Natural Gas in a Low Carbon Future

Environmental Opportunities & Challenges

Mark Brownstein
Associate Vice President
U.S. Climate & Energy Program
Must address the ‘fracking’ issues

Roughly 200 tanker trucks deliver water for the fracturing process. A pump truck injects a mix of sand, water and chemicals into the well. Natural gas flows out of well. Recovered water is stored in open pits, then taken to a treatment plant. Natural gas is piped to market.

**Hydraulic Fracturing**

Hydraulic fracturing, or “fracking,” involves the injection of more than a million gallons of water, sand and chemicals at high pressure down and across into horizontally drilled wells as far as 10,000 feet below the surface. The pressurized mixture causes the rock layer, in this case the Marcellus Shale, to crack. These fissures are held open by the sand particles so that natural gas from the shale can flow up the well.
And then, there’s methane…

Gas storage tank

Same tank, same time, infrared camera view

…an increasingly ‘visible’ problem
CH₄ traps more heat than CO₂…

Each methane molecule traps 84x more heat

Ratio of direct radiative efficiencies, W m⁻² ppb⁻¹ (IPCC AR5)
...but breaks down faster than CO$_2$

**METHANE DISSIPATES FASTER THAN CARBON DIOXIDE**

- CH$_4$ produces tropospheric ozone and stratospheric water vapor as it decays.
- Increases the direct warming effect by 65% (IPCC AR5)

![Graph showing the dissipation of methane and carbon dioxide over time](image-url)
Methane and CO2 reductions required

Gas can be worse than alternatives

* Depending on emission rate and timeframe

Updated calculations of fuel-switching scenarios in EDF’s 2012 PNAS paper.*
Individual results vary by the technology choice(s) made in each case. EDF is expanding the range of technologies evaluated.

*Adapted from Alvarez et al. (2012) PNAS, 109: 6435-6440, reflecting new IPCC AR5 & 2013 EPA GHG data. IPCC updates: (1) direct/indirect radiative forcing of CH₄ and CO₂, (2) CH₄ lifetime, (3) CO₂ impulse response function. Additional effects due to climate-carbon feedbacks and CO₂ from the oxidation of CH₄ not included (AR5 lacks data to support time-dependent analysis but EDF believes these effects to be small). Emissions updates include factors in Table 1 and corresponding L_red values in Table S1 of PNAS paper; an L_red value specific to heavy-duty CNG vehicles is now used.
Comprehensive emission study effort

Over-flight/Coordinated Campaign Work

Tower/Drive-by/Mapping Work

Production module

Gathering and processing module

Transmission and storage module

Local distribution module

Natural gas vehicles and fuel stations module
Highly cost-effective reductions

http://www.edf.org/icf-methane-cost-curve-report

Economic Analysis of Methane Emission Reduction Opportunities in the U.S. Onshore Oil and Natural Gas Industries
ICF International, March 2014,