PARTNER UPDATE

FALL 2011

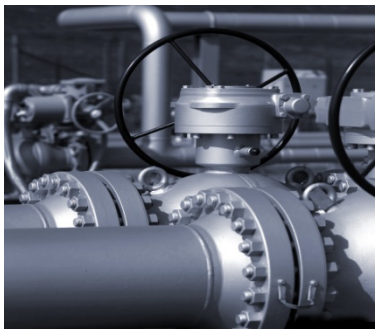
Natural Gas STAR 2012 Annual Implementation Workshop

April 10 - 12, 2012
The Westin Denver Downtown/Tabor Center
Denver, Colorado United States

Join us for the 18th Annual Implementation Workshop, featuring an exhibitor area and facility tours highlighting methane emissions detection, measurement, and reduction methods. The workshop will bring together Natural Gas STAR domestic and international Partners and industry experts to explore the latest technologies and practices. There will also be an update on current federal policies and regulations affecting the industry.

Conference updates, information about no-cost exhibitor space, and registration will be posted to the Natural Gas STAR website this fall at epa.gov/gasstar/workshops.

Natural Gas STAR 2010 Emission Reductions: Continuing Success


For the 2010 calendar year, Natural Gas STAR Partners reported worldwide methane emissions reductions of 101 billion cubic feet (Bcf).

U.S. Reductions

Partners from the U.S. reduced 94.1 Bcf in 2010, The production segment leads the way, accounting for over 77 percent of reductions. The next highest segment was transmission at 14 percent. The emission reduction breakdown can be seen in Figure 1 below.

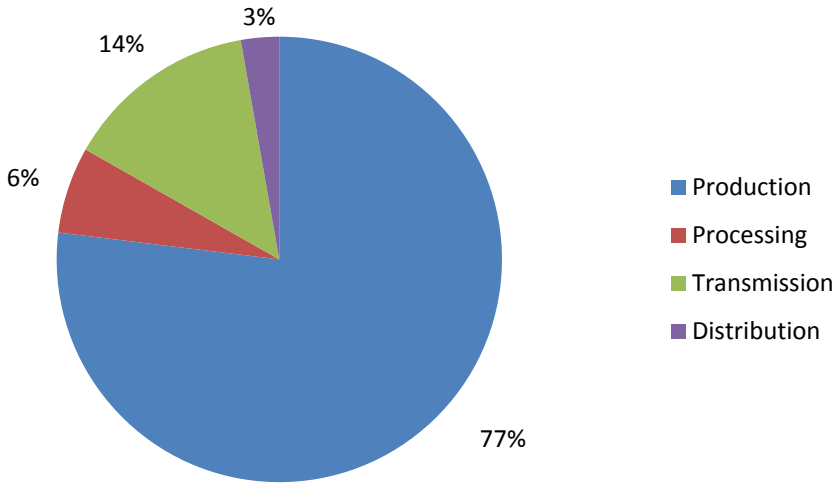


Figure 1: 2010 U.S. Methane Emissions Reduction by Segment (94.1 Bcf)

The production segment contains the top three technologies employed to reduce emissions for 2010 and are listed below:

- Perform reduced emission completions (27.1 Bcf)
- Artificial lift: install plunger lifts (11.9 Bcf)
- Identify and replace high-bleed pneumatic devices (6.0 Bcf)

Figure 2 shows the cumulative accomplishments of the Program. Since the Natural Gas STAR Program's inception 18 years ago, U.S. Partners have reduced methane emissions by over 1,000 Bcf .

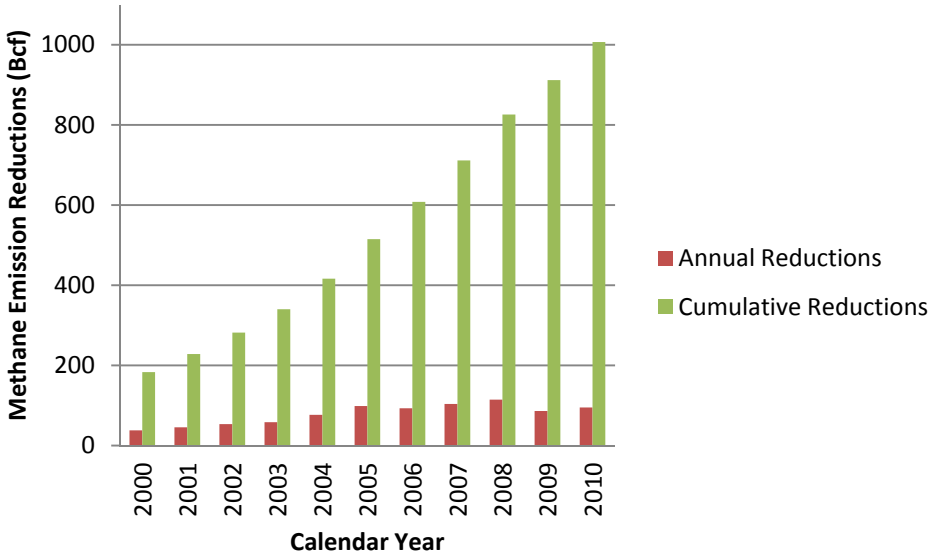


Figure 2: Domestic methane emission reductions (Bcf) since 2000

International Reductions

In just the third year of reporting, the international Partners reported 6.8 Bcf in emission reductions in 2010. The international Program's top three technologies for reducing are listed below.

- Route casinghead gas to vapor recovery units (VRU) or compressor (3.9 Bcf)
- Install VRUs (0.6 Bcf)
- Install automated air/fuel ratio control systems (0.6 Bcf)

International Partner reductions took place in Argentina, Brazil, Canada, and India.

Significance

Regardless of the perspective taken, the 2010 reductions represent a significant achievement. In financial terms, the 101 Bcf of total reductions for 2010 represents about $505 million at $5 per thousand cubic foot. This level of emissions reductions is equivalent to reducing the carbon dioxide emissions from almost 10 coal fired power plants or the energy used by over 3.5 million homes.. In environmental terms, this level of reductions is equivalent to the carbon sequestered annually by over 8.7 million acres of pine or fir forests. Equivalently, the reductions achieved during the 2010 calendar year avoided emissions of 11.31 million tonnes carbon equivalent which reduced the carbon footprint of each reporting Partner company and collectively reduced the global carbon footprint. Both the magnitude of the reductions and their various impacts illustrate a business philosophy that many Natural Gas STAR Partners employ—reducing methane emissions demonstrates environmental stewardship and can also be profitable.

Did you know?

- Emission reductions reported by Partners are incorporated into the Inventory of U.S. Greenhouse Gas Emissions and Sinks submittal to the United Nations Framework Convention on Climate Change (UNFCCC).
- The Natural Gas STAR Program has over 130 domestic Partners and 13 international Partners.
- Natural Gas STAR have used over 80 different technologies and practices to achieve emission reductions since 1993.

Prospective Projects Spotlight: Use Ejector to Capture Compressor Blowdown Emissions

Compressor blowdown emissions are challenging to capture given that a large volume of gas at high pressure is evacuated in a short period of time. A prospective project explored in this article is capturing this gas using an ejector.

Recovering the emissions with a dedicated booster compressor may be too expensive to justify because blowdown emissions are intermittent, so a large amount of capital is underutilized most of the time. A less mechanically complex (and therefore less capital-intensive) ejector, using gas from another main line compressor as the motive force, is a solution that can operate intermittently and that has more economic potential.

Background

Both on an individual installation basis and on a national level, blowdown releases are significant. Capturing blowdown gas can reduce emissions to the atmosphere and save a substantial volume of product and revenue. For example, in 2009 an estimated 138,000 thousand cubic feet (Mcf) of methane was released in compressor blowdowns from the production sector alone. Across the entire industry, this value would be substantially higher. In addition to compressor blowdowns, gas from depressurizing vessels and piping can be captured in much the same way to increase revenue and decrease emissions even further.

One method for reducing emissions when taking compressors and other equipment offline is directing the blowdown to a lower pressure system such as fuel gas. This method does not require any additional equipment such as a booster compressor or ejector. Natural Gas STAR Partner companies have reported using this technique; however it is not always applicable because it depends on the availability and proximity of the lower pressure system. If a gas system is not available at a low enough pressure to receive the blowdown gas, the gas must be vented to the atmosphere. Another method to avoid blowdown emissions is keeping the unit pressurized, though this is not always possible due to operational and / or safety reasons.

New Application

The goal of this prospective project is to route equipment blowdowns to a closed system to avoid product loss. The closed system must be able to accommodate the high vent rate seen during the blowdown, the relatively short blowdown duration, and the constantly decreasing pressure encountered when depressurizing the compressor case. The closed system must both capture the gas and boost the pressure sufficiently to deliver the gas to a receiving line. The project is more feasible at locations where two or more compressors are in close proximity.

With these considerations in mind, the project proposes installation of an ejector as shown in Exhibit 1. The ejector is installed between the discharge of an operating main line compressor and the fuel gas system. The ejector uses a portion of the main line compressor's high pressure discharge stream as the motive gas. The motive gas is routed through a venturi nozzle to draw suction on the lower pressure blowdown gas being discharged from an adjacent offline compressor. The motive and blowdown gas co-mingle in the ejector, and the combined stream is then directed to the fuel gas system where care is taken to ensure the ejector throughput is less than the fuel gas consumption rate.

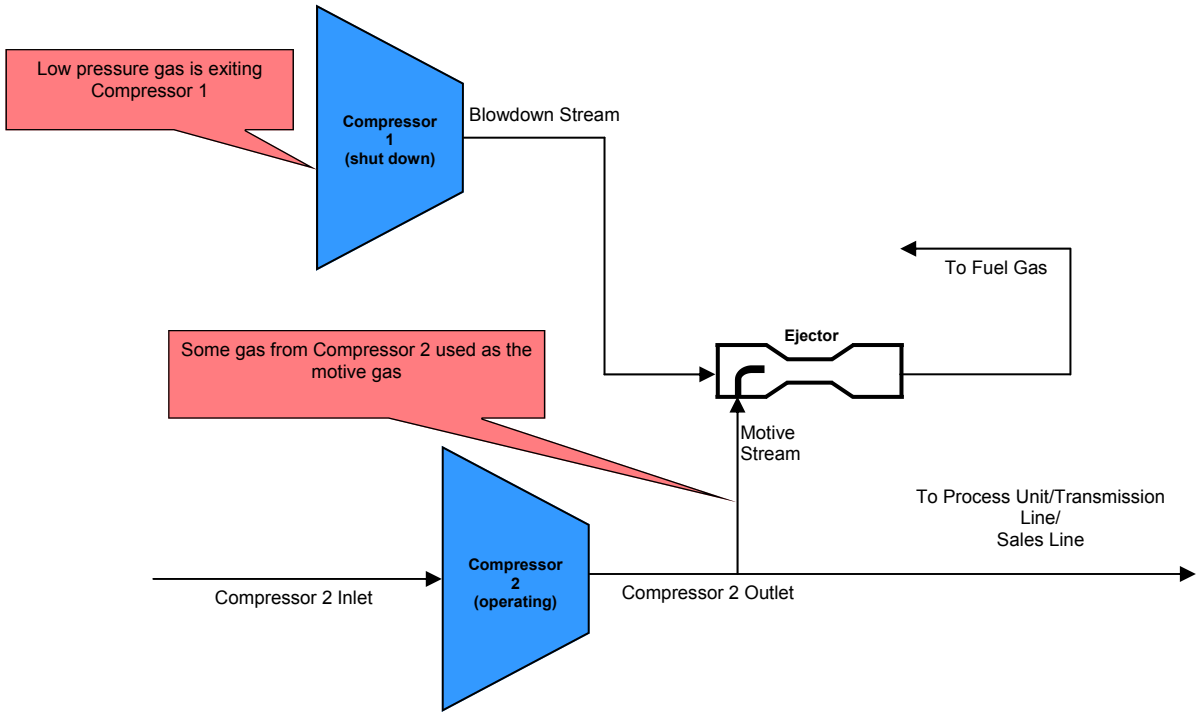


Exhibit 1: Ejector for capturing blowdown gas into the fuel gas line.

Potential Savings, Costs, and Project Economics

A concept was developed for an ejector receiving motive gas at 800 pounds per square inch gauge (psig) from an operating compressor's discharge and routing the combined motive and blowdown gas into the fuel system at 100 psig.

The ejector has two inlets and one outlet. The motive gas flow into the ejector is from the operating compressor and is at 800 psig, and the blowdown gas flow into the ejector is from the adjacent offline compressor, initially at 100 psig (assuming the blowdown has been diverted into the fuel gas system). The combined stream flows out of the ejector at 100 psig and is directed to fuel gas.

Benefits: The benefits of capturing blowdown gas are avoiding product loss and avoiding methane emissions to the atmosphere. Emissions reduction will vary for each individual application based on the amount of blowdown gas and the fraction of blowdown gas captured instead of vented. It will also depend on the size of the operation, with larger facilities experiencing the greatest benefits. The example below assumes that a main line compressor emits 15 Mcf gas to the atmosphere per blowdown, which represents a large multistage compressor that has been taken offline and has its blowdown line connected to the fuel gas system. The example also assumes that compressor blowdowns occur once a week at the compressor station and that virtually all of the gas is captured by the ejector. (Recovery of blowdowns from other nearby equipment are also possible but were not included in this example.) The value of the gas saved will vary based on the operating environment. This example uses three different values: $3, $5, and $7 per Mcf.

Costs: Installing an ejector at a compressor facility requires both capital and operating expenditures. In addition to the ejector itself, capital expenditures include ejector block valves, piping from the blowdown vent line connections, and engineering design work to size the nozzle and expander for the site. The main advantage of an ejector over other gas capture methods is

that it does not require installation of an additional booster compressor which would result in increased capital, operating, and maintenance costs.

Ejector operating costs result from the energy required to pressurize the motive gas. According to the Gas STAR Lessons Learned presentation "Reducing Methane Emission with Vapor Recovery on Storage Tank," the typical ratio of motive gas to captured gas is in the range of 3.2:1 to 5.2:1. This example used a ratio of 3.5:1. This ratio and the amount of gas available at the compressor discharge determine the amount of gas that needs to be diverted from the sales line, and subsequently the additional power requirements for the compressor. Maintenance costs are expected to be negligible, because ejectors do not have moving parts.

Exhibit 2 illustrates the costs and benefits of installing an ejector for a centrifugal compressor and capturing blowdown emissions.

Exhibit 2: Example project economics for an ejector (U.S. dollars)

Capital and Installation Costs (for ejector)	$11,644		
Operating Costs (energy costs to pressurize motive gas)	$1,575		
Gas Price ($/Mcf)	$3	$5	$7
Annual Value of Gas Saved	$4,680	$7,800	$10,920
Payback Period in Years	3.8	1.9	1.3

Technology Spotlight: Revised Technical Documents Soon to be Released

Natural Gas STAR is giving its recommended technologies and practices a makeover! Both the *Lessons Learned* and *Partner Reported Opportunity* (PRO) Fact Sheet technical documents are being revised and updated with new information and a new streamlined appearance. One notable update is that the economics will include gas price scenarios of $3/Mcf, $5/Mcf, and $7/Mcf to provide a more accurate depiction of project economics in relation to varying conditions. The new documents will soon be made available at epa.gov/gasstar/tools/recommended.html.

In addition to revising the existing Lessons Learned documents to include a new format and updated information, a few PROs are also being combined into new Lessons Learned documents.

The existing PROs are undergoing similar changes to the *Lessons Learned* documents, including a new template and revised economics. The PROs will now have an executive summary

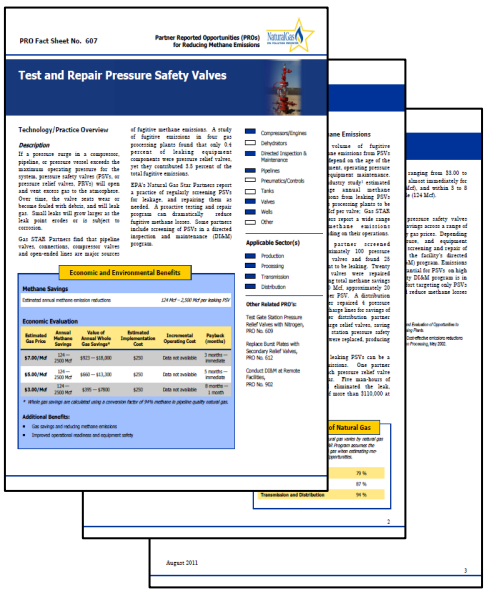


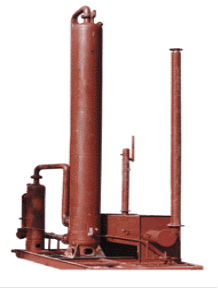
Exhibit 1: An example of an updated PRO document in the new layout.

table on the first page to display all relevant economics. Some PROs will also be expanded to include additional text, diagrams, and pictures.

Below is a selection of technical documents that will soon be released in the new format.

Optimizing Glycol Circulation and Installing Flash Tank Separators

Optimizing Glycol Circulation and Installing Flash Tank Separators are two possible options to cost-effectively reduce methane emissions in dehydrators. Most dehydration systems use triethylene glycol (TEG) as the absorbent fluid to remove water from natural gas. The amount of methane absorbed and vented is directly proportional to the TEG circulation rate. Reducing circulation rates reduces methane emissions at negligible cost.



Installing flash tank separators on glycol dehydrators further reduces methane emissions, volatile organic compound (VOC) emissions, hazardous air pollutant emissions and saves even more money. Recovered gas can be recycled to compressor suction and/or used as a fuel.

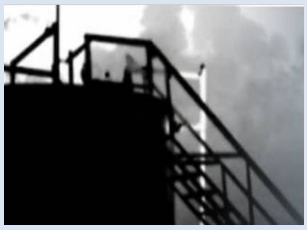
Replacing gas-assisted glycol pumps with electric pumps increases system efficiency and also significantly reduces emissions. Electric pumps require no gas for operation and therefore don't release methane to the atmosphere.

Installing Plunger Lift Systems in Gas Wells with a Smart Automation System

Installing Plunger Lift Systems in Gas Wells with a Smart Automation System is a cost-effective alternative for removing liquids. A plunger lift uses gas pressure buildup to lift a column of accumulated fluid out of the well tubing. Plunger lifts have the additional benefit of increasing production, as well as significantly reducing methane emissions associated with blowdown operations. A smart automation system on plunger lifts monitors the well's production parameters—such as tubing and casing pressures, flow rate, and plunger arrival velocities—to optimize plunger cycles, enabling significant reductions in gas venting volumes along with production improvements.

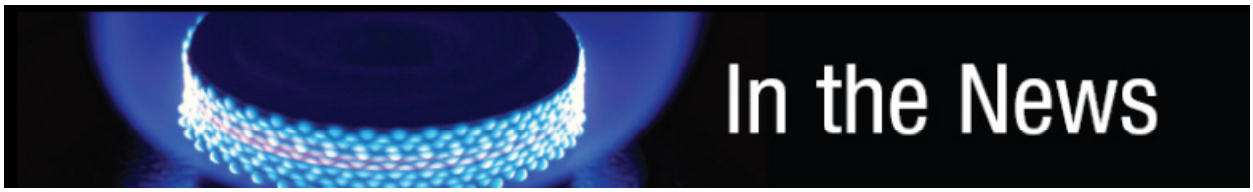
Directed Inspection and Maintenance (DI&M)

Directed Inspection and Maintenance (DI&M) is a proven, cost-effective way to detect, measure, prioritize, and repair equipment leaks to reduce methane emissions. A DI&M program begins with a baseline survey to identify and quantify leaks. Repairs are then made to only the leaking components that are cost-effective to fix, based on criteria such as repair cost, expected life of the repair, and payback period. Subsequent surveys are designed based on data from previous surveys, allowing operators to concentrate on components that are most likely to leak and profitable to repair. Natural Gas STAR Partners have demonstrated that a DI&M program can profitably eliminate as much as 96 percent of gas fugitive losses.



Reducing Methane Emissions from Compressor Rod Packing Systems

Reducing Methane Emissions from Compressor Rod Packing Systems involves replacing worn packing systems in reciprocating compressors. All packing systems leak under normal conditions, the amount of which depends on cylinder pressure, fitting, and alignment of the packing parts, and amount of wear on the rings and rod shaft. Partners can determine emission levels at which it is cost-effective to replace rings and rods. Benefits of calculating and utilizing this economic replacement threshold include methane emission reductions and cost savings.



Upcoming Events

Apart from the Annual Implementation Workshop (described one page 1), a number of other events are scheduled to take place around the globe:

GMI Partnership-Wide Meeting 2011

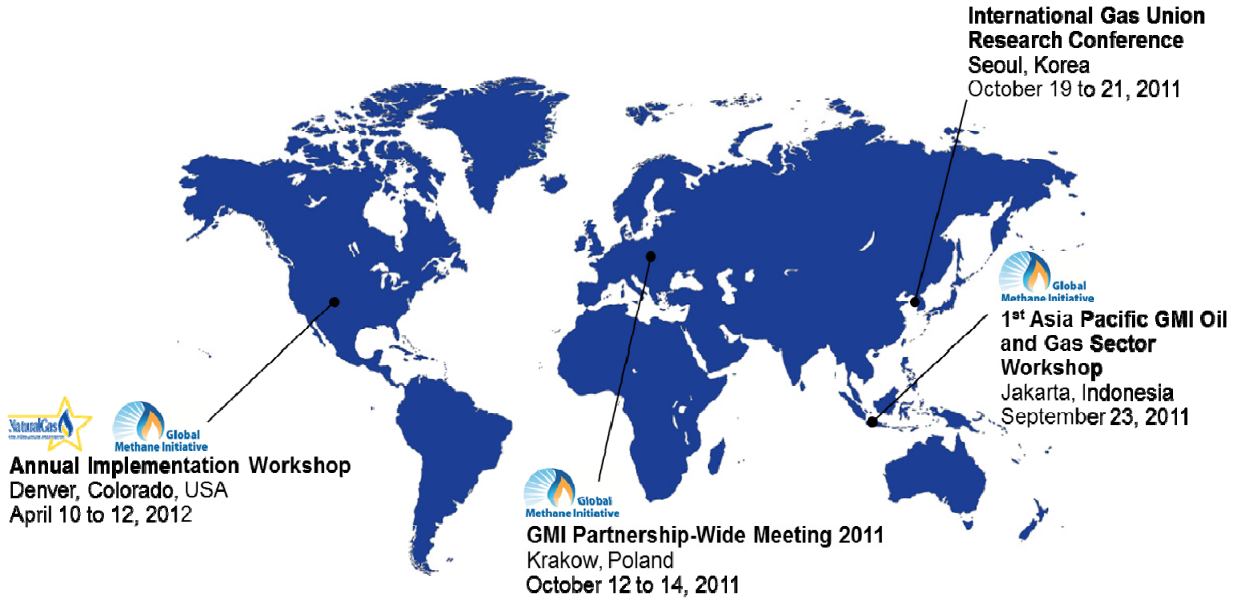
The Global Methane Initiative (GMI), in cooperation with the government of Poland, is hosting a partnership-wide meeting in Krakow, Poland. In addition to plenary sessions about methane reduction and capture issues, this event will feature breakout meetings focusing on agriculture, oil and gas, landfills, coal, and wastewater. Technical and policy-specific topics will be discussed in the breakout sessions, as well as sector-specific Subcommittee discussions. A meeting of the GMI Steering Committee will convene concurrently. For more information, visit: globalmethane.org/news-events/meeting20111012.aspx

1st Asia Pacific Oil and Gas Sector Workshop

This inaugural meeting is taking place in Asia Pacific to explore ways of reducing methane emissions from oil and gas operations. The workshop will include a demonstration of advanced infrared cameras tuned to detect methane emissions to the atmosphere. For more information, visit: globalmethane.org/news-events/event_detailsByEventId.aspx?eventId=353

International Gas Union Research Conference

The International Gas Union Research Conference (IGRC) is held under the auspices of the International Gas Union (IGU). The IGRC provides gas researchers and other interested business partners with an excellent opportunity to exchange thoughts and ideas on the tremendous challenges facing the industry such as energy demand, security of supply and climate change. For more information, visit: igrc2011.com/words-of-welcome



Recent Events

New Global Methane Initiative Member Country

Jordan

Jordan was welcomed into GMI on April 22, 2011 as the first Middle Eastern nation to join. Jordan will participate in the agriculture and landfill subcommittees as well as on the wastewater task force. According to data from the EPA's *Global Anthropogenic Emissions of Non-CO_2 Greenhouse Gases* report, Jordan's 2010 estimated anthropogenic methane emissions totaled 2.40 million tonnes carbon dioxide equivalent ($MMTCO_2E$). Landfills represent more than 40 percent (1.02 $MMTCO_2E$) of Jordan's anthropogenic methane emissions and an additional 35 percent (0.83 $MMTCO_2E$) come from the agriculture (manure management), oil and gas, and wastewater sectors.

Collaborative International Workshop in China Brings Together Methane Emission Reduction Experts, Promotes Discussion

Organized by the China University of Petroleum ("University") and EPA, the second *International Workshop on Methane Emission Reduction Technologies in the Oil and Natural Gas Industry* was held on the Qingdao Campus of the University, with more than ten domestic and international experts in attendance on April 21 and 22, 2011.

The workshop focused on methane emissions from the oil and gas production, processing, and transmission sectors and demonstrated how methane emission reductions can benefit private companies, the local economy, and the environment. Speakers shared techniques for detecting, measuring, and reducing methane emissions. Topics included casinghead gas recovery, leak detection/measurement, and specific issues for compressors and storage tanks.

Workshop speakers included representatives from the University, EPA, FLIR, ONGC, Hy-Bon Engineering, Frontier Company, and Natural Resources Canada.

For more information on this event, go to: globalmethane.org/news-events/event_detailsByEventId.aspx?eventId=328.

Gas Flaring/Venting and Fugitive Emissions Measurement Workshop Spreads Knowledge of Reduction Technologies and Practices

Sponsored by Secretaría de Energía (SENER), Comisión Nacional de Hidrocarburos (CNH), Petróleos Mexicanos (PEMEX), Global Gas Flaring Reduction (GGFR), and Global Methane Initiative (GMI), this conference brought together around 80 participants to discuss cost-effective reduction technologies and practices for methane emissions on May 13 and 14, 2011. The conference featured a presentation of PEMEX's Strategic Flare/Vent/Fugitives Measurement Plan and the newly formed Measurement Group, as well as a detailed overview of current best practices on measuring gas flare/vent and fugitive volumes. Also discussed were key constraints and considerations when selecting flare measurement systems for both new and existing flaring and vent/fugitive installations. Participants also shared and discussed practical experiences and challenges in metering, monitoring, verification, and regulatory supervision.

For more information on this event, including an agenda and presentations, go to: globalmethane.org/news-events/event_detailsByEventId.aspx?eventId=342.

Some presentations from this event are in English and others are in Spanish. Presentations are available only in the languages given on the workshop website.

Global Methane Initiative Oil and Gas Subcommittee Meeting Webinar Provides an Update on Sector Happenings

On June 15, 2011, the Global Methane Initiative (GMI) Oil and Gas Subcommittee met via webinar to discuss country-specific strategies and activities relevant to the oil and gas industry. Participants resolved barriers and/or issues that hinder methane emission reduction projects, discussed how countries engage global climate change initiatives and how GMI fits within country priorities, and planned future member engagement activities.

The webinar had 18 participants from five countries—Canada, Denmark, India, Mexico, and the United States—with delegates from Partner countries providing brief updates on activities in their country since the last Subcommittee meeting in New Orleans, Louisiana (November 2010). The primary focus of the webinar was planning for the upcoming GMI all-partnership meeting in Krakow, Poland from October 12 to 14. The Krakow meeting will include technical and policy sessions for the Oil and Gas sector.

For more information on this event, including meeting minutes and an audio recording, go to: globalmethane.org/news-events/event_detailsByEventId.aspx?eventId=340.

e-GGRT: New Tool for Submitting GHG Data Electronically Available for Some Sectors

On August 22, 2011, the U.S. Environmental Protection Agency launched its new tool that allows 28 industrial sectors to submit their 2010 greenhouse gas (GHG) emissions data electronically.

At this time, the tool is not available for petroleum and natural gas systems Subpart W reporters. Please note that reporting under Subpart W (Petroleum and Natural Gas Systems) does not

apply to the 2010 reporting year, however, such facilities may be subject to 2010 reporting requirements under other subparts, such as stationary sources (e.g. Subpart C).

The data collected with e-GGRT will provide the public with important information about the nation's largest stationary sources of greenhouse gas emissions. Industries and businesses can also use the data to help find ways to decrease carbon emissions, increase efficiency and save money.

EPA's GHG Reporting Program (GHGRP), launched in October 2009, requires the reporting of GHG data from large emission sources across a range of industry sectors. Suppliers of products that would emit GHGs if released, combusted, or oxidized are also required to report GHG data. For more information on the GHGRP: epa.gov/climatechange/emissions/ghgrulemaking.html

New Natural Gas STAR Partners

The Natural Gas STAR program is pleased to welcome both GAIL (India) Limited and Star Energy as new International Partners and both Dominion Transmission, Inc. and Chevron North America Exploration and Production—Gulf of Mexico Business Unit as new Domestic Partners.

GAIL (India) Limited

GAIL is a state-owned natural gas processing and distribution company headquartered in New Delhi, India that transports natural gas and liquefied petroleum gas (LPG). It started as a natural gas pipeline company in 1984 and now has a network of trunk pipelines around 11,000 km in length. GAIL has laid 1,900 km of LPG pipeline across India, which includes the Jamnagar-Loni pipeline, exclusively for LPGs. The company transports more than 120 million standard cubic meters per day of gas through its pipelines and has recently completed the 218-km-long Chainsa-Sultanpur-Neemrana pipeline, which became operational in April 2011. The company is currently implementing pipeline projects to lay additional 6,900 km of pipelines.

Star Energy

Star Energy is an independent oil and gas operator and pipeline owner based in Indonesia. Established in 2003, is currently producing and exploring for petroleum in a number of areas in the Indonesian archipelago. The company's activities include producing oil and exporting gas to Singapore in the Natuna Sea and drilling exploratory wells in Central Java and East Kalimantan. The company also has activities in central southern Sumatra, where there exists oil and conventional natural gas potential.

GAIL (India) and Star Energy bring the total number of Natural Gas STAR International Partners to fourteen. These global industry leaders are cooperating to identify and implement a range of cost-effective methane emission reduction projects often available in oil and natural gas operations.

Dominion Transmission, Inc.

The Natural Gas STAR Program is pleased to welcome Dominion Transmission, Inc. as an official transmission sector Partner. Dominion Transmission is the interstate gas transmission subsidiary of

Dominion and is a provider of gas transportation and storage services to customers such as major utilities and power plants. The company operates one of the largest underground natural gas storage systems in the U.S. with links to other major pipelines, giving Dominion Transmission access to markets in the Midwest, Mid-Atlantic, and Northeast regions of the U.S. The company has 7,800 miles of pipeline in six states—Ohio, West Virginia, Pennsylvania, New York, Maryland, and Virginia—and also is a producer and supplier of natural gas liquids.

Chevron North America Exploration and Production—Gulf of Mexico Business Unit

The Natural Gas STAR Program is pleased to welcome Chevron North America Exploration and Production, Gulf of Mexico (Chevron Gulf of Mexico) as an official production sector Partner. As one of the major areas of exploration in 2010, Chevron Gulf of Mexico is one of the larger producers of crude oil and natural gas in the Gulf, both on the shelf and in deepwater. In 2010, the company's average net daily production in the Gulf was 169,000 barrels of crude oil, 444 million cubic feet of natural gas, and 17,000 barrels of natural gas liquids. Company projects include the Blind Faith and Tahiti deepwater developments.

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