Enbridge Gas Inc.
50 Keil Drive North
Chatham, Ontario, Canada
N7M 5M1

December 19, 2019

Christine Long
Registrar and Board Secretary
Ontario Energy Board
2300 Yonge Street, 27th Floor
Toronto, ON M4P 1E4

Dear Ms. Long:

Re: Report on Unaccounted for Gas

In its Decision and Order dated August 30, 2018 in the EB-2017-0306 / EB-2017-0307 proceeding regarding the amalgamation of Enbridge Gas Distribution and Union Gas, the Ontario Energy Board stated that it considers the issue of Unaccounted for Gas important and directed Enbridge Gas Inc. to file a report on this issue for both the legacy Union Gas and legacy Enbridge Gas Distribution service areas by December 31, 2019.

Enbridge Gas Inc. hereby submits a Report on Unaccounted for Gas prepared by ScottMadden Management Consultants.

Should you have any questions on this submission, please do not hesitate to contact me.

Yours truly,

[*Original Signed By*]

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Encl.

REPORT ON UNACCOUNTED FOR GAS

Prepared for Enbridge Gas Inc.

December 2019

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scottmadden
MANAGEMENT CONSULTANTS

TABLE OF CONTENTS

EXECUTIVE SUMMARY

ScottMadden, Inc. ("ScottMadden") was retained by Enbridge Gas Inc. ("Enbridge")[1] to prepare a report that reviewed and evaluated factors contributing to Unaccounted For Gas ("UFG")[2] within the legacy Union Gas Limited ("legacy Union") and legacy Enbridge Gas Distribution's ("legacy EGD") (together, the "legacy Companies") service areas. The report was prepared in compliance with the Ontario Energy Board's ("OEB" or the "Board") Decision and Order in EB-2017-0306 / EB-2017-0307, which directed Enbridge to file a report regarding UFG by December 31, 2019.[3]

UFG is broadly defined as the difference between gas receipts and gas deliveries, where gas receipts are volumes that enter the gas distribution system and gas deliveries are volumes that exit the gas distribution system.

Several independent studies examining UFG across U.S. gas utilities identify certain sources of UFG, including physical losses, metering variations, and billing and accounting adjustments. In addition, the independent studies describe certain initiatives to monitor and manage UFG, including replacement of mains and services, testing and replacement of meters, and changes to billing and accounting practices.

Information from these studies enabled ScottMadden to compare industry practices and initiatives to those employed by the legacy Companies. The comparison was accomplished in three phases: (1) conduct research and analysis on industry practices to monitor and manage UFG; (2) review and summarize legacy Union and legacy EGD materials that describe their practices to monitor and manage UFG;[4] and (3) compare industry practices to monitor and manage UFG to those employed by the legacy Companies.

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[1] Enbridge Gas Inc. is a Canadian natural gas utility that provides transmission, distribution and storage services to approximately 3.7 million residential, commercial and industrial customers in over 400 communities in Ontario. In addition, Enbridge Gas provides storage and transportation services to customers outside of the Enbridge in-franchise area. Enbridge Gas was formed on January 1, 2019 with the amalgamation of Union Gas Limited and Enbridge Gas Distribution.

[2] While there are several abbreviations for Lost and Unaccounted for Gas including LAUF and UAF, ScottMadden used UFG for purposes of this report.

[3] Decision and Order, EB-2017-0306 AND EB-2017-0307, August 30, 2018 and amended on September 17, 2018.

[4] In addition, ScottMadden had several discussions with Enbridge staff.

This three-phased approach enabled ScottMadden to compare the legacy Companies' UFG practices used to monitor and manage UFG to those in the industry – as well as develop findings and recommendations using an analysis framework based on the following questions:

- How do the legacy Companies' UFG levels compare to the industry?
- How do the legacy Companies' sources of UFG compare to the industry?
- How do the legacy Companies' practices used to monitor and manage UFG compare to the industry?

Based on the analysis discussed herein, ScottMadden developed certain findings and recommendations that are summarized below.

FINDINGS

- Comparative Experience
  - Over the past 10 years, the legacy Companies demonstrated lower UFG levels than comparative gas utilities, as shown in Figure 1 (below). The Figure shows legacy Union and legacy EGD have an average UFG level of 0.31 percent and 0.81 percent of gas receipts, respectively, over the past 10 years. During the same period, U.S. gas utilities have an average UFG level of 1.06 percent,[5] select Canadian gas utilities have an average UFG level of 1.18 percent,[6] regional U.S. gas utilities have an average UFG level of 0.90 percent,[7] and a "Comparison" group of gas utilities have an average UFG level of 1.15 percent of gas receipts.[8]

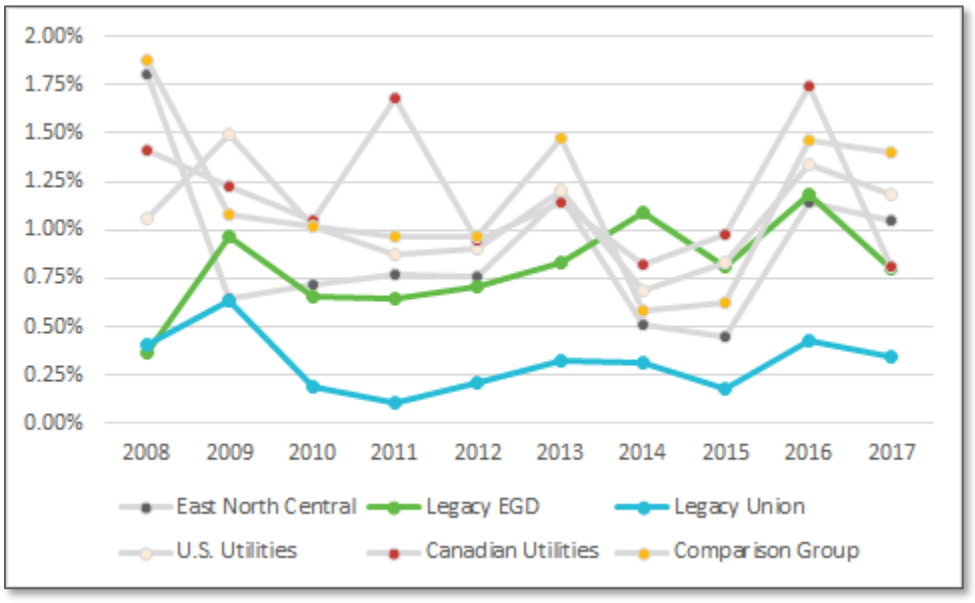
[5] Based on 'unaccounted for' and 'losses from leaks' data reported by 106 utilities to the U.S. Energy Information Administration. Utilities with less than 10-years of data and less than 10 million Mcf (thousand cubic feet) disposition volumes were not considered. See Appendix-B.

[6] Based on Canadian utilities with publicly-accessible UFG data collected by ScottMadden, which include Manitoba Hydro, AltaGas Ltd., ATCO Gas Ltd., FortisBC, and Pacific Northern Gas Ltd. (Northeast Region). See Appendix-B.

[7] Based on utilities in the U.S. East North Central Region which included the states of Illinois, Wisconsin, Indiana, Michigan, and Ohio. Utilities with less than 10-year data, and less than 10 million Mcf disposition volumes were not considered. See Appendix-B.

[8] Based on UFG data for a sub-group of U.S. gas utilities selected based on comparable volumes, and adjacency of region. See Appendix-B.

Figure 1: UFG Benchmark Analysis[9]



- The Figure shows legacy Union and legacy EGD have year-to-year fluctuations in UFG levels that are generally consistent with those of other gas utilities. The fluctuations are a result of many factors, including weather, estimation variation, measurement variation, and billing and accounting adjustments. The year-to-year change in UFG levels was discussed by the Alberta Utilities Commission, which stated in a decision regarding an UFG rider: "The Commission recognizes that all gas distribution pipeline systems have UFG as an element of operating a natural gas distribution system and that because of the numerous factors that impact UFG, the UFG percentage will fluctuate over time."[10]

- <u>Sources of UFG</u>
  - Based on its research and analysis, ScottMadden identified certain common sources of UFG across the industry, including physical losses (e.g., leaks, third-party damage and venting during construction and maintenance activities), metering variations, non-registering meters,

[9] Based on 'unaccounted for' and 'losses from leaks' data reported by gas utilities to EIA, and ScottMadden research and analysis.

[10] Alberta Utilities Commission, Decision 22889-D01-2017, 2017-2018 Unaccounted-For Gas Rider D. (ATCO Gas and Pipelines Ltd.)

theft, line pack and billing and accounting adjustments. The sources of UFG for the legacy Companies are generally consistent with those at other gas utilities.

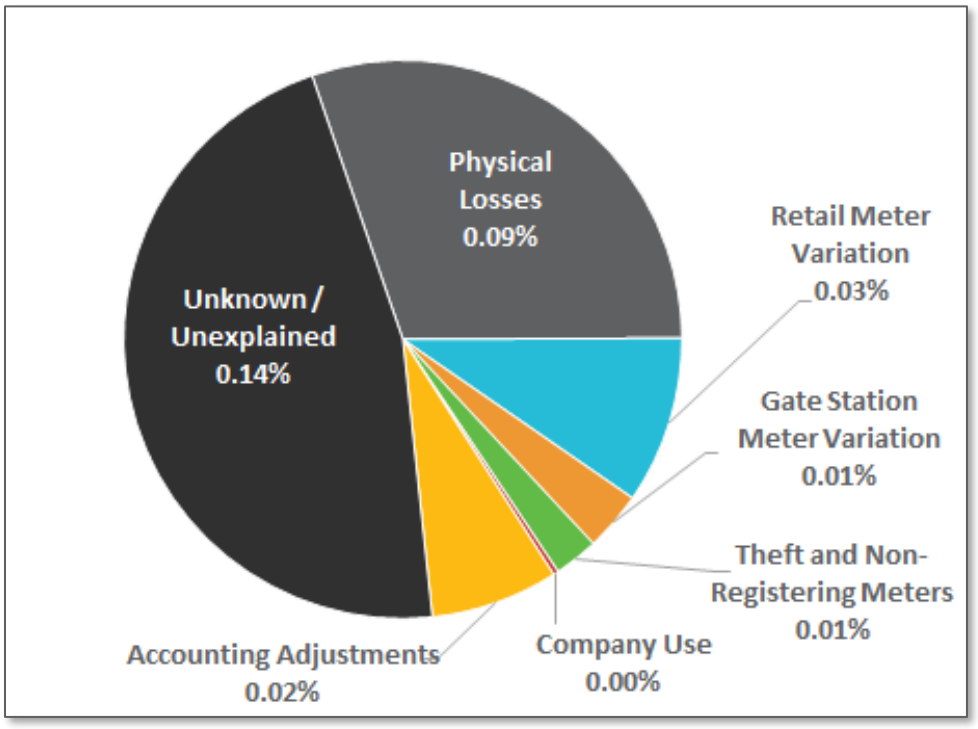
- Identifying all sources of UFG, however, can be challenging as noted by the National Regulatory Research Institute ("NRRI"):

> "…it is not a straightforward task to measure LAUF [Lost and Unaccounted for] gas. Even after adjusting for measurable factors, uncertainty prevails over the precision of those measurements. LAUF gas has a "black box" element that makes it difficult for state commissions to quantify the effect of individual sources."[11]

- Furthermore, sources of UFG can vary across gas utilities. By way of example and as discussed below, for certain gas utilities accounting adjustments may represent a significant source of UFG and measurement variances a minor source of UFG; conversely, for other gas utilities accounting adjustments may represent a minor source of UFG and measurement variances a significant source of UFG.
- The data for legacy Union show the primary sources of UFG include physical losses, retail meter variations, and gate station meter variations, as shown in Figure 2A (below).

[11] National Regulatory Research Institute (NRRI), Lost and Unaccounted-for Gas: Practices of State Utility Commissions, Ken Costello, June 2013.

Figure 2A: Legacy Union Indicative Sources of UFG[12]



Specifically, Figure 2A shows the primary sources of legacy Union UFG include physical losses, retail meter variations, and gate station meter variations, which when applied to the 10-year average of 0.31 percent per year represents, respectively, 0.09 percent, 0.03 percent and 0.01 percent of gas receipts.[13]

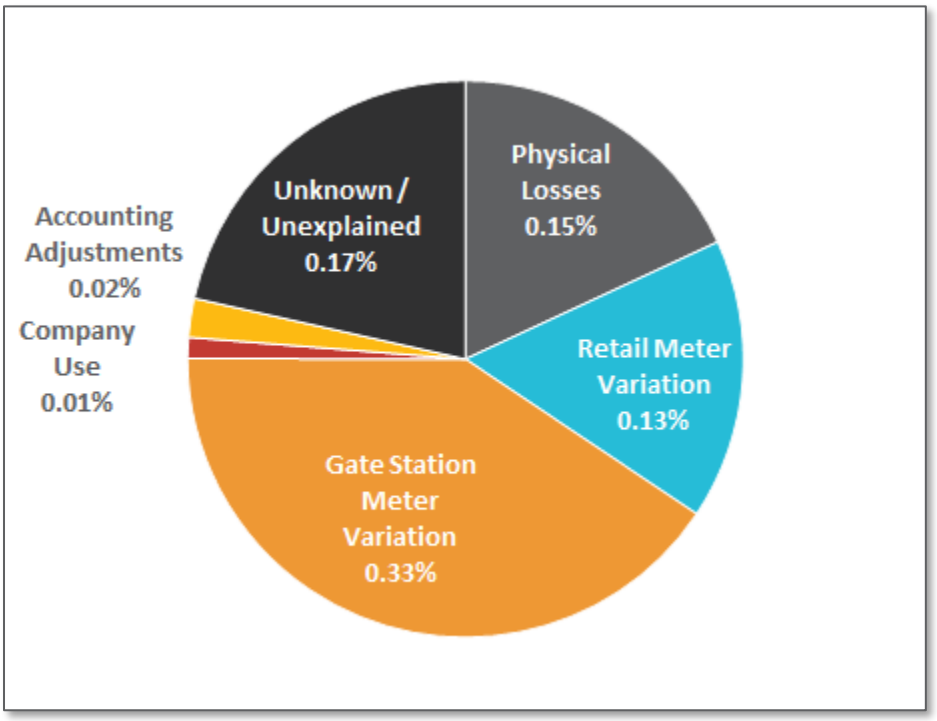
– Figure 2B shows the primary sources of UFG for legacy EGD are similar to those listed for legacy Union and include physical losses, retail meter variations, and gate station meter variations, which when applied to the 10-year average of 0.81 percent per year represents, respectively, 0.15 percent, 0.13 percent, and 0.33 percent.[14]

[12] Historical sources of UFG applied to 10-year UFG average.

[13] Based on data and analyses provided by legacy Union.

[14] Based on data and analyses provided by legacy EGD.

Figure 2B: Legacy EGD Indicative Sources of UFG[15]



- It is important to note, as explained below, that gate station meter variations represent differences between custody (or supplier) meters and check (or legacy Companies) meters and are not necessarily a source of UFG but may contribute to the calculated UFG value.
- Figures 2A and 2B also show that a portion of UFG is unexplained, which may include other sources of UFG, such as accounting and billing adjustments, non-registering meters and theft – as well as estimation variations associated with UFG.

- Initiatives to monitor and manage UFG

  The legacy Companies have undertaken and continue to undertake various activities and practices to monitor and manage potential sources of UFG. These activities and practices generally fall into one of the following three categories: (1) investments in facilities (i.e., changes to physical infrastructure that affects UFG), (2) improvements in process and

[15] Historical sources of UFG applied to 10-year UFG average.

procedures (i.e., changes to a calculation, data inputs, or a protocol that affects UFG); and (3) evaluation of new techniques and practices (i.e., identify, assess, and potentially implement a facility investment or practice change that affect UFG).[16] The legacy Companies' activities and practices, as summarized below, are generally consistent with those of other gas utilities.

Investments in facilities

- Asset replacement programs – to manage potential leaks through systematic replacement of the most leak-prone facilities
- Installation of dual valves at industrial locations – to more accurately measure and record volumes at meters designed for large industrial customers
- Installation of dual rotor meters with turbocorrectors ("TOCs") at industrial locations – to more accurately measure and record low-flow volumes at meters designed for large industrial customers
- Replacement of Pressure Factor Metering ("PFM") sets with Electronic Volume Integrators ("EVIs") – to more accurately measure and record volumes at elevated pressures
- Replacement of all measurement equipment at storage facilities (legacy EGD only)

Improvements in process and procedures

- Refinements to the bill estimation process – to more accurately estimate customer usage when an actual meter read is not obtained
- Updates to the supercompressibility parameters – to more accurately measure and record volumes at elevated pressures (legacy EGD only – expected to be implemented starting March 2020)

Evaluation of new techniques and practices

- Review leak detection equipment in areas with multiple transmission assets – to monitor and manage fugitive gas leaks

[16] There is an ongoing effort by Enbridge to review, evaluate and standardize practices and procedures across legacy EGD and legacy Union.

- Review techniques to capture and reinject gas that may be released into the atmosphere during construction and maintenance activities – to minimize discharge of gas into the atmosphere
- Review application of AGA-8 Supercompressibility standard through installation of EVIs with AGA-8 capability – to more accurately measure and record volumes at elevated pressure

RECOMMENDATIONS

Based on the report findings, ScottMadden makes the following recommendations:

- Identify and standardize “best practices” related to monitoring and managing UFG across the legacy Companies
- Document data, processes and studies related to monitoring and managing UFG
- On a periodic basis:
  - Investigate the sources of Enbridge UFG (including the unknown / unexplained category)
  - Research practices and initiatives at other gas utilities for monitoring and managing UFG
  - Implement, as appropriate, new practices and initiatives to better monitor and manage UFG

I. INTRODUCTION

This section describes the purpose of the report, provides industry definitions of UFG and describes certain challenges faced by gas utilities in quantifying UFG.

ScottMadden was retained by Enbridge to prepare a report that reviewed and evaluated factors contributing to UFG within the legacy Union and legacy EGD service areas. The report was prepared in compliance with the OEB's Decision and Order in EB-2017-0306/EB-2017-0307 issued on August 30, 2018 and amended on September 17, 2018. In its Decision and Order, the OEB directed Enbridge to file a report reviewing UFG for both the legacy Union and legacy EGD service areas, stating:

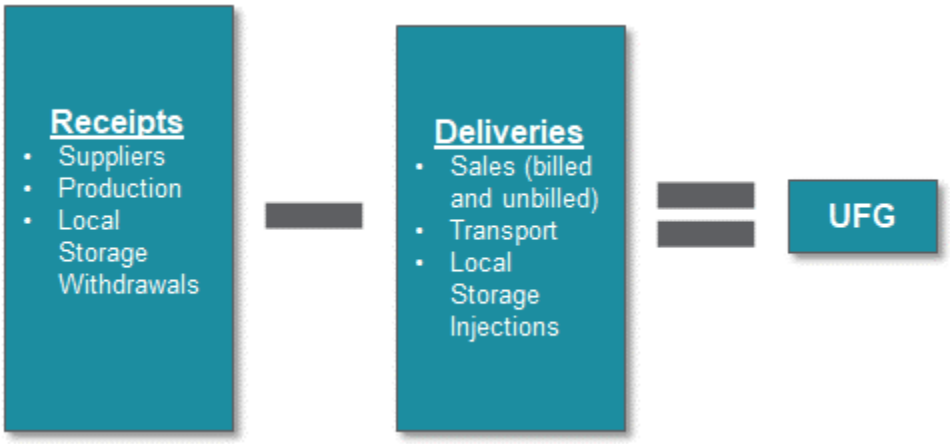
> "In the 2016 Earnings Sharing Mechanism proceeding, Enbridge Gas agreed to review potential metering issues that might be contributing to Unaccounted for Gas, and to report on that review. In the Enbridge Gas 2018 rates amended settlement proposal, Enbridge Gas agreed to continue this review and report on the progress in the 2019 rate-setting application…The OEB considers the issue of Unaccounted for Gas important and requires Amalco to file a report on this issue for both the Union Gas and Enbridge Gas service areas by December 31, 2019".[17]

UFG is broadly defined as the difference between gas receipts[18] and gas deliveries, where gas receipts are volumes that enter the distribution system and gas deliveries are volumes that exit the distribution system, as shown in Figure 3 (below). The Figure shows that gas receipts generally include gas supplies from pipeline and withdrawals from on-system storage facilities, while gas deliveries generally include sales to retail customers and injections into on-system storage facilities.

[17] *See,* Ontario Energy Board, Decision and Order EB-2017-0306 and EB-2017-0307 issued on August 30, 2018 and amended on September 17, 2018.

[18] Also referred to as 'sendout' in this report.

Figure 3: Unaccounted for Gas



More specific UFG definitions are provided below.

Energy Information Agency ("EIA")

Unaccounted For (Natural Gas) represents the difference between the sum of the components of natural gas supply and the sum of components of natural gas disposition, as reported by survey respondents. These differences may be due to quantities lost or to the effects of differences in company accounting systems in terms of scope and definition. A positive "unaccounted for" volume means that supply exceeds disposition by that amount. A negative "unaccounted for" volume means that supply is less than disposition.[19]

Pipeline and Hazardous Materials Safety Administration ("PHMSA")[20]

Unaccounted for gas" is gas lost; that is, gas that the operator cannot account for as usage or through appropriate adjustment. Adjustments are appropriately made for such factors as variations in temperature, pressure, meter-reading cycles, or heat content; calculable losses from construction, purging, line breaks, etc., where specific data are available to allow reasonable

[19] U.S. Energy Information Administration, Natural Gas Annual 2017, Glossary Definition.

[20] PHMSA or Pipeline and Hazardous Materials Safety Administration is a United States Department of Transportation Agency.

calculation or estimate; or other similar factors. [(Purchased gas + produced gas) minus (customer use + company use + appropriate adjustments)] divided by (purchased gas + produced gas) equals percent unaccounted for.[21]

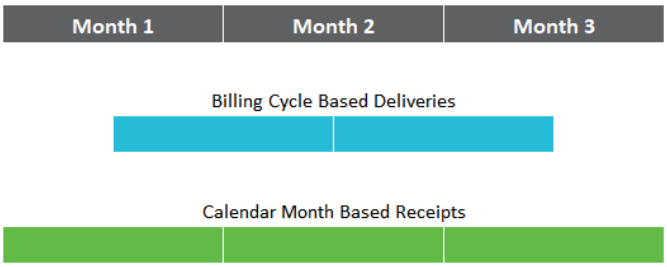
American Gas Association ("AGA")

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. In cycle billings, an amount of gas supply used but not billed as of the end of a period.[22]

As illustrated by the various definitions of UFG, gas utilities face certain challenges in quantifying UFG, as discussed below.

The first challenge is the fundamental mismatch between gas receipts and gas deliveries. Specifically, gas receipts are generally measured and recorded by calendar month while gas deliveries are generally measured and recorded by billing cycle month, as shown in Figure 4 (below).[23]

Figure 4: Gas Receipts vs. Gas Deliveries Mismatch (Illustration)



Gas receipts that are measured and recorded in December, for example, are reflected in gas deliveries that are measured and recorded in December and January. Gas utilities attempt to correct for the mismatch through an "unbilled" sales adjustment that represents the portion of gas receipts that will be billed in the subsequent month (i.e., "unbilled" sales). The "unbilled" sales adjustment relies on estimated

[21] PHMSA Instructions for completing Form PHMSA F 7100.1-1 (rev 1-31-2017).

[22] American Gas Association, Glossary Definition of Unaccounted for Gas.

[23] Utility Customers are typically grouped into varying billing cycles through the month to level the workload for meter readers and bill processing.

usage per day to calculate the baseload or non-heating portion of "unbilled" sales and estimated usage per heating degree days to calculate the heating portion of "unbilled" sales. Thus, the UFG calculation is subject to potential variations between actual and estimated unbilled sales.

A second challenge in quantifying UFG is potential variations between actual and metered gas volumes at the gate station (i.e., the transfer point from the pipeline to the gas utility), as regulations provide for some variation between actual and metered gas volumes. Measurement Canada, for example, permits +/- 3.0 percent variations or tolerance levels between actual and metered gas volumes; and such variations could contribute to UFG. Gas utilities generally verify the custody meters (which are owned and operated by the pipeline) through "check" meters (which are owned and operated by the gas utilities) to ensure custody meters are measuring and recording volumes within acceptable tolerance levels. Thus, the UFG calculation is subject to potential variations between actual and metered volumes within certain tolerance levels.

A third challenge in quantifying UFG is potential variations between actual and metered gas volumes at the retail meter (i.e., the transfer point from the gas utility to the customer). First, regulations provide for some variation between actual and metered gas volumes. Measurement Canada, for example, permits +/- 3.0 percent variations or tolerance levels between actual and metered gas volumes; and such variations could contribute to UFG. Second, in certain cases, gas volumes at the retail meter are based on estimated rather than actual reads. Some gas utilities, for example, read meters every other month. In those cases, for example, only fifty percent of customer bills in a given month are based on actual meter reads while the remaining customer bills are based on estimated meter reads. Thus, the UFG calculation is subject to potential variations between actual and estimated volumes.

One approach to address these challenges is to quantify UFG during the summer months when there are fewer differences between billed and unbilled sales. The Connecticut Public Utilities Regulatory Authority ("PURA") noted this approach in its report to the Connecticut General Assembly:[24]

[24] State of Connecticut, 2018 PURA Report to the General Assembly Concerning Lost and Unaccounted for Gas (Docket No. 18-03-28).

> "A 12-month period ending August 31st (or Summer-to-Summer) period provides a more accurate [Lost and Unaccounted for Gas] LAUF calculation because it encompasses a full winter heating season which permits complete billing reconciliation over this peak period. Consequently, the unbilled gas component of the LAUF gas calculation is often nominal if a Summer-to-Summer period is used."

While quantifying UFG during the summer months helps to address the timing of gas deliveries and gas receipts, it does not address variations related to metering and estimated use and may not have any material impact on the reported UFG levels at Enbridge.

Notwithstanding these challenges, comparative analysis provides useful insights related to UFG levels across the industry. As a result, ScottMadden prepared a Benchmark analysis comparing legacy EGD and legacy Union UFG levels to other gas utilities. The results of the analysis are discussed below.

II. BENCHMARK ANALYSIS

This section contains the Benchmark analysis conducted by ScottMadden that compares the legacy Companies' UFG levels to groups of U.S. and Canadian gas utilities.

The groups were selected based on access to publicly available data and applicability to the legacy Companies.[25] The Benchmark analysis relies primarily on data reported to EIA, whose definition of UFG was provided above. The Benchmark analysis shows that over the past 10 years the legacy Companies demonstrated lower UFG levels than the comparative gas utilities.

The Benchmark analysis conducted by ScottMadden compares the legacy Companies to the following groups of U.S. and Canadian gas utilities:

- All investor-owned U.S. gas utilities[26]
- Regional U.S. East North Central Region gas utilities[27]
- Select Canadian gas utilities[28]
- "Comparison" group of U.S. gas utilities[29]

The results of the Benchmark analysis are shown in Figure 5 (below). Appendix B contains a more detailed description of the Benchmark analysis.

[25] The comparisons, for example, excluded gas utilities that deliver to customers less than 10 million Mcf per year (~0.3 $10^9 m^3$). These utilities are smaller in comparison to legacy Union and legacy EGD which deliver to customers, approximately 36.0 $10^9 m^3$ and 12.0 $10^9 m^3$ per year, respectively.

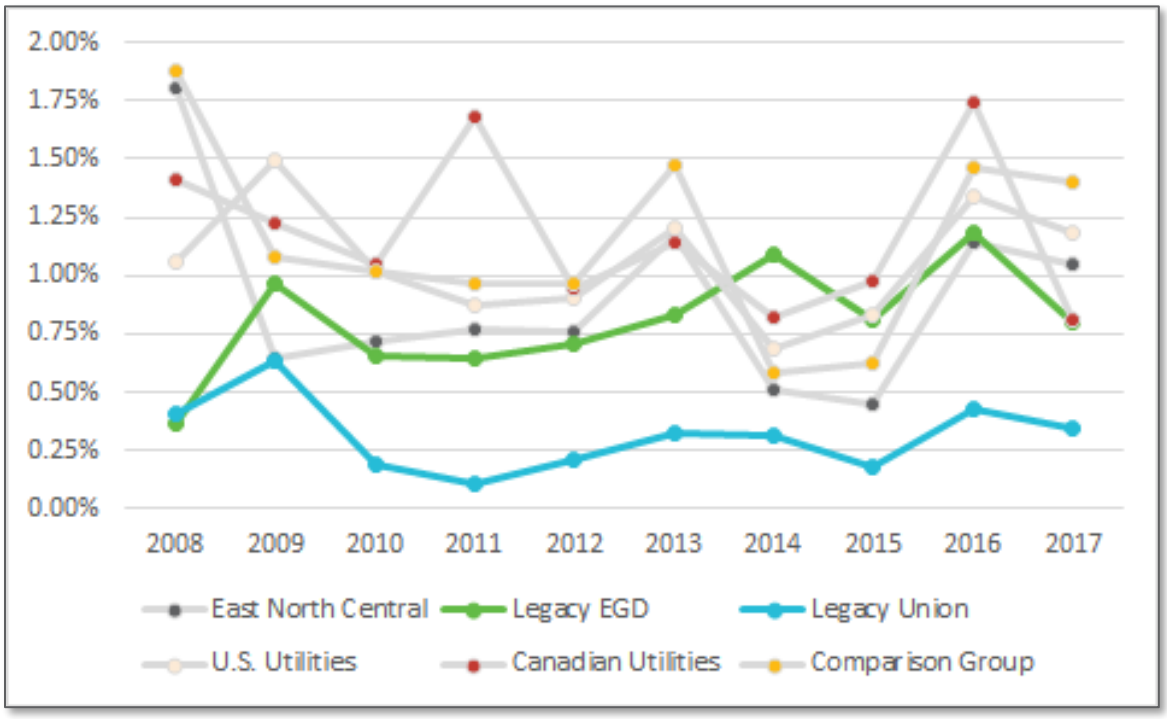
[26] Based on 'unaccounted for' and 'losses from leaks' data reported by 106 utilities to EIA. See Appendix-B.

[27] The U.S. East North Central Region includes the states of Illinois, Wisconsin, Indiana, Michigan, and Ohio. See Appendix-B.

[28] Canadian utilities with publicly-accessible UFG data collected by ScottMadden include Manitoba Hydro, AltaGas Ltd., ATCO Gas Ltd., FortisBC, and Pacific Northern Gas Ltd. (Northeast Region). See Appendix-B.

[29] Comparison group of U.S. utilities selected based on comparable disposition volumes and adjacency of region. See Appendix-B.

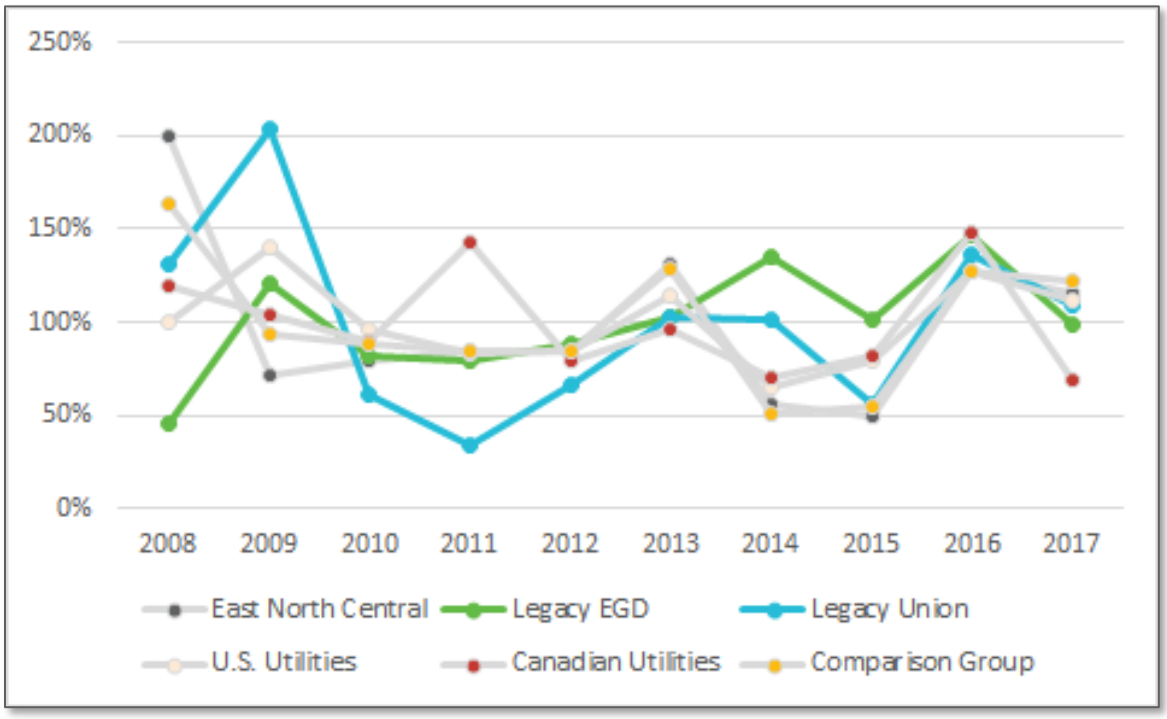
Figure 5: Benchmark Analysis of UFG Levels



The Figure shows that over the past 10 years the legacy Companies demonstrated lower UFG levels than any group of U.S. and Canadian gas utilities reviewed by ScottMadden. Specifically, the UFG levels for legacy Union and legacy EGD averaged, respectively, 0.31 percent and 0.81 percent of total sendout. During the same period, UFG levels for all U.S. gas utilities, Regional U.S gas utilities, Select Canadian gas utilities and a "Comparison" group of U.S. gas utilities averaged, respectively, 1.06 percent, 0.90 percent, 1.18 percent, and 1.15 percent of total sendout.

Over the past 10 years, the legacy Companies also demonstrated year-to-year fluctuations in UFG levels, as shown in Figure 6 (below).

Figure 6: Year-to-Year Fluctuation in UFG Levels As % of 10-Year Average



The Figure shows that legacy Union and legacy EGD have year-to-year fluctuations in UFG levels that are generally consistent with other gas utilities. The fluctuations are a result of many factors, including weather, estimation, measurement variability, billing and accounting adjustments. For example, the Alberta Utilities Commission stated in its decision on a UFG rider:

> "The Commission recognizes that all gas distribution pipeline systems have UFG as an element of operating a natural gas distribution system and that because of the numerous factors that impact UFG, the UFG percentage will fluctuate over time." [30]

As shown in Figures 5 and 6, the legacy Companies UFG levels and annual fluctuations in those levels are generally consistent with other gas utilities.

[30] Alberta Utilities Commission, Decision 22889-D01-2017, 2017-2018 Unaccounted-For Gas Rider D. (ATCO Gas and Pipelines Ltd.)

III. SOURCES OF UFG

Based on its research and analysis, ScottMadden identified certain common sources of UFG across the gas utility industry, including physical losses (e.g., leaks, third-party damage and venting during construction and maintenance activities), metering variations, non-registering meters, theft, line pack and billing and accounting adjustments. Identifying all sources of UFG, however, can be challenging as noted by the National Regulatory Research Institute ("NRRI"):

> "…it is not a straightforward task to measure LAUF [Lost and Unaccounted for] gas. Even after adjusting for measurable factors, uncertainty prevails over the precision of those measurements. LAUF gas has a "black box" element that makes it difficult for state commissions to quantify the effect of individual sources." [31]

Furthermore, sources of UFG vary across gas utilities, as shown in Figure 7 (below). The Figure shows that accounting issues or adjustments represent 71.5 to 88.0 percent of UFG for Connecticut gas utilities, while measurement errors represent 10.3 to 16.7 percent of UFG, leaks caused by corrosion, third-party damages and cast-iron joints represent 0.77 to 13.8 percent of UFG, and theft represents 0.0 to 0.33 percent of UFG.[32]

The Figure also shows that measurement error represents 60.0 to 80.0 percent of UFG in a study by ATCO Pipelines North submitted to the Alberta Energy and Utilities Board, while leaks represent 8.0 to 10.0 percent of UFG, accounting issues or adjustments represent 3.0 to 10.0 percent of UFG and theft represents 2.0 to 6.0 percent of UFG.[33]

Finally, Figure 7 shows that measurement errors represent 60.0 to 64.0 percent of UFG for Southern California Gas ("SoCalGas") and San Diego Gas & Electric ("SDG&E"), while leaks represent 14.0 to 17.0 percent of UFG, accounting issues or adjustments represent 5.0 and 8.0 percent of UFG and theft represents 4.0 percent to 5.0 percent of UFG.[34]

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[31] National Regulatory Research Institute (NRRI), Lost and Unaccounted-for Gas: Practices of State Utility Commissions, Ken Costello, June 2013.

[32] State of Connecticut, 2018 PURA Report to the General Assembly Concerning Lost and Unaccounted for Gas (Docket No. 18-03-28).

[33] Alberta Energy and Utilities Board, Decision 2003-042: ATCO Pipelines North, Unaccounted-For-Gas Allocation Methodology, Application No. 1286668.

[34] SoCalGas and SDG&E 2018 Presentation "Introduction to LAUF", November 2018.

Figure 7: Sources of UFG

Sources of UFG	*Connecticut PURA Report*	*ATCO Pipelines North*	*SoCalGas and SDG&E*
Physical Losses	**0.8% – 13.8%**	**8.0% – 10.0%**	**14.0% – 17.0%**
Measurement Errors	**10.3% – 16.7%**	**60.0% – 80.0%**	**60.0% – 64.0%**
Accounting Issues or Adjustments	**71.5% – 88.0%**	**3.0% – 10.0%**	**5.0% – 8.0%**
Theft and Non-Registering Meters	**0.0% – 0.3%**	**2.0% – 6.0%**	**4.0% – 5.0%**

UFG Categories

Based on its research and analysis, ScottMadden identified six primary sources of UFG.

1. **Physical Losses**: represents volumes that exit the gas distribution system through leaks and fugitive emissions, venting and third-party damages.

2. **Retail Meter Variations**: represents variations between actual and metered volumes at retail customer locations.

3. **Gate Station Meter Variations**: represents variations between actual and metered volumes at gate stations.

4. **Theft and Non-Registering Meters**: represents volumes that are not metered or recorded due to unauthorized use (i.e., theft) or faulty metering equipment (i.e., non-registering meters).

5. **Company Use**: represents volumes that are used by the utility but are not metered and/or recorded.

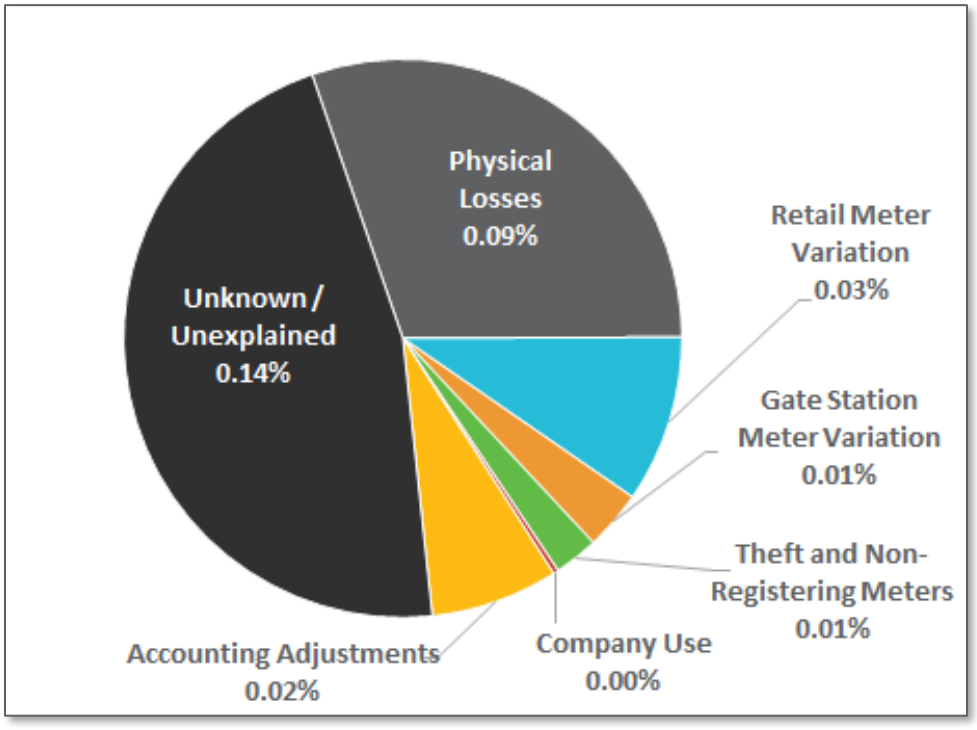
6. **Accounting Adjustments**: represents variations between actual and reported volumes due to various accounting adjustments, including unbilled sales adjustment, billing adjustments, line pack, and other accounting-related adjustments.

Sources of UFG

ScottMadden estimated sources of UFG at the legacy Companies based on available data. Legacy EGD data was supplied primarily from recent regulatory proceedings,[35] while legacy Union data was supplied primarily by various subject matter experts.

The estimated sources of UFG at legacy Union are shown in Figure 8 (below). The Figure shows the primary sources of legacy Union UFG include physical losses, retail meter variations, and gate station meter variations, which when applied to the 10-year average of 0.31 percent per year represents, respectively, 0.09 percent, 0.03 percent and 0.01 percent of gas receipts.[36]

Figure 8: Legacy Union Indicative Sources of UFG[37]



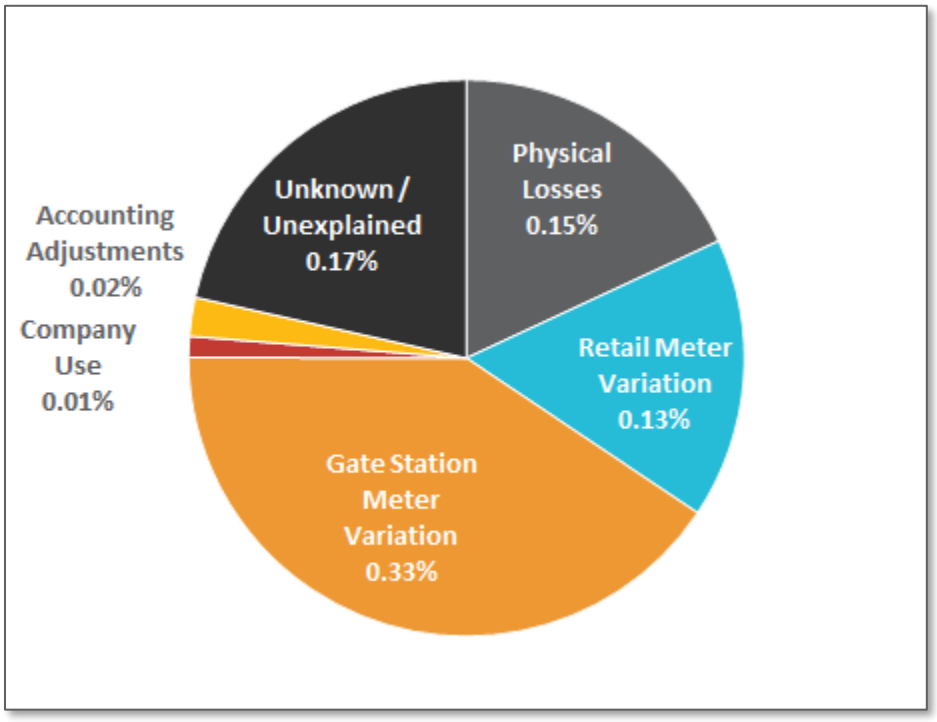
[35] As filed in EB-2017-0102, Response to BOMA Interrogatory #21 (Exhibit I.B.EGDI.BOMA.21).

[36] Based on data and analyses provided by legacy Union.

[37] Historical sources of UFG applied to 10-year UFG average.

The estimated sources of UFG at legacy EGD are shown in Figure 9 (below). The Figure shows the sources of UFG are similar to those listed for legacy Union and include physical losses, retail meter variations, and gate station meter variations, which when applied to the 10-year average of 0.81 percent per year represents, respectively, 0.15 percent, 0.13 percent, and 0.33 percent.[38]

Figure 9: Legacy EGD Indicative Sources of UFG[39]



Figures 8 and 9 also show that a portion of UFG is unexplained, which may include other sources of UFG, such as accounting and billing adjustments, non-registering meters and theft – as well as estimation variations associated with UFG.

The sections below describe the sources of UFG in more detail. The sections also describe the industry and legacy Companies experience related to each source of UFG.

[38] Based on data and analyses provided by legacy EGD.

[39] Historical sources of UFG applied to 10-year UFG average.

IV. PHYSICAL LOSSES

This section describes the practices and initiatives that gas utilities and the legacy Companies have taken to monitor and manage physical losses as a potential source of UFG.

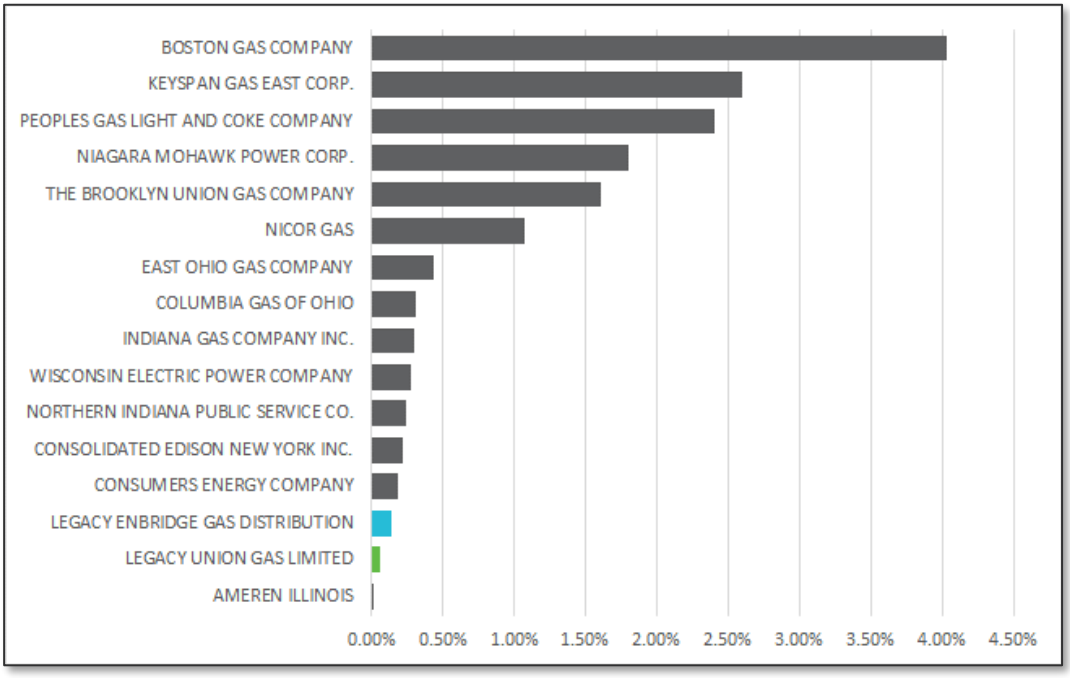
Industry Background

Physical losses are generally recognized as a potential source of UFG in the gas utility industry and include:

- Leaks and emissions from natural gas facilities
- Controlled release of natural gas during maintenance, construction and emergency situations
- Release of natural gas from line hits during third-party construction or excavation activities

Leaks and emissions are generally quantified and reported using estimation factors, such as the data presented in Figure 10 (below).

Figure 10: Physical Losses from Leaks as % of Total Sendout (2015-17)[40]



[40] As reported to U.S. Energy Information Administration. Comparison group methodology provided in Appendix B.

The Figure shows a comparison of leak data between the legacy Companies and select U.S. gas utilities. The legacy Companies data is taken from an annual report to Environment Canada and Statistics Canada on fugitive emissions and leaks, while the U.S. gas utilities data is taken from EIA.

The Figure demonstrates that legacy Union and legacy EGD compare favorably to other U.S. gas utilities regarding leaks.

Gas utilities generally monitor their facilities for leaks through surveys and various other activities. For example, AltaGas Utilities Inc. has an established program to monitor its facilities for leaks through pressure surveys, leak surveys, other operational activities, and customer notifications.[41]

Gas utilities actions to minimize potential leaks include replacement of leak-prone pipes (e.g., cast iron mains), which is an industry-recognized priority. The National Association of Regulatory Utility Commissions (NARUC) in 2013 approved a resolution encouraging state regulators and the industry to "consider sensible programs aimed at replacing the most vulnerable pipelines as quickly as possible and to explore, examine and consider adopting alternative rate recovery mechanisms to accelerate the modernization, replacement and expansion of the nation's natural gas pipeline systems." [42]

AltaGas Utilities Inc. Leak Surveys and Pressure Testing

AltaGas' formal program includes Leak surveys in the following time frames:

- Rural systems every 5 years
- Town systems every 4 years
- Business districts every year
- High-pressure pipelines every year
- Pressure surveys throughout system, as required, particularly in areas where line losses or flows appear to be an issue

Consumers Energy Infrared Cameras and Hi-Flow Analyzers

In 2010-11, Consumers Energy purchased two Forward Looking Infrared cameras and two hi-flow analyzers to identify and measure leaks at the compressor stations, city gates, and storage fields. Using this equipment, the Company established a program to identify and estimate the magnitude of any leaking valves, and compressor engines.

[41] AltaGas Utilities Inc. 2018-2019 Rate Rider E and Rate Rider H – Unaccounted for Gas Application, submitted to Alberta Utilities Commission (July 2018).

[42] NARUC Resolution Encouraging Natural Gas Line Investment and the Expedited Replacement of High-Risk Distribution Mains and Service Lines, Adopted by the NARUC Board of Directors July 24, 2013.

In addition, gas utilities use the latest technologies and install high-quality materials in construction of new pipeline installations.[43]

Gas utilities minimize potential for line hits and facility damage through 'call-before-you-dig' programs. In addition, gas utilities assess penalties and charges for gas losses and repairs related to third-party damage.

Gas utilities minimize potential for release of natural gas during maintenance, construction and emergency situations by capturing "blowdown" gas and injecting it back into the distribution system. Another practice to minimize potential release of natural gas is to reduce the line pressure before the work begins. For example, Pacific Gas & Electric and Southern California Gas reported reductions in blowdown and vented emissions by reducing line pressure during maintenance activities.[44]

PG&E and SoCalGas Blowdown Gas Reduction Initiatives

PG&E reduced blowdown and vented emissions by bundling its maintenance projects so that one blowdown serves several projects, and from a focused effort to decrease pressures prior to blowdown.

SoCalGas reduced blowdown and vented emissions through its efforts to re-route gas and decrease line pressures before blowdowns.

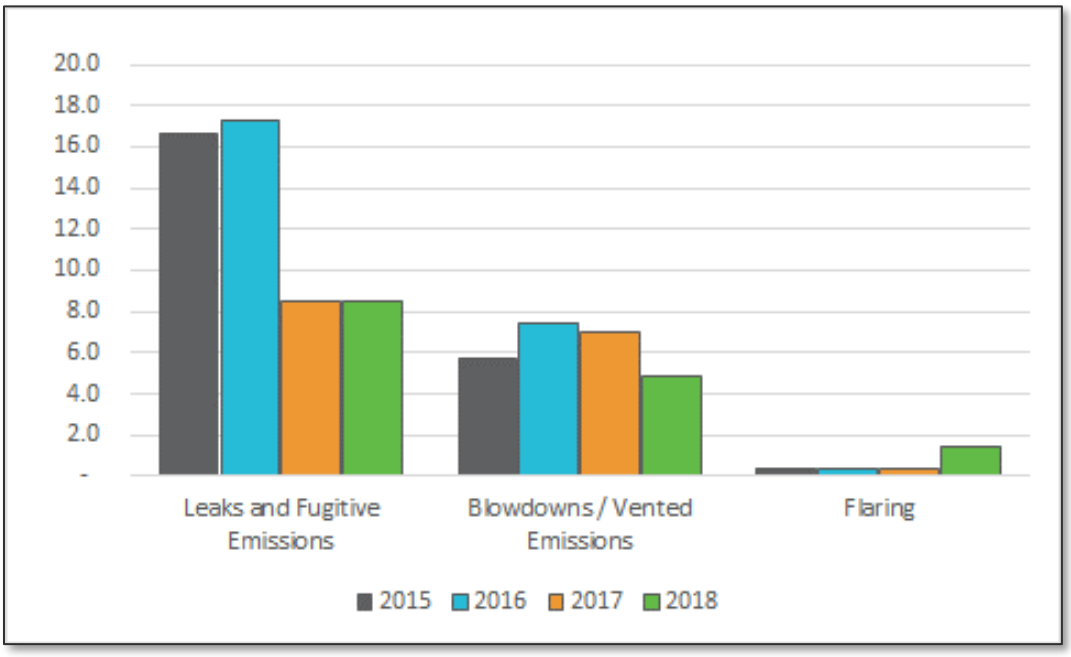
Legacy Union Experience

Legacy Union reports annually fugitive emissions and leaks to Environment Canada and Statistics Canada, as shown in Figure 11 (below).

[43] For example, a New York Staff Whitepaper states: "…technological advances in the quality of piping materials and their installation methods have reduced the rate of deterioration in newer systems…" (NYS Department of Public Service, Staff White Paper on Lost and Unaccounted for Gas, Case 13-G-0031).

[44] California Public Utilities Commission (CPUC) Analysis of the Utilities' June 16, 2017 Natural Gas Leak and Emission Reports.

Figure 11: Legacy Union Lost Gas from Leaks and Emissions (10^6 m^3)



The Figure shows a decline in leaks and fugitive emissions by 35.0 percent since 2015.

Over the last several years, Legacy Union implemented various practices and initiatives to monitor and manage UFG related to physical losses.

Investments

- Replaced all cast iron mains
- Developed program to review and evaluate replacement of bare-steel mains

Processes and Procedures

- Monitor facilities for leaks and emissions through field surveys. Higher risk areas are surveyed more frequently. Leaks are repaired in order of priority based on safety, level of emissions and other considerations.
- Examine material specifications for new pipeline installations. Conduct audits of manufacturing facilities to ensure pipeline specifications and quality are met.
- Deploy damage prevention programs, such as “Call-before-you-dig” and “Dig-safe” programs.
- Communicate with third-party contractors prior to construction/excavation to minimize risk of damage to facilities during construction.

- Deploy dedicated staff to oversee certain large construction projects (e.g., high pressure / high diameter lines).
- Recover repair costs related to line hits from the responsible party.

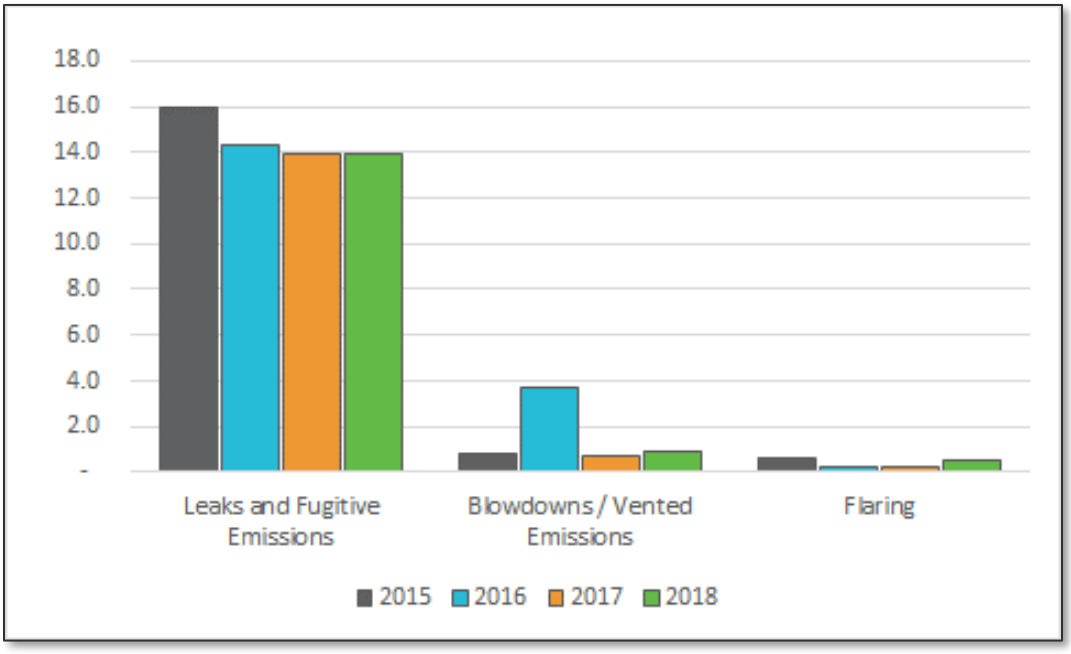
New Techniques and Practices

- Review leak detection equipment at installations with multiple transmission assets; expedites identification and repair of leaks.
- Review techniques to avoid controlled release of natural gas during maintenance, construction and emergency situations; capture gas and inject it back into the system.

Legacy EGD Experience

Legacy EGD has annually reported fugitive emissions and leaks to Environment Canada and Statistics Canada, as shown in Figure 12 (below).

Figure 12: Legacy EGD Lost Gas from Leaks and Emissions (10^6 m^3)



The Figure shows a decline in leaks and fugitive emissions by 12.0 percent since 2015.

Over the last several years, Legacy EGD implemented various practices and initiatives to monitor and manage UFG related to physical losses.

Investments

- Replaced all cast iron mains.
- Developed program to proactively and reactively replace facilities; assets are replaced proactively if they are known to be nearing end of life and replaced reactively after they have failed.
- Developed program to prioritize facility replacement based on multiple parameters including historical leaks, corrosion and other metrics.

Processes and Procedures

- Monitor facilities for leaks and emissions through field surveys. Higher risk areas with known asset failures are surveyed more frequently. Leaks are repaired in order of priority based on safety, level of emissions and other considerations.
- Test new pipeline materials to ensure they meet industry standards and perform to company operating requirements. Conduct field trials before approval.
- Conduct audit of manufacturing facilities based on failure trends and rollout of new products.
- Participate in Provincial Committees, such as Ontario Regional Common Ground Alliance ("ORCGA"), to communicate safe excavation guidelines to third parties.
- Initiate controls to identify sites where new assets have been installed after "locates" have been completed but prior to excavation.
- Maintain a Third-party, Repeat Offenders list and provide to Technical Standards and Safety Authority ("TSSA").
- Recover repair costs related to line hits and facility damage from the responsible party.

New Techniques and Practices

- Monitor and identify disturbances around high risk assets, including aerial patrol and vital main locate identification. Communicate with third party contractors prior to excavation.

Findings

- Physical losses represent a source of UFG for the legacy Companies in recent years.
- Enbridge has practices and initiatives to monitor and manage physical losses, including asset replacement, leak surveys and damage prevention programs.
- Enbridge's practices and initiatives are generally consistent with those found at other gas utilities.
- Enbridge has an ongoing effort to identify and standardize "best practices" across the legacy Companies.

V. RETAIL METER VARIATIONS

This section describes the practices and initiatives that gas utilities and the legacy Companies have taken to monitor and manage retail meter variations as a potential source of UFG.

Industry Background

Retail meter variations are a potential source of UFG if there are differences between actual and metered volumes. Such differences are attributable to:

- Meter failure. Meters can fail over time leading to differences between actual and metered volumes. These differences can represent a source of UFG. In some cases, meters may run "fast"; i.e., metered volumes are more than actual volumes. In other cases, meters may run "slow"; i.e., metered volumes are less than actual volumes. Fast meters tend to decrease UFG, while slow meters tend to increase UFG.

- Not accurately correcting for temperature and pressure variations. Meters that do not accurately correct for temperature and pressure variations lead to differences between actual and metered volumes. These differences can represent a source of UFG. For example, meters that do not correct for cold temperatures or elevated pressures would generally lead to an increase in UFG since the metered volumes would be less than actual volumes.

- Not sized properly. Meters that are not sized properly can lead to differences between actual and metered volumes. These differences can represent a source of UFG. For example, turbine meters that do not record low-flow volumes would generally lead to an increase in UFG since the metered volumes would be less than the actual volumes.

Connecticut Meter Testing Programs

In Connecticut, the utilities require the worst performing meter classifications to undergo a greater number of periodic tests in subsequent years. Utilities have addressed the meter accuracy component by establishing a meter test program the results of which are reported to the Commission on an annual basis.

Gas utilities have implemented several practices and initiatives to help ensure meters measure and record actual volumes. These practices and initiatives include random meter testing, recalibration and

replacement.[45] Canada and most U.S. states have regulations that require periodic meter testing that provides a continuous and systematic verification of the accuracy of the meters. The testing may include placing meters into different risk groups with an emphasis on lower performing groups. For example, Connecticut requires gas utilities to conduct more frequent testing on underperforming meters.[46] Periodic meter testing ensures not only more accurate customer billings but also more accurate UFG levels.

In addition, gas utilities have replaced non-temperature compensating meters with those that compensate for temperature.

In addition, varying elevation zones between receipt point and delivery points can create variations between gas receipts volumes and gas deliveries volumes. For example, AltaGas Utilities recently reviewed elevation zone pressures to confirm that the pressure factors in the billing system were accurately recording gas usage.[47]

AltaGas Elevation Zones

AltaGas' billing system utilizes elevation zones to derive the pressure factor applied to a customer's measured consumption and to convert to billed usage. Although revisions to elevation zone pressures are very seldom required, AltaGas reviewed the zone pressures in the billing system to eliminate this area as a contributor to UFG.

Legacy Union Experience

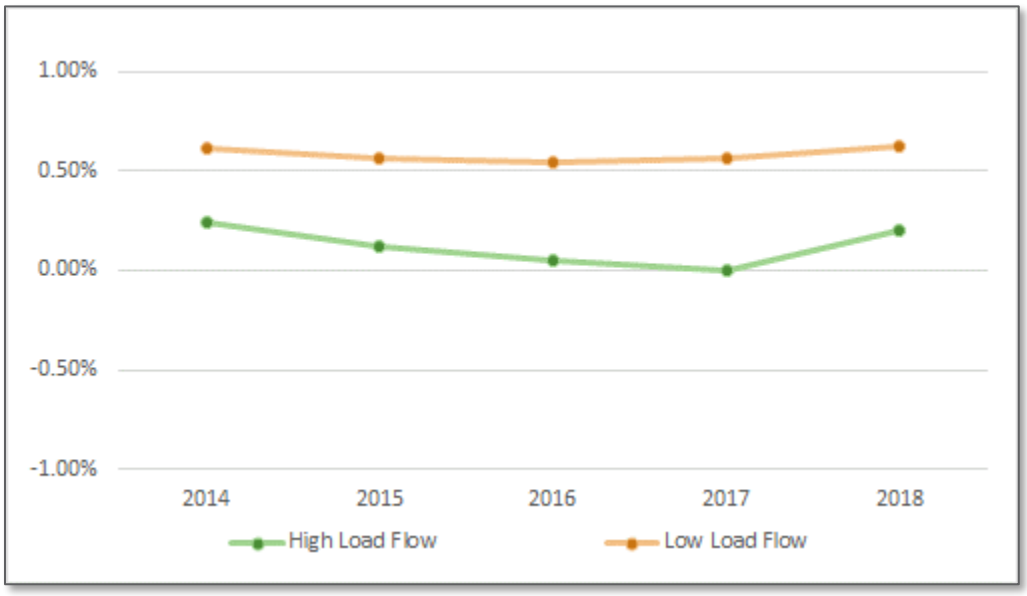
Retail meter variations represent a potential source of UFG for legacy Union. As a result, legacy Union conducts meter testing on a sample of diaphragm meters annually. The tests are conducted under low-flow and high-flow conditions. Recent tests are shown in Figure 13 (below).

[45] Lost and Unaccounted-for Gas: Practices of State Utility Commissions, National Regulatory Research Institute (June 2013).

[46] State of Connecticut, 2018 PURA Report to the General Assembly Concerning Lost and Unaccounted for Gas (Docket No. 18-03-28).

[47] AltaGas Utilities Inc. 2018-2019 Rate Rider E and Rate Rider H – Unaccounted for Gas Application, submitted to Alberta Utilities Commission (July 2018).

Figure 13: Legacy Union Meter Test Results



The Figure shows that tests under high-flow conditions result in a variance of 0.12 percent over the past five years, while tests under low-flow conditions show a variance of 0.58 percent. The variances are within the Measurement Canada specifications of +/- 3.0 percent. Meters not meeting Measurement Canada specifications are taken out of service.

All rotary, turbine and ultrasonic meters are tested as well on a regular basis. The frequency of testing is prescribed by Measurement Canada regulations.

Legacy Union implemented several practices and initiatives to monitor and manage retail meter variations.

Investment in Facilities

- Replaced all non-temperature compensating meters with temperature compensating meters.
- Developed program to install dual rotor meters with TOCs at industrial locations to more accurately measure and record volumes at elevated pressures.
- Developed program to install EVIs to more accurately measure and record volumes at elevated pressures.
- Installation of dual valves at industrial locations – to more accurately measure and record volumes at meters designed for large industrial customers.

Processes and Procedures

- Meter testing, calibration and replacement, as necessary, to comply with Measurement Canada requirements.[48] Statistical analysis to estimate meter performance until the next testing period.
- Review and update supercompressibility parameters to more accurately measure and record volumes at elevated pressures.[49]
  - There is an ongoing effort to standardize this procedure across the legacy Companies.
- Apply pressure factors in the billing system to accurately record volumes at elevated pressures.
- Select meters to match customer requirements, such as installing high-flow meters to serve equipment with high flow requirements and low-flow meters to serve equipment with low flow requirements.
- Deploy internal controls associated with the Sarbanes-Oxley Act (commonly referred to as SOX) to ensure accurate measurement and recording of volumes.

New Techniques and Practices

- Evaluate standardizing supercompressibility standards between interconnects and industrial customer sites to more accurately measure and record volumes.
  - At interconnects, AGA-8 Supercompressibility standard is applied, while at industrial sites, the NX-19 standard is applied. The variation in standards can result in meters registering less than actual gas usage.

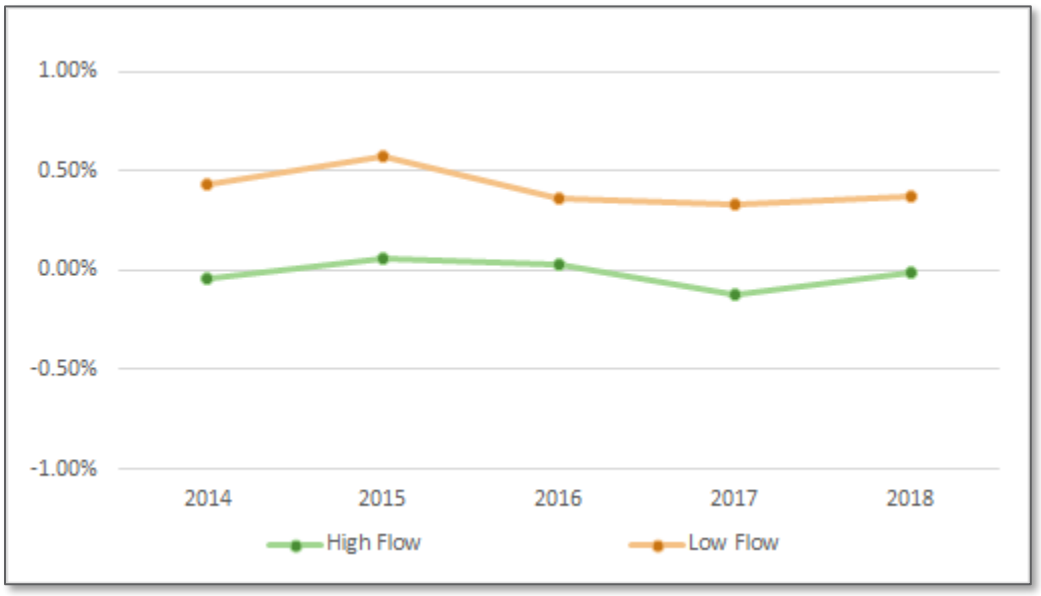
Legacy EGD Experience

Retail meter variations represent a potential source of UFG for legacy EGD. Legacy EGD conducts meter testing on a sample of diaphragm meters annually. The tests are conducted under low-flow and high-flow conditions. Recent tests are shown in Figure 14 (below).

[48] Measurement Canada regulations prescribe verification of all metering equipment at fixed frequency. For example, all turbine and ultrasonic meters shall be re-verified every 4 years; if re-verification process is expanded to meter renewal, re-verification frequency is every 6 years. For diaphragm meters, re-verification of accuracy of installed meters is done through sampling process.

[49] Supercompressibility factor is a factor to compensate for the compressibility of the flow gas, what is sometimes termed the deviation from Boyle's law. The factor is derived based on compressibility factors of the gas at base pressure and at flow conditions. (U.S. National Bureau of Standards)

Figure 14: Legacy EGD Meter Test Results



The Figure shows that tests under high-flow conditions resulted in a variance of -0.02 percent over the past five years, while tests under low-flow conditions showed a variance of 0.41 percent. The variances are within the Measurement Canada specifications of +/- 3.0 percent. Meters not meeting Measurement Canada specifications are taken out of service.

All rotary, turbine and ultrasonic meters are tested on a regular basis; the frequency of testing is prescribed by Measurement Canada regulations.

Legacy EGD implemented several initiatives to monitor and manage retail meter variations.

Investment in Facilities

- Replaced all non-temperature compensating meters with temperature compensating meters
- Developed program to install EVIs to more accurately measure and record volumes at elevated pressures. EVIs more accurately measure and record volumes at elevated pressures.

Processes and Procedures

- Meter testing, calibration and replacement, as necessary, to comply with Measurement Canada requirements.[50] Statistical analysis to estimate the meter performance until the next testing period.
- Program to replace over time high-capacity diaphragm meters with ultrasonic meters.
- Review and update supercompressibility parameters to more accurately measure and record volumes at elevated pressures.
  - There is an ongoing effort to standardize this procedure across the legacy Companies. The update of supercompressibility parameters is expected starting March 2020.
- Apply pressure factors in the billing system to adjust for elevated pressures.
- Review and replace meters, as necessary, to ensure they are properly sized to accurately measure and record volumes.
  - Collect customer requirements to ensure meters are adequately sized.
- Conduct investigation of billing and metering issues on large volume customer accounts to ensure that metering issues are resolved.

Evaluation of New Techniques and Practices

- Review Automated Meter Reading ("AMR") and Advanced Metering Infrastructure ("AMI") for improved accuracy of measured and recorded volumes.

Findings

- Retail meter variations are a potential source of UFG at Enbridge.
- Enbridge has several practices and initiatives to monitor and manage retail meter variations. These include investments in meter technology that more accurately measure and record volumes at elevated pressures, meter testing and replacement, and meter sizing.
- Enbridge's practices and initiatives are generally consistent with those at other gas utilities.
- Enbridge has an ongoing effort to identify and standardize "best practices" across the legacy Companies.

[50] Measurement Canada regulations prescribe verification of all metering equipment at fixed frequency. For example, all turbine and ultrasonic meters shall be re-verified every 4 years; if re-verification process is expanded to meter renewal, re-verification frequency is every 6 years. For diaphragm meters, re-verification of accuracy of installed meters is done through sampling process.

VI. GATE STATION METER VARIATIONS

This section describes practices and initiatives by gas utilities and the legacy Companies to monitor and manage gate station meter variations as a potential source of UFG.

Industry Background

Gate station meter variations represent a potential source of UFG if there are differences between actual and metered volumes. Gate station meter variations have been recognized by gas utilities and the legacy Companies as a potential source of UFG and have implemented a number of practices and initiatives to monitor and manage gate station meter variations.

A report by the New York Public Service Commission Staff identified several ways gate station meter variations could be a potential source of UFG.[51]

- Measurement tolerance levels – gate station meters are designed and operated within certain tolerance levels. City gate meters are typically allowed a tolerance level of +/- 2.0 percent. Variations within this range could be a potential source of UFG.
- Flow rates – gate station meters are designed to record volumes within a certain range of flow rates. Volumes below that range (e.g., during summer periods when gas flows are low) could result in variations between actual and metered volumes and could represent a potential source of UFG. New York State Electric and Gas Corporation ("NYSEG"), for example, identified 18 meters that were

NYSEG Low Flow Meters Identification

New York State Electric and Gas Corporation identified eighteen supply receipt meters where low usage volumes during summer months can possibly affect the meter accuracy, since the meters were designed for larger flow volumes.

Consumers Energy Orifice Plates

In 2009, Consumers Energy investigation noted lack of orifice plates and seal rings for varying flow conditions. As load changes occur, orifice plate sizes must be adjusted to ensure accuracy. An inventory of all orifice plate sizes was taken at each orifice meter location and required plates and rings were purchased.

[51] NYS Department of Public Service, Staff White Paper on Lost and Unaccounted for Gas, Case 13-G-0031.

designed for higher flow rates but may under measure during the summer, low flow months. Similarly, Consumers Energy found that insufficient orifice plates and seal rings to match varying flow conditions can represent a source of meter variations.[52]

- City Gates Design – the design of city gate meters can represent a potential source of meter variations and UFG. City gates may have a "cascading" design where valves automatically open or close to combine or split gas flows to one or more meters. The design and operation of the valves can represent a potential source of meter variations and UFG.

- Metering Station Age – the age of the metering station can represent a potential source of meter variations and UFG as newer stations with newer technology tend to have better meter accuracy.

Gas utilities have implemented various practices and initiatives to monitor and manage gate station meters as a potential source of meter variations and UFG, including deployment of check meters to validate the accuracy of custody or supplier meters, identification and replacement as necessary of those meters where low flow rate can impact accuracy, and meter inspections and audits of configuration and functionality of meters.

DTE Gas Check Metering and Monitoring

DTE Gas employs the use of check meters at large interconnects, continuous condition monitoring of ultrasonic meters, physical meter inspections, and audits of the configuration / functionality of the meter installations.

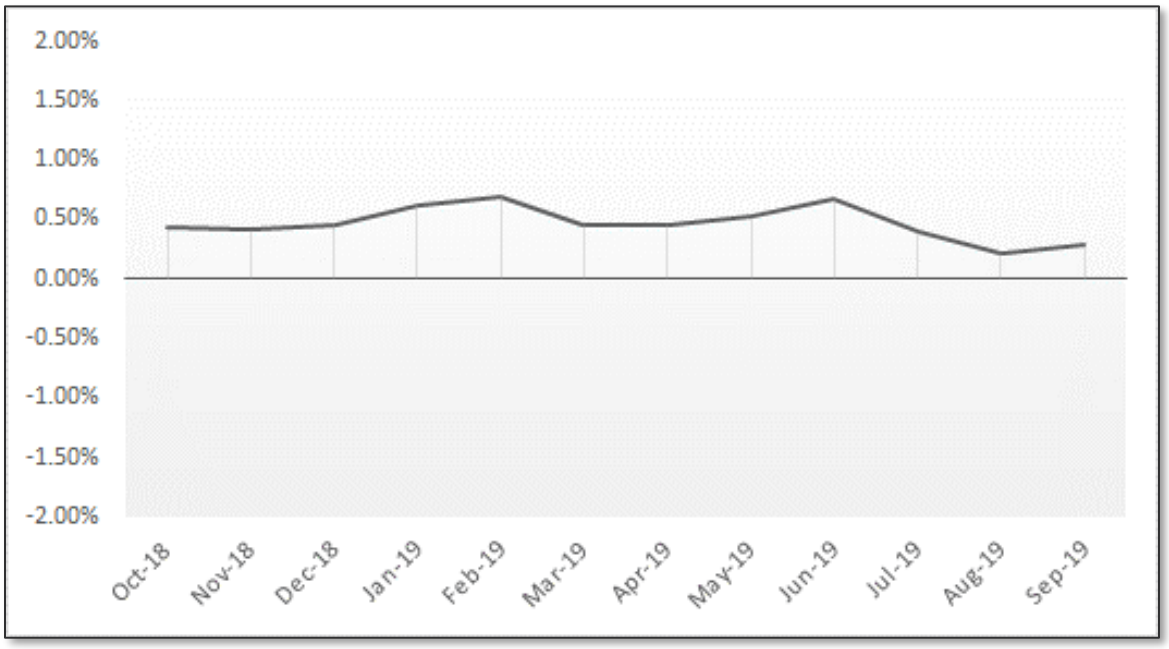
Legacy Union Experience

Gate station meter variations represent a potential source of UFG for legacy Union if there are differences at the receipt points between actual and metered volumes. Legacy Union's system includes several receipt points for gas volumes, including pipelines and on-system storage facilities.

Legacy Union deployed check meters to validate the accuracy of the custody or supplier meters. A comparison between legacy Union's check meters and third-party custody transfer meters shows the differences are within the +/- 3.0 percent Measurement Canada requirements and within the +/- 2.0 percent of legacy Union's internal benchmark, as shown in Figure 15 (below).

[52] Consumers Energy LAUF Program Assessment, Case No. 16855 Exhibit A-31 (SBB-16).

Figure 15: Third-Party Custody Transfer vs. Legacy Union Check Meter Differences[53]



The Figure shows the third-party custody meters register gas receipts at a level within +/- 2.0 percent for the period twelve-month ending September 2019.

It is important to note that gate station meter variations represent differences between the custody meters and check meters and are not necessarily a source of UFG as the variations may be attributable to a variety of circumstances, including differences in the type of meters.

Legacy Union implemented various practices and initiatives to monitor and manage gate station meter variations.

Investment in Facilities

- Replaced two 30" meters in series with three 24" meters in parallel to improve the accuracy of measurements at Vector/Dawn.
- Replaced orifice meters with ultrasonic meters at storage pool 156 to improve the accuracy of measurements.

[53] Includes both legacy Union North and legacy Union South service area gate stations. Some of the differences are driven by known and explainable issues.

- Replaced orifice plates with ultrasonic and turbine meters at most gate stations, improving accuracy of measurement.

Processes and Procedures

- Implement SOX controls to ensure accurate measurements.
  - These include comparison of custody vs. check measurement at both Union and non-Union gate stations and storage sites.
  - These ensure that the customer volumes sent downstream to the billing system match the upstream measurement system.
- Deploy validation procedures to identify a variety of issues including missing measurement, out of tolerance measurement, temperatures, and pressures.
- Onsite review of third-party meter inspections.
- Regularly inspect and calibrate as needed legacy Union's metering equipment.
- Conduct training programs that include measurement and gas quality equipment, installation, inspection and troubleshooting procedures.
- Conduct audits of third-party stations, resulting in improvement to gate station design.
- Semi-Annual audit of underground storage pools measured volumes compared to calculated volumes. Audit process includes investigation into variances, resolution of issues, and continuous monitoring.

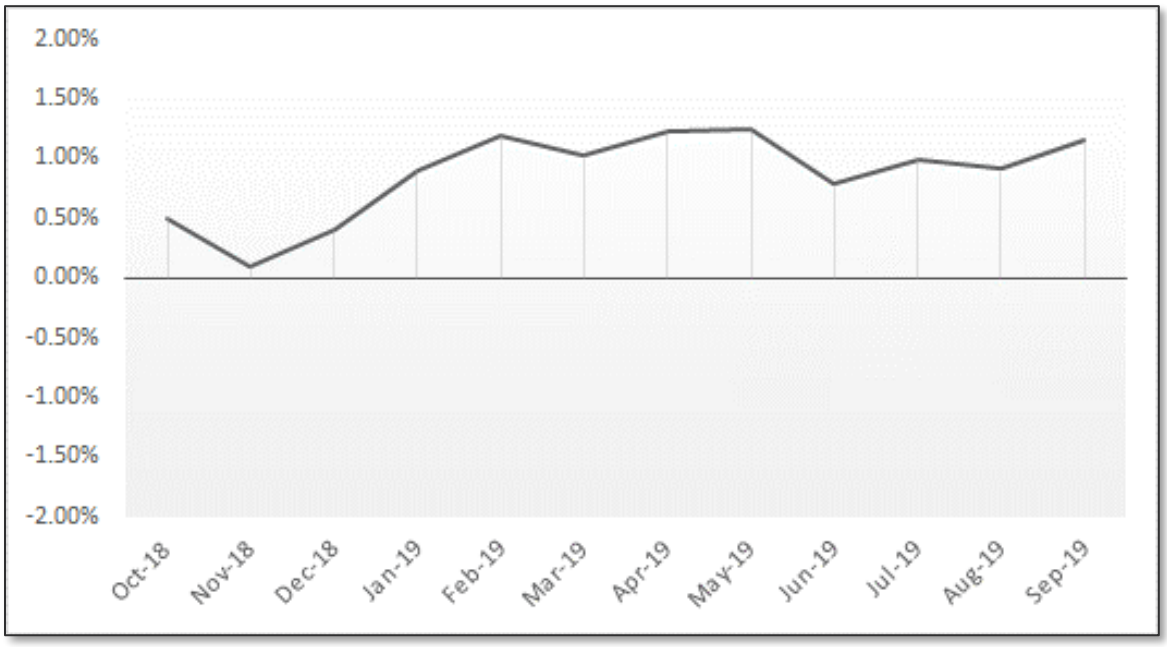
Legacy EGD Experience

Gate station meter variations represent a potential source of UFG for legacy EGD if there are differences at the receipt points between actual and metered volumes. Legacy EGD's system includes approximately 40 receipt points, including interconnections with TC Energy and legacy Union, who own the custody transfer meters. Legacy EGD installed check meters downstream of the custody meters to validate the gas receipts.

Check meters are reviewed daily with meter variances greater than 2.0 percent investigated first, by the Telemetry group for check meter issues, and then if required, by the supplier for any custody meter issues. Meter differences can be attributed to variability in the types of meters between the companies, including turbine, ultrasonic and rotary meters. Differences between actual and measured volumes can be a source of UFG.

A comparison between legacy EGD's check meters and custody meters shows differences to be within the +/- 3.0 percent Measurement Canada requirements and within the +/- 2.0 percent legacy EGD's internal benchmarks, as shown in Figure 16 (below).

Figure 16: Third-Party Custody Transfer vs. Legacy EGD Check Meter Differences[54]



The Figure shows the third-party custody meters register gas receipts at a level within +/- 2.0 percent for the period twelve-month ending September 2019.

Legacy EGD in 2017 prepared data on the sources of UFG.[55] The data showed that variations between check meters and custody meters represented a potential source of UFG (28.4 percent of 2016 UFG). The most notable meter variation was at Victoria Square gate station. Legacy EGD prepared additional data that showed variations between check meters and custody meters of 0.75 percent of gas receipts.[56]

[54] Includes all third-party custody gate station measurements for legacy EGD.

[55] As filed in EB-2017-0102, Response to BOMA Interrogatory #21 (Exhibit I.B.EGDI.BOMA.21).

[56] As filed in EB-2017-0086, Exhibit D1 Tab 2.

It is important to note that gate station meter variations represent differences between the custody meters and check meters and are not necessarily a source of UFG as the variations may be attributable to a variety of circumstances, such as differences in the type of meters.

Legacy EGD implemented various practices and initiatives to monitor and manage gate station meter variations.

Investment in Facilities

- Redesigned the Victoria Square Gate Station to more accurately measure gas flows. The project is scheduled to commence in 2020.
- Replaced all measurement equipment at storage facilities.

Processes and Procedures

- Improve process to monitor and evaluate measurement variations at TC Energy's gate stations (Including consideration of meter specification differences when reviewing check vs. custody measurement variances).
- Transfer gate station monitoring responsibilities to a specialized measurement group which would incorporate best practices and have greater resources to investigate discrepancies.
- Hold monthly cross-functional meetings to discuss measurement variances, issues, and potential steps to minimize these variances.

Evaluation of New Techniques and Practices

- Review receipt point meter changes, as needed, to better align measurements.
- Review exchanging or swapping check meters to evaluate meter bias.
- Review requests for meter audits.
- Potential review of all measurement sites within an isolated geographic area (gate stations, interconnects, customer sites) to identify actual UFG from gate station measurement.

Findings

- Gate station meter variations are a potential source of UFG at Enbridge.
- Enbridge has procedures and processes to monitor and manage gate station meter variations, including check meters to verify the accuracy of the custody meters.
- Enbridge has an ongoing effort to identify and standardize "best practices" across the legacy Companies.

VII. THEFT AND NON-REGISTERING METERS

This section describes initiatives that gas utilities and the legacy Companies have taken to monitor and manage theft and non-registering meters as a potential source of UFG.

Industry Background

Theft and non-registering meters can be a potential source of UFG.

Theft is gas that is intentionally used and not paid for by customers. One study found that the amount is trivial for most U.S. utilities.[57] This finding is consistent with a PURA report which found that theft accounted for 0.0 percent to 0.33 percent of UFG for Connecticut gas utilities in 2017. [58]

Non-registering meters are those meters that fail to measure and/or record gas usage, such as when the meter is broken.

Theft and non-registering meters are generally identified through a review of billing records and periodic field inspections. For example, gas utilities review billing records for unexplained changes in customer usage. In addition, gas utilities conduct field visits to visually inspect and report meter damage.

Some gas utilities offer incentives when theft is detected and confirmed.

DTE Gas Identification and Monitoring Programs

DTE Gas continuously analyzes usage and billing data to determine sources of unmetered, unbilled or under-estimated volumes.

- Meters that stop registering or indicate significantly less usage than historical volumes are investigated for equipment malfunction or theft
- A third-party uses thermal imaging to determine which locations appear heated. The homes with an apparent heat source but no active customers are referred for investigation of possible theft or for non-registering meters

Legacy Companies' Experience

Theft and non-registering meters represent a potential source of UFG for the legacy Companies, although their experience suggests that theft and non-registering meters have little to no impact on UFG.

[57] Lost and Unaccounted-for Gas: Practices of State Utility Commissions, National Regulatory Research Institute (June 2013).

[58] State of Connecticut, 2018 PURA Report to the General Assembly Concerning Lost and Unaccounted for Gas (Docket No. 18-03-28),

The legacy Companies have processes and procedures to identify theft and non-registering meters. The processes and procedures include a review of billing records to identify unexplained changes in customer usage. In addition, the legacy Companies conduct field visits to visually inspect and report meter damage.

The legacy Companies have implemented several practices and initiatives to monitor and manage potential theft and non-registering meters.

- Detect and investigate potential theft (i.e., unauthorized bypass, or reversing flows); or gas usage that occurs on a meter that was turned off.
- Detect meter tampering (i.e., meter turned on and/or lock removed, and meter turned on without authorization); unexplained changes in gas usage.
- Install meters outside (to the extent possible) – provides easy access and detection of theft and any other metering issues.
- Conduct annual training for meter readers on identifying theft and unauthorized usage.
- Bill customers for gas usage associated with theft or meter tampering.

Findings

- Theft and non-registering meters are a potential source of UFG, although they appear to have little impact on UFG at Enbridge.
- Enbridge has processes and procedures in place to identify and limit theft and non-registering meters. The processes and procedures are generally consistent with those found at other gas utilities.

VIII. COMPANY USE

This section describes practices and initiatives that gas utilities and the legacy Companies have taken to monitor and manage Company use as a potential source of UFG.

Industry Background

Company use is natural gas used by gas utilities in its operations. Company use can be a source of UFG if the volumes are not accurately metered, recorded and accounted for. Gas utilities generally use natural gas for office heating systems, backup power generation, vehicle use and in-line process equipment, such as heaters at gate stations. Gas utilities meter, record and account for Company use as part of quantifying UFG.[59]

New York: Company Use as UFG Source

A NY PSC Staff Whitepaper identified Company Use as not being correctly accounted for by some utilities; specifically, the whitepaper states: "This study initiated an internal investigation within the LDCs [local distribution companies] and found that they neglect to account for some heater and compressor gas usage." The study recommended: "Gas for company use should be included in the metered-out gas, like any other end user, to be fair and consistent with other sales customers."

One study recognized Company use as a large source of UFG.[60] The study described the importance of metering, recording and accounting for all Company use in quantifying UFG.

Legacy Companies' Experience

The legacy Companies measure, record and account for Company use on a monthly basis. Company use includes volumes related to the heating systems for offices, backup power generation units, and heaters at the gate stations. The legacy Companies have procedures in place to ensure completeness and accuracy of meter reads, which includes Company use meter reads.[61] The legacy Companies include Company use in "Accounted For" gas; as a result, Company use appears to have little impact on UFG.

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[59] For example, most NY utilities include Company use as an addition to Disposition volumes. (NYS Department of Public Service, Staff White Paper on Lost and Unaccounted for Gas, Case 13-G-0031)

[60] ICF International: Lost and Unaccounted for Gas, Prepared for Massachusetts Department of Public Utilities (December 2014).

[61] We note that Legacy EGD recently started to reflect Company Vehicle Gas volumes in the UFG calculation.

Findings

- Company use is a potential source of UFG, although it appears to have little impact on UFG at Enbridge.
- Enbridge measures, records and includes Company use in “Accounted For” gas.
- Enbridge has an ongoing effort to identify and standardize “best practices” across the legacy Companies.

IX. ACCOUNTING ADJUSTMENTS

This section describes practices and initiatives that gas utilities and the legacy Companies have implemented to monitor and manage accounting adjustments as a potential source of UFG.

Industry Background

Accounting practices and procedures can be a potential source of UFG when accounting adjustments impact reported gas receipts or gas deliveries. This can include adjustments related to unbilled sales and billing errors and corrections.

- Unbilled sales adjustments: Variations between estimated unbilled sales (included in reported gas deliveries) and actual unbilled sales can be a potential source of UFG. Estimated unbilled sales that are higher than actual unbilled sales would tend to lower UFG levels, with all other things the same, while estimated unbilled sales that are lower than actual unbilled sales would tend to raise UFG levels.

AltaGas Usage Estimation

AltaGas, in its Rate Rider Application, recognized estimated and prorated deliveries to be a source of UFG. The Application states: "Usage estimation variances may be large enough to create an apparent negative UFG volume in a given month or, more rarely, two or three consecutive months. Negative UFG volumes on a monthly basis occur almost exclusively in the shoulder and summer months, are low in relation to total UFG volumes, and generally reverse or correct themselves within a one-year period."

- Billing errors and corrections: Large billing errors included in reported gas deliveries can be a source of UFG, especially if the billing errors and subsequent corrections occur in different UFG study periods. This would occur, for example, if the error occurred in one year and the correction occurred in a different year. Billing errors that overstate gas usage would tend to lower UFG levels, with all other things the same, while billing errors that understate gas usage would tend to raise UFG levels.

- Billing Estimation: Usage estimates are required for periods when meter reads are unavailable. Any variances in usage estimations can result in UFG. For example, AltaGas, in its Rate Rider

Application,[62] recognized estimation and proration of gas delivery volumes to be a potential source of UFG.

- Line Pack: Line pack represents the gas volumes contained within the distribution system. Changes in line pack can be a potential source of UFG. For example, the installation of a new pipeline would increase gas receipts used to fill the pipeline without a corresponding increase in gas deliveries, thus creating a potential source of UFG. Changes in line pack can also result from changes in weather and pressure conditions.

Some gas utilities address potential variations between estimated and actual unbilled sales by reporting UFG during the summer months.[63] This approach minimizes unbilled sales since month-to-month sales during the summer are generally consistent.

In addition, some gas utilities address billing errors through periodic audits, training and well-defined billing practices to promptly identify and correct any such errors.[64] Billing errors as a potential source of UFG are generally small if the billing errors are identified and corrected within the same period.

Finally, some gas utilities address the impact of line pack by identifying changes in line pack. For example, Central Hudson Gas & Electric's UFG calculation incorporates a line pack adjustment to compensate for the effect of temperature and pressure on the amount of gas in the system.[65]

Legacy Companies' Experience

Unbilled sales and billing errors can represent a potential source of UFG for the legacy Companies. The legacy Companies have developed a process to estimate unbilled sales. The legacy Companies have a process to periodically review and refine, as necessary, the estimation process to improve the accuracy of the unbilled sales estimates.

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[62] AltaGas Utilities Inc. 2018-2019 Rate Rider E and Rate Rider H – Unaccounted for Gas Application, submitted to Alberta Utilities Commission (July 2018).

[63] Examples of Canadian Utilities reporting UFG on summer-to-summer basis include AltaGas Ltd., and Manitoba Hydro who report UFG on a 12 month-ending May basis.

[64] Lost and Unaccounted-for Gas: Practices of State Utility Commissions, National Regulatory Research Institute (June 2013).

[65] NYS Department of Public Service, Staff White Paper on Lost and Unaccounted for Gas, Case 13-G-0031.

Presently, legacy Union adjusts for line pack in its calculation of UFG. In December 2019, Enbridge plans to adjust for line pack in its calculation of UFG.

Findings

- Unbilled sales and billing errors are a potential source of UFG for Enbridge.
- Enbridge plans to ensure all of its UFG calculations account for changes in line pack.
- Enbridge has an ongoing effort to identify and standardize “best practices” across the legacy Companies.

X. CONCLUSION

This report employed a three-phased approach to compare the legacy Companies practices to monitor and manage UFG to those in the gas utility industry.

The report found that the legacy Companies' UFG levels are generally lower than comparative gas utilities over the past 10 years. The report also found that UFG levels fluctuate from year-to-year, consistent with other gas utilities. The fluctuations are a result of many factors, including weather, estimation variation, measurement variation, and billing and accounting adjustments.

The report found that the primary sources of UFG for the legacy Companies include physical losses, retail meter variations, and gate station meter variations. The Companies have established practices and initiatives to monitor and manage these potential sources of UFG. Some of the initiatives include investment in new facilities, new processes and procedures, and review of new practices and techniques. The practices and initiatives at the legacy Companies to monitor and manage sources of UFG are generally consistent with those employed by other gas utilities.

ScottMadden recommends Enbridge identify and standardize "best practices" across the legacy Companies. In addition, ScottMadden recommends Enbridge document data, processes and studies related to monitoring and managing UFG. Finally, ScottMadden recommends that, on a periodic basis, Enbridge investigate the sources of UFG, research industry practices and initiatives for monitoring and managing sources of UFG, and implement, as appropriate, new practices and initiatives to better monitor and manage sources of UFG.

APPENDIX-A: UNACCOUNTED FOR GAS FORECASTING

Legacy Union

Legacy Union's UFG forecast is based on forecasted throughput volumes multiplied by a UFG ratio, currently approved by the Ontario Energy Board for rate-setting purposes to be 0.219 percent. The UFG ratio is determined using a Board approved weighted average of the most recent three years of actual activity. [66] The most recent year has a weighting of 3/6ths, the second year has a weighting of 2/6ths and the first year has a weighting of 1/6th. Legacy Union resets the UFG forecast ratio and the resulting volume through each rebasing (or cost of service) rate setting proceeding.

All budgeted UFG is assumed to be in legacy Union South and is forecast based on the same Board approved methodology as noted above utilizing the most current three years of actual UFG to determine a weighted average UFG ratio.[67] This ratio is applied to budgeted throughput volumes resulting in budgeted UFG volumes and multiplied by the Weighted Average Cost of Gas ("WACOG"). The monthly variance to budget in the legacy Union South service area will be made up of a volume and price variance. UFG is not specifically budgeted for the Union North service area and therefore any UFG actually incurred per the legacy Union North calculation is a volume variance to the budgeted UFG.

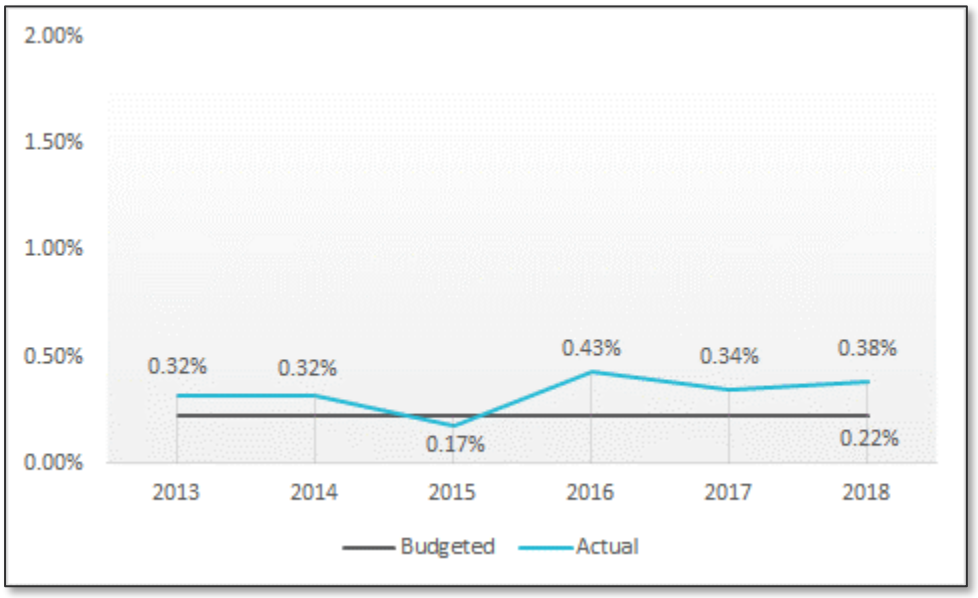
In forecasting UFG volumes for both budgeting and rate setting purposes, legacy Union's forecast throughput volumes are a key input to the calculation, as described above. UFG is measured and often described as a percentage of legacy Union's throughput volumes. For this purpose, legacy Union's throughput volumes include all of legacy Union South's in-franchise consumption and the transportation throughput volumes on historically defined ex-franchise transport paths. Maintaining consistency for the definition of throughput volumes used to measure UFG as a percentage historically and for the forecast period is essential.

Figure 17 (below) shows legacy Union 5-year historical UFG compared to the approved UFG budget.

[66] As approved in EB-2011-0210.

[67] The UFG costs are allocated to all rate classes including those in Union North based on transmission and storage volumes.

Figure 17: Legacy Union Budgeted UFG vs. Actual UFG (as % of Sendout)



Legacy EGD

Legacy EGD uses a regression model to forecast the UFG which relies on the total number of unlocked customers as its primary explanatory variable to proxy for the size of the distribution system. The greater the number of customers, the larger the distribution network, the greater the potential for UFG volume, all other factors equal. The model also includes variables to account for a structural change in 2002, a negative UFG value, as well as higher than anticipated UFG in 2013.

The actual UFG, unlocks, and forecasted unlocks are required to update the model for the budget year forecast. The actual UFG data is received from 'Utility Gas Cost' department. Unlocks forecast is developed by the 'Demand Forecasting' department using the Board approved methodology.

In 2016, legacy EGD tested a variety of forecasting models and proposed to use the model that produced the most accurate and reasonable results. In the Settlement Proposal for EB-2015-0114, parties agreed

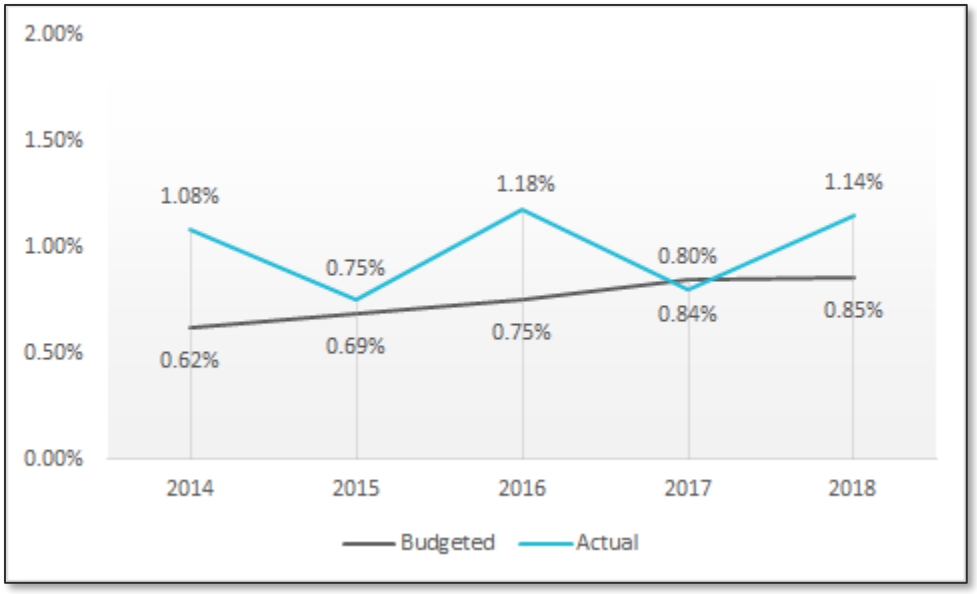
that it is not appropriate to update UFG forecasting methodology during the Custom IR term; the Board approved the Settlement Proposal.[68]

As a result, the below model that was applied and approved as a part of the 2016 Rate Application has continued to be used since then.[69]

$$UFG_t = \beta_0 + \beta_1 * LOG(ULKS)_t + \beta_2 * DUM02_t + \beta_3 * DUMNEG_t + \beta_4 * DUM2013_t + \varepsilon_t$$

Figure 18 (below) shows Legacy EGD 5-year historical UFG compared to UFG forecast.

Figure 18: Legacy EGD Budgeted UFG vs. Actual UFG (as % of Sendout)



The Figure shows legacy EGD has experienced year-to-year fluctuations in UFG levels. ScottMadden evaluated the UFG data for potential drivers of the year-over-year changes in legacy EGD UFG but did not observe any noticeable patterns. However, as discussed in Section II of this report, these fluctuations are generally consistent with those of other gas utilities, and can be a result of many factors, including weather, estimation variation, measurement variation, and billing and accounting adjustments.

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[68] Decision and Accounting Order, EB-2015-0114, December 10, 2015.

[69] Refer to EB-2014-0276, Exhibit D1, Tab 2, Schedule 3. ULKS denotes Total Number of Unlocked Customers; DUM02 denotes dummy variable for a structural change in 2002, DUMNEG denotes dummy variable for a negative UFG value, and DUM2013 denotes a dummy variable for higher than anticipated UFG in 2013.

APPENDIX-B: BENCHMARKING METHODOLOGY

The benchmark analysis included U.S. and Canadian investor-owned gas utilities. The U.S. gas utilities data were collected from EIA, while the Canadian gas utilities data were collected from various publicly accessible sources. U.S. gas utilities without 10 years of data were removed from the analysis. In addition, U.S. gas utilities with less than 10 million Mcf of disposition volumes were also removed.

Benchmarking is conducted against four groups of utilities

1. U.S. gas utilities
   - 106 investor-owned utilities
   - Utilities with less than 10-years of data were removed
   - Utilities with less than 10 million Mcf disposition volumes were removed
2. East North Central Region gas utilities
   - Utilities in the U.S. states adjacent to Ontario. These include Illinois, Indiana, Ohio, Michigan, and Wisconsin
   - Utilities with less than 10 million Mcf disposition volumes were removed

Figure 19: East North Central Region Utilities

Utility Name	State of Operation	2017 Disposition Volumes (Mcf)
NICOR GAS	Illinois	576,970,901
PEOPLES GAS LIGHT AND COKE COMPANY	Illinois	190,572,384
AMEREN ILLINOIS	Illinois	184,775,985
NORTH SHORE GAS COMPANY	Illinois	32,351,664
MIDAMERICAN ENERGY COMPANY	Illinois	10,120,543
NORTHERN INDIANA PUBLIC SERVICE CO	Indiana	340,088,401
INDIANA GAS COMPANY INC	Indiana	130,739,915
SOUTHERN INDIANA GAS AND ELECTRIC	Indiana	39,465,546
CONSUMERS ENERGY COMPANY	Michigan	463,522,818
SEMCO ENERGY GAS COMPANY	Michigan	64,639,669
MICHIGAN GAS UTILITIES CO	Michigan	32,501,328
EAST OHIO GAS COMP DOMINION EAST OH	Ohio	346,056,951
COLUMBIA GAS OF OHIO	Ohio	242,263,831
DUKE ENERGY OHIO	Ohio	69,615,580
VECTREN ENERGY DELIVERY OF OHIO	Ohio	53,421,556
WISCONSIN ELEC PWR CO	Wisconsin	101,724,779
WISCONSIN POWER AND LIGHT COMPANY	Wisconsin	62,272,184
MADISON GAS ELEC CO	Wisconsin	27,550,350
NORTHERN STATES PWR CO	Wisconsin	24,245,497

3. Canadian Utilities

   - Canadian Utilities with publicly accessible data on UFG. These include Manitoba Hydro, AltaGas Ltd., ATCO Gas Ltd., FortisBC, and Pacific Northern Gas Ltd. (Northeast Region)

Figure 20: Canadian Utilities Data

Year	Manitoba Hydro	AltaGas	ATCO Gas	FortisBC	PNG (NE)	Average UFG
2008	0.68%	1.18%	0.59%	3.20%		1.41%
2009	1.35%	0.94%	1.02%	1.60%		1.23%
2010	0.73%	1.35%	0.93%	1.20%		1.05%
2011	1.01%	1.64%	1.02%	2.10%	2.64%	1.68%
2012	0.52%	1.19%	0.88%	1.40%	0.73%	0.94%
2013	1.27%	1.38%	1.37%	1.40%	0.28%	1.14%
2014	1.32%	1.08%	1.20%		-0.30%	0.83%
2015	0.67%	1.28%	0.92%		1.03%	0.97%
2016	0.24%	0.89%	0.57%		5.30%	1.75%
2017	0.58%	1.05%	0.83%		0.79%	0.81%

4. U.S. Utilities Comparison Group

   - Comparison group of 14 U.S. utilities selected based on the following criteria:
     - Disposition volumes more than 100 million Mcf
     - Northeast region including U.S. states of Illinois, Ohio, Indiana, Michigan, Wisconsin, New York, and Massachusetts

Figure 21: Select Comparison Group of U.S. Utilities

Utility Name	State of Operation	2017 Disposition Volumes (Mcf)
NICOR GAS	Illinois	576,970,901
PEOPLES GAS LIGHT AND COKE COMPANY	Illinois	190,572,384
AMEREN ILLINOIS	Illinois	184,775,985
NORTHERN INDIANA PUBLIC SERVICE CO	Indiana	340,088,401
INDIANA GAS COMPANY INC	Indiana	130,739,915
BOSTON GAS CO DBA NATIONAL GRID	Massachusetts	118,525,820
CONSUMERS ENERGY COMPANY	Michigan	463,522,818
CONSOLIDATED EDISON NEW YORK INC	New York	318,164,393
THE BROOKLYN UNION GAS CO	New York	189,278,715
KEYSPAN ENERGY DBA NATIOAL GRID NY	New York	183,103,988
NIAGARA MOHAWK DBA NATIONAL GRID	New York	155,751,005
EAST OHIO GAS COMP DOMINION EAST OH	Ohio	346,056,951
COLUMBIA GAS OF OHIO	Ohio	242,263,831
WISCONSIN ELEC PWR CO	Wisconsin	101,724,779

APPENDIX-C: LIST OF ACRONYMS

Acronym	Description
AGA	American Gas Association
AMI	Advanced Metering Infrastructure
AMR	Automated Meter Reading
EIA	U.S. Energy Information Administration
Enbridge	Enbridge Gas Inc.
EVI	Electronic Volume Integrators
Legacy EGD	Legacy Enbridge Gas Distribution
Legacy Union	Legacy Union Gas Limited
Mcf	Thousand Cubic Feet
NRRI	National Regulatory Research Institute
NYSEG	New York State Electric and Gas Corporation
OEB	Ontario Energy Board
ORCGA	Ontario Regional Common Ground Alliance
PFM	Pressure Factor Metering Set
PHMSA	Pipeline and Hazardous Materials Safety Administration
PPA	Prior Period Adjustments
PURA	Connecticut Public Utilities Regulatory Authority
SOX	Sarbanes-Oxley Act
SDG&E	San Diego Gas & Electric
Sendout	Total gas produced, purchased, or net withdrawn from storage within a period
SoCalGas	Southern California Gas
TC Energy	TransCanada Pipeline Limited (affiliate of TC Energy)
TOCs	Turbocorrectors for rotor meters
TSSA	Technical Standards and Safety Authority
UFG	Unaccounted for Gas
WACOG	Weighted Average Cost of Gas