

Reducing Lost and Unaccounted for Natural Gas in Distribution Systems

Summary:

Reduce lost and unaccounted (L&U) for natural gas from natural gas distribution operations by 15% by the year 2020. The period of analysis is 2013 through 2020. Fugitive emissions reductions are assumed to be implemented linearly until the 15% target is reached in 2020.

Introduction:

The Pennsylvania Public Utility Commission (PUC) requires Nature Gas Distribution Companies (NGDC) to report their levels of unaccounted for gas regularly. However, there is little case law defining unaccounted for gas. The American Gas Association defines L&U as the difference between the total gas available from all sources, and the total gas accounted for as sales, net interchange, and company use. Prior to April 2012 unaccounted for natural gas was not defined in 66 Pa. C.S. § 1307 or 52 Pa Code §§ 53 or 59. On April 4, 2012, the PUC finalized rulemaking establishing a uniform definition of unaccounted natural gas and level metrics for natural gas distribution system losses for Pennsylvania's NGDCs. Unaccounted for natural gas is now defined as the difference between total amount of gas supplies delivered to the NGDC and the amount of gas that the NGDC subsequently delivers to its retail, commercial and industrial customers, adjusted for company use, temperature, pressure variations or other allowed variables. It is the gas that is lost during transportation from supplier to customer. This uniform definition will allow for more accurate accountability for lost and unaccounted for natural gas.

Natural gas is released to the atmosphere through fugitive and vented emissions. Fugitive emissions are methane leaks often through pipeline and system components (such as compressor seals, pump seals and valve packing). Vented emissions are methane leaks from a variety of equipment and operational practices, such as well completion activities and are directly attributed to an organization's actions but also through accidental line breaks and thefts.

Baseline Activities for 2009 (latest data):

Natural Gas Consumers in Pennsylvania in 2009 ¹¹ – 2,873,948

- Residential – 2,635,869 (91.7%)
- Commercial – 233,333 (8.12%)
- Industrial – 4,746 (0.002%)

Pennsylvania Natural Gas Consumption by End User in 2009

- Residential – 228 Bcf (30%)
- Commercial – 144 Bcf (19%)
- Industrial – 173 Bcf (23%)
- Electric Power Generation – 211 Bcf (28%)

Pennsylvania Natural Gas Production in 2009

- Conventional Production – 209.3 Bcf
- Marcellus Production – 78.4 Bcf
- Total Production – 287.8 Bcf

Lost & Unaccounted for Natural Gas:

¹ Gas Consumers and Gas Consumption information was provided through an U.S Energy Information System query – 2010 Data

NGDCs report L&U natural gas to the PUC. It is important to reduce natural gas losses for safety concerns. Reducing these losses also provides significant environmental benefit via the reduction of greenhouse gas emissions. According to the Environmental Protection Agency (EPA) natural gas (methane) is approximately 21 times more harmful as a greenhouse gas than carbon dioxide.

Table 1 indicates the last reported Distribution Utilities L&U natural gas was 18.7 billion cubic feet (Bcf). In the previous action plan the reported L&U was 19.6 Bcf. This is a decrease in L&U gas of approximately 4.6% while the number of natural gas consumers has increased by approximately 1.2% and the amount of natural gas consumption has increased approximately 19.5% since last reported in the previous action plan. However, the reported L&U values are not accurately estimating gas companies' individual contributions to fugitive or vented emissions for the following reasons:

- 1) End-use consumer meters (likely to be residential sector meters) do not accurately measure delivered volumes. This is because some meters do not accurately account for temperature and pressure sensitivities. It is thought that consumer meters are approximately + or – 3% in measurement accuracy.
- 2) Natural gas companies use a portion of their product in various stages of the transmission process (i.e. compressors), which is not separately quantified.
- 3) Gas theft may also be occurring, although it is assumed to be a relatively minor loss with regard to L&U reporting.
- 4) The PUC does not have standardized calculation/reporting procedures for L&U. In previous years, some utilities have actually report gains (delivered volumes in excess of what was reportedly placed into the system) instead of losses. This means that it is not possible to draw conclusions from the PUC's statewide L&U statistics.
- 5) The PUC indicates there are approximately 6,000 line breaks per year due to accidents (i.e. digging-up a line during construction). Methane releases from these individual accidents have not been quantified.

Therefore, there are three primary areas that need to be addressed to improve our understanding L&U natural gas:

- Accurate measurement and reporting.
- Operations and maintenance improvements (or replacements) to lines and aging parts and
- Minimization of accidental losses through line breaks.

Potential GHG Reductions and Economic Costs:

Table 1. Estimated GHG Reductions and Cost-effectiveness

GHG emission savings (2020)	0.006	MMtCO ₂ e
Net present value (2013–2020)	N/Q	\$million
Cumulative emissions reductions (2013–2020)	0.102	MMtCO ₂ e
Cost-effectiveness (2013–2020)	N/Q	\$/tCO ₂ e

GHG = greenhouse gas; MMtCO₂e = million metric tons of carbon dioxide equivalent; \$/tCO₂e = dollars per metric ton of carbon dioxide equivalent. Negative numbers indicate costs savings.

Table 2: Lost & Unaccounted-for Natural Gas for Major Gas Distribution Companies⁺

Distribution Company	Total Lost & Unaccounted-for (Mcf)	Total Deliveries (Mcf)	Percent L & U	Data Year
Columbia	66,646	117,680,838	0.06%	2010
Dominion-Peoples	5,764,495	90,143,516	6.39%	2008
Equitable	2,428,560	60,568,085	4.01%	2010
National Fuel	939,364	50,456,478	1.86%	2010
PECO Gas	2,480,886	91,030,465	2.73%	2010
UGI - Penn	291,315	65,334,580	0.45%	2010
Phila. Gas Works	4,969,805	89,222,623	5.57%	2010
PPL Gas	1,531,629	27,831,130	5.50%	2007
UGI - Gas	279,301	124,401,133	0.22%	2010
Totals	18,752,001	716,668,848	2.62%	

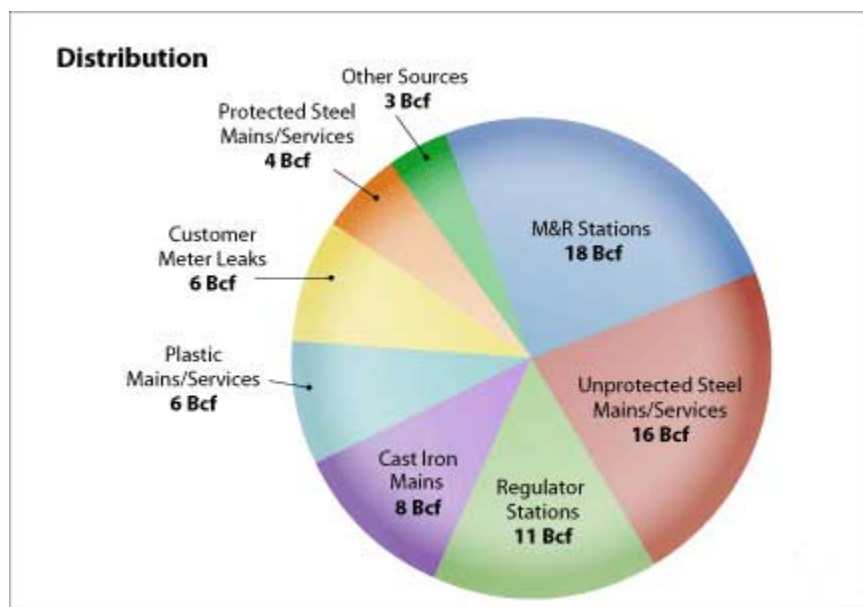
+ There are no PUC standards for reporting lost and unaccounted for natural gas

Table 2 provides data on the amount of cast iron and unprotected steel pipe in each distribution company's territory. These two types of pipe have the highest fugitive loss rates. Much of the pipeline replacements that are occurring use plastic coated steel or similar material that is less permeable and provides a measure of increased safety and increased longevity. Each of the distribution companies has a plan in place with the PUC for ongoing replacement of aging distribution pipelines.

Table 3: Pennsylvania Distribution Sector – Report on Cast Iron and Unprotected Steel²

Distribution Company	Miles of Cast Iron	Miles of Unprotected Bare Steel	Total Miles Distribution	% of Statewide Total Cast Iron	% of Statewide Total Unprotected Bare Steel
Columbia Gas of PA	74	2127	7,260	2.3%	25.0%
Dominion Peoples	66	1,908	6,566	2.0%	22.4%
Equitable Gas	47	705	3,307	1.4%	8.3%
National Fuel Gas	93	1,051	4,916	2.8%	12.3%
PECO	836	369	6,614	25.5%	4.3%
UGI Penn Natural	82	305	2,562	2.5%	3.6%
Phila. Gas Works	1,624	-	3,019	49.5%	0.0%
PPL Gas	28	661	3,619	0.9%	7.8%
T.W. Phillips	-	1,095	2,955	0.0%	12.9%
UGI	428	300	5,012	13.1%	3.5%

² Developed by the PUC using U.S. Department of Transportation Data

Figure 1: 2009 U.S. Distribution Sector Methane Emissions (72 Bcf)³**Table 4: 15 Percent of Pennsylvania L&U 2009 Distribution Sector Emissions (18.7 Bcf)**

	% loss	Loss (MCF)	Implementation Cos (\$ Million)	NG Recovered (Mcf)	NG Saved (\$ Million)	CO2e (MMT)	Cost \$/t CO2e
Meters	8%	224,400	\$5.180	29,806	\$0.146	0.008	\$629
Cast and Unprotected Steel	33%	925,650	\$58.906	122,948	\$0.603	0.034	\$1,943
other	18%	504,900	n/a	67,063	\$0.324	0.019	N/Q
Metering and Regulating Stations	40%	1,122,000	n/a	149,028	\$0.731	0.041	N/Q
TOTAL	99%	2,776,950	\$64.086	368,845	\$1,804	0.102	

Economic Cost:

According to the EPA, fugitive emissions from commercial/industrial and residential customer meters account for 8 percent of the national total for natural gas industry methane emissions.* The average leak rate per residential meter is only 0.01 scf/hr (0.0003 m³/hr), but there are approximately 40 million customer meters located outdoors, 2.6 million of which, according to the PUC, are located in PA. These emissions are related to fugitive methane losses from the meter and associated pipe and fittings. To contribute to the 15 percent reduction in L&U natural gas by the year 2020, PA distribution companies would need to replace 51.8 thousand meters by 2020. This amount of meter replacements would result in more than 8,000 metric tons of methane emission reductions.

According to the EPA, distribution sector emissions are driven primarily by underground pipeline leaks and metering and pressure regulating stations (M&PR stations), as identified in Table 4. Fugitive methane emissions from underground pipe lines (cast iron and unprotected steel) account for 33 percent

³ U.S. EPA, 2011: November 2011, Natural Gas Star Program Accomplishments

* Based on Figure 1 above

of the national total from the natural gas industry. The PUC states that about 12,000 miles of aging gas mains need replacing (3,278 miles of cast iron, 8,907 miles of unprotected bare steel-see table above). The estimated cost of replacing gas mains is approximately \$1 million/mile. To achieve a 15 percent reduction in L&U natural gas from 2013 through 2020, 58 miles of gas mains would need to be replaced, resulting in nearly 34,000 metric tons of methane emission reductions. Assuming a linear relationship between lost gas and the rate of pipeline replacement would yield a cost of approximately \$58.9 million. At historical rates of replacement, the replacement of 58 miles of underground pipeline would take approximately 20 years. In order to facilitate the goal of this work plan and to address the aging gas main safety issues a more rigorous plan to replace 8.5 miles of gas mains annually should be undertaken by the NGDCs. The PUC believes there may be future federal government requirements to eliminate the older gas mains and expedite their replacement with the installation of new generation gas mains..

M&R stations in the distribution segment include both transmission-to-distribution custody transfer points and the downstream pressure reduction stations. The EPA estimates fugitive emissions from regulator stations and M&R stations account for 40 percent of the total annual national methane emissions*. The primary losses from M&R stations include both fugitive emissions and, in some cases, emissions from pneumatic devices. Some pressure regulating stations use gas-operated pneumatic devices to position the pressure regulators. These gas-operated pneumatic devices bleed to the atmosphere continuously and/or when the regulator is activated for some system designs. Other designs bleed the gas downstream into the lower pressure pipeline and, therefore, have no losses associated with the pneumatic devices. By redesigning bleed devices and addressing other sources of fugitive emission at M&R stations, methane emissions could drop by 15 percent by 2020. This could eliminate approximately 40.7 thousand metric tons of methane emissions.

According to the EPA “Other Sources” of methane emissions are responsible for 4% of total national annual methane emissions*. One of these sources of emissions is blow and purge operations. Blow (or blow-down) gas refers to intentional and unintentional venting of gas for maintenance, routine operations, or emergency conditions. For Example; periodically natural gas is discharged to the atmosphere for one of two reasons: 1) maintenance blow-down-- the gas is vented from equipment to eliminate the flammable material inside the equipment providing a safer working environment for personnel that service or enter the equipment; or 2) emergency blow-down-- the gas is vented from a site to eliminate a potential fuel source, for example in case of fire. The factors that affect the volume of methane blow-down released to the atmosphere are frequency, volume of gas blow-down per event, and the disposition of the blow-down gas. By limiting the frequency and volume of blow and purge events and redirecting the gas downstream back into the line nearly 18 thousand metric tons could be eliminated by 2020.

Implementation Steps:

- Replacing customer meter sets with “temperature and pressure compensated” meters may cost \$100 per meter (PUC estimate). There are about 2.6 million households using natural gas (not including commercial and industrial consumers which may have temperature/pressure meters). This will result in improved metering with more accurate measuring of end-use calculation for L&U and consumption along with reduced fugitive emissions from aging meters.
- NGDCs should be encouraged to participate in existing voluntary industry programs, such as EPA’s Natural Gas STAR Program. Natural Gas STAR is focused on reducing methane emissions through technology transfer using best practices in operation and maintenance. Natural Gas STAR provides analytical tools and services to assist in calculating companies methane emissions.
- Encourage utilities to regularly perform self-assessments and report (to the PUC) operation and maintenance practices that have resulted in environmental savings.

- Improved and standardized L&U reporting for all NGDCs doing business in Pennsylvania. This would require PUC staff to develop standardized accurate reporting methods. Note: In early June 2012 the PUC issued for comment proposed regulations that would create a uniform definition of UFG and level metrics for natural gas distribution system losses for the state's NGDCs.
- We must improve on reducing accidental line breaks in Pennsylvania. Despite the availability and use of Pennsylvania's One Call System to identify underground utilities before digging, there remain too many accidents. Accidents by home owners and contractors have occurred even after notification to the One Call System and identification of underground utility services has been made. Perhaps increased enforcement and penalties of the Pennsylvania One Call System could help reduce the number of accidents. This could require additional staff time to enforce, but may be offset by fines and penalties.
- Develop and implement a plan for the replacement of at least 8.5 miles of aging cast iron and unprotected steel pipe gas mains annually through 2020 and beyond.

Potential Overlap:

None

References:

U.S. Energy Information System query – 2010 Data.

U.S. EPA, 2011: November 2011, *Natural Gas Star Program Accomplishment*.

PA. PUC, 2010: February 2010, *Natural Gas Statistics Report for Pennsylvania*

U.S. EPA, **Estimate of Methane Emissions from the U.S. Natural Gas Industry**