowest cost debt available to Union?

Please make, state, and discuss any assumptions as necessary, including any assumptions used to allocate the lifetime savings to each year. Please make best efforts to provide a response and include any caveats if necessary.

---

Response:
Please see the response at Exhibit B.ED.25.

UNION GAS LIMITED

Answer to Interrogatory from
Environmental Defence ("ED")

Reference: Exhibit 3, Tab 4, Appendix A, pp. 1-7

Question: Please provide all studies and internal analysis prepared by or for Union with respect to the costs and benefits of proposing incremental customer abatement as part of its 2018 Cap and Trade Compliance Plan.

---

Response:
Union utilized the MACC Report, CPS, and LTCPF to assess the costs and benefits of proposing incremental customer abatement as part of its 2018 Cap and Trade Compliance Plan. Union's analysis of these studies is provided in its application at Exhibit 3, Tab 4 and Exhibit 3, Tab 4, Appendix A.

Please see the responses at Exhibit B.Staff.17, at Exhibit B.Staff.29, and at Exhibit B.Staff.31 a)-c), for further details regarding Union's analysis.

UNION GAS LIMITED

Answer to Interrogatory from
Environmental Defence ("ED")

Reference: Exhibit 3, Tab 4, Appendix A, pp. 1-7

Question: Please provide a table listing Ontario most current GHG emissions reductions targets.

---

Response:
Ontario's GHG emissions reductions targets are as follows:[1]

- 15% below 1990 levels by 2020
- 37% below 1990 levels by 2030
- 80% below 1990 levels by 2050

[1] Bill 172, Section 6 (1)

UNION GAS LIMITED

Answer to Interrogatory from
Environmental Defence ("ED")

Reference: Exhibit 3, Tab 4, Appendix A, pp. 1-7

Question: Approximately what percent of Ontario's GHG emissions are currently attributable to natural gas (please provide the most up-to-date figure available).

---

Response:
Please see Attachment 1 to the response at Exhibit B.Energy Probe.7 a). Union understands that in response to a similar question, EGD has referenced a study that quotes the percentage of Ontario's GHG emissions attributable to natural gas as 22%. Union's response at Exhibit B.Energy Probe.7 a) references approximately 26% as the percentage of Ontario's GHG emissions attributable to natural gas. Union notes that these two figures offer a representative range of Ontario's GHG emissions attributable to natural gas.

UNION GAS LIMITED

Answer to Interrogatory from
Environmental Defence ("ED")

Reference: Exhibit 3, Tab 4, Appendix A, pp. 1-7

Question: By letter dated February 9, 2017, the Board established a Technical Advisory Group for the development of a Long-Term Carbon Price Forecast (LTCPF) and a Marginal Abatement Cost Curve (MACC). This included two members from Union. Please provide a copy of all documents circulated through that process relating to the MACC that are in Union's possession. Please include documents emailed to and from Union's representatives on the Advisory Group relating to the MACC, but do not limit it only to those individuals (e.g. include other documents or data that may have been provided to ICF by other Union staff).

---

Response:
Union has included all documents that were circulated as part of the Technical Advisory Group ("TAG") in relation to the Marginal Abatement Cost Curve ("MACC") process. These documents relate to the TAG meetings and to the Draft MACC Report. Union has also included correspondence related to the LTCPF that was provided to the OEB as part of the TAG process.

1. **OEB TAG Meeting #1:**
   - TAG Meeting Date: February 21, 2017
   - TAG Meeting Location: Ontario Energy Board
   - Related Documents Circulated:
     - Please see Attachment A

2. **ICF-OEB Draft LTCPF Report:**
   - Correspondence related to Draft LTCPF Report issued April 26, 2017
   - Related Documents Circulated:
     - Please see Attachment B

3. **OEB TAG Meeting #2:**
   - TAG Meeting Date: June 8, 2017
   - TAG Meeting Location: Ontario Energy Board
   - Related Documents Circulated:
     - Please See Attachment C

4. **ICF-OEB Draft MACC Report:**
   - Date Draft MACC Report was issued: July 21, 2018
   - Documents Circulated:
     - Please refer to all files named:

- Attachment D
- Attachment E

**OEB Technical Advisory Group: Union Gas Comments**
**March 1, 2017**

**Key Messages:**

- Union believes that the development of the initial LTCPF and MACC should include another review / comment period by the TAG (or at least by the utilities) before they are finalized. This additional review session will allow the TAG to view the outcomes of the initial feedback provided to ensure the highest quality and most accurate end product is being produced that it is aligned with its intended objectives.
- Union believes that the Master Excel analytics tool that ICF will deliver to the OEB should also be available to the utilities for use when evaluating customer abatement options; this will ensure that all parties are working from a consistent set of assumptions, which would have been created as part of the stakeholder engagement process.

**Feedback to the OEB's Questions on the LTCPF and MACC Work:**

| PPT Slide # | OEB's Requested Areas of Input | Union Gas Feedback |
|---|---|---|
| **Slide 15** | **1. Conservation Potential Study (CPS) Data:**<br>*What scenario data from the CPS should be used as a basis for the greenhouse gas abatement potential of measures on the MACC? i.e., should a cost-effectiveness screen be applied when selecting which measures to include or exclude from the MACC?* | • Technical potential should be utilized with an "Achievable Potential" screen applied to it.<br>• Economical potential should not be used as a screen at this point, as it screened measures out using a TRC that did not yet include the cost of LTCPF; therefore, some measures could have been screened out unnecessarily.<br>• Union would like to have the key areas of debate/misalignment that arose during the CPS stakeholder engagement process documented within this study to ensure that these are kept top of mind when utilizing this data – so underlying assumptions are considered (e.g. no free rider rate included). |
| **Slide 16** | **1. Definition of MACC Cost Abatement (i.e. $/tCo2e metric)**<br>*What should be included in the cost measurement?*<br>• *Should program admin costs (those related to program delivery,* | • Union would like to see the below included in the cost measurement:<br>▪ Program Costs related to program delivery, including:<br>o Incentive costs<br>o Program costs<br>o Administration costs |

| | | |
|---|---|---|
| | *and those related to the C&T program) be included?*<br>• *Should avoided natural gas costs include all the same aspects as DSM avoided costs (commodity costs, upstream and downstream capacity costs)?*<br>• *Carbon costs are intended to be included as an avoided cost, i.e. assessing lifetime $/t against compliance instruments. If not, how would you suggest incorporating the 10-year LTCPF?*<br>• *Based on the discussion, no costs shall be included for non-energy benefits that are not yet quantified (such as economic, social, and environmental benefits captured under DSM's "TRC-plus" 15% adder).* | ▪ Natural Gas Avoided Costs – which should include:<br>o Commodity Costs<br>o Upstream capacity costs (pipeline and storage costs upstream of the utility city gate)<br>o Downstream distribution system costs (transmission, storage and distribution system downstream of the utility)<br>o Carbon cost<br>▪ Electricity Avoided Costs<br>▪ Upfront capital costs and installation costs<br>▪ Ongoing operation and maintenance costs<br><br>*Union does not believe non-energy benefits should be included within this cost measurement |
| **Slide 20** | **Treatment of Additionally:**<br>*Should the MACC display "all" available customer abatement potential, or only the incremental potential beyond DSM? Should a qualitative discussion of the impact of other abatement activities in the market (such as DSM and future CCAP programs) be included?* | • Union would like to see the MACC display "all" available customer abatement – cost effective and non-cost effective. |
| **Slide 18-19** | **Granularity of MACC Categories (bars)** | • Union agrees with ICF's recommendation to display MACC results by sub-sector (one bar per sub-sector). |

| | | |
|---|---|---|
| | *What "categories" should be displayed as bars on the MACC curve? Should they be end-uses (e.g. residential space heating, industrial process, etc.), or sub-sectors (e.g. offices, hospitals)? Discussions suggested that displaying sectors (residential, commercial, industrial) or individual measures (efficient boiler, optimized industrial process, etc.) were too high level or too granular, respectively.* | • Union would like to understand how Innovation (e.g. RNG), Federal Plan, building codes etc. will be considered/impact the MACC. |
| **Slide 8** | **Timeframe:**<br>*What timeframe is appropriate for the final MACC diagram?*<br>*Some options:*<br>*a) 10-year timeframe from 2018-2028 (including net costs and benefits)*<br>*b) "Snapshot" in 2020*<br>*c) By compliance period (2018-2020) to account for compliance obligation* | • Union would like to see the MACC diagram created by Compliance Period – either three one year snap shots OR one snap shot that shows the average for the three year period. |
| **General** | **General:**<br>*Please comment on the usefulness of including other qualitative or quantitative analyses to test the robustness of the results for both the LTCPF and MACC.* | See '**Other Comments'** below |
| | | |
| **Other Comments** | **Technical Advisory Group:**<br>*LTCPF/MACC Input Process* | • Union believes that the development of the initial LTCPF and MACC should include another |

| | | |
|---|---|---|
| | | review / comment period by the TAG (or at least by the utilities) before they are finalized. This additional review session will allow the TAG to view the outcomes of the initial feedback provided to ensure the highest quality and most accurate end product is being produced that it is aligned with its intended objectives.<br><br>• Union recommends that the quantitative factors / considerations should accompany the forecast once it is issued. These factors are a critical component to ensure that the public audience who will utilize this information outside of the OEB process (e.g. intervenors, stakeholders, other provincial ministries) understand the context and embedded assumptions so the information is used correctly.<br><br>• Union believes that the Master Excel analytics tool that ICF will deliver to the OEB should also be available to utilities for use when evaluating our options. |
| | **Long Term Carbon Price Forecast** | • The maximum LTCPF should represent a maximum market price, and not a maximum auction price. This is important in a scenario where Ontario does not link to WCI (or longer term when WCI is in a net short position); entities will need to go to the secondary market to secure allowances unless they can abate. Alternatively, consideration should be given to presenting both a maximum auction price and a maximum market price scenario.<br>• Program unknowns / assumptions should be clearly spelled for the mid-term pricing:<br>o Assumptions around the Federal Program<br>o The quantum of abatement for demand response, policy/regulations, and CCAP/complementary measures clearly defined<br>• Union endorsed including the proposed regulation amendment in California to deal with excess (unsold) allowances on the market.<br>• Consideration of further sensitivities based on various factors that would impact prices;<br>o Changes in foreign exchange rates<br>o Future WCI linking<br>o Reductions in offsets % in California (and therefore Ontario) |
| | **MACC – Interactive/Cascading** | • Union believes that interactive/cascading should be considered in the MACC. |
| | **RNG Potential: Risks and Assumptions** | The estimated potential of RNG in Ontario must consider a number of risks and underlying / assumptions. These assumptions should be clearly outlined.<br>• Many sources of data and information regarding the RNG potential for Ontario are based on |

| | | |
|---|---|---|
| | | studies that have not been updated for a few years (i.e. 2011 Alberta Innovates Study)<br>• Some of the landfills in Ontario have already committed their landfill biogas to produce electricity under provincial programs such as the 'Feed in Tariffs' ('FIT') program.<br>• Development of RNG from biogas could take up to 3 years from the time of conception to RNG production and will be highly dependent on availability of funding through the Climate Change Action Plan; details of which are not currently available.<br>• A percentage of the RNG potential in Ontario will be developed here but the credits / emission benefits will be sold outside of Ontario (i.e. California).<br>• Union believes the 4% discount rate (which originated from DSM) should be evaluated to determine if it is the right value for the RNG considerations as well. |
| | **RNG Cost to Develop: Risks and Assumptions** | In developing the Cost to Deliver RNG from various sources, a number of underlying factors/assumptions need to be considered that will impact the costs. These assumptions should be clearly outlined.<br>• The distance of the RNG source from a natural gas pipeline.<br>• The take away capacity of the natural gas pipeline (i.e. can the pipeline handle increased capacity from an RNG source?)<br>• The cost to inject into a natural gas pipeline will vary greatly depending upon operating pressure of that pipeline.<br>• The price to develop RNG from biogas will vary over time based on various input prices (e.g. electricity prices).<br>• The risk, and associated market price impact, of RNG from Ontario being developed and injected into an Ontario natural gas pipeline but the credits / emission benefits sold outside of Ontario (i.e. California). |

Hello Rachele and Valerie

Thank you for the opportunity to provide feedback on the draft LTCPF. Our comments / questions are below.

- Union appreciates that ICF has recognized the uncertainty surrounding the various inputs which will impact the LTCPF in their methodology by creating Minimum, Maximum and Base Case scenarios for the LTCPF.
    - As time goes on and these factors are clarified, what is the plan to update the LTCPF?
    - It would be useful to see the uncertainties quantified in terms of the price forecast range
- While a number of assumptions are noted, the sensitivities for significant varying assumptions are not captured and it would be useful to note these
    - For example:
        - *If complementary measures are not achieved as planned*
        - *If linking to WCI does not occur*
        - *If California amendments re. offsets / unsold allowances are passed. (Particularly for the base case where the assumptions are fairly conservative in terms of how tight the market could get).*
- Minimum-Maximum-Base Case Scenarios:
    - Since the LTCPF includes 3 price scenarios and is a key input into the MACC, how will the 3 scenarios be used in the development of the MACC?
- Page 5, Section 1.3 Data Caveats:
    - Union suggests this be categorized as 'reasonable efforts' vs. "best available" estimates
- Page 6, Section 2.1.1, Paragraph 1:
    - The influences on the price of permits also includes offsets, economic activity and complementary regulations
- Page 17, Section 2.4, Paragraph 1:
    - Regarding the phrase "contribute to increasing fairness"; not sure it is a case of fairness; it might be better to say "alignment"
- Page 18, Section 2.4.2:
    - Refers to the assumption of full auction subscription and revenue to fund complementary policies. Do we know what impact this has on the price if this does not happen?
- Page 21 Table:

- Can you confirm these are in Canadian dollars and who the “third party” sources are?

- Page 23, Section 3.2:
  - The assumptions related to the foreign exchange rate could have a substantial impact on the Canadian LTCPF. Were there other alternatives considered?
- Page 25:
  - Describes when the secondary market could exceed – it would be good to have a range or some quantification of this in relation to some key assumptions

    *(e.g. market is tighter because complementary measures not as effective as planned, Cali amendments are made re: offsets, unsold allowances)*
- Page 25, Section 3.5 Mid-Range Scenario Assumptions:
  - Should include that unsold allowances are handled per current regulatory framework, not as proposed which would remove them from the market (would be good to put into context the magnitude of the California length – currently at about 142 MT (i.e. as big as Ontario’s cap for 2017 emissions)
- Page 28 Chart:
  - Is the Maximum LTCPF linked to the market or not?

Please let us know if you have any questions or would like to discuss further. We look forward to reviewing the draft MACC and to our next meeting in early June.

Jeff Hodgins, MBA

Manager, Distribution Business Development Planning

Hello Rachele ……

Thank you for the opportunity to comment on the Draft MACC Report; Union's comments and questions are below.

One overall comment on the MACC information. By its nature and based on the information available, the MACC analysis is underpinned by a lot of assumptions. Union feels that it is very important that these assumptions and how they are applied are clearly understood by the audience of the MACC information so that it is interpreted correctly.

1. Energy Efficiency Section:

a. This MACC curve identifies all abatement opportunity, it does not just identify incremental abatement – above and beyond DSM

b. Details on the screen that was used must be included - Was it the ratepayer, or utility/PAC screen used?

- In addition to identifying which screen was used, please also include the detail around what benefits and costs were included, as well as a comparison to what was originally done in the CPS so it's clear how the two screens are different

c. Any further details on the expectations of how the MACC should be used by the utilities in the development of their Compliance Plans should be included.

d. Union and EGD have very different C/I customer profiles, and the MACC programs could be applied very differently (and have different degrees of relevance) to the utilities.

- Consider using the broad assumption that was used in the CPS of:

i. Commercial – UG has 40% of the market

ii. Industrial – UG has 76% of the market

e. Note the interdependent nature of the MACC – cascading:

- It was noted in the discussion at last week's meeting that deploying 1 measure impacts the economics of the remaining measures.

f. The abatement opportunity identified has not been adjusted for Free Rider, this caveat should be captured in the report

g. The report should capture that this abatement opportunity identified has not been adjusted for the fact that it is 2018-2020 values – but that the CPS captured measures that started to be installed in 2015 – this would reduce the abatement opportunity identified

h. The facilities abatement section should note that this content requires "local content" that is specific to the utilities

2. ASHP Section:

a. Union suggests that 2 important factors should be noted as part MACC Report.

i. The cost of electrification is not considered as part of the ASHP calculations

- These impacts were highlighted as part of Union/EDG's LTEP submission and the joint study ICF completed for Union/EDG last fall.

ii. The ASHP analysis is not an 'apples-to-apples' comparison to energy efficiency measures, since it involves switching to another fuel. It includes capital cost impacts to homeowners, whereas the energy efficiency measures do not.

3. RNG Section:

a. Slide 30: Column 2 – Potential by 2028

i. Can you confirm the source of information used to develop the market potential?

- Based on the 2011 Alberta Innovates Study the RNG market potential totalled 50-55 PJs in Ontario (without RNG produced through gasification technology); whereas this chart indicates about 91 PJs?

ii. Can you confirm that there are no assumptions on 'gasification' included in these potential estimates?

iii. Can you confirm these potential estimates are for Ontario only?

b. Slide 30 and Slide 31: Column 4 and 5 - $/m3 and $/tC02

i. Can you confirm the sources of information and underlying assumptions for these estimates? (They appear to be much higher than the cost estimates Union has calculated).

ii. Union does not believe it's appropriate to include the cost of collection for SSO. Municipalities and Industrials will need to collect organics based on emerging policy. The same entities will also need digester infrastructure because the province doesn't need that much compost. SSO should also receive tipping fees for taking the waste bringing down the cost further.

iii. As noted in slide 32, the estimated cost to develop and deliver RNG to the natural gas grid is based on dated information and the actual costs will be very project specific. Any RNG development costs included as part of the MACC should acknowledge these limitations.

c. Slide 30: Column 6 – Notes

☐ Regarding the references for evaluating different facilities to calculate these results – are there further details that can be provided on those sites?

Please let us know if you have any questions or would like to discuss further.

thanks

Jeff Hodgins

*DRAFT Report*

# Marginal Abatement Cost Curve for Assessment of Natural Gas Utilities' Cap and Trade Activities (EB-2016-0359)

**June 21, 2017**

# Table of Contents

# List of Exhibits



# List of Tables

# Executive Summary

The Executive Summary will be developed once the report language is finalized.

- The executive summary should clearly state the application, caveats and limitations with the report. Most critical in this is that the energy efficiency portion of the MACC includes existing DSM measures; therefore, not all costs can be considered “marginal”. The next incremental unit of abatement in the cases where there are existing DSM programs is not represented by the cost identified in this report.
- It should also recognize that choosing low-carbon options involves analysis beyond the MACC – this represents one tool for analysis, but is not definitive in and of itself
- The MACC does not consider acceptance of certain measures, infrastructure requirements, lead time to implement, delivery costs, etc.
-

# 1. Introduction

## 1.1 Background

Ontario's cap and trade program is a regulatory instrument aimed at meeting the provincial government's greenhouse gas (GHG) emissions reduction targets. Beginning in January 2017, the cap and trade program and resulting price on carbon will impact the price end users pay for transportation fuels, natural gas and other fossil fuels.

Ontario's cap and trade program is based on the cap and trade program design of the Western Climate Initiative (WCI). The government of Ontario has signaled its intention to link with the WCI Partner jurisdictions' (i.e., California and Quebec) joint cap and trade market in 2018.

The cap and trade program defines a compliance obligation for Ontario's natural gas distributors, including Union Gas Limited ("Union Gas"), Enbridge Gas Distribution Inc. ("Enbridge Gas Distribution") and Natural Resource Gas Ltd., collectively referred to as the "utilities". The utilities' compliance obligation includes:

- Facility-related obligations for facilities owned or operated by the utilities; and,
- Customer-related obligations for natural gas-fired generators, and residential, commercial and industrial customers who are not independently covered under the cap and trade program (i.e., that are not Large Final Emitters (LFEs) or voluntary participants).

The utilities' compliance obligations will require that they undertake cap and trade activities. The associated costs will be recovered from customers. Charged with regulating Ontario's natural gas and electricity sectors, including natural gas utility rates, the Ontario Energy Board (OEB) therefore has a new role in assessing the cost consequences of the utilities' cap and trade activities for the purpose of approving cost recovery in rates.

The OEB issued a Regulatory Framework for the Assessment of Costs of Natural Gas Utilities' Cap and Trade Activities (the "Regulatory Framework") on September 26, 2016. The Regulatory Framework describes the OEB's expectation for each Utility to develop cap and trade Compliance Plans that include robust information regarding compliance strategies. The OEB will assess these Compliance Plans for cost-effectiveness, reasonableness and optimization in its decision to approve recovery of cap and trade costs from customers. In the Regulatory Framework, the OEB indicated it will provide (committed to providing) a province-wide, generic marginal abatement cost curve (MACC) for the Utilities to use in developing their Compliance Plans, which will also be used by the OEB as a key input into its assessment of the cost consequences of those Plans.

## 1.2 Study Scope and Objectives

The objective of this study is to provide the OEB with its first province-wide MACC to inform the Utilities in the development of their Compliance Plans. The MACC will illustrate the full range of customer conservation-related compliance options and renewable natural gas options for the

2018-2020 timeframe (full dataset 2018-2028) along a spectrum of costs presented from the perspective of the Utilities[1].

Because the MACC will be used by the OEB to support its evaluation of the cost-effectiveness of the Utilities' strategies for complying with the cap and trade program outlined in their Compliance Plans, the MACC will be updated every three years, prior to the start of a new WCI compliance period (next MACC will be due in the spring of 2019).

It is also important to note that the MACC curve includes energy conservation measures which overlap with existing programs administered by the natural gas utilities via DSM. Therefore, this means that for some measures, the costing is "average", and not necessarily "marginal" for the next incremental project that could be introduced.

The approach and any associated limitations and caveats used in the development of the MACC are presented by key study category including customer conservation in Section 2, renewable natural gas in Section 3, and facility abatement options in Section 4.

## 1.3 Report Organization

This report presents the MACC study results for the 2018-2020 period. It is organized into the next six sections as follows:

- Section 2 presents the background, approach, limitations and caveats and results for the three customer conservation sectors, including industrial, commercial and residential.
- Section 3 presents the background, approach, limitations and caveats and results for the renewable natural gas assessment.
- Section 4 presents the background and approach for facility abatement options.
- Section 5 presents the summary MACCs for all three customer conservation sectors (industrial, commercial and residential) and RNG.
- Section 6 presents study recommendations.
- Appendix A provides the background information on the air source heat pump analysis conducted for this study.

## 1.4 Definition of Terms

It is important to ensure that readers have a clear understanding of what each of the key terms means in the context of this study. Below is a brief description of some of the most important terms:

**Marginal Abatement Cost Curve (MACC)** – in this study, the MACC is a diagram presenting the cost of natural gas energy efficiency options, from the utility bill perspective, in dollars per cubic metre of annual savings[2] (also represented as dollars per tonne of $CO_2e$ of GHG abatement) relative to a baseline. The baseline, or zero dollars line in this study, is the "cost-effective" threshold, which represents the price of an allowance that is tied to the forecasted price of carbon in a given year. Energy efficiency options with a cost to the utility below the zero-line are

**Comment [CW1]:**
I think a clearer way of explaining this paragraph would be as follows
NOTE: I have pulled the footnote into the paragraph because if it is "key to understanding the study results" it needs to be called out clearly in the report.

The MACC Study identifies the full range of customer conservation-related and renewable natural gas compliance options and their associated savings and costs. It is important to understand that costs for each compliance option was determined based on what it would cost the utility and not from the perspective of what it would cost the customer; meaning, the MACC identifies what options are more cost effective for the utilities than purchasing allowances and not what has the greatest overall economic benefit. This was done because the MACC is intended to inform the development of the Utilities' Compliance Plans specifically *and* assist the OEB in evaluation of those compliance plans. Within each MACC, the compliance options' are grouped into end-use categories and the associated utility related costs and savings are illustrated. Although costs and savings were calculated for each option for the 2018-2028 timeframe, each MACCs shown below only illustrates the range of costs and a summation of the annual savings for 2018, 2019 and 2020.

**Comment [CW2]:** In this case, is it the average forecasted cost of an allowance in 2018, 2019 and 2020? We should call this out.

[1] MOVED above – too critical to be a footnote.
[2] Calculated using measure lifetime costs over measure lifetime savings.

deemed cost-effective relative to the price of an allowance, and values above the zero-line are options that are deemed to be more expensive for the utility to implement than purchasing an allowance.

**Technical Potential** – The technical potential is the estimated level of natural gas savings that would result from the implementation of all technically feasible energy efficiency measures, regardless of cost effectiveness or market acceptance, as calculated in the Conservation Potential Study (CPS).

**Economic Potential: Do we need an "Economic Potential" definition here? And call out how it is different here than what's in the CPS?**

**Achievable Potential** – The achievable potential is the estimated level of natural gas savings that would result from the implementation of all economically feasible energy efficiency measures, taking into account realistic market penetration rates over the study period, as calculated in the CPS. The definition of the achievable potential market penetration rates are based on a number of factors including market barriers, customer preference and acceptance based on payback periods, return on investment, investment hurdle rates and other factors.

**Comment [CW3]:**
I think this definition is going to be confusing. As noted in the intro, these definitions are in context of *this study* --- the achievable potential opportunity calculated in the CPS is not the same as the achievable potential that is calculated/used here.
Maybe we just need to remove "as calculated in the CPS"? OR define that the same methodology was used but actual calculated value is different?

**Reference Year** – The reference year in this study was 2017; therefore, the natural gas energy efficiency savings for the 2018-2020 study period were calculated by subtracting the natural gas consumption CPS model results for the year 2017 from the natural gas consumption model results for 2020.

**Measure Total Resource Cost Test (TRC)** – The TRC test is often used to determine whether a measure would be considered economically attractive when factoring in all costs. The measure TRC is a cost/benefit analysis of the net present value of energy savings that result from an investment in an efficiency or fuel choice technology or measure. The measure TRC calculation considers a measure's full or incremental capital cost (depending on application) plus any change (positive or negative) in the combined annual energy and operation and maintenance costs. It is expressed as a ratio of benefits divided by costs, with both the numerator and denominator calculated as net present values.

**Program Administrator Cost Test (PAC)** – The PAC test is used to measure the net costs of a program based on the costs incurred by the program administrator, including incentives, marketing budgets, and salaries, and excluding any costs incurred by the participant (or utility customer).

**Measure Total Resource Cost-Plus Test (TRC-plus)** – The measure TRC-plus test is the measure TRC test with the inclusion of a 15% non-energy benefit adder In the 2016 CPS, measure TRC-plus was expressed as a ratio of benefits divided by costs, with both the numerator and denominator calculated as net present values. Within the CPS, A technology or measure with a measure TRC-plus benefit/cost ratio of 1.0 or greater was included in the technical, economic, and achievable potential analyses. A measure with a TRC-plus benefit/cost ratio below 1.0 was not considered economically attractive and was therefore included only in the CPS technical potential analysis. Consistent with OEB DSM Guidelines, a lower benefit/cost ratio threshold of 0.7 was used for measures applied to low-income subsectors.

**Comment [CW4]:**
I think to make it less confusing this should just be "Measure TRC-Plus test is the Measure TRC as defined above, with the inclusion of a 15% non-energy benefit adder"

Anything that describes the Measure TRC should be in the above definition

# 2. Customer Conservation

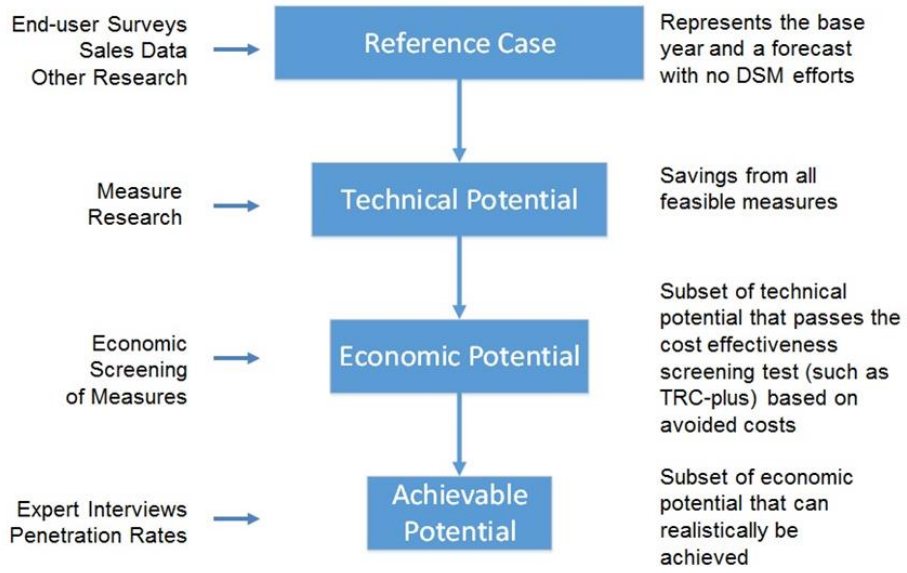
## 2.1 Background

The Regulatory Framework indicates that the Utilities are required to set charges for the recovery of costs associated with cap and trade activities based on the weighted average cost of compliance options described in their Compliance Plans for a particular rate year. The MACC developed in this study is designed to assist Utilities in this task by presenting a standard description of compliance options relative to the cost of an allowance.

The foundation for the development of this MACC study was the Conservation Potential Study (CPS) completed by ICF for the OEB in 2016[3]. A CPS includes compilation and analysis of market and technology data to generate an assessment of the total technical, economic and achievable conservation potential over a specified study time period. The CPS is recognized as a best practice approach from the perspective of cost recovery activities under the OEB's oversight and it generally follows a traditional approach in determining natural gas conservation potential in Ontario, as shown in **Error! Reference source not found.**.

**Comment [CW5]:** Just moved some information from the "Approach" section to this "Background" section to differentiate what was done in the CPS vs what was leveraged and added upon/changed in this MACC Study approach.

Exhibit 1 General Methodology for Conservation Potential Studies




The 2016 CPS utilized in this MACC Study answered the question of how much natural gas conservation is cost effective, from a TRC or economic perspective, in the absence of an explicit

[3] Natural Gas Conservation Potential Study, July 7, 2016, ICF International, July 2016 (EB-2015-0117), http://www.ontarioenergyboard.ca/OEB/Industry/Regulatory+Proceedings/Policy+Initiatives+and+Consultations/Natural+Gas+Conservation+Potential+Study#20160711

carbon price. To answer this, a proprietary model was developed and populated with detailed data representing technologies, operation and maintenance and control measures that save natural gas across energy end uses in each sector of the Ontario economy. More than 50 measures were considered for each of the residential, commercial and industrial sectors, and all of the data inputs and assumptions used to develop the model were reviewed and approved by the OEB and natural gas stakeholders. The CPS model, including its inputs and assumptions were subject to rigorous review through extensive consultation with the OEB, the two major utilities and other natural gas sector stakeholders before being approved by the OEB during the 2016 CPS.

In order to answer this MACC Study's question of how much natural gas conservation is both more cost effective than purchasing allowances from the utility's perspective and achievable under the three different carbon price scenarios, ICF leveraged all of the data inputs and assumptions from utilities and stakeholders that was used to develop the proprietary 2016 CPS model.as well as the long-term carbon pricing forecasts (LTCPF) developed by ICF and published by the OEB on May 31, 2017.

## 2.2 Approach

**Comment [CW6]:** As noted in Comment CW5 above, moved some items from "background" into this approach section to try and make the process/approacg clearer for those not as close to this study

As noted above, to develop a MACC that illustrates which conservation measures could represent lower costs to the utilities than purchasing compliance allowances , ICF used data from the CPS completed for the OEB in 2016 and its associated proprietary model.

The first key item to reiterate is that this study, and the resulting MACCs, was approached through the lens of a natural gas utility in Ontario, as the purpose is to identify what abatement opportunity is more cost effective than purchasing allowances, and not what options have the greatest economic impact. Therefore, the MACCs presented here group all energy conservation options into end use categories, such as space heating, and then illustrate the average cost per cubic metre of natural gas conserved annually[4] (or cost per tonne of GHGs abated) for each end use category within each sector relative to the price of carbon over the 2018-2020 timeframe,.

The decision to present results by end use category was based on two key factors:

- Consumer choice is unpredictable – there are many different equipment options for customers to pursue efficiency, but most customers will not pursue all of them (e.g., a customer may replace their furnace with a high efficiency furnace OR an air source heat pump, but not both), so savings associated with individual measures based on customer choice may not be good indicators.
- Conservation measure interactions should be considered – if customers install more than one measure for one end use (a high efficiency furnace *and* wall insulation), each subsequent measure saves less cubic metres of natural gas, and will mitigate less GHG emissions than if it was installed in isolation. By grouping measures by end use category,

[4] Calculated using measure lifetime costs over measure lifetime savings.

the MACC is designed to illustrate a realistic total GHG abatement potential for a given end use, given measure interactive effects. The 2016 CPS methodology for accounting for these interactions was used (see Section 2.6.1 of the 2016 CPS report); however, it should be noted that this is an assumption and other credible approaches could be used and would possibly produce slightly different $/tonne values for each measure (but would likely not have much of an impact on the overall GHG potential of each end use).

This MACC development study was designed to leverage the 2016 CPS data and assumptions, given the level of rigour and review that was involved, and considering the relatively short timeline for the MACC study. The following data and assumptions remain unchanged from the CPS[5]:

- Lists of conservation measures for industrial, commercial and residential sectors and the associated measure-level assumptions/parameters including:
  - natural gas savings (cubic metres)
  - other fuel savings (including electricity)
  - effective useful life
  - measure applicability
  - operating and maintenance costs, and
  - classification into measure types
- Adoption rates – note: although these were applied only to the economic potential in the 2016 CPS, they can also be applied to technical potential if required
- End use classification (e.g., industrial HVAC, commercial space heating, etc.)
- Utility program and incentive costs
- Cascade order for treatment of conservation measure interactions
- All economic and market assumptions (including 4% discount rate)

**Comment [CW7]:** Moved this image above as I believe it fits better in the background on how a CPS is done, and then it can be referenced here in the approach

Because this study is different than the CPS in that it is looking to quantify how much natural gas conservation would be cost-effective from the utility's perspective relative to the price of carbon, under different carbon pricing assumptions, it was necessary to implement the following revisions to the above noted CPS model:

1. Changes to the 2016 CPS cost effectiveness screen, which was the Measure TRC Plus test, including:

**Comment [CW8]:** Would like this put into a chart to show what was included in CPS TRC Plus cost effectiveness scree VS what is included in this MACC cost effectiveness screen.

NOTE: My chart is just an example, please change/add anything that is required

| Cost Effectiveness Screen Comparison – CPS vs MACC | | |
|---|---|---|
| | **CPS - TRC+ Screen** | **MACC -- Screen?** |
| **Avoided Energy Costs, including ?** | | |
| **Avoided capacity costs** | | |
| **Participants' incremental cost (above baseline) of efficient** | | |

[5] Natural Gas Conservation Potential Study, July 7, 2016, ICF International.

| | | |
|---|---|---|
| **equipment** | | |
| **Incentives (rebates)** | | |
| **Program Administration Costs (staff, marketing, evaluation etc.)** | | |
| **Other benefits (water savings, equipment O&M etc)** | | |
| **Non-Energy Benefit Adder (e.g 15% Plus for environmental, societal etc)** | | |
| **Lost utility revenue** | | |

Post the above chart, it would be good to have a few summary statements that outline what exactly the above differences mean and why it's important to understand when interpreting the results of the MACC

An example of how I've seen the above chart done before is below --- just an idea, and this chart could be out of date, just example purposes

Cost-Effectiveness Tests

| | TRC | Societal | Utility | Ratepayer | Participant |
|---|---|---|---|---|---|
| Avoided energy costs (fuel, O&M of power plants, T&D lines) | Benefit | Benefit | Benefit | Benefit | |
| Avoided capacity costs (constructing power plants, T&D lines, pipelines, balancing, storage) | Benefit | Benefit | Benefit | Benefit | |
| Participants' incremental cost (above baseline) of efficient equipment | Cost | Cost | | | Cost |
| Incentives (rebates) | Transfer | Transfer | Cost | Cost | Benefit |
| Program administration costs (staff, marketing, evaluation, etc.) | Cost | Cost | Cost | Cost | |
| Other benefits (fossil fuel savings, water savings, equipment O&M, etc.) | Benefit (Cost) | Benefit (Cost) | | | Benefit (Cost) |
| Externalities (e.g., environmental benefits like emissions reductions) | | Benefit | | | |
| Lost utility revenue / lower energy bills (due to lower sales) | Transfer | Transfer | | Cost | Benefit |

2. Estimates of natural gas consumption volumes representing 'covered' participants under Ontario's cap and trade program were developed through consultation with the Utilities and removed from the modelling exercise. Facilities directly covered under the program are excluded from the utilities' compliance obligations, so the associated abatement potential was excluded from the MACCs.

3. Heat pumps were assessed through an analysis separate from the CPS model exercise (refer to Appendix A) Given the extremely large abatement potential associated with this technology (irrespective of cost), heat pumps were not included in the MACC to avoid skewing the results for space-heating measures and because they are considered a fuel-switching initiative and not comparable to energy-efficiency alternatives.

**Comment [JB9]:** The utilities have not communicated this intention to the OEB or to ICF as part of this study. It is not appropriate for the MACC study to opine on what the utilities will or will not do, or how they will apply the information in the study. Measures should not be included because the utilities are expected to pursue them, or excluded because they are expected not to. That will be up to the utilities to present and defend in their Compliance Plans.

4. All technically feasible conservation measures from the CPS were used with an achievable adoption rate for their implementation. For the measures that were deemed cost effective in the 2016 CPS, the achievable potential was used. For measures that were not deemed cost effective, achievable potential savings were developed using the technical potential savings, implemented according to an achievable adoption rate.

THIS COULD BE MOVED ABOVE UNDER POINT 1 – as it's about the cost screen as well- The cost-benefit analysis in this study did not use a traditional total resource cost (TRC) or program administrator cost (PAC) test, nor the TRC-plus test that was used in the 2016 CPS[6]. As the modelling was completed from the perspective of the utility, a metric similar to the PAC was used – the benefits included the net present values of avoided natural gas, electricity ???and carbon allowance costs, and the costs included program delivery and incentive costs.

## 2.3 Limitations and Caveats

The main limitations and caveats used in the development of the MACCs are listed below.

- The MACCs include existing DSM savings and activities as well as potential future cap and trade-incented abatement activities, i.e. MACCs represent a "menu of options" that can be, and/or are already being used for DSM and for cap and trade abatement activities. Therefore, this means that for measures where existing DSM programs are in place, the cost curve does not represent what the next incremental unit of savings will cost. This limits the applicability of these measures for the utilities when assessing expansion of existing or new DSM programs.
- The study timeframe was 2018-2028 for the CPS modelling exercise and analytics. However, it was determined in consultation with the OEB and Technical Advisory Group (TAG) that it would be more useful to present the results on a MACC representing the first Ontario cap and trade compliance period. While the underlying analytics and results cover the 2018-2028 timeframe and account for lifetime costs over lifetime savings[7], the presentation of the MACC results in this report are confined to the 2018-2020 period. This is important to understand when evaluating ??

  The 2016 CPS study used 2014 as the base year and therefore the starting point for the analysis, from which to measure the savings in subsequent years. In this MACC study, the savings presented in the results (see Sections 2.4, 2.5, 2.6 and 5) are calculated based on a reference year of 2017 in order to capture all potential savings associated with customer conservation measures started in 2018, 2019 and 2020. Therefore when looking at the savings quoted for the 2018-2020 timeframe, this means that ….

- In the CPS model, assumptions for the industrial sector are defined by subsector, e.g., chemicals. Although the natural gas volumes representing the consumption of 'covered'

**Comment [CW10]:** Confirm: First the MACC cost-effective screen used, and if it was cost-effective AND cost-effective in the CPS, then used the achievable potential. If not cost-effective using MACC screen then would use technical potential with a achievable adoption rate?

If this comment is true, please reflect changes in point #4 to make that clear.

**Comment [CW11]:** Why electricity if this is from the perspective of the gas utility bill ?
If it will be counted as a benefit, it should be counted as a cost as well I tihnk

**Comment [CW12]:** It is critical for readers of this MACC Study to truly understand the "so what?" for each of these limitations and caveats, as this is what truly provides the context required when reading and interpreting the MACCs; For this reason, you will see a "Therefore…." Or a "so what does this mean?" after each caveat - we would like ICF to expand upon each of these caveats and spell out in detail what the impact of this caveat could be – and why it's so important that this caveat be understood when interpreting the results.

[6] For definitions of the TRC, TRC-plus and PAC cost-benefit tests, refer to Section 1.4 of this report.
[7] Varying measure lifetimes were accounted for from 1 year to beyond 10 years.

emitters were removed from the model accounting for much of the LFE volume, no revisions were made to market penetration rates for industrial conservation measures[8]. The model uses an average for all sizes of industrial facilities and does not differentiate between LFEs and non-LFEs. Therefore, when looking at the savings quoted for industrials in the 2018-2020 timeframe, this means that ….

5. Heat pumps were analyzed separately from the CPS model exercise and excluded from the MACC because to include them would skew the results for space-heating measures since they are considered a fuel-switching initiative and not comparable to energy-efficiency alternatives.

- 
- CPS Assumptions/Caveats hold true here, including:
    - Free Rider rate has not been applied to the identified opportunity?
    - What other major limitations or caveats were identified in the CPS that should be highlighted again here for the reader to ensure all context is set?

**Comment [JB13]:** See earlier comment

## 2.4 Customer Conservation MACC Results

**Comment [CW14]:** The MACCs are confusing to understand, so we have tried to edit the below based on discussions within the group to help new readers who are not close to this study, understand it more easily.

The customer conservation MACC results are presented by sector (industrial, commercial and residential) in the sub-sections that follow. The MACC diagrams illustrate the estimated achievable potential savings in $m^3$ and tonnes $CO_2e$ for natural gas abatement through customer conservation measures (including DSM *and* incremental abatement beyond DSM) for the three different carbon pricing scenarios[9]. It is important to recognize that each end use bar on the MACCs represents a group of conservation measures that are applicable to a particular sector.

**Comment [CW15]:** Should 'achievable' be removed, since the graphs show both cost effective and non-cost effective?

**Zero Dollars Line (x-axis):** On each MACC, the zero dollars line (x-axis) represents the "cost-effective" threshold which includes the price of an allowance. Options below the zero-line are deemed to be less costly from the utility's perspective than the price of an allowance, and options above the zero-line are measures that are deemed to be more expensive for the utility to implement than purchasing an allowance.

**Comment [CW16]:** "Includes the price of an allowance" or IS the price of an allowance? Or is the average price of an allowance in 2018-2020?

**Height of the Bar / Cost of the Savings:** Within each MACC, the height of a bar represents the range of costs from the utility's perspective per cubic metre of natural gas saved for the measures included in that end-use bar (or tonne of GHGs abated) over the 2018-2020 study period.

**Width of the Bar / Savings Labels:** On each MACC, the width of the bar represents the total annual savings to be realized during the year 2020 specifically (in cubic metres and tonnes abated). This total 2020 annual savings potential number is calculated by summing the 2020

[8] Consistent with the approach in the 2016 CPS, average market penetration rates were used for LFEs and non-LFEs alike.
[9] Three long-term carbon price forecasts were analyzed in this study including minimum, maximum and mid-range carbon price forecasts. For more detail on the LTCPFs, refer to Long-Term Carbon Price Forecast Report, ICF, May 31, 2017, https://www.oeb.ca/industry/policy-initiatives-and-consultations/consultation-develop-regulatory-framework-natural-gas

annual savings for those measures that were installed in 2018, 2019, and 2020. It's important to note that for those measures installed in 2018 and 2019, any annual savings generated prior to 2020 are not included in this number, only their 2020 annual savings.

It's key to note that the width of each bar, or the total savings potential of an end-use, includes both cost effective and non-cost effective measures; therefore, the figure is not intended to represent the total abatement potential that could/should be delivered by the NG utilities to the benefit of the rate payer. If an end-use bar does span across both the cost-effective and non-cost effective x-axis zero dollar line, and a reader wants to understand more specifically which measures and associated savings within that bar falls above and below the zero dollars/allowance cost line, a more detailed data set must be referenced.

**Savings Labels:** The savings label associated with each bar on the MACCs indicate cumulative potential savings data in $m^3$ and $tCO_2e$. Estimates of the proportion of the savings that are associated with cost-effective measures are also provided for each end use (% value in brackets). Each MACC diagram is followed by a table that presents the average cost data and estimated savings used to create the MACC.

At the end of each of the industrial, commercial and residential sub-sections, a table identifying all of the measures included in each end use category for that sector is provided, as well as measure-level cost data[10] (both $\$/m^3$ and $\$/tCO_2e$) for each LTCPF scenario.

### 2.4.1 Industrial Results

This section presents the results of the industrial customer conservation analysis for each of the three LTCPF scenarios in the format of a MACC diagram and a supporting data table, which provides the average cost from the perspective of the utility and estimated savings data used to create the MACC. At the end of this section, there is a summary table that identifies all of the measures included in each industrial end use category as well as measure-level cost data for each LTCPF scenario.

#### Minimum LTCPF Scenario

Exhibit 2 presents the minimum LTCPF MACC for the industrial sector. In this carbon price scenario, the results show that the average cost for a utility to implement the measures in three of the industrial end use categories including HVAC, steam hot water system and direct heating is lower than the cost of purchasing allowances in the 2018-2020 timeframe. The total annual savings to be realized during the year 2020 specifically is 96 million $m^3$ (or 180,000 $tCO_2e$). These values also represent the estimated savings associated with measures that are cost effective for the utility relative to the carbon price.

[10] Tables of measure-level savings are provided to help the reader better understand the MACCs presented. It is important to note that this **measure-specific data is based on cascaded savings**. These values should not be read independently of the full modeled scenario results; they are averaged across multiple subsectors and regions, and the savings depend on the combination of other measures which are simultaneously deployed (cascading).

Exhibit 2 Industrial MACC for Minimum LTCPF

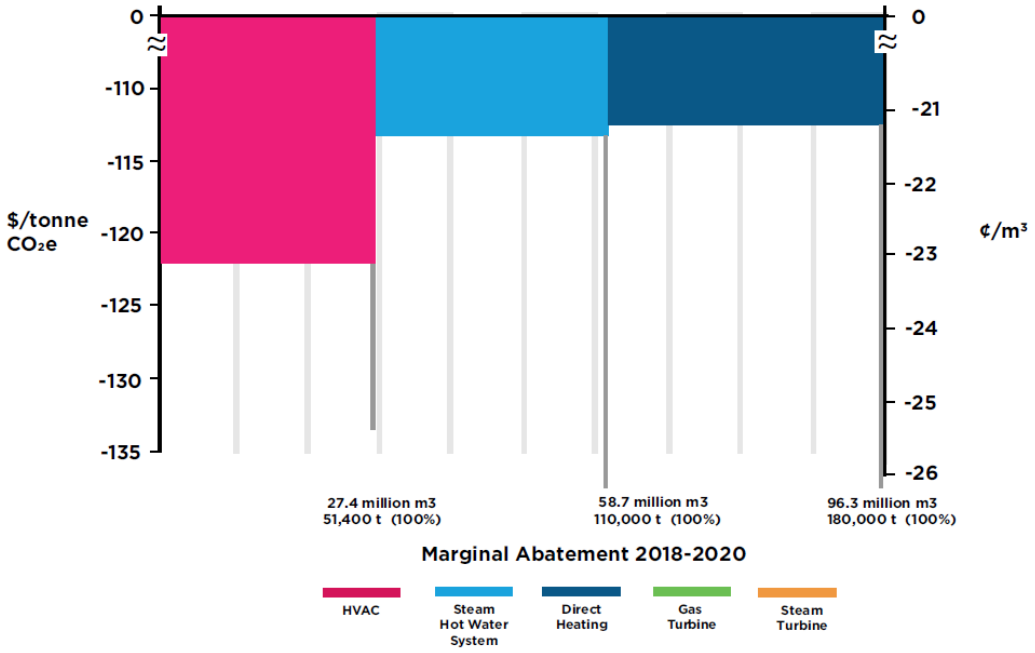



Table 1 Industrial MACC for Minimum LTCPF, Average Cost and Savings Results

| Industrial End Use | Average $/tCO2e | Average ¢/m3 | Estimated Savings (tCO2e) | Estimated Savings (million m3) | Estimated % Savings <$0/tCO2e |
|---|---|---|---|---|---|
| **Gas Turbine** | -130 | -24 | 550 | 0.3 | 100% |
| **Steam Turbine** | -130 | -24 | 250 | 0.1 | 100% |
| **HVAC** | -122 | -23 | 51,400 | 27 | 100% |
| **Steam Hot Water System** | -112 | -21 | 58,600 | 31 | 100% |
| **Direct Heating** | -111 | -21 | 69,700 | 37 | 100% |

## Maximum LTCPF Scenario

Exhibit 3 presents the maximum LTCPF MACC for the industrial sector. In this carbon price scenario, the results show that the average cost for a utility to implement the measures in three of the industrial end use categories including HVAC, steam hot water system and direct heating is lower than the cost of purchasing allowances in the 2018-2020 timeframe. The total annual savings to be realized during the year 2020 specifically is 96 million $m^3$ (or 180,000 $tCO_2e$). These values also represent the estimated savings associated with measures that are cost effective for the utility relative to the carbon price.

Exhibit 3 Industrial MACC for Maximum LTCPF

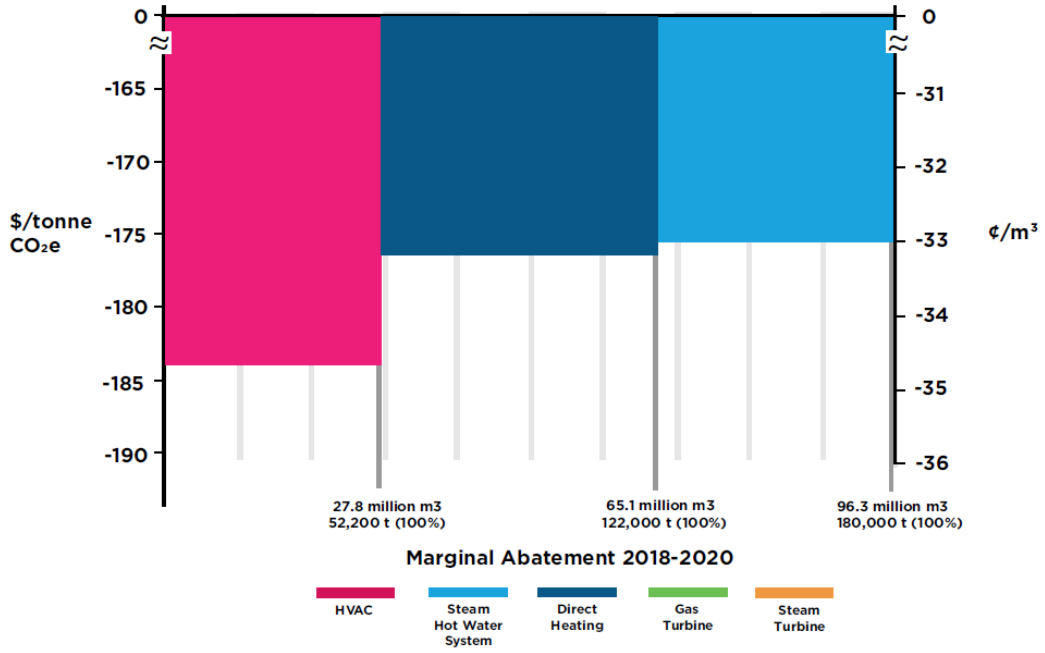



Table 2 Industrial MACC for Maximum LTCPF, Average Cost and Savings Results

| Industrial End Use | Average $/tCO2e | Average ¢/m3 | Estimated Savings (tCO2e) | Estimated Savings (million m3) | Estimated % Savings <$0/tCO2e |
|---|---|---|---|---|---|
| **Gas Turbine** | -186 | -35 | 550 | 0.3 | 100% |
| **Steam Turbine** | -186 | -35 | 250 | 0.1 | 100% |
| **HVAC** | -184 | -34 | 51,400 | 27 | 100% |
| **Direct Heating** | -176 | -33 | 69,700 | 37 | 100% |
| **Steam Hot Water System** | -175 | -33 | 58,600 | 31 | 100% |

## Mid-Range LTCPF Scenario

Exhibit 4 presents the mid-range LTCPF MACC for the industrial sector. In this carbon price scenario, the results show that the average cost for a utility to implement the measures in three of the industrial end use categories including HVAC, steam hot water system and direct heating is lower than the cost of purchasing allowances in the 2018-2020 timeframe. The total annual savings to be realized during the year 2020 specifically is 96 million $m^3$ (or 180,000 $tCO_2e$). These values also represent the estimated savings associated with measures that are cost effective for the utility relative to the carbon price.

Exhibit 4 Industrial MACC for Mid-Range LTCPF

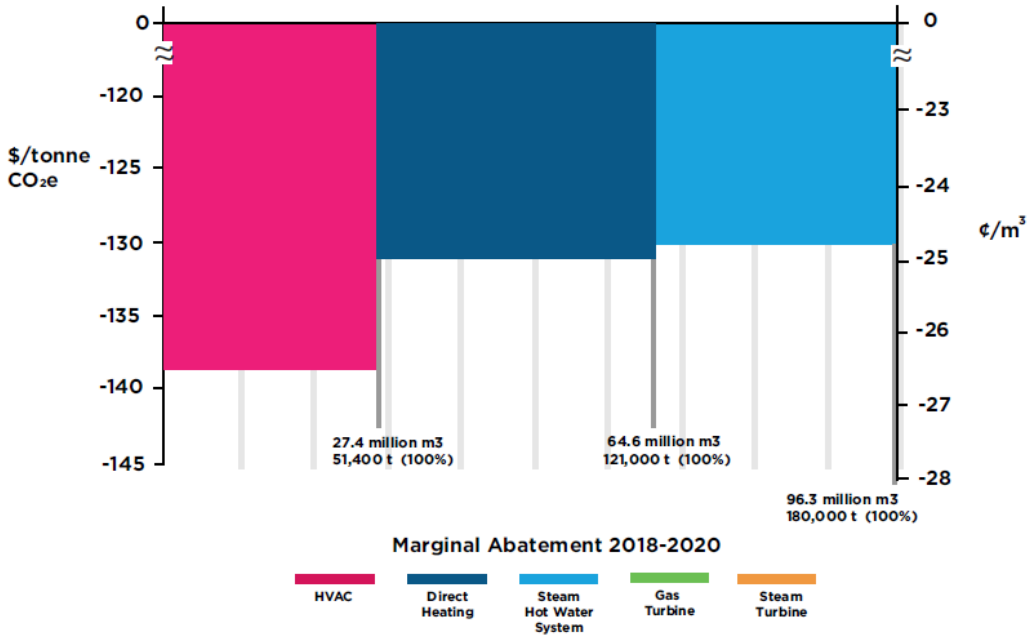



Table 3 Industrial MACC for Mid-Range LTCPF, Average Cost and Savings Results

| Industrial End Use | Average $/tCO2e | Average ¢/m3 | Estimated Savings (tCO2e) | Estimated Savings (million m3) | Estimated % Savings <$0/tCO2e |
|---|---|---|---|---|---|
| **HVAC** | -139 | -26 | 51,400 | 27 | 100% |
| **Direct Heating** | -132 | -25 | 69,700 | 37 | 100% |
| **Steam Hot Water System** | -131 | -25 | 58,600 | 31 | 100% |
| **Gas Turbine** | -130 | -24 | 550 | 0.3 | 100% |
| **Steam Turbine** | -130 | -24 | 250 | 0.1 | 100% |

Table 4 Industrial Measure-Level Marginal Abatement Cost Data (Ranges) for 2018-2020 Timeframe

| Industrial End Use | Measure Name | Mid-Range LTCPF | | | | Minimum LTCPF | | | | Maximum LTCPF | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $/m$^3$ | | $/tCO$_2$e | | $/m$^3$ | | $/tCO$_2$e | | $/m$^3$ | | $/tCO$_2$e | |
| Direct Heating | High Efficiency Burners (Process) | -0.26 | -0.24 | -138 | -126 | -0.21 | -0.20 | -113 | -106 | -0.34 | -0.31 | -182 | -167 |
| Direct Heating | Reduced Furnace Openings (Air & Chain Curtains) | -0.26 | -0.24 | -138 | -126 | -0.21 | -0.20 | -113 | -107 | -0.34 | -0.31 | -182 | -168 |
| Direct Heating | Exhaust Gas Heat Recovery | -0.26 | -0.24 | -138 | -126 | -0.21 | -0.20 | -113 | -106 | -0.34 | -0.31 | -182 | -167 |
| Direct Heating | Insulation (Process) | -0.26 | -0.24 | -138 | -126 | -0.21 | -0.20 | -113 | -106 | -0.34 | -0.31 | -182 | -167 |
| Direct Heating | Advanced Heating and Process Controls | -0.26 | -0.24 | -138 | -126 | -0.21 | -0.20 | -113 | -106 | -0.34 | -0.31 | -182 | -167 |
| Direct Heating | Optimize Combustion | -0.24 | -0.22 | -131 | -118 | -0.24 | -0.22 | -127 | -118 | -0.35 | -0.32 | -186 | -172 |
| Direct Heating | High-efficiency Ovens & Dryers | -0.26 | -0.24 | -138 | -126 | -0.21 | -0.20 | -113 | -106 | -0.34 | -0.31 | -182 | -167 |
| Direct Heating | High-efficiency Furnaces | -0.26 | -0.24 | -138 | -126 | -0.21 | -0.20 | -113 | -106 | -0.34 | -0.31 | -182 | -167 |
| Direct Heating | Regenerative Thermal Oxidizers | -0.26 | -0.24 | -138 | -127 | -0.21 | -0.20 | -113 | -108 | -0.34 | -0.32 | -182 | -169 |
| Direct Heating | Process Heat Recovery | -0.26 | -0.24 | -138 | -126 | -0.21 | -0.20 | -113 | -106 | -0.34 | -0.31 | -182 | -167 |
| Direct Heating | Process Improvements (changing cleaning chemicals, set points, exhaust, moisture control, etc.) | -0.26 | -0.24 | -138 | -126 | -0.21 | -0.20 | -113 | -107 | -0.34 | -0.31 | -182 | -168 |
| Direct Heating | Food and Beverage Manufacturing Process Improvements | -0.26 | -0.24 | -138 | -126 | -0.21 | -0.20 | -113 | -107 | -0.34 | -0.31 | -182 | -167 |
| Direct Heating | Refining Process Improvements | -0.26 | -0.24 | -138 | -127 | -0.21 | -0.20 | -113 | -108 | -0.34 | -0.32 | -182 | -169 |
| Direct Heating | Mining Process Improvements | -0.26 | -0.23 | -137 | -124 | -0.22 | -0.21 | -117 | -110 | -0.34 | -0.31 | -181 | -167 |
| Direct Heating | Primary Metal Manufacturing Process Improvements | -0.26 | -0.24 | -138 | -127 | -0.21 | -0.20 | -113 | -108 | -0.34 | -0.32 | -182 | -169 |
| Direct Heating | Non-Metallic Mineral Product Manufacturing Process Improvements | -0.26 | -0.24 | -138 | -127 | -0.21 | -0.20 | -113 | -108 | -0.34 | -0.32 | -182 | -169 |
| Direct Heating | Asphalt and Cement Manufacturing Process Improvements | -0.26 | -0.24 | -137 | -126 | -0.21 | -0.20 | -113 | -107 | -0.34 | -0.31 | -182 | -168 |
| Direct Heating | Fabricated Metal Manufacturing Process Improvements | -0.26 | -0.24 | -138 | -126 | -0.21 | -0.20 | -113 | -107 | -0.34 | -0.31 | -182 | -168 |
| Direct Heating | Transportation and Machinery Manufacturing Process Improvements | -0.26 | -0.24 | -138 | -126 | -0.21 | -0.20 | -113 | -107 | -0.34 | -0.31 | -182 | -167 |
| Gas Turbine | Gas Turbine Optimization | -0.25 | -0.24 | -132 | -127 | -0.25 | -0.24 | -132 | -127 | -0.36 | -0.34 | -191 | -181 |
| HVAC | Air Compressor Heat Recovery | -0.27 | -0.25 | -145 | -133 | -0.24 | -0.22 | -125 | -119 | -0.36 | -0.33 | -190 | -177 |
| HVAC | Ventilation Optimization | -0.27 | -0.25 | -146 | -134 | -0.24 | -0.22 | -126 | -120 | -0.36 | -0.33 | -190 | -177 |

| Industrial End Use | Measure Name | Mid-Range LTCPF | | | | Minimum LTCPF | | | | Maximum LTCPF | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $/m$^3$ | | $/tCO$_2$e | | $/m$^3$ | | $/tCO$_2$e | | $/m$^3$ | | $/tCO$_2$e | |
| HVAC | Ventilation Heat Recovery | -0.27 | -0.25 | -145 | -133 | -0.23 | -0.22 | -125 | -119 | -0.36 | -0.33 | -190 | -176 |
| HVAC | Automated Temperature Control | -0.27 | -0.25 | -145 | -133 | -0.23 | -0.22 | -125 | -119 | -0.36 | -0.33 | -190 | -176 |
| HVAC | Destratification Fans | -0.27 | -0.25 | -145 | -133 | -0.23 | -0.22 | -125 | -119 | -0.36 | -0.33 | -190 | -176 |
| HVAC | Warehouse Loading Dock Seals | -0.27 | -0.25 | -145 | -133 | -0.23 | -0.22 | -125 | -119 | -0.36 | -0.33 | -190 | -176 |
| HVAC | Minimize Door Openings | -0.27 | -0.25 | -145 | -134 | -0.24 | -0.22 | -126 | -120 | -0.36 | -0.33 | -190 | -177 |
| HVAC | Solar Walls | -0.27 | -0.25 | -142 | -132 | -0.21 | -0.20 | -114 | -108 | -0.36 | -0.33 | -194 | -179 |
| HVAC | Radiant Heaters | -0.27 | -0.25 | -145 | -133 | -0.23 | -0.22 | -125 | -119 | -0.36 | -0.33 | -190 | -176 |
| HVAC | Greenhouse Curtains | -0.27 | -0.24 | -143 | -130 | -0.24 | -0.23 | -130 | -123 | -0.36 | -0.33 | -191 | -178 |
| HVAC | Greenhouse Envelope Improvements | -0.27 | -0.25 | -141 | -133 | -0.26 | -0.25 | -138 | -133 | -0.37 | -0.35 | -197 | -186 |
| HVAC | Improved Building Envelope | -0.27 | -0.25 | -145 | -133 | -0.23 | -0.22 | -125 | -119 | -0.36 | -0.33 | -190 | -176 |
| HVAC | High Efficiency Heating Units | -0.27 | -0.25 | -145 | -133 | -0.23 | -0.22 | -125 | -119 | -0.36 | -0.33 | -190 | -176 |
| Steam Hot Water System | Minimize Deaerator Vent Losses | -0.26 | -0.24 | -137 | -125 | -0.21 | -0.20 | -113 | -106 | -0.34 | -0.31 | -182 | -167 |
| Steam Hot Water System | Insulation (Steam Systems) | -0.26 | -0.24 | -138 | -126 | -0.21 | -0.20 | -113 | -106 | -0.34 | -0.31 | -182 | -167 |
| Steam Hot Water System | Boiler Tune Up | -0.24 | -0.22 | -130 | -119 | -0.24 | -0.22 | -127 | -119 | -0.35 | -0.32 | -186 | -173 |
| Steam Hot Water System | Condensing Economizers | -0.26 | -0.24 | -138 | -126 | -0.21 | -0.20 | -113 | -107 | -0.34 | -0.31 | -182 | -167 |
| Steam Hot Water System | Burn Digester Gas in Boilers | -0.26 | -0.24 | -138 | -127 | -0.21 | -0.20 | -113 | -108 | -0.34 | -0.32 | -182 | -169 |
| Steam Hot Water System | Steam Leak Repairs | -0.25 | -0.22 | -133 | -120 | -0.23 | -0.21 | -120 | -113 | -0.34 | -0.31 | -181 | -168 |
| Steam Hot Water System | Feedwater Economizers | -0.26 | -0.24 | -138 | -126 | -0.21 | -0.20 | -113 | -106 | -0.34 | -0.31 | -182 | -167 |
| Steam Hot Water System | Boiler Combustion Air Preheat | -0.26 | -0.24 | -138 | -126 | -0.21 | -0.20 | -113 | -106 | -0.34 | -0.31 | -182 | -167 |
| Steam Hot Water System | Blowdown Heat Recovery | -0.26 | -0.24 | -138 | -126 | -0.21 | -0.20 | -113 | -106 | -0.34 | -0.31 | -182 | -167 |
| Steam Hot Water System | Automated Blowdown Control | -0.26 | -0.24 | -138 | -126 | -0.21 | -0.20 | -113 | -106 | -0.34 | -0.31 | -182 | -167 |
| Steam Hot Water System | Condensate Return | -0.26 | -0.24 | -138 | -126 | -0.21 | -0.20 | -113 | -106 | -0.34 | -0.31 | -182 | -167 |
| Steam Hot Water System | Steam Trap Survey and Repair | -0.25 | -0.23 | -131 | -121 | -0.23 | -0.22 | -123 | -118 | -0.34 | -0.32 | -183 | -173 |
| Steam Hot Water System | Boiler Right Sizing and Load Management | -0.26 | -0.24 | -138 | -126 | -0.21 | -0.20 | -113 | -106 | -0.34 | -0.31 | -182 | -167 |
| Steam Hot Water System | Reduce Boiler Steam Pressure | -0.26 | -0.24 | -138 | -127 | -0.21 | -0.20 | -113 | -108 | -0.34 | -0.32 | -182 | -169 |
| Steam Hot Water System | Advanced Boiler Controls | -0.26 | -0.23 | -137 | -124 | -0.22 | -0.21 | -117 | -110 | -0.34 | -0.31 | -181 | -167 |
| Steam Hot Water System | Condensing Boiler | -0.26 | -0.24 | -137 | -126 | -0.21 | -0.20 | -113 | -106 | -0.34 | -0.31 | -182 | -167 |
| Steam Hot Water System | Direct Contact Water Heaters | -0.26 | -0.24 | -137 | -126 | -0.21 | -0.20 | -113 | -107 | -0.34 | -0.31 | -182 | -167 |
| Steam Hot Water System | High Efficiency Burners - Boilers | -0.26 | -0.24 | -138 | -126 | -0.21 | -0.20 | -113 | -107 | -0.34 | -0.31 | -182 | -167 |
| Steam Hot Water System | Chemical Manufacturing Process Improvements | -0.26 | -0.24 | -138 | -126 | -0.21 | -0.20 | -113 | -107 | -0.34 | -0.31 | -182 | -167 |
| Steam Hot Water System | Greenhouses Other EE Upgrades | -0.26 | -0.24 | -138 | -126 | -0.21 | -0.20 | -113 | -106 | -0.34 | -0.31 | -182 | -167 |
| Steam Hot Water System | Pulp and Paper Process Improvements | -0.26 | -0.24 | -138 | -127 | -0.21 | -0.20 | -113 | -108 | -0.34 | -0.32 | -182 | -169 |
| Steam Turbine | Steam Turbine Optimization | -0.25 | -0.24 | -132 | -127 | -0.25 | -0.24 | -132 | -127 | -0.36 | -0.34 | -190 | -180 |

### 2.4.2 Commercial Results

This section presents the results of the commercial customer conservation analysis for each of the three LTCPF scenarios in the format of a MACC diagram and a supporting data table, which provides the average cost from the perspective of the utility and estimated savings data used to create the MACC. At the end of this section, there is a summary table that identifies all of the measures included in each commercial end use category as well as measure-level cost data for each LTCPF scenario.

#### Minimum LTCPF Scenario

Exhibit 5 presents the minimum LTCPF MACC for the commercial sector. In this carbon price scenario, the results show that the average cost for a utility to implement the measures in four of the commercial end use categories including food service, systems, service water heating and space heating is lower than the cost of purchasing allowances in the 2018-2020 timeframe. The total annual savings to be realized during the year 2020 specifically is 108 million $m^3$ (or 202,000 $tCO_2e$), and the estimated savings associated with measures that are cost effective for the utility relative to the carbon price is 98 million $m^3$ (or 184,000 $tCO_2e$).

Exhibit 5 Commercial MACC for Minimum LTCPF

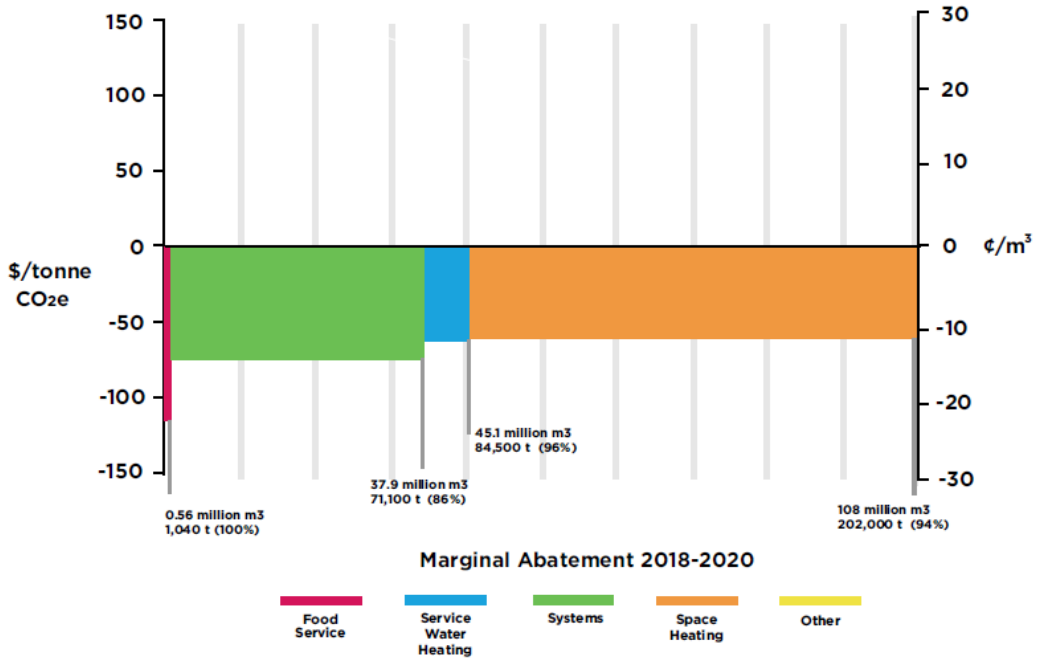



Table 5 Commercial MACC for Minimum LTCPF, Average Cost and Savings Results

| Commercial End Use | Average $/tCO2e | Average ¢/m3 | Estimated Savings (tCO2e) | Estimated Savings (million m3) | Estimated % Savings <$0/tCO2e |
|---|---|---|---|---|---|
| **Food Service** | -105 | -20 | 1,040 | 0.6 | 100% |
| **Systems** | -75 | -14 | 70,100 | 37 | 86% |
| **Service Water Heating** | -62 | -12 | 13,400 | 7 | 96% |
| **Space Heating** | -62 | -12 | 117,000 | 63 | 94% |

| | | | | | |
|---|---|---|---|---|---|
| **Other** | 176 | 33 | 3 | 0.002 | 0% |

## Maximum LTCPF Scenario

Exhibit 6 presents the maximum LTCPF MACC for the commercial sector. In this carbon price scenario, the results show that the average cost for a utility to implement the measures in four of the commercial end use categories including food service, systems, service water heating and space heating is lower than the cost of purchasing allowances in the 2018-2020 timeframe. The total annual savings to be realized during the year 2020 specifically is 108 million $m^3$ (or 202,000 $tCO_2e$), and the estimated savings associated with measures that are cost effective for the utility relative to the carbon price is 106 million $m^3$ (or 198,000 $tCO_2e$).

Exhibit 6 Commercial MACC for Maximum LTCPF

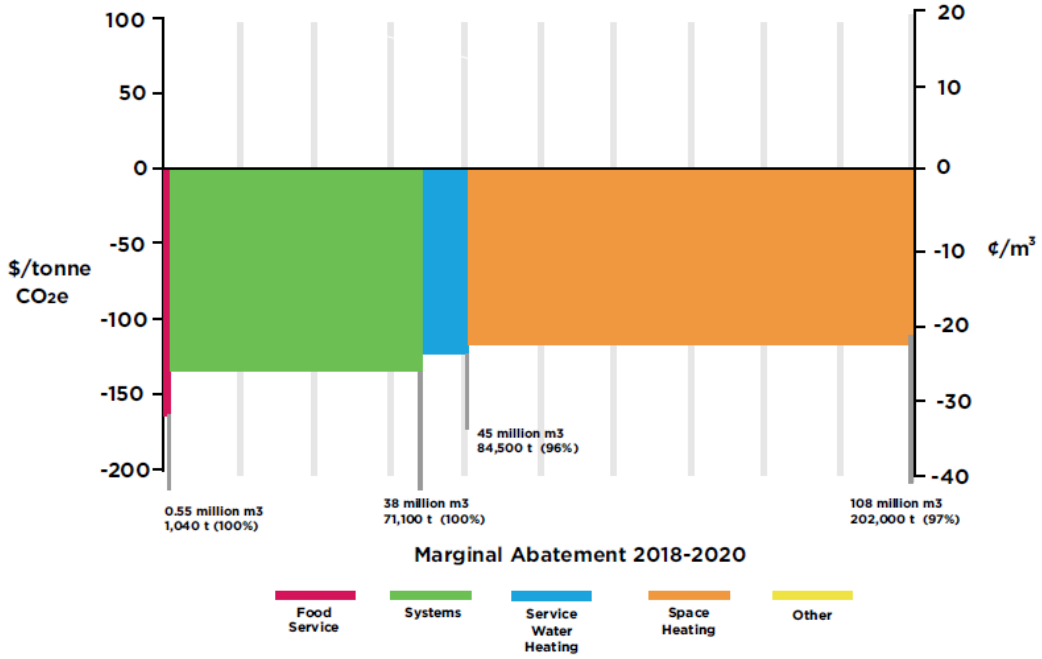



Table 6 Commercial MACC for Maximum LTCPF, Average Cost and Savings Results

| Commercial End Use | Average $/tCO2e | Average ¢/m3 | Estimated Savings (tCO2e) | Estimated Savings (million m3) | Estimated % Savings <$0/tCO2e |
|---|---|---|---|---|---|
| **Food Service** | -165 | -31 | 1,040 | 0.6 | 100% |
| **Systems** | -137 | -26 | 70,100 | 37 | 100% |
| **Service Water Heating** | -127 | -24 | 13,400 | 7 | 96% |
| **Space Heating** | -127 | -24 | 117,000 | 63 | 97% |
| **Other** | 106 | 20 | 3 | 0.002 | 0% |

## Mid-Range LTCPF Scenario

Exhibit 7 presents the mid-range LTCPF MACC for the commercial sector. In this carbon price scenario, the results show that the average cost for a utility to implement the measures in four of the commercial end use categories including food service, systems, service water heating and

space heating is lower than the cost of purchasing allowances in the 2018-2020 timeframe. The total annual savings to be realized during the year 2020 specifically is 108 million $m^3$ (or 202,000 $tCO_2e$), and the estimated savings associated with measures that are cost effective for the utility relative to the carbon price is 99 million $m^3$ (or 186,000 $tCO_2e$).

Exhibit 7 Commercial MACC for Mid-Range LTCPF

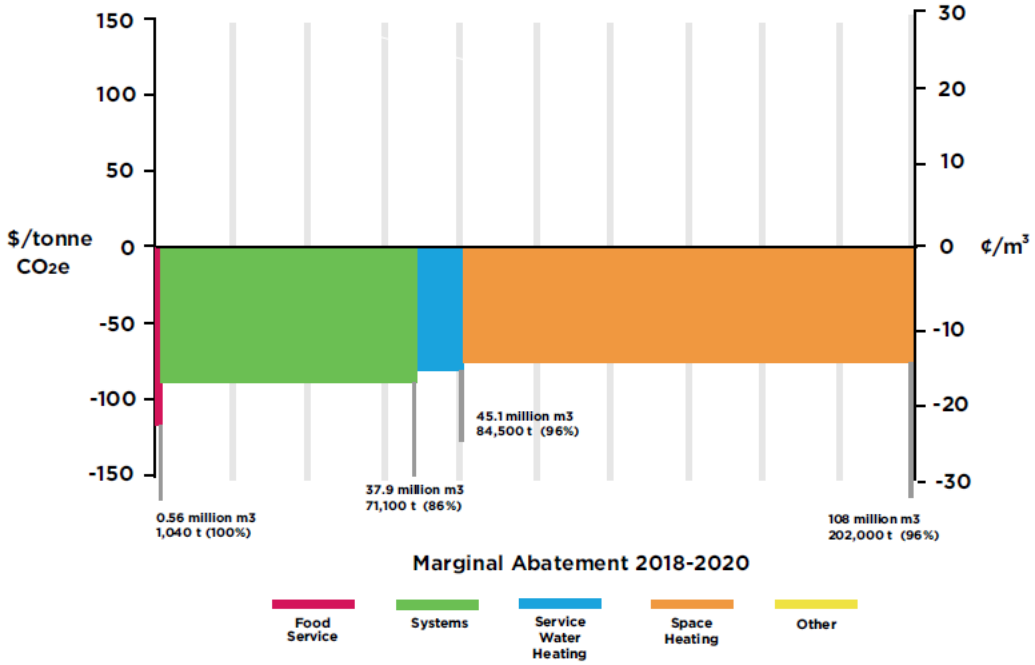



Table 7 Commercial MACC for Mid-Range LTCPF, Average Cost and Savings Results

| Commercial End Use | Average $/tCO2e | Average ¢/m3 | Estimated Savings (tCO2e) | Estimated Savings (million m3) | Estimated % Savings <$0/tCO2e |
|---|---|---|---|---|---|
| **Food Service** | -119 | -22 | 1,040 | 0.6 | 100% |
| **Systems** | -88 | -16 | 70,100 | 37 | 86% |
| **Service Water Heating** | -83 | -16 | 13,400 | 7 | 96% |
| **Space Heating** | -83 | -15 | 117,000 | 63 | 96% |
| **Other** | 151 | 28 | 3 | 0.002 | 0% |

Table 8 Commercial Measure-Level Marginal Abatement Cost Data (Ranges) for 2018-2020 Timeframe

| Commercial End Use | Measure Name | Mid-Range LTCPF | | | | Minimum LTCPF | | | | Maximum LTCPF | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $/m$^3$ | | $/tCO$_2$e | | $/m$^3$ | | $/tCO$_2$e | | $/m$^3$ | | $/tCO$_2$e | |
| Space Heating | High-Performance Glazing | -0.26 | 0.81 | -138 | 431 | -0.21 | 0.85 | -110 | 455 | -0.36 | 0.72 | -190 | 384 |
| Space Heating | Roof Insulation | -0.25 | 0.88 | -132 | 471 | -0.20 | 0.93 | -104 | 495 | -0.35 | 0.80 | -184 | 425 |
| Space Heating | Wall Insulation | -0.23 | 0.89 | -122 | 473 | -0.18 | 0.93 | -94 | 497 | -0.33 | 0.80 | -174 | 427 |
| Space Heating | Super-High Efficiency Furnaces | -0.24 | -0.22 | -130 | -120 | -0.20 | -0.19 | -107 | -102 | -0.33 | -0.30 | -174 | -162 |
| Space Heating | Condensing Boilers (for Space Heating) | -0.26 | -0.23 | -137 | -123 | -0.21 | -0.19 | -113 | -104 | -0.34 | -0.31 | -181 | -165 |
| Space Heating | Condensing Make-Up Air Units | -0.27 | -0.24 | -142 | -127 | -0.22 | -0.20 | -117 | -108 | -0.35 | -0.32 | -186 | -169 |
| Space Heating | Condensing Unit Heaters | -0.24 | -0.22 | -126 | -115 | -0.19 | -0.18 | -103 | -98 | -0.32 | -0.29 | -170 | -157 |
| Space Heating | Destratification Fans | -0.14 | -0.12 | -72 | -62 | -0.10 | -0.09 | -52 | -48 | -0.22 | -0.20 | -117 | -105 |
| Space Heating | Gas Fired Rooftop Units (Two-Stage) | -0.23 | -0.20 | -124 | -106 | -0.19 | -0.17 | -104 | -92 | -0.31 | -0.28 | -168 | -150 |
| Space Heating | High Efficiency Boilers (for Space Heating) | -0.26 | -0.21 | -139 | -114 | -0.21 | -0.18 | -114 | -94 | -0.34 | -0.29 | -183 | -155 |
| Space Heating | Heat Reflector Panels | -0.24 | -0.21 | -127 | -111 | -0.20 | -0.18 | -104 | -94 | -0.32 | -0.29 | -171 | -153 |
| Space Heating | Boilers - High Efficiency Burners | -0.17 | -0.13 | -93 | -69 | -0.13 | -0.09 | -69 | -50 | -0.26 | -0.21 | -137 | -111 |
| Space Heating | Infrared Heaters | -0.24 | -0.22 | -127 | -116 | -0.20 | -0.19 | -105 | -100 | -0.32 | -0.30 | -171 | -158 |
| Space Heating | Boilers - Feedwater Economizers | 0.66 | 0.71 | 354 | 377 | 0.71 | 0.74 | 378 | 396 | 0.58 | 0.63 | 309 | 335 |
| Space Heating | Boilers - Combustion Air Preheat | 0.69 | 0.73 | 368 | 392 | 0.73 | 0.76 | 388 | 407 | 0.61 | 0.65 | 324 | 348 |
| Space Heating | Boilers - Blowdown Heat Recovery | 0.45 | 0.49 | 240 | 264 | 0.50 | 0.53 | 265 | 283 | 0.37 | 0.42 | 196 | 222 |
| Space Heating | Refrigeration Waste Heat Recovery | -0.27 | -0.25 | -142 | -131 | -0.23 | -0.22 | -122 | -117 | -0.35 | -0.33 | -186 | -174 |
| Space Heating | Heat Recovery Ventilation | -0.22 | 0.05 | -117 | 27 | -0.18 | 0.08 | -98 | 40 | -0.30 | -0.03 | -162 | -17 |
| Space Heating | Energy Recovery Ventilation | -0.25 | -0.11 | -133 | -59 | -0.21 | -0.09 | -114 | -46 | -0.33 | -0.19 | -178 | -103 |
| Space Heating | Energy Recovery Ventilation (Enhanced) | -0.28 | -0.22 | -149 | -119 | -0.24 | -0.20 | -129 | -105 | -0.36 | -0.30 | -194 | -162 |
| Space Heating | Ventilation Fan VFDs | -0.27 | -0.25 | -145 | -133 | -0.23 | -0.22 | -125 | -119 | -0.35 | -0.33 | -189 | -177 |
| Space Heating | Demand Control Kitchen Ventilation | -0.24 | -0.22 | -131 | -120 | -0.21 | -0.20 | -111 | -106 | -0.33 | -0.31 | -175 | -163 |
| Space Heating | Adaptive Thermostats | -0.25 | -0.12 | -136 | -65 | -0.22 | -0.09 | -116 | -51 | -0.34 | -0.20 | -180 | -108 |
| Space Heating | Demand Control Ventilation | -0.26 | -0.21 | -138 | -113 | -0.23 | -0.20 | -124 | -106 | -0.35 | -0.30 | -185 | -161 |
| Space Heating | Demand Control Ventilation (Enhanced) | -0.26 | -0.24 | -139 | -127 | -0.22 | -0.21 | -119 | -113 | -0.34 | -0.32 | -184 | -171 |
| Space Heating | Air Curtains | -0.27 | -0.23 | -143 | -123 | -0.23 | -0.20 | -123 | -109 | -0.35 | -0.31 | -187 | -166 |
| Space Heating | Use Shades/Blinds | -0.28 | -0.26 | -150 | -138 | -0.28 | -0.26 | -150 | -138 | -0.39 | -0.36 | -208 | -190 |
| Systems | New Construction - 25% Better | -0.24 | -0.08 | -130 | -42 | -0.19 | -0.03 | -102 | -18 | -0.34 | -0.17 | -182 | -88 |

| Commercial End Use | Measure Name | Mid-Range LTCPF | | | | Minimum LTCPF | | | | Maximum LTCPF | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $/m$^3$ | | $/tCO$_2$e | | $/m$^3$ | | $/tCO$_2$e | | $/m$^3$ | | $/tCO$_2$e | |
| Systems | New Construction - 40% Better | -0.25 | -0.11 | -136 | -58 | -0.20 | -0.06 | -108 | -34 | -0.35 | -0.20 | -188 | -104 |
| Systems | Advanced BAS/Controllers | -0.22 | 0.33 | -119 | 175 | -0.18 | 0.35 | -99 | 189 | -0.31 | 0.25 | -163 | 132 |
| Systems | Operations and Maintenance (O&M) Improvements | -0.28 | -0.26 | -150 | -138 | -0.28 | -0.26 | -150 | -138 | -0.39 | -0.36 | -208 | -190 |
| Systems | Building Recommissioning (Standard) | -0.27 | -0.26 | -142 | -136 | -0.26 | -0.26 | -138 | -136 | -0.37 | -0.36 | -198 | -190 |
| Systems | Building Recommissioning (Enhanced) | -0.27 | -0.26 | -142 | -136 | -0.26 | -0.26 | -138 | -136 | -0.37 | -0.36 | -198 | -190 |
| Systems | Faucet Aerators | -0.24 | -0.22 | -131 | -116 | -0.22 | -0.20 | -118 | -109 | -0.33 | -0.31 | -178 | -164 |
| Systems | Low-Flow Showerheads | -0.23 | -0.18 | -123 | -99 | -0.21 | -0.17 | -110 | -92 | -0.32 | -0.27 | -171 | -147 |
| Service Water Heating | Condensing Boilers (for Service Water Heating) | -0.22 | -0.14 | -115 | -73 | -0.17 | -0.10 | -91 | -54 | -0.30 | -0.22 | -160 | -115 |
| Service Water Heating | Condensing Storage Water Heaters | -0.22 | 0.04 | -115 | 24 | -0.18 | 0.07 | -95 | 38 | -0.30 | -0.04 | -160 | -20 |
| Service Water Heating | Condensing Tankless Water Heaters | -0.22 | -0.03 | -120 | -18 | -0.18 | 0.00 | -95 | 1 | -0.31 | -0.11 | -164 | -60 |
| Service Water Heating | Drain Water Heat Recovery (DWHR) | -0.25 | -0.23 | -134 | -120 | -0.20 | -0.18 | -106 | -98 | -0.34 | -0.31 | -181 | -163 |
| Service Water Heating | High Efficiency Boilers (for Service Water Heating) | -0.17 | 0.13 | -89 | 72 | -0.12 | 0.17 | -64 | 91 | -0.25 | 0.06 | -133 | 30 |
| Service Water Heating | Indirect Water Heaters | 0.15 | 0.23 | 81 | 121 | 0.19 | 0.25 | 101 | 135 | 0.07 | 0.15 | 37 | 78 |
| Service Water Heating | Solar Water Preheat (DHW) | 0.28 | 0.44 | 152 | 234 | 0.34 | 0.49 | 179 | 261 | 0.20 | 0.35 | 105 | 187 |
| Service Water Heating | Commercial Ozone Laundry Treatment | -0.26 | -0.23 | -136 | -124 | -0.22 | -0.21 | -116 | -110 | -0.34 | -0.31 | -181 | -168 |
| Service Water Heating | ENERGY STAR Dishwashers | -0.24 | -0.21 | -126 | -114 | -0.20 | -0.19 | -106 | -100 | -0.32 | -0.30 | -170 | -158 |
| Service Water Heating | ENERGY STAR Clothes Washers | -0.26 | -0.22 | -140 | -116 | -0.23 | -0.20 | -125 | -107 | -0.35 | -0.30 | -187 | -163 |
| Service Water Heating | CEE Tier 2 Clothes Washers | -0.16 | -0.12 | -85 | -65 | -0.13 | -0.11 | -70 | -56 | -0.25 | -0.21 | -132 | -112 |
| Service Water Heating | Pre-Rinse Spray Nozzles | -0.22 | -0.13 | -119 | -71 | -0.22 | -0.13 | -116 | -68 | -0.33 | -0.23 | -175 | -125 |
| Food Service | ENERGY STAR Griddles | -0.25 | -0.23 | -135 | -124 | -0.21 | -0.20 | -114 | -109 | -0.34 | -0.31 | -179 | -167 |
| Food Service | ENERGY STAR Convection Ovens | -0.22 | -0.20 | -119 | -108 | -0.19 | -0.18 | -102 | -98 | -0.31 | -0.29 | -165 | -153 |
| Food Service | ENERGY STAR Fryers | -0.21 | -0.19 | -112 | -101 | -0.18 | -0.17 | -96 | -91 | -0.30 | -0.27 | -158 | -147 |
| Food Service | ENERGY STAR Steam Cookers | -0.25 | -0.23 | -133 | -122 | -0.22 | -0.21 | -117 | -112 | -0.34 | -0.31 | -179 | -168 |
| Food Service | Pizza/Bakery Oven Insulation | -0.20 | -0.18 | -108 | -97 | -0.17 | -0.16 | -92 | -87 | -0.29 | -0.27 | -154 | -142 |
| Food Service | High Efficiency Underfired Broilers | -0.24 | -0.22 | -126 | -115 | -0.21 | -0.20 | -110 | -105 | -0.32 | -0.30 | -172 | -161 |
| Other | Solar Water Preheat (Pools) | 0.24 | 0.49 | 127 | 259 | 0.29 | 0.53 | 154 | 282 | 0.15 | 0.41 | 80 | 216 |

### 2.4.3 Residential Results

This section presents the results of the residential customer conservation analysis for each of the three LTCPF scenarios in the format of a MACC diagram and a supporting data table, which provides the average cost from the perspective of the utility and estimated savings data used to create the MACC. At the end of this section, there is a summary table that identifies all of the measures included in each residential end use category as well as measure-level cost data for each LTCPF scenario.

#### Minimum LTCPF Scenario

Exhibit 8 presents the minimum LTCPF MACC for the residential sector. In this carbon price scenario, the results show that the average cost for a utility to implement the measures in four of the residential end use categories including clothes dryers, fireplaces, systems and space heating is lower than the cost of purchasing allowances in the 2018-2020 timeframe. The total annual savings to be realized during the year 2020 specifically is 144 million $m^3$ (or 270,000 $tCO_2e$), and the estimated savings associated with measures that are cost effective for the utility relative to the carbon price is 96 million $m^3$ (or 180,000 $tCO_2e$).

**Comment [JH17]:** This comments does not seem to match Table 9 below.

Exhibit 8 Residential MACC for Minimum LTCPF

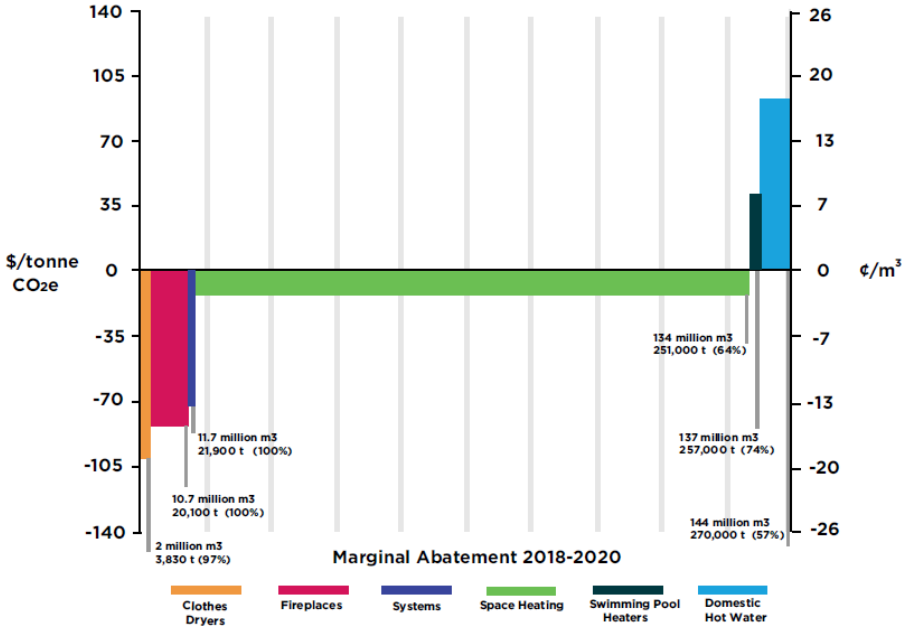



Table 9 Residential MACC for Minimum LTCPF, Average Cost and Savings Results

| Residential End Use | Average $/tCO2e | Average ¢/m3 | Estimated Savings (tCO2e) | Estimated Savings (million m3) | Estimated % Savings <$0/tCO2e |
|---|---|---|---|---|---|
| **Clothes Dryers** | -100 | -19 | 3,830 | 2 | 97% |
| **Fireplaces** | -83 | -16 | 16,200 | 8.7 | 100% |
| **Systems** | -72 | -13 | 1,850 | 1 | 100% |
| **Space Heating** | 13 | 2 | 230,000 | 122 | 64% |
| **Swimming Pool Heaters** | 40 | 8 | 5,480 | 3 | 74% |

| | | | | | |
|---|---|---|---|---|---|
| **Domestic Hot Water** | 127 | 24 | 12,900 | 7 | 57% |

## Maximum LTCPF Scenario

Exhibit 9 presents the maximum LTCPF MACC for the residential sector. In this carbon price scenario, the results show that the average cost for a utility to implement the measures in five of the residential end use categories including clothes dryers, fireplaces, systems, space heating and swimming pool heaters is lower than the cost of purchasing allowances in the 2018-2020 timeframe. The total annual savings to be realized during the year 2020 specifically is 144 million $m^3$ (or 270,000 $tCO_2e$), and the estimated savings associated with measures that are cost effective for the utility relative to the carbon price is 110 million $m^3$ (or 207,000 $tCO_2e$).

Exhibit 9 Residential MACC for Maximum LTCPF

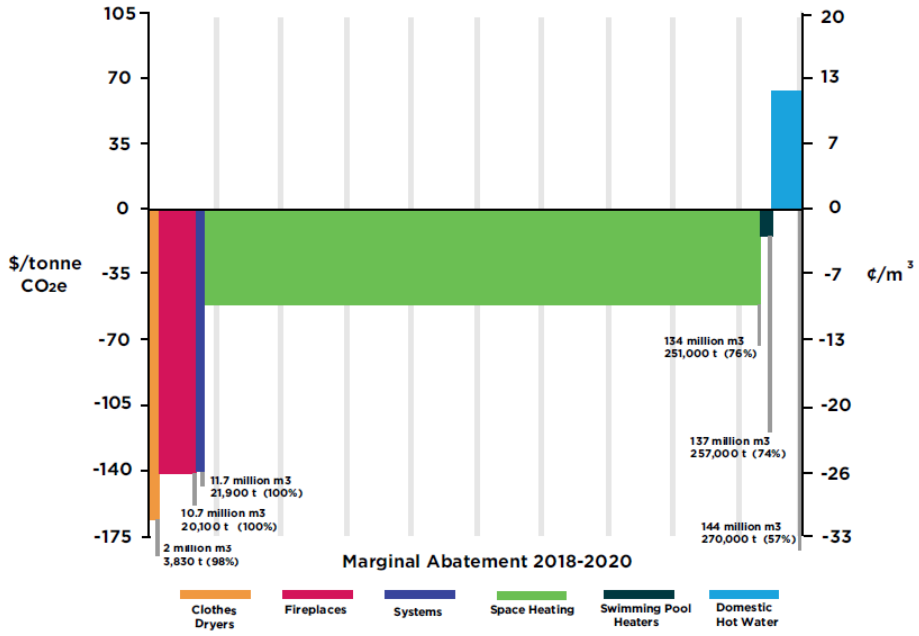



Table 10 Residential MACC for Maximum LTCPF, Average Cost and Savings Results

| Residential End Use | Average $/$tCO_2e$ | Average ¢/$m^3$ | Estimated Savings ($tCO_2e$) | Estimated Savings (million $m^3$) | Estimated % Savings <$0/$tCO_2e$ |
|---|---|---|---|---|---|
| **Clothes Dryers** | -166 | -31 | 3,830 | 2 | 98% |
| **Fireplaces** | -143 | -27 | 16,200 | 8.7 | 100% |
| **Systems** | -143 | -27 | 1,850 | 1 | 100% |
| **Space Heating** | -54 | -10 | 230,000 | 122 | 76% |
| **Swimming Pool Heaters** | -22 | -4 | 5,480 | 3 | 74% |
| **Domestic Hot Water** | 63 | 12 | 12,900 | 7 | 57% |

## Mid-Range LTCPF Scenario

Exhibit 10 presents the mid-range LTCPF MACC for the residential sector. In this carbon price scenario, the results show that the average cost for a utility to implement the measures in four of the residential end use categories including clothes dryers, systems, fireplaces and space heating is lower than the cost of purchasing allowances in the 2018-2020 timeframe. The total annual savings to be realized during the year 2020 specifically is 144 million $m^3$ (or 270,000 $tCO_2e$), and the estimated savings associated with measures that are cost effective for the utility relative to the carbon price is 97 million $m^3$ (or 182,000 $tCO_2e$).

Exhibit 10 Residential MACC for Mid-Range LTCPF

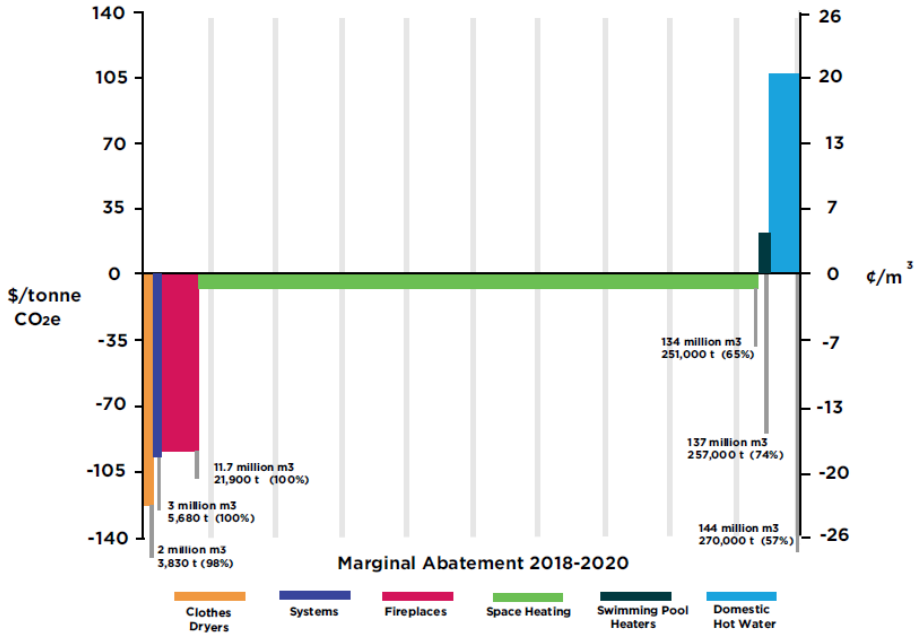



Table 11 Residential MACC for Mid-Range LTCPF, Average Cost and Savings Results

| Residential End Use | Average $/$tCO_2e$ | Average ¢/$m^3$ | Estimated Savings ($tCO_2e$) | Estimated Savings (million $m^3$) | Estimated % Savings <$0/$tCO_2e$ |
|---|---|---|---|---|---|
| **Clothes Dryers** | -123 | -23 | 3,830 | 2 | 98% |
| **Systems** | -97 | -18 | 1,850 | 1 | 100% |
| **Fireplaces** | -94 | -18 | 16,200 | 8.7 | 100% |
| **Space Heating** | -7 | -1 | 230,000 | 122 | 65% |
| **Swimming Pool Heaters** | 24 | 5 | 5,480 | 3 | 74% |
| **Domestic Hot Water** | 108 | 20 | 12,900 | 7 | 57% |

Table 12 Residential Measure-Level Marginal Abatement Cost Data (Ranges) for 2018-2020 Timeframe

| Residential End Use | Measure Name | Mid-Range LTCPF | | | | Minimum LTCPF | | | | Maximum LTCPF | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $/m$^3$ | | $/tCO$_2$e | | $/m$^3$ | | $/tCO$_2$e | | $/m$^3$ | | $/tCO$_2$e | |
| Space Heating | Attic/Ceiling Insulation | -0.12 | -0.08 | -62.9 | -42.3 | -0.07 | -0.03 | -34.8 | -18.2 | -0.22 | -0.17 | -115 | -89 |
| Space Heating | Basement Wall Insulation (R-12) | -0.17 | -0.04 | -89.3 | -20.5 | -0.11 | 0.01 | -61.1 | 3.6 | -0.26 | -0.13 | -141 | -66.8 |
| Space Heating | Crawlspace Insulation | 0.62 | 2.25 | 330 | 1,201 | 0.67 | 2.30 | 358 | 1,227 | 0.52 | 2.17 | 278 | 1,155 |
| Space Heating | Draft Proofing Kit | -0.19 | -0.17 | -101 | -89.5 | -0.19 | -0.17 | -101 | -89.5 | -0.30 | -0.27 | -159 | -141 |
| Space Heating | Wall Insulation | -0.19 | 0.51 | -103 | 272 | -0.14 | 0.55 | -75 | 296 | -0.29 | 0.42 | -155 | 225 |
| Space Heating | Zoned-Up Windows: (ENERGY STAR) Rating for a Colder Climate | -0.24 | 0.30 | -128 | 162 | -0.19 | 0.35 | -100 | 186 | -0.34 | 0.22 | -180 | 115 |
| Space Heating | Heat Reflector Panels | -0.25 | -0.22 | -133 | -117 | -0.20 | -0.18 | -106 | -95 | -0.34 | -0.30 | -180 | -160 |
| Space Heating | Air Leakage Sealing and Insulation (Old Homes) | -0.22 | -0.10 | -116 | -54.7 | -0.16 | -0.06 | -88.0 | -30.6 | -0.31 | -0.19 | -168 | -101 |
| Space Heating | Super High-Performance Windows | -0.55 | -0.07 | -291 | -39.2 | -0.49 | -0.03 | -263 | -15.1 | -0.64 | -0.16 | -343 | -85.5 |
| Space Heating | Professional Air Sealing/Weather Stripping/Caulking | -0.19 | 0.14 | -101 | 75.8 | -0.14 | 0.19 | -73.4 | 99.8 | -0.29 | 0.06 | -153 | 29.4 |
| Space Heating | Condensing Gas Boilers | 0.27 | 1.89 | 146 | 1,008 | 0.32 | 1.94 | 170 | 1,033 | 0.19 | 1.81 | 102 | 964 |
| Space Heating | Early Furnace Replacement - 60% AFUE - 90% AFUE Furnace | -0.09 | -0.08 | -47.8 | -43.5 | -0.09 | -0.08 | -47.8 | -43.5 | -0.20 | -0.18 | -106 | -96.7 |
| Space Heating | Early Furnace Replacement - 70% AFUE - 90% AFUE Furnace | 0.04 | 0.04 | 19.7 | 24.0 | 0.04 | 0.04 | 19.7 | 24.0 | -0.07 | -0.05 | -38.1 | -29.2 |
| Space Heating | High Efficiency Condensing Furnace | 0.32 | 0.49 | 172 | 262 | 0.36 | 0.53 | 194 | 285 | 0.24 | 0.41 | 128 | 218 |
| Space Heating | 95% or Higher Efficiency Furnace | -0.21 | -0.08 | -110 | -40.7 | -0.16 | -0.04 | -87.0 | -23.4 | -0.29 | -0.16 | -154 | -82.8 |
| Space Heating | Programmable Thermostat | -0.20 | -0.16 | -109 | -86.7 | -0.17 | -0.14 | -89.0 | -72.6 | -0.29 | -0.24 | -153 | -130 |
| Space Heating | Adaptive Thermostats | -0.30 | -0.28 | -159 | -147 | -0.26 | -0.25 | -139 | -133 | -0.38 | -0.36 | -203 | -190 |
| Space Heating | Adaptive Thermostats - Direct Install (from base measure Programmable Thermostat) | -0.28 | -0.17 | -149 | -92.5 | -0.24 | -0.15 | -129 | -78.4 | -0.36 | -0.25 | -194 | -136 |
| Space Heating | Close windows and blinds | -0.29 | -0.26 | -156 | -139 | -0.29 | -0.26 | -156 | -139 | -0.40 | -0.36 | -214 | -191 |
| Space Heating | Maintain Weatherstripping | 0.06 | 0.86 | 32.6 | 457 | 0.06 | 0.86 | 34.2 | 461 | -0.04 | 0.75 | -22.3 | 402 |
| Systems | High-Efficiency (ENERGY STAR®) Clothes Washers | -0.27 | -0.20 | -145 | -109 | -0.24 | -0.18 | -126 | -96.1 | -0.36 | -0.29 | -189 | -153 |
| Domestic Hot Water | Faucet Aerator (Bathroom, 1.5 GPM) | -0.23 | -0.21 | -125 | -114 | -0.21 | -0.20 | -111 | -107 | -0.32 | -0.30 | -172 | -162 |
| Domestic Hot Water | Faucet Aerator (Kitchen, 1.5 GPM) | -0.24 | -0.22 | -128 | -118 | -0.22 | -0.21 | -115 | -110 | -0.33 | -0.31 | -176 | -165 |
| Domestic Hot Water | High-Efficiency (ENERGY STAR®) Dishwashers | 0.65 | 3.36 | 346 | 1,793 | 0.68 | 3.39 | 360 | 1,808 | 0.56 | 3.27 | 299 | 1,747 |
| Domestic Hot Water | Low-Flow Shower Head (1.5 GPM) | -0.20 | -0.17 | -104 | -92.7 | -0.17 | -0.16 | -91.1 | -85.6 | -0.28 | -0.26 | -152 | -141 |
| Domestic Hot Water | Pipe Wrap | -0.25 | -0.23 | -135 | -124 | -0.22 | -0.21 | -115 | -110 | -0.34 | -0.31 | -179 | -167 |

| Residential End Use | Measure Name | Mid-Range LTCPF | | | | Minimum LTCPF | | | | Maximum LTCPF | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $/m^3 | | $/tCO2e | | $/m^3 | | $/tCO2e | | $/m^3 | | $/tCO2e | |
| Domestic Hot Water | DHW Tank Insulation | 0.03 | 0.60 | 18.7 | 317 | 0.07 | 0.62 | 36.2 | 329 | -0.05 | 0.51 | -26.6 | 273 |
| Domestic Hot Water | Faucet Aerator (Bathroom, 1.0 GPM) | -0.24 | -0.22 | -128 | -118 | -0.22 | -0.21 | -115 | -111 | -0.33 | -0.31 | -176 | -166 |
| Domestic Hot Water | Faucet Aerator (Kitchen, 1.0 GPM) | -0.24 | -0.22 | -130 | -120 | -0.22 | -0.21 | -117 | -113 | -0.33 | -0.31 | -178 | -168 |
| Domestic Hot Water | Low-Flow Shower Head (1.25 GPM) | -0.33 | -0.31 | -178 | -165 | -0.31 | -0.30 | -165 | -158 | -0.42 | -0.40 | -226 | -213 |
| Domestic Hot Water | Early Hot Water Heater Replacement (0.575 to 0.62 EF) | 0.44 | 0.45 | 232 | 239 | 0.44 | 0.45 | 232 | 239 | 0.33 | 0.34 | 177 | 180 |
| Domestic Hot Water | High Efficiency Gas Storage Water Heater | 0.51 | 0.57 | 270 | 305 | 0.55 | 0.60 | 291 | 321 | 0.42 | 0.49 | 226 | 263 |
| Domestic Hot Water | Tankless Water Heater (High Efficiency Non-Condensing) | 0.63 | 0.70 | 337 | 375 | 0.68 | 0.74 | 361 | 397 | 0.55 | 0.62 | 292 | 333 |
| Domestic Hot Water | Condensing Gas Water Heaters | -3.95 | 2.52 | -2,105 | 1,344 | -3.91 | 2.55 | -2,088 | 1,360 | -4.03 | 2.44 | -2,150 | 1,300 |
| Domestic Hot Water | Tankless Water Heater (Condensing) | -0.98 | 0.28 | -521 | 147 | -0.93 | 0.31 | -497 | 166 | -1.06 | 0.20 | -566 | 105 |
| Domestic Hot Water | Active Solar Water Heating Systems | 0.87 | 3.05 | 461 | 1,629 | 0.92 | 3.10 | 489 | 1,656 | 0.78 | 2.97 | 415 | 1,582 |
| Domestic Hot Water | DHW Recirculation Systems (e.g. Metlund D'MAND®) | 0.04 | 0.76 | 19.7 | 403 | 0.08 | 0.80 | 42.7 | 425 | -0.05 | 0.68 | -24.2 | 361 |
| Domestic Hot Water | Wastewater Heat Recovery Systems | 0.25 | 1.34 | 134 | 717 | 0.30 | 1.40 | 163 | 745 | 0.15 | 1.25 | 83 | 665 |
| Domestic Hot Water | Minimize Hot and Warm Clothes Wash | -0.26 | -0.24 | -137 | -126 | -0.26 | -0.24 | -137 | -126 | -0.37 | -0.33 | -195 | -178 |
| Domestic Hot Water | Reduce Temperature of DHW | -0.26 | -0.24 | -137 | -126 | -0.26 | -0.24 | -137 | -126 | -0.37 | -0.33 | -195 | -178 |
| Clothes Dryers | High-Efficiency Gas Clothes Dryers | 0.08 | 0.81 | 40.7 | 433 | 0.12 | 0.85 | 63.7 | 451 | -0.01 | 0.73 | -3.2 | 391 |
| Clothes Dryers | Use sensor for clothes dryer | -0.05 | 0.34 | -24.1 | 180 | 0.00 | 0.37 | -1.2 | 197 | -0.13 | 0.26 | -68.1 | 138 |
| Clothes Dryers | Clothes lines and drying racks | -0.25 | -0.21 | -133 | -115 | -0.20 | -0.18 | -108 | -94.7 | -0.33 | -0.29 | -178 | -156 |
| Swimming Pool Heaters | Insulating Pool Covers | -0.24 | -0.12 | -125 | -62 | -0.21 | -0.10 | -112 | -54.5 | -0.32 | -0.21 | -173 | -110 |
| Swimming Pool Heaters | High-Efficiency Gas-Fired Pool Heaters | 1.48 | 2.09 | 787 | 1,116 | 1.48 | 2.10 | 790 | 1,120 | 1.38 | 2.00 | 735 | 1,064 |
| Swimming Pool Heaters | Solar Pool Heaters | -0.23 | -0.19 | -123 | -101 | -0.18 | -0.15 | -98 | -82.1 | -0.31 | -0.27 | -167 | -143 |
| Fireplaces | Fireplace Intermittent Ignition Control Retrofit | -0.17 | -0.10 | -90.9 | -55.5 | -0.15 | -0.10 | -81.2 | -51.5 | -0.26 | -0.20 | -141 | -106 |
| Fireplaces | High Efficiency Fireplace with Pilotless Ignition (freestanding fireplace) | -0.25 | -0.21 | -131 | -110 | -0.20 | -0.17 | -107 | -91.3 | -0.33 | -0.29 | -176 | -152 |
| Fireplaces | High Efficiency Fireplace with Pilotless Ignition (insert) | -0.25 | -0.21 | -131 | -110 | -0.20 | -0.17 | -107 | -91.0 | -0.33 | -0.28 | -175 | -152 |
| Fireplaces | High Efficiency Fireplace with Pilotless Ignition (Zero Clearance <40 kBtu/h) | -0.24 | -0.21 | -131 | -110 | -0.20 | -0.17 | -106 | -90.5 | -0.33 | -0.28 | -175 | -151 |

| Residential End Use | Measure Name | Mid-Range LTCPF | | | | Minimum LTCPF | | | | Maximum LTCPF | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $/m$^3$ | | $/tCO$_2$e | | $/m$^3$ | | $/tCO$_2$e | | $/m$^3$ | | $/tCO$_2$e | |
| Fireplaces | High Efficiency Fireplace with Pilotless Ignition (Zero Clearance ≥40 kBtu/h) | -0.25 | -0.21 | -135 | -114 | -0.21 | -0.18 | -110 | -94.8 | -0.34 | -0.29 | -179 | -156 |

# 3. Renewable Natural Gas

## 3.1 Background

In order to support the assessment of the utilities' cap and trade costs over the study period, it is important to consider not only the abatement that can be achieved through natural gas conservation measures implemented by natural gas customers (see Section 2), but also opportunities for abatement that utilities provide aimed at reducing the GHG emissions intensity of the fuel, such as procurement of renewable natural gas (RNG). This section describes the potential for abatement through greening the gas grid using RNG. It is important to emphasize that this study was a desk-based literature review, not an in-depth survey or on-the-ground potential assessment.

RNG is biogas that has been processed to match the specifications (energy content and quality) of conventional fossil-derived natural gas, and which can be injected into the natural gas pipeline. It is functionally equivalent to conventional natural gas, and can be used by utilities' customers to meet the same purposes without generating fossil fuel-related emissions of $CO_2$. By sourcing and procuring RNG, utilities can reduce the emissions intensity of the gas they deliver to customers. While this reduces the cap and trade compliance obligation associated with each $m^3$ of natural gas delivered to customers, it can also affect the cost effectiveness and emissions abatement success associated with conservation measures. As the emissions intensity of the gas in the pipeline is reduced, each $m^3$ of conservation potential abates a lesser amount of GHG emissions, thereby reducing the cost effectiveness of customer conservation measures.

RNG is produced over a series of steps – namely collection of a feedstock, delivery to a processing facility for biomass-to-gas conversion, gas conditioning, compression, and injection into the pipeline. ICF developed resource potential curves to estimate the deployment of RNG for pipeline injection. These curves present the cost of greenhouse gas (GHG) abatement (in units of dollars per tonne, $/tonne) as a function of supply (in units $m^3$). These curves are based on a combination of a) the availability of feedstocks for conversion to RNG and b) the costs of converting feedstocks into RNG using anaerobic digestion and thermal gasification technologies.

**Comment [JH18]:** RNG contains only methane as the gas component with a heating value. RNG @ 100 % pure methane is 37mj/m3. Conventional gas typically contains small amounts propane, butane and ethane which have a higher heating value. Union's South distribution area's heating value is 38.81 mj/m3. You could say that biogas is cleaned and conditioned to pipeline quality specifications which is interchangeable with conventional natural gas.

**Comment [JH19]:** If total amount of RNG in the system stays the same by offsetting the conventional NG used, this wouldn't be true. You wouldn't offset RNG use.

**Comment [JH20]:** Organic specification needed?

## 3.2 Approach

### Resource and RNG Potential

To develop the resource potential for RNG across Canada and in Ontario within the study scope and timeline, ICF completed a desk-based literature review of publicly available documents. Input was also sought from known experts in the field of RNG/renewable fuels as to the usefulness of the available literature. Several studies were reviewed including:

- Canadian Biogas Study: Benefits to the Economy, Environment and Energy, Biogas Association, December 2013.
- Potential Production of Renewable Natural Gas from Ontario Wastes, Alberta Innovates Technology Futures, May 2011.

- Economic Study on Renewable Natural Gas Production and Injection Costs in the Natural Gas Distribution Grid in Ontario: Biogas plant costing report, Electrigaz Technologies, September 2011.

It was determined that the Canadian Biogas Study is the most comprehensive study available publicly regarding feedstock resource potential, with a national focus (and broken down by province). ICF relied on this study for this analysis, largely because the study was given high marks by stakeholders during conversations at the outset of the project. ICF explicitly asked for direction from multiple stakeholders re: other references, and the Canadian Biogas Study was referred to as a reliable basis for our analysis.

The table below provides an overview of the feedstocks considered in this analysis[11]:

Table 13 RNG Feedstocks

| Feedstock for RNG | Description |
|---|---|
| **Landfill gas (LFG)** | Biogenic waste in landfills produces a mix of gases, including methane (40-60%). |
| **Wastewater treatment (WWT) gas** | Wastewater consists of waste liquids and solids from household, commercial and industrial water use. In the processing of wastewater, a sludge is produced, which can be anaerobically digested to produce methane. |
| **Animal manure** | Manure produced by livestock, including dairy cows, beef cattle, swine, sheep, goats, poultry, and horses. |
| **Source separated organics (SSO)** | Food waste separated from the garbage stream of either residential, commercial, or institutional sources for separate collection and processing. |
| **Agricultural residue** | The material left in the field, orchard, or other agricultural setting after a crop has been harvested. Inclusive of unusable portion of crop, stalks, stems, leaves, branches, and seed pods. |

**Comment [JH21]:** Produces biogas. This is also a mix of gases like LFG. (40-65% methane) which also holds true for the other digested feedstocks identified

ICF used the RNG production estimates from the Canadian Biogas Study to develop the abatement curves; while the study does not explicitly indicate the timeframe by which the resource can be developed, it was assumed that the production potential is limited by investment rather than technological development. In that regard, it was assumed that nearly 100% of the RNG production potential estimated in the Canadian Biogas Study is achievable by 2028 for each feedstock. The table below outlines the annual RNG production potential for pipeline injection used in the analysis, in units of million cubic metres (million $m^3$).

Table 14 RNG Resource Potential in 2028 for Canada and Ontario

| Feedstock for RNG | Canada Resource Potential Estimate (million $m^3$/y) | Ontario Resource Potential Estimate (million $m^3$/y) |
|---|---|---|
| **LFG** | 290 | 113 |
| **WWT gas** | 180 | 71 |
| **Animal manure** | 874 | 191 |
| **SSO (Residential and** | 300 | 110 |

[11] Section 3.3 of this report identifies several feedstocks that have not been included in this analysis with a reason provided for the exclusion.

| Feedstock for RNG | Canada Resource Potential Estimate (million $m^3$/y) | Ontario Resource Potential Estimate (million $m^3$/y) |
|---|---|---|
| **Commercial)** | | |
| **Agricultural residue** | 774 | 142 |
| **Total** | **2,418** | **627** |

### RNG Production and Cost

ICF considered RNG production via two conversion technologies: anaerobic digestion or thermal gasification.

- Anaerobic digestion is the process whereby microorganisms break down organic material in an environment without oxygen. In the context of RNG production, the process generally takes place in a controlled environment, referred to as a digester or reactor. When organic material is introduced to the digester, it is broken down over time (e.g., days) by microorganisms, and the gaseous products of that process contain a large fraction of methane and carbon dioxide.
- Thermal gasification describes a broad range of processes whereby a carbon-containing feedstock is converted into a mixture of gases referred to as synthetic gas or syngas, including hydrogen carbon monoxide, steam, carbon dioxide, methane, and trace amounts of other gases (e.g., ethane, hydrogen sulfide, and nitrogen). The process occurs at high temperatures (650-1350°C) and varying pressures (depending on the gasification system). There is limited commercial-scale deployment of thermal gasification technologies.

ICF assumed that RNG production occurs via anaerobic digestion for LFG, wastewater treatment plants, animal manure, and SSO. It was assumed that agricultural residue was converted to RNG via thermal gasification.

The main cost components considered in ICF's analysis include:

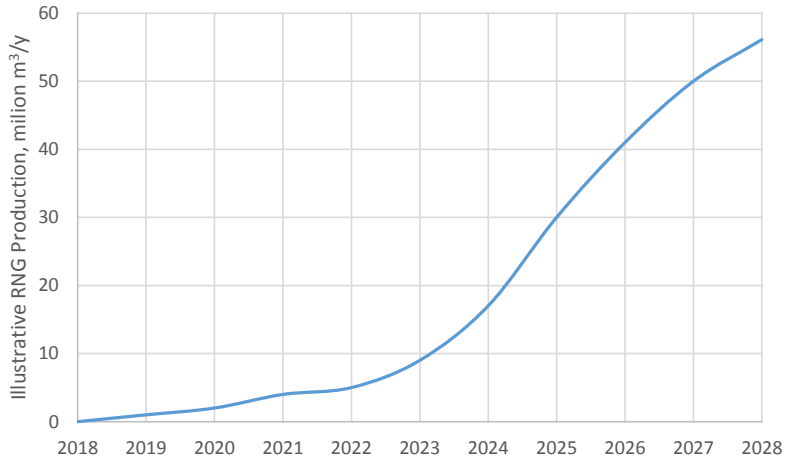
- Collection - This refers to a variety of cost elements, including the capture of gas from landfills or wastewater treatment plants or the collection of a feedstock.
- Upgrading biogas for injection - Broadly speaking, raw biogas needs to upgraded and scrubbed of contaminants prior to injection into a transmission pipeline. The primary cost components for upgrading biogas that ICF included in the analysis are: conditioning the biogas, compression of the biogas, sulfur removal, and a nitrogen rejection system. ICF notes that there are a variety of biogas conditioning systems that are commercially available with different approaches to conditioning gas prior to injection. Our assumptions for conditioning align with what we consider conservative estimates (i.e., our assumed costs are likely higher than other estimates).
- Pipeline interconnect - Pipeline interconnect represents the combination of the point of receipt from the customer pipeline and the pipeline extension to the utility pipeline. These costs vary by project size, complexity, and distance from common carrier pipeline.
- Construction and engineering - The deployment of biogas projects requires significant investments in construction and engineering, including site design, labour to install equipment, etc.
- Operations and maintenance - ICF includes the costs of operating and maintaining the biogas production facility - including collection, conditioning, compression, and injection.

These costs are generally expressed as a percentage of the capital expenditures, and range from 5-15%.

In all scenarios, ICF assumed an s-curve of deployment (see figure below for an example) of RNG production facilities: the underlying principle of this assumption is that the initial investments will be modest over the first 5-7 years (2018-2024), but that deployment in the out-years ramps up. ICF's deployment curves should not be considered a forecast, rather, they are meant to capture plausible investment in RNG production considering the barriers to financing, permitting a project, and completing it (typically with an 18-36 month timeframe between project financing and coming online).

**Comment [JH22]:** It is important to recognize the timeline of a project. It may be worth mentioning that another 8-12 months of work goes into these projects before they get to the financing from concept/idea and establishing a business case for decision makers

Exhibit 11 Illustrative S-Curve Representing Assumed Deployment of RNG Facilities for One Feedstock Type from 2018-2028




ICF's RNG production cost modelling is dependent on the size of the system, and is linked to the inlet flow of biogas for conditioning. The Canadian Biogas Study has limited information regarding the size of each digester facility assumed; however, ICF extracted feedstock specific data to the extent feasible. The sub-sections below outline the size of digester facilities assumed for landfill operations, wastewater treatment facilities, animal manure, and source separated organics. It also includes our approach to developing thermal gasification costs.

For each feedstock, ICF calculated the levelized cost of energy (LCOE) by incorporating the capital expenditures from equipment, operations and maintenance (O&M), and a discount rate of 4% for our calculations[12].

**Comment [JH23]:** Is there a return on Capital cost contemplated?

### Landfill gas

ICF developed abatement cost estimates using five different facility size estimates based on a survey of 63 landfill sites reported in the Canadian Biogas Study (which is sourced from a

[12] This treatment of costs is analogous to the treatment of costs in the customer conservation analysis in Section 2.

separate study[13]). The table below includes the assumed biogas flow for each facility in units of standard cubic feet per minute (SCFM) and the calculated annual output of RNG. The table also includes the assumed share of the market for each production facility size. ICF calculates RNG production assuming a methane content of landfill gas of 48% and a capacity factor (i.e., how frequently the system is operational) of 90%. The table below presents ICF's calculated LCOE for each landfill size.

**Comment [JH24]:** How do these costs compare to Electrigaz estimates? Electrigaz estimates have 3 size categories. How many of Ontario's 2400 landfills might fit within these categories?

Table 15 LFG Facility Assumptions by Facility Size (from smallest to largest landfill)

| Biogas flow (SCFM) | RNG Annual Production (million $m^3$/y) | Estimated Share of Market | LCOE ($/$m^3$) |
|---|---|---|---|
| **360** | 2.3 | 10% | $0.82 |
| **500** | 3.2 | 50% | $0.71 |
| **1,200** | 7.7 | 20% | $0.46 |
| **2,500** | 13.8 | 10% | $0.38 |
| **3,250** | 21 | 10% | $0.33 |

**Comment [JH25]:** A small landfill generating offset credits will produce 6 times the abatement compared to a landfill not generating offset credits. Offset credits will significantly improve the MACC for RNG for sources that are eligible, such as small landfills.

ICF notes that for the largest landfill category we did not include the costs of collecting biogas in the estimates, because we assume that they are regulated and required to capture and flare biogas rather than allowing it to vent to the atmosphere. It is possible that other landfills have collection systems in place, particularly the larger landfills (e.g., with biogas flow greater than 1,000 SCFM). In that regard, it is conceivable that we have over-stated the LCOE of RNG production because the collection systems can represent a significant share of the cost.

**Comment [JH26]:** Our estimate is 5-7 cents / m3

### Wastewater treatment gas

ICF developed abatement cost estimates based on four different sized wastewater treatment plants using internal modelling from other jurisdictions. Unfortunately, ICF was unable to identify a reference (e.g., the Canadian Biogas Study) that provided a breakdown of WWT plants. The table below includes the assumed biogas flow for each facility in units of SCFM and the calculated annual output of RNG. Because there was no available information regarding the distribution of WWT plant sizes, ICF made the simplifying assumption that the market share would be split evenly between the four facility sizes considered in our analysis. ICF calculates RNG production assuming a methane content of gas captured from WWT plants of 56% and a capacity factor of 90%. The table below includes our calculated LCOE of each WWT plant size.

Table 16 WWT Facility Assumptions by Facility Size (from smallest to largest WWT facility)

| Biogas flow (SCFM) | RNG Annual Production (million $m^3$/y) | Estimated Share of Market | LCOE ($/$m^3$) |
|---|---|---|---|
| **60** | 0.43 | 25% | $3.73 |
| **110** | 0.81 | 25% | $2.34 |
| **525** | 3.94 | 25% | $0.67 |
| **1,170** | 8.75 | 25% | $0.48 |

[13] Identification of Potential Additional Greenhouse Gas Emissions Reductions From Canadian Municipal Solid Waste Landfills. Contract Number K2A82-11-0009. Prepared for Environment Canada By Conestoga-Rovers and Associates, August, 2012

### Animal manure

ICF developed abatement cost estimates based on three different sized farms. The farm sizes and number of cattle are based on the Electrigaz study. They define three farms: a baseline agricultural facility with 1,315 dairy cows, a large agricultural facility with 2,616 cows, and an agricultural cooperative with 3,950 dairy cows. The table below includes the assumed biogas flow for each farm size in units of SCFM and the calculated annual output of RNG. Because there was no available information regarding the distribution of farm sizes or a detailed analysis regarding the potential for agricultural cooperatives, ICF made the simplifying assumption that the market share would be split evenly between these three facility sizes. ICF calculates RNG production assuming a methane content of gas captured from dairy manure of 60% and a capacity factor of 95%. The table below includes our calculated LCOE of each agricultural facility size.

**Comment [JH27]:** Ontario Dairy Farmers information: Average dairy heard is ~80 cows. 3700 dairy operations in Ontario. Only 47 farms with 450 or more cows with the biggest one around 1700. Stats Canada identifies about 317,000 dairy cows in Ontario. Beef cattle in Ontario 236k with average of 88 per farm giving about 2600 beef farms. Only ~330 beef farms have more than 122 cows. There are lots of small farms in Ontario and most of them will be too small to produce RNG.

Table 17 Livestock Farm Assumptions by Farm Size (from smallest to largest farm facility)

| Facility | Dairy Cows | Biogas flow (SCFM) | RNG Annual Production (million $m^3$/y) | Est Market Share | LCOE ($/$m^3$) |
|---|---|---|---|---|---|
| **Baseline** | 1,315 | 90 | 0.75 | 33% | $1.66 |
| **Large** | 2,616 | 180 | 1.50 | 33% | $1.06 |
| **Co-op** | 3,950 | 265 | 2.25 | 33% | $0.87 |

### Source separated organics

The RNG production potential for source separated organics (SSO) was distinguished by residential and commercial applications in the Canadian Biogas Study: residential and commercial applications have been combined here. The anaerobic digestion of SSO requires the development of a separate digester facility – it is not merely the collection of biogas analogous to the functioning of a landfill or WWT plant. This can add significant cost; further, there are different sized facilities in the literature. The Canadian Biogas Study assumes the construction of facilities that can handle 60,000 tonnes of SSO via anaerobic digestion. ICF used that single facility size to develop the abatement curve for SSO; although we note that there are references that suggest facilities could process as much as 100,000 tonnes. In that regard, it is conceivable that the LCOE for RNG from SSO may be over-stated if larger facilities are constructed in response to the appropriate price signal.

**Comment [JH28]:** What equipment is this for?

ICF assumed that a facility processing 60,000 tonnes of waste would produce approximately 500 SCFM of biogas and calculated yield of about 4 million $m^3$/year of RNG, assuming a 60% methane content and a capacity factor of 90%. ICF also assumed an additional capital expenditure of organics processing ($14 million) and the cost of the digester ($17.5 million). The total capital costs are on the order of $40-45 million for this type of RNG production. This yields a LCOE of $2.90/$m^3$.

**Comment [JH29]:** This is 78$/GJ… which is much higher than what was needed on the Electricity price paid through FIT type program to get digesters built. They get tip fees on the waste coming into the facility. CBA would suggest that ~$21-23$/gj or $0.78 to $0.85/m3 is a more representative number needed for a facility of this size which is on par with $0.18/kwh from the FIT side.

### Agricultural residue

As noted previously, ICF made the broad assumption that agricultural residue is converted to biogas via thermal gasification. ICF used a combination of internal estimates on conversion efficiency of a thermal gasification facility and feedstock pricing to develop a series of abatement curves for agricultural residue as a resource for RNG production. These estimates have a high degree of uncertainty for two reasons: 1) thermal gasification of biomass has not

**Comment [JH30]:** The AI study estimates that 20% of agri residues are amendable to generating RNG from biogas. The AI study assumed that 80% of residues would undergo gasification to produce RNG. Since the volume of RNG estimated has excluded gasification based sources, so should cost estimates of RNG from gasification.

been developed at commercial scale, so cost information is scarce, and 2) the market for agricultural residues is not mature (because the residue is primarily used as ground cover as part of agricultural operations for nutrient loadings), therefore feedstock pricing is speculative. To address these uncertainties, ICF developed six estimates of RNG production from a thermal gasification facility, assuming different yields of gasification and different feedstock pricing scenarios.

Table 18 Agricultural Residue Assumptions by Varying Yield and Feedstock Price

| RNG Yield | RNG Production (million $m^3$/y) | Feedstock Price ($/tonne) | LCOE ($/$m^3$) |
|---|---|---|---|
| **Low** | 105 | $23.50 | $0.90 |
| | | $130 | $1.57 |
| **Medium** | 115 | $23.50 | $0.81 |
| | | $60 | $1.01 |
| **High** | 140 | $23.50 | $0.66 |
| | | $60 | $0.83 |

**Comment [JH31]:** We would expect these to be much higher. Is ICF certain they have facility costs and O&M at least similar to anaerobic digestion?

## 3.3 Limitations and Caveats

### Resource and RNG Potential Data

- While the consensus among RNG experts was that the Canadian Biogas Study was the best available study to provide national and provincial estimates of RNG potential for this analysis, it referenced RNG potential data from other reports that are no longer available for review. With many of the CBS' key references unavailable or inaccessible, it made it difficult for ICF to conduct a critical evaluation of the methodologies employed to build up the national and provincial estimate. Further, because these information and baseline data are not readily available, it makes it impractical for ICF (or other reviewers) to assess the results in the context of revised or updated methodologies to develop resource assessments (e.g., using updated sustainability criteria).

- ICF did not include forest residue as a potential feedstock because it was excluded from the Canadian Biogas Study and due to the uncertainty of availability and accessibility (i.e. the potential costs of transporting the feedstock could be prohibitive). Even if forest residue was added to the possible feedstocks in this study, it would not change the available RNG potential in the 2018-2020 study period, as the timeline on thermal gasification extends several years past 2020.

- ICF did not include the production of hydrogen via steam reformation of biomethane. Renewable hydrogen could also conceivably be produced by electrolysis using renewable energy generation; however, this was not in the scope of consideration as RNG (the focus of this study was on biomethane, not any renewable gas). This was a scoping decision at the outset of the project. ICF notes that renewable hydrogen from either SMR or electrolysis are more expensive (on a dollar per tonne basis) than the RNG abatement opportunities presented in the analysis.

- This analysis did include thermal gasification (of agricultural residue) which is a syngas process. ICF did not consider industrial gases because these are not biogenic or considered renewable.

- This analysis also excluded the consideration of purpose grown energy crops because the uncertainty associated with the potential for this technology and the lack of reliable documentation.

- Two new Ontario policy drivers including an organics ban at landfills and the prohibition of spreading untreated sewage sludge on agricultural fields have not been accounted for in this RNG assessment. These policies could potentially accelerate the development of LFG and WWT facilities that are generating RNG, but they would not likely affect the price to bring the RNG to the grid.

**Comment [JH32]:** This statement seems to contradict table 19. It is reasonable to exclude gasification based sources of RNG at this point in time since the technology and costs are not commercially mature.

### Costs

- Since the RNG originates from all of Canada, this analysis makes a simplifying assumption that the upstream capacity costs associated with RNG are equivalent to fossil-derived natural gas. In reality, these costs would be dependent on the distance and sources of RNG flowing into Ontario. Upstream capacity costs are approximately 10-20% of natural gas commodity costs (in the 2016 CPS assumptions).

- Future changes in technology costs used in the study, i.e. improvement in efficiency and drop in price over time, have not been included in the analysis. This may over-state forecasted $/m$^3$ and $/t $CO_2$e estimates in the later years of the study period, making the cost estimates more conservative.

- The estimates of cost to deliver RNG to the natural gas grid in $/m$^3$, and the equivalent cost in $/tonne $CO_2$e do not account for the sale of any associated emissions reductions or offset credits in Ontario's nascent offset system. While several of the RNG feedstocks[14] identified in this study may have the potential to generate offset credits through avoidance of methane venting to the atmosphere, in addition to lowering the emissions intensity of the natural gas system, the financial value of those offsets has not been included in the $/m$^3$ and $/tonne $CO_2$e estimates. Given that the Ontario offset system is still under development and the protocols[15] expected to be relevant for this study are not yet published, there is still a great deal of uncertainty around what RNG projects might be able to generate offsets vs. those not eligible due to rules that are still unknown.

- Once the Ontario offset program is established and the protocols are available for review, the $/m$^3$ and $/tonne $CO_2$e estimates presented here could be re-assessed. Consideration of the improved economics of the proportion of RNG that is also able to generate offsets will

[14] LFG, WWT, Agricultural manure and SSO
[15] An offset protocol is a jurisdiction and cap and trade program-specific set of rules that determine eligibility of an offset credit.

reduce the cost of the resource. Note: at this time, the RNG MACCs in Section 3.4 do not include stacking of environmental benefits.

- This RNG assessment developed $/m$^3$ and $/tonne $CO_2e$ estimates for 19 RNG feedstock cost categories[16] (including the 5 LFG, 4 WWT, 3 Agricultural manure, 1 SSO and 6 Agricultural residue categories described in the feedstock tables in the Approach section above). While efforts were made to disaggregate feedstock potential into various realistic cost categories, these costs are still averages and should be considered illustrative.

## 3.4 Results

Table 19 below summarizes the national and Ontario provincial RNG potential in 2028 by feedstock.

Table 19 Summary of the National and Ontario Provincial RNG Potential in 2028 by Feedstock

| Feedstock | National Potential by 2028 (million $m^3$/yr) | National Potential by 2028 ($tCO_2$/yr) | Ontario Potential by 2028 (million $m^3$/yr) | Ontario Potential by 2028 ($tCO_2$/yr) | Cost ($/$m^3$) | Cost* ($/$tCO_2$) | Notes |
|---|---|---|---|---|---|---|---|
| **Landfill gas** | 290 | 540,000 | 113 | 210,000 | $0.33-$0.82 | $70-$330 | Evaluated 5 different sized facilities based on survey referenced in Canadian Biogas Study; linked to study for Environment Canada |
| **WWT gas** | 180 | 340,000 | 71 | 135,000 | $0.48-$3.73 | $150-$1,900 | Evaluated 4 different sized facilities – ICF analysis |
| **Animal manure** | 874 | 1,640,000 | 191 | 360,000 | $0.87-$1.66 | $360-$780 | Considered 3 different farms (Electrigaz study): baseline, large, and co-op |
| **SSO residential & commercial** | 300 | 560,000 | 110 | 210,000 | $2.90 | $1,450 | Assumed a single facility capable of processing 60,000 tonnes/yr per Canadian biogas study. Larger/smaller facilities conceivable |
| **Agricultural residue** | 774 | 1,450,000 | 142 | 265,000 | $0.66-$1.57 | $250-$730 | Produced via thermal gasification, assuming varying efficiency of processing |

**Comment [JH33]:** It should be noted that the CBA study did not include all landfills as part of their potential calculations.

[16] Refer to results presented in Exhibits 12 and 13 for the potential disaggregated by feedstock cost category. The results presented in Exhibits 14 and 16 for the RNG LTCPF scenario MACCs aggregate feedstocks by category.

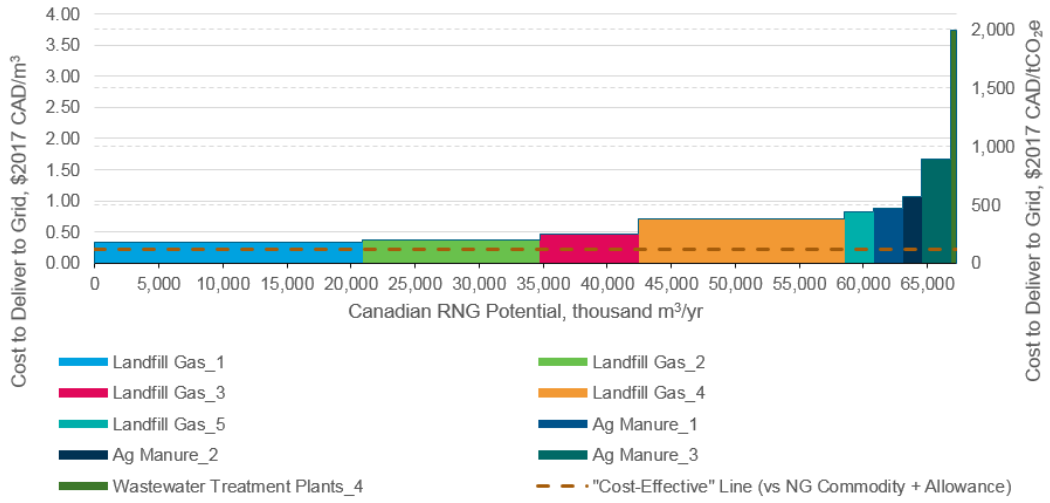
| Feedstock | National Potential by 2028 (million $m^3$/yr) | National Potential by 2028 ($tCO_2$/yr) | Ontario Potential by 2028 (million $m^3$/yr) | Ontario Potential by 2028 ($tCO_2$/yr) | Cost ($/$m^3$) | Cost* ($/$tCO_2$) | Notes |
|---|---|---|---|---|---|---|---|
| | | | | | | | Included 6 feedstock price estimates: $23.50-$130 per dry tonne |

**Comment [JH34]:** Only use AD based cost to estimate RNG from this segment?

Exhibit 12 below presents the national RNG potential MACC, by feedstock cost category, developed for the 2018-2020 study period and Exhibit 13 presents national RNG potential to 2028. RNG potential (in $m^3$ and equivalent $tCO_2e$) from nine out of the possible 19 RNG feedstock cost categories is estimated to become available by 2020[17].

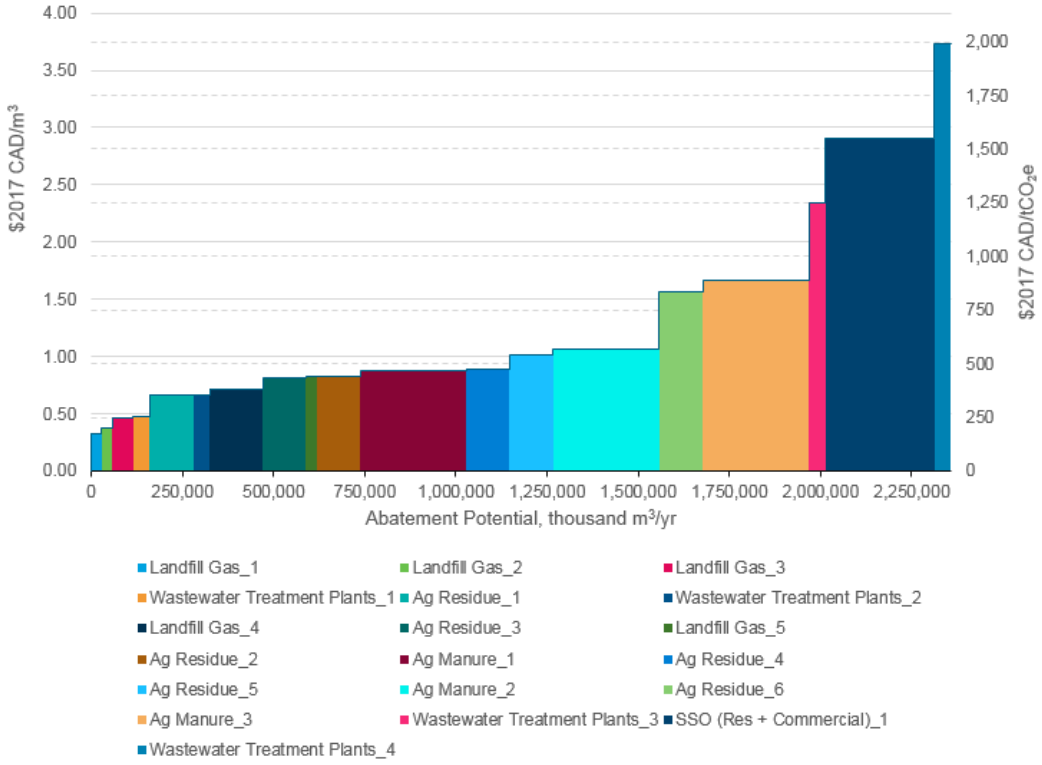
Exhibit 12 Canadian RNG Potential by 2020

**Comment [JH35]:** Shouldn't these just be Ontario based tables?




[17] The potential by 2020 is based on the potential deployment s-curve starting in 2018 and reaching full deployment potential by 2028. The underlying principle of this assumption is that the initial investments will be modest over the first 5-7 years (2018-2024), but that deployment in the out-years ramps up.

Exhibit 13 Canadian RNG Potential by 2028




If the scope of the feedstock sourcing is confined to Ontario, the RNG potential is significantly reduced from the results presented in Exhibits 12 and 13. Based on the high costs of much of the RNG potential, coupled with an expected modest deployment over the next few years, RNG development in Ontario could benefit immensely from investment of CCAP dollars to fund better province-specific analytics and potential assessments. Additionally, funding is required for pilot projects such as the G4 Insights' RNG Demonstration plant in Edmonton[18], and as described by the Ontario Ministry of the Environment and Climate Change as a part of $20 million to be invested over the next four years in RNG pilot projects to reduce emissions associated with transportation and goods movement.

Successful realization of RNG potential requires the appropriate policy, market, regulatory and technology funding support aligned with this emergent RNG renewable energy supply. Developing and retaining this renewable resource to Ontario's marketplace will require

[18] Two projects advance wood waste to biocrude, renewable natural gas technologies, Maurice Smith, March 15, 2017 (http://www.jwnenergy.com/article/2017/3/two-projects-advance-wood-waste-biocrude-renewable-natural-gas-technologies/, accessed June 13, 2017)

supportive government and regulatory policies, suitable market support mechanisms and substantive technology development funding.

### 3.4.1 Minimum and Mid-Range LTCPF Scenario

Exhibit 14 below presents the minimum (and mid-range[19]) LTCPF MACC for national RNG abatement potential. In this carbon price scenario, the results show the average cost to bring the RNG to market over and above the price of an allowance and the natural gas commodity cost for the 2018-2020 timeframe[20]. The potential savings by 2020 period is 67 million $m^3$ (or 126,000 $tCO_2e$). Table 20 presents the average cost data and estimated savings used to create the MACC.

Exhibit 14 RNG MACC for Minimum and Mid-Range LTCPF

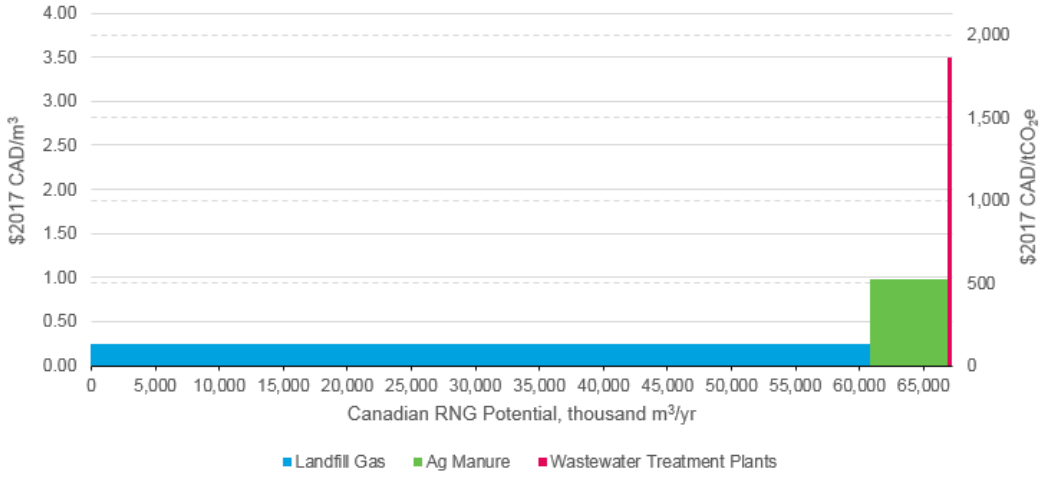



Table 20 RNG MACC for Minimum and Mid-Range LTCPF, Average Cost and Savings Results

| RNG Feedstock | Average $/tCO2e | Average $/m3 | Estimated Savings (tCO2e) | Estimated Savings (million m3) |
|---|---|---|---|---|
| **Landfill Gas** | 133 | 0.25 | 114,000 | 61 |
| **Agricultural Manure** | 527 | 0.99 | 11,200 | 6 |
| **Wastewater Treatment Gas** | 1,867 | 3.50 | 800 | 0.4 |

### 3.4.2 Maximum LTCPF Scenario

[19] For the RNG MACC, the minimum and mid-range scenarios for 2018-2020 are identical because the price of carbon in those years is identical in these two scenarios.
[20] The zero-line in the RNG MACC in Exhibits 13 and 14 is equivalent to the zero-line in the customer conservation MACCs in Section 2.

Exhibit 15 below presents the maximum LTCPF MACC for national RNG abatement potential. In this carbon price scenario, the results show the average cost to bring the RNG to market over and above the price of an allowance and the natural gas commodity cost for the 2018-2020 timeframe. The potential savings by 2020 period is 67 million $m^3$ (or 126,000 $tCO_2e$). Table 21 presents the average cost data and estimated savings used to create the MACC.

Exhibit 15 RNG MACC for Maximum LTCPF


Table 21 RNG MACC for Maximum LTCPF, Average Cost and Savings Results

| RNG Feedstock | Average $/tCO$_2$e | Average $/m$^3$ | Estimated Savings ($tCO_2e$) | Estimated Savings (million $m^3$) |
|---|---|---|---|---|
| **Landfill Gas** | 77 | 0.14 | 114,000 | 61 |
| **Agricultural Manure** | 471 | 0.88 | 11,200 | 6 |
| **Wastewater Treatment Gas** | 1,811 | 3.40 | 800 | 0.4 |

# 4. Facility Abatement Options

## 4.1 Background and Approach

Under Ontario's Quantification, Reporting and Verification of Greenhouse Gas Emissions Regulation (O. Reg. 143/16) (Reporting Regulation) gas distributors have a duty to report two types of emissions:

- Emissions that result from the combustion of the quantities of natural gas provided to end users who are not capped participants, and
- Emissions resulting from all specified GHG activities at distribution system facilities, or "facility emissions".

The gas distributors are required to acquire and remit allowance for both sources of emissions over the 2017-2020 timeframe. Total cap and trade compliance allowance obligation of Ontario's natural gas distribution companies is in the 40Mt $CO_2$/yr range. The vast majority of this obligation (>99%) results from the residential, commercial and small industrial (<10,000 t $CO_2$/yr) customers (end users) as well as consumption by the natural gas-fired generating stations.

Facility emissions, which include emissions associated with transmission, storage, and distribution segments, total between 250,000 and 350,000 t $CO_2$/yr or less than 1% of total cap and trade compliance obligation.

**Comment [GH36]:** Comment by Peter Mussio:

Under the new GHG Reporting Regulations implemented under Cap and Trade, Union Gas's Facility Related Emissions are higher than what has been listed. Under ON 400 – emissions resulting from UFG and blowdown (calculated as if combusted) are included in addition to ON.20 (Stationary Combustion) emissions. The emissions listed likely only include 2015 Stationary Combustion emissions. Below is a summary of the UG Stationary Combustion (ON20) emissions for 2015/16 and the total UG Facility Obligation (ON20 and ON400) for 2016:

Union GHG Reporting

Stat Comb.
2015 233,000 tCO2e
2016 166,000 tCO2e

2016 Facility Obligations = 423,000 tCO2e
ON.20 (Stat Comb) 166,000 tCO2e
ON.400 (Dist) 257,000 tCO2e

With regard to facility emissions the gas distributors operate in distinct regions and distinct business areas / operations with distinct emission profiles. In Ontario these include:

- Natural Gas Transmission,
- Natural Gas Storage, and
- Natural Gas Distribution.

There are 4 main categories of emissions from these operations;

- Fugitive emissions from piping and associated equipment components. These emissions include unintentional leaks from underground pipeline, seals, packings or gaskets resulting from corrosion, faulty connection, inadequate maintenance or wear.
- Vented emissions are intentional releases to the environment (by design or operational practice). Sources include equipment and pipeline blowdowns and purging, M&R station control loops, accidental third party dig-ins, and gas operated devices that use natural gas as the supply medium.
- Combustion emissions include $CO_2$, $CH_4$ and $N_2O$ emitted from the combustion of fossil fuels to fire compressor station engines, turbines and pipeline heaters.
- Miscellaneous (other) emissions include emissions from vehicles, domestic fuel consumption for building heating and indirect emissions associated with electrical usage.

Gas distributor facility emissions can include combustion emissions (e.g., fuel used at compressor stations), flaring (e.g., at a battery or storage facility), venting (e.g., gas-driven pneumatic devices) and fugitives (e.g., unintentional leaks).

Under the Ontario Regulation 143/16, Natural Gas Distributors are required to calculate greenhouse gas (GHG) emissions based on the net volume of natural gas distributed, after excluding deliveries to other distributors or exports, net deliveries to storage, and deliveries to capped participants, in accordance with Standard Quantification Method (SQM) ON.400 Natural Gas Distribution in the Ontario Ministry of the Environment and Climate Change's (MOECC's) "Guideline for Quantification, Reporting and Verification for GHG Emissions - January 2017" (Guideline). As per SQM ON.400, the net volume reported includes those volumes resulting from the natural gas distributed to non-capped end users, unaccounted for gas (UFG) and blowdown volumes.

Additionally, emissions from general stationary combustion sources fall under SQM ON.20 of the MOECC's Guideline.

As such, the distributors have a compliance obligation with respect to facility-related emissions from compressors, buildings, line heaters, unaccounted for gas and blowdowns.

The majority of Facility emissions result from natural gas combustion in compressor station engines and turbines associated with the transmission system, storage facilities, and distribution pipeline heaters, and from unaccounted for gas loss. Other minor sources include emissions from domestic fuel consumption for building heating and blowdowns. Facility emissions vary significantly between the individual natural gas distribution companies based on differing infrastructure / assets under management and annually based on operational requirements.

There are a number of efficiency opportunities that could reduce utilities' combustion emissions, including upgrades and/or replacements of compressors, prime movers, controls, capacity/operational optimization; pipeline layout and maintenance; and waste heat recovery. Fuel switching to electric compressors is likely not a feasible option in Ontario, due to cost and other barriers. While there may be opportunities to reduce gas distributors' combustion emissions, these emissions are typically a small to medium proportion in the emissions profile of gas distributor facility emissions. For example even assuming a 10% decrease in facility emissions would only reduce the entire compliance burden by [~30,000 t $CO_2$e/yr].

A high-level assessment of facility emissions abatement options was planned for inclusion in the scope of this study.

However, recognizing;

- the relatively small contribution of Facility emissions (and associated abatement potential),
- the unique emissions profile and thus abatement potential and options afforded each distribution company,
- the fact that abatement opportunities afforded utility commercial buildings within Facilities emissions are included within the relevant Customer Conservation measures discussed in Section 2, and
- limited publicly available information on emissions by technology and utility specific activity data that could inform an illustrative high level MACC for Facilities.

It was concluded that a high-level illustration of abatement cost without utility context would be of limited applicability and relevance to the objective of this study. Entity-level information (historic and forward planning) relevant to assessing abatement options (research and estimates that have been conducted to date related to Facility abatement opportunities) was requested from the gas utilities.

This context was not available in time to inform this study. However, the utilities are in the process of completing facility abatement opportunity studies along with descriptions of GHG abatement measures implemented and available to inform their 2018 Compliance Plans. The results will be available within their Compliance Plans but NOT within the timeline of this MACC development study. As such it was concluded to re-assess this area upon release of the relevant facility level context.

# 5. Summary MACCs

Exhibit 16 Summary MACC Including Customer Conservation Measures and RNG Potential for Minimum LTCPF

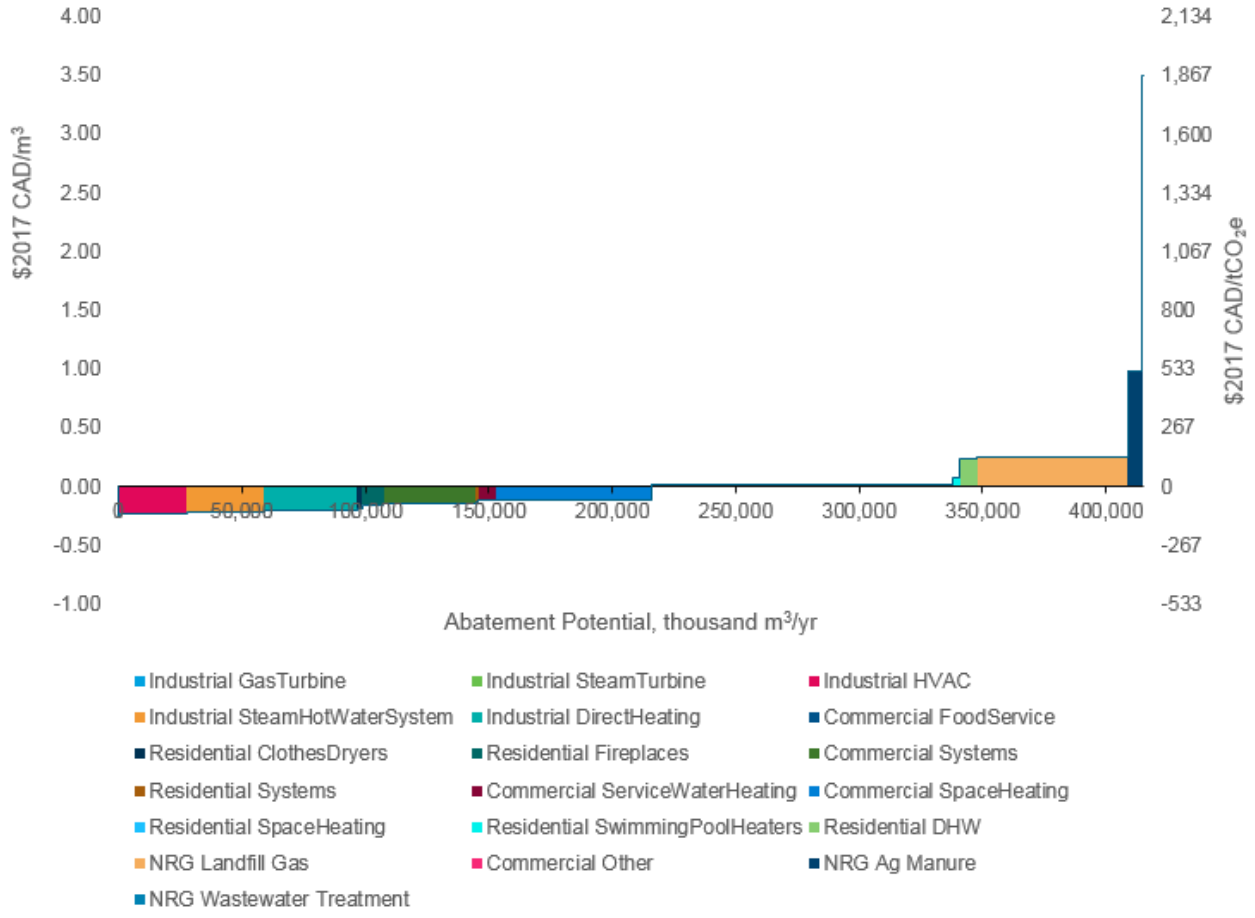


Exhibit 17 Summary MACC Including Customer Conservation Measures and RNG Potential for Maximum LTCPF

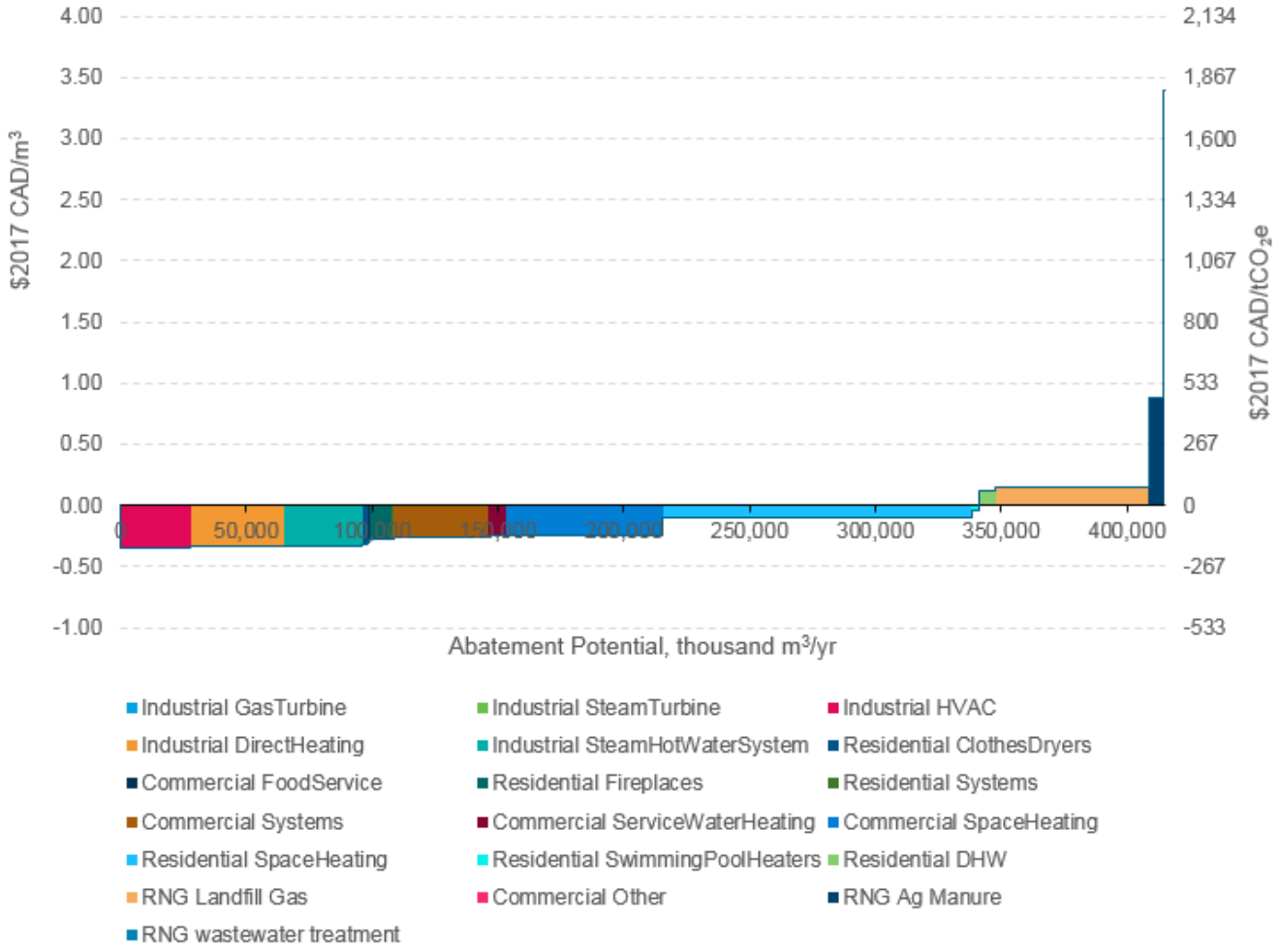
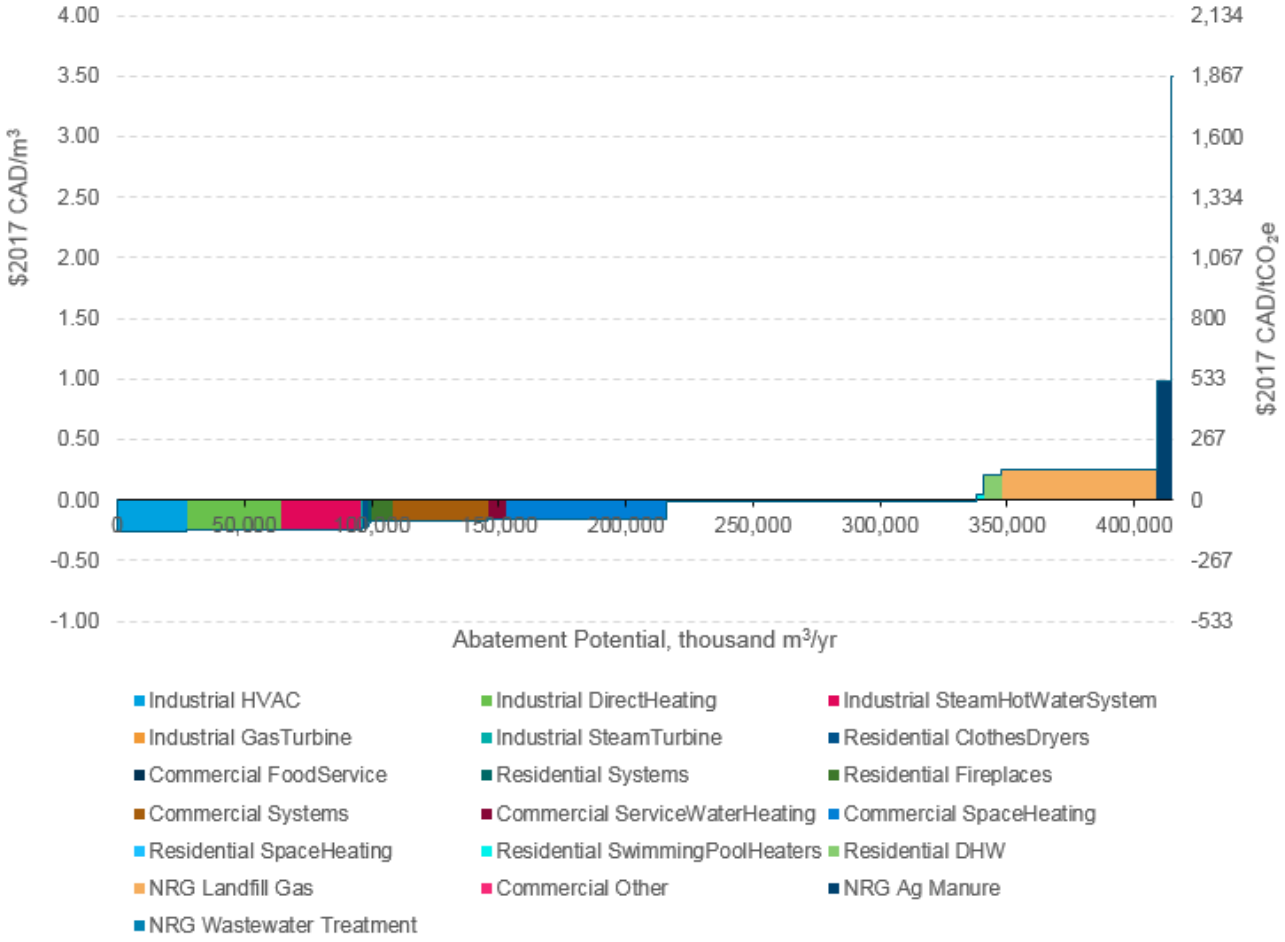


Exhibit 18 Summary MACC Including Customer Conservation Measures and RNG Potential for Mid-Range LTCPF



# 6. Recommendations

The development of a province-wide MACC for Ontario is expected to be conducted on a three-year cycle. The purpose of this section is to identify ways to enhance the next MACC study, both by capturing some of the successful features of this exercise and by improving on other aspects.

## 6.1 Successes to Retain

Features of the current study that ICF found greatly assisted the work include the following:

- The Technical Advisory Group was dedicated to producing a good study, and provided review and constructive feedback (during and after the TAG meetings) that the consultants found extremely valuable. It was important that the group represented a variety of perspectives.

## 6.2 Recommended Improvements

Aspects of the current study that could be improved in the next study include the following:

- The next study should have a longer timeframe for completion. In particular, this extended period would allow for more detailed review and more flexibility for the contractor to make modelling changes in response to feedback.
- Subsequent studies and any updates to this study should account for the impacts of the Ontario government's Climate Change Action Plan (CCAP), once details of the plan are made public. CCAP is expected to underpin new programs and policies designed to reduce provincial emissions through allocation of revenues from the cap and trade program.
- The model uses an average for all sizes of industrials and does not differentiate between LFEs and non-LFEs. Given more time, market penetration rates that might be more reflective of non-LFEs should be developed and used to model the industrial sector.
- Once the Ontario offset program is established to support the cap and trade program, and the protocols are available for review, the $/m$^3$ and $/tonne $CO_2e$ estimates presented in the analysis in Section 3 could be re-assessed. Consideration of the improved economics of the proportion of RNG that is also able to generate offsets will reduce the cost of the resource.
- Ontario is a vast province and more detailed, locally relevant feedstock availability and cost data would significantly improve the estimates presented in this study.
- As noted in the Long Term Carbon Price Forecast study, there remains significant uncertainties with respect to the C&T market and program, for example, WCI linking, offset development, federal requirements, and CCAP (as noted above). Developments in these areas over the next 12-18 months might dictate the need for an updated MACC prior to the next C&T compliance period.

# Appendix A Air Source Heat Pumps

Air source heat pumps (ASHPs) are a residential and commercial heating and cooling technology which are technologically similar to central air conditioners (CACs). In cooling mode, ASHPs are identical to CACs; CACs intake air from indoors, remove its heat using a compressor/condenser, and transfer the heat outside. When in heating mode, this process works in reverse; ASHPs intake air from outdoors, remove the heat using a compressor, and push the heat through a duct system in the same fashion as a furnace. ASHPs can also be "ductless," comprising an outdoor unit and one or more indoor units which intake and disburse the cool or warm air. When using multiple units, ductless ASHPs can also transfer heat from a warm part of the house to a colder one (e.g. second floor to the basement).

Of relevance to Ontario at lower temperatures, the heating process becomes less efficient, to the point where all ASHPs require backup resistance heating coils when temperatures are extremely low. ASHP technology has developed significantly over the last 5 years with more efficient and lower cost units and better cold climate solutions that can be 20-30% more efficient than resistance electric even at temperatures in the -20 °C range.

ASHPs have a significant energy efficiency benefit however they are considered distinctly from the Customer Conservation measures (discussed in Section 2 of this report) as the technology is electric fired and therefore the measure is fundamentally a fuel switch measure (natural gas to electric). Further some natural gas conservation measures include electricity co-benefits as avoided costs and some add cost due to increased electrical consumption. However in the latter example the electricity burdens are typically immaterial. The ASHP measure reduces natural gas consumption however the increased cost of electricity will be material and a key factor in cost effectiveness. This measure must be thought through from the benefit to the residential energy consumer as opposed to the natural gas rate payer.

The GHG abatement potential is driven by the amount of energy required to fire the heating / cooling system and the GHG intensity of the energy (natural gas vs electric). The ASHP requires less energy on an annual basis that conventional heating / cooling technology and natural gas consumed in the home is more GHG intensive (~0.2t $CO_2$/MWh) than Ontario's electricity system (0.05t $CO_2$/MWh). As such the technology has GHG abatement potential.

However, the appropriateness and cost effectiveness of this technology is driven by capital cost (conventional heating / cooling vs ASHP), avoided cost of energy (natural gas), and unlike pure energy efficiency measures added cost of electrical energy must considered. As the technology costs have become close to equivalent the measures level cost effectiveness is predominantly driven by the energy cost spread between natural gas and electricity. As depicted in the analysis below the delivered cost of electricity in Ontario at ~$140/MWh (IESO Ontario Planning Outlook, September 2016) vs. that of natural gas at ~$30/MWh equivalent challenges the cost effectiveness of ASHPs in Ontario. Given Ontario's capacity mix it is important to note that natural gas-fired electricity (0.4t $CO_2$/MWh) has a higher GHG intensity than when natural gas is consumed in the building as a result of the loss of efficiency in converting thermal to electrical energy as well as minor energy loss in electricity transmission.

The analysis below is not intended to illustrate all ASHP applications nor get into significant detail on the electric grid supply or cost of electricity (current or forward). Key forward assumptions on cost of electricity are taken from the IESO's Ontario Planning Outlook (September 2017). Additionally,

- Capital costs include equipment purchase, installation, and a cost to upgrade amperage service for all-electric ASHP
- Annual costs are based on current gas and electricity rate structures and assumptions of time of use/seasonality. Future reports should consider the benefit of using published forecasted prices of natural gas and electricity for the life of the measure.
- ASHP application in the existing home is considered distinctly from the new home
- Full system lifetime is 15 years; no discount rate is applied to calculate lifetime costs
- Emission factor of 0.418 t/MWh for natural gas-fired electricity (based on 45% conversion efficiency and 5% T&D losses); emission factor of 0 t/MWh for zero-carbon electricity
- The report does not consider how zero-carbon electricity will be attained in the province, and at what cost. In addition, Per home lifetime costs do NOT include an impact on electricity rates as a result of any new electricity generation capacity required to meet a winter peaking load. Both of these elements would likely increase the cost of this measure. Further consideration should be given in future reports towards estimating this impact.
- Assumptions related to ASPH capital cost intended to illustrate cost over 2017-2020.

Table 20 Assessment of Abatement Cost Associated with Residential ASHPs – Capital Cost Assumptions

| Type of Home: | Existing Homes | | | | New Homes | | | |
|---|---|---|---|---|---|---|---|---|
| Scenario: | Base Case | ASHP | ASHP + HPWH | Intgrtd ASHP + NG | Base Case | ASHP | ASHP + HPWH | Intgrtd ASHP + NG |
| Source of household heat | Natural Gas Furnace | ASHP | ASHP | ASHP with Auxiliary NG Furnace | Natural Gas Furnace | ASHP | ASHP | ASHP with Auxiliary NG Furnace |
| Source of household cooling | Electric A/C | ASHP | ASHP | ASHP | Electric A/C | ASHP | ASHP | ASHP |
| Heating/Cooling System Capital Costs | $9,000 | $7,000 | $7,000 | $8,000 | $9,000 | $6,000 | $6,000 | $7,000 |
| Source of household hot water | NG Storage | NG Storage | Heat Pump (HPWH) | NG Storage | NG Storage | NG Storage | Heat Pump (HPWH) | NG Storage |
| Hot Water System Capital Costs | $1,500 | $1,500 | $2,250 | $1,500 | $1,500 | $1,500 | $2,250 | $1,500 |
| Average Cost of Amperage Upgrade | $0 | $2,000 | $2,000 | $0 | $0 | $0 | $0 | $0 |
| Total Capital Costs | $10,500 | $10,500 | $11,250 | $9,500 | $10,500 | $7,500 | $8,250 | $8,500 |

**Comment [CW37]:** Base case is more expensive than an integrated?

The table above illustrates the capital costs associated with different home heating technology deployments. Over all we have been conservative on the price of the ASHP technology (so as not to overestimate the cost) and we have assume a standard ASHP technology deployment vs a cold climate ASHP that would come with improved performance and higher cost. The base case represents the conventional gas fired furnace and hot water and electric driven AC. The ASHP scenario replaces the conventional heating and cooling with an ASHP (hot water remains natural gas storage tank type). The ASHP + HPWH is a full electrification scenario that also assumes that hot water is provided via an electric high performance water heater. The integrated solution ASHP + NG assumes a natural gas fired furnace is also available and deployed to meet cold day heating requirements when the ASHP performance degrades to a low COI.

The results illustrate that in most scenarios there is little delta in capital cost between the base case and the ASHP solutions.

In addition the following assumptions were made with regard to peak day demand and performance.

- Peak temperature of -26°C
- Furnace input rate of 54,200 BTU/h for an existing home and 40,000BTU/h for a new home at peak design conditions
- Blended COP of 1for all-electric air source heat pump (ASHP) at peak day design conditions (includes contribution of electric resistance heating to overall heat pump performance)
- COP of 1.63at operating peak of hybrid ASHP, which occurs just above a switch-over temperature of -8°C (zero power draw on Ontario's peak design day)
- Water heating peak based on an average daily hot water usage profile, where 10% of total daily energy consumption occurs in the peak hour
- Heating profile over the peak design day based on typical variation of temperature over a cold day (based on all days under 0°C in CWEC data)

Based on the above, the following table illustrates the results of GHG abatement potential and cost ($/t $CO_2$) analysis. Annual operating costs for the ASHP technology deployment scenarios will be up to $1000/yr higher than that of the base case as a result of the high cost of electric energy in Ontario relative to natural gas.

Table 21 Assessment of Abatement Cost Associated with Residential ASHPs – The Existing Home

| Type of home: | | Existing Homes | | |
|---|---|---|---|---|
| Scenario: | | ASHP | ASHP + HPWH | Integrated ASHP + NG |
| Capital Costs (delta vs NG Base Case) | | $0* | $750* | -$1,000 |
| Annual Energy Costs (delta vs NG Base Case) | | $930/yr | $1,000/yr | $600/yr |
| Total Measure Spend (= Capital Cost + Lifetime Energy Costs) | | $14,000 | $16,000 | $7,900 |
| Annual Emissions from NG | | 0.82 $tCO_2e$/yr | 0 $tCO_2e$/yr | 1.6 $tCO_2e$/yr |
| Annual Emission | Gas-Fired Elec. | 0.09 $tCO_2e$/yr | -0.19 $tCO_2e$/yr | -0.15 $tCO_2e$/yr |

| | | | | |
|---|---|---|---|---|
| Reductions (Reduction=negative) | Zero-Carbon Elec. | -4.3 $tCO_2e$/yr | -2.7 $tCO_2e$/yr | -1.9 $tCO_2e$/yr |
| Emission Reductions over Measure Life (15 yrs) | Gas-Fired Elec. | 1.3 $tCO_2e$ | -2.8 $tCO_2e$ | -2.3 $tCO_2e$ |
| | Zero-Carbon Elec. | -65 $tCO_2e$ | -40 $tCO_2e$ | -28 $tCO_2e$ |
| Electricity Consumption | | +8,700 kWh/yr | +11,000 kWh/yr | +5,900 kWh/yr |
| Natural Gas Consumption | | -1,900$m^3$ | -2,300$m^3$ | -1,400$m^3$ |
| Lifetime Cost of Emission Reduction | Gas-Fired Elec. | $-12,000 / $tCO_2e$ | $2,800 / $tCO_2e$ | $1,900 / $tCO_2e$ |
| | Zero-Carbon Elec. | $240 / $tCO_2e$ | $200 / $tCO_2e$ | $150 / $tCO_2e$ |

**Comment [JB38]:** Pls explain how ASHP results in more emissions reduction than ASHP + HPWH (all electric) scenario

Assuming non-emitting source of electricity emissions can be reduced by up to 4.3 $tCO_2e$/home/yr for the typical single family home in Ontario. The cost of abatement would be up to $270/$tCO_2e$ and $200/$tCO_2e$ where an integrated ASHP and NG furnace were deployed. The text in red illustrates an increase in emissions where the incremental electric load is met with natural gas-fired electricity vs non-emitting generation.

**Comment [JB39]:** Can the math be confirmed? $16,000 / 40 tco2e = $400/tonne not $200?

Within the new home the ASHP applications are more cost effective due to a decrease in capital cost and operating costs associated with cost of energy. As such emissions can be reduced by up to 3.3t $CO_2e$/home/yr and at between $130 to $180/$tCO_2e$.

Table 22 Assessment of Abatement Cost Associated with Residential ASHPs – The New Home

| Type of home: | | New Homes | | |
|---|---|---|---|---|
| Scenario: | | ASHP | ASHP + HPWH | Integrated ASHP + NG |
| Capital Costs (delta vs NG Base Case) | | -$3,000 | -$2,250 | -$2,000 |
| Annual Energy Costs (delta vs NG Base Case) | | $650/yr | $570/yr | $410/yr |
| Total Measure Spend (= Capital Cost + Lifetime Energy Costs) | | $6,700 | $6,300 | $4,200 |
| Annual Emissions from NG | | 0.82 $tCO_2e$/yr | 0 $tCO_2e$/yr | 1.4 $tCO_2e$/yr |
| Annual Emission Reductions (Reduction=negative) | Gas-Fired Elec. | 0.08 $tCO_2e$/yr | -0.03 $tCO_2e$/yr | -0.15 $tCO_2e$/yr |
| | Zero-Carbon Elec. | -2.5 $tCO_2e$/yr | -3.3 $tCO_2e$/yr | -1.9 $tCO_2e$/yr |
| Emission Reductions over Measure Life (15 yrs) | Gas-Fired Elec. | 1.2 $tCO_2e$ | -0.51 $tCO_2e$ | -2.3 $tCO_2e$ |
| | Zero-Carbon Elec. | -37 $tCO_2e$ | -49 $tCO_2e$ | -28 $tCO_2e$ |
| Electricity Consumption | | +6,100 kWh/yr | +7,800 kWh/yr | +4,100 kWh/yr |
| Natural Gas Consumption | | -1,300$m^3$ | -1,800$m^3$ | -1,000$m^3$ |
| Lifetime Cost of Emission Reduction | Gas-Fired Elec. | $-5,500 / $tCO_2e$ | $12,000 / $tCO_2e$ | $1,900 / $tCO_2e$ |
| | Zero-Carbon Elec. | $180 / $tCO_2e$ | $130 / $tCO_2e$ | $150 / $tCO_2e$ |

The integrated ASHP + NG solution could minimize the need for incremental winter peaking capacity and electric system transmission and distribution upgrades where the measure taken to an economy wide scale. Rather than the full-electric air source heat pump (ASHP)

exclusively, leverage ASHP efficiency for spring, fall and most winter days and integrated natural gas fired technology for extreme cold periods. This option could reduce GHG emissions by ~60%versus a home that currently heats with natural gas alone.

Incremental assessment of associated with commercial ASHPs was not carried out. However, the following should be considered related to commercial application.

- Commercial application of the ASHP is technically feasible and shown to be economic in markets with a more favorable energy price delta between natural gas and electric
- ASHP units can be scaled (2-100 tons) to meet the higher demand load of larger buildings such as care homes, schools, offices, hospitals, community and public buildings
- Larger three phase models incorporate twin or quadruple compressors for multiple stages of power
- Due to the variety of building types and sizes within Ontario a simple illustration of technical and cost effectiveness are not relevant as they are in the less diverse residential sector
- Similarly little pricing information is available in the public domain due to issues related to applicability
- For the purposes of this study we suggest that costs in the range of \$100/t $CO_2$ to \$250/t $CO_2$ provide a reasonable range depending size of building and heating/cooling demand

**Concluding comments:**
While ASHPs have recently reached levels of performance that make them a viable alternative to electric resistance heat in Ontario's climate, they are not yet a cost-effective alternative to natural gas furnaces in residential or commercial settings. At current price/performance ratios, and given existing shares of natural gas on the electricity grid, ASHPs have both higher capital and operating costs, and may increase emissions if the marginal electricity generation is supplied mainly by natural gas. If electricity were carbon-free, it would require a carbon price above \$200/t $CO_2$e for the existing home and \$130/tCO2 for the new home for the lifetime cost to be equivalent (at current retail electricity prices).

This analysis assumes no improvements in ASHP technology over the study timeframe (through 2020 and 2028). Further focus on the cold climate ASHP would be warranted where the prices for these come into comparison with conventional technology.

The abatement costs associated with ASHPs presented in the above are illustrative and based on several simplifying assumptions. The following context should be considered with regard to residential and commercial applications and the overall objective of this analysis.

- Programmatic costs associated with the delivery of an ASHP deployment project are NOT included in the above analysis
- ASHP technology cost and efficiency are likely to improve throughout the 2018-2028 period
- The cost of electric energy to the rate payer is a key input to cost of abatement – \$/Kwh and rate structure are relevant
- The proliferation of ASHP deployment will drive the Ontario electric system to a winter peaking from summer peaking and require the addition of considerably more peak reliable capacity – potentially adding to system cost
- The GHG intensity (t $CO_2$/MWh) of the electrical system's winter peak supply is critical to determining abatement potential and cost

- Where winter peaking capacity is met by natural gas fired generation total GHG emissions are likely to increase (along with demand for natural gas)
- Where winter peaking capacity is met by natural gas fired generation and existing capacity the cost per marginal demand for electricity to the system could be lower significantly than $140/MWh
- The electrical distribution system infrastructure and behind the meter technology in the home will need to be re-thought to accommodate +14kW peak load attributed to an ASHP (in parallel with other issues like home charging for EVs)
- Dedication of proceeds of sale of allowance to the ASHP could improve cost effectiveness.

**Cover Letter that Accompanied UGL Comments to OEB on ICF_OEB DRAFT MACC Report – Sent June 29, 2017**

Rachele…….thank you for the opportunity to provide our input into the latest draft of the MACC Report.

Union recognizes that this was a significant effort to complete and a short period of time, and we appreciate the efforts of the OEB and ICF to do so. We also appreciate the opportunity to review via TAG meetings and subsequent comment periods. Union acknowledges that ICF has done a good job of leveraging existing studies and public documents to the extent possible, including the CPS which was fully reviewed and vetted with stakeholders.

As ICF has noted in the report, that there are significant caveats and limitations with the findings, some of which is based on available data and some due to time constraints. Union also notes that significant uncertainties in the C&T market/program have also resulted in a wide LTCPF range, and therefore wide MACC curve range of possible outcomes.

While there are some technical changes suggested in the document (attached, with tracked changes) that hopefully speak for themselves, there are other comments/themes that we would like to provide more context on:

- The MACCs do not distinguish what of the potential abatement shown is existing DSM and what is above and beyond this (more of the same DSM we are already doing or new); this means that these MACCs do not allow us to identify what new/additional abatement should be considered (if there is any)
- We feel it is very important that the report clearly delineates that the energy efficiency measures are inclusive of the existing DSM programs. Therefore, in the case of specific measures where programs already exist, these costs are not marginal, but rather more representative as average. Stated another way, the delivery of the next incremental GHG reduction would likely not come at the cost reflected in the report.
- Recognizing that the report will be viewed publically and used by parties who have not had the advantage of attending TAG meetings, Union has suggested wording changes to hopefully simplify technical references, and clearly state the implications of the report's assumptions, caveats and stated limitations.
- We also feel that it is within the scope of the report to identify marginal costs and potential for measures, but not to opine on whether a measure will or will not (should or should not) be pursued by the utilities. Therefore, it should not be identified that ASHP's are excluded because of their relative cost or on speculation whether the utilities would employ these measures.

Union acknowledges that there are certain items outside of the scope of this report, such as how zero-carbon electricity will be achieved and at what cost, and what the electricity infrastructure cost impacts of fuel-switching measures are. However, in future MACC's particularly if more fuel-switching alternatives are included, Union recommends that these impacts should be considered as they may be significant.

Union recommends that detailed assumptions and calculations forming the basis of information be distributed, at least for those on the TAG team if not in the public version of the report. Without the underlying assumptions and calculations, the certainty of results cannot be fully understood and interpreted. In the interests of time, this information could be shared following the issuance of the final report.

Please let us know if you have any questions or if you would like to discuss further.

Thanks…. Jeff Hodgins

UNION GAS LIMITED

Answer to Interrogatory from
Environmental Defence ("ED")

Reference: Exhibit 3, Tab 4, Appendix A, pp. 1-7

Question:
Please describe in detail the involvement of Union's DSM team in the development of the Cap and Trade Compliance plan. Please include a list of DSM team members and an approximate estimate of how many hours each spent in relation to the development of the Cap and Trade Compliance plan.

---

Response:
Three members of Union's DSM team were involved in the development of Union's 2018 Cap-and-Trade Compliance Plan. Their roles and an estimation of their associated hours are detailed in Table 1 below.

**Table 1**

| DSM Team Member | Description of Involvement | Hours |
|---|---|---|
| **Manager, Energy Efficiency Strategy and Initiatives** | **OEB MACC Technical Advisory Group ("TAG") Member**<br>• Participation in two TAG meetings<br>• Provided written feedback to OEB on TAG/MACC meeting | ~60 hours |
| | **OEB-ICF MACC Report Review and Feedback**<br>• Provided written feedback to OEB-ICF on Draft MACC Report | |
| | **Energy Efficiency Abatement Opportunity Analysis**<br>• Oversaw analysis utilizing LTCPF, MACC Report, and the CPS Report to compare the cost-effectiveness of investing in incremental abatement to purchasing compliance instruments | |
| | **Contributions to Union's 2018 Compliance Plan**<br>• Exhibit 3, Tab 4, Section 2.2, pp. 38-43<br>• Exhibit 3, Tab 4, Appendix A, pp. 1-7 | |
| **Senior Advisor, DSM Strategy** | **OEB-ICF MACC Report**<br>• Provided written feedback to OEB-ICF on Draft MACC Report | ~60 hours |
| | **Energy Efficiency Abatement Opportunity Analysis**<br>• Completed analysis utilizing LTCPF, MACC Report, and the CPS Report to compare the cost-effectiveness of investing in incremental abatement to purchasing compliance instruments | |
| | **Contributions to Union's 2018 Compliance Plan**<br>• Exhibit 3, Tab 4, Section 2.2 – pp. 38-43<br>• Exhibit 3, Tab 4, Appendix A, pp. 1-7 | |
| **Director, Energy Conservation Strategy** | **Management Oversight** | ~5 hours |

UNION GAS LIMITED

Answer to Interrogatory from
Environmental Defence ("ED")

Reference: Exhibit 3, Tab 4, Appendix A, pp. 1-7

Question: Union seems to suggest that incremental conservation is not available in part because of the amount of new non-ratepayer funded gas conservation. The extent of non-ratepayer funded conservation is relevant to this proceeding for that and other reasons.

Please provide the following information broken out by (a) Union's non-ratepayer funded conservation programs (e.g. those funded by the GIF), (b) Union's ratepayer funded resource acquisition conservation programs, and (c) the sum of those two:

i. The total budget;
ii. The forecast lifetime gas savings (cubic metres); and
iii. The forecast lifetime GHG emission reductions (tonnes).

Please provide this information for 2018, 2019, and 2020.

---

Response:

Union's non-ratepayer funded natural gas conservation programs consist solely of the enhancements to the Home Reno Rebate offering, funded by the Green Investment Fund. Union expects that the funding made available to Union's Home Reno Rebate offering by the Green Investment Fund will be fully spent within 2018. Therefore, no forecasted figures are available beyond 2018.

It should be noted that the budget forecast for the Green Investment Fund includes programming for homes not heated by natural gas (i.e. homes heated by oil, propane, or wood). A budget forecast by fuel-type was not developed. In contrast, the natural gas savings and GHG emission reductions forecasts reflect savings from homes heated by natural gas only.

Union has provided the information requested in three tables below:

- Table 1 – Budget Forecast
- Table 2 – Lifetime Natural Gas Savings ($m^3$) Forecast
- Table 3 – Lifetime GHG Emission Reductions (tonnes) Forecast

**Table 1**

| **Budget Forecast:** Natural Gas Conservation Programs | | | | |
|---|---|---|---|---|
| | | **2018** | **2019** | **2020** |
| Non-Ratepayer Funded | Green Investment Fund | $ 21,500,000 | $ 0 | $ 0 |

| | | | | |
|---|---|---|---|---|
| Ratepayer Funded | DSM Resource Acquisition Scorecard (OEB-Approved Budget) | $ 36,633,281 | $ 36,310,983 | $ 36,310,983 |
| **Total** | | **$58,133,281** | **$ 36,310,983** | **$ 36,310,983** |

**Table 2**

| **Lifetime Natural Gas Savings ($m^3$) Forecast:** Natural Gas Conservation Programs | | | | |
|---|---|---|---|---|
| | | **2018** | **2019** | **2020** |
| Non-Ratepayer Funded | Green Investment Fund | 162,500,000 | 0 | 0 |
| Ratepayer Funded | DSM Resource Acquisition Scorecard (OEB-Approved Budget) | 1,185,792,799 | 1,186,045,987 | 1,186,045,987 |
| **Total** | | **1,348,292,799** | **1,186,045,987** | **1,186,045,987** |

**Table 3**

| **Lifetime GHG Emission Reductions (tonnes) Forecast:** Natural Gas Conservation Programs | | | | |
|---|---|---|---|---|
| | | **2018** | **2019** | **2020** |
| Non-Ratepayer Funded | Green Investment Fund | 304,688 | 0 | 0 |
| Ratepayer Funded | DSM Resource Acquisition Scorecard (OEB-Approved Budget) | 2,223,361 | 2,223,836 | 2,223,836 |
| **Total** | | **2,528,049** | **2,223,836** | **2,223,836** |

UNION GAS LIMITED

Answer to Interrogatory from
Environmental Defence ("ED")

Reference: Exhibit 3, Tab 4, Appendix A, pp. 1-7

Question: Please provide a table showing the (a) lifetime gas savings, (b) lifetime GHG emissions reductions, and (c) DSM budget (resource acquisition only) from its DSM programs for the most recent 10 years of available data.

---

Response:
Resource Acquisition programs were introduced in 2012, therefore Union is providing two sets of information in its response:

- Table 1 – Results from all of Union's DSM programs for the most recent 10 years of available data.
- Table 2 – Results from Union's DSM Resource Acquisition scorecard since 2012.

All savings are net of Free-Ridership.

**Table 1 – All DSM Programs**

| Year | Annual Natural Gas Savings ($000m^3$) | Lifetime Natural Gas Savings ($000m^3$) [1] | Lifetime GHG Emission Reductions (tonnes $CO_2e$) | DSM Budget Spent ($000) |
|---|---|---|---|---|
| 2006 | 90,475 | N/A | N/A | $12,882 |
| 2007 | 55,852 | N/A | N/A | $16,132 |
| 2008 | 61,852 | N/A | N/A | $20,259 |
| 2009 | 92,604 | N/A | N/A | $22,038 |
| 2010 | 121,116 | N/A | N/A | $21,607 |
| 2011 | 139,027 | N/A | N/A | $27,971 |
| 2012 | 137,438 | 2,336,351 | 4,380,658 | $31,322 |
| 2013 | 179,967 | 2,820,834 | 5,289,063 | $32,839 |
| 2014 | 131,825 | 1,889,459 | 3,542,735 | $33,714 |
| 2015 (Pre-audit) | 109,238 | 1,568,082 | 2,940,154 | $32,393 |

[1] Reporting of lifetime natural gas savings was introduced in 2012. Prior to 2012, natural gas savings is only available as annual savings.

**Table 2 – Resource Acquisition Scorecard**

| Year | Annual Gas Savings ($000m^3$) | Lifetime Gas Savings ($000m^3$) | Lifetime GHG Emission Reductions (tonnes $CO_2e$) | DSM Budget Spent ($000) |
|---|---|---|---|---|
| 2012 | 51,813 | 887,303 | 1,663,693 | $14,368 |
| 2013 | 54,996 | 920,775 | 1,726,453 | $15,959 |
| 2014 | 58,330 | 961,572 | 1,802,948 | $16,429 |
| 2015 (Pre-audit) | 57,729 | 939,589 | 1,761,729 | $16,819 |

UNION GAS LIMITED

Answer to Interrogatory from
Environmental Defence ("ED")

Reference: Exhibit 3, Tab 4, Appendix A, pp. 1-7

Question: Does Union plan to propose incremental ratepayer funded customer abatement activities for 2019 as a cap and trade compliance tool? If yes, please provide an approximate range of the budget level for those activities that Union believes is worth considering. If no, please fully explain and justify that position.

---

Response:
Union's 2019-2020 Compliance Plan is yet to be completed, and will in part depend on the outcome of the 2018 Compliance Plan proceeding, continued developments in the Cap-and-Trade market, and further details regarding CCAP and GreenON funding. As is Union's historic practice, Union will continue to assess, within the prevailing DSM Framework and established DSM budget, the appropriateness of existing DSM measures and new DSM measures on a continuous basis. Union will also continue to review the feasibility of new technology initiatives, to the extent possible given available resources and funding.

UNION GAS LIMITED

Answer to Interrogatory from
Environmental Defence ("ED")

Reference: Exhibit 3, Tab 4, Appendix A, pp. 1-7

Question: Does Union believe that incremental conservation driven by cap and trade compliance should be implemented via the DSM Framework? Please fully explain the response.

---

Response:
Please see the response at Exhibit B.GEC.22.

UNION GAS LIMITED

Answer to Interrogatory from
Environmental Defence ("ED")

Reference: Exhibit 3, Tab 4, Appendix A, pp. 1-7

Question: Does Union believe that incremental conservation driven by cap and trade compliance should wait until after the DSM mid-term review is completed? Please fully explain the response.

---

Response:
Please see the response at Exhibit B.GEC.22.

UNION GAS LIMITED

Answer to Interrogatory from
Environmental Defence ("ED")

Reference: Exhibit 3, Tab 4, Appendix A, pp. 1-7

Question:

a) If incremental conservation driven by cap and trade compliance is only to be implemented after the DSM mid-term review is completed, please discuss the timing of the steps that would be necessary for a prompt ramp up seeing as the DSM mid-term renew will not be completed until December 1, 2018?
b) Please discuss the pre-planning that would be necessary to begin a ramp up of incremental DSM starting January 1, 2019.
c) Please discuss whether Union is intending on taking those steps.

---

Response:

a) – c)

Once Union receives OEB-approval of the incremental offerings and their corresponding budgets as proposed by Union within its DSM Mid-Term Review submissions,[1] Union will include these offerings within the next available DSM program year. This is expected to be as soon as Q1 of Union's 2019 DSM program year since the OEB's Report of the Board on the DSM Mid-Term Review, is not expected to be released until December 2018. The incremental offerings proposed within Union's DSM Mid-Term Review submissions include an Energy Literacy offering (October 2, 2017 submission) and a Residential Adaptive Thermostat offering (January 15, 2018 submission).

Union notes that the evolving energy conservation landscape in Ontario could impact Union's ability to implement any incremental offerings in ways that are currently unknown. For example, should the OEB approve Union's proposed Residential Adaptive Thermostat offering, Union could explore collaboration opportunities with other program administrators offering similar rebates for the adaptive thermostat technology. Successful collaboration could impact the implementation of Union's offering.

[1] EB-2017-0127, Union Submissions, September 1 2017, October 2 2017, January 15 2018.

UNION GAS LIMITED

Answer to Interrogatory from
Environmental Defence ("ED")

Reference: Exhibit 3, Tab 4, Appendix A, pp. 1-7

Question: Would Union be opposed to a portion of conservation-related shareholder incentives being dependent not only on performance in achieving targets, but also on the aggressiveness of the overall conservation achievements (i.e. based on gross TRC benefits, gas savings, or GHG emissions reductions)? Please explain.

---

Response:
The shareholder incentive mechanisms for utility natural gas conservation programs were established within the current 2015-2020 DSM Framework (EB-2014-0134), Union's 2015-2020 DSM Plan (EB-2015-0029) and the OEB's Decision on that plan. Changes to the DSM Framework are out of scope of Union's 2018 Compliance Plan proceeding. Further, Union would require adequate time to fully assess this type of fundamental change to the DSM shareholder incentive mechanism. A more appropriate time for consideration of such changes is during the establishment of a future DSM Framework.

UNION GAS LIMITED

Answer to Interrogatory from
Energy Probe

Reference: Exhibit 3, Tab 4, p. 13

Preamble: Both Union and Enbridge are proposing $2 million Low Carbon Initiative Fund (LCIF).

Question:

a) Given that the two utilities are proposing to merge their operations, is there any overlap between the two utilities from money being collected in the LCIF?
b) Have to two utilities coordinated their efforts and plans in regards to money from the LCIF.
c) If there has been coordination, please provide any evidence that the money spent will not be duplicated.

---

Response:

a) – c)

Please see the response at Exhibit B.Staff.14 a).

UNION GAS LIMITED

Answer to Interrogatory from
Energy Probe

Reference: Exhibit 3, Tab 4, p. 14

Question: Please provide references or evidence for other jurisdictions or regulators allowing utilities to use their regulated businesses to fund unproven technologies.

---

Response:
Please see the response at Exhibit B.Staff.21 f).

UNION GAS LIMITED

Answer to Interrogatory from
Energy Probe

Reference: Exhibit 3, Tab 5, p. 4

Question:

a) Why does Union require more than 50% more FTEs – 12.5 versus – than Enbridge to carry out a similar level of cap-and-trade related activities?
b) How does this compare to other companies in California and Quebec? Does Union or Clear Blue have this information?
c) Please provide an organizational chart for the GGEIDA- funded C&T employees.

---

Response:

a) Please see the response at Exhibit B.SEC.13 for an explanation of Union's FTE requirements compared to EGD.

b) Neither ClearBlue nor Union are aware of any entities in Quebec or California that make public their staffing requirements for Cap-and-Trade. Union's forecasted 2018 administration costs of $4.0 million, represent approximately 1.4% of the total forecast cost of compliance. This is within the range of administrative costs reported by California utilities for 2015 of up to 2.7% (as noted in the OEB Staff discussion paper).[1]

c) The staffing chart included in Union's application is organized by functional team.[2] A single organization chart cannot be created for GGEIDA-funded Cap-and-Trade employees as these employees belong to various functional areas across the company, and do not fall under one department.

[1] EB-2015-0363, OEB Staff Discussion Paper, May 25 2016, p. 30.
[2] Exhibit 3, Tab 5, p. 6.

UNION GAS LIMITED

Answer to Interrogatory from
Energy Probe

Reference: Exhibit 7, Tab 1, Schedule 1

Question:

a) Please calculate the 2018 cap and trade rate and bill impacts for customers including administrative and other carrying costs.
b) For a Union South residential customer, Cap and Trade charges will increase by $5.27 compared to 2017. Please explain in detail the drivers for the increase, including lower volumes, carbon price etc.
c) Please provide the Foreign Exchange Rate forecast for 2018
d) How sensitive is the Unit Rate to foreign exchange? Please provide an illustrative example.
e) Please provide Union's view whether lack of bill transparency is resulting in low(er) customer understanding and acceptance of C&T

---

Response:

a) Please see Table 1 below. For the purposes of this response, Union updated the 2018 Cap-and-Trade bill impacts found in its application at Exhibit 7, Tab 1, Schedule 2, to include the forecast 2018 GGEIDA costs of $6 million, including administration costs of $4.0 million and Low Carbon Initiative Fund costs of up to $2.0 million, as described at Exhibit 3, Tab 5, pp. 4-13.

Table 1
General Service Bill Impacts
Updated to Include the 2018 GGEIDA Costs

| Line No. | Particulars | 2018 Cap-and-Trade Bill Impacts ($) (1) | Estimated 2018 GGEIDA Bill Impacts ($) (2) (3) | Total Bill Impacts ($) |
|---|---|---|---|---|
| | | (a) | (b) | (c) = (a + b) |
| | Union South | | | |
| 1 | Rate M1 | 5.27 | 2.27 | 7.54 |
| 2 | Rate M2 | 174.95 | 17.30 | 192.25 |
| | Union North | | | |
| 3 | Rate 01 | 5.27 | 2.77 | 8.04 |
| 4 | Rate 10 | 222.93 | 26.97 | 249.90 |

Notes:
(1) Exhibit 7, Tab 1, Schedule 2, p. 1, line 11 and Exhibit 7, Tab 1, Schedule 2, pp. 2-3, line 12.
(2) Bill impacts are based on annual consumption of 2,200 $m^3$ for Rate M1 and Rate 01, 73,000 $m^3$ for Rate M2 and 93,000 $m^3$ for Rate 10.

(3) Bill impacts based on 2018 forecast GGEIDA amount of $6 million.

b) The total bill increase of $5.27 for a typical Rate M1 residential customer with annual consumption of 2,200 $m^3$ includes an increase of $5.31 related to customer-related Cap-and-Trade charges, offset by a decrease of $0.04 related to facility-related Cap-and-Trade charges. Please see Attachment 1 for a breakdown of the 2018 total bill increase.

c) The forecasted foreign exchange rate for Union's 2018 Compliance Plan filing is 1.23 CAD/USD.[1]

d) The foreign exchange rate and the Cap-and-Trade unit rates have a direct correlation. As the foreign exchange rate changes, the Cap-and-Trade unit rates will change in the same direction and at the same ratio. The direct correlation occurs because the foreign exchange rate is used within the calculation of the Cap-and-Trade unit rate.

For illustrative purposes, a 0.01 CAD/USD (0.8%) increase to the foreign exchange rate will increase the CAD carbon price by approximately $0.16 per tonne, based on the Annual Carbon Price Forecast in Exhibit 2, Schedule 2. An increase of $0.16 per tonne to the carbon price will increase the customer-related unit rate by approximately 0.0300 cents/$m^3$ (0.8%) and increase the facility-related unit rate by 0.0002 cents/$m^3$ (0.8%).

e) Union has not evaluated the impact of including Cap-and-Trade charges in the Delivery charge line item. In 2016, Union voiced its support of bill transparency as one means to influence customer behaviour, consistent with statements from the government of Ontario:[2]

"A key purpose of this Act is to establish a broad carbon price that will change the behaviour of everyone across the Province".[3]

"People and businesses want to know how to change their behaviours and their actions to make a difference."[4]

Union recognizes that the OEB has relied on transparency through customer outreach and rate schedules, and defined in the Framework that Cap-and-Trade charges be captured in the Delivery rate. Since this determination has been made, Union has not dedicated resources to evaluate the impact on customer understanding or acceptance of Cap-and-Trade.

Union measured customer awareness and understanding of the Cap-and-Trade program in three survey waves over the fall/winter of 2016/2017, but conclusions cannot be drawn from the research about the extent to which greater bill transparency would have altered the

[1] Exhibit 2, Schedule 2, line 2.
[2] EB-2015-0363, Union Submissions, April 22, 2016 and June 22, 2016 – Consultation to Develop a Regulatory Framework for Natural Gas Distributors' Cap and Trade Compliance Plans
[3] Preamble to Bill 172 (Climate Change Mitigation and Low-carbon Economy Act, 2016).
[4] CCAP, p. 7.

results. The results of these surveys have been provided in Union's application at Exhibit 5, Appendix A. However, a focus group study completed earlier in 2016 concluded that "Respondents were nearly unanimous that whatever additional cost consumers have to bear as a result of the cap and trade program should be transparent to the consumer and that additional charges for cap and trade should be specifically referenced on natural gas bills."[5]

[5] EB-2015-0363, Natural Gas Consumer Reaction to Ontario Government Reported Cap and Trade Plan, June 21, 2016, p. 5.

UNION GAS LIMITED
Change in 2018 Cap-and-Trade Forecast Compliance Cost Unit Rates

| Line No. | Particulars | 2017 (1) (a) | 2018 (2) (b) | Difference (c) = (b - a) | Unit Rate Impact (cents/$m^3$) (4) (d) | Total Bill Impact ($) (e) = (d /100 x 2200) |
|---|---|---|---|---|---|---|
| | Customer-Related Charge | | | | | |
| 1 | Proxy Carbon Price ($/$tCO_2e$) | 17.70 | 18.99 | 1.29 | 0.2418 | 5.31 |
| 2 | Emission Volumes ($tCO_2e$) | 14,993,040 | 14,439,690 | (553,350) | (0.1272) | (2.80) |
| 3 | Emission Costs ($000's) (line 1 x line 2 /1000) | 265,377 | 274,210 | 8,833 | | |
| 4 | Forecast Volumes ($10^3m^3$) (3) | 7,997,879 | 7,702,700 | (295,179) | 0.1272 | 2.80 |
| 5 | Customer-Related Unit Rate (cents/$m^3$) (line 3 /line 4 x 100) | 3.3181 | 3.5599 | 0.2418 | 0.2418 | 5.31 |
| | Facility-Related Charge | | | | | |
| 6 | Proxy Carbon Price ($/$tCO_2e$) | 17.70 | 18.99 | 1.29 | 0.0015 | 0.03 |
| 7 | Emission Volumes ($tCO_2e$) | 560,764 | 452,022 | (108,742) | (0.0049) | (0.10) |
| 8 | Emission Costs ($000's) (line 6 x line 7 /1000) | 9,926 | 8,584 | (1,342) | | |
| 9 | Forecast Volumes ($10^3m^3$) (3) | 41,420,609 | 39,242,095 | (2,178,514) | 0.0013 | 0.03 |
| 10 | Facility-Related Unit Rate (cents/$m^3$) (line 8 /line 9 x 100) | 0.0240 | 0.0219 | (0.0021) | (0.0021) | (0.04) |
| | Total Bill Impact | | | | | |
| 11 | Customer-Related Bill Impact ($) (line 5 /100 x 2200) | 73.00 | 78.31 | 5.31 | | |
| 12 | Facility-Related Bill Impact ($) (line 10 /100 x 2200) | 0.51 | 0.47 | (0.04) | | |
| 13 | Total Bill Impact ($) | 73.51 | 78.78 | 5.27 | | |

Notes:

(1) EB-2016-0296, Exhibit 7, Schedule 1, p.1.

(2) EB-2017-0255, Exhibit 7, Tab 1, Schedule 1, p.1.

(3) EB-2017-0255, Exhibit 7, Tab 1, Schedule 1, p.3, line 24.

(4) Proxy Carbon Price unit rate impact calculated as Proxy Carbon Price difference ($/$tCO_2e$) x 2018 Emission Volumes ($tCO_2e$) /2018 Forecast Volumes ($10^3m^3$) /10.
Emission Volumes unit rate impact calculated as Emission Volume difference ($tCO_2e$) x 2017 Proxy Carbon Price ($/$tCO_2e$) /2018 Forecast Volumes ($10^3m^3$) /10.
Forecast Volumes unit rate impact calculated as -1 x Forecast Volumes difference ($10^3m^3$) x 2017 Cap-and-Trade Unit Rate (cents/$m^3$) /2018 Forecast Volumes ($10^3m^3$).

UNION GAS LIMITED

Answer to Interrogatory from
Green Energy Coalition ("GEC")

Reference: Exhibit 3, Tab 1, p. 5

Preamble: At Exh. 3, T1, p. 5, Union states that it "views a cost-effective Compliance Plan as one that achieves a reasonable cost of compliance for ratepayers compared to the carbon market price for compliance options and abatement alternatives available to Ontario entities."

Question:

a) Please elaborate on what the Company means by "cost of compliance for ratepayers" in this statement. Is it solely the utility cost of compliance (that will be passed onto ratepayers), or does it include other costs that ratepayers will incur in the form of payments they make out of their own pockets for measures, taxes they pay to government to pay for Government subsidies of measures and/or any other costs? In other words, when Union is assessing cost- effectiveness of its cap and trade compliance plan, is it using something akin to the Utility Cost Test (UCT) or something more akin to the TRC or Societal Cost Tests? Please explain the rationale for the perspective being used.
b) In developing its 2018 Compliance Plan, did the Company assign value to measures or strategies that if implemented in 2018 would provide carbon emission reductions not only in 2018 but in subsequent years as well? In other words, did the Company value a strategy that reduced carbon emissions for 5 years more than one that reduced carbon emissions – or enabled the Company to meet carbon emission obligations, such as through purchase of emission allowances – for only one year.
c) If the answer to part "b" of this question is yes, how was that done? For example, did the Company develop estimates of multi-year streams of costs, carbon emission reductions, and other benefits for each measure or strategy considered for implementation in 2018 and then compare the net present value (NPV) of costs per lifetime ton of carbon emissions avoided or offset? Or did it compute a levelized cost per ton of carbon emissions avoided or offset? If it did neither of these things, what form of analysis did it perform to compare the relative costs of different potential strategies? Please provide copies of all such analyses, in Excel with formulae intact. If parts of any such analyses are deemed confidential, please provide portions that are not confidential, as well as a hypothetical example of how the confidential portions of the analyses were conducted (i.e. absent the confidential assumptions).

Response:

a) Cost of compliance for ratepayers refers to the costs required to cover customer and facility related compliance obligations. This could include the cost of compliance instruments as well as abatement. The Framework identifies the various alternatives available to compliance entities: emissions units (allowances and offset credits) and GHG abatement measures.[1]

Union has used the OEB LTCPF and MACC to evaluate cost-effectiveness, not UCT or TRC. This is consistent with the Framework:[2]

"Some environmental groups felt that the cost-effectiveness test should be based on total societal costs and benefits (TRC [Total Resource Cost] or SCT [Societal Cost Test]), and that the OEB should require Utilities to undertake abatement where it is less costly than the procurement of allowances.

Given the newness of the Cap and Trade program the OEB considers it premature to apply the TRC or SCT to the Utilities' Compliance Plans at this time. The OEB will consider the use of additional tests such as the TRC or SCT after gaining experience with the assessment of Compliance Plans."

Union also notes that initiatives that may not be cost effective may be eligible for government funding aimed at reducing GHG emissions. This can be another avenue to advance abatement opportunities.

Union notes that cost-effectiveness is one of the Guiding Principles included in the Cap-and-Trade Framework that the OEB will use to evaluate prudence and reasonableness in meeting Cap-and-Trade obligations.[3]

b) & c)

Union's assessment of energy conservation potential (utilizing the CPS and as outlined in Union's application at Exhibit 3, Tab 4, Schedule 1) included the savings attributed to the full life of measures, as opposed to the savings attributed to 2018 only. Therefore, measures with longer useful lives were valued appropriately compared to measures with shorter useful lives.

[1] Framework, p. 5.
[2] Framework, p. 22.
[3] Framework, p. 7.

UNION GAS LIMITED

Answer to Interrogatory from
Green Energy Coalition ("GEC")

Reference: Exhibit 2, p. 5

Preamble: At Exh 2, p. 5, Union states that the DSM volume impact removed amounts to 98,317,116 $m^3$ which "corresponds to the 2016-2020 DSM plan approved by the OEB".

Question:

a) Is that a "partially effective volumetric reduction" associated with the Company's 2018 DSM plan, or the full annual reduction.
b) Is that volume only for non-capped customers? If not, please explain.
c) Please provide the specific assumptions and calculations that led to the estimate of 98,317,116 $m^3$. Please provide them in Excel, with formulae intact.
d) Please provide a breakdown of the 98,317,116 $m^3$ by program.

---

Response:

a) The 98,317,116 $m^3$ figure represents the full annual reduction from 2017 and 2018 DSM within the General Service market.

b) The 98,317,116 $m^3$ figure represents volumes from the General Service market, which can include both capped and non-capped customers.

c) Union has provided the requested Excel spreadsheet (Exhibit B.GEC.2 Attachment A) directly to GEC via email, copying the OEB. Should any other interested parties wish to receive the document please contact Union directly.

d)

| **DSM Program** | **2017 and 2018 DSM Volumes (Annual, General Service)** |
|---|---|
| Residential | 10,289,466 $m^3$ |
| Commercial/Industrial | 82,260,014 $m^3$ |
| Performance-Based | 228,920 $m^3$ |
| Low Income | 5,538,716 $m^3$ |
| **TOTAL** | **98,317,116 $m^3$** |

*Note that the Commercial/Industrial and Performance-Based programs consist of volumes in the contract market as well.*

*Please see part c) above and the corresponding attached spreadsheet for the calculations and assumptions.*

UNION GAS LIMITED

Answer to Interrogatory from
Green Energy Coalition ("GEC")

Reference: Exhibit 2, Schedule 1, p.1

Preamble: Exhibit 2, Schedule 1, p. 1 shows total DSM volume saved in 2018 as 323,134,370 $m^3$.

Question:

a) Are those incremental annual savings?
b) Please provide the specific reference to Union's 2015-2020 DSM plan – or the related Board order – from which that value is derived.

---

Response:

a) The 323,134,370 $m^3$ figure represents the full annual reduction from 2017 and 2018 DSM. Union has identified an error in the figure, which should be 323,136,922 $m^3$ the impacts from this change are not material.

b) Please see Attachment A for the assumptions and calculations for the 323,136,922 $m^3$ figure, including corresponding references to Union's 2015-2020 DSM Plan and the OEB's Decision and Order on Union's 2015-2020 DSM Plan where appropriate.

| | Union 2015-2020 DSM Plan Annual Gas Savings (m3) | | | | 10% Increase (as per OEB Decision) | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2017 | 2017 Reference | 2018 | 2018 Reference | 2017 | 2018 | 2017 | 2018 | 2017 and 2018 Total |
| | a | | b | | c = a x 10% | d = b x 10% | e = a + c | f = b + d | g = e + f |
| Home Reno Rebate | 4,157,360 | Exhibit A, Tab 3, Appendix A, Page 15, Table 5 | 5,196,700 | Exhibit A, Tab 3, Appendix A, Page 15, Table 5 | 415,736 | 519,670 | 4,573,096 | 5,716,370 | 10,289,466 |
| C/I Prescriptive | 15,769,734 | Exhibit A, Tab 3, Appendix A, Page 42, Table 12 | 16,375,788 | Exhibit A, Tab 3, Appendix A, Page 42, Table 12 | 1,576,973 | 1,637,579 | 17,346,707 | 18,013,367 | 35,360,074 |
| C/I Custom (General Service) | 4,495,322 | Exhibit A, Tab 3, Appendix A, Page 42, Table 12 | 4,495,322 | Exhibit A, Tab 3, Appendix A, Page 42, Table 12 | 449,532 | 449,532 | 4,944,854 | 4,944,854 | 9,889,708 |
| C/I Custom (Contract) | 40,934,812 | Exhibit A, Tab 3, Appendix A, Page 42, Table 12 | 40,934,812 | Exhibit A, Tab 3, Appendix A, Page 42, Table 12 | 4,093,481 | 4,093,481 | 45,028,293 | 45,028,293 | 90,056,586 |
| Low Income (Single Family) | 1,402,296 | Exhibit A, Tab 3, Appendix A, Page 89, Table 30 | 1,528,909 | Exhibit A, Tab 3, Appendix A, Page 89, Table 30 | 140,230 | 152,891 | 1,542,526 | 1,681,800 | 3,224,326 |
| Low Income (Multi Family) | 1,064,374 | Exhibit A, Tab 3, Appendix A, Page 89, Table 30 | 1,039,617 | Exhibit A, Tab 3, Appendix A, Page 89, Table 30 | 106,437 | 103,962 | 1,170,811 | 1,143,579 | 2,314,390 |
| RunSmart | 250,000 | Exhibit A, Tab 3, Appendix A, Page 60, Table 21 | 385,000 | Exhibit A, Tab 3, Appendix A, Page 60, Table 21 | Not Applicable | Not Applicable | 250,000 | 385,000 | 635,000 |
| Strategic Energy Management | 0 | Exhibit A, Tab 3, Appendix A, Page 60, Table 21 | 300,000 | Exhibit A, Tab 3, Appendix A, Page 60, Table 21 | Not Applicable | Not Applicable | - | 300,000 | 300,000 |
| **DSM Sub-Total** | **68,073,898** | | **70,256,148** | | **6,782,390** | **6,957,115** | **74,856,288** | **77,213,263** | **152,069,551** |
| | Additional Progams added by OEB | | | | Not Applicable | | Total | | |
| | aa = [(h / i) x (j) x (k)] / (l) | | ab = [(m / j) x (n) x (k)] / (l) | | | | ac = aa | ad = ab | ae = ac + ad |
| C/I Direct Install | 2,277,722 | See Direct Install assumptions below | 2,323,276 | See Direct Install assumptions below | | | 2,277,722 | 2,323,276 | 4,600,998 |
| | af = [(t) x (u) x (v)] / w | | ag = [(z) x (u) x (v)] / (w) | | | | ah = af | ai = ag | aj = ah + ai |
| Large Volume | 82,917,043 | See Large Volume assumptions below | 83,549,330 | See Large Volume assumptions below | | | 82,917,043 | 83,549,330 | 166,466,373 |
| **Additional Sub-Total** | **85,194,765** | | **85,872,606** | | | | **85,194,765** | **85,872,606** | **171,067,371** |
| **TOTAL** | | | | | | | **160,051,052** | **163,085,869** | **323,136,922** |

| Direct Install | Assumptions | Reference | Ref # |
|---|---|---|---|
| 2016 Cumulative Nautral Gas Savings Target | 6,699,181 | OEB Decision and Order, Schedule A | h |
| 2016 Budget | $ 500,000 | OEB Decision and Order, Schedule A | i |
| 2017 Budget | $ 2,500,000 | OEB Decision and Order, Schedule A | j |
| RA Productivity Improvement Factor | 1.02 | OEB Decision and Order, Schedule C | k |
| Measure Life (Years) | 15 | Assumed | l |
| 2017 Cumulative Nautral Gas Savings Target | 34,165,823 | As per formula | m = aa x l |
| 2018 Budget | $ 2,500,000 | OEB Decision and Order, Schedule A | n |

| Large Volume | Assumptions | Reference | Ref # |
|---|---|---|---|
| 2014 Large Volume Cost-effectiveness | 308.79 | 2014 Union Annual Report | o |
| 2015 Large Volume Cost-effectiveness (Pre-Audit) | 284.56 | 2015 Union Draft Annual Report | p |
| 2016 Large Volume 100% Target (Pre-Audit) | 1,057,431,375 | Pre-Audit assumption | q |
| 2016 Large Volume Budget | $ 3,150,000 | OEB Decision and Order, Schedule A | r |
| 2016 Large Volume Cost-effectiveness (Forecasted) | 335.69 | As per formula | s = q / r |
| 2014-2016 Avg Large Volume Cost-effectiveness | 309.68 | As per formula | t = (o + p + s) / 3 |
| 2017 Large Volume Budget | $ 3,150,000 | OEB Decision and Order, Schedule A | u |
| LV Productivity Improvement Factor | 1.02 | OEB Decision and Order, Schedule C | v |
| Measure Life (Years) | 12 | Assumed | w |
| 2017 Large Volume Cost-effectiveness (Forecasted) | 315.87 | As per formula | y = (af x w) / r |
| 2015-2017 Avg Large Volume Cost-effectiveness | 312.04 | As per formula | z = (p + s + y) / 3 |

UNION GAS LIMITED

Answer to Interrogatory from
Green Energy Coalition ("GEC")

Reference: Exhibit 4, Tab 4, Schedule 1, p.1

Question:

a) In the above referenced table Union appears to equate the cost of DSM driven carbon abatement to the DSM program cost per $CO_2e$ tonne abated. Have we read that correctly (if not please elaborate)?
b) Does Union agree that to determine whether marginal DSM that would abate emissions is cost-effective it would be appropriate to count all avoided costs, not just the avoided cost of allowance or credit procurements?
c) If the answer to b. is yes, has Union done such an analysis? If so, please provide.
d) If the answer to b. is no, please explain.

---

Response:

a) Union's application at Exhibit 3, Tab 4, Schedule 1 provides the energy conservation program cost per tonne $CO_2e$ abated in each scenario (plus two incremental assessments), based on the costs and savings provided in the CPS (not including large volume customers).

b) Within the current 2015-2020 DSM Framework, Union agrees that cost-effectiveness screening for DSM programs should include more than just the avoided cost of carbon. However, the details of cost-effectiveness screening for DSM programs and changes to the DSM Framework are out of scope of Union's 2018 Compliance Plan proceeding. A more appropriate time for consideration of such changes is during the establishment of a future DSM Framework.

   Energy conversation program cost-effectiveness for the purpose of Union's 2018 Compliance Plan is described further in the response at Exhibit B.GEC.7 d).

c) Please see the response at Exhibit B.GEC.7 d).

d) Please see the response to part b) above.

UNION GAS LIMITED

Answer to Interrogatory from
Green Energy Coalition ("GEC")

Reference: Exhibit 3, Tab 4, Appendix A, p. 3

Question:

a) What is Union's understanding of how the free-rider rate is treated in the CPS Constrained and Unconstrained scenarios?
b) In utilizing the CPS data what free-rider rate did Union utilize for each customer segment? Specifically, what free-rider rates did Union use in the unconstrained scenario and the constrained scenario in its comparisons?
c) Does Union agree that moving from a constrained to an unconstrained DSM program spend (whether funded by rates or by government funding) would enable higher customer incentives that could lower the free-rider rate, and thereby improve program cost-effectiveness and increase abatement in a non- linear manner (i.e. more than in proportion to the increased program spend)?

---

Response:

a) Please see the response at Exhibit B.Staff.30 a), for more detail.

b) Union did not utilize free-ridership adjustments in the CPS analysis included in Table 1 of Union's application at Exhibit 3, Tab 4, Appendix A, p. 3, or at Exhibit 3, Tab 4, Schedule 1.

c) Higher customer incentives, in general, could lead to lower free-ridership rates. Government funding could be used to increase customer incentives for utility DSM programs. However, it should be acknowledged that in some cases, increasing incentives may not lead to lower free-ridership rates. The assessment of program design, including the issue of appropriate customer incentive levels and changes to the DSM Framework are out of scope of Union's 2018 Compliance Plan proceeding. A more appropriate time for consideration of such changes is during the establishment of a future DSM Framework.

UNION GAS LIMITED

Answer to Interrogatory from
Green Energy Coalition ("GEC")

Reference: Exhibit 3, Tab 4, Appendix A, p. 4

Question:

a) Union indicates that the MACC data was utilized by applying sectoral net to gross rates. Is this consistent with an assumption of customer incentive rates similar to those utilized within Union's current DSM portfolio?
b) If government funding was leveraged (similar to the approach that Union proposes for RNG) could net to gross rates be improved by increasing customer incentives?
c) The results Union provides for its MACC-based analysis suggest that there is cost- effective incremental residential DSM-driven abatement potential. Has Union compared the cost of each component of that potential abatement to the cost of each element of its C&T compliance plan (if so, please provide)?
d) Is it the company's understanding that the MACC includes or excludes the avoided costs of DSM (apart from the avoided C&T compliance costs)?
e) Does the company agree that DSM can be cost effective even though the utility costs of the DSM are higher than the avoided cost of allowances or credits?

---

Response:

a) Yes. Please see response at Exhibit B.Staff.31 b) and c).

b) Please see the response at Exhibit B.GEC.5 c)

c) Regarding the incremental energy conservation opportunities, Union compared the cost of incremental energy conservation programs to the avoided cost of carbon as established by the LTCPF.

d) Union's understanding is that the MACC Report includes the avoided cost of natural gas, as well as the avoided costs of carbon based on the LTCPF. Union was not able to confirm if additional avoided costs were included in the MACC, and how they compare to the avoided costs used within the DSM Framework.

e) Using the existing DSM Framework's cost-effectiveness screening methodology for DSM programs (i.e. TRC-Plus), DSM programs could be cost-effective even though the cost of the program is higher than the avoided cost of carbon, as TRC-Plus includes additional avoided costs beyond the avoided cost of carbon.

UNION GAS LIMITED

Answer to Interrogatory from
Green Energy Coalition ("GEC")

Reference: Exhibit 3, Tab 1, p. 4

Preamble: At Exh 3, tab 1, p. 4, Union states that "there is no cost-effective incremental efficiency program that would be prudent to pursue at this time within the DSM Framework."

Question:

a) Does the reference to "incremental efficiency program" include consideration of expansion of existing programs, or just consideration of new programs not already included in Union's plan? If it only considers new programs not already included in Union's plan, please explain why expansion of existing – i.e. increased aggressiveness through higher incentives, additional marketing and/or other means – was not considered.
b) What is the qualifier "that would be prudent" intended to convey? Are there cost-effective incremental energy efficiency programs that would *not* be prudent to pursue? What would render a cost-effective new program imprudent to pursue?
c) What is the purpose of the qualifier "within the DSM framework"? Is the Company suggesting that additional efficiency could only be pursued within the DSM framework, even if less expensive than other carbon emission compliance strategies? If so, why?
d) How does Union define the term "cost-effective" as used in this statement? Does it mean TRC cost-effective, or Utility Cost Test (UCT) cost-effective, or something else. For clarity, please state which of the following potential categories of benefits and costs are included:

Benefits

i. Avoided carbon emission permit costs,
ii. avoided energy costs,
iii. avoided T&D costs,
iv. price suppression effects from lower demand,
v. any other gas utility system cos savings,
vi. electricity or water cost savings,
vii. customer non-energy benefits (e.g. improved comfort or improved business productivity)
viii. societal non-energy benefits (e.g. reduced emissions of pollutants other than greenhouse gases)
ix. other (please specify)

Costs

i. DSM program costs,
ii. Customer contributions to measure costs (i.e. the portion of measure cost not covered by utility financial incentives)
iii. Other (please specify)

Whatever the response, please explain why Union is defining cost-effective in that way for the purpose of determining which abatement options to consider.

---

Response:

a) Union's reference to incremental DSM programs includes both the introduction of new programs and the expansion of existing programs.

   Union utilized the LTCPF, the CPS, and the MACC Report, to analyze whether implementing new and/or expanding existing DSM programs would be more cost-effective than purchasing compliance instruments. Because the CPS and the MACC Report identify opportunities inclusive of Union's current DSM activities, by using these data sets as the basis of its analysis Union has considered both implementing new and expanding existing DSM programs. Through this analysis Union concluded that there is no cost-effective, incremental DSM that is prudent to pursue in 2018.

b) Please see the response at Exhibit B.Staff.31 a).

c) Please see the response at Exhibit B.GEC.22.

d) In Union's 2018 Compliance Plan, cost-effective incremental energy efficiency is the difference between the assessment of program costs (including the program delivery costs and customer incentive costs) and the cost of carbon.[1] In other words, if a program costs less than the cost of carbon it avoids, it is considered cost-effective.

   For the incremental efficiency programs referenced in Union's application the benefit within the cost-effectiveness analysis includes "(i) avoided carbon permit costs", and the cost includes "(i) DSM program costs" (which includes program delivery costs and customer incentive costs). Union understands this to be consistent with the OEB's Cap-and-Trade Framework, specifically "For the purposes of assessing the cost-effectiveness of each of the Utilities' Compliance Plans, the OEB has determined that two carbon forecasts will be needed: an annual carbon price forecast and a long term (10-year) forecast",[2] and "Given the newness of the Cap and Trade program the OEB considers it premature to apply the TRC or SCT to the Utilities' Compliance Plans at this time. The OEB will consider the use of additional tests such as the TRC or SCT after gaining experience with the assessment of Compliance Plans."[3]

[1] EB-2017-0255 Exhibit 3, Tab 4, Appendix A
[2] EB-2015-0363, Report of the Board, pp. 28-19.
[3] EB-2015-0363, Report of the Board, p. 22.

UNION GAS LIMITED

Answer to Interrogatory from
Green Energy Coalition ("GEC")

Reference: Exhibit 3, Tab 1, p. 4

Preamble: At Exh 3, tab 1, p. 4, Union states that "There were a few incremental cost-effective measures that could be pursued for residential customers if the existing DSM budget and DSM framework were revised.

Question:

a) How much incremental additional savings would these measures provide?
b) How much additional lifetime savings would these measures provide?
c) How much would it cost to acquire these additional savings in 2018?
d) What would be the net present value of the avoided gas cost (both energy and infrastructure) associated with the savings estimated in response to parts "a" and "b" of this question?
e) What would be the cost per ton of carbon emissions reduced – net of all avoided gas costs – from pursuing these measures in 2018. Please provide all assumptions and calculations supporting the response.
f) Why does the DSM budget and DSM framework need to be revised to pursue these measures? Why would it not have been possible for Union to propose them as part of its 2018 Compliance Plan and get approval to pay for them through this proceeding?

---

Response:

a) – e)

Union identified measures that were included in the MACC Report but are not included within Union's existing DSM programs. Please see the response at Exhibit B.Staff.31 a), for further details regarding these measures.

Union did not assess the savings potential associated with each individual measure, as the MACC Report does not include savings potential at a measure level. The MACC Report only includes savings potential at an end use level.

f) Please see the response at Exhibit B.GEC.22.

UNION GAS LIMITED

Answer to Interrogatory from
Green Energy Coalition ("GEC")

Reference: Exhibit 3, Tab 4, p. 43

Preamble: Exhibit 3, Tab 4, Page 43 Union states: "Union did, however, identify cost-effective abatement opportunities incremental to Union's existing DSM programs within the Residential sector in all carbon price forecast scenarios. Union will assess the incremental opportunity and pursue it through the DSM Framework where possible."

Question: Has Union assessed that incremental opportunity as part of its Mid-Term DSM filing, and if so, what added savings and carbon abatement has been identified and what added savings and carbon abatement (and related measures, targets and budgets) have been proposed in that filing?

---

Response:
Please see the response at Exhibit B.Staff.31 a), for details on the residential energy conservation opportunities identified in the MACC Report that are not included with Union's current DSM programs.

Within its DSM Mid-Term Review submission on Part 2 Requirement 1, Union requested a decision from the OEB regarding a new standalone Energy Literacy offering.[1] Should the OEB direct Union to develop a standalone offering, Union requested $250,000 of incremental budget per year starting in 2019. Union did not include targets with its proposed offering.

Within its DSM Mid-Term Review submission on Part 2 Requirement 2, Union proposed a new Residential Adaptive Thermostat offering.[2] The proposal included a request for $1.5 million of incremental budget per year starting in 2019, and the addition of 34,645,000 cumulative natural gas $m^3$ to the Union's 2019 Resource Acquisition scorecard.

[1] EB-2017-0127, Union Submission, October 2 2017, pp. 16-19.
[2] EB-2017-0127, Union Submission, January 15 2018, pp. 4-6.

UNION GAS LIMITED

Answer to Interrogatory from
Green Energy Coalition ("GEC")

Reference: Exhibit 3, Tab 1, p. 5

Preamble: At Exhibit 3, Tab 1, Page 5 of 24 Union states: "Union is also proactively addressing cost-effectiveness by working collaboratively with government to pursue funding that will allow customer abatement initiatives (such as RNG) to proceed."

Question:

a) Please list and briefly describe the topics discussed in all meetings between the company and government entities during 2016 and 2017 where government or utility energy efficiency or other (non-RNG) GHG reduction efforts or potential efforts were discussed.
b) Please provide copies of all correspondence sent or received between the company and government entities during 2016 and 2017 where government or utility energy efficiency or other (non-RNG) GHG reduction efforts or potential efforts were discussed.

---

Response:

a) & b)

Correspondence with government has been so numerous that it is not possible to provide the details of each conversation. Instead, the presentations identified below (and attached for reference) represent a summary of those discussions.

Through 2016 and 2017, Union had numerous discussions with government regarding how potential abatement initiatives could be supported by the province through the application of funds collected by the government under its Cap-and-Trade Program as contemplated in the CCAP. A summary of the representative discussions and associated presentation and/or discussion materials can be found below:

Union meeting with MOECC – February 2016

- Cap and Trade Emission Reduction Program – Renewable Natural Gas Discussion Paper *(Attachment A)*
- Cap and Trade Emission Reduction Program – Combined Heat and Power Discussion Paper *(Attachment B)*

Union meetings with Government –

- Complimentary Measures Summary *(Attachment C)*
- Cap-and-Trade and the Climate Change Action Plan *(Attachment D)*

- August 2016 – Meeting with Minister Thibeault *(Attachment E)*
- September 2017 – Enbridge in Ontario *(Attachment F)*

More recently, Union and EGD have responded to RFPs issued by the Green Ontario Energy Fund for the provision of services in support of certain of the Fund's carbon emission reduction programs.

Please also see Union's responses at Exhibit B.Staff.1.Attachment 1, and Exhibit B.Energy Probe.2 for additional materials related to correspondence with government.

A Spectra Energy Company

# Cap and Trade Emission Reduction Program- Renewable Natural Gas

***POTENTIAL BENEFITS:***

- **Reduce emissions up to 8 MtCO2e by 2030 (through replacement of up to 16% of the Ontario conventional natural gas supply with Renewable Natural Gas by 2030).**
- **Encourage economic development of Ontario's bioenergy sector and 'Made-in-Ontario' greenhouse gas reduction solutions.**
- **Avoid the export of Ontario RNG resources to other marketplaces (e.g. California), and therefore emissions reductions, to other jurisdictions.**

***REQUIRED ACTION:***

- **Provide a policy directive to the Ontario Energy Board that a Renewable Natural Gas supply program needs to be established in 2016 to ensure supply is available at the start of 2017. The market mechanism to establish the RNG program would be as follows:**
  - **Based on a Renewable Portfolio Standard (RPS) approach, including an interim 2020 target volume of RNG to be purchased by the Ontario gas utilities (Enbridge and Union) in order to get the program underway.**
  - **The RPS process would require the gas utilities to source the RNG based on an RFP bid process to ensure market competitive terms (i.e., price, contract length, conditions of supply (e.g. firm, interruptible)) for the contracted RNG supply.**
  - **Review of the RNG purchase mechanism after an interim period (perhaps in 2020) when the program is established in order to meet the 2030 target of 8 $MtCO_2e$ of emissions reduction (by replacing 16% of total Ontario conventional supply by 2030).**
- **Offer funding as soon as possible from the Cap and Trade proceeds to invest in biomass gasification to RNG technology development (technology critical to meeting the 2030 target).**

Renewable Natural Gas (RNG), also known as "biomethane" is produced from biogas (produced by anaerobic digesters) and landfill gas (captured at landfill facilities) which contains approximately 60 percent methane and 40 percent carbon dioxide ($CO_2$). Methane is generated from the decomposition of organic material in an oxygen-free environment. This process is known as anaerobic digestion, and can be efficiently controlled within an anaerobic digester, or occurs naturally under landfill conditions. Examples of organic material include livestock

manure, municipal wastewater and food waste. Therefore RNG is an innovative way to manage wastes from agricultural, industrial and residential activities. RNG is an example of a circular bio economy that captures value from converting wastes into useful and saleable "by-products", known as by-product synergy (BPS). Farmers and agricultural producers could benefit in this way by reducing their solid waste streams and receiving an additional revenue stream from RNG. Municipalities could likewise benefit from an additional revenue stream from their source separated organics (SSO) or landfill facilities.

To become RNG, the biogas and landfill gas must be cleaned to remove $CO_2$ and other impurities in order to meet pipeline quality standards, after which it can be fed into the local natural gas distribution network. RNG can also be produced from the conversion of biomass (wood waste and crop residue that cannot be easily anaerobically digested) through thermal-chemical processes, such as "gasification", that do not involve the combustion or burning of biomass to generate energy. Although the gasification process has been commercially viable for decades, the technological innovation required to create methane (RNG) from biomass is still developing and has not yet reached commercial maturity. Ontario has an opportunity to become a leading jurisdiction in commercializing this technology. Approximately two-thirds of the estimated RNG supplies are related to biomass conversion.

*Barriers to a Made-in-Ontario RNG Industry*

a) Immediate Barrier

There is no technology barrier for biogas and landfill gas RNG projects. However, as was the case with Renewable Electricity, the immediate barrier to Renewable Natural Gas is the lack of a price for Ontario RNG producers to recover the operating and capital costs associated with RNG systems. Markets for RNG have been established in competitive jurisdictions within the United States (particularly California) and potential producers are exploring these opportunities to develop Ontario RNG resources for export (and resulting carbon abatements) out of the province. In 2015, the largest RNG facility in Canada opened at a Progressive Waste Landfill in Quebec with their RNG production (and resulting abatement) being sold into California markets.

b) Long Term Barrier

While existing, commercial technology can upgrade biogas and landfill gas into RNG for injection in the natural gas system, there is a requirement for commercialization of technologies that can convert biomass into methane (RNG). Approximately two-thirds of the estimated RNG supplies in Ontario are related to biomass conversion and funding support for gasification technology is critical.

*Made-in-Ontario Solution*

To achieve emission reductions related to RNG, a viable RNG industry must be established in Ontario. The first step is to immediately create a RNG supply program. The following table forecasts potential supply in Union Gas's franchise, 2017 through 2030, which coincides with the Government's planned start for Cap & Trade (2017) and the emission reduction target year 2030.

**Estimated RNG Volume, Union Gas franchise, cumulative, by year (million $m^3$/yr)**

| Year | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|
| RNG Supply (M $m^3$/yr) | 9 | 17 | 73 | 129 | 190 | 243 | 506 |
| Year | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
| RNG Supply (M $m^3$/yr) | 721 | 1,169 | 1,612 | 2,055 | 2,405 | 2,755 | 3,141 |

The year 2020 is the first Compliance Period for which Ontario will be a full WCI trading partner and the next mid-term emissions target. In order to move forward with an Ontario RNG industry, Union Gas proposes the government provide policy direction to the OEB to establish a Renewable Portfolio Standard (RPS). An immediate Ontario program is required in order to ensure carbon abatement opportunities are not shipped out of province. Union Gas recommends establishing a RPS with a target of 2% of Union's system gas supply to be RNG by 2020. The total potential RNG forecasted by 2020 is 129 million $m^3$, all of which comes from biogas or landfill gas, and represents just below 2% of Union Gas's system gas supply. This is an achievable target which enables an RNG industry to be established in Ontario, and allows time for further learning and program review, before embarking on a 2030 target.

Program Essentials:

- Renewable Portfolio Standard that targets a maximum 2% of Union's system supply by 2020
- Pricing and commercial framework allowing Union to competitively purchase RNG at prices required to support production and meet the 2% target
- Contract supply terms that allow Union to purchase RNG from Ontario producers on long term contracts (10 – 20 years)
- RNG purchased by Union will be incorporated into the utility's gas supply portfolio under a Board-approved process

Union also recommends that the government and the Board plan for a full RNG market review in 2020 with the goal of adjusting the program as required facilitating maximum GHG reduction by RNG through to 2030. Reviewing the program in 2020 will provide an opportunity for industry participants to discuss costs and rate impacts, ensuring that this new industry develops into an economic market segment that is self-sustaining.

In addition, the ability to achieve RNG targets post-2020 rests on the commercialization of technologies that can convert biomass into methane at an economic price. Technology funding for biomass conversion systems is required and significant funding can establish Ontario as an innovation leader for this necessary technology. Union Gas recommends a portion of Cap and Trade proceeds be allotted to support this technology commercialization.

**By 2030, RNG can reduce emissions up to 8Mt $CO_2e$ by replacing 16% of the conventional natural gas supply.**

# Cap and Trade Emission Reduction Program – Combined Heat and Power

***POTENTIAL BENEFITS:***

- **Create capacity on the electricity grid to be used to support programs like the electrification of vehicles**
- **Help local electricity distribution companies meet conservation targets**
- **Reduce emissions up to 1MtCO2e by installing 1,000 MW of Combined Heat and Power (CHP) projects**
- **Increase long-term planning and commitment to economic development in Ontario**

***REQUIRED ACTION:***

- **Recognize Combined Heat and Power (CHP) systems as an important component in the emissions reduction for Ontario**
- **CHP plants under 10MW should be covered entities in the cap and trade system and exempt from the need to procure compliance instruments**
- **Encourage and financially support investment into CHP**

Combined Heat and Power (CHP), also known as "cogeneration", produces both heat and electricity at the same time using a single fuel, such as natural gas, which is the best fuel for the process. The CHP process is 24% more energy efficient than producing thermal energy and electrical energy separately[1].

CHP is part of the solution for reducing greenhouse gas (GHG) emissions. As identified in Ontario's Long Term Energy Plan, "CHP can help support regional economic development, and local energy needs, while reducing carbon dioxide ($CO_2$) emissions at a competitive cost.[2]" CHP supports the deployment of new technologies, by creating capacity on the existing electricity grid, and reducing the capital required for infrastructure.

CHP systems produce 20% less $CO_2$ emissions and other pollutants than a central natural gas power producing plant[3]. This is due to the recovery of the thermal energy and use for heating

[1] Conventional fossil fuel generation vs. CHP: http://www.epa.gov/chp/fuel-and-carbon-dioxide-emissions-savings-calculation-methodology-combined-heat-and-power
[2] http://www.energy.gov.on.ca/en/ltep/achieving-balance-ontarios-long-term-energy-plan/#oil-and-natural-gas
[3] "How CHP Systems Save Fuel and Reduce CO2 Emissions" presented to IESO by Enbridge. July 22, 2015.

purposes, rather than no heat-recovery (simple cycle plant) or recovering the heat and using it for another, less-efficient electrical generation process (combined cycle plant). By 2030, 1,000 MW of CHP can reduce $CO_2$ emissions by 1Mt by displacement of grid-connected, gas-fired generation.

*Barriers*

CHP faces a number of barriers for adoption. Most prevalent is the financial challenge – CHP is a large capital investment with a low internal rate of return, often with payback exceeding a couple of years. If companies have capital available for investment, they prefer spending on core business assets, not infrastructure, such as CHP. Although the long-term price forecast for natural gas is low, uncertainty on this input cost causes hesitation in CHP development. Further uncertainty around the future economic benefit of CHP has been created by the lack of clarity around the introduction of Cap and Trade.

*Supporting the Electric System*

The most important benefit of using CHP is that existing electricity infrastructure needs are reduced, freeing up capacity on the electricity grid for GHG emission-reducing initiatives, such as the electrification of vehicles. Many of the proposed strategies to reduce GHG emissions in Ontario will require more electricity generation than exists today. Enabling private enterprise to build CHP plants by removing barriers and allocating free allowances is the most cost effective way of creating this capacity without burdening taxpayers. These CHP projects will be self-sufficient — designed, financed, built and operated by private businesses, not by the Government of Ontario.

CHP is an enabler of new, lower carbon technologies, as not only will existing electricity infrastructure be available for effective, emission-reducing strategies, but the requirement to build new electricity infrastructure will be reduced. This will free up resources that can be used towards new technologies, such as wind, solar and energy storage.

CHP is the only sizeable electricity reduction opportunity available for local distribution companies (LDC's) that need to meet mandated conservation targets. In Ontario's Conservation First reduction strategy, CHP has been identified as a solution for 1TWh of the 7TWh target. The Government of Ontario needs to continue to encourage and financially support investments into CHP to ensure these targets can be met.

*Economic Drivers*

Using natural gas fuelled CHP reduces operating costs for businesses, allowing them to be cost competitive and keep more jobs in Ontario. Thanks to abundant and affordable natural gas supply sources in North America, businesses are able to enjoy security of energy supply and price stability, both of which encourage long-term planning and commitment to future development.

The North American natural gas resource base can supply the U.S. and Canada gas markets for over 100 years and prices at Henry Hub are expected to remain stable ranging from $5.50 to $7.50CDN/GJ at current exchange rates.

Growing the CHP industry will create jobs in Ontario in areas such as equipment manufacturing, installation, labour, operations and maintenance, and consulting.

Consideration of those companies that have already invested in CHP also needs to be factored in. They would have analyzed the economic savings to ensure the expenditure was valuable at the time of investments. However, economics would not have considered additional costs for an emission reduction program. In order to preserve these established systems, no financial burden should be added from Cap and Trade.

*Program Support*

Investment in CHP infrastructure needs to be made a priority and encouraged. CHP incentive programs supported by the Independent Electricity System Operator (IESO) have been key in the adoption of CHP in Ontario. The current Program and Systems Upgrade Incentive (PSUI) program is driving CHP growth, while helping electric LDC's achieve reduction targets. This program needs to continue. CHPSOP 2.0 has also been well utilized. Going forward a new program replacing CHPSOP needs to be developed that will serve industrial and commercial enterprises wanting to generate power for behind-the-meter applications and allows for on-grid generation. These programs reduce GHG emissions, so future funding for the studies and capital investments could come from the Green Investment Fund or Cap and Trade auction proceeds.

Union Gas has recently heard from customers that some CHP projects have been put on hold until Cap and Trade program details are released, due to the anticipated cost of purchasing allowances. This has created another challenge in the CHP project cycle. These delays are

costing commercial and industrial customers the opportunity to take advantage of the cost savings of CHP immediately. The Government should announce program details as timely as possible. Government support is also required to ensure no additional costs are added to CHP as a result of the Cap and Trade framework. In particular, small-scale CHP projects (up to 10MW) should be given free allowances so there is not an additional cost and administrative barrier to operating these facilities.

*Who has CHP*

A number of industry sectors currently take advantage of the economical savings and reliability of a CHP system. Those who install CHP at their commercial or industrial operations do so to improve their resiliency and increase the reliability of their electricity supply. Intermittent supply can have serious consequences to their operations. Notable industry proponents of CHP include hospitals, such as London Health Sciences Centre and Sudbury Regional Hospital, and educational institutes, such as Queen's University and the Ontario Police College. Government facilities are also benefiting from CHP, such as the Canadian Forces Base in Petawawa, which uses CHP to ensure that they have energy in critical times, as well as, to generate more than $921,000 in annual savings and reduce greenhouse gas emissions[4].

Free allowances for CHP systems will ensure no unintended consequences for these important industries.

*Ask*

1. Recognize CHP projects (up to 10MW) as covered entities and exempt them from the need to procure compliance instruments.
2. Continue with PSUI and design a replacement incentive program for CHPSOP 2.0 that is a hybrid program enabling both "behind the fence" generation and selling into the grid.

Electricity rate payers have already contributed significantly to the greening of Ontario's electricity grid, and those costs are already reflected in current electricity rates. It is therefore appropriate that no further contributions should be required from the CHP segment.

As a complement to the above mentioned, Union Gas Ltd. is strongly aligned and supportive of the Quality Urban Energy Systems of Tomorrow (QUEST) views expressed in its Dec. 15, 2015 submission on behalf of the Ontario CHP Consortium.

[4] http://www.johnsoncontrols.ca/content/dam/WWW/jci/be/canada/case_studies/Canadian_Forces_CS.pdf

By maintaining existing programs, providing funding from the auction proceeds and granting free allowances, CHP projects can stimulate economic development, unlock opportunity on the electricity grid and reduce GHG emissions.

**CHP can play an important role in meeting Ontario's energy needs, GHG emission reduction targets, positively impacting local economies and supporting the Province's policy goals.**

# Natural gas can support a transition to a carbon-reduced economy



**1. Natural gas for transportation**

- Ontario's transportation sector the largest energy consumer, using 34% of all energy consumed in 2010; the single largest remaining share of Ontario's GHG emissions
- Natural gas used in place of gasoline or diesel for heavy duty transport and return to base fleets can reduce GHG emissions by 17%, produces almost no sulphur dioxide or particular matter

**2. Expanded energy-efficiency activities**

- Since 1997, Union Gas energy-efficiency programs have reduced natural gas use by 1/3 and cut CO2 emissions by the equivalent of taking 2.5 million cars off Ontario's roads for a year (also generating savings for our customers).
- Significant opportunities exist to expand the energy efficiency activities in which natural gas distributors already engage

# Natural gas can support a transition to a carbon-reduced economy



**3. Renewable natural gas** –produced from sources such as landfills and waste treatment plant could reduce emissions by 8 MtCO2e per year by 2030

**4. Combined Heat and Power** - wider use of natural gas CHP systems would strengthen Ontario's electricity system, through increased energy security and relieving pressure on the grid

**5. Green technology innovation -** use C&T proceeds to establish a "Green Fund" that invests in promising technologies that will economically reduce greenhouse gas emissions

**Union Gas can work with government on new opportunities and emission reduction solutions that protect Ontario families from escalating energy costs**

Uniongas
A Spectra Energy Company

# Cap-and-Trade and the Climate Change Action Plan

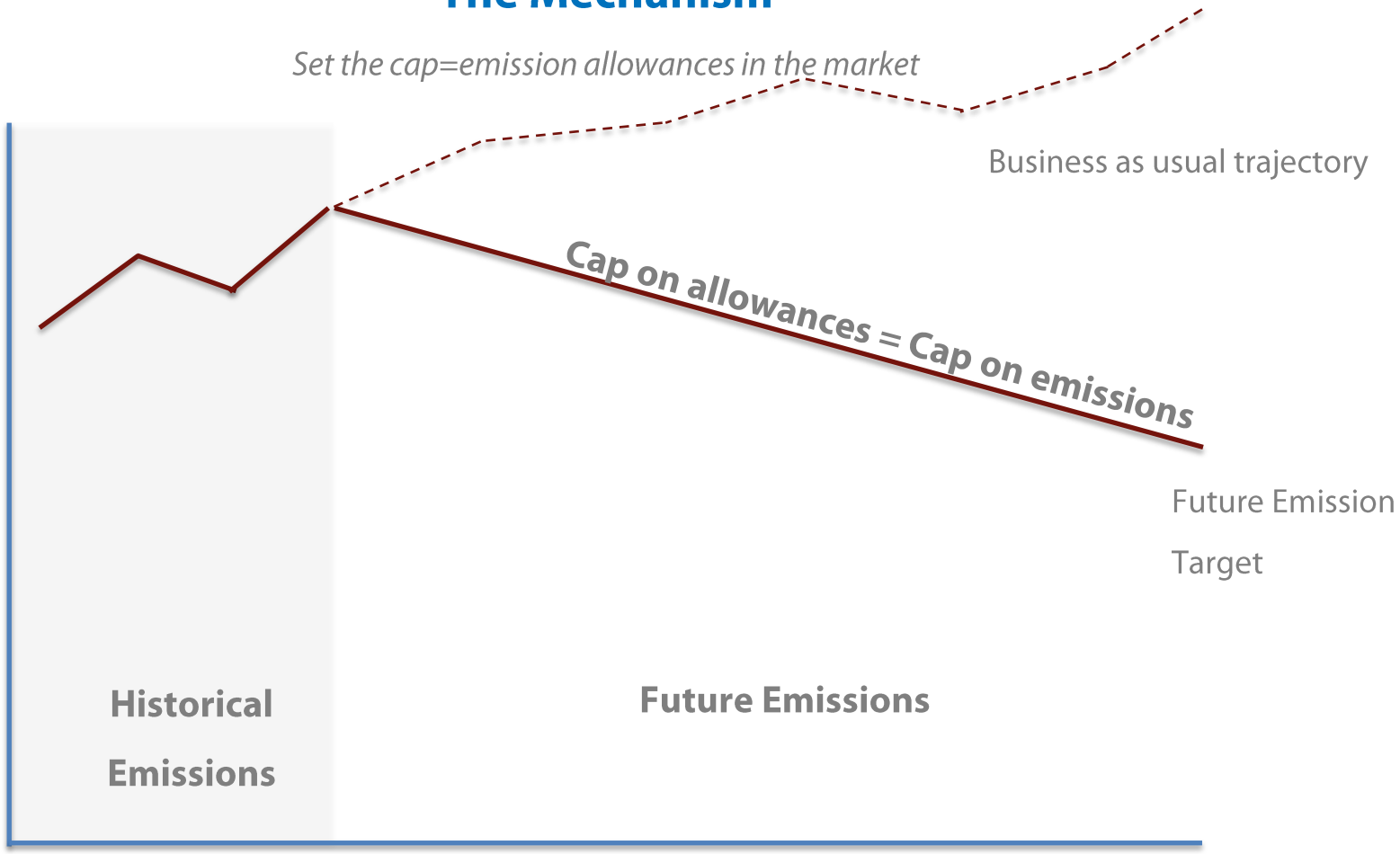
Xxxxx

xxxxx

# Cap & Trade Overview

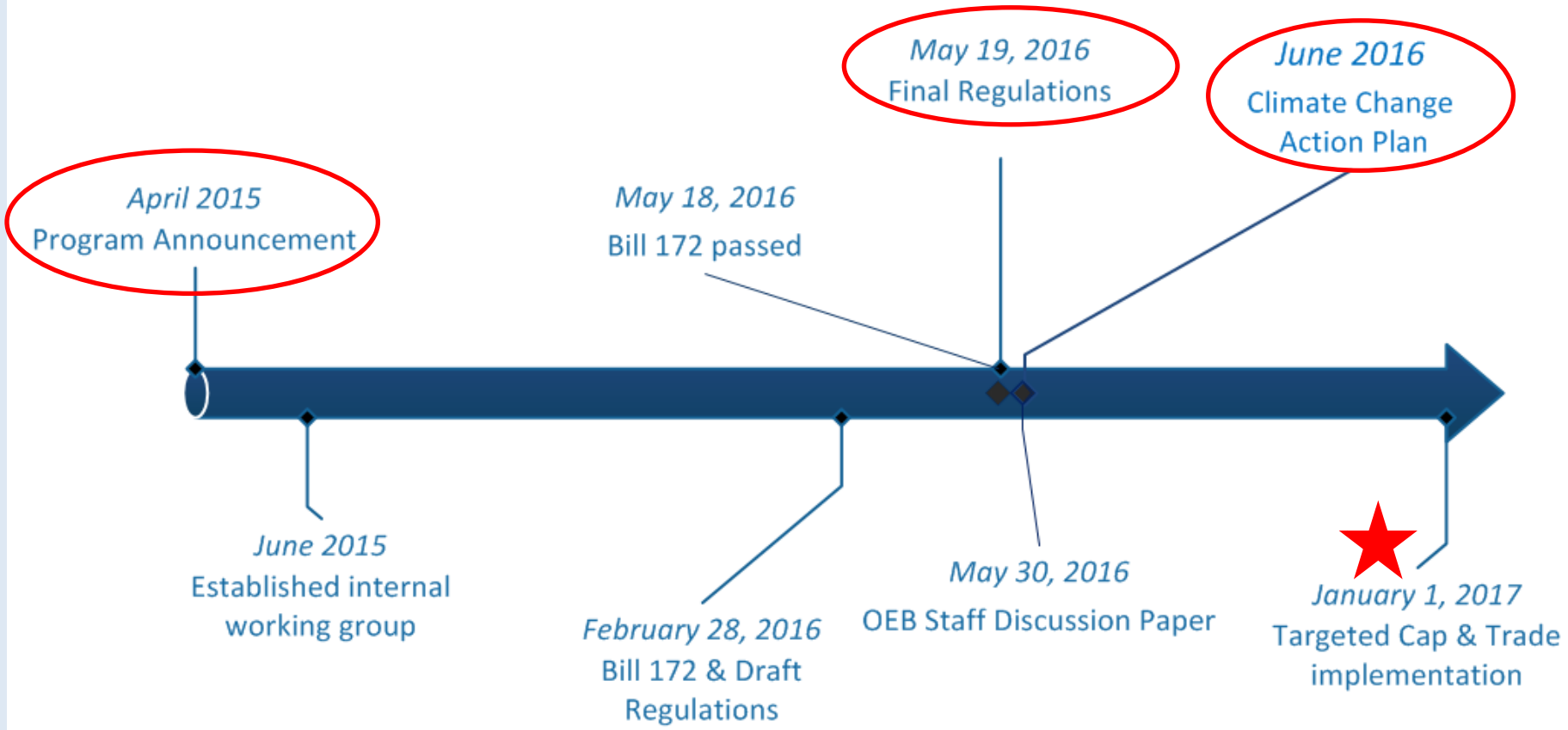
## The Mechanism

*Set the cap=emission allowances in the market*



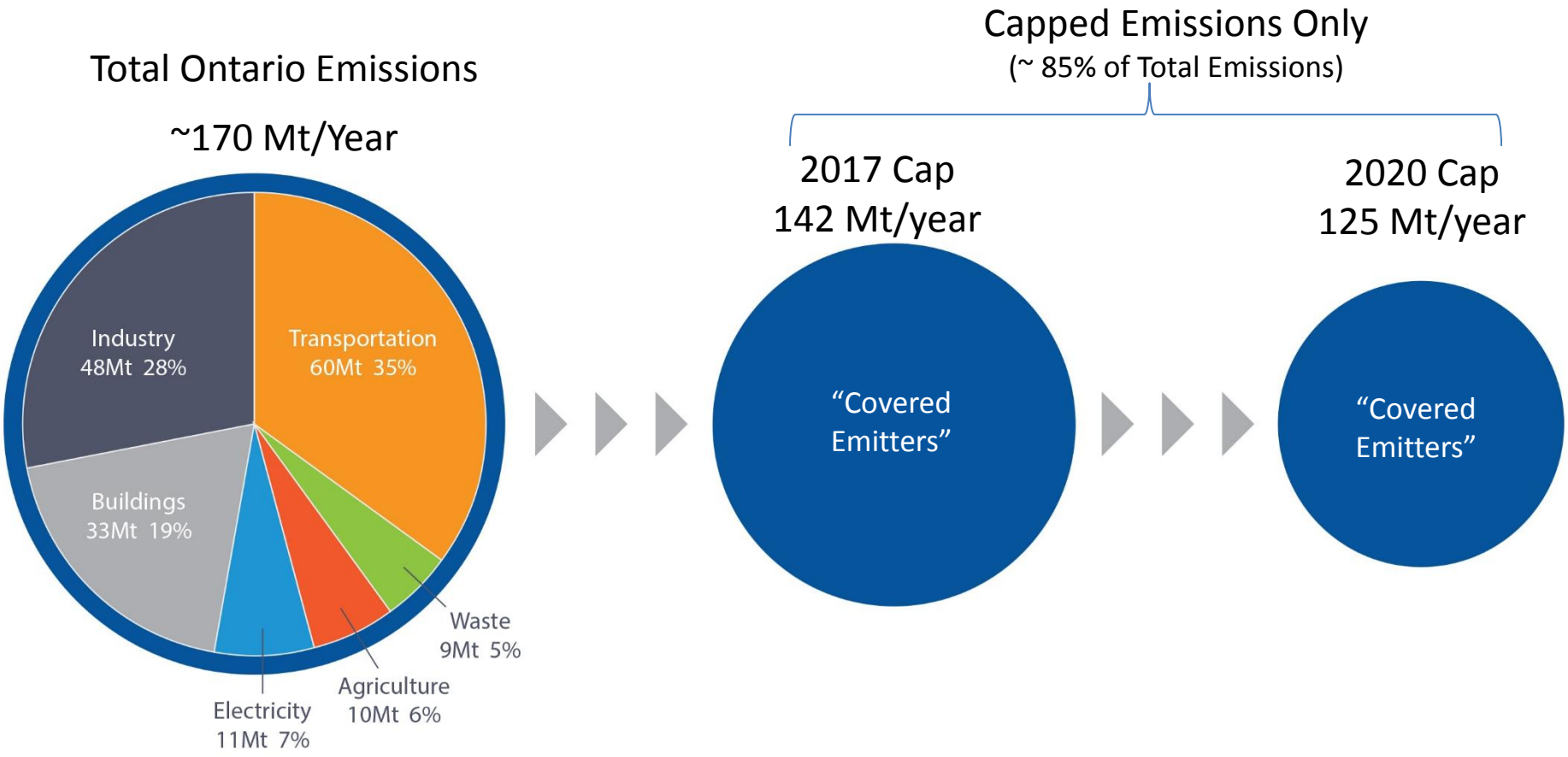

**Not to scale, for illustrative purposes only*

# Cap & Trade Timeline



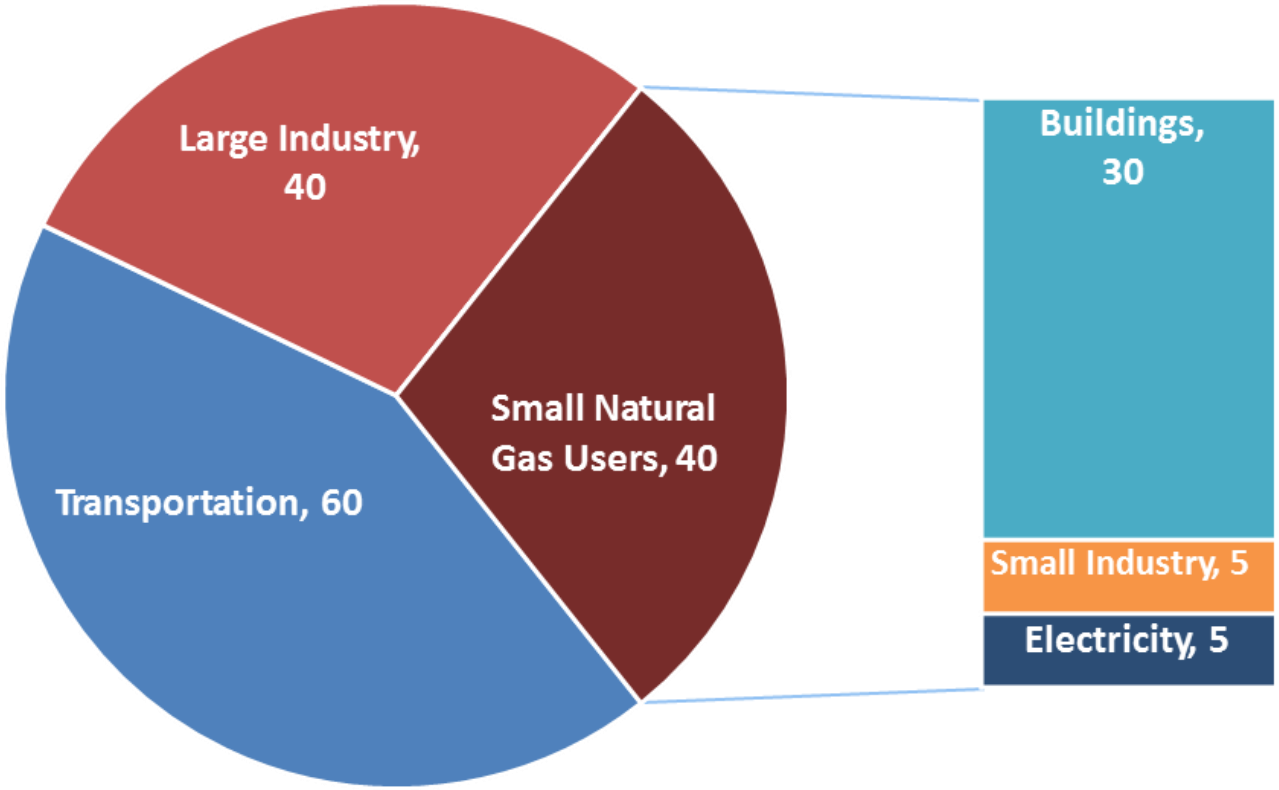

May 31, 2016

# Ontario's Cap-And-Trade Program




**"Covered emitters" need allowances to cover emissions. Available allowances decline by ~4.2% each year.**

# Ontario's Emissions Profile

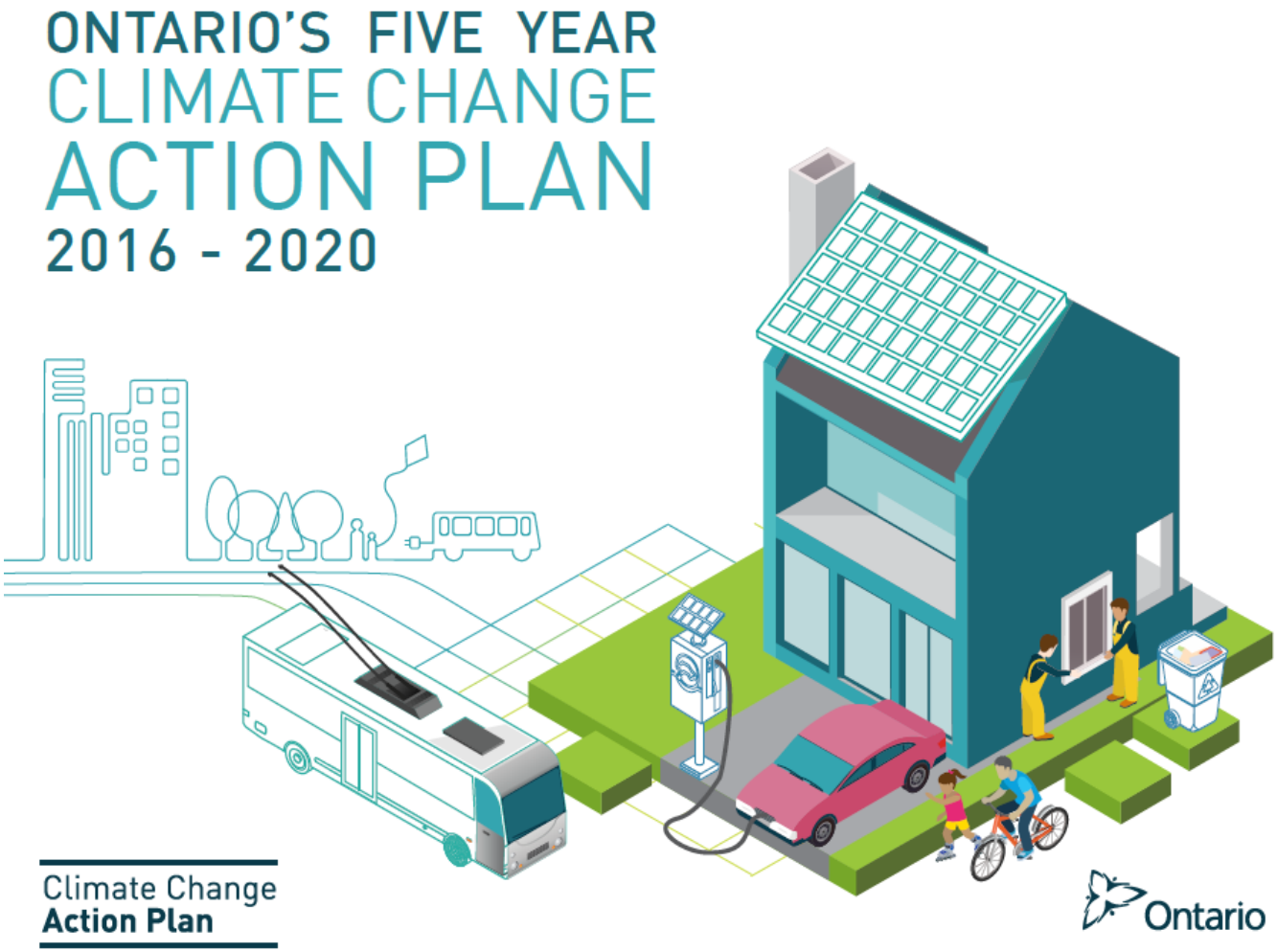



Ontario's 2017 GHG emissions profile for "Cap" covered sectors:

- 60 Mt/yr from transport fuel usage
- 40 Mt/yr from NG usage
- 40 Mt/yr from large industry, including non-combustion/fixed process emissions

**Ontario Forecast 2017 GHG emissions for sectors / sources covered under proposed cap and trade ($MtCO_2e$)**

# The Climate Change Action Plan



# Estimated Cumulative Impact to Ontario Consumers



## People

**$85/yr**
increase average spending on natural gas **2017/18**

**$450/yr**
increase average spending on natural gas **2030**

**$80/yr**
increase average spending on gasoline/vehicle **2017/18**

**$405/yr**
increase average spending on gasoline/vehicle **2030**

$165 - $855/ Household

## Businesses

**$170,000**
increase annual spending on natural gas **2017/18**

**$900,000**
increase annual spending on natural gas **2030**

$170,000 - $900,000/ Medium Size Business

Source: ICF International, February 2016

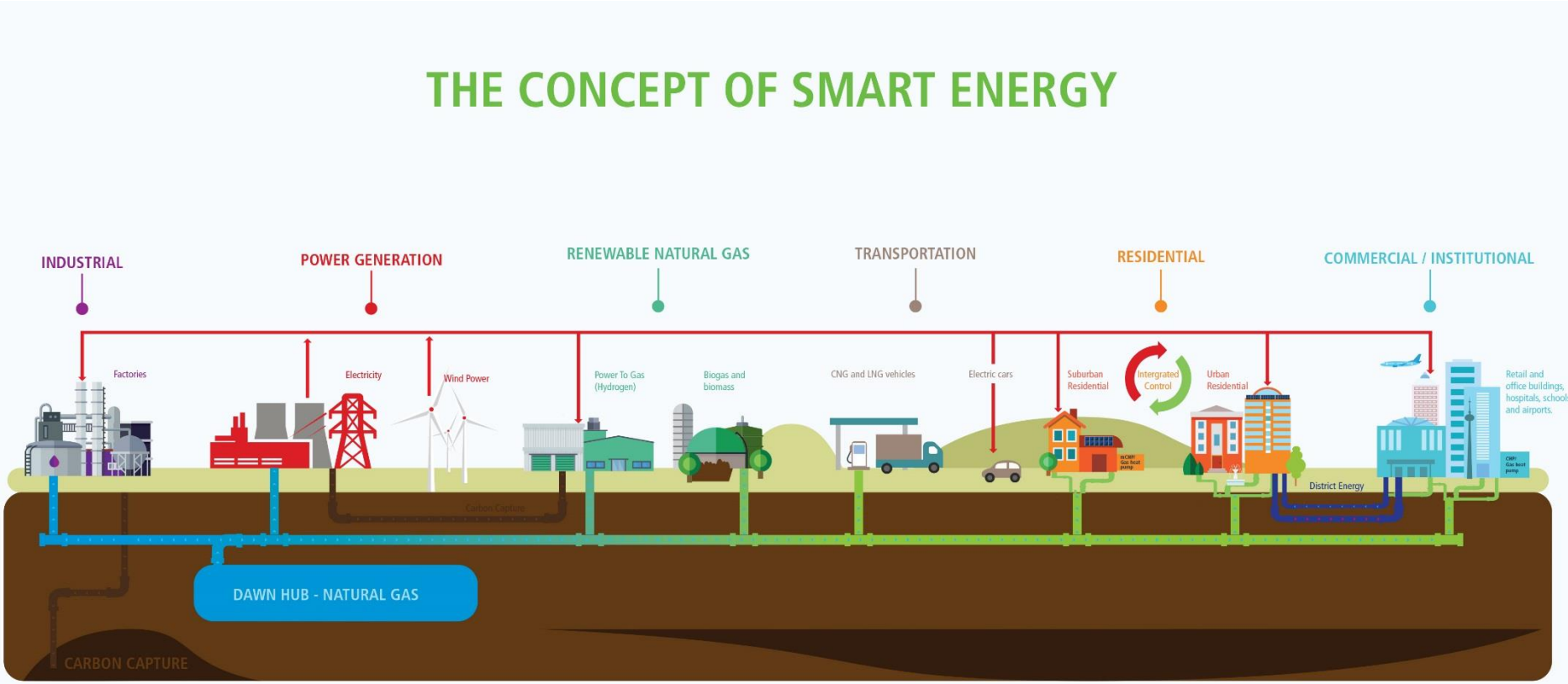
# Natural Gas Solutions: Balancing Economy and Environment




# Natural Gas Solutions:
# Balancing Economy and Environment







# Investing In Ontario

# Parting Thoughts

- Natural gas is a key part of a low-carbon future.
- Terms such as “net zero carbon” for small buildings must be clarified.
- The cost of cap-and-trade allowances should be clearly displayed on natural gas bills so consumers know what they are paying for.
- New natural gas applications, such as CNG/LNG for transport and RNG will yield the most affordable and immediate emissions reductions and should receive more funding.

# Q&A


uniongas
A Spectra Energy Company

CONNECT WITH US

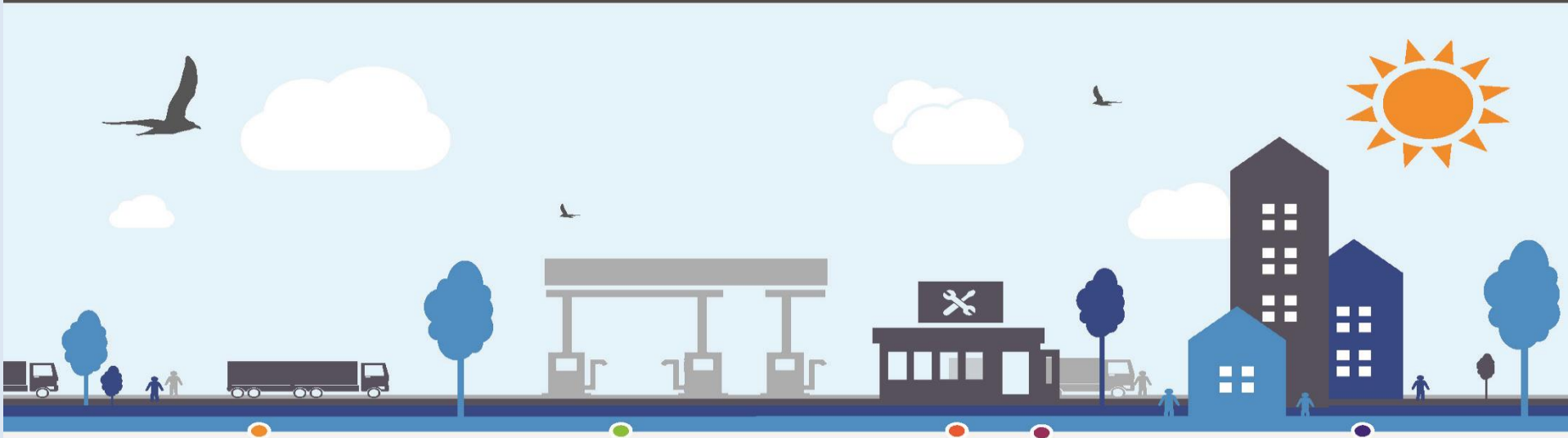
15th ANNIVERSARY EDITION: 2000-2015
Canada's Top 100 Employers 2015

# APPENDIX

# Transportation

uniongas
A Spectra Energy Company

## A PLAN TO REDUCE GHGs BY 2030



### REPLACE ENGINES

Over 5100 engines replaced in 4 years. Also support conversion of off road vehicles, marine and rail

### NATURAL GAS STATIONS

30 stations strategically placed in key transportation corridors

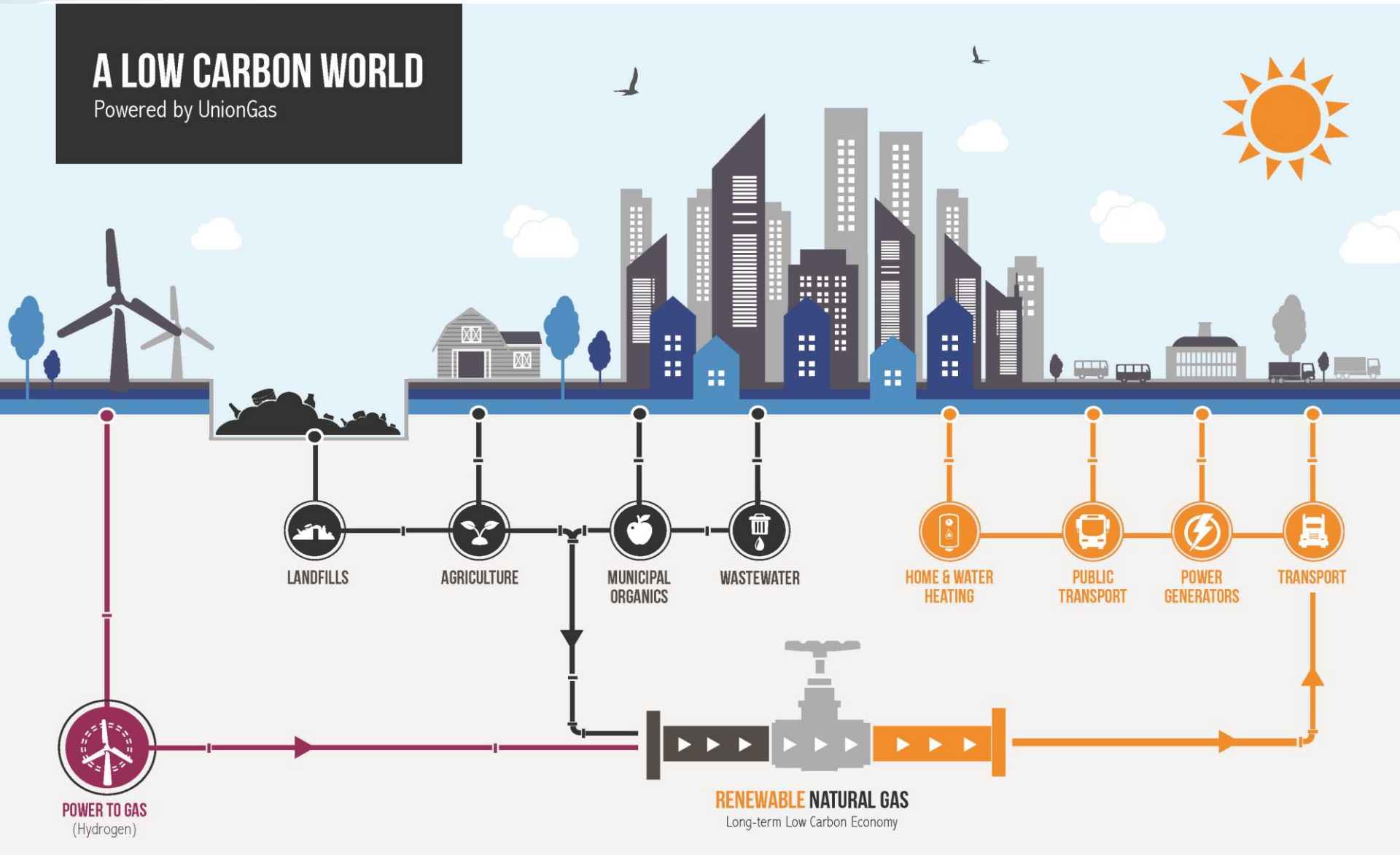
### REPAIR STATIONS & TRAINING

Support for retrofitting garages and training staff on maintenance and repair of the engines

### RESEARCH & REGULATION

Improve engine efficiency and the production of, and infrastructure for, LNG/CNG. Recognition of heavier trucks and modernize monitoring of compression

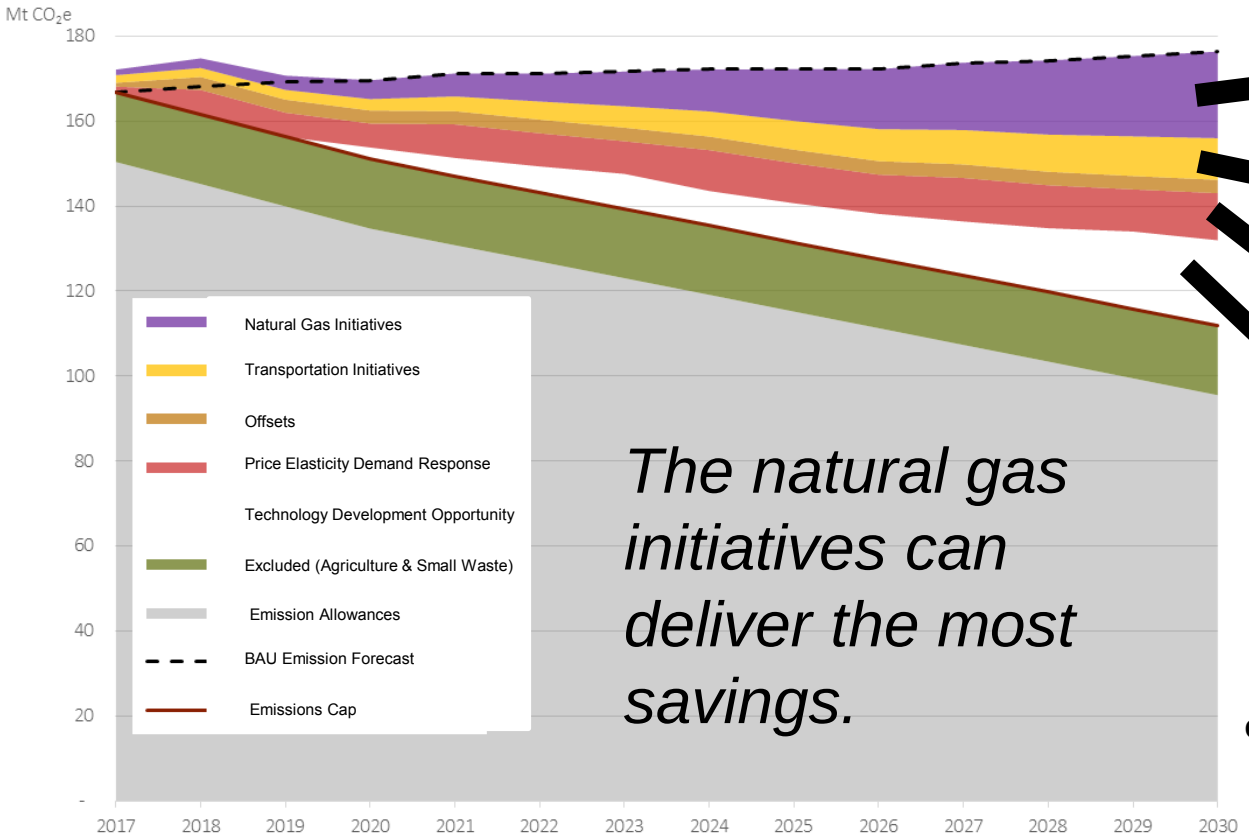
# Renewable Natural Gas



# Ontario's Climate Change Challenge








*The natural gas initiatives can deliver the most savings.*

Natural Gas Initiatives offer 21 Mt CO2e

Electrify light-duty cars and biofuels offer 10 Mt CO2e

Price-related demand reductions 11 Mt CO2e

Technology Innovation can address 20 Mt CO2e

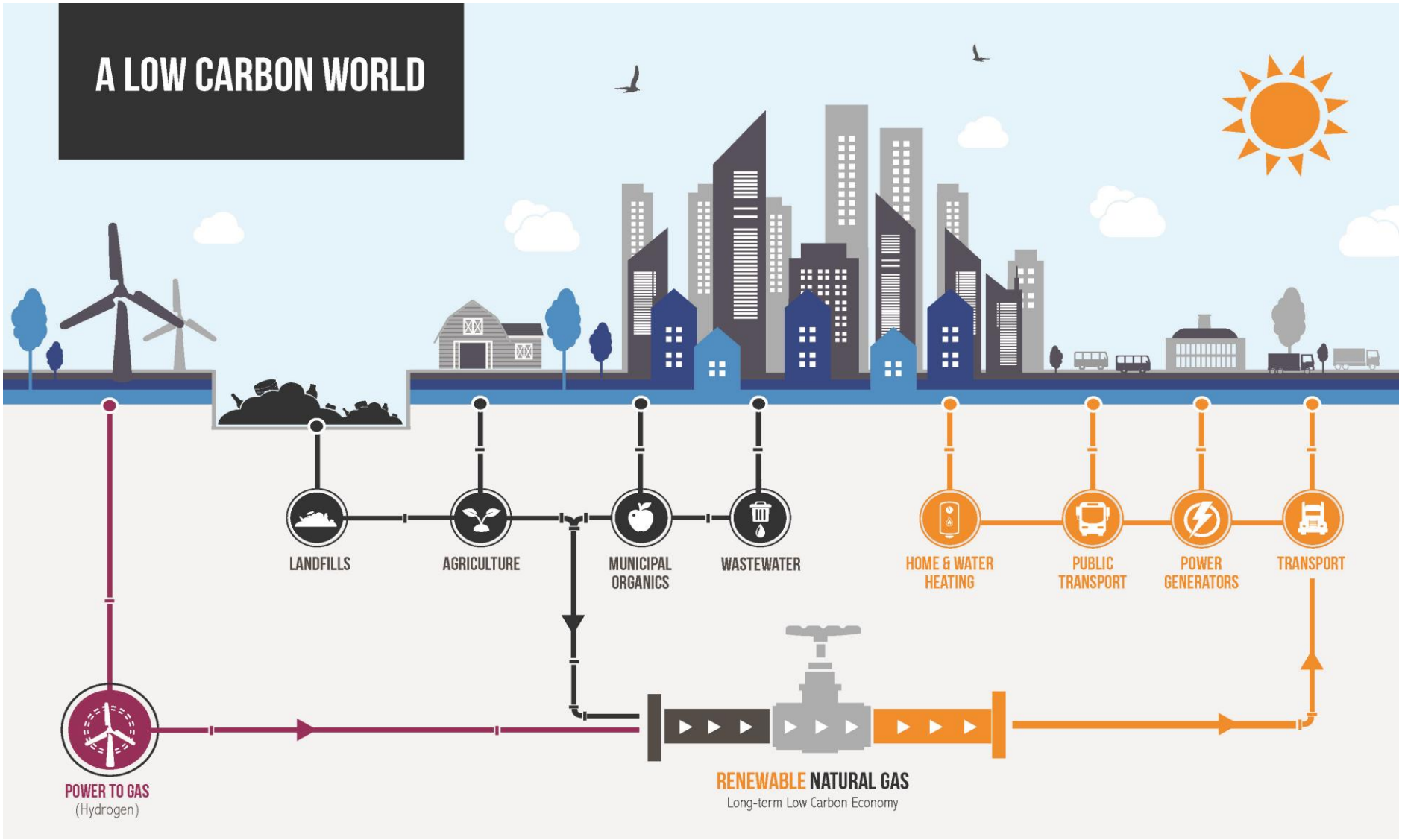
**Chart Source: ICF International Consulting**

- Greening the natural gas supply (~8Mt CO2e)
- Fuel switching in the transportation sector (~3Mt CO2e)
- Reducing per-customer consumption with more conservation (~9Mt CO2e)
- Make Investments in innovation (to close the gap)

# Ontario's Climate Change Action Plan
## Natural Gas Opportunities



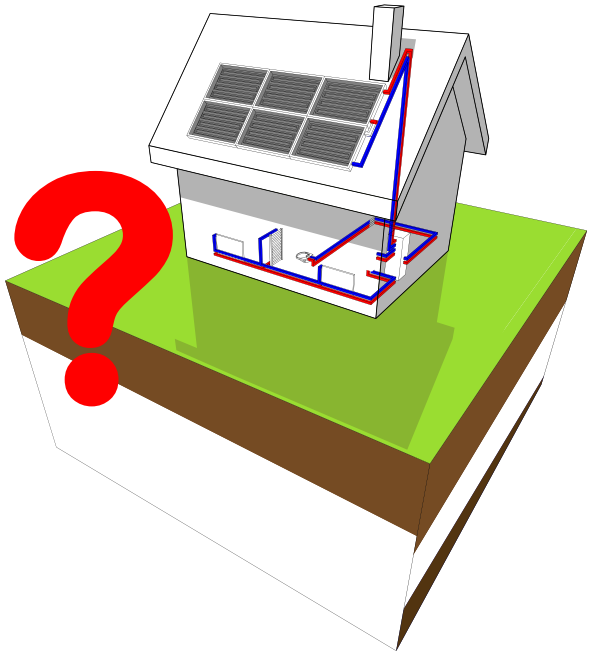


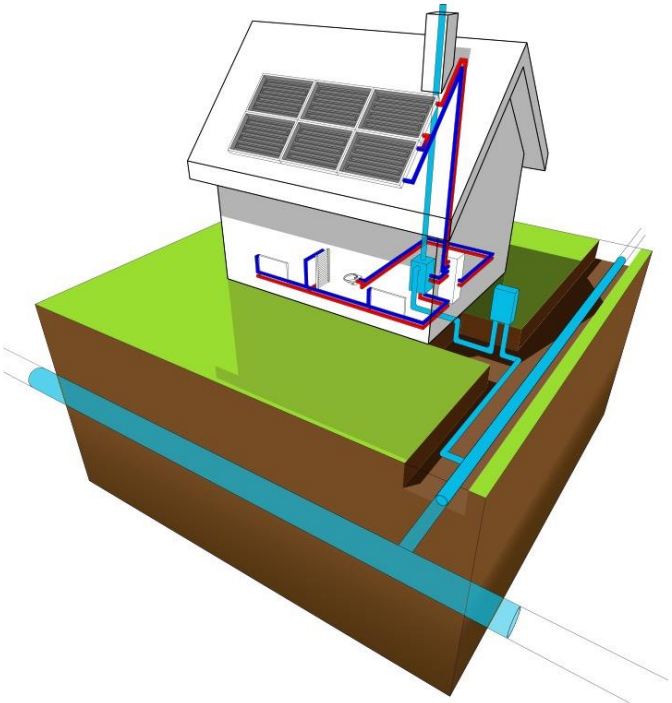


# Ontario's Climate Change Action Plan
## Defining Net Zero





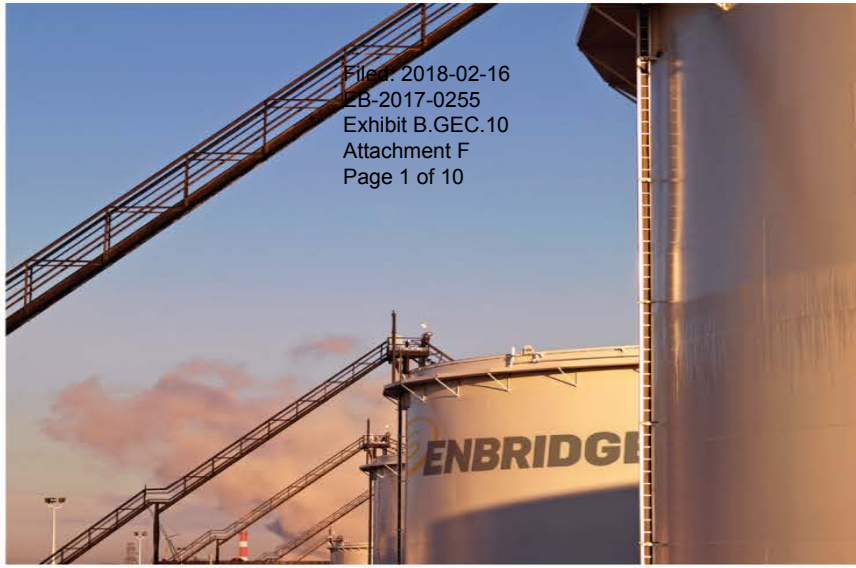




**Net zero carbon =**
Not clearly defined; **Uncertainty** for natural gas

**Net zero energy =**
Known and balanced solution that **includes natural gas**

**Net zero clarity is our top priority**



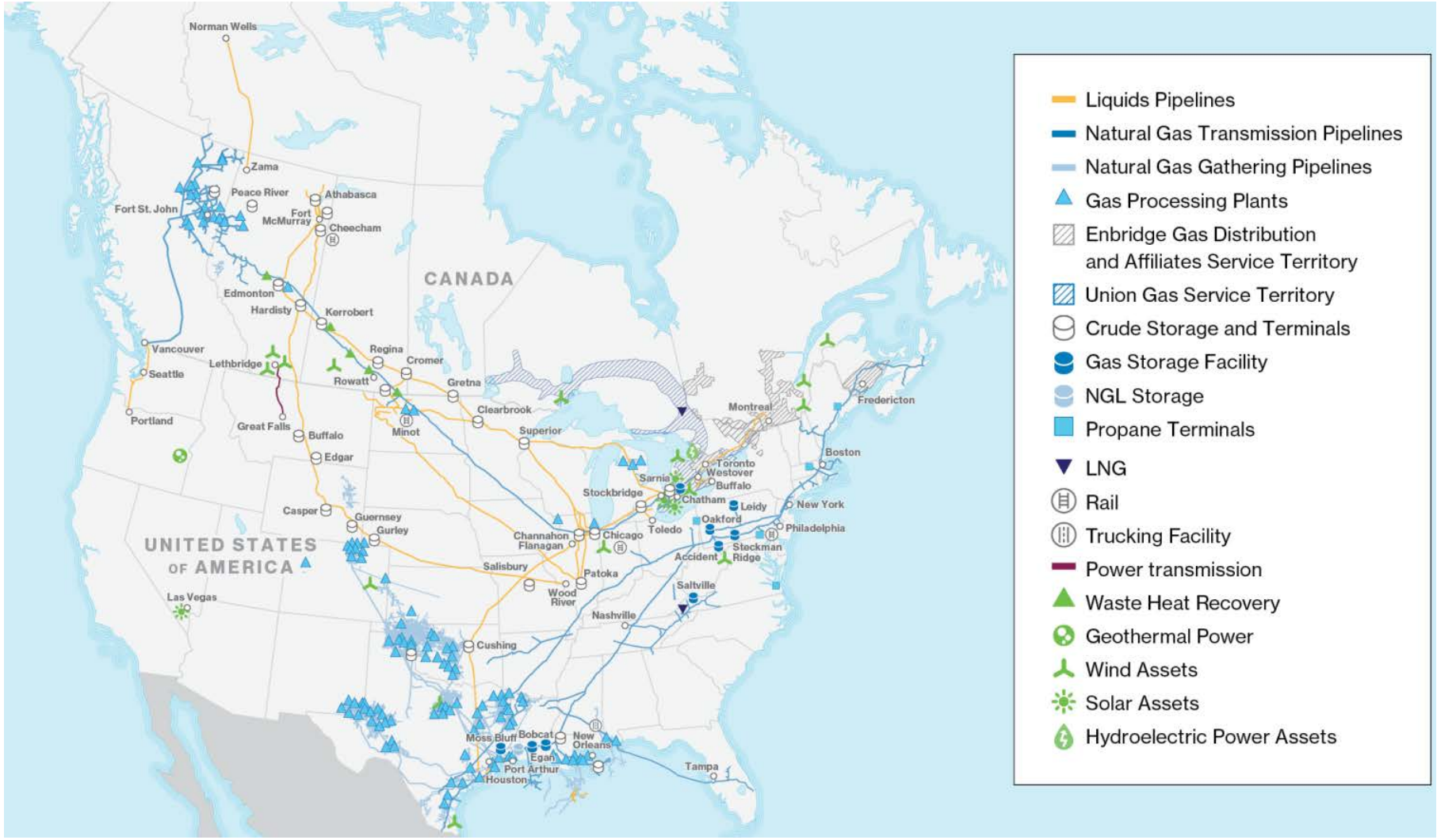

# Enbridge in Ontario

27 September 2017

ENBRIDGE

# The New Enbridge

- **4th largest company in Canada**
- **Operates the longest crude oil transportation system in the North America**
- **Operates Canada's largest energy distribution companies:** Enbridge Gas & Union Gas: serve consumer markets in Ontario, Quebec & New Brunswick and New York
- **Canada's second largest investor in renewables** (wind, solar, hydroelectric, geothermal etc.)



# Enbridge in Ontario

## Delivers 95% of Ontario's natural gas and 96% of its petroleum products

### Key Projects of Interest:

**Natural Gas Rural Expansion:** $100M expansion program to add rural communities and economic development projects; applications due in July.

**Line 10:** replacement of 35km of Line 10 segment near Hamilton, approved by NEB in 2017.

**East-West Tie Transmission:** upcoming application to the OEB.


### Natural Gas
**3.5 M customers, heating more than 75% of Ontario homes, through two utilities**

### Renewables
**7 projects: wind, solar and hydroelectric (490 MW).**

### Liquids Pipelines
**3 pipelines which move 491,000 barrels per day.**

### Infrastructure
**~$14 billion (2016) between Enbridge Gas Distribution and Union Gas**

### Property Taxes
**Pays more than $127 million in property and other taxes each year.**

### Employment
**Over 4,500 Ontario-based permanent and temporary staff.**

# Utility Integration

## One Company. One Team. One Message.

- With the recent merger of Enbridge Inc. and Spectra Energy, the two leading Ontario natural gas utilities, Union Gas and Enbridge Gas Distribution, are now part of the same company, Enbridge Inc.

- In order to lower customer energy costs and increase operational efficiency over the long term, Enbridge Gas Distribution and Union Gas plan to apply to the OEB for approval to integrate the two utilities. This will allow us to focus on doing what's right for our customers.

- The Merger will save money for our 3.5 million Ontario customers while maintaining the safe, reliable delivery of affordable natural gas.

- We know that energy affordability and the safe, reliable delivery of natural gas are important to our customers. With this integration, customers will benefit from long-term rate stability, our continued outstanding quality of service and pursuit of efficiencies.

uniongas
An Enbridge Company

ENBRIDGE
Life Takes Energy™

# Enbridge – Part of the Solution

## Supporting the Transition to the Low Carbon Economy



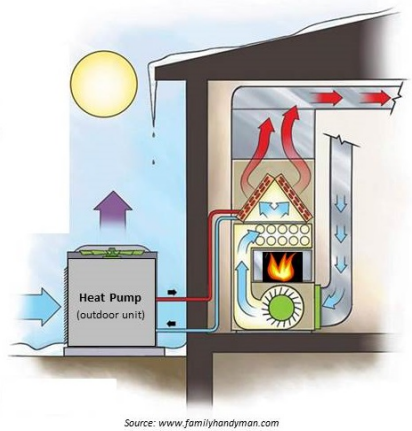
### Energy Conservation

**Average Residential Customer Usage Reduced Natural Gas use by 21%**

**Residential Customers save $2.67 for each dollar spent on natural gas conservation**
(Environmental Commissioner of Ontario, 2016)

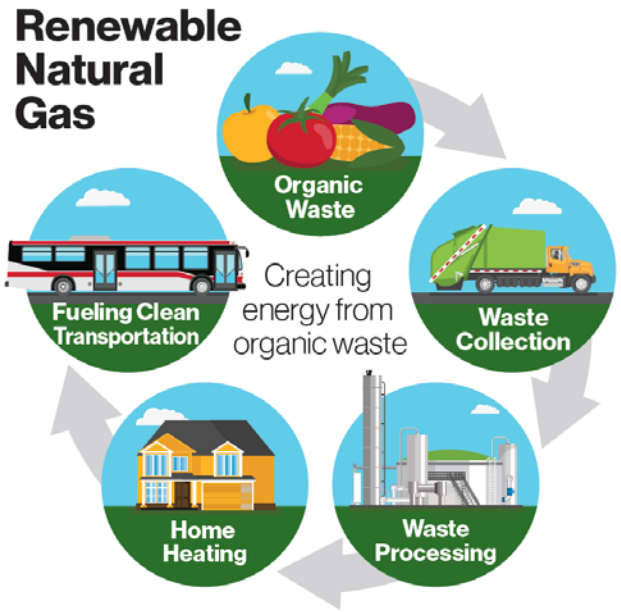
Ontario
HOME ENERGY CONSERVATION INCENTIVE PROGRAM
With funding from Ontario's Green Investment Fund

### Technology & Energy Optimization




- Rely on natural gas on coldest days
- Use air source heat pump on most days
- 60% reduction in GHG's
- Less than ½ lifecycle cost of full electric air source heat pump

### Decarbonize the Gas Supply with Renewable Natural Gas & Hydrogen



# Energy Conservation

## Proven Leadership, Expertise & Speed

**Conservation remains the lowest cost solution to reducing emissions and saving customers money. Ontario should use 'GreenON' to enhance the utilities' conservation initiatives.**

$

**Residential Customers save $2.67 for each dollar spent on natural gas conservation**

(Environmental Commissioner of Ontario, 2016)

**Average Residential Customer Usage Reduced 21% (1995-2015)**

## Moving forward:

- Reach of the gas utilities: 3.5M customers (78% of homes); New GIF program reaches all Ontarians
- Enbridge's proposals to partner with GreenON beyond the existing Green Investment Fund Partnership would allow further cost-effective opportunities to further reduce emissions by leveraging Enbridge's business model, relationships, expertise and speed
- Enbridge's conservation teams at Enbridge Gas and Union Gas can ensure alignment with government, participation from market players and we can be in the market quickly.

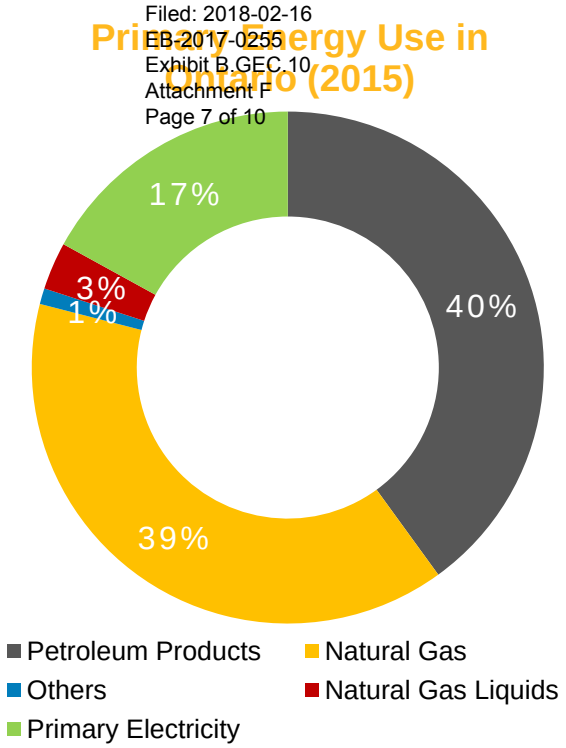
# Technology & Energy Optimization

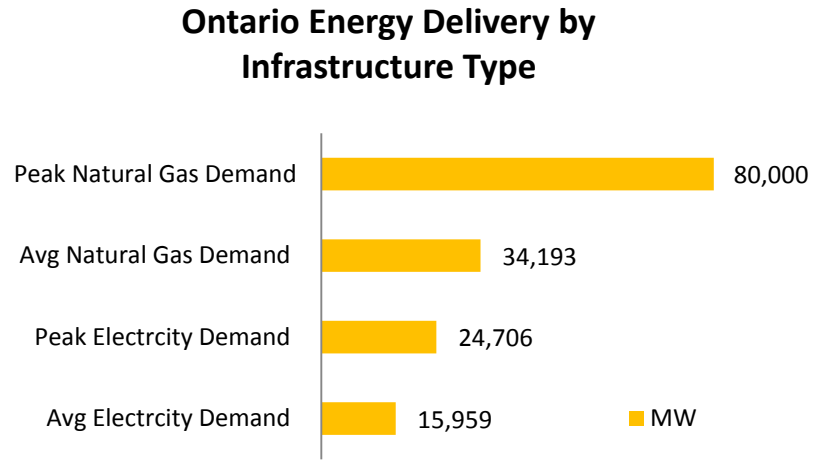
## Electrification?

- **While Ontario strives towards its ambitious emission reduction objectives it needs to ensure that our energy systems are as reliable and affordable as possible for consumers.**

- Ontario's natural gas distribution and storage network delivers more than three times the energy on a peak day (equivalent to ~80,000 MW) compared to the electricity system (24,700 MW).

- The most desirable and cost effective electrification utilizes existing infrastructure and does not create the need for new capacity resources, while at the same time displacing fuels to reduce emissions. (eg. electric cars vs home heating)



# Decarbonizing Ontario's Natural Gas Supply

## Renewable Natural Gas

- Renewable Natural Gas (RNG) is created by upgrading biogas that can be found on farms, landfills and food processing facilities to a quality that meets pipeline injection specifications. RNG can be transported throughout the natural gas distribution system.

- RNG is non-emitting, and would allow the province to reduce building emissions significantly, without having to build new transmission or distribution, at a fraction of the cost of electrification.

- RNG could provide 8 MT CO2e emission reductions by 2030

| Energy Costs: | |
|---|---|
| Traditional Natural Gas | 2 cents / kWh |
| RNG (Low-Cost) | 4 cents / kWh |
| RNG (High-Cost) | 8 cents / kWh |
| Electricity (Mid-Peak) | 13 cents / kWh |
| Electricity (On-Peak) | 19 cents / kWh |

# Natural Gas Transportation

## Catching Up on Low-Carbon Vehicles

- While light duty vehicles will be increasingly powered by electricity, natural gas – including increasing amounts of renewable content – is the best solution for lowering emissions with today's medium and heavy-duty vehicles.

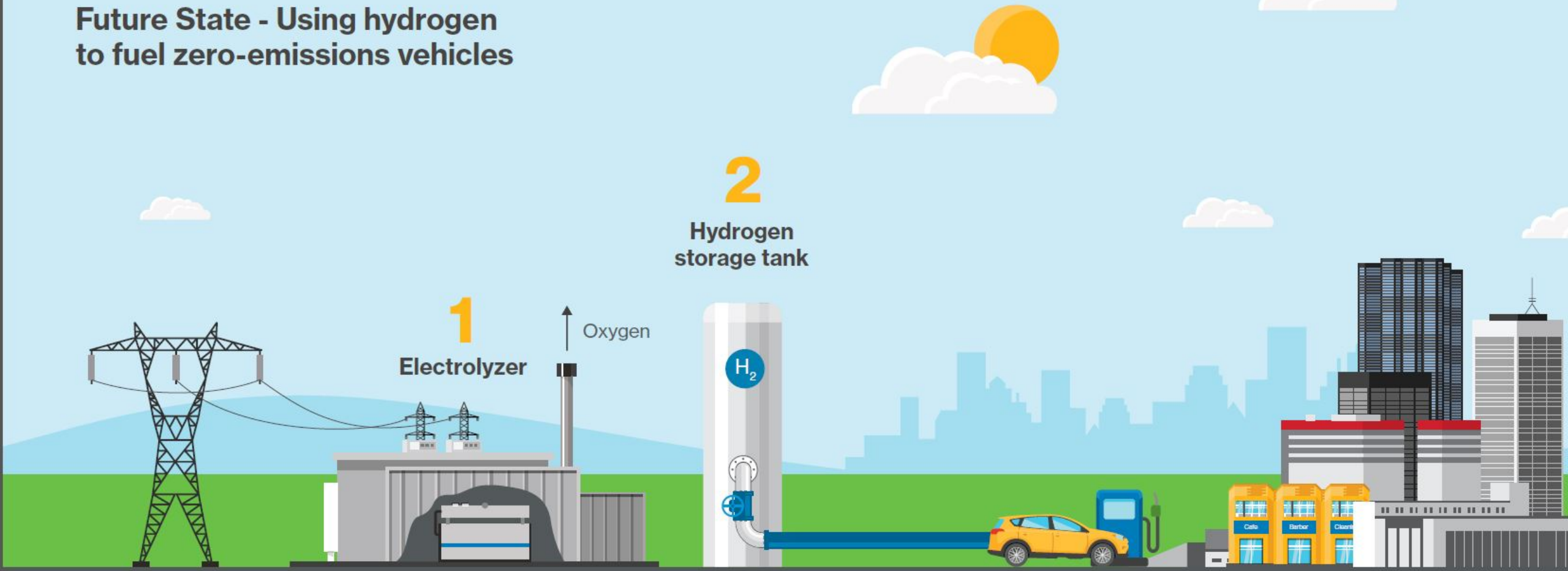
- Natural gas has roughly 20% fewer GHG emissions and is up to 40% less expensive than diesel or gasoline.


- Ontario's proposed Green Commercial Vehicle Program which will provide rebates for heavy-duty natural gas vehicles will help this transition.

- The next step is to support the need for natural gas vehicle refueling infrastructure along the 400-series highways and in urban distribution areas.

# Enbridge Invests in Power to Gas

## Future State - Using hydrogen to fuel zero-emissions vehicles




1 Since electricity can't be stored, when there is a surplus, an electrolyzer can take the electricity and use it to split water into hydrogen and oxygen.

2 The hydrogen that is produced is then stored.

3 Hydrogen can be shipped directly to refueling stations or to industrial and commercial customers.

ENBRIDGE
Life Takes Energy

UNION GAS LIMITED

Answer to Interrogatory from
Green Energy Coalition ("GEC")

Reference: Exhibit 3, Tab 1, p. 20

Preamble: At Exh. 3, T1, p 20, Union states that one limitation of the MACC study is that its analysis of efficiency measures is inclusive of the impacts of existing DSM programs and that it "would be faulty to assume that future projects will cost the same as existing ones".

Question:

a) In making this statement, is Union talking about utility cost or TRC/Societal cost? If the latter, why would the costs per unit of savings change appreciably?
b) Does Union believe that the utility costs of acquiring incremental efficiency would be greater than those to acquire the efficiency resources already being captured by its current DSM plan? If so, what is the basis for that belief? Has the Company performed any analysis to confirm it? If so, did that analysis consider the potential for lowering free rider rates by more aggressively seeking increases in program participation? If so, how?
c) Please provide any analysis conducted by the Company to support its response to part "b" of this question. Please provide it in Excel, with formulae intact.

---

Response:

a) Union is referring to program costs (including program delivery costs and customer incentive costs). As customer incentive costs are increased to achieve more aggressive participation levels, the costs per unit would also increase.

b) Yes, in general, it is reasonable to assume that it is less cost-effective to achieve aggressive levels of participation compared to moderate levels of participation for an energy efficiency measure. This is due to the cost of increased customer incentives and increased promotional costs required to achieve aggressive participation levels.

   As noted within the MACC Report "for measures where existing DSM and/or other abatement programs are already in place, the average costs presented in the MACCs do not represent what the next incremental unit of savings will cost. This limits the applicability of these cost estimates for the utilities when assessing expansion of existing or new DSM Programs".[1]

   Union has not conducted or reviewed analysis specific to this issue. Union submits that this type of assessment is more appropriately evaluated on a case-by-case basis, specific to individual energy conservation programs or measures. Further, Customer incentive levels and

[1] EB-2016-0359, MACC Report, p. 18.

their impacts on participation levels, free-ridership rates, and overall program cost-effectiveness is more appropriately addressed within the DSM Framework. A more appropriate time for consideration of such changes is during the establishment of a future DSM Framework.

c) As stated in part b) above Union has conducted no such analysis.

**UNION GAS LIMITED**
Answer to Interrogatory from
Green Energy Coalition ("GEC")

Reference: Exhibit 3, Tab 1, p. 21

Preamble: At Exh. 3, T1, p 21, Union states that one limitation of the MACC study is that it focused "only on impacts to natural gas utilities" and did not consider other customer impacts.

Question:

a) Is Union making the point that the MACC essentially used the Utility Cost Test (UCT) rather than the more expansive TRC or Societal Cost tests?
b) If the answer to part "a" of this question is "yes", why is this a limitation if the utility is using the UCT to assess the relative cost-effectiveness of other compliance options?

---

Response:

a) & b)

Union's understanding of the MACC Report is that it assesses program costs (including the program delivery costs and customer incentive costs) versus the avoided cost of natural gas and the avoided cost of carbon based on the LTCPF. This assessment is limited since other benefits (such as the avoided costs of other resources) and costs (such as customer equipment costs) are not included. This has been noted to ensure appropriate interpretation of the MACC Report.

UNION GAS LIMITED

Answer to Interrogatory from
Green Energy Coalition ("GEC")

Reference: Exhibit 3, Tab 1, p. 23

Preamble: At Exhibit 3, Tab 1, Page 23 of 24 Union notes: "The MACC does not consider alternative sources of funding available (i.e. provincial funding, CCAP, GreenON, and federal programs), which could impact the economics of programs from the Utilities' perspectives. For example, based on the MACC alone, RNG would not be feasible for Union to pursue within the existing regulatory construct rooted in cost prudence." And at Exhibit 3, Tab 4, Page 7 of 60 it is noted that "Union and EGD have worked together to develop the following abatement guiding principles:

1. Funding: Abatement programs should be able to draw on a variety of funding sources, including CCAP or GreenON funding, incremental amounts tracked through the GGEIDA and other Government funding (provincial or federal) to support projects that do not meet regulated measures for cost prudency."

Question: Please explain why the MACC was not seen as a constraint for proposing an RNG plan that relies on external funding but was seen as a constraint on proposing enhancement of existing DSM programs in 2018 or thereafter (for example, by supplementing customer incentive levels with government program funds to increase participation and reduce free ridership)?

---

Response:
Union views external funding as an option to address the constraint of cost-effectiveness for energy efficiencies as well as RNG. Union has met with government to explore funding options to support incremental energy efficiencies, as described in the response at Exhibit B.Staff.1 e). However, these discussions are not as advanced as RNG and have not progressed to the stage of developing program concepts. Union recognizes that the provincial government is also in the process of establishing energy efficiency programs through GreenON, and has advocated with government that these programs should not be duplicative to utility DSM programs.

Union does not view the MACC as a constraint in terms of its ability to offer incremental DSM programs as part of its 2018 Compliance Plan. As outlined in Union's application at Exhibit 3, Tab 4, Union used the OEB's MACC as part of its evaluation of incremental energy efficiency programs. For further information, please see Union's response at Exhibit B.GEC.22.

UNION GAS LIMITED

Answer to Interrogatory from
Green Energy Coalition ("GEC")

Reference: Exhibit 3, Tab 4, pp. 6-7

Preamble: At Exh 3, T 4, pp. 6-7, Union states that "abatement programs should be able to draw on a variety of funding sources…" and "where appropriate, an abatement program proposal will be supported by an assessment which may use a range of funding models and appropriate valuations and assumptions."

Question:

a) Is Union suggesting that the ability to "draw on a variety of funding sources" presented is a desirable "end" or rather that attempting to leverage other funding sources should be a standard practice to keep ratepayer costs as low as possible (i.e. a "means to an end")? For example, if hypothetical Strategy A had to be paid for entirely by gas ratepayers and cost $10 per ton of carbon emission reduced, would it not be preferable over hypothetical strategy B whose costs would be split 50/50 between gas ratepayers and other sources but had a total cost of $30 (and therefore $15 of ratepayer funds) per ton of carbon emission reduced.
b) When choosing between strategies, does Union believe it is appropriate to consider only the utility cost per unit of carbon emission reduction, or the full societal cost per unit of carbon emission reduction, when determining which strategies are preferable? For example, would hypothetical Strategy A that had to be paid for entire by gas ratepayers and cost $10 per ton of carbon emission reduction be preferable or less desirable than hypothetical Strategy C whose costs would be split 20/80 between gas ratepayers and government and/or other funding sources but had a total cost of $25 (and therefore $5 of ratepayers funds) per ton of carbon reduced. Please explain the Company's rationale.
c) What does the term "assessment" in the cited text mean? Is it a comparative analysis of costs per unit of carbon emission reduction? If not, what is it?
d) Under what conditions does the Company believe that it would be "appropriate" for an abatement program proposal to be supported by an assessment?
e) Please provide copies of all such "assessments" of compliance options conducted by Enbridge for its 2018 Compliance Plan.

---

Response:

a) It is not Union's intent to solely advance programs that are externally funded. Similarly, it would be premature to assume any one approach should be taken as "standard practise" given the nascence of Cap-and-Trade in the province. Market players, regulators, and utilities are still learning how the Framework is to be applied, and how it intersects with other regulatory frameworks as well as funded programs offered by governments at all levels. Indeed,

government funded programs have only begun to be announced; there remains great uncertainty as to how these programs will be offered and with what structure.

What remain constant are the guiding principles of the framework and the Abatement Construct. Applying these, Union will seek opportunities to cost-effectively and prudently advance abatement initiatives both in the short-term and in the long-term. These opportunities may be cost-effective on a stand-alone basis, or may be dependent upon external factors such as regulatory process or funding. The use of government funding to support abatement initiatives offered by the utility supports energy affordability by ensuring that programs are not duplicative of exiting programs and frameworks, and also provides abatement solutions for customers who have funded CCAP through the Cap-and-Trade program.

b) As stated in the response at Exhibit B.GEC.1 and consistent with the Framework, Union has used the OEB LTCPF to evaluate possible abatement options. Union agrees with the Framework that "Given the newness of the Cap and Trade program the OEB considers it premature to apply the TRC or SCT to the Utilities' Compliance Plans at this time",[1] and the use of TRC or SCT should be given in the future once more experience is gained in evaluating cost-effectiveness.

c) Assessment in this context is the qualitative and quantitative evaluation of a potential abatement investment. This includes, but is not limited to, a comparison to the cost of carbon.

d) Please see the response at Exhibit B.Staff.17.

e) Union assumes this question is intended for Union not EGD. For assessments of energy efficiency programs and potential facility abatement, see Union's application at Exhibit 3, Tab 4. For assessments of new technology initiatives, please see the response at Exhibit B.Staff.17.

[1] Framework, p. 22

UNION GAS LIMITED

Answer to Interrogatory from
Green Energy Coalition ("GEC")

Reference: Exhibit 3, Tab 4, pp. 6-8

Preamble: At Ex. 3, Tab 4, pp. 6-8 Union lists attributes of its Abatement Construct, including: "Efficient and rational development: Abatement programs should balance customer cost impacts by leveraging existing infrastructures (particularly utility infrastructure, including physical, brand, billing, program delivery) where appropriate and by not duplicating existing frameworks (e.g. DSM)."

Question: Please elaborate on the goal of not duplicating the existing DSM framework. Specifically:

a) Would increasing participation and reducing free ridership by using government program funding to increase customer incentives comply with or conflict with this goal? Please explain the reasoning for the Company's answer.
b) Would increasing financial incentive levels currently paid by the Company (or planned to be paid under its current DSM plan) in order to increase participation, savings and therefore carbon emission reductions from a given measure, set of measures or programs comply with or conflict with this goal? Please explain the reasoning for the Company's answer.
c) Would promoting a new technology or program not currently part of the Company's approved DSM plan in order to generate additional savings and carbon emission reductions comply with or conflict with this goal? Please explain the reasoning for the Company's answer.

---

Response:

a) & b)

If government funding for energy conservation programs is not coordinated with the DSM Framework, duplication of programs and offerings which already exist in the market is possible. Duplication will result in a lack of efficiency with respect to energy conservation programming in Ontario. Increased participation and reduced Free-Ridership within the context of Union's DSM program through any means does not necessitate duplication of the DSM Framework. However, replication of existing and recently proposed DSM programs and measures contemplated as part of the utilities' respective 2015-2020 DSM Plans directly conflicts with the goal of not duplicating the established DSM Framework. This conflict holds true regardless of the means of funding or the regulatory framework any such program is supported by. Consequences of ignoring such duplication include regulatory inefficiency, market uncertainty, and increased cost burden for customers.

c) If energy conservation program design for new technologies is not coordinated within the DSM Framework, duplication of program offerings which already exist in the market is possible. Duplication will result in a lack of efficiency with respect to energy conservation programming in Ontario. Please see the response at parts a) & b) above.

UNION GAS LIMITED

Answer to Interrogatory from
Green Energy Coalition ("GEC")

Reference: Exhibit 3, Tab 4, pp. 19-22

Preamble: At Exh 3, T4, pp. 19-22, Union's describes how its proposed RNG procurement model would work.

Question: Why is the Company not asking for approval of a similar model for funding additional energy efficiency resources?

---

Response:
Please see the response at Exhibit B.Staff.19.

UNION GAS LIMITED

Answer to Interrogatory from
Green Energy Coalition ("GEC")

Reference: Exhibit 3, Tab 4, pp. 27-28

Preamble: At Exh 3, Tab 4, pp. 27-28, Union discusses its proposed Ground Source Heat Pump initiative.

Question: Under which conditions would the Company believe it to be appropriate to promote geothermal heating and cooling to its customers. For example, if cold climate air source heat pumps would be more economical for any categories of buildings, would the Company promote them instead? If not please explain why not?

---

Response:
Optimal markets and conditions for GSHP's will be determined through execution of Union's roadmap.

This will inform the implementation plan for a potential GSHP program offering. Alternative technologies and program offerings may be proposed depending on how they progress through the initiative funnel.

Please see the response at Exhibit B.Staff.23 for additional information related to GSHP.

UNION GAS LIMITED

Answer to Interrogatory from
Green Energy Coalition ("GEC")

Reference: Exhibit 3, Tab 4, pp. 28-30

Preamble: At Exh 3, Tab 4, pp. 28-30, Union discusses the net zero ready (NZR) program. On p.29, line 10, the Company suggests that an NZR home requires "natural gas to provide supplemental energy on the coldest days."

Question: Please explain how a building could be net zero energy if it is burning natural gas on-site to meet its energy needs. Why wouldn't the Company instead promote new construction practices that were efficient enough to rely exclusively on the newest generation of very efficient, cold climate electric heat pumps, with enough on-site renewable energy generation to offset the building's entire electric load?

---

Response:
A building can be net zero energy when it is designed, modelled and built to produce as much energy as it consumes on an annual basis. This is achieved by a combination of building construction efficiency enabling to reduce the energy consumption of the home with the integration of additional hybrid technologies and renewable energy supplies. To satisfy its thermal energy needs, the house would operate using electricity from the grid and its on-site renewable source (e.g. solar) during the summer, shoulder months and mild winter days, and would switch to natural gas only when the performance of the heat pumps becomes less efficient. Throughout the year, the house would return to the grid electricity produced by its renewable power source making it net zero energy on an annual basis. Cold climate heat pumps could reduce the GHG emissions compared to natural gas, but at a significantly increased cost to the customer.

Union proposes to produce research resulting from the two ASHP/NG Solution pilot projects studying hybrid heating efficiencies and optimal switch-points for GHG savings and cost savings. Over time, Union will work to increase the efficiencies of smaller gas and alternative thermal equipment for NZER and NZE homes until all-electric solutions become more economically viable.

UNION GAS LIMITED

Answer to Interrogatory from
Green Energy Coalition ("GEC")

Reference: Exhibit 3, Tab 4, p. 13

Preamble: At Exh. 3, Tab 4, p. 13, Union provides a list of proposed 2018 projects, organized by Stage (1, 2 or 3). These projects are each described in more detail in ensuing pages. However, little information is provided regarding the likely levels of carbon emission reduction and costs.

Question:

a) For each option included in Stages 1 through 3, please provide the following:
   i. The average annual change in gas, electricity and any other fuel consumption relative to a baseline technology, building or situation.
   ii. The "measure life" of the technology or building in the application being considered.
   iii. The annual carbon emission reduction per unit (e.g. per piece of equipment, per building, per vehicle or per whatever of unit of measurement is appropriate)
   iv. The incremental cost of the technology or building or process, relative to the baseline condition.
   v. The portion of the incremental cost that Union would propose to cover in 2018.
   vi. The portion of the incremental cost that Union envisions gas ratepayers would be asked to cover in the future.
   vii. The levelized societal cost per tonne of carbon emission reduction. viii.
   viii. The levelized utility cost per tonne of carbon emission reduction.
b) Did Union conduct a comparative analysis of the relative cost-effectiveness of carbon emission reductions – or even of future carbon emission reduction potential – for each of the items included in Table 1 and/or for any other abatement options considered but not included in Table 1 (e.g. expanding existing DSM programs)? If so, please provide the analysis in Excel form, with all assumptions and formulae intact.
c) If the Company did not conduct the analysis referenced in part "b" of this question, please explain:
   i. Why it did not?
   ii. How it could come to the conclusion that the strategies and investments proposed in table 1 are the best ones to pursue?

Response:

a) – c)

Due to the nature of the Initiative Funnel and the fact that most initiatives are at Stage 1 or Stage 2, the level of detailed analysis being sought is not available at this time. This type of analysis is more appropriate for mature and commercial-ready technologies, which would likely be Stage 3 initiatives.

As described in Union's application at Exhibit 3, Tab 4, and in the responses at Exhibit B.BOMA.1, and at Exhibit B.Staff.21 a), the Stages of the Initiative Funnel run from concept through to a developed proposal. At each stage of the Initiative Funnel, the level of analysis differs. Throughout the lifecycle of the project, the concept becomes refined, based on the investment of time and study. Therefore, the level of information available at Stage 1 will vary greatly from a proposal at Stage 3 and initiatives that are ultimately implemented. For example, in Stage 1 "Conceptual", evaluation measures are developed around a particular idea or technology. In general, these measures will be qualitative in nature and will focus on the initiative's feasibility and alignment with guiding principles. At Stage 2 "Formulate", more data will be gathered to help form the idea into greater specificity that could then be developed into a project or application. In Stage 2, investment is required to gather more data in order to begin to quantify and prove assumptions around costs, benefits, and GHG reductions. By Stage 3, analysis is qualitative as well as quantitative, and provides more fulsome insight into the costs and benefits of the proposed project.

In part, Union's proposed Low Carbon Initiative Fund will assist in evaluating ideas in Stage 1 and Stage 2, and providing data that can be used to support the type of quantitative analysis that is being requested. Please see the response at Exhibit B.Staff.21 a), for further detail on how Union develops projects through the Initiative Funnel.

The response at Exhibit B.Staff.17 provides references for the data that is currently available for the projects defined at each stage of the Initiative Funnel. The response at Exhibit B.Staff.17 also identifies what relief is being sought in 2018.

UNION GAS LIMITED

Answer to Interrogatory from
Green Energy Coalition ("GEC")

Reference: Exhibit 3, Tab 4, p. 40

Preamble: At Exh 3, Tab 4, p. 40, Union summarizes three recommendations it has made for the DSM mid-term review which it believes will "ensure aggressive pursuance of DSM results and to continue to maximize benefits for ratepayers." The second of those recommendations is to "adjust DSM budgets and targets to recognize the importance of DSM in the energy efficiency market as a result of Cap and Trade".

Question: Please clarify what the Company means by this statement.

a) Is the Company suggesting that DSM budgets and targets should be increased? If not, what is the Company suggesting with regards to how DSM budgets and savings targets should change to reflect "the importance of DSM in the energy efficiency market as a result of Cap and Trade"?
b) If the Company is suggesting that DSM budget and targets should be increased, what principles does the Company believe should guide decisions regarding how much they should be increased? For example, does the Company believe that they should be increased to the point where all efficiency resources that are cost-effective (including avoided need to purchase carbon emission allowances) should be acquired? If so, using what definition of cost-effectiveness? If not, why not?

---

Response:

a) – b)

Given the new programs entering the energy conservation landscape, Union is aggressively pursuing energy efficiency to ensure the success of its existing programs. As noted within Union's DSM Mid-Term Review submission to Part 1:[1]

"The OEB's January 2016 decision to increase Union's targets by 10%, without a corresponding increase to budgets (to accommodate for the additional customer incentives required to achieve the increased targets), is not appropriate. Union requests that the OEB reduce Union's targets by 10%, effective for the 2018 DSM program year. Alternatively, Union requests that the OEB increase Union's DSM budget by 10%, effective for the 2018 DSM program year, providing the utility the ability to fund the additional participation (via customer incentives) required to achieve the increased targets."

[1] EB-2017-0127, Union Submission, September 1 2017, p. 21.

Union's recommendation above was based on providing Union the ability to fund the additional participation (via customer incentives) required to achieve its targets, specific to the OEB's January 2016 Decision.

The assessment of DSM budgets and targets, and changes to the DSM Framework are out of scope of Union's 2018 Compliance Plan proceeding. A more appropriate time for consideration of such changes is during the establishment of a future DSM Framework.

UNION GAS LIMITED

Answer to Interrogatory from
Green Energy Coalition ("GEC")

Reference: Exhibit 3, Tab 4, p. 40-41

Preamble: At Exhibit 3, Tab 4, pp. 40-41, Union states that it has "evaluated what additional incremental energy efficiency abatement exists", first "determining where incremental cost-effective opportunity versus non cost-effective opportunity should be pursued", then completing "an analysis to understand what incremental abatement opportunity exists, what of this incremental opportunity is cost-effective and what is not cost-effective."

Question:

a) What does the Company mean by first determining "where incremental cost-effective opportunity versus non cost-effective opportunity should be pursued." Does the "where pursued" language refer to different policy constructs, like the cap and trade plan versus the DSM Plan? If so, how was that determination made? If not, what does the sentence mean?
b) In assessing whether an incremental cost-effective opportunity for abatement exists, how did the Company define "cost-effective"?
c) Please provide copies of all the analyses referenced, including both assumptions and calculations in Excel form with formulae intact.

---

Response:

a) As stated in its application, with respect to energy conservation programs "Union believes that any cost-effective opportunity identified through the CPS and/or MACC analysis should not be pursued via the 2018 Compliance Plan but that it should, instead, be pursued within the DSM Framework."[1] Please see the response at Exhibit B.GEC.22.

b) Please see the response at Exhibit B.GEC.7 d).

c) Please see the response at Exhibit B.ED.27.

[1] Exhibit 3, Tab 4, p. 41.

UNION GAS LIMITED

Answer to Interrogatory from
Green Energy Coalition ("GEC")

Reference: Exhibit 3, Tab 4, p. 41

Preamble: At Exhibit 3, Tab 4, p. 41, Union states that it "believes that any cost-effective opportunity identified through the CPA and/or MACC analysis should not be pursued via the 2018 Compliance plan", but instead through the DSM framework.

Question: Why couldn't or shouldn't additional energy efficiency that is less expensive than other compliance options be included in the Company's Compliance plan?

---

Response:
Opportunities to abate carbon such as those identified through the CPS and/or MACC analysis should be considered within the appropriate regulatory framework. The DSM framework is proven and offers best practices in delivery of cost effective energy efficiency measures to the market. The existing approved DSM Framework:

- Allows the utility to propose and deliver energy conservation programs which meet principles established through a public regulatory process;
- Allows the OEB and interested stakeholders the opportunity to assess and provide comments on the utility's proposed energy conservation programs;
- Facilitates oversight by the regulator; the OEB can approve or reject the utility's proposed energy conservation programs; and,
- Ensures continued monitoring and verification of results; the OEB and interested stakeholders can assess the results of a utility's OEB-approved natural gas conservation programs.

It should be noted that cost-effectiveness is one of many factors used by utilities, the OEB, and stakeholders to assess the appropriateness of offering ratepayer-funded energy conservation programs. In other words, a simplified carbon cost-effectiveness test should not be the only tool used to determine whether an energy conservation program should be offered. Instead, the program should be assessed based on several factors as is the case within the DSM Framework. Other factors may include determining whether the program will provide value to customers or consider the potential success of the program given the technology's market saturation.

For example, within Union's 2015-2020 DSM Plan, Union proposed a residential behavioural offering and an energy savings kit offering within the residential segment. Upon OEB and stakeholder review of the offerings, both were denied by the OEB. Regarding the behavioural offering, the OEB stated it "is not convinced, based on the evidence filed, that the proposed

budgets are a good use of customer funds or that the programs provide value for money."[1] Similarly, regarding the energy saving kit offering, the OEB stated that it "is of the view that the market for ESK measures is saturated."[2] Although the behavioural and energy savings kit measures were identified as cost-effective within the CPS and the MACC, it would not be appropriate to propose and assess the programs again through the Cap-and-Trade Framework given the OEB's decision.

In addition to the regulatory inefficiency and associated financial burden to ratepayers that would result from assessing energy conservation programs within two OEB frameworks, if the utility were to deliver separate energy conservation programs to the same customer, it could result in customer confusion.

Rather than duplicating the assessment and delivery of energy conservation programs within two OEB frameworks, the DSM Framework should be enhanced to ensure that any energy conservation opportunity that is cost-effective relative to the cost of carbon is included for assessment within the DSM Framework.

Enhancing the DSM Framework, rather than assessing and delivering energy conservation programs within two separate OEB frameworks, would facilitate:

- Leveraging the existing DSM Framework, which is robust and effective, to assess and deliver any additional energy conservation programs that are deemed cost-effective relative to the cost of carbon.
- Ratepayers would avoid funding two regulatory processes for the assessment of energy conservation programs.

In order to ensure that energy conservation opportunities that are cost-effective relative to the cost of carbon are included for assessment within the DSM Framework, enhancements to the DSM Framework could include:

- Adding the LTCPF to the DSM Framework cost-effectiveness test (i.e. the TRC-Plus test), to ensure the benefits of the avoided cost of carbon is captured within the DSM Framework cost-effectiveness test.
- Adding the cost-effectiveness test from the Cap-and-Trade Framework (i.e. comparing the cost of energy conservation programs to the avoided cost of carbon) to the DSM Framework, to ensure opportunities that are cost-effective within the Cap-and-Trade Framework are included for assessment within the DSM Framework.

Further details and assessments of the specific enhancements to the DSM Framework should be part of the OEB's development of the next DSM Framework, should include stakeholder and utility input, and should begin as soon as possible.

[1] EB-2015-0029, Decision, p. 37.
[2] EB-2015-0029, Decision, p. 15.

**UNION GAS LIMITED**
Answer to Interrogatory from
Green Energy Coalition ("GEC")

Reference: Exhibit 3, Tab 4, p. 42

Preamble: At Exhibit 3, Tab 4, p. 42, Union states that it "did not identify any cost-effective abatement opportunity at the LTCPF's minimum or mid-range price scenarios."

Question: Please explain how this determination was made.

a) Did Union consider both new programs and the expansion of programs already in its DSM Plan?
b) Did Union compare the costs of additional incremental efficiency to just the forecast cost of carbon emissions – i.e. without considering the value of the avoided energy and other avoided gas infrastructure costs – or did it net out from the cost all such gas system benefits? How was this done?
c) Please provide a copy of the analysis conducted by Union in Excel, including all assumptions and with all formulae intact.

---

Response:

a) Yes. Please see the response at Exhibit B.GEC.7 a).

b) Union utilized the CPS and LTCPF to compare to cost of incremental energy conservation programs to the avoided cost of carbon as provided within the LTCPF. Please see the response at Exhibit B.GEC.7 d) for detail on costs and benefits used for cost-effectiveness analyses within Union's 2018 Compliance Plan.

c) Please see the response at Exhibit B.ED.27.

UNION GAS LIMITED

Answer to Interrogatory from
Green Energy Coalition ("GEC")

Reference: Exhibit 3, Tab 4, p. 43

Preamble: At Exhibit 3, Tab 4, p. 43, Union states "through the CPS and MACC analyses, Union has determined that it is not appropriate to include incremental DSM abatement opportunities in the 2018 Compliance Plan.

Question:

a) Were those results of the CPS and MACC the sole bases on which Union arrived at this conclusion? If not, what other references and or analyses were used as well. Please provide any such additional analyses.
b) Is it accurate to say that the MACC study relied heavily upon efficiency potential identified in the Conservation Potential Study?
c) Is it accurate to say that the Conservation Potential Study (CPS) quantified efficiency that was cost-effective based on the TRC test?
d) Is it accurate to say that the Company is assessing cost-effectiveness of potential carbon abatement strategies using the equivalent of the utility cost test (UCT) – i.e. by comparing only the cost the utility must incur to reduce or offset carbon emissions, and not including other costs borne by Government and/or other parties for those measures or strategies?
e) If the answers to the three previous questions above are all "yes", wouldn't the CPS and MACC study understate cost-effective efficiency potential – perhaps even by a very large amount – because it did not consider how much savings could be acquired if cost-effectiveness was based on the UCT (given that utility costs are often much lower than TRC cost)?

---

Response:

a) The CPS and MACC Report were the bases on which Union assessed energy conservation opportunity for the purpose of its 2018 Compliance Plan.[1] Please see the response at Exhibit B.Staff.31 a), for further details on the MACC Report analysis.

b) Yes.

c) The CPS included three conservation potential scenarios. "The technical potential scenario (includes savings from all technically-feasible measures), the economic potential scenario (a subset of the technical potential that includes only those measures that are cost-effective using the TRC-plus test) and finally, the achievable potential scenario. The achievable

[1] Exhibit 3, Tab 4 and Exhibit 3, Tab 4, Appendix A.

potential scenario is the subset of the economic potential savings that can realistically be achieved." [2]

d) Please see the response at Exhibit B.GEC.7 d).

e) For the purpose of Union's 2018 Compliance Plan, Union compared the cost of energy conservation programs to the avoided cost of carbon. The DSM Framework includes a different cost-effectiveness screening approach, with differing costs and benefits. Union submits that it is not appropriate to duplicate the DSM Framework within the Cap-and-Trade Framework. Please see the response at Exhibit B.GEC.22. Union reiterates that the Cap-and-Trade Framework is unique from the DSM Framework and similarly that abatement must be incremental to Union's 2015-2020 DSM Plan (EB-2015-0029).[3]

[2] ICF Natural Gas Conservation Potential Study, Updated July 7 2016, p. ii.
[3] EB-2015-0363, Report of the Board, p. 23.

**UNION GAS LIMITED**
Answer to Interrogatory from
Green Energy Coalition ("GEC")

Preamble: The MACC results are presented in terms of utility costs rather than societal costs.

Question:

a) Does Union agree that "utility cost" is the best cost metric for informing decisions regarding which carbon emission compliance options should be pursued? If not, why not?
b) If the answer to part "a" of this question is yes, does the Company believe that the test Ontario uses to assess cost-effectiveness of energy efficiency be changed to the Utility Cost Test? If not, why should the test used to determine which efficiency resource merit investment be different than the test used to determine which other gas utility resources merit investment?
c) If the answer to part "a" of this question is yes, does the Company agree that any efficiency resource whose utility cost per ton of GHG emission reduction is lower than other alternatives should be procured? If not, why not?

---

Response:

a) & b)
Please see the response at Exhibit B.GEC.7 d).

c) Please see the response at Exhibit B.GEC.7 d). Other alternatives should be evaluated on a case-by-case basis.

UNION GAS LIMITED

Answer to Interrogatory from
Green Energy Coalition ("GEC")

Question: Regarding Union's recent energy efficiency program performance, please provide an Excel file with all of the different efficiency measures promoted by the Company, the number of participants by measure and program, both gross and net savings per measure and program, rebate/incentive dollars per measure and program, other costs per program, measure life per measure and program, NPV of the value of savings per measure and program, and NPV of TRC costs per measure and program for all of 2017 and all of 2016 (separately for each year). The information for custom C&I can be provided in aggregate for the program (rather than by measure or project).

---

Response:
Union is currently supporting the verification and evaluation of its 2016 DSM program year through the 2016 DSM Audit, which is currently underway, coordinated by OEB Staff and the Evaluation Contractor. As such, it would not be appropriate to provide this level of information prior to the completion of the audit process. This information will be made available to the stakeholders involved in the 2016 DSM Audit, as well as to the broader stakeholder group as part of the 2016 DSM Deferrals Disposition proceeding.

Union is in the process of compiling this information for the 2017 DSM program year to prepare the 2017 Draft DSM Evaluation Report, which will be filed with the OEB later this year.

UNION GAS LIMITED

Answer to Interrogatory from
Low Income Energy Network ("LIEN")

Reference: Exhibit 3, Tab 1, p. 4

Preamble: "In terms of existing customer abatement measures, Union continues to reflect the OEB-approved DSM impacts as a reduction to its emission forecast, as noted in Exhibit 2. As noted in Union's 2017 Compliance Plan, Union has included an additional customer abatement program, the Government of Ontario's GIF. 2018 GIF volumes have been reflected in Union's volume and emissions forecast, (see Exhibit 2, Schedule 1) and are incremental to the DSM volumes."…

(footnote) The Green Investment Fund is a government program that was announced in February, 2016. Union will receive funding of $42 million to enhance the Home Reno Rebate offering and achieve additional GHG emissions reductions through 2018.

Question:

a) Please provide a breakdown of Union's plan (including which specific measures will be employed and timing for implementation) for Union's Home Reno Rebate offering through the Green Investment Fund, for 2018 and beyond.
b) Does Union intend to implement social housing retrofits through the Green Investment Fund? If so, please provide a breakdown of Union's plan (including which specific measures will be employed and timing for implementation) for 2018 and beyond.
c) Does Union plan to seek approval from the Board to implement GHG abatement activities/measures that expand or increase funding for Union's existing DSM programs (other than the Home Reno Rebate offering)?

---

Response:

a) With funding from the Green Investment Fund ("GIF"), Union enhanced the Home Reno Rebate offering by making the following three changes:

    1. Expanded eligibility for participation, including:
        - Homes that use oil, propane, or wood as their primary heating fuel (rather than just natural gas); and,
        - Homes that use natural gas as their primary heating fuel but are not serviced by Union or EGD.

    2. New rebates for:
        - High-efficiency oil furnaces and boilers;
        - High-efficiency propane furnaces and boilers;
        - High-efficiency wood burning systems;

- Air-source heat pumps; and,
- Smart thermostats.

3. Increased rebate levels for measures already included in the offering.

The enhancements have been made available since 2016 and will continue to be available in 2018. Union expects that the funding made available to Union's Home Reno Rebate offering by the GIF will be fully spent within 2018. Details beyond 2018 have not been determined.

b) No. Union's Home Reno Rebate offering, and the funding from GIF to enhance the offering, did not include a focus on social housing. The offering is a general residential offering. Union has a robust low-income DSM program that supports the social housing single family and multi family sectors.

c) Union is not seeking approval from the Board to implement abatement activities that expand or increase funding from existing DSM programs as part of this proceeding. Union included two proposals for increased funding for existing DSM programs within its submissions in the ongoing 2015-2020 DSM Mid-Term Review proceeding (EB-2017-0127). Please see the response at Exhibit B.GEC.9 for additional detail.

UNION GAS LIMITED

Answer to Interrogatory from
Low Income Energy Network ("LIEN")

Reference: Exhibit 3, Tab 4, p. 2

Question: Many of Union's customer abatement activities target new homes and new builds. Does Union plan to include any low-income-specific GHG abatement activities/measures in its offerings (and if so, please describe)?

---

Response:

Please see the response at Exhibit B.LIEN.6.

UNION GAS LIMITED

Answer to Interrogatory from
Low Income Energy Network ("LIEN")

Reference: Exhibit 3, Tab 4, p. 13

Question: At what stage of the pilot project process will low-income consumers be considered?

---

Response:
Low-income consumers will be considered at all stages for involvement in a residential customer abatement pilot project.

As identified in the response at Exhibit B.APPrO.5 c), Union has identified Building Skins as a project where low-income customers are the specific target market.

UNION GAS LIMITED

Answer to Interrogatory from
Low Income Energy Network ("LIEN")

Reference: Exhibit 5, p. 3

Question: Union surveyed its customer base to establish whether customers were absorbing Cap-and-Trade information. Did Union establish the success rate of communications among low-income consumers?

---

Response:
The Cap-and-Trade Awareness and Communication Study was completed in three Waves over the fall/winter 2016/2017 time period. The intent of the Study was to identify and measure customer awareness and understanding of the Cap-and-Trade program as well as evaluate the effectiveness of the communications issued by Union about the program.

Low-income households were not specifically identified in the survey. However, of those customers that self-identified their income in the survey as earning less than $40,000 per year, Union has noted a decrease in the level of such customers that have not heard of Cap-and-Trade (see Table 1 below). Union interprets this result to represent an improvement in the level of awareness for low-income customers. Union's Wave 3 survey results are provided in EB-2017-0255, Exhibit 5, Appendix A. Union's Wave 2 survey results are provided in Union's response at EB-2016-0296 Exhibit B.BOMA.32.

Table 1

| **Unaware: Have NOT Heard of Cap-and-Trade** | **Wave 1 September 2016** | **Wave 2 December 2016** | **Wave 3 March 2017** |
|---|---|---|---|
| Income <$40K | 59% | 60% | 46% |

UNION GAS LIMITED

Answer to Interrogatory from
Low Income Energy Network ("LIEN")

Reference: Exhibit 1, p. 12

Preamble: Union estimates a $5 increase per year to customer bills for a typical residential customer.

Question:

a) Please provide the average residential Union natural gas customer's total billed amount for 2017.
b) Please provide the average residential Union natural gas customer's billed amount broken down for each month in 2017.

---

Response:

a) & b)

Please see Attachment 1.

UNION GAS LIMITED

2017 Total Bill for an Average Residential Customer Consuming 2,200 $m^3$ per Year

| Line No. | Particulars | January (1) | February (1) | March (1) | April (2) | May (2) | June (2) | July (3) | August (3) | September (3) | October (4) | November (4) | December (4) | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (a) | (b) | (c) | (d) | (e) | (f) | (g) | (h) | (i) | (j) | (k) | (l) | (m) = sum(a:l) |
| | **Union South** | | | | | | | | | | | | | |
| 1 | Volumes ($m^3$) | 385 | 403 | 332 | 200 | 114 | 64 | 48 | 46 | 48 | 106 | 158 | 295 | 2,200 |
| 2 | Total Bill - Rate M1 ($) | 119.27 | 123.69 | 106.05 | 73.22 | 50.95 | 37.73 | 34.55 | 33.94 | 34.55 | 48.89 | 62.72 | 98.16 | 823.72 |
| | **Union North** | | | | | | | | | | | | | |
| 3 | Volumes ($m^3$) | 384 | 328 | 284 | 170 | 102 | 52 | 44 | 48 | 80 | 133 | 232 | 344 | 2,200 |
| | Total Bill ($) | | | | | | | | | | | | | |
| 4 | Rate 01 - North West | 145.61 | 127.71 | 113.48 | 78.24 | 55.61 | 38.64 | 35.99 | 37.09 | 47.96 | 67.04 | 101.49 | 140.07 | 988.93 |
| 5 | Rate 01 - North East | 164.19 | 143.61 | 127.24 | 85.73 | 60.13 | 40.93 | 38.78 | 40.11 | 53.01 | 72.68 | 111.36 | 154.69 | 1,092.46 |

Notes:

(1) Monthly bill calculated using approved January 2017 QRAM rates (EB-2016-0334) including temporary charges if applicable.
(2) Monthly bill calculated using approved April 2017 QRAM rates (EB-2017-0089) including temporary charges if applicable.
(3) Monthly bill calculated using approved July 2017 QRAM rates (EB-2017-0185) including temporary charges if applicable.
(4) Monthly bill calculated using approved October 2017 QRAM rates (EB-2017-0278) including temporary charges if applicable.

UNION GAS LIMITED

Answer to Interrogatory from
Low Income Energy Network ("LIEN")

Reference: Exhibit 1, p. 12

Question: Has Union considered, and will Union consider, rate mitigation measures (through GHG abatement measures, financial assistance, or other measures), specific to low-income customers to minimize the impact of cap and trade on low-income customers? Please specify which measures Union has considered and will consider.

---

Response:
Union has not considered specific measures for low-income customers within its 2018 Compliance Plan. Union provides natural gas conservation offerings specific to low-income customers through the DSM Framework. Please refer to Union's 2015-2020 DSM Plan (EB-2015-0029) for details on Union's low-income DSM offerings. A summary is provided below.[1]

**Low-income DSM offerings include:**
- Home Weatherization offering
- Indigenous offering
- Furnace End-of-Life Upgrade offering
- Multi-Family offering

In addition, as described in the response at Exhibit B.APPrO.5 c), Building Skins is a technology for the low-income residential target market that Union is investigating.

As per Union's application at Exhibit 5 and Union's response at EB-2016-0296 Exhibit B.LIEN.3, through customer outreach (including such items as bill messages and website content), customers have been and will continue to be educated that their Cap-and-Trade costs are directly related to their gas usage and that they can reduce this usage by taking advantage of Union's DSM energy saving programs and tips, including the Low Income Home Weatherization program. Union's call centre staff is similarly trained to assist in educating customers.

[1] EB-2015-0029, Exhibit A, Tab 3, Appendix A, pp. 72-98.

UNION GAS LIMITED

Answer to Interrogatory from
London Property Management Association ("LPMA")

Reference: Exhibit 2, p. 2

Question: Is there a more recent list of capped participants available than the June 7, 2017 list used by Union? If so, are there any significant differences (in terms of volumes) that would result from use of the more up-to-date list?

---

Response:
Yes. The most recent list of capped participants was provided by the MOECC dated November 24, 2017. The result of the update is a reduction of 7% of the volume forecast underlying Union's GHG obligation from 7,702 $10^6m^3$ to 7,161 $10^6m^3$.

UNION GAS LIMITED

Answer to Interrogatory from
London Property Management Association ("LPMA")

Reference: Exhibit 2, p. 5

Question:

a) How does Union estimate the volume for capped participants in the general service market? For example, does Union calculate the average use for the capped participants based on their historical usage, or does Union assume that the average use for capped participants is equal to the average use of the rate class they are in?
b) For each general service rate class that includes capped participants, please provide the average use for all customers in the class and for the capped participants in the class.

---

Response:

a) The estimated volume for the large final emitters and voluntary participants in the general service market is the actual billed volume in 2016 for those customers.

b) Please see Table 1 below.

**Table 1**
**2016 Actual Average Use (m3)**

| | Entire Rate Class | LFE / Voluntary Participants |
|---|---|---|
| Rate M1 | 2,535 | 9,958 |
| Rate M2 | 152,150 | 624,195 |
| Rate 01 | 2,678 | 7,246 |
| Rate 10 | 153,911 | 519,800 |

UNION GAS LIMITED

Answer to Interrogatory from
London Property Management Association ("LPMA")

Reference: Exhibit 2, pp. 4-5

Question: Does Union take into account customer shrinkage estimates when calculating the total number of billed customers? If not, is this a change from the methodology used in EB-2016-0296?

---

Response:
Yes. Customer shrinkage is included when calculating the total number of billed customers.

UNION GAS LIMITED

Answer to Interrogatory from
London Property Management Association ("LPMA")

Reference: Exhibit 2, p. 5

Question: Please explain and show how the weather normal explanatory variable was determined.

---

Response:
The weather normal provides the weather estimates for the year 2018, and is obtained using the Board-approved "50:50" weather normal methodology. This method is a blend of the 20-year trend and the 30-year average, weighted at 50% each, and has been in use since the OEB approved it as part of Union's 2013 Rates proceeding (EB-2011-0210).

The weather normal is calculated for each of Union South and Union North regions. The 2018 weather normal includes actual weather from years 1987 to 2016 to calculate the 30-year simple average, and uses actual weather from years 1997 to 2016 to calculate the 20-year trend. The 30-year average is held constant for years 2017 and 2018. The 20-year trend is projected out two years (2017 and 2018). The weather normal then is calculated using a 50:50 ratio.

Figure 1 and Figure 2 below show the actual weather and calculated weather normal for Union South and Union North respectively.

**Figure 1**

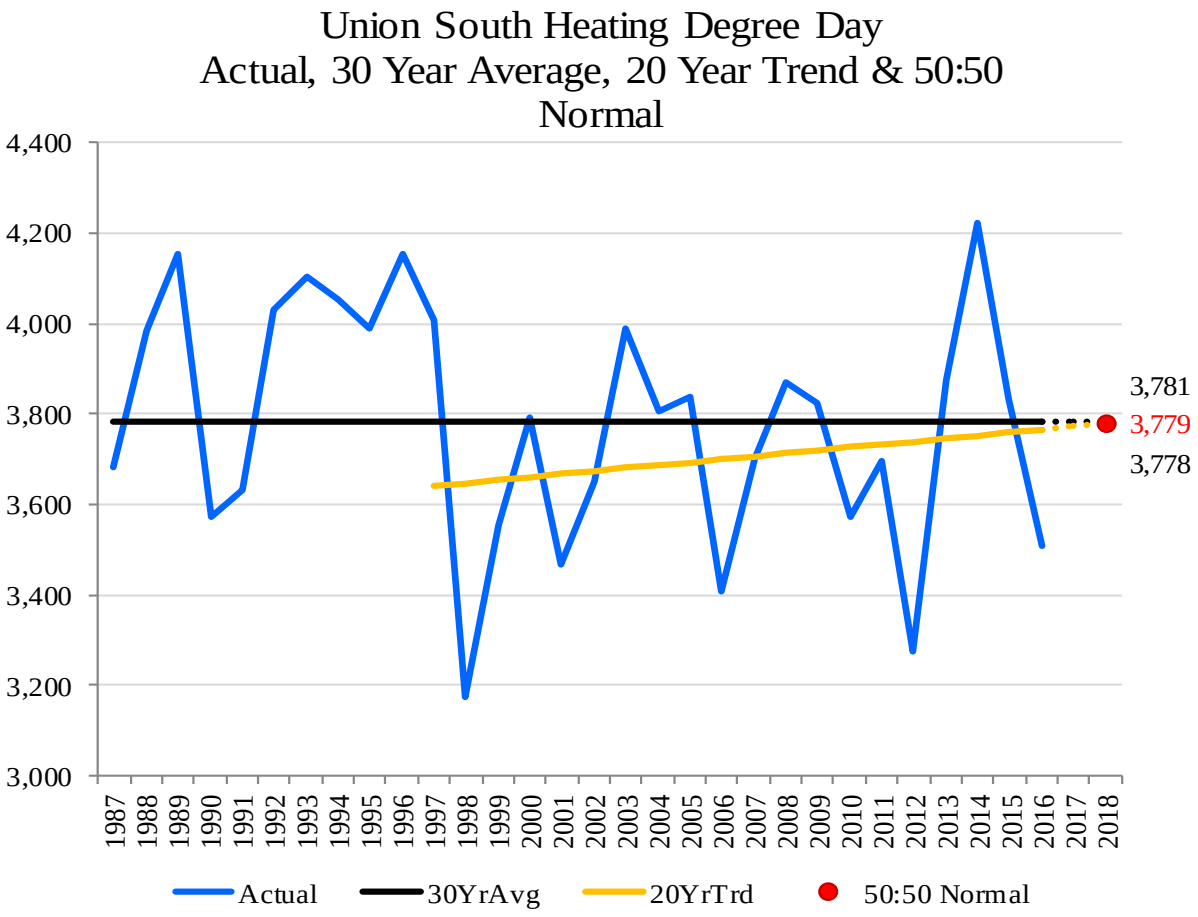
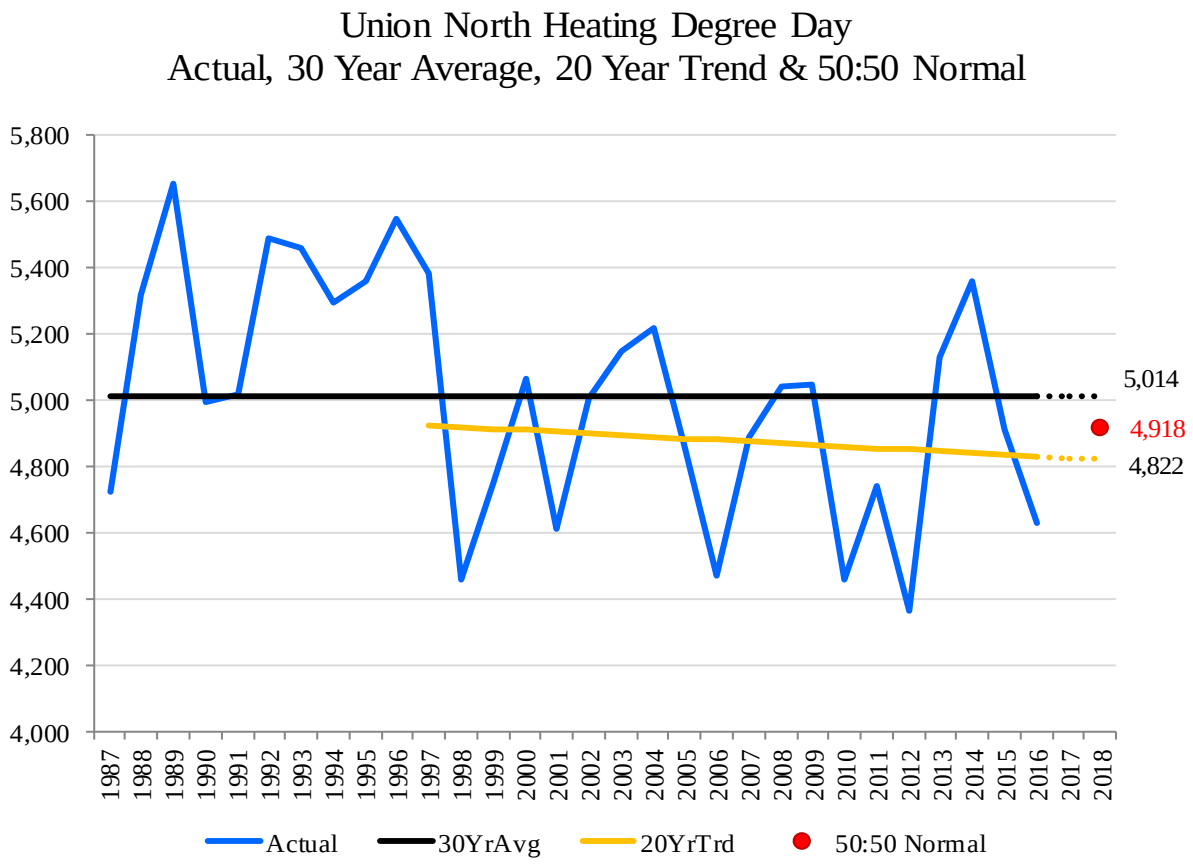

Union South Heating Degree Day
Actual, 30 Year Average, 20 Year Trend & 50:50 Normal
4,400
4,200
4,000
3,800
3,600
3,400
3,200
3,000
3,781
3,779
3,778
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Actual
30YrAvg
20YrTrd
50:50 Normal

**Figure 2**


Union North Heating Degree Day
Actual, 30 Year Average, 20 Year Trend & 50:50 Normal
5,800
5,600
5,400
5,200
5,000
4,800
4,600
4,400
4,200
4,000
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
5,014
4,918
4,822
Actual
30YrAvg
20YrTrd
50:50 Normal

UNION GAS LIMITED

Answer to Interrogatory from
London Property Management Association ("LPMA")

Reference: Exhibit 2, p. 5

Question: Please explain how the GIF volumes of 7,035,000 m3 was forecast.

---

Response:
Union forecasted 10,500 Home Reno Rebate participants (homes) would be supported by the funding from the Green Investment Fund ("GIF") in 2017 and 2018. Union also estimated that approximately one-third (33%) of participants in the program would not be Union customers. These participants would be one of the following:

- Kitchener Utilities customers,
- Utilities Kingston customers,
- Natural Resource Gas Limited customers,
- Six Nations Natural Gas customers,
- Homes heated by oil,
- Homes heated by propane, or
- Homes heated by wood.

The remaining participants (67%) were estimated to be Union customers. Union also estimated that each participant (home) in the Home Reno Rebate offering would save, on average, 1,000 $m^3$ of natural gas per year. This figure was based on information from Union's 2015-2020 DSM Plan application, where the estimated average natural gas savings was 1,039 $m^3$ per year per home.

The calculations are as follows:

- 10,500 participants × 67% = 7,035 forecasted Union customer participants (homes) driven by funding from the GIF in 2017 and 2018
- 7,035 participants × 1,000 $m^3$ = 7,035,000 $m^3$ saved by Union customer participants (homes) driven by funding from the GIF in 2017 and 2018

Subsequent to development of the above noted forecast, Union refined the estimated GIF savings. Participation from Union's customers is now estimated to be 84% (instead of 67%), which results in the following savings calculation:

- 10,500 participants × 84% = 8,820 forecasted Union customer participants (homes) driven by funding from the GIF in 2017 and 2018
- 8,820 participants × 1,000 $m^3$ = 8,820,000 $m^3$ saved by Union customer participants (homes) driven by funding from the GIF in 2017 and 2018

Union has not updated the GIF forecasts found in its 2018 Cap-and-Trade Compliance Plan, as the impacts from this change are not material.

UNION GAS LIMITED

Answer to Interrogatory from
London Property Management Association ("LPMA")

Reference: Exhibit 2, p. 6 and Schedule 1

Question:

a) How does Union estimate the throughput to capped participants that are included in the LDVCI and greenhouse market sectors?
b) Please breakout lines 4 through 7 in Schedule 1 for the contract market into the LCI/greenhouse market sector (where Union used an econometric approach to the forecast) and those customers included in the bottom up forecast methodology.

---

Response:

a) The LCI and Greenhouse market sectors forecasted throughputs are based upon customers' historical consumption multiplied by an econometric forecast factor. Adjustments are layered into the forecast for identified operational changes (i.e. growth and reductions) as identified by Union Sales and Marketing representatives.

   The current capped participant list at the time of the forecast is used to determine the throughput for capped participants.

b) Please see Table 1 below:

**Table 1**

| Contract Market 2018 Volumes Forecast | | | | |
|---|---|---|---|---|
| **Market Sector** | **Total Throughput m³ (column b, line 4)** | **Throughput m³ Wholesale (column b, line 5)** | **Throughput m³ capped (column b, line 6)** | **Throughput m³ non-capped (column b, line 7)** |
| **Chemical Refinery** | 2,347,961,000 | | 1,873,365,000 | 474,596,000 |
| **Steel** | 1,320,300,433 | | 1,320,300,433 | - |
| **Power** | 1,180,819,000 | | 25,000,000 | 1,155,819,000 |
| | | | | |
| **Large Comm/Indl** | 2,259,112,601 | | 1,682,064,475 | 577,048,126 |
| **Greenhouse** | 471,118,921 | | 198,229,186 | 272,889,735 |
| | | | | |
| **DSM** | (224,817,254) | | - | (224,817,254) |
| **CNG/LNG** | 6,978,760 | | - | 6,978,760 |
| **Unidentified Stretch** | 19,634,076 | | - | 19,634,076 |
| | | | | |
| **Total Contract excluding Wholesale** | **7,381,107,537** | | **5,098,959,094** | **2,282,148,443** |
| | - | | | |
| **Wholesale** | **359,543,250** | **359,543,250** | | |
| | | | | |
| **Total Contract** | **7,740,650,787** | **359,543,250** | **5,098,959,094** | **2,282,148,443** |

UNION GAS LIMITED

Answer to Interrogatory from
London Property Management Association ("LPMA")

Reference: Exhibit 2, p. 9

Question: Please add a column to Table 1 to reflect actual GHG emissions for 2017.

---

Response:
The actual 2017 Union Gas Greenhouse Gas emissions reported under Standard Quantification Methods (SQM) ON.20 (General Stationary Combustion) and ON.400 (Natural Gas Distribution) of the Ontario Ministry of the Environment and Climate Change's (MOECC's) Guideline for Quantification, Reporting and Verification of Greenhouse Gas Emissions – 2017, will be provided as part of the 2019-2020 Compliance Plan. The actual 2017 facility-related and customer-related emissions are required to be reported to the MOECC by June 1, 2018 and verified by September 1, 2018, as per Ontario Regulation 143/16: Quantification, Reporting and verification of Greenhouse Gas Emissions (Section 24 and 27, respectively).

UNION GAS LIMITED

Answer to Interrogatory from
London Property Management Association ("LPMA")

Reference: Exhibit 3, Tab 4, pp. 25-34

Question:

a) Is Union working with Enbridge, Epcor and energy associations to explore the stage 2 customer abatement measures noted? If not, why not?
b) How has Union ensured that there is no overlap or duplication of effort and cost between Union and other parties that may be investigating similar projects?

---

Response:

a) Yes, Union is working with EGD and Enbridge Inc. on customer abatement measures noted in Stage 2. In addition, as indicated in its application at Exhibit 3, Tab 2, p. 10, Union works with other industry partners and energy associations such as the Advanced Energy Center at MaRS and the CGA and its members to explore customer abatement measures noted in Stages 1 and 3. Union is not currently working with EPCOR on any abatement measures.

b) Union is selecting and designing its projects taking into consideration specific requirements applicable in its franchise. For instance, differences in regulations, energy mix, customer profiles and market structures can lead to fundamentally different results for projects and technologies that could appear to be similar on the surface. Furthermore, Union is taking the following actions to reduce and/or completely eliminate the amount of overlap with other parties:
    - As part of the technology scan process Union reviews any current literature and publications that are available from other parties;
    - As part of the technology scan process Union maintains constant communication with the manufacturer or technology provider organization to understand any other organization they may be working with;
    - Union maintains relationships and constant communication with many researching bodies (such as NRCan, MaRS, ESC) to understand what research is being done elsewhere; and,
    - Union participates and helps facilitate work with the CGA to understand what work is being done by other natural gas utilities and organizations.
    - Union has not worked with EPCOR on any technology initiatives.

UNION GAS LIMITED

Answer to Interrogatory from
London Property Management Association ("LPMA")

Reference: Exhibit 3, Tab 4, pp. 25-34

Question:

a) Did Union incur any costs associated with external legal counsel in 2016? If yes, please quantify and indicate where in Table 1 these costs have been included. If no, did Union incur costs associated with internal legal counsel? If so, please quantify and confirm that these costs are included in salaries and wages in Table 1.
b) Did Union incur any costs related to customer outreach and information in 2016? If yes, please quantify and indicate where in Table 1 these costs have been included.

---

Response:

a) Union incurred approximately $135,000 in external legal counsel fees in 2016. This amount is incorporated within Consulting and Market Research (Line 2) in Union's application at Exhibit 6, Table 1.

Table 1
Total GGEIDA Costs for the year ending December 31, 2016

| Line No. | Particulars | 2016 Cost ($000) |
|---|---|---|
| 1 | Salaries and Wages | 1,682 |
| 2 | Consulting and Market Research | 484 |
| 3 | Other | 63 |
| 4 | Revenue Requirement on Capital Costs | (4) |
| 5 | Total | **2,225** |

b) Union incurred an approximate incremental cost of $50,000 related to customer outreach in 2016. Please see the response at EB-2016-0296 Exhibit B.CCC.8 for an explanation of Union's costs related to customer outreach and information in 2016. These incremental costs are reflected in Line No. 2 "Consulting and Market Research" in Table 1.

UNION GAS LIMITED

Answer to Interrogatory from
London Property Management Association ("LPMA")

Reference: Exhibit 7, Tab 1, pp. 4-5

Question: Given that rates were not declared interim effective January 1, 2018, what mechanism is Union proposing to recover the difference between approved rates for 2018 and the current rates being charged for the period January 1, 2018 to the implementation date of the new rates? Please distinguish between the general service and contract rate classes, if appropriate.

---

Response:
Please see the response at Exhibit.B.Staff.37.

UNION GAS LIMITED

Answer to Interrogatory from
London Property Management Association ("LPMA")

Reference: Exhibit 7, Tab 2, p. 2

Question:

a) Did Union consider any other allocation methodology for the GGEIDA costs? If yes, please provide details on what other methodologies were considered and why they were rejected.
b) Will the costs be recovered from all customers – system gas supply customers, direct purchase customers and large final emitters (including voluntary participants and wholesale customers)?
c) How does Union allocate its administrative costs that are related to the purchase of its system gas supply?
d) If the Board directed Union to allocate the GGEIDA costs based on volumes by rate class, what would be the impact on the costs by rate class, as shown in Exhibit 7, Tab 2, Schedule 1?

---

Response:

a) No, Union has not considered other allocation methodologies for the GGEIDA costs. Union's proposed allocation of the GGEIDA balance is in compliance with the Framework which states that administrative costs relating to the Cap and Trade program be allocated and recovered from all customers in the same manner as existing administrative costs.[1] Accordingly, Union has proposed to allocate the GGEIDA balance in proportion to the 2013 OEB-approved Administrative and General O&M expense.

b) Yes, the GGEIDA costs will be recovered from all customers in the same manner as existing administrative costs.

c) Administrative costs related to system sales gas supply are allocated to rate classes based on system sales gas supply volumes and recovered through a common Gas Supply Administration Charge, which is a component of the Commodity and Fuel Charges.

d) Please see Attachment 1 for the allocation of the 2016 GGEIDA balance based on 2016 in-franchise delivery and ex-franchise transportation volumes.

[1] Framework, Section 6.1, p. 30.

UNION GAS LIMITED
Allocation of 2016 GGEIDA Balance by Volume

| Line No. | Particulars ($000's) | 2016 Delivery and Transportation Volumes ($10^3m^3$) (1) | Greenhouse Gas Emissions Impact Deferral Account 179-152 (2) | |
|---|---|---|---|---|
| | | (a) | (b) | |
| | Union South In-Franchise | | | |
| 1 | Rate M1 | 2,779,165 | 180 | |
| 2 | Rate M2 | 1,174,963 | 76 | |
| 3 | Rate M4 | 472,042 | 31 | |
| 4 | Rate M5 | 194,195 | 13 | |
| 5 | Rate M7 | 475,225 | 31 | |
| 6 | Rate M9 | 72,275 | 5 | |
| 7 | Rate M10 | 247 | 0 | |
| 8 | Rate T1 | 447,213 | 29 | |
| 9 | Rate T2 | 4,213,980 | 273 | |
| 10 | Rate T3 | 250,167 | 16 | |
| 11 | Total South In-Franchise | 10,079,472 | 653 | |
| | Union North In-Franchise | | | |
| 12 | Rate 01 | 908,447 | 59 | |
| 13 | Rate 10 | 342,884 | 22 | |
| 14 | Rate 20 | 565,469 | 37 | |
| 15 | Rate 25 | 116,389 | 8 | |
| 16 | Rate 100 | 1,365,541 | 88 | |
| 17 | Total North In-Franchise | 3,298,730 | 214 | |
| | Ex-Franchise (3) | | | |
| 18 | Rate M12 | 14,139,658 | 916 | |
| 19 | Rate M13 | 91,905 | 6 | |
| 20 | Rate M16 | 270,988 | 18 | |
| 21 | Rate C1 | 6,577,849 | 426 | |
| 22 | Excess Utility Storage Space | - | - | |
| 23 | Total Ex-Franchise | 21,080,400 | 1,365 | |
| 24 | Total In-Franchise & Ex-Franchise | 34,458,603 | 2,232 | (4) |

Notes:
(1) Includes in-franchise delivery volumes and ex-franchise transportation volumes.
(2) Allocated in proportion to column (a).
(3) Ex-franchise transportation volumes converted to $10^3m^3$ based on 38.81 GJ/$10^3m^3$.
(4) Exhibit 6, Schedule 1, column (a), line 1.

UNION GAS LIMITED

Answer to Interrogatory from
London Property Management Association ("LPMA")

Reference: Appendices A and B

Question: Other than the changes for rates M9, M10 and T3, is Union proposing any changes to the way the customer-related and facility-related charges in the proposed rate schedules? If yes, please explain fully all of the changes.

---

Response:
Yes, as described in Union's application at Exhibit 7, Tab 1, p.7, Union has proposed to update the Rate C1 rate schedule to remove the facility-related Cap-and-Trade unit rates for interruptible transportation and short-term firm transportation. Facility-related Cap-and-Trade unit rates are not required for these services as the pricing is either negotiated or provided under Union's Schedule 2 Hub pricing.

Union is not proposing any other changes to the rate schedules as part of this proceeding.

UNION GAS LIMITED

Answer to Interrogatory from
London Property Management Association ("LPMA")

Question: Given the Board's decision to not approve interim rates effective January 1, 2018, what is Union's current proposal for an implementation date of the final rates?

---

Response:
Please see the response at Exhibit B.Staff.37.

UNION GAS LIMITED

Answer to Interrogatory from
Northeast Midstream LP ("Northeast")

Reference: Exhibit 3, Tab 5, Section 4.2

Preamble: Enbridge and Union are each seeking approval for up to $2 million (for a total of $4 million) for the 2018 compliance term to create a Low Carbon Innovation Fund (LCIF). The LCIF would finance research, development, demonstration, and commercialization of new technologies to reduce future GHG emissions.

Question:

a) Please provide a summary of the consultations and public engagement activities leading up to the proposal to create the LCIF, including discussions with specific federal and provincial government departments, universities and research institutes, and Canadian and international companies and industry groups.
b) What are the objectives of the program in terms of GHG reductions, net increase in employment in Ontario, and increased R&D output (i.e., research contracts, patents, licensing, spin-out company formation, teaching)?
c) How does the LCIF plan to leverage existing investments in publicly and privately funded researchers, research centres, industry groups, and federal and provincial programs to better mobilize clean technologies?
d) How would the LCIF be different from the Natural Gas Innovation Fund (NGIF), which was created by the Canadian Gas Association in 2016? Is the LCIF expected to complement or leverage NGIF investments?
e) Please indicate whether only projects that include financial or in-kind contributions from project partners would be funded under the LCIF.
f) Would the LCIF be an autonomous, arm's-length entity with an independent management team and an investment committee that includes qualified non-utility members?

---

Response:

a) Please see the responses at Exhibit B.Staff.22 and at Exhibit B.GEC.10 a).

b) As outlined in the response at Exhibit B.Staff.21, Union requires the LCIF to support the identification and development of low carbon technologies that could result in future abatement opportunities. To the extent that LCIF initiatives become commercial-ready and are implemented in Ontario, this will support Ontario's transition to a low-carbon economy. Ancillary benefits such as employment and R&D output could result; however, such benefits have not been quantified by Union.

c) Depending on the nature of the projects, Union would work with a variety of partners such as other natural gas and electric LDCs, industry partners, technology providers, energy associations, NRCan, OCE academia and others to complement the LCIF and increase the number and the diversity of projects it pursues.

d) The NGIF is administered by the CGA on behalf of its members and was created with the objective to support the funding of innovation in the natural gas value chain across Canada. The LCIF is administered by Union and is specifically meant to support the development of new technologies aimed at facilitating abatement opportunities and creating value for its customers in Ontario. Depending on the nature of the projects, Union would work with CGA's NGIF on opportunities benefiting directly its customers in Ontario.

e) Union currently has no plans with respect to requiring financial or in-kind contributions from potential project partners with respect to LCIF projects.

f) No, the LCIF will be a fund planned for and administered by Union.

UNION GAS LIMITED

Answer to Interrogatory from
Northeast Midstream LP ("Northeast")

Reference: Exhibit 3, Tab 5, Section 4.2

Preamble: Enbridge and Union are each seeking approval for up to $2 million (for a total of $4 million) for the 2018 compliance term to create a Low Carbon Innovation Fund (LCIF). The LCIF would finance research, development, demonstration, and commercialization of new technologies to reduce future GHG emissions.

Question:

a) Would the LCIF be technology agnostic and consider any proposal that meets the program's objectives and key eligibility criteria? Or would the LCIF only consider technologies mentioned in the applications?
b) Please indicate whether any or all of the entities would be eligible for LCIF funding: (1) For-profit organizations such as utilities and private companies; (2) Not-for-profit organization such as industry associations and research groups; (3) Indigenous organizations and groups; (4) Canadian postsecondary institutions and research centres; (5) Community groups; and (6) Municipal governments and their departments and agencies.
c) Can the technology solutions originate from anywhere globally for testing, demonstration, and/or deployment in Ontario?

---

Response:

a) Please see the response at Exhibit B.Staff.21.

b) The LCIF is not an investment fund like the Natural Gas Innovation Fund where interested entities can apply for funding. Instead, the LCIF is administered by Union and is specifically meant to move identified technologies and abatement opportunities through the Initiative Funnel. However, Union may collaborate with or jointly develop initiatives with any of the listed entities as long as it meets the LCIF's objectives and key eligibility criteria.

c) The technologies Union will pursue can and will originate from anywhere globally as long as they meet the selection criteria laid out in the technology and innovation selection approach, described in more detail in the response at Exhibit B.Staff.21 a).

UNION GAS LIMITED

Answer to Interrogatory from
Northeast Midstream LP ("Northeast")

Reference: Exhibit 3, Tab 5, Section 4.2

Preamble: Enbridge and Union are each seeking approval for up to $2 million (for a total of $4 million) for the 2018 compliance term to create a Low Carbon Innovation Fund (LCIF). The LCIF would finance research, development, demonstration, and commercialization of new technologies to reduce future GHG emissions.

Question:

a) Please indicate how the requested LCIF funding would be allocated to residential, commercial, and industrial sectors.
b) Please indicate how the requested LCIF funding would be allocated to: (1) R&D projects, from applied R&D to pilot projects; and (2) Demonstration projects, including up to first commercial installations.
c) How much would the LCIF expect to contribute per project on a percentage basis? What would be the maximum percentage allocated per project? Would the percentage be different for R&D projects and demonstration projects?
d) How much would the LCIF expect to contribute per project on a dollar amount basis? What would be the maximum dollar amount allocated per project? Would the dollar amount be different for R&D projects and demonstration projects?
e) Would LCIF contributions be non-repayable, conditionally repayable, or something else?

---

Response:

a) Please see the response at Exhibit B.APPrO.5 c).

b) – d)

Union does not plan to use a percentage method, or a maximum dollar per project method to allocate the LCIF funds. Instead, Union plans to leverage its selection approach to develop projects to be funded through the LCIF, as described in the response at Exhibit B.Staff.21 a).

For an estimate of how funding will be allocated in 2018, please refer to the response at Exhibit B.Staff.21 b).

e) The LCIF will be used for activities such as consulting, testing, data analysis, and measurement and verification to advance technologies that have the potential to facilitate abatement opportunities and create value for Customers in Ontario. It is not anticipated at this time that the contributions would be repayable.

UNION GAS LIMITED

Answer to Interrogatory from
Northeast Midstream LP ("Northeast")

Reference: Exhibit 3, Tab 5, Section 4.2

Preamble: Enbridge and Union are each seeking approval for up to $2 million (for a total of $4 million) for the 2018 compliance term to create a Low Carbon Innovation Fund (LCIF). The LCIF would finance research, development, demonstration, and commercialization of new technologies to reduce future GHG emissions.

Question:

a) How the LCIF will ensure a consistent, fair, and transparent project selection process in order to identify, select, and approve funding of projects that best fit the program's objectives?
b) Would there be a formal request for proposals? If so, what would be an indicative timeline from the initial call to the selection of projects?

---

Response:

a) Union Gas will use its selection approach to select the projects to be funded through the LCIF. Criteria such as environmental performance and GHG emissions, energy efficiency, market segments, economics and more will be used to determine which projects should be funded through the LCIF. Please see the response at Exhibit B.Staff.21 for more details.

b) Please see the response at Exhibit B.Northeast.6 b).

UNION GAS LIMITED

Answer to Interrogatory from
Northeast Midstream LP ("Northeast")

Reference: Exhibit 3, Tab 5, Section 4.2

Preamble: Enbridge and Union are each seeking approval for up to $2 million (for a total of $4 million) for the 2018 compliance term to create a Low Carbon Innovation Fund (LCIF). The LCIF would finance research, development, demonstration, and commercialization of new technologies to reduce future GHG emissions.

Question:

a) How will potential projects be assessed (i.e., design and methodology, project team, uptake potential, environmental impact, economic and social impact)?
b) Will considerations be given to regional diversity and sector distribution (i.e. residential, commercial, industrial)?
c) Will consideration be given to projects that support increased economic development opportunities for rural, northern and Indigenous communities?

---

Response:

a) Please see the response at Exhibit B.Staff.21.

b) Yes.

c) Yes.

UNION GAS LIMITED

Answer to Interrogatory from
Northeast Midstream LP ("Northeast")

Reference: Exhibit 3, Tab 5, Section 4.2

Preamble: Enbridge and Union are each seeking approval for up to $2 million (for a total of $4 million) for the 2018 compliance term to create a Low Carbon Innovation Fund (LCIF). The LCIF would finance research, development, demonstration, and commercialization of new technologies to reduce future GHG emissions.

Question:

a) Please indicate how successfully funded projects will be required to report on expected outcomes to ensure that targets and objectives are being met.
b) Since outcomes may only be realized after funding has ended, what provisions would be made for ongoing data collection and assessment for a period of five years following a project's completion date?

---

Response:

a) As noted in the response at Exhibit B.SEC.11 c), any initiative that proceeds to proposal for inclusion in utility Compliance Plans is subject to the OEB process.

   Union expects that it would report forecast costs, GHG reductions, and cost per tonne information for abatement activities to ensure transparency, consistent with the Cap-and-Trade Framework.

b) To the extent that abatement programs are implemented, actual abatement throughput volumes will be quantified and reflected in Union's volume and emissions forecast going forward.

UNION GAS LIMITED

Answer to Interrogatory from
Ontario Sustainable Energy Association ("OSEA")

Reference: Exhibit 3, Tab 1, p. 2

Preamble**:** "Union's 2018 Compliance Plan for customer and facility-related obligations is largely based on purchasing compliance instruments… In completing the 2018 Compliance Plan Union has expanded its consideration about customer and facility abatement measures. Union has evaluated incremental energy efficiency opportunities, facilities abatement initiatives, as well as new technologies. Generally, these opportunities cannot be advanced, because they are not cost-effective at this time. Given that cost recovery within the existing regulatory mechanisms (whether DSM, gas supply procurement, or carbon procurement) is largely predicated upon prudency and cost-effectiveness, this represents a barrier to advancing these measures."

Question:

a) Has Union considered using the Total Resource Cost net benefits used in DSM in its analysis of the cost-effectiveness of abatement measures in Cap and Trade to address the barrier to advancing abatement measures? If no, why not?

---

Response:

a) Please see the response at Exhibit B.GEC.1 a).

UNION GAS LIMITED

Answer to Interrogatory from
Ontario Sustainable Energy Association ("OSEA")

Reference: Exhibit 3, Tab 1, pp. 4

Preamble: "Union has used the MACC to assess potential incremental cost-effective DSM and energy efficiency programs. Through analysis using this report and the underlying CPS Union has determined that there is no cost –effective incremental energy efficiency programs that would be prudent to pursue at this time within the existing DSM Framework. There were a few incremental cost-effective measures that could be pursed for residential customers if the existing DSM Budget and DSM Framework were revised. Budget changes to the 2015 – 2020 DSM Plan could occur as a result of the DSM Mid-Term Review process, which is expected to be finalized December 1, 2018. This would not have any impact on Union's 2018 Compliance Plan; however, it could impact future Compliance Plans."

Question:

a) Please explain Union's rationale for proceeding with RNG compared to other potential customer abatement measures given that the Board's 2017 MACC study identified RNG as one of the few abatement measures that was not cost effective under the different long term carbon price scenarios.
b) Please describe the incremental cost-effective measures identified by Union that could be pursued if the existing DSM Budget and DSM Framework were revised.
c) What changes does Union think are needed to the existing DSM Budget and DSM Framework that would allow for additional incremental cost-effective measures to be pursued under Cap and Trade? For example, has Union considered exempting Large Final Emitters and using the associated budget to provide cost-effective programs to non-Final Emitters? Has Union considered expanding its DSM programs to other customer segments, for example schools are currently only offered prescriptive programs and could be offered custom programs?

---

Response:

a) Please see the response at Exhibit B.Staff.19.

b) Please see the response at Exhibit B.Staff.31 a).

c) Specific assessments regarding the overall DSM budget and changes to the DSM Framework are out of scope of Union's 2018 Compliance Plan proceeding. A more appropriate time for consideration of such changes is during the establishment of a future DSM Framework. Union submits that it is not appropriate to duplicate the DSM Framework within the Cap-and-Trade Framework. Please see the response at Exhibit B.GEC.22.

UNION GAS LIMITED

Answer to Interrogatory from
Ontario Sustainable Energy Association ("OSEA")

Reference: Exhibit 3, Tab 1, p. 6

Preamble**:** "Union is also proactively addressing cost-effectiveness by working collaboratively with government to pursue funding that will allow customer abatement initiatives (such as RNG) to proceed."

Question:

a) Is Union actively seeking government funding for customer abatement initiatives, other than RNG? If so, please describe all customer abatement initiatives for which government funding is being sought.
b) Given that the feasibility of RNG is heavily dependent on securing funding from the provincial government, has Union considered prioritizing other abatement initiatives that do not rely on government funding? If not, please explain Union's rationale for prioritizing seeking government funding for RNG.

---

Response:

a) Please see the response at Exhibit B.Staff.17 a).

b) Please see the response at Exhibit B.Staff.19.

UNION GAS LIMITED

Answer to Interrogatory from
Ontario Sustainable Energy Association ("OSEA")

Reference: Exhibit 3, Tab 4, pp. 6-8 and 13

Question:

a) For the abatement measures identified in Table 1, please provide Union's analysis of Union's guiding principles that it developed to screen abatement measures (e.g. available funding, timing, support of government targets, efficient and rational development, applicable regulatory constructs).
b) Has Union considered other abatement initiatives not listed in Table 1? If so, please provide Union's rationale and its analysis for excluding those abatement initiatives from consideration.
c) Has Union prepared its own MACC that it used to consider potential abatement measures? Has Union conducted any additional studies about potential abatement measures that it used to screen abatement measures? If so, please provide.

---

Response:

a) Please see the response at Exhibit B.Staff.20.

b) Union has considered other ideas not listed in Table 1. However, Union has not yet included these in the Initiative Funnel because there is still work to be done to validate the concept and ensure they are worth further evaluation for feasibility and analysis.

c) No, Union utilized the OEB's MACC Report, CPS, and LTCPF to assess and screen potential abatement measures as applicable. Please see the response at Exhibit B.Staff.17 for additional detail.

UNION GAS LIMITED

Answer to Interrogatory from
Ontario Sustainable Energy Association ("OSEA")

Reference: Exhibit 3, Tab 4, pp. 13-16

Question:

a) Does Union have any current proposed expenditures for the Low Carbon Initiative Fund? If so, please describe.
b) Does Union propose that any costs incurred to-date will be recovered through the LCIF or will it only be used for future expenditures once it is approved?
c) Will customers be able to access funds through the LCIF to explore potential pilot programs and abatement measures or will it only be used for Union's costs?
d) Has Union explored obtaining funding from the government to support the LCIF instead of it being recovered through customers?
e) If the LCIF is not approved, is it Union's intention to not continue to proceed with the existing and proposed pilot programs for the abatement measures identified in stage 2 of the Initiative Funnel?

---

Response:

a) Please see the responses at Exhibit B.Staff.17 and at Exhibit B.Staff.21.

b) Once approved, the LCIF will be used to finance future expenditures specific to research, development, demonstration, and commercialization of new technologies aimed at reducing GHG emissions.

c) Customers will not be able to directly access the funds to explore potential projects on their own. However, there may be instances (depending on the type of project), where Union may work with a customer in developing a new technology. In that case, some or all of their costs may be eligible for LCIF. Please also see the response at Exhibit B.Northeast.6 b).

d) No.

e) Please see the response at Exhibit B.Staff.21 e).

UNION GAS LIMITED

Answer to Interrogatory from
Ontario Sustainable Energy Association ("OSEA")

Reference: Exhibit 3, Tab 4, pp. 40-43

Question:

a) Please explain why Union believes that any cost-effective opportunity for abatement identified by the CPS and/or MACC should be pursued within the DSM Framework and not Cap and Trade.
b) Please provide Union's analysis that it used to determine that there were no cost-effective abatement opportunities at the LTCPF's minimum or mid-range price scenarios.
c) Please provide Union's analysis that it used to determine that there were no cost-effective commercial/industrial abatement opportunities incremental to Union's existing DSM programs.
d) What were the cost-effective abatement opportunities that Union identified for the residential sector? Why does Union believe that these abatement opportunities should be pursued through DSM instead of Cap and Trade?

---

Response:

a) Please see the response at Exhibit B.GEC.22.

b) Please see Union's application at Exhibit 3, Tab 4, Appendix A, and the response at Exhibit B.Staff.29 a)-c).

c) Please see Union's application at Exhibit 3, Tab 4, Appendix A, pp. 4-7, and the response at Exhibit B.Staff.31 b).

d) Please see the responses at Exhibit B.Staff.31 a) and at Exhibit B.GEC.22.

UNION GAS LIMITED

Answer to Interrogatory from
Ontario Sustainable Energy Association ("OSEA")

Reference: Exhibit 3, Tab 4, pp. 44-45

Question:

a) Please provide a copy of the Union's Facility Abatement study.
b) Please provide Union's analysis in evaluating the potential facilities abatement projects that it considered.

---

Response:

a) The summary evidence provided within Union's application at Exhibit 3, Tab 4, Section 3 reflects a compilation of various analyses and the most up-to-date data that is the outcome of the Facility Abatement Project. The potential facility abatement measures which Union is pursuing are provided in its application at Exhibit 3, Tab 4, Appendix B.

b) The Economic Evaluation Methodology outlined in Union's application at Exhibit 3, Tab 4, was used to evaluate the potential opportunities, and the results of the economic analyses are summarized in the "Measure Cost" column found at Exhibit 3, Tab 4, Appendix B.

UNION GAS LIMITED

Answer to Interrogatory from
School Energy Coalition ("SEC")

Question: With respect to Union and Enbridge:

a) Please confirm that Enbridge and Union are affiliates.
b) If (a) is confirmed, please explain why Enbridge and Union require separate cap and trade groups within their companies considering they are now affiliates.
c) Please confirm that subsection 65(3) and (4) of O.Reg 144/16 has been revoked.
d) If (c) is confirmed, please explain any changes in how Enbridge and Union plan to participate in allowances auctions compared to 2017 when the provisions were in force.

---

Response:

a) Confirmed.

b) Union and EGD are affiliates, but continue to operate as separate legal entities. Each utility has its own compliance obligations, and in late 2017 filed their respective 2018 Compliance Plans in relation to satisfying those obligations, since subsection 65(3) and 94) of O.Reg 144/16 was in place during the development of these plans in 2017. Please also see the response at Exhibit B.Staff.14.

c) Confirmed.

d) The Climate Change Mitigation and Low-carbon Economy Act, 2016 ("Climate Change Act") outlines prohibitions on the disclosure of certain information. These prohibitions are reflected in Section 4 of the OEB's Cap-and-Trade Framework. This question refers to information that has been classified as Strictly Confidential. In keeping with the legislation and with the best interests of ratepayers in mind, such information must remain Strictly Confidential in order to maintain the ability to effectively execute on Compliance Plans.

Union has provided content related to this question to the OEB in its 2018 Cap-and-Trade Compliance Plan.[1]

[1] Exhibit 3, Tab 3, and Exhibit 3, Tab 6.

UNION GAS LIMITED

Answer to Interrogatory from
School Energy Coalition ("SEC")

Reference: Exhibit 3, Tab 4, p. 10

Question: Please provide the internal memorandum, guide, and/or other document that sets out in detail the Abatement Construct.

---

Response:
Union's work on the Abatement Construct began in mid-2017 and was refined through drafts and discussion. The detail provided in Union's application at Exhibit 3, Tab 4, reflects the final version. For additional detail on the Abatement Construct see the responses at Exhibit B.Staff.20, at Exhibit B.Staff.21, and at Exhibit B.BOMA.1.

UNION GAS LIMITED

Answer to Interrogatory from
School Energy Coalition ("SEC")

Reference: Exhibit 3, Tab 4, p. 10

Question: Has Union developed any formal or informal marginal abatement cost curve or similar tool to use in conjunction with the Abatement Construct, or for any other reason? If so, please provide a copy. If not, please explain why it has not.

---

Response:
Please see the response at Exhibit B.OSEA.9.

UNION GAS LIMITED

Answer to Interrogatory from
School Energy Coalition ("SEC")

Reference: Exhibit 3, Tab 4, pp.13 and 25

Question: With respect to the Stage 2 of the Abatement Construct:

a) Please provide a work plan for 2018 regarding each of the listed initiatives.
b) For each listed initiative, please provide a copy of any memorandum, concept outline, and/or other internal document describing in full the potential initiative, costs, benefits and work that should be undertaken before it can be considered for Stage 3.

---

Response:

a) & b)

Please see the response at Exhibit B.Staff.21 b).

UNION GAS LIMITED

Answer to Interrogatory from
School Energy Coalition ("SEC")

Reference: Exhibit 3, Tab 4, p. 13

Question: With respect to the proposed Low Carbon Initiative Fund:

a) Please provide a breakdown of the proposed $2M in 2018.
b) Enbridge has proposed a similar fund. Please explain what type of coordination will be undertaken regarding the use of each utility's fund.
c) Please discuss Union's positon regarding a potential condition of approval that all research activities undertaken using these ratepayer funds should be made available to the public.
d) Please confirm that there would be no subsequent review for prudence of the amount spent up to $2M.

---

Response:

a) Please see the response at Exhibit B.Staff.21 b).

b) Please see the response at Exhibit B.Staff.14 a).

c) Union expects that initiatives that proceed to proposal for inclusion in the utility's Compliance Plan will be subject to the OEB process, and will therefore become public record as part of the regulatory filing. Therefore, such a condition of approval is not necessary.

d) Union must have certainty of recovery in order to pursue new technology initiatives that serve to reduce future GHG emissions and related costs on behalf of ratepayers. Union seeks assurance from the OEB in this proceeding that actual LCIF costs will be deemed reasonable and consistent with the expectations established in the Framework if executed on the basis outlined in Union's application. Union expects that these amounts will not be subject to further review unless there is a change in circumstances that warrants review as determined by the OEB when they are filed for disposition.

UNION GAS LIMITED

Answer to Interrogatory from
School Energy Coalition ("SEC")

Reference: Exhibit 3, Tab 4, p. 44

Question: Please provide a copy of the Facilities Abatement Study.

---

Response:
Please see the response at Exhibit B.OSEA.7.

UNION GAS LIMITED

Answer to Interrogatory from
School Energy Coalition ("SEC")

Reference: Exhibit 3, Tab 5, p. 6

Question: With respect to the proposed FTEs:

a) Please provide a breakdown of the staffing costs into the following categories: i) total salary, ii) total benefits, iii) total compensation, and iv) total overhead.
b) Do the listed 12.5 FTEs include all incremental FTEs that are being recovered in any part of the 2018 administrative costs? For example, is Union planning to add FTEs as part of its proposed Low Carbon Initiative Fund? If not, please provide another version of the requested breakdown in part (a) to include those positions.
c) Please explain why 9 of the 12.5 FTE positions are 'managers'.

---

Response:

a) The table below outlines Union's breakdown of forecast 2018 staffing costs:

| | **Forecast ($000s)** | **Forecast ($000s)** |
|---|---|---|
| Salary and wages | | $1,435 |
| Total Overhead Loading (81.01%) | | $1,163 |
| Benefits Loading (33.37%) | $479 | |
| Total General Overheads (35.97%) | $516 | |
| Incentive Plan Loading (11.67%) | $168 | |
| **Total Salary & Wages including loadings** | | **$2,598** |

b) Yes, the 12.5 FTEs include all incremental FTEs that are forecasted to be incurred. No additional incremental FTEs are expected to administer the Cap-and-Trade program in 2018. Actual costs will be captured in the GGEIDA and subject to future disposal.

c) Union's forecast 2018 FTE requirements reflect the anticipated incremental level of effort Union expects to require across the organization to administer the Cap-and-Trade program in 2018. The Cap-and-Trade FTE requirements and staffing titles are determined in accordance with Union's HR policies and procedures and with consideration for respective responsibilities. Union has outlined its incremental role accountability requirements in its application at Exhibit 3, Tab 5, Table 1.

UNION GAS LIMITED

Answer to Interrogatory from
School Energy Coalition ("SEC")

Reference: Exhibit 3, Tab 6

Question: Considering there is a provincial election scheduled for spring 2018, please discuss how Union is mitigating the risk of a change in policy regarding the current Cap & Trade program.

---

Response:
As outlined in Union's application at Exhibit 3, Tab 6, p. 24, "Union is also aware that a provincial election must occur in Ontario before June 2018, Union cannot speculate on the outcome of that event and its potential implications to the existing carbon pricing mechanism (i.e. the Cap-and-Trade program). Union is dedicated to achieving compliance with all legislative and regulatory requirements, regardless of the election result."

UNION GAS LIMITED

Answer to Interrogatory from
School Energy Coalition ("SEC")

Reference: Exhibit 3, Tab 5

Question: Please work with Enbridge to provide a single response to this interrogatory:

a) Please provide a table showing a comparison broken down by common categories of the 2016 actual administrative costs. Please provide an explanation of any differences +/- 10% between utilities per category.
b) Please provide a table showing a comparison broken down by common categories of the 2017 actual administrative costs. Please provide an explanation of any differences +/- 10% between utilities per category.
c) Please provide a table showing a comparison broken down by common categories for the 2018 administrative costs. Please provide an explanation of any differences +/- 10% between utilities per category.

---

Response:

a) – c)

Although Union and EGD (collectively the "Utilities") have made efforts to be responsive to this question, each entity developed their Cap-and-Trade programs independently to meet their individual requirements. Accordingly, there are differences in the incremental costs associated with facilitating Cap-and-Trade. Further, the Utilities continue to operate separately, please see the response at Exhibit B.Staff.14 a).

The response to this interrogatory corresponds with SEC #20 for EGD and SEC #15 for Union.

| | 2016 EGD | 2016 Union | % Δ | 2017 EGD | 2017 Union | % Δ | 2018 EGD | 2018 Union | % Δ |
|---|---|---|---|---|---|---|---|---|---|
| | Actuals ($000s) | Actuals ($000s) | | Actuals ($000s) | Actuals ($000s) | | Forecast ($000s) | Forecast ($000s) | |
| IT Billing System (Revenue Req't on capital) | (99.5) | (4) | 96% | 97.6 | 90 | -8% | 191 | 193 | 1% |
| Staffing Resources | 533.3 | 1,682 | 215% | 694.6 | 2,437 | 251% | 1,500 | 2,598 | 73% |
| Market Intelligence & Consulting Support | 268.2 | 264 | -2% | 156.8 | 236 | 51% | 400 | 420 | 5% |
| Customer Education & Outreach | 44.8 | 50 | 12% | 12.9 | 2 | -84% | 0 | 8 | |
| External Legal Counsel | 93.5 | 135 | 44% | 363.6 | 40.8 | -89% | 400 | 150 | -63% |
| Incremental C&T Framework related GHG Reporting and Verification Audit | 0 | 35 | | 9.5 | 63 | 563% | 40 | 100 | -60% |
| Bad Debt Provision | - | - | n/a | 600 | 141.4 | -76% | 960 | 425 | 126% |
| Low Carbon Initiative Fund ("LCIF") | - | - | n/a | - | - | n/a | 2,000 | 2,000 | 0% |
| OEB Cap & Trade related Consultations (e.g., LTCPF, MACC, working group) | - | - | n/a | 318 | 112.3 | -65% | 100 | 50 | 100% |
| Other | 0 | 63 | | 20.7 | 96 | 364% | 60 | 60 | 0% |
| **Total** | **840.3** | **2,225** | **165%** | **2,273.7** | **3,218.5** | **42%** | **5,251** | **6,004** | **14%** |

To more efficiently respond to this question, the Utilities have addressed parts a) - c) in the response following, as rationale for cost differences were similar on a year to year basis.

Incremental requirements related to Cap-and-Trade differed in several areas for each company,

and the primary differences have been highlighted below.

**IT Billing Cost/Revenue Requirement**
The variances in each company's IT billing system revenue requirements are primarily driven by differences in the total installed system costs, existing systems' adaptability to changes, and respective company's accounting policies and assumptions.

**Staffing Resources**
The Utilities incurred incremental staffing requirements as a result of the Ontario government's implementation of a Cap-and-Trade program. Each company independently assessed the program and in turn identified the number of staff necessary to successfully implement the program and sustain its operation.

EGD's incremental Full Time Equivalents ("FTE") are dedicated staff to support implementation of Cap-and-Trade. Additional EGD staff provides support to the Cap-and-Trade function, in addition to the roles that those staff members play in other areas of EGD's operations. Given that these staff members are partly performing roles that were contemplated at the time that EGD's Custom incentive regulation ("IR") model was approved, and therefore their costs are included in the Custom IR model, EGD is not seeking recovery for their costs through the Greenhouse Gas Emissions Impact Deferral Account ("GGEIDA").

Union, operating under a different IR model (40% of inflation price cap), is appropriately treating all eligible Cap-and-Trade resources as incremental.

Table 1 below highlights both the Utilities average incremental staffing requirements from 2016 through to 2017. Staffing requirements for 2018 are forecasted as per each company's respective Compliance Plan.

**Table 1: Union and EGD 2016-2018 Average Incremental Staffing Requirements**

| Company | 2016 average incremental staffing requirements | 2017 average incremental staffing requirements | 2018 incremental staffing requirements (forecasted) |
|---|---|---|---|
| EGD | 2.8 | 4.4 | 8.0 |
| Union | 8.0 | 10.0 | 12.5 |

A detailed breakdown of Union's 2016 actual and 2018 forecast staffing requirements can be found in Union's application at Exhibit 6, p. 6, and Exhibit 3, Tab 5, Schedule 2, respectively.

In 2016, Union's costs were comprised of 13 FTE new roles and portions of existing roles totaling 0.5 full time employees. The new roles were added throughout the year, and the average incremental FTE for the year was 8.0. In addition to resources required to administer the Cap-and-Trade program (e.g. procurement, GHG reporting, compliance planning), Union forecasted up to 5.0 FTE of business development and technology and innovation roles in 2016, and began

to ramp up these activities through 2017, continuing into 2018. These resources have supported the development of the methodologies that facilitate the Initiative Funnel and pursue the technologies listed in Union's response at Exhibit B.Staff.21 a) & b).

In 2017, Union forecast that a similar 13.5 FTE roles would be required. In actuality, Union's average incremental FTE for the year was less, due to changes in Customer Contact Centre requirements (please see the response at Exhibit B.Staff.11 b)), two unfilled vacancies, and the incremental workload for one Finance role distributed across multiple roles in Finance, with no individual committing more than 25% of their time to Cap-and-Trade activities.

For 2018 Union's forecast includes one less FTE than forecast for 2017. The difference is due to the Finance role that was expected to be allocated to Cap-and-Trade on a permanent basis.

As outlined in Union's application at Exhibit 6, Union uses a decision tree and process to evaluate the requirement for FTEs on an annual basis and ensure that salaries and wage costs related to Cap-and-Trade accountabilities are properly accounted for. If an employee will not be committing greater than 25% of their time to Cap-and-Trade activities, then an allocation of that FTE is not included in the staffing costs.

EGD's 2018 forecast, 2017 forecast and 2016 actual staff costs are available at EB-2017-0224 Exhibit D, Tab 1, Schedule 1, EB-2016-0300, Exhibit C, Tab 3, Schedule 6 and Exhibit D, Tab 1, Schedule 2, respectively.

In 2016, EGD's Cap-and-Trade team consisted of approximately 2.8 FTE with a new FTE beginning in Q1. An average of 4.4 FTEs were included on EGD's Cap-and-Trade team in 2017. As noted in EB-2016-0300, Exhibit C, Tab 3, Schedule 6, paragraph 11, EGD will draw on experience from other parts of the business to assist with the implementation and sustainment of the Cap-and-Trade program.

**Market Intelligence and Consulting Support**
The actual costs incurred in 2016 and forecasted 2018 costs for market intelligence and consulting support are similar between the two companies.

Due to the level of support deemed necessary by each company, market intelligence and consulting support costs differed in 2017.

**External Legal Counsel**
Differences in external legal costs between the Utilities can be attributed to each company's respective legal counsel providers and the individual requirements of each company. The Utilities continue to engage external legal counsel in respect of each company's Compliance Plan.

EGD's external legal costs are inclusive of all legal costs related to OEB regulatory proceedings, which include, but are not limited to, evidence review, witness and argument preparation.

Additionally, EGD's legal costs also would include costs incurred for external regulatory interpretation and assistance.

Union's legal costs are related to interpretation of climate regulations and to ensure Union's compliance with regulatory requirements and legislation. Legal costs associated with regulatory proceedings, similar to those noted for EGD above, are included in Union's existing rates. Please also see Union's response at Exhibit B.Staff.12.

**Incremental Cap-and-Trade Framework related GHG Reporting and Verification Audit**
Beginning in 2016 Union incurred costs related to GHG Reporting and Forecasting in order to meet new regulatory GHG emissions reporting requirements associated with the implementation of Cap-and-Trade in Ontario, including O. Reg. 452. In 2016, Union's incremental costs were directly attributed to the development of new reporting tools to facilitate reporting and forecasting of GHG emissions for a natural gas distributor, critical review of calculation methodologies, and assistance with submissions in response to the Greenhouse Gas Reporting Guideline.[1]

In 2017, Union initiated a voluntary pre-audit verification process for GHG reporting related to Cap-and-Trade to assess calculations of ON.400 emissions to ensure compliance with the regulations. Union also incurred incremental consulting costs to support the consultation process for changes to the GHG Reporting Regulation and Guideline. Union plans to continue engagement of consultants to complete incremental work related to GHG reporting and forecasting in 2018.

In 2017, EGD also incurred incremental GHG reporting costs relating to a pre-audit verification process for GHG reporting related to natural gas distribution. The costs of this audit were $9,500. These costs were incremental to the pre-existing facility related GHG verification costs, which are charged to EGD's Operations and Maintenance budget. For additional information, please refer to EB-2016-0300, Exhibit C, Tab 3, Schedule 6.

For 2018, EGD anticipates that it will incur $40,000 related to incremental GHG reporting and verification audit costs as a result of the implementation of the Cap-and-Trade program. Please refer to EB-2017-0224, Exhibit D, Tab 1, Schedule 1.

**Customer Education and Outreach**
Prior to the Board's direction to develop consistent messaging between the Utilities, Union and EGD worked together to ensure messaging was available to customers across the Utilities' respective service areas. However, differences existed in research undertaken, communication tactics, customer numbers and frequency of communications.

EGD completed one focus group and a standalone bill insert in 2016. In 2017, the majority of

[1] Guideline for Quantification, Reporting And Verification Of Greenhouse Gas Emissions-2017,https://www.ontario.ca/page/report-greenhouse-gas-ghg-emissions

the costs incurred in this component were associated with training requirements for the call centre staff. Throughout 2017, EGD relied primarily on non-cost communication methods, such as website, call centre, on-bill message and social media tools, to communicate with customers about Cap-and-Trade.

In 2016, Union incurred incremental costs related to the development of customer communications material including design and content for the new Cap-and-Trade section of its website, as well as two customer research studies. The first study included focus group sessions to assess general awareness of the government's Cap-and-Trade plan, reactions to the plan and to Cap-and-Trade costs, and preferences related to how Cap-and-Trade costs might appear on natural gas bills. In the second study, Union engaged a consultant to conduct customer surveys among Residential and General Service business customers to evaluate the effectiveness of Union's Cap-and-Trade customer communications.

**Bad Debt**

As explained in Union's application at Exhibit 3, Tab 5, Union used a simplified method to estimate Cap and Trade related bad debts for 2017, assuming that a 10% increase in customer bills as a result of Cap and Trade costs would result in a 10% increase in bad debt. This simplified method was employed because Union had no previous experience with bad debt in a Cap-and-Trade environment. For the 2018 forecast, Cap-and-Trade related bad debt is estimated using Union's corporate bad debt forecast methodology, and is calculated by taking Union's forecast compliance obligation costs for General Service customers and applying Union's average actual write-off factor from the past five years.

As outlined in Union's 2017 Compliance Plan interrogatory response at EB-2016-0296, Exhibit B, FRPO 1, the actual incremental bad debt amount directly related to Cap-and-Trade in 2017 was expected to be lower than the estimate in 2017 due to the implementation of Cap-and-Trade commencing January 1, 2017 and the lag time before Cap-and-Trade amounts would be included in customer accounts that were written off. Only the actual costs will be captured in a deferral account for future disposition; the forecast for 2017 of $0.6 million was not in rates and was not in a deferral account. The amount of bad debt recognized in actuals is included in the GGEIDA. For 2017 the actual amount of bad debt included in the GGEIDA is approximately $141,000. Union's actual bad debt write-offs are lower in 2017 due to the time lag described above, which results in only partial year impacts in 2017. For 2018, Union will realize a full year of bad debt write-offs in the GGEIDA.

As identified in paragraphs #27 through 30 of EB-2017-0224, Exhibit D, Tab 1, Schedule 1, EGD utilized the Company's total revenue requirement, total forecasted cost of compliance and corporate bad debt forecast to calculate a forecasted cost of bad debt associated with EGD's Cap-and-Trade program. In 2017, EGD forecasted $0.9 million. Based on the actual bad debt realized in 2017, EGD incurred $0.6 million associated with the Cap-and-Trade program.

**OEB Cap and Trade Related Consultations**

Both EGD and Union incurred costs related to the OEB Cap-and-Trade related consultations in

2017. The costs were allocated as per the Board's methodology. The difference between the Utilities stems from the assignment of consultation costs. EGD included the costs of the "Report of the Board – Regulatory Framework for the Assessment of Costs of Natural Gas Utilities' Cap and Trade Activities" (EB-2015-0363) ("Framework") and "Marginal Abatement Cost Curve for Assessment of Natural Gas Utilities' Cap and Trade Activities" ("MACC") (EB-2016-0359) in the 2017 OEB Cap & Trade related consultation costs component.

Union's costs incurred for the Framework and MACC were included in Union's existing rates and 2017 Cap-and-Trade related consultation costs, respectively.

Each company forecasted different amounts related to the upcoming Long Term Carbon Price Forecast refresh and any other related stakeholder work. Costs associated with the OEB Cap-and-Trade related consultations will be allocated to each company based on the Board's methodology.

In 2018, Union has forecast its portion of OEB costs to be approximately half of the cost charged in 2017 as a MACC refresh is not within scope. Similarly, EGD's forecast is based on 60% of 2017's consultation costs.