Supplement to Testimony
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Are climate and energy security goals mutually exclusive? C02 emissions have fallen 12% since 2005- the beginning of the shale revolution- and are the lowest since 1994. Do you believe the growth of natural gas had anything to do with that?

The largest variable impacting trends in U.S. CO2 emissions overall in the United States since 2005 has been lower economic activity due to the recession. The improvement in automotive fuel efficiency and a decline in the vehicles miles traveled by Americans was another major contributor to the trend of lower greenhouse gas emissions in the United States. The transportation sector represents 34% of all U.S. CO2 emissions, making it an important sector for climate friendly policy.

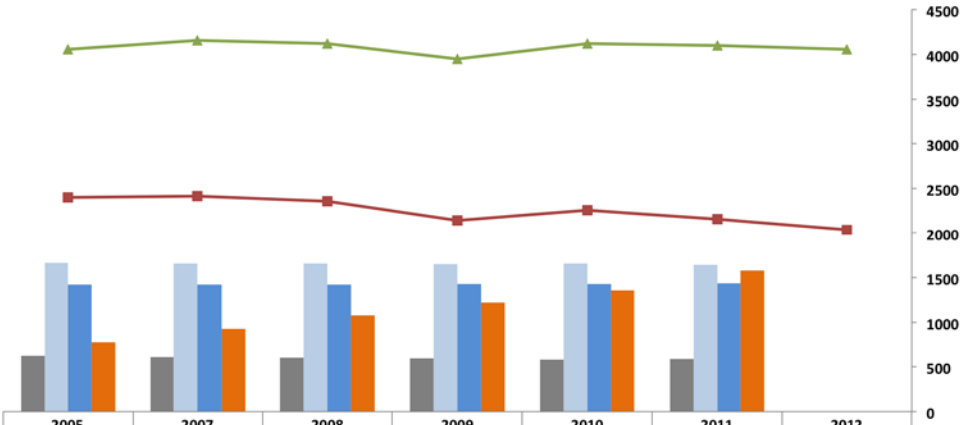
The growth of natural gas as a fuel for electricity generation, however, did contribute somewhat to a lowering of overall CO2 emissions in the U.S. which on average saw an increase in GDP between 2005 and today.

During the period between 2005 and 2012, U.S. electricity production remained flat to lower largely due to increased efficiency and to a lesser extent due to lower economic activity for part of the time period in question. During this same time frame, CO2 emissions from the sector fell substantially, with the U.S. electric sector reducing its carbon intensity by 15%. In the five year period from 2007 to 2011, overall electricity generation fell from 2,412 million metric tons in 2007 to 2,158 in 2011.

Many inefficient coal-fired and natural gas-fired facilities have been closed in the United States since 2005, while there has been a dramatic gain in the amount of renewable energy generation added across the country. From 2005 to today there have been 12 hydro- and 801 non-hydro- renewable power plants installed, while over 30 coal plants have been shuttered. Some 370 TWh of electricity produced by coal and petroleum TWh was eliminated over the period, while 252 natural gas-fired TWh and 232 hydro-powered TWh were added. Thus, both renewable energy and natural gas have contributed to the lowering of CO2 emissions in the U.S. electricity sector. This rise in natural gas use reflects both

utilities substituting low-priced natural gas for coal as well as the use of natural gas to back up renewable power during intermittency lows. Natural gas plants generally have a higher efficiency compared to the oil-fired and coal-fired plants that were closed over the period in question. Figure A shows the change in electricity generation by fuel.

Figure A

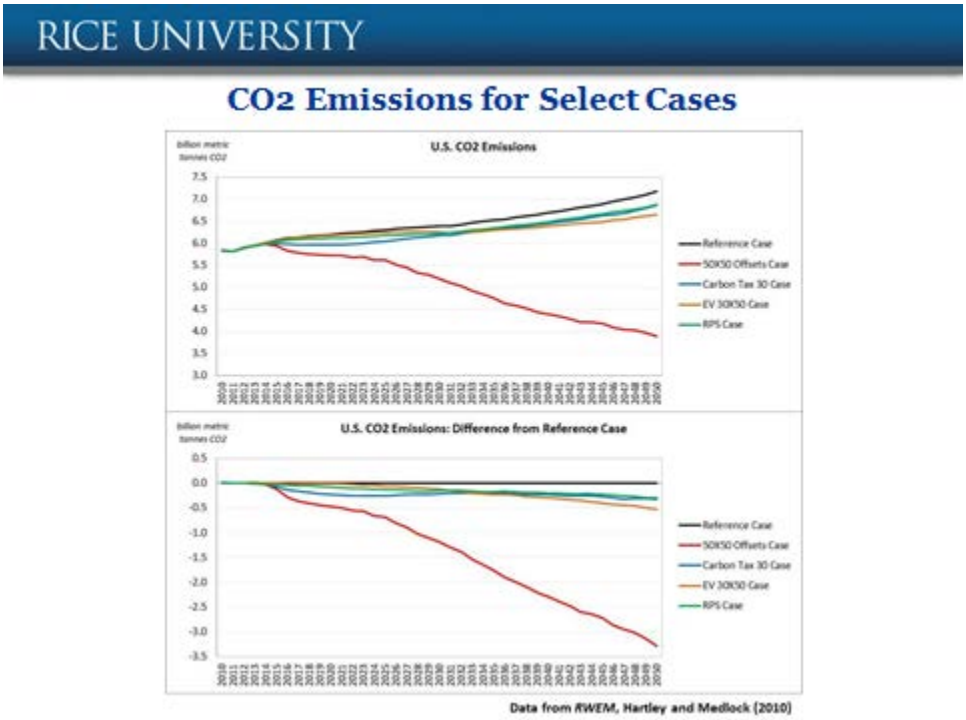


	2005	2007	2008	2009	2010	2011	2012
Coal Plants	619	606	598	593	580	589	
Natural Gas Plants	1,664	1,659	1,655	1,652	1,657	1,646	
Hydro Plants	1,422	1,424	1,423	1,427	1,432	1,434	
Non-hydro Plants	781	929	1,076	1,219	1,355	1,582	
TCO2eq	2,402.10	2,412.80	2,360.90	2,146.40	2,259.20	2,158.00	2039.195
GWh	4055.423	4156.745	4119.388	3950.331	4125.06	4100.656	4054.485

Worldwide, coal is responsible for about 40 to 45 % of energy related CO2 emissions. Natural gas combined cycle plants emit about 50 % CO2 emissions of a typical coal plant and perhaps even more savings compared to older steam turbine coal plants. Gas-fired peaking plants, because of their operational flexibility, are also the generation of choice to supplement intermittent power generated by wind, solar and other renewable sources.

A 2010 study by the Baker Institute at Rice University showed that while strong competition by natural gas to coal would ease an increase in greenhouse gases (GHGs) in the United States between now and 2030. The study also found that the imposition of a national renewable portfolio standard would contribute to a small reduction (4%) in GHGs in the U.S. by 2050 but could lead to higher electricity prices than a business as usual natural gas pathway where natural gas demand would increase by 40% by 2040 (see Figure B below)

Figure B



At present, California's Low Carbon Fuel Standard (LCSF) gives natural gas vehicles a pollution credit compared to oil-powered vehicles. A push to promote renewable natural gas (biogas)[1] could also provide support for natural gas fueling infrastructure and vehicles in the state. But environmental groups have raised concerns about methane leakage that takes place throughout the natural gas supply chain. Oil companies say that green completions are enabling companies to limit methane emissions from production activities to 2 percent or lower in most instances but initial studies are showing that some 10% to 15% of drillers are not using the most advanced procedures to limit venting of CO2 from shale gas operations. At leakage rates below 2%, natural gas offers a carbon emissions improvements over other fossil fuels. Studies to determine the leakage rates in urban distribution and delivery systems are being undertaken in several locations including Boston and New York City and preliminary data shows a highly variable range of ambient methane concentrations, requiring further analysis to determine the sources.

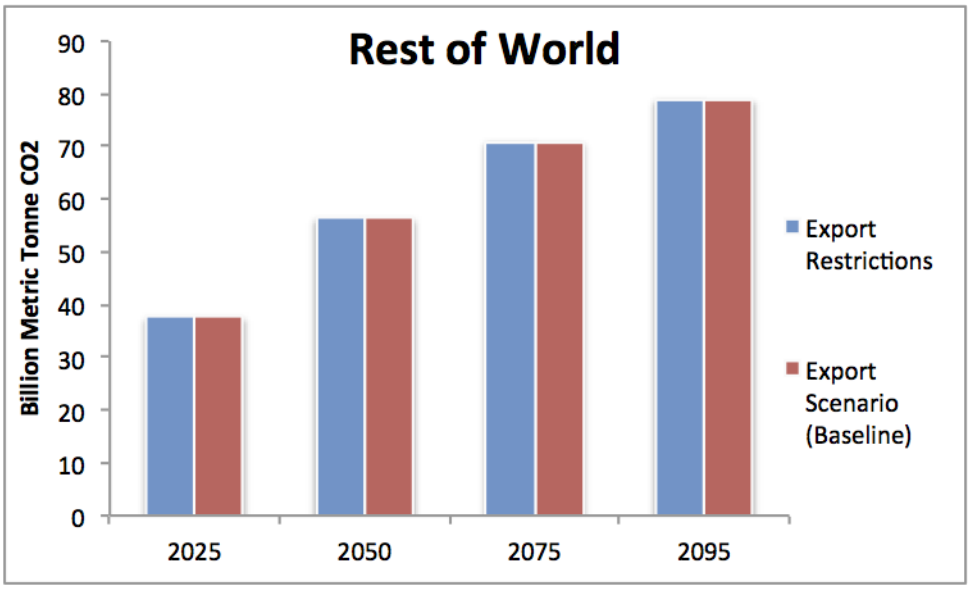
The controversy over methane leakage derives from the fact that methane is a more potent global warming gas than CO2. The intensity depends on the time horizon under consideration because methane is shorter lived than CO2. For example, over a 20-year period, methane is 70 times more potent than CO2. Over a 100-year horizon (the usual period for comparison) methane is only 20 times more potent than CO2.

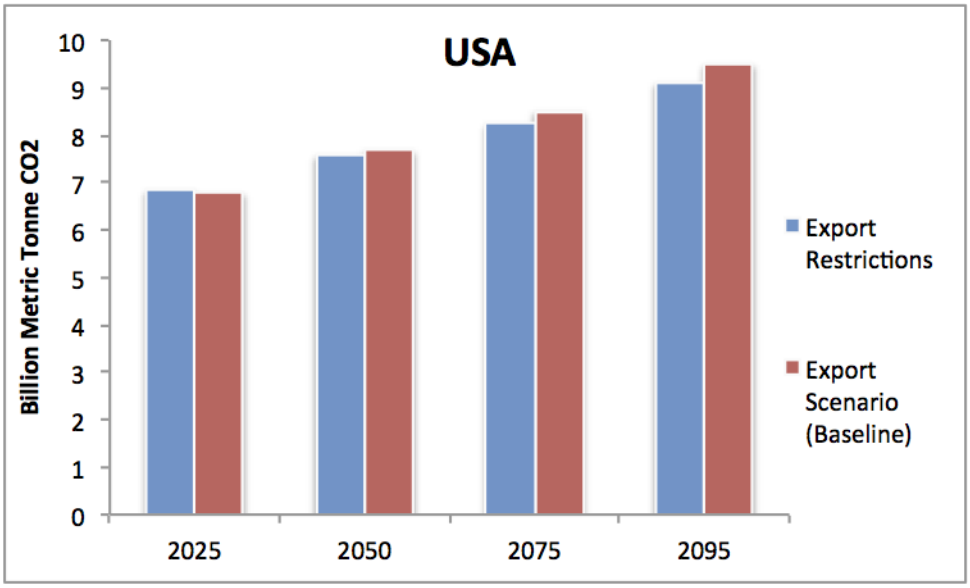
Fugitive emissions of methane happen throughout the supply chain of natural gas, oil and coal. There are involuntary leaks, and voluntary venting and flaring of methane.

Finally, it is worth mentioning than greenhouse gas emissions are a global concern, and there are ways in which a reduction in the use of carbon intensive fuel in the United States through higher natural gas use and fuel substitution can actually increase the rest of the world carbon emissions based on a "rebound effect": growth in domestic shale gas use, if not coupled with the possibility of US natural gas exports, will make more oil and coal available in international markets, dropping the prices of those commodities and incentivizing use, which could result in an overall net incremental gain in global GHG emissions, according to ongoing research by the Institute of Transportation Studies (ITS) at University of California Davis. The ITS Davis research shows that U.S. LNG exports might indeed be more carbon friendly than an export ban which could encourage higher oil and coal use in other parts of the globe by displacement (see Figure C).

[1] The California Biomass Collaborative, a University of California Davis led public-private partnership for the promotion of California biomass industries, estimates that 32.5 million BDT of in-state biomass feedstocks could be available for conversion to useful energy. In particular, estimates for methane production from landfill gas are 55 BCF/year, 4.8 BCF/yr for waste water biogas, and 14.6 BCF/yr for biogas from manure sources. Similar biomass resources are located in states that border California or along routes for the transmission of natural gas to the state from major producing states. We estimate that the methane potential from landfill gas in the Western states outside of California is 105 BCF/yr based on existing and candidate landfills identified by the U.S. Environmental Protection Agency.

Figure C


Rest of World
Billion Metric Tonne CO2
90
80
70
60
50
40
30
20
10
0
2025
2050
2075
2095
Export Restrictions
Export Scenario (Baseline)


USA
Billion Metric Tonne CO2
10
9
8
7
6
5
4
3
2
1
0
2025
2050
2075
2095
Export Restrictions
Export Scenario (Baseline)