



Natural Gas STAR Partner Update

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2015 Natural Gas STAR Annual Implementation Workshop
 Pittsburgh, Pennsylvania
 November 16-18, 2015



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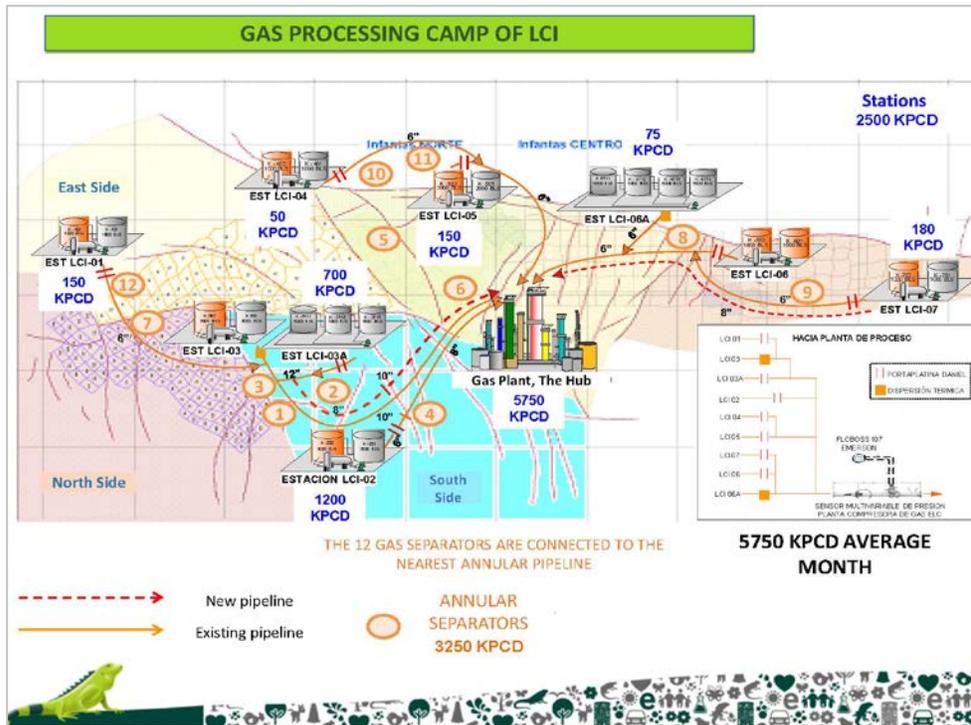
Online registration is open. See page 7 for more details. We hope to see you there!

In-Depth Technology/Partner Profile

Ecopetrol Case Study: Experience Reducing Casinghead Gas Emissions

This case study discusses greenhouse gas (GHG) emissions from natural gas vented by Ecopetrol's La Cira Infantas (LCI) field production wells. The project was conducted with the Colombian Petroleum Institute (ICP) as part of an inventory of GHG emissions for Ecopetrol led by the ICP in the System for Atmospheric Management Project (SIGEA). Figure 1 presents a production diagram of the LCI gas processing field.

Figure 1. Production Diagram of LCI Gas Processing Field



Note: KPCD = MSCFD (Thousand Standard Cubic Feet per Day)

Ecopetrol’s corporate goal to voluntarily reduce GHG emissions began in 2012 and continues to contribute to the company’s overall commitment to reduce the environmental impact associated with operations. Ecopetrol’s emissions reductions strategies and progress are outlined in annual sustainability reports such as the Global Reporting Initiative (GRI), Carbon Disclosure Project (CDP) and the Dow Jones Sustainability Index. Likewise, with the formalization of a cooperative agreement with the Global Methane Initiative, Ecopetrol aims to further reduce its environmental impact and recover gas as an additional economic benefit.

Figure 2. Sources of Gas Collection for LCI Field

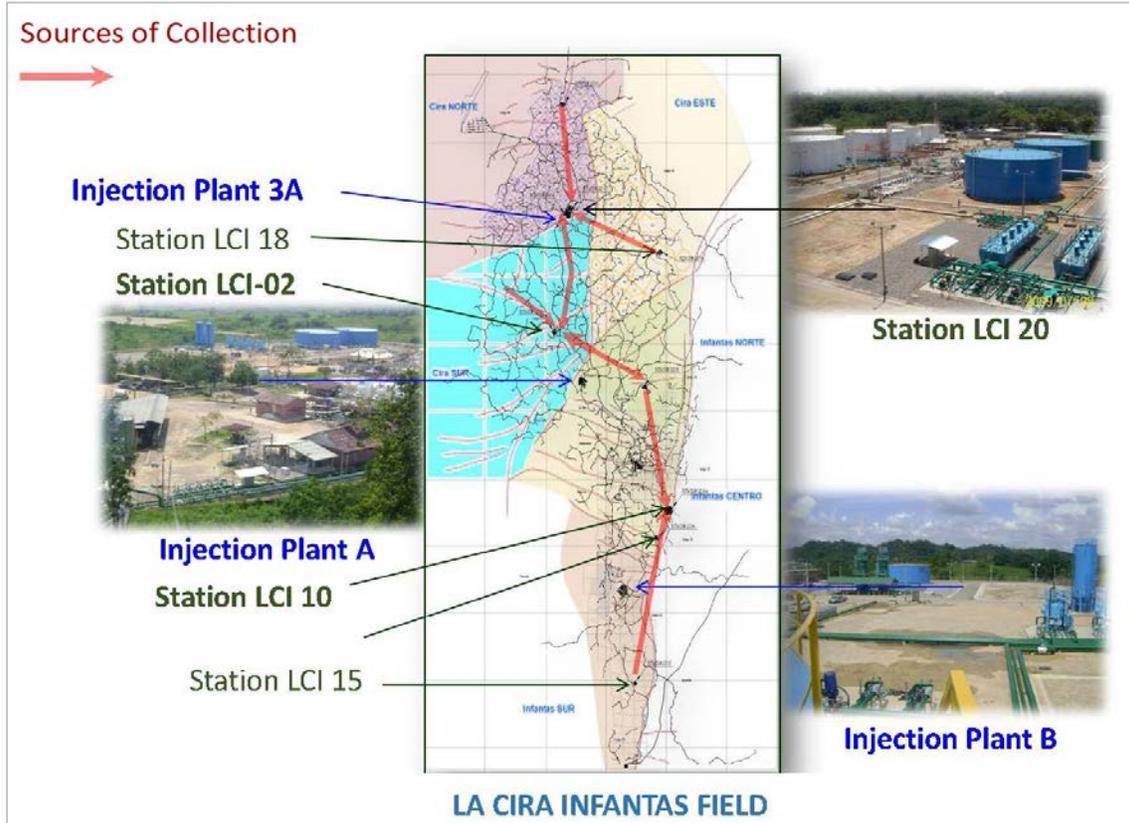


Figure 2 above shows the sources of gas collection at the LCI field. The scope of the project initially encompassed reducing casinghead gas emissions from 900 wells by 2013, and has since increased to a projected 1,000 wells by the end of 2015. The characteristics of vented natural gas directly correspond to gas chromatography samples entering the LCI processing plant.

Table 1 displays the characteristics of the vented gas that were determined based on monthly monitoring and verification.

Table 1. Characteristics of Vented Gas*

Gas density (lb/ft ³)	0.055
Molecular weight of gas (g/mol)	21
CO ₂ percentage (Chromatography)	8.85 %
Methane percentage (Chromatography)	74 %
Molecular weight of CO ₂ (g/mol)	44
Molecular weight of Methane (g/mol)	16
Conversion factor (lb to tons)	2204.623
kg CO ₂ /kg CH ₄	2.75

* The composition of gas corresponds to a typical well

Discussion of Technologies Implemented to Reduce Casinghead Gas

While conducting the project to reduce annular vented gas from production wells in the LCI field, Ecopetrol implemented innovative solutions and incorporated technologies in the well production stages to establish a series of annular gas sub-projects to achieve GHG emission reductions.

Technologies used as alternatives to reduce vented annular gas emissions from production wells focused on the collection, transportation and processing of this gas for sale. These included:

- Annular Gas Collection Networks:** Systems consist of 2-inch annular gas lines from the wellhead to 3-inch gas branch lines, which collect gas from several wells and reach a 4-inch collector gas line that carries the gas to liquid-gas separators (see Figure 3). Each network has a dedicated separator for the liquid-gas pipelines that carry gas from the field to the center plant compressor and then to the central gas processing plant.

Figure 3. Diagram of Liquid-Gas Separator

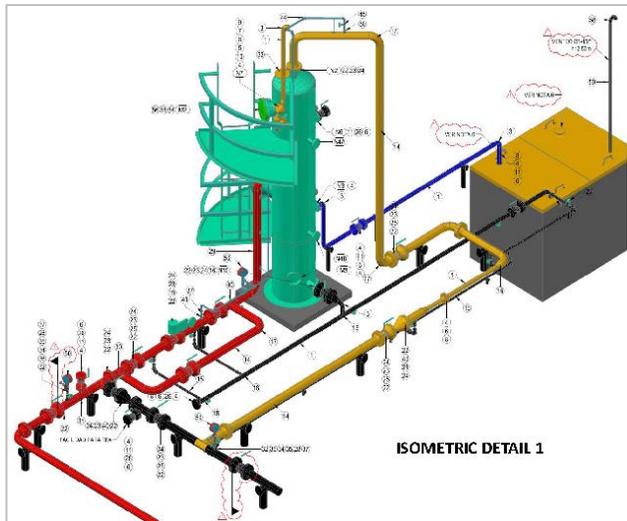


Image of a liquid gas separator



- Compressor Beams (Beam Gas Compressor):** Beam Gas Compressors (BGC) are installed in production wells with mechanical pumping units whose location is far from the annular gas pipeline networks. The compressor doubles the suction effect on the gas contained in the annular line, which is injected into the existing production line. This technology takes advantage of the ascending and descending movement of this type of artificial lift and optimizes the use of facilities. In addition, this accomplishes the collection of gas from wells with a low volume of gas production (< 3 MSCFD), is a feasible solution and provides favorable economic results.

Images of Beam Gas Compressors



- Gas Compressors:** Gas compressors are a practical option for production wells that are remote from annular gas networks and gas pipelines, which employ different artificial lift systems (such as progressive cavity pumps and electric submersible pumps) than the mechanical pumping units. This technology is designed to collect gas from several wells and inject it into existing production lines to avoid the cost of installing extensive new lines.

Description of the Benefits Realized by Reducing Casinghead Gas Emissions

Table 2 shows the number of annular wells connected and BGCs installed; it also provides estimates of annular gas that was not vented and the emissions reductions achieved as a result of the project. To determine the average amount of gas not vented per well, an average of approximately five MSCFD per well was established based on the estimated volume of venting (3,174 average MSCFD in 2009 from 610 wells) and the SIGEA project GHG emissions in 2009 (287.433 Tons of CO₂e/year).

Table 2. Summary of Project Benefits

	2008	2009	2010	2011	2012	2013	2014	Total
Network of Annular Wells Connected	65	81	59	131	58	40	210	644
Wells with Beam Gas Compressors	NA	NA	NA	2	18	6	15	41
New Wells Connected	NA	NA	NA	NA	NA	51	30	81
TOTAL Wells	65	81	59	133	76	97	255	766
Investment (Million USD)	\$ 2.0	\$ 2.5	\$ 2.4	\$ 8.2	\$ 3.7	\$ 11.8	\$ 20	\$ 50.6
Volume of Gas Not Vented (MSCFD)	330	411	299	675	386	492	1,295	3,888
Methane Emissions Reductions (Tons of CO₂e/year)	30,281	37,734	27,486	61,959	35,405	45,188	102,920	340,973

As shown in Figure 4, from the beginning of the project through 2015, the quantified net benefits are estimated to be \$6.3 million USD, and by 2020 are expected to reach a value of \$13.8 million USD (for projects that have already been established).

Figure 4. Summary of Project Profit

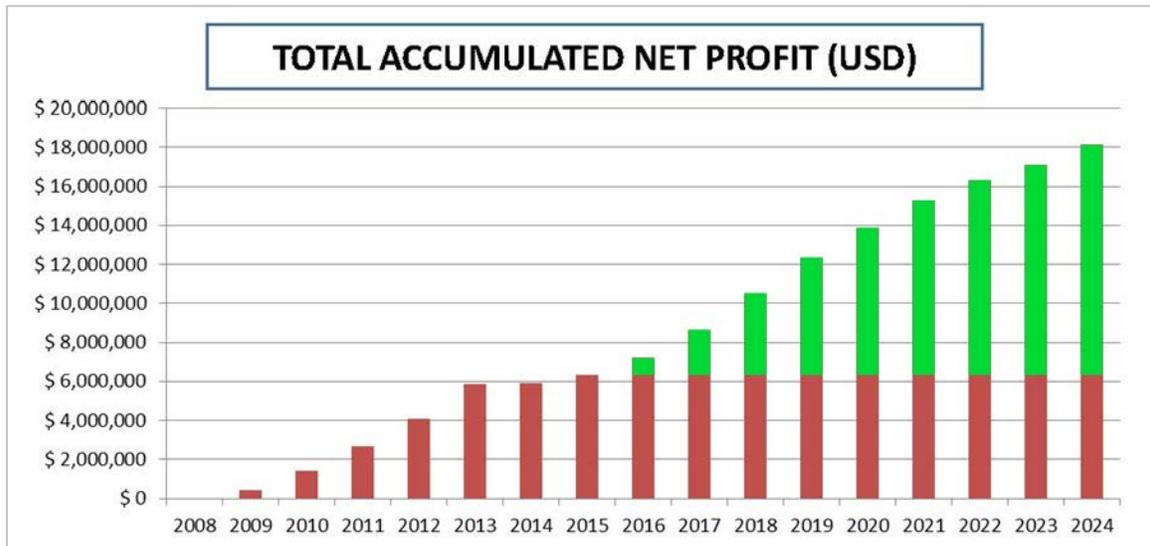
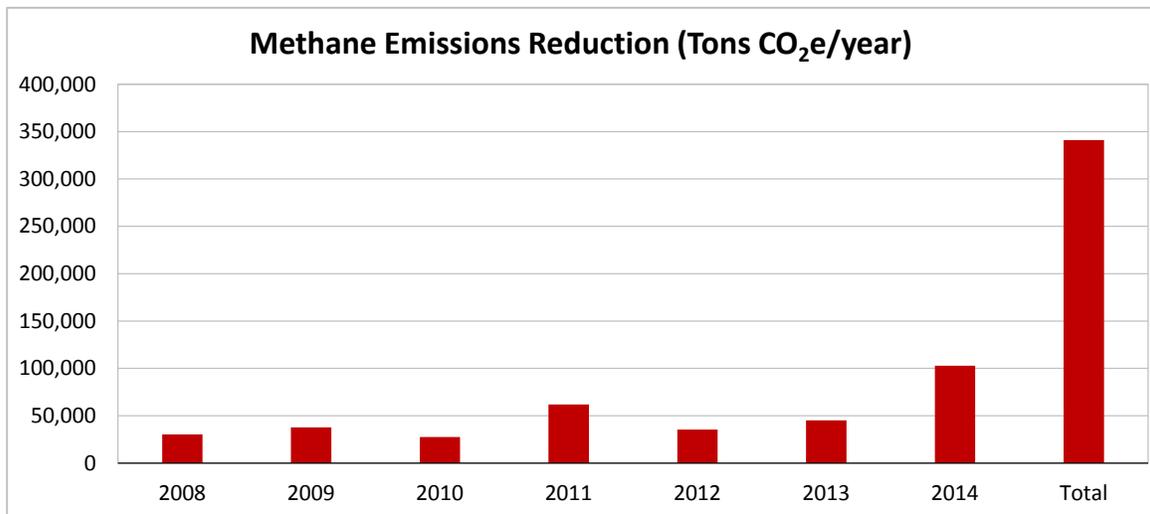


Figure 5 shows the estimated methane emissions reductions for the project.

Figure 5. Summary of Methane Emissions Reductions



Conclusion

Ecopetrol expects to meet its goal of reducing casinghead gas emissions from 1,000 wells by the end of 2015 and is seeking to consolidate an inventory of vented gas and fugitive emissions to broaden the scope of the project. In addition, Ecopetrol is beginning a general project to reduce flaring and to use collected gas for heating and crude oil dilution systems. Considering the number of connected wells and the environmental and economic benefits, this has been a notable project for Ecopetrol’s production operations, and other areas have begun similar projects.

Project Timeline

The timeline below summarizes the steps Ecopetrol has taken to reduce casinghead gas emissions from its operations.

- 2007** Well production is conducted with venting and flaring of gas as part of normal operations. Fifty portable flaring devices are installed in wells with the greatest presence of annular gas.
- 2008** Based on an operations initiative to eliminate the installation of flaring devices in the field, three gas collection annular gas separators are installed, and a total of 65 production wells are connected by the end of the year.
- 2009** Ecopetrol and its partner Occidental Andina LLC continue the connection of production wells to reduce venting and flaring in the field to comply with legal and environmental laws. Eighty-one production wells are connected. ICP also starts gathering information about Ecopetrol's GHG emissions.
- 2010** The reduction of venting and flaring at production wells begins by focusing on the elimination of annular gas venting at production wells for the LCI field. This increases the initiative's scope to wells with more than three MSCFD of annular gas production and the search begins for new technologies to implement. Progress is made in connecting 59 production wells and 3 additional assemblies. In addition, a study using an external consultant is conducted to determine the volumetric flow output of vented gas in the LCI field.
- 2011** Based on the results of the 2010 study, Ecopetrol conducted the following actions:
- Made advancements in capacity-building.
 - Modernized and automated the annular gas collection system.
 - Prioritized the installation of additional networks in other areas of the field.
 - Replaced six existing conventional separators and incorporated six annular gas separators.
 - Connected 131 production wells and installed 2 BGCs.
- The above steps included the use of new technologies to reduce venting in production wells with mechanical pumping units and gas pipelines.
- 2012** The project was recognized with an award for efficiency and for the utilization of gas in the LCI field. Completed work included: (1) the connection of 400 annular gas wells to 12 network collection pipelines, (2) alignment of 462 wells to the production line, and (3) installation of 20 BGCs in wells with distant networks and existing mechanical pumping pipelines.
- 2013-2014** The connection of 260 additional wells to the primary annular gas network is completed.

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Upcoming Events



[2015 Natural Gas STAR Annual Implementation Workshop](#)

**Sheraton Pittsburgh Hotel at Station Square
November 16-18, 2015 - Pittsburgh, Pennsylvania**

[Online registration](#) is open for the Natural Gas STAR Program's Annual Implementation Workshop to be held in Pittsburgh, Pennsylvania from November 16-18, 2015. The Annual Implementation Workshop facilitates information exchange between Natural Gas STAR partners and industry experts and will include topics about cost-effective methane emission reduction technologies and practices. The workshop will feature a site tour of the Waynesburg Compressor Station; a keynote speech by Teresa Marks, Principal Advisor to the EPA Administrator; and an exhibitor area. View the preliminary [agenda](#) for more information about the presentations planned for the 2015 Annual Implementation Workshop.

[Stakeholder Workshop on EPA GHG Data on Petroleum and Natural Gas Systems](#)

**Sheraton Pittsburgh Hotel at Station Square
November 19, 2015 - Pittsburgh, Pennsylvania**

Following the Annual Implementation Workshop, EPA will host a stakeholder workshop on petroleum and natural gas system GHG data from the Greenhouse Gas Reporting Program (GHGRP) and U.S. Greenhouse Gas Inventory of Emissions and Sinks (GHG Inventory). [Registration](#) is open for the stakeholder workshop, during which EPA will present information on 2014 GHGRP data, including newly available activity data. EPA will also present details about existing GHG inventory methods and planned improvements under consideration based on previous stakeholder comments and data from the GHGRP and external studies. The workshop will provide an opportunity for stakeholders to offer feedback on planned improvements.

Global Methane Forum

**Georgetown University Hotel and Conference Center
March 28-30, 2016 - Washington, DC**

The Global Methane Forum provides an opportunity for methane experts and policy-makers from around the world to convene to discuss options for methane reduction and abatement activities. The forum will include:

- High-level plenary sessions on cross-cutting issues, such as project financing.
- Technical sessions on oil and natural gas systems, biogas (agricultural sources, municipal solid waste, municipal wastewater systems), and coal mines.
- Joint Global Methane Initiative (GMI) and Climate and Clean Air Coalition (CCAC) discussions on policy and projects.
- Opportunities for networking with methane experts in the public and private sectors from around the world.



The Forum is organized by the GMI in partnership with CCAC. It will be held back-to-back with a 2-day CCAC Working Group meeting, which will take place at the same venue on March 31 - April 1, 2016.

Methane Challenge Program Proposal

EPA is proposing the voluntary Natural Gas STAR [Methane Challenge Program](#), which would provide a new mechanism through which oil and gas companies could make and track ambitious commitments to reduce methane emissions. The Program is based on extensive stakeholder outreach and reflects a revision of EPA's previously proposed Gas STAR Gold framework. While tremendous progress has been made during the last 20 years through the successful Natural Gas STAR Program, significant opportunities remain to reduce methane emissions, improve air quality, and capture and monetize this valuable energy resource. This new program has the capability to comprehensively and transparently reduce emissions and realize significant voluntary reductions in a quick, flexible, cost-effective way.

The Methane Challenge Program is an integral part of EPA's — and the Administration's — ongoing commitment to address methane emissions and global climate change. In March 2014, the White House released the [Strategy to Reduce Methane Emissions](#) that included EPA efforts to reduce methane emissions in the oil and natural gas sector. In January 2015, the Obama Administration further demonstrated its commitment by announcing a new goal to cut methane emissions from this sector by 40-45 percent from 2012 levels by 2025.

In July 2015, EPA hosted a series of [webinars](#) to review the Methane Challenge Program details. On October 19th, EPA released a [supplemental technical document](#) that provides additional technical information for stakeholders to evaluate and provide feedback on the proposed program. EPA encourages stakeholders to closely review and [provide feedback](#) on any and all elements of the proposed Methane Challenge Program by November 13, 2015. EPA will carefully consider and evaluate all feedback received with the goal to finalize the Methane Challenge Program by the end of 2015.

In the News

EPA Proposes Climate, Air Quality and Permitting Rules for the Oil and Natural Gas Industry

On September 18, 2015, EPA proposed requirements that together will help combat climate change, reduce air pollution and provide greater certainty about Clean Air Act permitting requirements for the oil and natural gas industry. The proposals are a key component under the President's [Climate Action Plan](#) to achieve the Administration's goal of cutting methane emissions from the oil and gas sector by 40 to 45 percent from 2012 levels by 2025.

Methane, the key constituent of natural gas, is a potent GHG with a global warming potential more than 25 times greater than that of carbon dioxide. Methane is the second most prevalent GHG emitted in the United States from human activities, and nearly 30 percent of those emissions come from oil production and the production, transmission and distribution of natural gas.

In January 2015, EPA and the Obama Administration announced a [strategy for reducing methane emissions](#) from the rapidly growing oil and gas industry. EPA's proposed actions will complement the methane reductions the country is seeing today as co-benefits of the Agency's 2012 rules to reduce volatile organic compound (VOC) emissions from the oil and gas industry. These rules, along with the Agency's proposed voluntary Natural Gas STAR Methane Challenge Program, will help ensure safe and responsible oil and natural gas development.

The proposed requirements would require methane and VOC reductions from hydraulically fractured oil wells and would complement the Agency's 2012 standards addressing emissions from this industry. It would also extend emission reduction requirements further "downstream," covering equipment in the natural gas transmission segment of the industry that was not regulated in the Agency's 2012 rules. These proposed updates include requirements that owners and operators:

- Find and repair leaks.
- Capture natural gas from the completion of hydraulically fractured oil wells.
- Limit emissions from new and modified pneumatic pumps.
- Limit emissions from several types of equipment used at natural gas transmission compressor stations and at gas storage facilities, including compressors and pneumatic controllers.

The standards for new and modified sources are expected to reduce 340,000 to 400,000 short tons of methane in 2025, the equivalent of reducing 7.7 to 9 million metric tons of carbon dioxide. EPA estimates the rule will yield net climate benefits of \$120 to \$150 million in 2025.

The deadline for submitting comments on the proposed requirements has been extended to December 4, 2015. Visit <http://www.epa.gov/airquality/oilandgas/actions.html> for more information about the proposed actions and instructions for submitting comments.

ARPA-E's Methane Detection Program

In order to improve operators' ability to detect and quantify methane leaks—and, in turn, mitigate the amount of methane that is leaked—the U.S. Department of Energy's Advanced Research Projects Agency-Energy ([ARPA-E](#)) created a \$35 million program named, Methane Observation Networks with Innovative Technology to Obtain Reductions ([MONITOR](#)).



ARPA-E's MONITOR Program consists of 11 project teams, each developing innovative technologies to cost-effectively and accurately locate and measure methane emissions associated with natural gas production. MONITOR's diverse portfolio spans a range of optical and chemical pathways and includes point sensors, long path sensors, distributed sensor networks, and even unmanned aerial vehicle (UAV)-mounted applications.

Developing low-cost sensing systems is vital to promoting the more efficient use of U.S. domestic natural gas resources, decreasing safety hazards and lowering the overall GHG impact from natural gas development. The MONITOR program aims to give the entire natural gas industry the tools necessary to increase the capabilities of, and decrease the cost of, methane detection systems; this will accelerate the adoption of monitoring programs from the well pad to the burner tip. Many of the projects seek to engage with oil and gas companies as part of their technology development process, and companies that are interested in playing a role in this process are encouraged to identify projects of interest in the [Project Listing](#) on the MONITOR website.

For more information on the MONITOR program, contact the ARPA-E Technology-to-Market Advisor, Nate Gorence, via email at nathaniel.gorence@hq.doe.gov.

U.S. Department of Transportation (DOT) Pipeline and Hazardous Materials Safety Administration (PHMSA) Awards Five New Research Projects

In fiscal year 2015, the DOT/PHMSA awarded five new research projects that address methane emissions reduction challenges for natural gas pipelines, three of which involve both the detection and flow rate measurement of very small leaks. Input on the design of these projects was solicited from the EPA, U.S. Department of Energy, Environmental Defense Fund and various pipeline operators. This is a strong investment by PHMSA that will comprehensively encourage innovation and address challenges in the growing market of minimizing methane leaks to the environment. See Table A for details about the research projects awarded in 2015.

Table A. FY 2015 Research Projects Awarded by PHMSA

Project Title	Recipient
Small-Scale DIAL for Methane Detection	University of Colorado at Boulder
Emissions Quantification Validation Process	Northeast Gas Association
Natural Gas Pipeline Leak Rate Measurement System	Physical Sciences Inc.
Rapid Aerial Small Methane Leak Survey	Ball Aerospace & Technologies Corp.
Framework for Verifying and Validating the Performance and Viability of Leak Detection Systems for Liquid and Natural Gas Pipelines	C-FER Technologies

Release of 2014 Greenhouse Gas Reporting Program Data

On October 6, 2015, EPA released the 2014 GHG data for Petroleum and Natural Gas Systems that was collected under the Greenhouse Gas Reporting Program (GHGRP). The GHGRP, which was required by Congress in the FY2008 Consolidated Appropriations Act, requires facilities to report data from large emission sources across a range of industry sectors. Suppliers of certain GHGs and products that would emit GHGs if released or combusted are also required to report.

In 2014, GHG emissions data was provided from more than 2,400 facilities that conduct Petroleum and Natural Gas Systems activities such as production, processing, transmission and distribution. These facilities accounted for GHG emissions of 236 million metric tons of carbon dioxide equivalent (CO₂e), an increase of 3.5% compared to 2013 GHG emissions from this sector.

Petroleum and Natural Gas Systems reporters submitted facility activity data for the first time for many emission categories, including activity data from previous years that were subject to deferred reporting until March 2015. This information includes equipment counts, operational parameters and other data that are used to calculate GHG emissions.

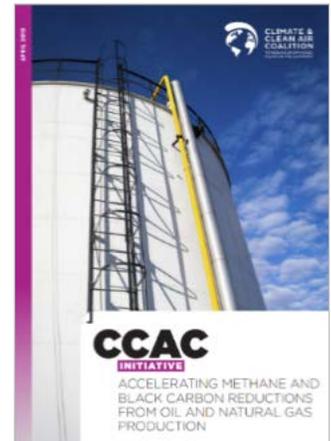
The GHG data represent a significant step in better understanding GHG emissions from Petroleum and Natural Gas Systems. EPA expects that the GHGRP will be an important tool for the Agency and the public to analyze emissions and understand emissions trends. Visit <http://www2.epa.gov/ghgreporting/ghgrp-2014-reported-data> for more information about the GHGRP data that was reported in 2014.

International News

CCAC Oil and Gas Initiative Releases “Accelerating Methane and Black Carbon Reductions from Oil and Natural Gas Production” Fact Sheet

The Climate and Clean Air Coalition’s (CCAC) Oil & Gas Initiative aims to reduce emissions of short-lived climate pollutants from oil and gas industry operations, with a focus on methane and black carbon. CCAC recently released a fact sheet, [Accelerating Methane and Black Carbon Reductions from Oil and Natural Gas Production](#), to describe its efforts to work with key stakeholders and to support the implementation of new and existing measures to substantially reduce methane emissions from natural gas venting, leakage and flaring. The fact sheet summarizes and presents the objectives and highlights of the initiative’s two components:

- 1) CCAC Oil & Gas Methane Partnership – The partnership is designed to help participating oil and gas companies better understand and systematically manage their methane emissions and to help them demonstrate their systematic management to stakeholders.
- 2) Technology Demonstration Project to Reduce Black Carbon from Gas Flares – This component involves the conduct of a series of demonstration projects to recover valuable, readily-condensable, hydrocarbon liquids contained in many natural gas streams currently being flared by the oil and gas industry.



New Program Partner

Domestic

Dominion Hope

Dominion is one of the nation's largest producers and transporters of energy and serves utility and retail energy customers in 13 states. Dominion Hope is a natural gas distribution utility provider for customers in West Virginia.



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