## 5. Global Warming Effects of Unconventional Shale Gas Development by Professor Anthony Ingraffea

Presenter – Mav Moorhead

Support for natural gas development appears to be based on the mistaken premise that natural gas is a "clean" fossil fuel, that it is "good" in our efforts to combat climate change. These are characterizations that shale gas cannot claim when fugitive methane emissions from development, transportation and use are taken into account.

Methane is a far more powerful greenhouse gas than carbon dioxide. For the first 20 years of its lifetime in the atmosphere, one pound of methane traps as much heat as at least 80 pounds of $CO_2$. Its potency declines until it is about 25 to 30 times more powerful than $CO_2$ over a hundred years. Although when burned gas emits half the $CO_2$ of coal, methane leakage eviscerates this advantage because of its greenhouse power. (Shindell et al., 2009)

And methane is leaking. At the downstream end of the methane life-cycle, recent measurements in Boston, Washington, DC, and New York City have revealed a shocking number of leaks in aging distribution pipelines and methane concentrations in the air in these major cities up to 5 times the natural background level (Phillips et al. 2013; Ackley and Payne, 2013). Recent field measurements led by scientists at the National Oceanic and Atmospheric Administration (NOAA) have found upstream/midstream only (not including transmission and distribution losses) emissions in a region of Colorado between 2.3 and 7 percent of production; upstream/midstream emissions only up to 9 percent in Utah; and upstream/midstream/downstream emissions up to 17 percent in the Los Angeles CA basin (Petron et al., 2012; Nature, 2013; Peischl et al. 2013).

These measurements validate the range predicted in the seminal paper on this topic published by scientists and engineers at Cornell University in 2011 (Howarth et al. 2011; Howarth and Ingraffea, 2011; Howarth et al. 2012; Howarth et al., 2012). A subsequent 2011 study from the National Center for Atmospheric Research (NCAR) concluded that unless leaks can be kept below about 2%, gas lacks any climate advantage over coal (Wigley, 2011). A 2012 paper from the Environmental Defense Fund pegs this crossover rate at about only 3% (Alvarez et al., 2013). A recent study by the science group Climate Central shows that the alleged 50%

climate advantage of natural gas is unlikely to be achieved for many decades, if at all (Larson, 2013).

Unfortunately, we don't have that long to address climate change—the next two decades are crucial. Shindell et al. (2012) note that the climate system is more immediately responsive to changes in methane (and black carbon) emissions than carbon dioxide emissions. They predict that unless emissions of methane and black carbon are reduced immediately, the Earth will warm to 1.5$^{o}$ C by 2030 and to 2.0$^{o}$ C by 2045 to 2050 whether or not carbon dioxide emissions are reduced. Reducing methane and black carbon emissions, even if carbon dioxide is not controlled, would significantly slow the rate of global warming and postpone reaching the 1.5$^{o}$ C and 2.0$^{o}$ C marks by 12 to 15 years. Controlling carbon dioxide as well as methane and black carbon emissions further slows the rate of global warming after 2045, through at least 2070. The life-cycle of shale gas produces all three of these climate change culprits: carbon dioxide, methane, and black carbon.

While it is possible to reduce fugitive emissions from shale gas development, the technologies to do so have not been embraced by operators because the costs are prohibitive from their view. For example, in 2012 the industry demanded a delay from the EPA until January 1, 2015 of the mandatory implementation of the simplest of these technologies: green completions. It is also certain that any efforts to adequately regulate the industry will be vigorously opposed by this well-resourced industry and its lobbyists.

The other unfounded assumption of some shale gas promoters is that natural gas is a bridge fuel to a cleaner low carbon economy. Not only does the evidence show that shale gas development is more problematic than continued use of oil and even coal, certainly over the short term, the supposed bridge period, there is no scientific basis for assuming that curbing methane emissions will be easier than implementing the conservation, efficiency and renewable energy strategies that will reduce our reliance upon fossil fuels including natural gas.

We have renewable wind, water, solar and energy-efficiency technology options now to avoid the enormous risks of fracking for shale gas (Jacobson et al., 2013). We can scale these quickly and affordably, creating economic growth, jobs, and a truly clean energy future to address climate change. Political will is the missing ingredient. Meaningful carbon reduction is impossible while the fossil fuel industry has captured too much of our energy policies and regulatory agencies, plus intentionally distorted public debate. Policy-makers, including the President, need

to listen more closely to the voices of independent scientists over the din of industry lobbyists.

Shindell DT, Faluvegi G, Koch DM, Schmidt GA, Unger N, Bauer SE (2009) Improved attribution of climate forcing to emissions. Science, **326**:716–718

NG. Phillips et al., Mapping urban pipeline leaks: Methane leaks across Boston. Environmental Pollution,**173** (2013) 1-4.

Ackley R, Payne B, Report on a Preliminary Investigation of Ground-Level ambient Methane Levels in Manhattan, New York City, New York, 2013. available at: http://www.damascuscitizensforsustainability.org/2013/03/manhattan-natural-gas-pipeline-emissions-2/

Pétron, G. et al. J. Geophys. Res. 117, D04304 (2012)

Peischl et al., 2013: Quantifying sources of methane using light alkanes in the Los Angeles basin, California, JGR/Atmos. doi: 10.1002/jrgd.50413

Nature 493, 12 (03 January 2013) doi:10.1038/493012a

Howarth RW, Santoro R, Ingraffea AR. 2011. Methane and the greenhouse gas footprint of natural gas from shale formations. Climatic Change Letters, doi: 10.1007/s10584-011-0061-5, 2011.

Howarth RW, Ingraffea AR. Should Fracking Stop? Yes, It's Too High Risk. Nature, **477**, 271-273, 2011.

RW Howarth, R Santoro, AR Ingraffea. Venting and leaking of methane from shale gas development: response to Cathles et al., Climatic Change (2012) 113:537–549, DOI 10.1007/s10584-012-0401-0.

Howarth RW et al., Methane Emissions from Natural Gas Systems, Background Paper Prepared for the National Climate Assessment, Reference number 2011-0003

Wigley T, Coal to gas: the influence of methane leakage. Climatic Change, 2012,

DOI 10.1007/s10584-011-0217-3.

Alvarez R, et al., Greater focus needed on methane leakage from natural gas infrastructure, www.pnas.org/cgi/doi/10.1073/pnas.1202407109

Larson E, Natural Gas & Climate Change, Climate Central, 2013. Available at: http://assets.climatecentral.org/pdfs/NaturalGas-and-ClimateChange.pdf

Shindell D et al. (2012). Simultaneously mitigating near-term climate change and improving human health and food security. Science 335: 183-189.

Jacobson MZ, Howarth RW, Delucchi M, Scobie S, Barth J, Dvorak M, Klevze M, Katkhuda H, Miranda B, Chowdhury N, Jones R, Plano L, Ingraffea AR. Examining the feasibility of converting New York State's all-purpose energy infrastructure to one using wind, water, and sunlight. Energy Policy (2013), http://dx.doi.org/10.1016/j.enpol.2013.02.036i