WHITE PAPER

Regulators Taking Aim at Methane Emissions: Does Anyone Know How Much Is Being Lost?

By Don Robinson, Hemant Mallya, and Matt Kelly

The Bottom Line

1. Regulators are developing detailed and far-reaching plans to reduce methane emissions. Big disagreements and inconsistencies exist in counting how much gas is actually escaping the system and then reaching the atmosphere.
2. In just one example, a recent Harvard study pegged Massachusetts' methane emissions to be 2.7 percent of the total natural gas consumed over a study period between 2012 and 2013, which is two times higher than Energy Information Administration (EIA) reported lost and unaccounted (LAUF) of 1.3 percent of gas consumption in 2013. When the difference in terms between LAUF and actual methane emissions is tallied, the result could be even more significant.
3. Achieving a more consistent and accurate estimate matters. Underestimates undermine an entire regulatory framework aimed at reducing greenhouse gas (GHG) emissions and global warming. Overestimates can inappropriately increase costs on industry and consumers.

Executive Summary

Both federal and state regulators are increasingly homing in on methane emissions as part of a broader effort to reduce greenhouse gases. More important than ever is understanding the role of natural gas that is lost from the local distribution system and how it factors into emissions of methane that reach the atmosphere.

A number of challenges occur in getting an accurate read on these emissions. First, analysts often use LAUF as a direct proxy for emissions, whereas emissions are a smaller subset of LAUF. Second, no common agreement exists on what the sources of LAUF are and how to estimate their relative role. Such disparities lead to confusing and wildly diverging results: a recent Harvard[1] study, for example, estimated methane emissions in Massachusetts at more twice the Federal Government's estimate of LAUF.

Big differences in methods and estimates can have serious consequences, including leading policy makers to over- or underregulate. Beyond its impact in driving regulation, the process of estimating both the components and total amount of LAUF can affect everything in the natural gas distribution system—from the rates applied to consumers to efforts to localize the sources of emissions and thereby identify potential threats to pipeline safety.

In this paper, ICF describes a recommended approach for achieving a more consistent, detailed, and accurate estimate of LAUF and emissions. We explain each of the potential components of LAUF and show how they can contribute to a total estimate by using a hypothetical case study. We also demonstrate the significant consequences of misunderstanding the different sources and terms involved in LAUF and emissions.

1 McKain, Kathryn, et. al., "Methane emissions from natural gas infrastructure and use in the urban region of Boston, Massachusetts", PNAS vol. 112 no. 7 , doi: 10.1073/pnas.1416261112

Why Does an Accurate LAUF Estimate Matter?

Getting a more accurate read on how much natural gas we are using, losing, and emitting is an increasingly crucial issue for policy makers, regulators, local distribution companies (LDCs), and ratepayers for several reasons:

- Gas already is a major part of the nation's energy picture. Its role will only grow further in the power and transportation sectors as increased supply and low prices combine with policies that incentivize fuel switching to gas-fired combined cycle generation to reduce CO_2 emissions.
- At the same time, methane emissions will be a critical component of future global warming policy. Methane makes up more than 93 percent of natural gas and is 25 times more efficient at trapping atmospheric radiation during a 100-year period than CO_2. Methane emissions from natural gas distribution systems are a component of lost and unaccounted for gas and are an important part of state and national inventories of greenhouse gases.
- The White House recently announced a major initiative to reduce methane emissions. "Leak detection and emissions reporting" is a significant component. Increased federal regulation is here to stay.
- States are equally interested in getting a handle on methane emissions as part of their reporting requirements and their own climate and air quality programs.
- Both under- and overestimation—and the resulting potential under- and overregulation—can lead to higher costs and significant problems. An estimate of lost gas and resulting emissions that is too low deeply undermines an entire regulatory framework aimed at reducing GHG emissions and global warming. An estimate that is too high places an unwarranted regulatory burden on the distribution companies, which also can flow through to higher costs on consumers.
- Accurate estimates of the various components of lost and unaccounted for gas can give early warning to LDCs on where emissions are occurring and where safety might be a future concern.

What Is the Problem in Estimating LAUF and Emissions?

State and federal regulators require that LDCs report on gas that is "lost" or cannot be otherwise accounted for between where it is purchased from the transmission companies and where it is sold to the customers. This calculation is called "lost and unaccounted for gas."

However, where to go from there is unclear. Many entities—including federal, state, and NGO bodies—have tried to estimate and quantify LAUF gas, but they tend to arrive at inconsistent answers. Part of the problem is their starting point: a review of the very definitions of LAUF used by the U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration, the American Gas Association, EIA, and various state departments of public utilities reveals important differences.

To make matters even more challenging, analyses often conflate different terms, with significant consequences, refer to Exhibit 1. "LAUF" refers to the difference between the total amount of gas that a gas distribution company purchases and the amount it delivers to customers, less

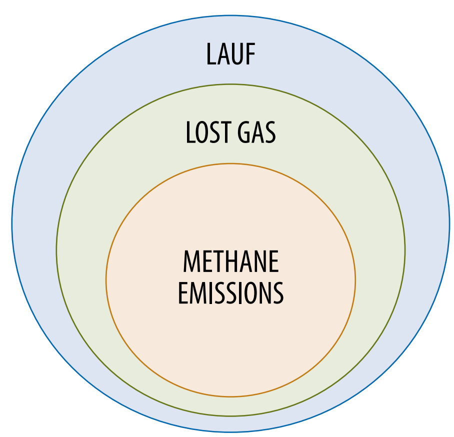


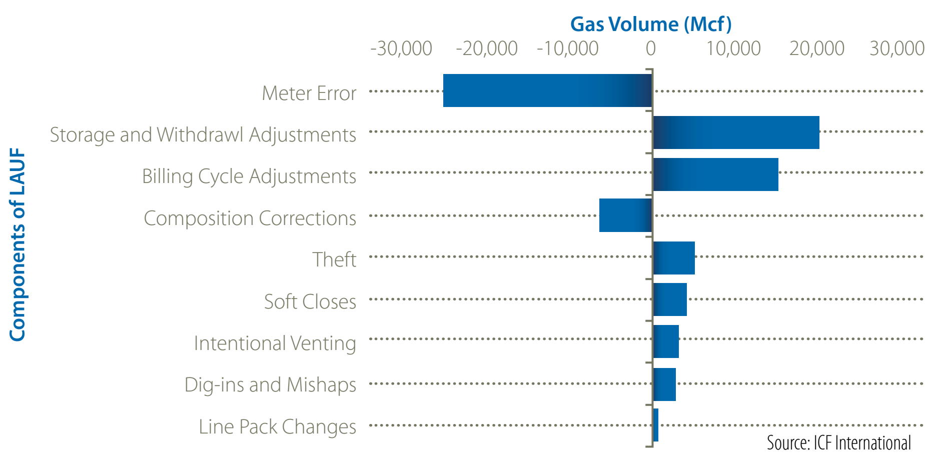
Exhibit 1: Only a portion of LAUF gas reaches the atmosphere as emissions

Source: ICF International

gas used by the company at its own facility (termed "own use"). A smaller subset of that category is "lost gas," which refers to the natural gas that actually escapes from the distribution system. And finally, "methane emissions" refers to the methane portion of natural gas that has escaped the system and that actually reaches the atmosphere. Clearly, the amount of LAUF and the amount of emissions can be very different, and confusing them can seriously bias estimates.

LAUF has many components, including meter bias, billing cycle adjustments, theft, changes in gas composition and distribution system volume, and nonmetered gas (Exhibit 2). Differences in how these components are calculated (or whether they are even included) can significantly affect the amount of gas reported as lost or unaccounted for. They are not consistently estimated across studies. Some components such as meter bias even may have a negative value. Negative values can be confusing and cause the calculation of lost and unaccounted for gas to be less than zero (more gas delivered than received). In some cases, they can obscure the degree of emissions within the system. As a consequence, regulators may get the wrong idea of what is going on, erroneously believing that a high-emitting system is in good shape.

Exhibit 2: Components of LAUF Can Have Positive or Negative Values, Leading to Confusing Net Results



A recent example clarifies just how significant an effect these differences in terms and estimation components can have. The EIA's current estimate of 5.8 billion cubic feet for lost and unaccounted for gas in 2013 in Massachusetts is based on local company reports.2 Based on EIA's estimates of total gas consumption in Massachusetts, this represents 1.3 percent of total consumption. By contrast, Harvard's study uses a different methodology, which estimates methane emissions to be 2.7 percent of delivered gas. The Harvard emissions estimate is two times greater in percentage terms than the Massachusetts' LAUF estimate, although emissions are only a subset of LAUF.

Neither methodology is definitively right or wrong. Rather, policy makers who rely on one estimate or the other will arrive at very different prescriptions for regulation, with very different consequences for companies and consumers.

2 U.S. Energy Information Adminstration. "Natural Gas Annual 2013". http://www.eia.gov/naturalgas/annual/pdf/table_a01.pdf accessed April 1, 2015.

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How to Fix It: Apply a More Consistent, Detailed, and Accurate Approach

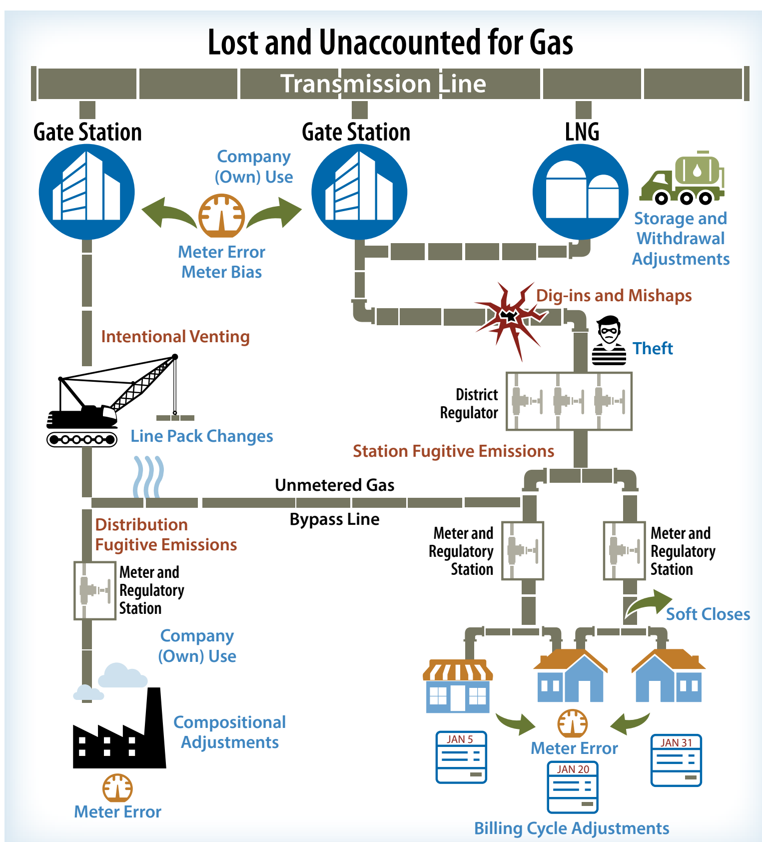
The first step in achieving a more accurate estimate that can be consistently applied across different markets is simple: account for all of the relevant factors in LAUF and emissions.

To do so, ICF employs two methods in our work: what we call, respectively, both a top-down and a bottom-up approach. The top-down approach is built on operational and billing data to quantify the components and uncertainties in lost and unaccounted for gas. It includes measurement error, billing cycle adjustments, theft, fuel use and other components, especially the all-important ways in which gas actually escapes the system as lost gas. The bottom-up approach generates an estimate of emissions from the distribution system, using engineering characteristics to differentiate what is happening among individual sources such as pipelines, metering and regulator stations, services, intentional venting, and dig-ins.

The two approaches complement each other. The top-down approach acts as a cross-check to the bottom-up analysis estimate of gas lost. It also identifies important individual components of LAUF, thus allowing for a better calibrated approach to reducing errors in calculating and reporting LAUF. The bottom-up approach finds specific sources of emissions that are important to addressing the GHG emissions from the system.

Exhibit 3 shows where these sources of LAUF may occur in a model LDC system and how they translate into emissions.

Exhibit 3: Sources of Lost and Unaccounted for Gas in a Distribution System



Company (Own) Use
What the LDC uses internally to generate power and produce heat, or for line heaters.

Storage and Withdrawal Adjustments
Adjustments to measure—either upward or downward—the inventory of stored gas within the system.

Soft Closes
Gas not billed to any customer—usually occurs when gas is not shut off between tenants.

Theft
Incidents of illegal access to pipes or bypassing meters.

Line Pack Changes
Amount of gas in the pipe, which can vary by temperature and pressure or due to the addition or removal of pipe sections.

Intentional Venting
Gas vented on purpose through a designed vent or during repair incidents of illegal access to pipes or bypassing meters.

Dig-ins and Mishaps
Gas releases due to external damage.

Meter Bias
Meters can run fast or slow; corrections up or down must be made.

Billing Cycle Adjustments
Adjustment to sync different LAUF reporting and billing cycles.

Gas Composition
Errors occur when gas volumes are converted to the heat content of gas delivered.

Distribution System Emissions
Emissions that escape through leaks in pipelines, regulating stations, and services.

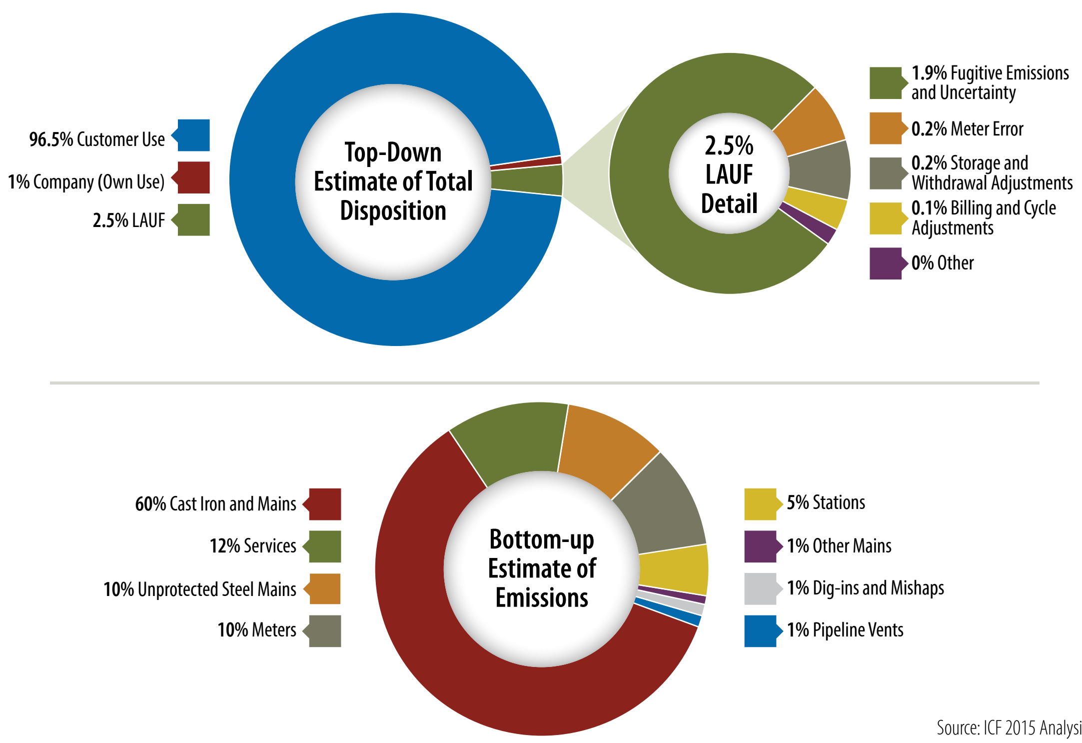
Adjustments for Nonmetered Gas
Some gas that is moved in between subsystems but is not metered.

Example: Hypothetical LAUF and Emissions Using These Approaches

A hypothetical case is presented here using this more inclusive approach with a clearer delineation both among categories of LAUF and between lost gas and emissions.

The top-down analysis first quantifies all of the LAUF components that can be analyzed by using existing data. This analysis includes any meter error and various accounting adjustments as well as vented emissions such as from dig-ins and pipe replacement. The remaining LAUF is assumed to be either fugitive emissions or uncertainty in the other LAUF components that have been quantified. Thus, the top-down analysis provides a range in which to expect vented and fugitive emissions.

Exhibit 4: Example of a Breakdown of LAUF Sources



Source: ICF 2015 Analysis

In Exhibit 4, the top pie charts show the results of the top-down analysis in this hypothetical case study.[3] They depict the individual components of LAUF gas after customer use and company (own) use is accounted for. Fugitive emissions and the uncertainty of components of LAUF gas account for the majority of LAUF gas. This uncertainty includes, but is not limited to, undocumented uses of gas such as unknown theft, limitations in meter precision, and unmetered uses of gas. However, typically these uncertainties can be expected to be much lower than fugitives. Meter error, storage and withdrawal adjustments, and billing cycle adjustments make up a significant portion of these LAUF components. Line pack changes, intentional venting, and dig-ins represent the small remainder.

3 Customer use and company own use account for almost all of the gas in the system. The chart depicts all other LAUF sources that ICF estimated.

The bottom-up analysis can be considered a subset of the top-down analysis as it specifically quantifies vented and fugitive emissions. As shown in the pie chart of the bottom-up analysis, the largest contributors to emissions are cast iron pipelines, services and unprotected steel mains, with the age of infrastructure being a particularly significant issue in urban areas with older cast iron pipe.

Saying that all gas estimated to be emitted in the bottom-up analysis actually ends up as methane emissions that enter the atmosphere is not accurate. A small amount of methane gas emitted from underground pipelines can be decomposed within the soil by natural oxidation and biological activity before it reaches the surface. Furthermore, gas lost from the system includes methane (which is the primary component of natural gas) but is by no means synonymous with methane emissions. It includes other gases such as ethane, propane, carbon dioxide, and nitrogen.

The important point for regulators to bear in mind is that recognizing the difference between lost gas and methane emissions is essential for giving consistent estimates of the actual atmospheric impact of LAUF.

Conclusion

Our recommended approach comprehensively and consistently uses the full range of factors involved in gas loss and emissions to arrive at more accurate estimations of how much gas is escaping the system and ultimately reaching the atmosphere. The approach is nonetheless subject to data limitations that in the future can be mitigated with a number of steps. We recommend that state and federal regulators work to improve the reporting already being done by employing the same common terminology and components of LAUF. Then regulators should apply consistent estimation methods and use soil oxidation factors as suggested here.

State public utility commissions can be leaders by adopting this type of accurate, consistent methodology and by setting a standard that can be adopted across the country. This adoption will help to rationalize national policy and ease regulatory burdens on LDCs by creating more standardization and consistency.

All stakeholders should pay close attention to the factors involved in gas loss and the actual estimated amount of emissions. They should more accurately calibrate methane emission reduction policy to the likely amount of emissions. Regulators also should be equally attuned to the risks of policies based on over- and underestimates.

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About the Authors

Donald Robinson is a Vice President in the Energy, Environment, and Transportation division and has more than 27 years of petroleum industry experience in the United States and internationally, upstream and downstream. He has worked the past 15 years with the U.S. Environmental Protection Agency (EPA) Natural Gas STAR Program. His team developed all 55 technical documents and presented at 65 U.S. technology transfer workshops and 28 international methane mitigation conferences across the world. He also led the team helping EPA develop the Mandatory Greenhouse Gas Reporting Rule and New Source Performance Standards rules for reducing emissions.

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