Climate Implications of methane leakage from natural gas operations

Steven P Hamburg
Chief Scientist

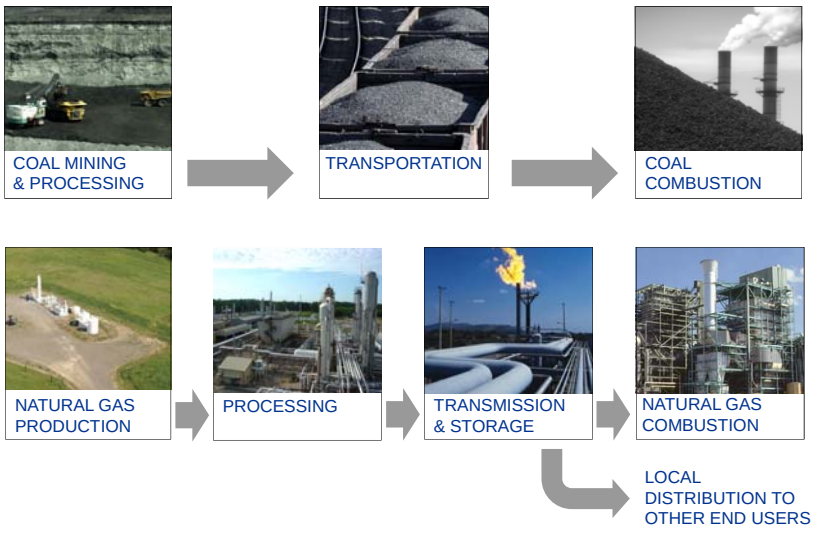
EDF ENVIRONMENTAL DEFENSE FUND
Finding the ways that work

Global Warming Potential (GWP)

- Allows comparison of a greenhouse gas' ability to trap heat in the atmosphere relative to CO_2
- Depends on time horizon of interest
- Methane has a shorter lifetime than CO_2 but each molecule can absorb more heat
- Effect of methane on aerosols increases GWP

TIME	GWP
20 years	72
100 years	21-25

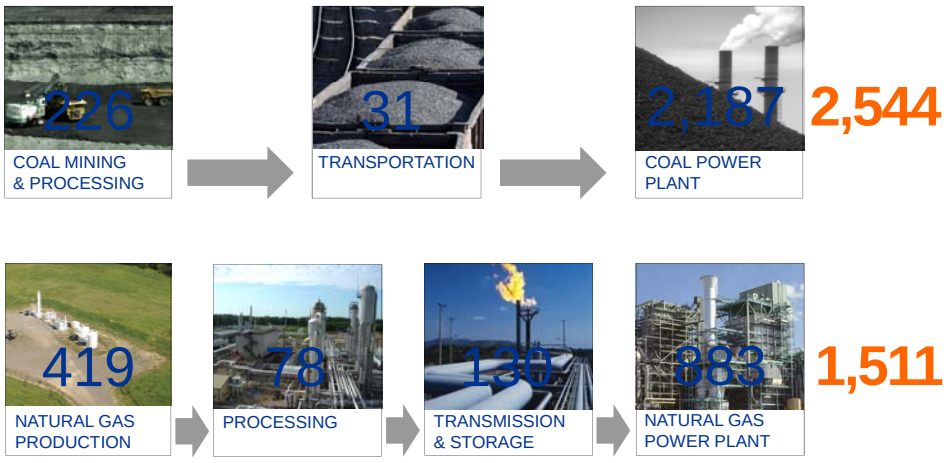
Power plant emissions aren't whole story



Source: Adapted from Jaramillo et al., (2007) EST 41, 6290

Fuel-cycle emissions; methane GWP = 72

DRAFT Estimates



Source: Adapted from Jaramillo et al., (2007) EST 41, 6290

Natural Gas vs. Coal:
Break-Even natural gas leak rate as low as 4-6%

20-YEAR GWP	100-YEAR GWP	Publication Date
5.3% (63)	**~11.5%** (21)	1990[1]
13% (N/A)		1990[2]
6% (N/A)		1990[3]
4.9 – 6.3% (60)	**10.5 –12.0%** (22)	1993[4]
4% (72)	**13%** (21)	1996[5]
5.6 – 0.7% (60)	**11.3 – 0.7%** (22)	2005[6]
4 – 6%	**10 – 13%**	**Published Ranges**

Sources:
[1] C. Mitchell et al. (1990). *Energy Policy*, November 1990, 809-818
[2] P.A. Okken (1990). *Energy Policy*, March 1990, 202-204
[3] H. Rodhe (1990). *Science*, **248**, 1217-1219 (EDF calculation using reported formula with limited consideration of upstream emissions)
[4] J. Lelieveld, P.J. Crutzen, and C. Bruhl (1993). *Chemosphere*, **26**, 739-768
[5] Gas Research Institute and U.S. EPA (June 1996). "Methane Emissions from the Natural Gas Industry, Volume 2: Technical Report", Appendix B (Value for GWP of 72 was calculated by EDF using a formula and values provided in report)
[6] J. Lelieveld et al. (2005). *Nature*, **434**, 841-842

Natural Gas vs. Gasoline:
Break-Even natural gas leak rate as low as 1-2%

20-YEAR GWP	100-YEAR GWP	Publication Date
5.3% (63)	**~11.5%** (21)	1990[1]
13% (N/A)		1990[2]
6% (N/A)		1990[3]
4.9 – 6.3% (60)	**10.5 –12.0%** (22)	1993[4]
4% (72)	**13%** (21)	1996[5]
5.6 – 0.7% (60)	**11.3 – 0.7%** (22)	2005[6]
4 – 6% 1-2%	**10 – 13%** 3-5%	**Published Ranges**

Sources:
[1] C. Mitchell et al. (1990). *Energy Policy*, November 1990, 809-818
[2] P.A. Okken (1990). *Energy Policy*, March 1990, 202-204
[3] H. Rodhe (1990). *Science*, **248**, 1217-1219 (EDF calculation using reported formula with limited consideration of upstream emissions)
[4] J. Lelieveld, P.J. Crutzen, and C. Bruhl (1993). *Chemosphere*, **26**, 739-768
[5] Gas Research Institute and U.S. EPA (June 1996). "Methane Emissions from the Natural Gas Industry, Volume 2: Technical Report", Appendix B (Value for GWP of 72 was calculated by EDF using a formula and values provided in report)
[6] J. Lelieveld et al. (2005). *Nature*, **434**, 841-842

Estimates of Natural Gas supply chain leak rates

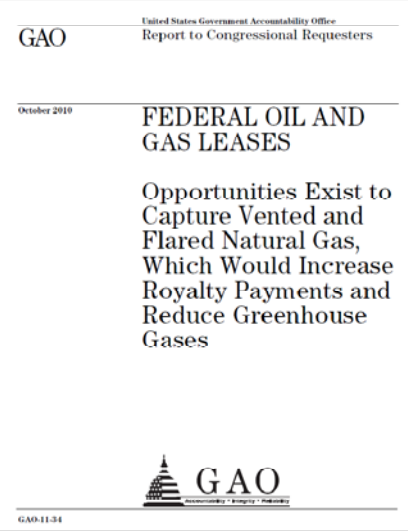
2.0 – 2.5% loss of NG upstream of any use for transportation – large uncertainty in accuracy and precision EPA

No empirical data on CNG/LNG leaks from vehicles

"For a 70-gallon LNG fuel tank with a heat leak rate of 12 W venting at 230 psig, the venting rate predicted by eqn. (2.15) is 3 x kg/s, which is the equivalent of **2.8 gallons per day** of LNG lost. This represents a **3% daily loss** by volume (for a full 70-gdlon tank), after the end of the non-venting hold time. For a 17-gdon tank with a 6.3 W heat leak rate, venting at 230 psig, a venting rate of 1.6 x 105 kg/s is predicted, which corresponds to a **6.5% daily loss** of LNG fuel."*

*Idaho National Engineering Laboratory (IN EEUEXT-98-00214,) 1998

There is a bit of a silver lining



4.2% of gas produced on onshore leases is vented or flared

"About **40%** of natural gas estimated to be vented and flared … could be economically captured with currently available control technologies, although some barriers to their increased use exist."