2015

What Gets Measured:

A Summary of Recent Policies, Studies, and Pilot Projects Related to Methane Emissions from California's Natural Gas Transmission and Distribution System

Recently established Federal and State climate change goals place new emphasis on reducing methane emissions from the natural gas industry. Scientific studies published in the last 2-3 years shed new light on the scientific understanding of sources of methane emissions from the natural gas infrastructure. Emerging new technologies have also expanded the capability for monitoring and tracking these sources. The purpose of this paper is to review recent policies, practices, and initiatives regarding methane emissions associated with the natural gas industry.

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Introduction

New Federal and State climate change goals seek to cut methane emissions from the oil and gas industry. For the U.S., the Federal government seeks to reduce methane emissions from this sector by 40-45% from 2012 levels by 2025. California has set a goal of reducing greenhouse gas (GHG) emissions overall by 40% below 1990 levels by 2030 and 80% by 2050.

These goals have resulted in new policies, plans, and initiatives to address methane emissions from the natural gas infrastructure. Specifically, the natural gas industry and its regulators are assessing traditional leak detection and repair (LDAR) programs that have historically been in place to address the leakage of methane from transmission and distribution (T&D) systems. In California, natural gas utilities have conducted traditional leak detection programs focused on occupational and public safety, with repair occurring only when a leak was found to be an immediate safety threat. With the emergence of new monitoring technologies and recent scientific studies on methane emissions from the T&D infrastructure, there is a growing inventory of new information and knowledge that enables better characterization and modeling of the natural gas system as it relates to leaks and methane emissions.

This paper summarizes 1) new goals, policies, and laws that are driving federal and state activity on the regulation of methane from California's natural gas infrastructure, 2) prior methods for estimating emissions and current estimates for California's T&D system, and 3) recent studies and initiatives whose goals are to add to current knowledge of natural gas infrastructure methane emissions and best management practices.

Background

California's Natural Gas System

In 2013 Californians consumed over 2.2 trillion cubic feet of natural gas[1]. The second largest consumer of natural gas in the United States[2], 90% of it is imported, primarily from Canada, Colorado, New Mexico and Texas. On a daily basis, natural gas demand in California averages 6 billion cubic feet and peaks at 11 billion cubic feet depending on the time of year[3],[4]. Over 13,000 miles of transmission pipelines and 200,000 miles of distribution pipelines are the backbone of the infrastructure that delivers natural gas to the state's 10.8 million industrial, commercial and residential customers along with electric power generators and vehicles[5,6].

[1] SNL, "Total Gas Sales for California, 2009-2013"
[2] California Energy Commission, Draft Staff Report, "AB 1257 Natural Gas Act Report," September 2015
[3] California Energy Commission, "Analysis of California Natural Gas Market, Supply, Infrastructure, Regulatory Implications and Future Market Conditions," PIER Final Project Report, CEC-500-02-004, pg. 65, December 2007
[4] California Energy Commission, "AB1257 Natural Gas Act Report," CEC 200-2015-006-5D, September 2015
[5] ARB Presentation, "California Air Resources Board Oil and Gas Emissions and Mitigation," CPUC SB 1371 Workshop, April 6, 2015
[6] CPUC website, "Natural Gas and California," http://www.cpuc.ca.gov/PUC/energy/Gas/natgasandCA.htm

Recent Federal and State Policy Initiatives

Up until 2014, methane was an unregulated air pollutant in the U.S. Previously any release of methane from a T&D system was of concern only if it posed an immediate occupational or public safety hazard. In 2014 the White House made methane emissions a national environmental priority with the release of its **Strategy to Reduce Methane Emissions**, proclaiming that the curbing emissions of methane are critical to our overall effort to address global climate change[7]. In January of this year, the Obama Administration established a national goal to cut methane emissions from the oil and gas sector by 40-45% from 2012 levels by 2025[8].

Concurrently, Governor Brown asserted in his inaugural speech in January 2015 that California must "reduce the relentless release of methane." The Governor noted that it will be a very tall order, requiring enormous innovation, research, and investment. Given its significance as a major contributor to climate change, reducing methane emissions is a vital strategy if California is to meet the Governor's ambitious goals of cutting the state's greenhouse gas emissions 40% below 1990 levels by 2030 and 80% below 1990 levels by 2050[9].

In 2014 the California legislature passed legislation that charged the CPUC with the task to develop a regulatory program to address methane emissions from California's for natural gas T&D systems. It stipulated that the CPUC, giving priority to safety, reliability and affordability of service, establish rules and procedures to reduce emissions of California's T&D systems. In particular, the law directed the CPUC to establish:

1. ***Technology-based standards*** that enable maximum technically feasible, cost-effective utility programs that focused on the prevention, reduction and repair of leaks,
2. ***Protocols*** for leak detection and repair programs that enable early and rapid response by utilities,
3. ***Best practice****s* for utility leak management programs,
4. ***Metrics*** to quantify the volume of emissions from leaking gas pipeline facilities and track the location of emission sources that provide accurate information,
5. ***Annual Reports*** by utilities to the CPUC and the California Air Resources Board (ARB) on methane emissions initiatives and results, and
6. ***Annual Evaluation*** by the CPUC of utility operations, maintenance and repair practice for effectiveness in reducing emissions.

California's overall policies for greenhouse gas emissions as stated in the California Global Warming Act of 2006 prescribes that programs must be the maximum technologically feasible, cost-effective, and be real, permanent, quantifiable, verifiable, and enforceable.

[7] Freitas, C., "DOE Methane Mitigation Efforts," Presentation at NARUC Staff Subcommittee on Gas, July 12, 2015
[8] White House Press Release, "Administration Takes Steps Forward on Climate Action Plan by Announcing Actions to Cut Methane Emissions," January 14, 2015
[9] Office of the Governor, State of California, Inauguration Address, January 5, 2015

Current Methods for Quantifying Methane Emissions

The Climate Impacts of Methane

It has been calculated that the climate system is more immediately responsive to changes in methane emissions than carbon dioxide (CO_2) and that unless emissions of methane are reduced immediately, the Earth will warm 1.5◦ C by 2030 regardless of CO_2 emissions[10]. Therefore, accurate measurements of methane emissions and its impact on climate change are essential in meeting California's short and long-term climate goals. It is worthwhile to examine how methane emissions from natural gas systems are currently accounted for and reported by the Environmental Protection Agency (EPA) and ARB with their respective greenhouse gas inventories.

In contrast to CO_2 which persists in the atmosphere for more than 100 years, methane will remain for 12 to 20 years. Despite its shorter lifespan, methane can have a more significant impact on climate change due to its larger ability to absorb heat. Parallel climate change strategies must focus on long- and short-lived pollutants, but not at the cost of reducing pressure for action on CO_2[11].

Greenhouse gases are rated for their Global Warming Potentials (GWPs) in comparison to CO_2 and are a quantified measure of the climate changing impacts of a particular greenhouse gas. Two years ago the Intergovernmental Panel on Climate Change (IPCC) reported in its Fifth Assessment Report that methane's Global Warming Potential (GWP) is 34 times stronger as a heat-trapping gas than CO2 over a 100-year time scale, a 40% increase from its previous estimate of 25. It also emphasized that over a shorter 20-year timeframe methane is 84 times more potent than CO_2[12]. The table below displays how the IPCC has increased the GWP for methane between 1996 and 2013[13].

Table One – Methane GWP Values, 1996-2013

	Reference	Lifetime (years)	GWP time horizon		
			20 years	100 years	500 years
Methane	IPCC **2013** – AR5	12.4	84	34	NA
	IPCC **2007** – AR4	12	72	25	7.6
	IPCC **2011**- TAR	12	62	23	7
	IPCC **1996** - SAR	12	56	21	6.5

[10] Shindell D. et al," Simultaneously Mitigating Near-term Climate Change and Improving Human Health and Food Security", Science 335: 183-189

[11] Shoemaker, J.K., D. P. Schrag, M. J. Molina, V. Ramanatha. What Role for Short-Lived Climate Pollutant in Mitigation Policy? Science. Vo. 342. December 2013

[12] IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

[13] Gillenwater, M. "What Is A Global Warming Potential? And Which One Do I Use?" GHG Management Institute, April 1, 2015 update, http://ghginstitute.org/2010/06/28/what-is-a-global-warming-potential/

Recent research suggests that previously unaccounted for gas-aerosol interactions in the atmosphere significantly increase the GWP of methane to 33 over a 100-year time horizon and 79 to 105 over 20 years[14].

This distinction in accounting for methane's GWP is important since the method in which the EPA and the ARB track greenhouse gas emissions in their annual inventory is based on IPCC's older Fourth Assessment Report. Such distinctions in GHG accounting have ramifications for calculating the benefits of new initiatives and programs for reduced emissions. Also worth noting is the significance of ongoing scientific research in changing the GWP values and how methane's climate impact was originally estimated at 21 but is now 62% higher.

Estimating T&D Emissions

Currently two types of methods are used by government agencies and climate researchers to produce estimates of methane emissions, each with their own respective limitations and caveats. Determining methane emissions from natural gas systems is widely recognized as an imperfect discipline and will need to be continuously assessed and improved over time as new scientific and technical information is acquired by the industry.

Determining the quantity and concentrations of methane in the U.S. began in earnest in 1992 when EPA and the Gas Resources Institute (GRI) jointly developed a methodology for estimating methane emissions from natural gas systems. Using a small, limited sample size, the EPA/GRI study produced its first greenhouse gas inventory report in 1996.

This method is used by EPA and ARB for their annual greenhouse gas inventories which are based on what is described as a "bottom-up" approach. These inventories take known assets in the natural gas system and assign EPA and ARB-determined emission factors (EFs) to estimate methane emissions leaked by different components of the system. For transmission pipelines, storage, and distribution systems, individual components for a system are compiled, such as total miles of a certain type of pipe, and then multiplied by respective EFs and GWPs to come up with a cumulative methane emission estimate. The table below shows EFs for different pipe materials.

Table Two – Leakage Rating of Piping Materials[15]

Material	Emissions Factor (scf/hour/mile)
Cast Iron	27.25
Unprotected Steel	12.58
Plastic	1.13
Protected Steel	0.35

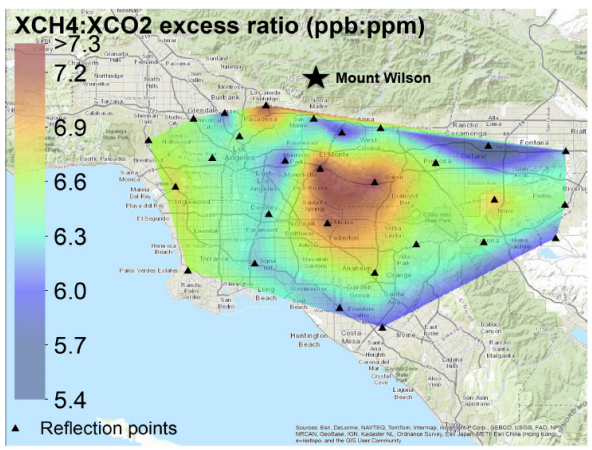
The second "top down" method entails field studies using remote sensing and field monitoring to measure methane concentrations in a regional air basin and then using atmospheric models to

[14] Cleveland, S., **Into Thin Air,** Conservation Law Foundation, p12
[15] See supra, **Into Thin Air**, at 10

determine emission rates. The difficulties associated with these studies include determining the sources of the emissions and screening out geologic or other sources such as landfills, wastewater treatment plants and dairies. Some studies have attempted to address this by measuring specific chemical isotopes and components to distinguish between different sources. Another difficulty with this method is the lack of standardized methods, protocols, and reporting of such studies.

An example of this second approach is a recent study examining methane emissions in the Los Angeles air basin resulting in a mapping of methane concentrations (see Figure One). Researchers used ground-based remote sensing devices located atop Mt. Wilson in eastern Los Angeles (LA) County to monitor carbon dioxide and methane in the LA air basin between September 2011 and October 2013. Their results found methane concentrations averaging 6.4 parts per billion (ppb) CH_4/ppm CO_2 compared to the ARB bottom-up estimate of 4.6 ppb CH_4/ppm CO_2, with results in a range of 18-61% above ARB's results[16]. Recent regionalization of the ARB inventory has reduced discrepancies between the two methods of monitoring for methane.

Figure One - Map of Methane Concentrations in Los Angeles Air Basin from Wong et al.



Quantifying Methane Emissions from California's Natural Gas Infrastructure

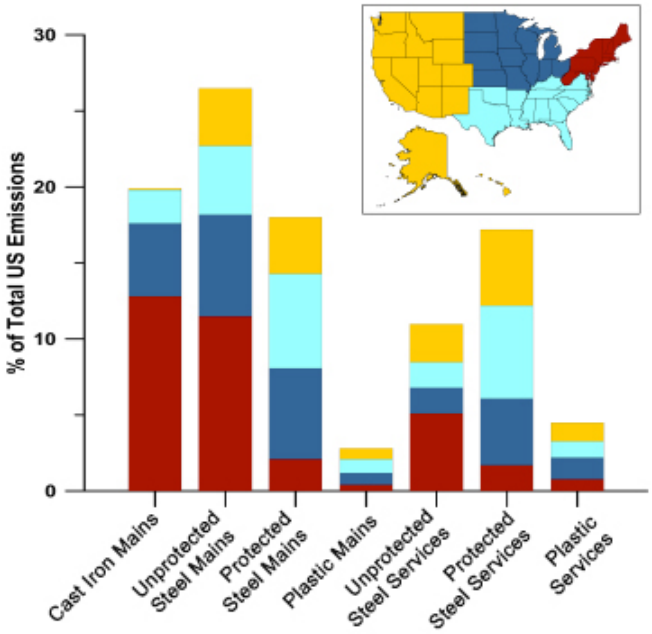
In the past, EPA and ARB have estimated 1% of methane in the natural gas system at any given time is leaked into the atmosphere[17]. Estimates in peer-reviewed literature for downstream emission of methane from natural gas systems range from 0.07% to 10%[18,19]. A recent study performed a meta-analysis of past studies conducted in the U.S. and concluded that actual emissions are about 1.5 times

[16] Wong, K.W. et al, "Mapping CH_4:CO_2 rations in Los Angeles with CLARS-FTS from Mount Wilson, California," **Atmos. Chem. Phys**., 15, 241-252, January 12, 2015
[17] California Air Resources Board, Transportation Fuels: ARB Technology Assessment, 2014
[18] Jeong, S. et al, "Spatially Explicit Methane Emissions from Petroleum Production and the Natural Gas System in California", **Environmental Science and Technology**, 48(10), 5982-5990
[19] Howarth, R., Methane Emissions from Natural Gas Systems, 2012

greater than reported in EPA's inventory[20] . These findings reinforce the high level of uncertainty associated with current methane emissions measurements and the value of developing better methods to track methane escaping into the atmosphere.

Natural gas systems are the single largest source of anthropogenic methane emissions in the United States, representing approximately 40% of the annual estimate by EPA[21]. In EPA's 2011 inventory, it was estimated that the annual methane emission rate from natural gas infrastructure was 6,890,000 metric tons of CO2 equivalents (MMTCO2e) per year with local distribution systems accounting for 1,329,000 MMTCO2e per year or 19% of the total from the natural gas system and 0.33% of gas delivered to customers. This inventory includes upstream emissions from wellheads and processing plants along with downstream transmission and distribution infrastructure. It also estimated that within the distribution system, 40% of emissions occur at meters and regulators (M&R) at city gate stations and speculates that a quarterly leak detection and repair monitoring could reduce emissions from this source by 60%. Similarly, DOE estimates that 20% of methane emissions from the natural gas sector are from distribution systems.

Figure Two- Estimates of % of US methane emissions by region and type of pipe[22]



For California, methane is the second largest and a growing component of GHG emissions. ARB estimates that for 2013 total methane emissions was 41.1 MMTCO2e with natural gas pipelines

[20] Brandt, A. et al, "Methane Leaks From North American Natural Gas Systems", **Science**, 343(6172), 733-735
[21] Howarth RW, et al, "Venting an Leakage of Methane from Shale Gas Development: Reply to Cathles et al., ***Climatic Change***, 2012
[22] Clean Air Task Force, **Waste Not, Common Sense Ways to Reduce Methane Pollution from the Oil and Natural Gas Industry**, January 2015

accounting for 9% of the total. ARB's estimated emissions from T&D pipelines in California are shown in Table 3 on the next page.

Table Three – ARB Estimated 2013 Methane Emissions from California T&D Infrastructure[23]

Pipeline	Miles	Estimated Emissions (Million Metric Tons CO_2 equivalent)	
		AR5 (100 Yr)	AR5 (20 Yr)
Transmission	10,000	0.20 (5%)	0.52 (5%)
Distribution	200,000	3.84 (95%)	9.70 (95%)

For California 95% of T&D methane emissions are from distribution systems while transmission systems only contribute 5%. These numbers may be due to the limited amount of transmission infrastructure in California, especially compared to other parts of the U.S., and the disproportional number of miles of distribution pipeline which is 20 times greater than transmission. In a recent report, DOE stated that California has 29 miles of leak prone iron mains and 8,200 miles of leak prone steel mains[24]. Figure Two above indicates that for the western U.S., protected steel services and unprotected steel mains were found to be the largest contributors to methane emissions from the distribution infrastructure.

Recent Scientific Studies

Historical approaches for determining air pollution are being supplanted by advances in technology and tools that enable lower-cost, portable monitoring equipment that provide timely, high resolution data. These attributes provide the opportunity to enlarge the knowledge base of air pollutant emissions and a more accurate understanding of how best to control its sources. Widespread data collection and data sharing using new sensors are already occurring. This changing paradigm of air pollution monitoring offers regulators a new source of air quality data that allows better regulatory guidance and requirements that more efficiently achieves program goals[25].

In 2012 the Environmental Defense Fund (EDF) began a large scientific project to better assess emissions from the full natural gas supply chain, from wellhead to burner tip. This collaborative effort involved partnerships with approximately 100 universities, research institutions, and utilities. It was divided into 16 separate projects including 1) a transmission and storage study 2) several studies quantifying methane emissions from facilities and pipes operated by 13 utilities in various regions of the U.S., and 3) a focused study of distribution systems in six cities including Boston, Indianapolis and Los Angeles (LA). For example, in the LA study a Google Street View mapping car was equipped with air monitoring

[23] ARB Presentation on Oil and Gas Emissions and Mitigation, CPUC Workshop on Senate Bill 1371, April 6, 2015
[24] USDOE, **Quadrennial Energy Review**, 2014
[25] Snyder, E.G., et al, "The Changing Paradigm of Air Pollution Monitoring," **Environmental Science and Technology**, 47, 11369-11377, 2013

equipment to obtain real-time air monitoring data[26]. This data was then released using an online interactive map showing locations of detected methane. According to EDF, this study indicated an average of about one leak for every four miles driven in the Pasadena, one leak for every five miles driven in Inglewood and one leak for every five miles driven in Chino. Subsequent to the EDF study, SoCal Gas issued its own online map of leaks that the company had detected as part of its leak monitoring program[27].

In a study of 13 urban distribution systems consisting of a national field sampling program published in March 2015[28], over 400 new emission field measurements were obtained, making it the most comprehensive set of direct measurements to date of emissions from distribution systems and was conducted with the cooperation of a number of gas utilities including PG&E and SoCal Gas. This study noted that the principal estimates for methane emissions from the natural gas system was from the EPA/GRI study in the 1990s and even EPA's most current emissions inventory is still dependent on the findings from that first study, despite the fact that there has been significant investment in new natural gas transmission and distribution infrastructure.

These direct field measurements were used to provide updated emission factors that were then incorporated in the traditional inventory method. The study found that methane emissions from individual leaks ranged from approximately 393,000 to 854,000 MMTCO2e per year, or between 0.1 and 0.2 percent of the methane delivered nationwide. Of the leaks sampled, three large leaks accounted for 50% of the total measured emissions. This supports earlier studies that have concluded that it is common for a large percentage of methane emissions to be from a small number of leaks, known as "super emitters." Overall, the study's emission estimate was 36% to 70% less than the 2011 EPA inventory.

The results of this study are the most comprehensive yet of direct measurement of emission from the distribution system in the U.S. Overall, the western region contributes 17% of total U.S. emissions from distribution systems. While distribution system pipeline mileage has increased approximately 44% since the 1990s, based on this study methane emissions are estimated to have decreased due to improvements in equipment and materials along with better inspection and maintenance.

Recent California Initiatives

As an example of recent industry pilot studies, Pacific Gas and Electric Company (PG&E) has been testing a "SuperCrew" approach to leak repairs in Oakland, Sacramento, and Sonoma County. In this pilot, PG&E has partnered with Santa Clara sensor company, Picarro, making it the first gas utility in the U.S. to use a car-mounted leak detection system, which PG&E states is 1,000 more sensitive than traditional equipment. This technology measures natural gas molecules in the atmosphere with a near-infrared laser. Leaks are displayed on an iPad secured on the dashboard. Originally designed for NASA to detect

[26] "Study Maps Hundreds of Methane Gas Leaks Under Streets in L.A. Region," **Los Angeles Times**, August 10, 2015
[27] http://www.socalgas.com/innovation/methane-emissions/methane-map.shtml
[28] Lamb, B.K. et al, "Direct Measurements Show Decreasing Methane Emissions from Natural Gas Local Distribution Systems in the United States," Environmental Science and Technology, 49, 5161-5169, March 31, 2015

methane for the Mars Rover mission, the technology can tell in less than 10 minutes whether the gas being detected is natural gas or naturally occurring methane. It's proven to detect natural gas regardless of whether it is emanating from plastic, steel, or cast iron pipe. PG&E asserts that its crews are now able to find 80% more leaks using this device. It currently has six vehicles mounted with the Picarro Surveyor, with plans to add four more by the end of 2015[29]. Figure Three is a graph demonstrating the increased sensitivity of the Picarro technology versus traditional methods.

PG&E was recently recognized by the US gas industry for this initiative. Steve Redding Sr., director of the company's leak management program, was named as the recipient of the 2015 Milton W. Heath Sr. Memorial Award at the American Gas Association's annual Operations Conference and Biennial Exhibition in May of this year. Specifically, PG&E was credited with reducing leaks through the use of cutting-edge technologies and the development of a management process that has reduced PG&E's backlog of leaks by 99% and the ability to find 80 more leaks than previous models and in less time[30]. Figure Four below is PG&E's view on how new practices differ from the previous practice[31].

Figure Three – PG&E Diagram Showing Traditional versus Next Gen Leak Detection

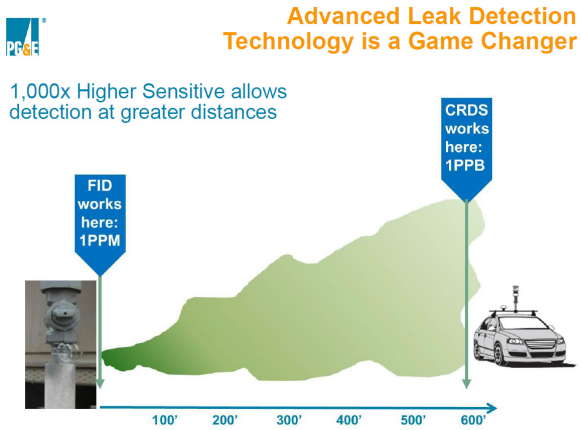
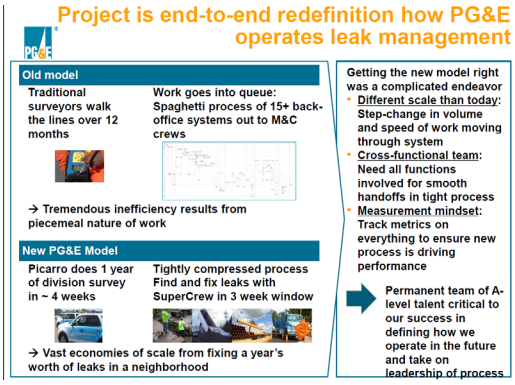


Figure Four – PG&E Redefinition of Leak Management



[29] https://www.youtube.com/watch?v=tpjVBOvcGdE
[30] PG&E Press Release, May 20, 2015
[31] Redding, S. "Road Map to…Redefining the Leak Management Process," May 13, 2014 Presentation

Government Initiatives

The U.S. Department of Energy is taking action to improve the knowledge base of methane emissions from natural gas infrastructure[32]. After significant stakeholder outreach in 2014, DOE created an initiative to help modernize natural gas transmission and distribution infrastructure. One component of this initiative was the partnering with the National Association of State Regulatory Utility Commissioners (NARUC) to accelerate investments for infrastructure modernization and repairs to natural gas distribution networks. It also began a research and development program called Methane Observation Networks with Innovative Technology To Obtain Reductions (MONITOR) which issued $30 million in grant money in 2014 to technology developers. Two California entities, Palo Alto Research Center and Aeris Technologies in Redwood City received over $5 million in research grants to develop new sensor technologies. DOE has also proposed the following efforts for the next fiscal year -

- **Improve quantification of emissions from natural gas infrastructure**- DOE has requested $10 million for FY 2016 to help update greenhouse gas inventory estimates of methane emissions from natural gas systems.
- **Expand DOE research and development (R&D) programs on cost-effective technologies** – DOE have requested $15 million for FY 2016 to expand efforts to develop new technologies for monitoring natural gas systems.
- **Demonstrate and deploy continuous emissions monitoring equipment** – DOE will pursue demonstration programs to identify promising technologies and determine how they perform under field conditions.

EPA has a major new initiative, called the Methane Challenge Program, which is intended to replace its Natural Gas STAR program. It will be a voluntary program through which oil and gas companies can make and track commitments to reduce methane emissions and would include transparent reporting through Subpart W of EPA's Greenhouse Gas Reporting Program. EPA is currently seeking input of program design and expects to develop systems for tracking and collecting data in 2016.

ARB is also engaged in efforts to improve its estimates of methane emissions. This includes contracting with the Gas Technology Institute to develop California-specific emission factors, including main and service distribution pipelines.

The California Energy Commission manages the Public Interest Energy Research (PIER) Natural Gas Program for the CPUC and under this program the Energy Commission is supporting studies designed to better characterize methane emissions from the natural gas system in California. For example, one of the research projects involves the detection and quantification of methane leaks from transmission lines using an instrument aircraft. The researchers have tested their methods using intentional releases of methane conducted by PG&E. Testing has shown that the aircraft can detect leaks and that the quantification of emissions to within 20% of controlled release rates. The research is also using a monitor for ethane, which enables unambiguous attribution of methane to the natural gas (NG) system as distinct from bio-genic sources (e.g., landfills). The next phase of work will use the

[32] Bradbury, J., USDOE, Presentation to NARUC Summer Committee Meetings – Committee on Gas, July 14, 2015

aircraft to detect and quantify leaks from real pipelines owned by PG&E. California. Similar measurements are being taken for the natural gas distribution system using a new mobile platform.

Calculating the Benefits

Finally, as an example of the cost-effectiveness of controlling methane emissions in the natural gas system, a recent industry presentation provided an example that compared the costs per ton of CO_2 removed for a natural gas retrofit measure with a residential solar project from a Canadian case study[33] . In this specific example, the methane emission reduction measure was 23 times more cost efficient at reducing GHG emissions.

Alternative #1 – Residential Solar PV

Install 1.4 kW solar photovoltaic system on a residential roof in Alberta, Canada

A 1.4 kW solar system generates 1,890 kWh/year (15% capacity factor)

Total system cost of ~$7,200

At 0.65 $kgCO_2e$/kWh, the system reduces GHG emissions by 1.23 tCO_2e/year

Over a 20-year life the system reduces GHG emissions by ~25 tCO_2e

The GHG abatement efficiency is $293/$tCO_2e$ reduced ◄

Alternative #2 – Replace Natural Gas Pneumatic pump

Retrofit an existing pneumatic methanol injection pump at an oil and gas well site with a solar electric pump

The gas-driven pneumatic pump vents 430 ft^3/day of natural gas (95% methane)

The cost to replace the pneumatic pump with a non-emitting solar-electric pump is $9,000

The annual GHGT reductions are 72 tCO_2e/year

Lifetime GHG reductions of 720 tCO_2e over 10 years

The GHG abatement efficiency is $12.50/$tCO_2e$ ◄

[33] Callendar, Jamie, "Challenges and Opportunities in the Upstream Oil and Gas Sector," **2014 PTAC Forum Energy Efficiency & Emissions Reduction Technologies**, November 18, 2014

Conclusion

In summary, with new climate change goals, policies, and laws, emerging technologies, recent scientific studies, and industry pilot projects, natural gas industry leak detection and repair programs are undergoing a significant evolution in methods, technologies and regulation. A number of current ongoing Federal, State and industry initiatives foresee continued development of methods and tools for reducing methane emissions from the natural gas industry.