



## Natural Gas STAR Partner Update

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### In-Depth Technology/Partner Profile

#### Experiences with Detection of Natural Gas Emissions Using Infrared Camera Technology

By: Nelson Menéndez

The Global Methane Initiative (GMI) is an international public-private initiative that advances cost-effective, near-term methane reduction and recovery-and-use projects across five sectors: agriculture, coal mines, municipal solid waste, oil and gas systems, and wastewater. As a clean energy source, methane is vital to conserve and use to the fullest extent possible. As a



partnership of 41 countries (plus the European Commission), GMI counts among its membership the top ten methane-emitting countries, and its partners account for about 70% of global anthropogenic (human-induced) methane emissions. Partners include both natural gas producers and consumers, and GMI's efforts help catalyze technology transfer and capacity building for the identification, evaluation and implementation of methane reduction projects in the oil and gas industry. Since methane is

the primary component of natural gas, these projects both reduce greenhouse gas (GHG) emissions in the short term and provide a number of important environmental, economic, energy and safety benefits in the long term.

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## 2015 Natural Gas STAR Annual Implementation Workshop

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

Please join the Natural Gas STAR Program at its Annual Implementation Workshop in Pittsburgh, Pennsylvania from November 16-18, 2015. The workshop will facilitate information exchange between Natural Gas STAR partners and industry experts and will feature topics about cost-effective methane emission reduction technologies and practices.

*Registration for the workshop will be available shortly.*

Interested presenters may submit one-page abstracts for technical sessions to [meetings@erg.com](mailto:meetings@erg.com). Abstracts must be submitted by **July 17, 2015** and should be focused on the deployment of commercially proven, 3rd-party verified technologies with documented case studies and may not promote specific products, services or companies.

Abstracts should contain:

- (1) presentation title;
- (2) name of presenter;
- (3) presenter's organization, mailing address, email and telephone number; and
- (4) a summary of the topic to be presented.

While the initial interest is environmental – given that methane, along with carbon dioxide, is one of the most active gases that contribute to the greenhouse effect – it is also in the general interest of all oil and gas companies, in terms of profitability and safety, that methane is not lost on its long path from the production well to the consumer.

Because of these dual benefits in the oil and gas sector, the national oil and gas company of Chile (ENAP) signed a technical and technology transfer cooperative agreement with the EPA in 2009 to participate in the Natural Gas STAR International Program. Immediately upon joining, ENAP initiated a pilot program to detect and control fugitive methane emissions from the installations it operates in the region.

In November 2009, a team of technical experts in the detection and quantification of methane emissions, led by the EPA, travelled to Chile to visit ENAP installations located in the region of Magallanes, bordering the Strait of Magellan. The trip's objective was to field-verify the actual level of emissions from the natural gas production installations selected for study.

### Infrared Technology for Leak Detection and Quantification

Of all the leak detection and quantification equipment used in this pilot program, the most vital device was the infrared camera, which uses infrared technology to visualize plumes of hydrocarbon gases. Once emissions sources were identified, flow measurements were taken using portable ultrasonic and turbine meters. In cases where it was not possible to measure flow rates, estimates based on previous studies were used. The measurement study quantified emissions from centrifugal compressor wet seal vents; fugitive emissions from pipes, valves and reciprocating compressors; and emissions from thief hatches on storage tanks. Figure 1 shows some of the inspected sources.

**Figure 1. Photographs from Inspections Performed in ENAP's 2009 Pilot Program.**



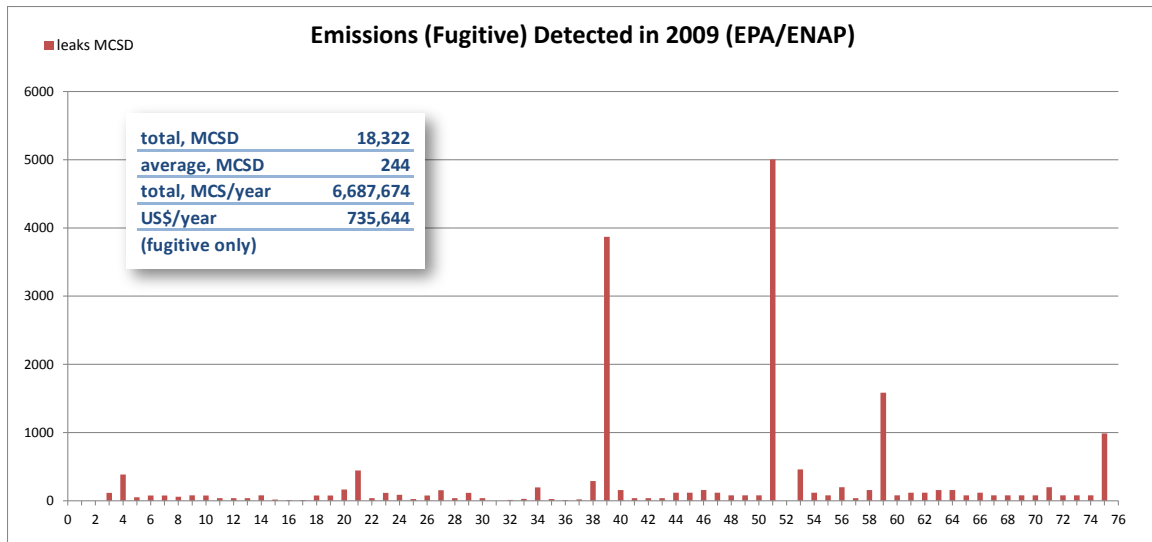
The team quantified methane emissions totaling nearly 12.5 million standard cubic meters per year (scmy). Total emissions were comprised of fugitive emissions (defined as unintentional leaks) and vented emissions, which are intentional and inherent to equipment design (e.g., standard vents for centrifugal compressor seal oil degassing).

In ENAP's experience, fugitive emissions were typically easy to repair (e.g., common fugitive emissions from faulty valve seals or flanges simply required tightening connections or replacing valves). By comparison, reducing vented emissions can require complex projects such as large scale design changes in a system or process; installation of new equipment or instruments; or in

the most simple and profitable of cases, changing packing or introducing a modification in operational procedures. Figure 2 illustrates details of detected vented and fugitive emissions in the 2009 campaign, some of which were then repaired at a low cost.

Based on the 2009 survey, the average volume of fugitive leaks was approximately 200 standard cubic meters methane per day (scmd). The 2009 survey allowed ENAP to recover some of the fugitive methane emissions immediately, saving nearly \$200,000 through avoided gas losses in the following year. Upon completion of this project, ENAP became the first South American company to perform this type of analysis in partnership with the EPA.

Figure 2. Fugitive and Vented Emissions Detected in ENAP’s 2009 Pilot Program that were Repaired at a Low Cost (EPA/ENAP).



### Technical-Economic Evaluations

Given the compelling results obtained in the pilot program, ENAP decided to continue to develop this company initiative by evaluating three projects:

- 1) **Purchase of an infrared camera.** To continue performing inspections as part of normal operations, this piece of equipment was an important contributing factor in the safety of ENAP’s installations.
- 2) **Installation of vapor recovery units (VRUs) in condensate tanks.** Capture hydrocarbon-rich vapors and store them in a tank.
- 3) **Reduction of gaseous emissions from wet seal centrifugal compressors.** Change traditional “wet” or oil seal systems with new systems that use inert gases.

The results of the technical-economic evaluations are shown in Figure 3.

Figure 3. Economic Evaluations of Potential Projects (2010).

	Initiative 1 Buy Infrared Camera	Initiative 2 Vapor Recovery	Initiative 3 Change Compressor Seals SULZER
			
Investment (MUS\$)	116	200	1200 (initial estimate) >2000 (end value)
Timeframe (year)	1	4	4
Result (NPV)	US\$ 48.000 Project Profitable	US\$ -183.000 Project NOT Profitable	US\$ -804.000 Project NOT Profitable

Figure 3 (above) shows that the purchase of an infrared camera was a profitable project and it was unanimously selected as the project to pursue. The equipment was received by the ENAP Magallanes plant in February 2011. The other projects had complex technical considerations, which increased both the costs and the time to achieve a positive return on investment.

Infrared technology, specific to hydrocarbon detection, allows clear visualization of gas phase hydrocarbons at virtually any concentration. This technology has been especially useful in helping ENAP detect very small concentrations (below the detectable threshold of human sight). This allows the company to take corrective action and prevent major accidents. Moreover, this technology is useful to detect fugitive emissions which are below the threshold of audible or other detection methods due to the high level of ambient noise or because the emissions source is at a significant height, as is common inside a plant. These fugitive emissions are easily detected by the camera.

The photographic sequence in Figure 4 shows the filming of natural gas fugitive emissions from a leak in an underground line at a compressor station. Before using the infrared camera, the workers at this location had no indication of this gas cloud either visibly, audibly or via odor (at this stage of the process, no odorant had been added).

Figure 4. Photographic Sequence of a Natural Gas Fugitive Emission from an Underground Line.



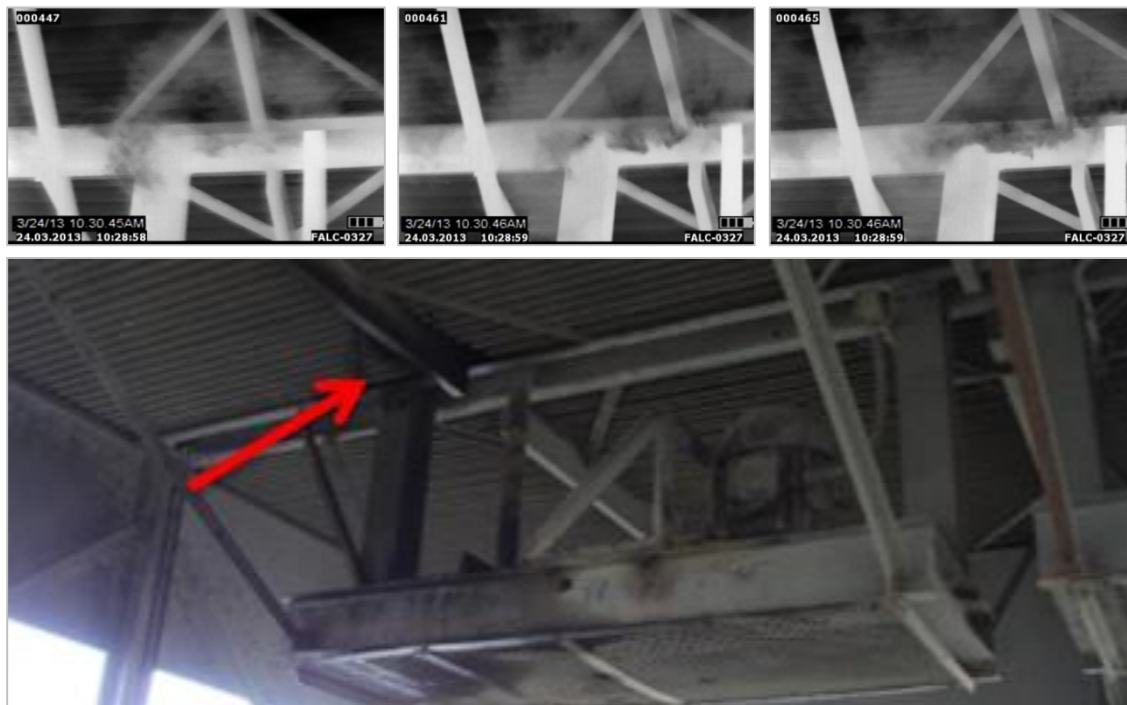
The fugitive emissions identified in Figure 4 came from a 2-inch underground line operating at 3,102,642 pascal (Pa), which had various perforations resulting from the formation of pitting due to corrosion (Figure 5).

**Figure 5. Photos of the Underground Line Before and After Repairs.**



While infrared technology can be appropriately applied to detect a range of organic compounds (such as methane, ethane, propane, methanol, benzene, toluene, etc.) at natural gas installations, methane (generally at concentrations greater than 90% by volume) was the principal compound encountered (as is logical to expect). ENAP also has taken infrared videos of units handling other hydrocarbons, such as propane, and the camera’s response is as good as its response to methane. The photographs in Figure 6 show infrared video images taken of an air cooler for a propane refrigeration circuit. After taking the video, the detected emissions led to the identification of a broken pipe.

**Figure 6. Photographic Sequence of Detected Fugitive Emissions for a Propane Refrigeration Circuit.**

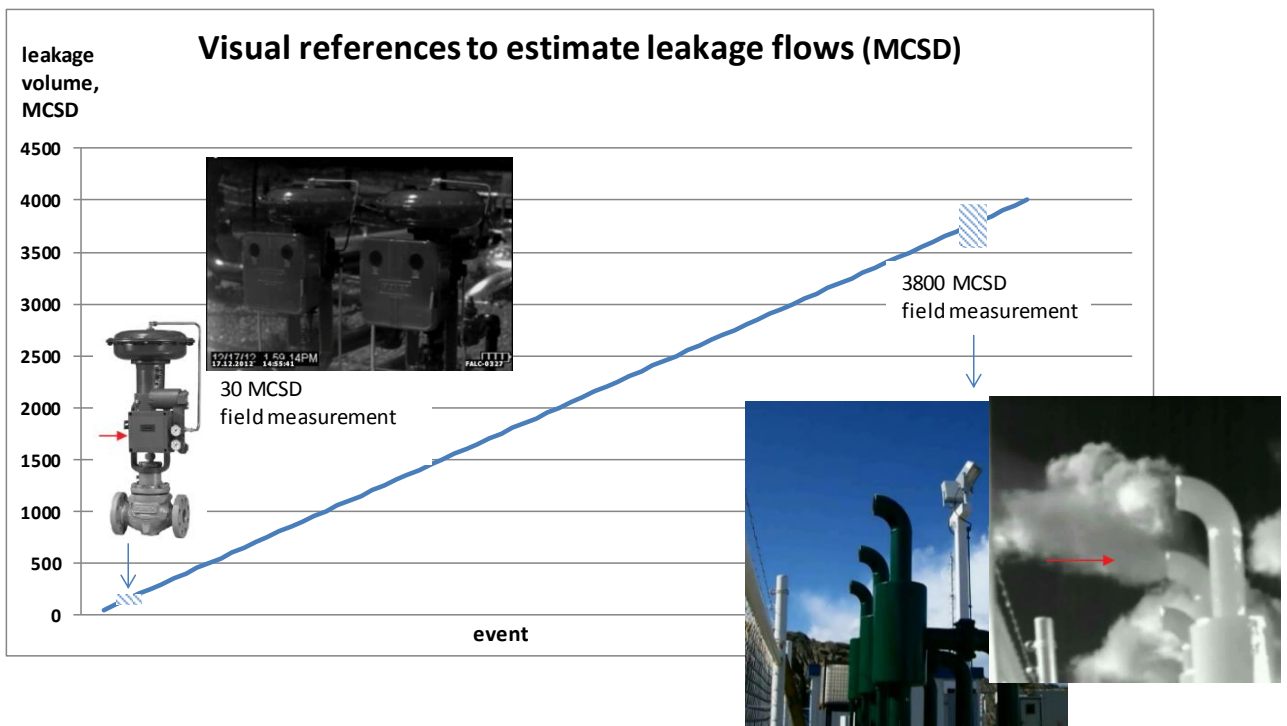


The video’s ability to indicate a propane gas leak is significant. This is in contrast with visual inspection, during which operators could not see anything. ENAP has seen this beneficial experience replicated at other locations.

### Estimation of the Volume of a Fugitive

ENAP prepared an indirect estimation system to determine the volume of gas leaked to the atmosphere from individual fugitive emission sources observed with the infrared camera. Figure 7 shows the estimation curve, which shows the plume sizes of two known fugitives. Any fugitive emission detected by the camera normally is of a volume between these extremes. It should be noted that the camera was designed to detect the presence of gaseous hydrocarbons, not to function as a flow measurement device.

Figure 7. Visual Calibration Curve to Estimate Volumes of Fugitive Emissions.



Between years 2011 and 2013, numerous inspection studies have been performed at various installations. The program has identified and saved more than 7 million cubic meters of natural gas to date, valued at greater than \$600,000 and resulting in methane reductions of 100,000 tons of carbon dioxide (CO<sub>2</sub>) equivalent. Figure 8 shows a technician conducting inspection work using the infrared camera.

Figure 8. Technician Performing Inspection Work.



## Conclusions

The Natural Gas STAR team's visit in 2009 allowed ENAP to verify that various sources of natural gas fugitive emissions existed that were not detectable with the naked eye. Through the application of infrared camera technology, previously invisible fugitives are now visible.

Discoveries of fugitive emissions and subsequent repairs to date have already paid back ENAP's investment in the infrared camera. In addition to cost savings, this technology contributes significantly to safety at ENAP's installations, an aspect that has an infinite return when compared to any economic variable.

Given that fugitive emissions are a permanent challenge across installations that handle natural gas and considering the great geographical dispersion of installations held by ENAP in Magallanes, the inspections performed using infrared camera technology will continue to bring substantial contributions aligned with three strategic pillars of any oil and gas business: economics, environment and safety.

## In the News

### Enhanced Voluntary Efforts in the Oil and Gas Sector

In support of the January 2015 release of the Administration's [plan to cut methane emissions from oil and gas operations](#), and as a result of the feedback received on the 2014 proposed "Gas STAR Gold" program, EPA is revising its approach on enhanced voluntary action in the oil and gas sector. EPA is actively seeking stakeholder feedback and participation in the design of this new approach.

The new "Enhanced Gas STAR" framework, which is still under development and scheduled to be released by mid-June, will allow EPA to work with individual companies to achieve the following:

- Encourage innovation and ambitious commitments with flexible achievement mechanisms
- Provide accountability and transparency for reduction commitments
- Track progress toward specific methane emission reduction activities
- Achieve significant methane reductions that could reduce the need for future regulations



To learn more about EPA's expanded Enhanced Gas STAR approach and outreach efforts, see the [Enhanced Voluntary Efforts in the Oil and Gas Sector homepage](#). EPA encourages interested stakeholders to contact us if you would like to provide input on this process.

### EPA Publishes 20th Annual U.S. Greenhouse Gas Inventory

On April 14, 2015, the EPA released its 20<sup>th</sup> Inventory of U.S. Greenhouse Gas Emissions and Sinks, showing a two percent increase in GHG emissions in 2013 compared to 2012 levels, but a nine percent drop in emissions since 2005.

Total U.S. GHG emissions were 6,673 million metric tons of CO<sub>2</sub> equivalent in 2013, with oil and gas systems accounting for 226 million metric tons of CO<sub>2</sub> equivalent. By sector, power plants were the largest source of emissions, accounting for 31 percent of total U.S. GHG pollution. The transportation sector was the second largest source, at 27 percent. Industry and manufacturing were the third largest source, at 21 percent. The increase in total national GHG emissions between 2012 and 2013 was due to increased energy consumption across all sectors in the U.S. economy and greater use of coal for electricity generation.

This year, EPA is publishing key data in a new, online [Greenhouse Gas Inventory Data Explorer tool](#), which allows users to view, graph and download data by sector, year and GHG type.

For more information, read the EPA's [news release](#) or view the [U.S. Greenhouse Gas Inventory Report](#) website.





# Natural Gas STAR Releases

## Calendar Year 2013 Accomplishments Data

### 58.4 Bcf of Methane Emissions Reductions

Working collaboratively with the oil and natural gas industry, the Natural Gas STAR Program provides a framework to encourage partner companies to implement technologies and practices that reduce methane emissions. Each year, Natural Gas STAR Program partners report the voluntary methane emissions reductions activities that they implemented in the previous year and the corresponding methane emissions reductions achieved.

The Natural Gas STAR Program recently released its accomplishments data for the 2013 calendar year. In 2013, Natural Gas STAR domestic and Natural Gas STAR International partners reported 58.4 billion cubic feet (Bcf) of methane emissions reductions. These voluntary activities have cross-cutting benefits on domestic energy supply, industrial efficiency, revenue generation and GHG emissions reductions. More information about the reported domestic and international reductions are provided below.

### Domestic Reductions Reported for 2013

Domestic Natural Gas STAR partners reported the implementation of nearly 50 technologies and practices to reduce methane emissions by 50.7 Bcf in 2013. Figure 1 shows the most common technologies and practices. Figure 2 shows the annual and cumulative methane emissions reductions reported by domestic Natural Gas STAR partners since 2004.

Figure 1. 2013 Methane Emissions Reductions by Sector (50.7 Bcf)

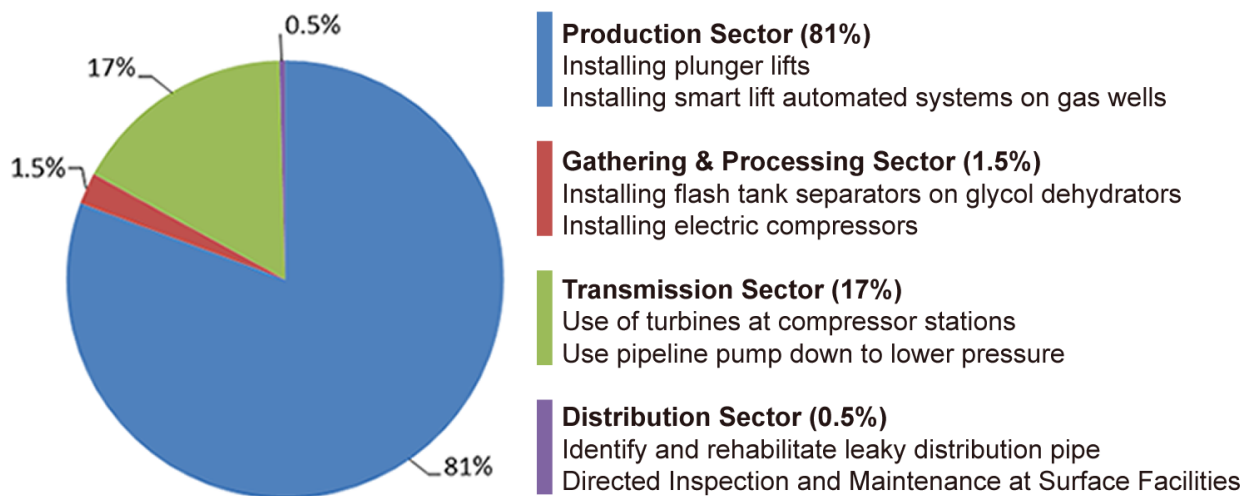
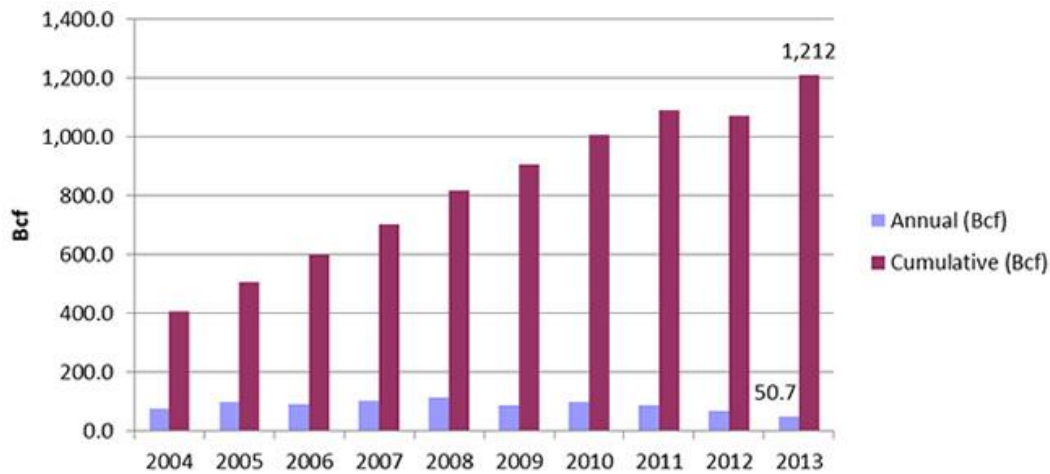


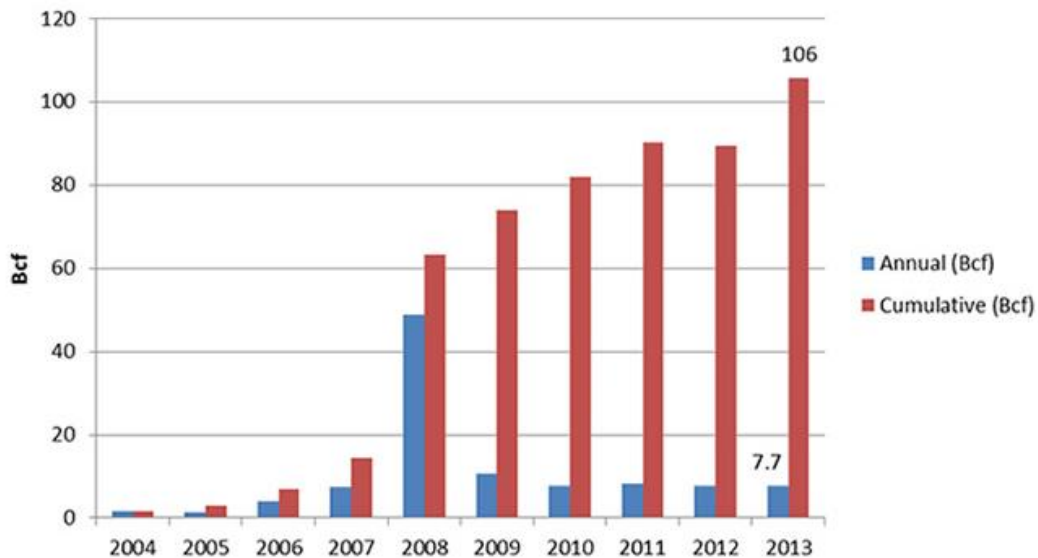
Figure 2. Domestic Natural Gas STAR Methane Emissions Reductions as of 2013



### International Reductions Reported for 2013

Natural Gas STAR International partners reported 7.7 Bcf in methane emissions reductions in 2013 resulting from the implementation of 11 technologies and practices (see figure 3). To date, Natural Gas STAR International partners with operations in Argentina, Brazil, Canada, Chile, Colombia, Equatorial Guinea, India, Indonesia, Nigeria, Oman, Poland and Qatar have undertaken activities resulting in a total of 106 Bcf in methane emission reductions.

Figure 3. Natural Gas STAR International Methane Emissions Reductions as of 2013



### Calendar Year 2014 Annual Reporting Is Open!

Natural Gas STAR partners may submit annual reports to document their voluntary methane emission reductions achieved in 2014. Reports are due by June 30, 2015, and may be submitted online by accessing the online reporting system at: <http://www.ttemiproduct.com/epagasstar-reporting/>.

## International News

### CCAC Launches Oil & Gas Methane Partnership

The Climate and Clean Air Coalition (CCAC) recently announced the CCAC Oil & Gas Methane Partnership, a voluntary initiative to reduce methane emissions in the oil and gas sector. The Partnership, officially launched at the UN Secretary General's Climate Summit in New York on September 23, 2014, provides companies with a credible mechanism to address their methane emissions systematically and responsibly and to report their methane emission reduction activities to stakeholders.



By joining the CCAC Oil & Gas Methane Partnership, partner companies can help achieve corporate GHG reduction goals or sustainability objectives through cost-effective actions that conserve natural gas, demonstrate leadership, and build industry-wide buy-in to reduce methane emissions. Participating companies:

- Sign a voluntary Memorandum of Understanding
- Develop an Implementation Plan
- Conduct emissions surveys to identify and quantify controlled and uncontrolled methane emission sources, focusing on nine core upstream sources
- Evaluate and implement mitigation options
- Submit annual reports to document progress and achievements

CCAC will provide technical support to assist partner companies in evaluating methane emissions, recognize ongoing and completed efforts by partner companies, and promote engagement. View the [Partnership Framework Document](#) or visit the [CCAC Oil & Gas Methane Partnership website](#) for more information.

### CCAC Releases Annual Report

CCAC's [annual report](#) provides an overview of the Coalition's progress and achievements from September 2013 through August 2014. The report summarizes actions by partners to reduce their short-lived climate pollutants domestically and outlines the Coalition's goals and milestones for 2014-2015. The report also contains updates on each of the Coalition's 11 initiatives, including information about the Oil & Gas Initiative's work with countries and companies to collaboratively design mechanisms and voluntary commitments to achieve substantial emission reductions from natural gas venting, leakage and flaring.



### GMI Oil & Gas Subcommittee Statement of Purpose

GMI's Oil & Gas Subcommittee recently finalized its [Statement of Purpose](#), which outlines its goals and identifies how organizations can help achieve them. The statement also defines key

stakeholders and stakeholder roles. As presented in the Statement of Purpose, the Oil & Gas Subcommittee:



“is committed to reducing the impacts of climate change by providing international leadership to mitigate global methane emissions through the abatement, recovery and use of methane from oil and gas operations as a clean energy source. The Oil & Gas Subcommittee encourages collaboration between delegates from Partner Countries and Project Network members to build capacity, develop strategies and markets and remove technical and non-technical barriers to methane mitigation project development in order to increase environmental quality, improve operational efficiency and strengthen the economy, from the additional gas brought to market.”

The Oil & Gas Subcommittee will periodically review and revise the Statement of Purpose to reflect regulatory, political and economic opportunities.

## Recent GMI Oil & Gas Sector Workshops

### April 27-28, 2015, Dhahran, Saudi Arabia

EPA joined Saudi Aramco, the Saudi Ministry of Petroleum and Energy Resources, and the United Nations Environmental Program (UNEP) to co-host a [GMI/CCAC Oil & Gas Sector Workshop](#), Methane Mitigation Technologies and Practices, in Dhahran, Saudi Arabia on April 27-28, 2015. The workshop drew approximately 200 participants from Saudi Arabia, Kuwait, India and Indonesia to present efforts to control and mitigate greenhouse gas emissions, in particular methane emissions from upstream oil and gas operations. His Royal Highness Prince Abdulaziz bin Salman bin Abdulaziz Al-Saud, Vice Minister of Petroleum and Mineral Resources, opened the conference and greeted the exhibitors along with Mr. Khalid Al-Falih, Saudi Aramco President and CEO. His Excellency Joseph W. Westphal, U.S. Ambassador to Saudi Arabia, and Ms. Christiana Figueres, Executive Secretary of the United Nations Framework Convention on Climate Change, also gave opening remarks to kick-off the conference. Scott Bartos, U.S. EPA International Program Manager, and Phil Swanson, CCAC Oil & Gas Methane Partnership (OGMP) Administrator,



discussed collaborative opportunities to minimize oil and gas sector methane emissions via the GMI and CCAC OGMP. Saudi Aramco presented their Flaring Minimization Program accomplishments over the past 30 years, leak detection and repair programs, and Volatile Organic Compounds (VOC) emissions control projects. EPA Natural Gas STAR International partners, Kuwait Oil Company, Cairn India and STAR Energy of Indonesia, presented about methane emission reduction projects. More than ten



international service providers exhibited their equipment and services at the exhibition. Following the workshop, Saudi Aramco hosted a tour of their Engineering Solutions Center.



**March 24-25, 2015, Bangkok, Thailand**

EPA joined PTT Public Company Limited to identify, measure and evaluate cost-effective methane mitigation opportunities at the Khanom Gas Separation Plant and NGV/GTM Nam Phong Facility from March 16-22, 2015. During the study, EPA and PTT evaluated nine core methane emission sources covered under the Climate and Clean Air Coalition (CCAC) and determined if they were considered “controlled” or “uncontrolled” under the CCAC framework. EPA’s technical team provided hands-on training to PTT’s staff to help improve their use of leak detection and measurement equipment. This joint study highlights the commitment PTT Thailand has made to CCAC and its commitment to find and repair methane leaks and reduce methane emissions.

Following the field study, more than 40 participants from roughly 10 companies, government ministries and universities attended the GMI/CCAC



Oil & Gas Sector Workshop hosted by PTT in Bangkok on March 24-25, 2015. The workshop opened with PTT hosting a visit to a natural gas vehicle fueling station to demonstrate advanced analytical tools used to improve methane management and increase operational efficiency and safety. Partners and interested stakeholders from India, Thailand, Indonesia, the United States and UNEP actively participated to exchange information on CCAC’s nine core emission sources, operational best practices, and



ongoing research and development on related environmental challenges associated with oil and gas development.



**December 10, 2014, New Delhi, India**

EPA joined Partner Company, Cairn India, to conduct a field methane emissions detection and measurement study at several of Cairn’s production and processing facilities in Barmer, Rajasthan from December 2-6, 2014. The team used equipment, such as an infrared camera and Hi-Flow Sampler®, to survey and quantify methane leaks and vented emissions as well as to set up a tracer gas system to verify flare gas measurements.

Following the study, EPA’s team joined the 2nd All India GMI Oil & Gas Sector Workshop hosted by Cairn India in New Delhi on December 10, 2014. More than 50 participants from five oil and gas companies and government



agencies attended the productive workshop. The workshop encouraged the use of methane emission identification and evaluation best practices and deployment of state of the art technologies at oil and gas facilities to economically improve environmental performance, operational safety and energy security. The workshop sessions included a panel discussion on policies and programs supporting methane mitigation, GMI Partner Company presentations on past and future methane mitigation activities, and vendor



presentations on technologies that are available to capture, treat and beneficially use poor quality and stranded gas.



### August 27-28, 2014, Bandung, Indonesia

More than 80 participants from 20 companies, government ministries and universities attended the 3<sup>rd</sup> Asia Pacific GMI Oil & Gas Sector Workshop,



hosted by Indonesia's Ministry of Energy and Mineral Resources in Bandung, Indonesia on August 27-28, 2014. Participants from across Southeast Asia shared ideas on how practical methane mitigation measures can contribute to national climate change objectives and commitments. EPA's Partner Company, Pertamina EP, hosted an informative field demonstration of methane emission detection and quantification equipment and procedures.



**VICO INDONESIA**





Following the workshop, EPA’s team joined Partner Company, VICO Indonesia, to identify and evaluate cost-effective methane mitigation opportunities at several oil and gas production facilities in East Kalimantan. The study’s findings will lay the foundation for future VICO projects to recover and utilize methane that might otherwise escape to the atmosphere. The cooperative field experience also provided VICO’s team with hands-on training to improve their use of advanced methane emission detection and quantification tools.

## New Program Partners

### International

#### Cairn India

Cairn India is one of the largest independent oil and gas exploration and production companies in India, operating 28% of India's domestic crude oil production. Through its affiliates, Cairn India has been operating for close to 20 years, playing an active role in developing India's oil and gas resources.



#### Jubilant Energy

Jubilant Energy is an emerging oil and gas player in India and has been engaged in upstream exploration and production since 1995. Jubilant’s portfolio is located in the hydrocarbon basins of Krishna Godavari, Assam-Arakan and Cambay in India, and the Central Burma basin in Myanmar.



#### Pertamina Asset

PT Pertamina EP is engaged in business activities in the upstream sector of oil and gas fields in Indonesia, including exploration and exploitation. Pertamina EP conducts activities related to the orientation finding and production of oil and gas resources.



#### Surtigas

For more than 43 years, Surtigas has been a distributor and marketer of natural gas services in Colombia. With a Management System Corporate Social Responsibility that focuses on sustainability, Surtigas aims to promote the country economically with equitable and viable business activity scenarios through a balance between social and environmental issues.



#### Ukrtransgaz

Ukrtransgaz is engaged in the transmission and storage of natural gas in Ukraine. The company's main activities include natural gas transmission via trunk gas pipelines; storage of natural gas in underground storage facilities; supplying natural gas to





consumers; operation, reconstruction and servicing of gas mains and associated facilities; and capital construction of gas pipelines and other facilities.

**Domestic**

**Dominion East Ohio**

Dominion is one of the nation's largest producers and transporters of energy and serves utility and retail energy customers in 12 states. Dominion East Ohio is a natural gas distribution utility provider for customers in East Ohio.



**Seneca Resources Corporation**

Seneca Resources Corporation, the exploration and production segment of National Fuel Gas Company, headquartered in Houston, Texas, explores for, develops and produces natural gas and oil reserves in California, Kansas and the Appalachian Region including the Marcellus and Utica Shales. Seneca operates more than 3,000 shallow wells and more than 150 deep shale wells in New York state and Pennsylvania.



**Vermont Gas Systems**

Established in 1965, Vermont Gas Systems serves 6,400 customers in Chittenden and Franklin Counties through a network of more than 750 miles of underground transmission and distribution lines.



**Wexpro**

Wexpro is an exploration and production company that develops and produces gas reserves on behalf of the Questar Gas utility. Wexpro’s operations stretch from the northern tip of the Greater Green River Basin in Pinedale, Wyoming through the Vermillion Basin of Wyoming and Colorado, down to the Uinta Basin of Utah.



Contact Us	
<p><b>Natural Gas STAR Program Managers USA</b></p> <p><b>Jerome Blackman</b>  <a href="mailto:blackman.jerome@epa.gov">blackman.jerome@epa.gov</a>                      (202) 343-9630</p> <p><b>Suzie Waltzer</b>  <a href="mailto:waltzer.suzanne@epa.gov">waltzer.suzanne@epa.gov</a>                      (202) 343-9544</p>	<p><b>Natural Gas STAR International/ Global Methane Initiative Program Managers</b></p> <p><b>Scott Bartos</b> (Eastern Europe, India, East and Southeast Asia, and Middle East)  <a href="mailto:bartos.scott@epa.gov">bartos.scott@epa.gov</a>                      (202) 343-9167</p> <p><b>Carey Bylin</b> (Europe and Latin America)  <a href="mailto:bylin.carey@epa.gov">bylin.carey@epa.gov</a>                      (202) 343-9669</p>