Natural gas: not clean enough

Findings. New research from Energy Innovation concludes that under the best of circumstances, natural gas-fired electric power plants can only make a modest dent on abating climate change—and, if developed poorly, with serious methane leaks, or if used to displace energy efficiency or renewable energy, natural gas could instead seriously contribute to the problem. Over a timeframe of 100 years, natural gas with careful leak control offers some reduction in greenhouse gas (GHG) emissions. However, these reductions are not large enough for natural gas to play an expanded role in efforts to manage GHG emissions.

Recommendations. It makes sense to use excess capacity from existing natural gas plants to help shut down the United States' aging fleet of coal plants. But investment in many more large natural gas power plants would not be sensible. New advanced gas turbines that are flexible – able to ramp up and down quickly while maintaining high efficiency – do have an important role going forward to help integrate variable renewable electricity sources like wind and solar power. But such plants are just one option in a portfolio of strategies available to handle renewables variability. A principal driver of natural gas's contribution to climate change is leaking methane. It is important, then, that the federal government and the states should put in place stronger regulations to reduce methane leakage to close to zero—and limit other environmental impacts.

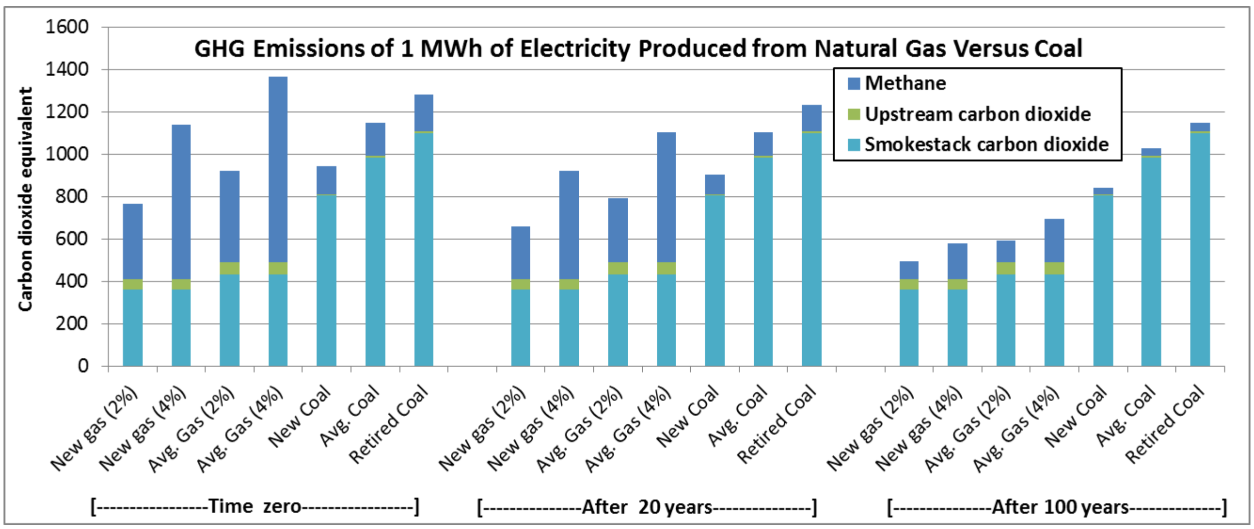
Background. Natural gas is made up of mostly methane, which is emitted due to intentional venting as well as accidental leaks at every stage of the natural gas system, from extraction to processing, transmission, distribution, and end-use. Methane is a powerful GHG. It causes 28 times more global warming than carbon dioxide on a mass basis over a 100-year period (34 times more when accounting for climate system feedback loops[1]). On a 20-year basis, the impact of methane is 84 times larger than carbon dioxide (86 times counting feedbacks). When first released, methane is 120 times more potent than carbon dioxide. These scaling factors (technically called Global Warming Potentials) are used to translate methane into a single composite measure of GHG emissions known as carbon dioxide equivalent measure. The results presented here are based on the figures without feedbacks. Taking into account feedback effects would further weaken the case for natural gas.

Methodology. Energy Innovation's analytical framework estimates the GHG emissions caused by the generation of one MWh of electricity from both coal and natural gas power plants. The analysis takes into account the three largest sources of emissions. These are: (1) methane – which not only leaks from the gas system but also during coal mining, though at lower levels; (2) smokestack carbon dioxide released due to fuel combustion, and (3) upstream carbon dioxide emission due to combustion in the production and transmission of fuel prior to its reaching the power plant. The efficiency of a power

[1] GHG emissions have direct and indirect (i.e. feedback) effects. GHG molecules allow sunlight to pass through but capture the heat reflected back from the earth's surface. This is the direct effect. Over time, due to atmospheric chemistry, methane reacts to form carbon dioxide. This indirect effect of methane emissions is the only feedback captured in the lower value. The higher value also captures other feed the indirect effects of methane on its own lifetime, tropospheric ozone and stratospheric water. See IPCC, Assessment Report 5, Working Group 1, *The Physical Science Basis*, section 8.7.1.4, p. 139.

plant significantly drives its GHG intensity, so our methodology tests a range of both gas and coal technology types. "New" represents the type of power plant typically constructed today. "Average" is a composite measure that represents the average plant efficiency taking into account all plants operating in 2012 (weighted according to their production). "Retired coal" uses the average efficiency for coal plants recently shut down.

Recent research (Brandt et al. 2014) has increased certainty about the rate of methane emissions from the natural gas system, indicating it is roughly in the range of two to four percent for the United States on average. We analyze two and four percent leakage scenarios to provide likely upper and lower bounds on GHG emissions. On the following graph, the leakage rate is shown in parenthesis for each gas scenario. For example, New Gas (2%) stands for a new natural gas plant with a methane emission rate of two percent. Note as well the three time horizons delineated along the bottom of the graph.



Results. These results illustrate the advantage natural gas has in smokestack emissions, as well as the extent to which methane emissions diminish this advantage. In the first year that GHGs are emitted, if methane emissions are at the high end of the likely range (four percent in our estimation), both new and average gas would be more GHG intensive than new or average coal. Keep in mind new power plants operate for several decades, which means this initial GHG penalty would be incurred, year after year, for many years. These results contribute to the argument that building new baseload gas plants is unadvisable. After 20 years, one MWh from new gas is 16 – 40 percent less GHG intensive than average coal, depending the level of methane emissions. After 100 years, the advantage of natural gas increases. It offers an improvement of 44 – 52 percent above coal. Yet, by this time, emissions reductions must be much more ambitious than this if we are to power civilization in a way that enables a safe and stable climate.

For more details about this work, see our article in the *Electricity Journal*, "Natural Gas versus Coal: Is Natural Gas Better for the Climate?"