IPIECA

Exploring methane emissions

An IPIECA fact sheet

While a significant amount of attention surrounding climate change has focused on carbon dioxide (CO_2) emissions, there is growing interest in the role of methane (CH_4) and other short-lived climate forcers[1]. This fact sheet explores methane emissions, their wider implications, and the associated challenges, opportunities and continuing efforts within the oil and gas sector to address them.

KEY FACTS

1. The role of natural gas in the energy mix is crucial to transitioning to a lower carbon future.
2. When used for electricity generation, natural gas results in about 50% less CO_2 equivalent emissions than coal-powered generation.
3. Carbon dioxide remains the key focus for long-term climate change mitigation, but mitigating emissions of other climate forcers such as methane will provide additional greenhouse gas (GHG) mitigation opportunities for society.
4. The contribution of global methane emissions to the atmosphere is roughly split between anthropogenic and natural sources, though significant uncertainty exists in quantifying particular sectors' contributions.
5. There is no significant difference between the life-cycle GHG emissions of natural gas produced in a 'conventional' or 'unconventional' manner. While there is a wide range in the estimates of methane emissions from the oil and gas sector, recent studies indicate that methane leakage rates associated with upstream production activities are on the order of 0.5% of total production.
6. The oil and gas sector continues to take actions to reduce methane emissions.

1. THE ROLE OF NATURAL GAS IN THE ENERGY MIX

The role of natural gas in the energy mix is crucial to transitioning to a lower-carbon future.

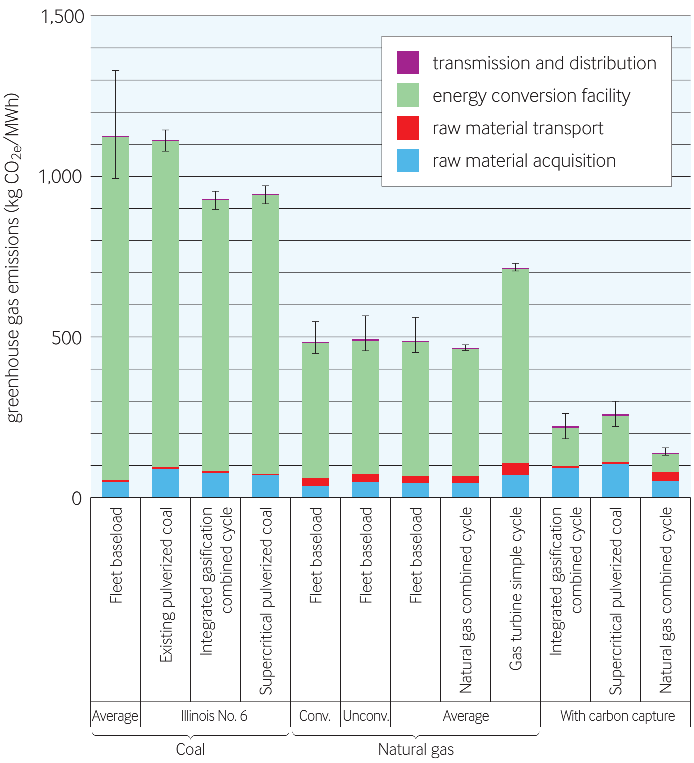
Natural gas is enjoying a period of strong growth. Almost all climate change mitigation scenarios established by international or national research organizations, such as the International Energy Agency (IEA), agree that the role of natural gas in the global fuel mix will expand significantly over the next few decades. In the IEA's most stringent 2°C scenario[2], the demand for gas will be more than 20% higher in 2040 than 2012. In the USA and other regions, natural gas is replacing coal for a variety of reasons, including its economic, environmental and climate benefits.

2. EMISSIONS FROM NATURAL GAS AND COAL FOR POWER GENERATION

When used for electricity generation, natural gas results in about 50% less CO_2-equivalent emissions than coal powered generation.

At natural gas supply chain emissions of around 1.5% or less, electricity generated by natural gas combined cycle power plants has about 50% less GHG emissions per MWh than equivalent coal-fired power plants, (see Figure 1).

Figure 1
Life cycle GHG emissions for electricity production[3]



3. METHANE AS A GREENHOUSE GAS MITIGATION OPPORTUNITY

Carbon dioxide remains the key focus for long-term climate change mitigation, but mitigating emissions of other climate forcers such as methane will provide additional GHG mitigation opportunities for society.

Despite its short lifetime in the atmosphere (~12 years), methane is a significant contributor to climate change through radiative forcing on account of its inherent radiative efficiency. The Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5)[4] estimates that methane is the second largest contributor to total anthropogenic radiative forcing, and equivalent to approximately 60% of the radiative forcing of CO_2. The IPCC AR5 also estimates that methane's global warming potential is in the range of 28–34 times that of CO_2 on a 100-year timescale[5].

The ability to lower the near-term rate of global warming through methane emission reductions provides society with a valuable mitigation option for climate risk management. However, it is important to note that carbon dioxide remains the key focus for long-term climate change mitigation.

Table 1 Methane global warming potentials
Source: IPCC Assessment Reports

	100 year	20 year
AR2 (1998)	21	56
AR3 (2003)	23	62
AR4 (2007)	25	72
AR5 (2013)	28–34	84–86

4. THE CONTRIBUTION OF METHANE EMISSIONS PER SECTOR

The contribution of global methane emissions to the atmosphere is roughly split between anthropogenic and natural sources, though significant uncertainty exists in quantifying particular sectors' contributions.

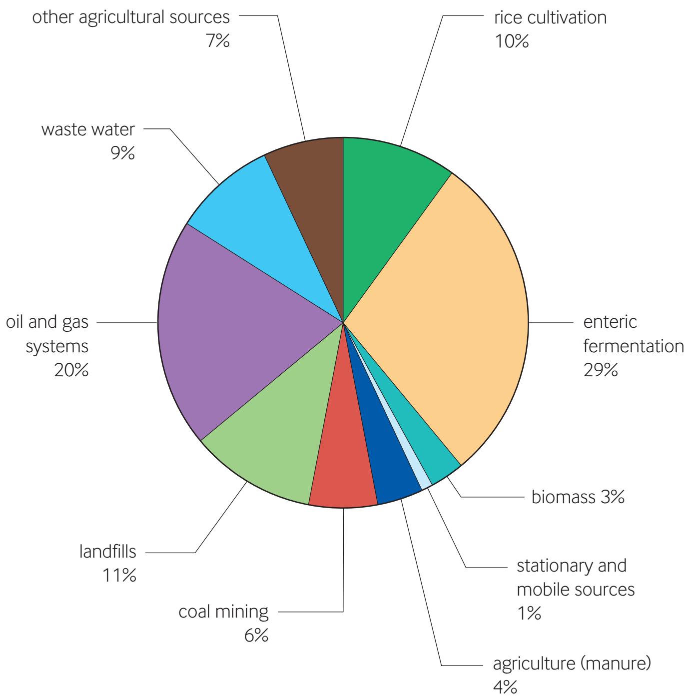
Methane emissions from anthropogenic activities result from energy production, landfills, waste water and agriculture, including livestock (see Figure 2). Agriculture likely accounts for more than 50% of total anthropogenic emissions. Energy-related methane emissions are mainly from oil, gas and coal, as well as biomass combustion. The oil and gas supply chain (e.g. production, processing, transmission and distribution) accounts for around 20% of anthropogenic methane emissions according to the US Environmental Protection Agency (EPA).

Natural emissions of methane are attributable to a number of sources including wetlands, natural seeps, animals (e.g. termites) and vegetation decay. Large volumes of methane are also trapped in permafrost regions and underwater methane hydrate deposits, some of which are released by natural processes.

Figure 2

Estimated global anthropogenic methane emissions by source, 2010

Source: US EPA



5. METHANE EMISSIONS STUDIES AND SHALE GAS

There is no significant difference between the life-cycle GHG emissions of natural gas produced in a 'conventional' or 'unconventional' manner, as recent studies demonstrate. While there is a wide range in the estimates of methane emissions from the oil and gas sector, recent studies[6,7,8,9] indicate that methane leakage rates associated with upstream production activities are on the order of 0.5% of total production.

Estimating methane emissions from the oil and gas industry and other sectors at both global and regional levels has significant uncertainty. Furthermore, a number of different methodologies exist, and each has inherent strengths and weaknesses. A recent series of studies aimed at measuring and characterizing the emissions from various components of the upstream production phase of onshore natural gas wells in the USA was carried out by a team from the University of Texas (UT)[6,7,8]. These studies, undertaken in partnership with nine natural gas producers and the Environmental Defense Fund (EDF), measured the emissions associated with upstream production including: flow-back of wells following hydraulic fracturing; well venting for liquids unloading; pneumatic controllers and equipment leaks. The studies concluded that there is little difference in methane emissions between gas fields developed using conventional techniques and those using hydraulic fracturing.

The results reported by Allen *et al.* (2013)[6] indicate that methane emissions from US gas production are about 0.42% of the total production, which is comparable with the US EPA inventory[9] results of 0.55% (2012 EPA inventory).

When other losses, upstream of natural gas-powered generation, processing and transmission are added, total methane leakage for natural gas power generation is estimated to be around 1%.

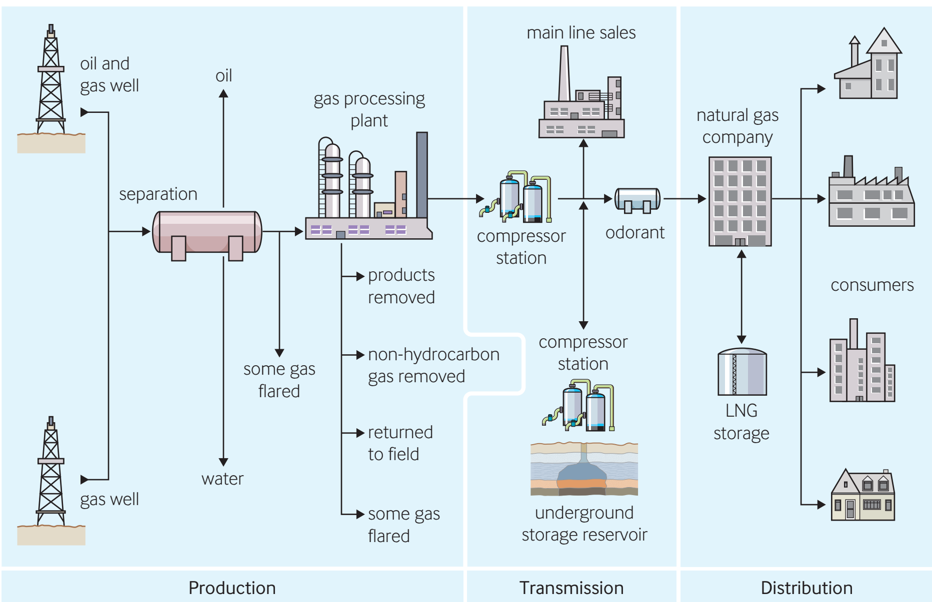


Figure 3

The natural gas production, transmission and distribution system

Source: Adapted from US Energy Information Administration

6. ACTING TO REDUCE METHANE EMISSIONS

The oil and gas sector continues to take actions to reduce methane emissions.

The industry has been working for many years to reduce methane emissions through mandatory and voluntary programmes, including the Natural Gas STAR Program and the Global Methane Initiative.

Through the efforts of oil and gas company partners in the Natural Gas STAR Program (see Figure 4), more than a trillion cubic feet of methane emission reductions have been achieved in the USA (Figure 5).

In addition to collaborative initiatives, oil and gas companies have individual programmes and best practices to reduce methane emissions, including leak detection and repair (LDAR) programmes. Abatement options are local and specific in nature, making it difficult to offer generic solutions for the industry. The economic, technical, geopolitical and commercial factors that determine the levelized cost of abatement differ for each region and country. For example, in parts of the USA, local gas markets are much more easily accessible, hence capturing, transporting and selling associated gas into the local market is comparatively cheaper and therefore more viable than in some other parts of the world.

Oil and gas companies have significant incentives to prevent methane emissions to assure the safety of their personnel and facilities. Where gas markets exist, there is also a powerful commercial incentive to prevent or reduce methane emissions.

The industry will continue to explore and take opportunities to reduce methane emissions, along with other greenhouse gases, to play its role in managing the risks of climate change.

Figure 4
Top technologies installed since 1990 under the Natural Gas STAR Program
Source: Natural Gas STAR Program

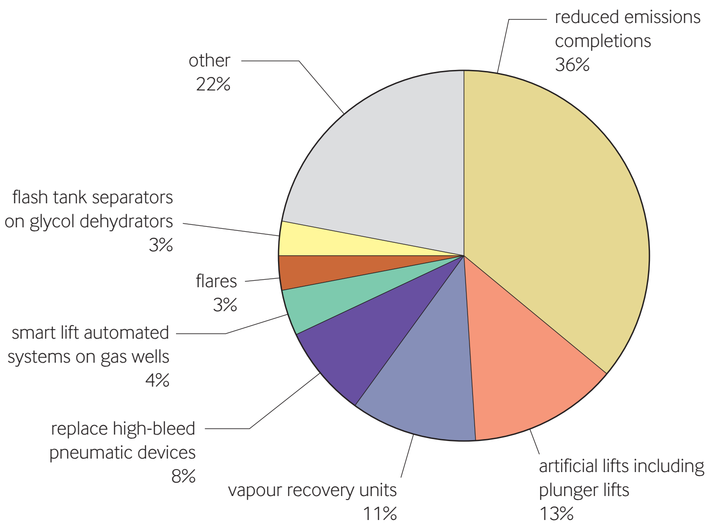
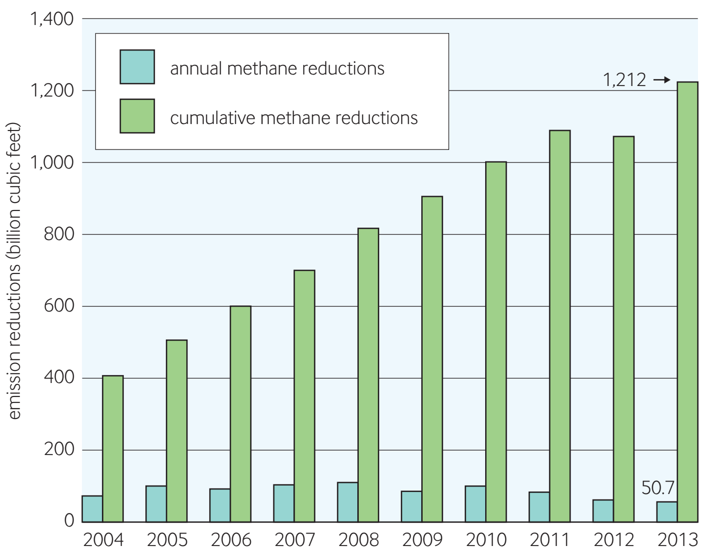


Figure 5
Domestic Natural Gas STAR methane emissions reductions as of 2013
Source: Natural Gas STAR Program



[1] Short-lived climate forcers are greenhouse gases which have a greater potency than carbon dioxide, but only persist in the atmosphere for a shorter period of time. They primarily include methane and black carbon, as well as other gases such as hydrofluorocarbons (HFCs).

[2] The IEA's New Policies Scenario serves as its baseline or reference case. The IEA states that its 450 scenario is roughly in line with a 2°C temperature rise.

[3] National Energy Technology Laboratory (NETL) (2014) Life Cycle Analysis of Natural Gas Extraction and Power Generation. www.netl.doe.gov/File%20Library/Research/Energy%20Analysis/Life%20Cycle%20Analysis/NETL-NG-Power-LCA-29May2014.pdf

[4] IPCC (2013). *Climate Change 2013. The Physical Science Basis*. Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). www.ipcc.ch/report/ar5

[5] The United Nations Framework Convention on Climate Change (UNFCCC) adopted the IPCC AR4 values in 2011. Subsequently, national governments have adopted the same values for consistent reporting to the UNFCCC and also for national regulations.

[6] Allen, D. T. *et al.* (2013). Measurements of methane emissions at natural gas production sites in the United States. In *Proceedings of the National Academy of Sciences of the United States of America*, Vol. 110, No. 44, pp. 17768-17773. www.pnas.org/content/110/44/17768

[7] Allen, D. T. *et al.* (2015). Methane Emissions from Process Equipment at Natural Gas Production Sites in the United States: Pneumatic Controllers. In *Environmental Science & Technology*, Vol. 49, Issue 1, pp. 633-640. DOI: 10.1021/es5040156.

[8] Allen, D. T. *et al.* (2015). Methane Emissions from Process Equipment at Natural Gas Production Sites in the United States: Liquid Unloadings. In *Environmental Science & Technology*, Vol. 49 Issue 1, pp. 641-648. DOI: 10.1021/es504016r.

[9] US EPA (2014). *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2012*. US Environmental Protection Agency, Washington DC. www.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2014-Main-Text.pdf