the ENERGY lab

ANALYSIS FACTS

Life Cycle Analysis

Role of Alternative Energy Sources

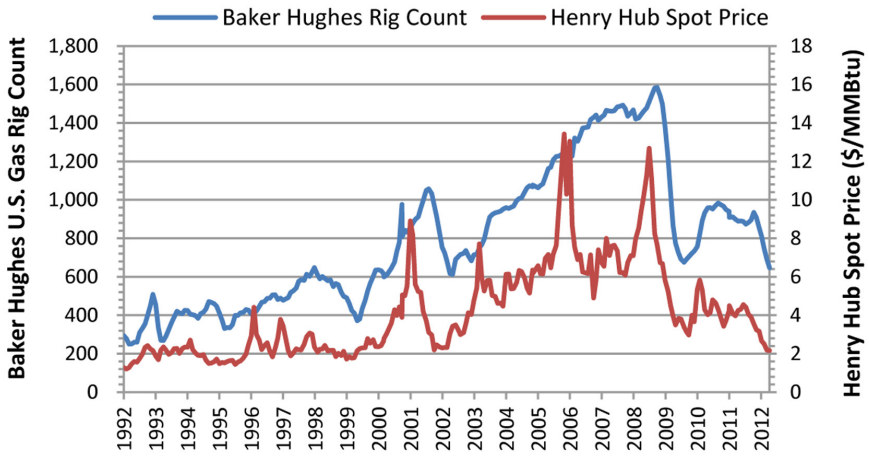
Natural Gas Technology Assessment

Project Description

This analysis evaluates the role of natural gas in the energy supply of the U.S. Natural gas is evaluated with respect to resource base, market growth, environmental profile, costs, barriers, risks, and what others are saying.

Resource Base and Growth

The U.S. supply of natural gas includes conventional and unconventional extraction technologies from domestic and imported sources. Total U.S. demand for natural gas was 24.1 trillion cubic feet (Tcf) in 2010 and is projected to grow to 26.5 Tcf by 2035 (EIA, 2012). Due to new extraction technologies, shale gas is a growing portion of the natural gas supply. The declining performance of conventional onshore wells has resulted in a gradual decline in their contribution to the U.S. natural gas supply.



Natural gas prices were low in 2010, but production climbed 4.8% and natural gas rig counts rose 22% due to an adherence to lease and drilling contracts (Baker-Hughes, 2012; EIA, 2012). As natural gas prices dropped further in 2011, producers rapidly reduced new well development.

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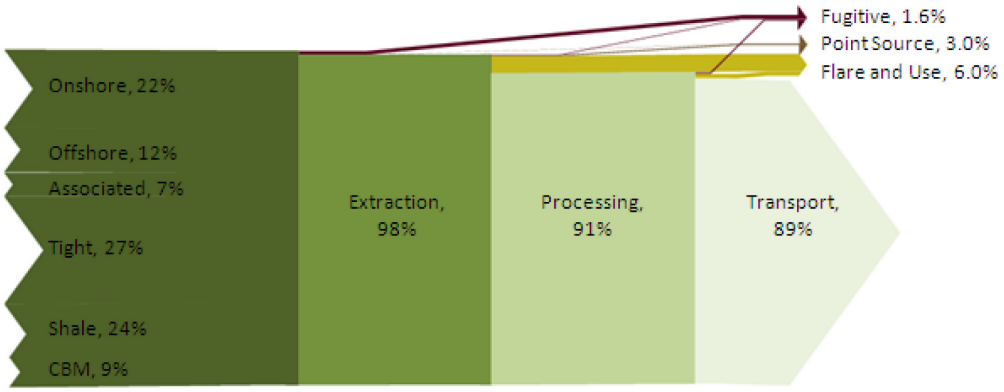


The high production rates, low rig counts, and declining natural gas prices are due in part to the improved recovery rates of natural gas, which have been made possible by new technologies, specifically horizontal drilling, seismic testing, and hydrofracking. Given the increase in shale gas production in the U.S., domestic natural gas prices are projected to remain low over the next few years due to a supply growth that exceeds demand growth.

In 2010 natural gas represented 19% of total energy consumed by U.S. electric utilities and 24% of net electricity generation (EIA, 2012). The U.S. natural gas power fleet has combined cycle (NGCC) and simple cycle (GTSC) power plants with a production-weighted efficiency of 47% (EPA, 2010).

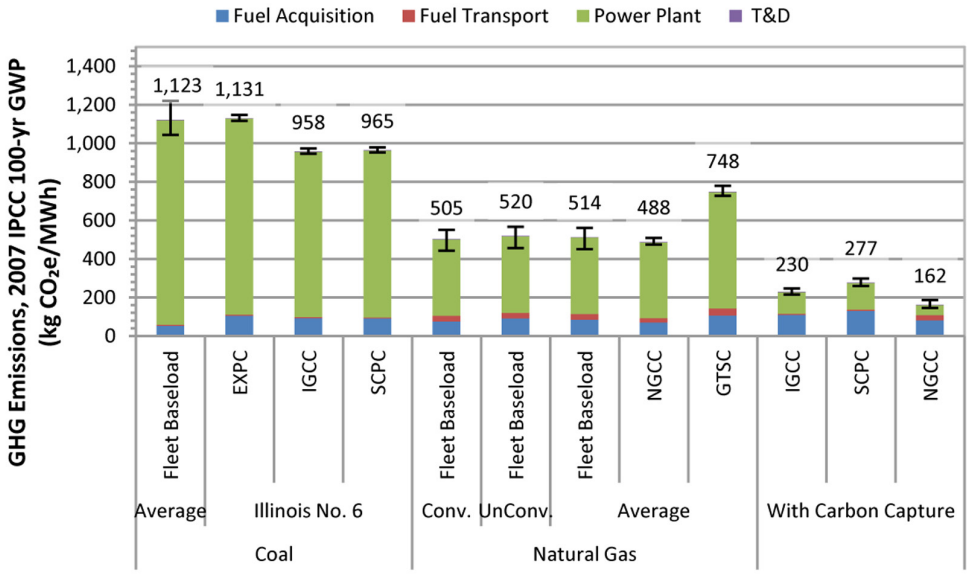
Environmental Profile

This analysis includes a cradle-to-grave life cycle analysis (LCA) of natural gas power, beginning with the acquisition of natural gas and ending with electricity delivered to the consumer. A full list of air, water, and land metrics were inventoried. Conventional and unconventional natural gas sources were modeled. Conventional sources include onshore, offshore, and associated gas; unconventional sources include coal bed methane (CBM), tight gas, and shale gas.

Of the natural gas extracted from the ground and used for the U.S. supply mix, only 89% is delivered to the power plant or city gate. The 11% reduction between extraction and delivery is due to the use of natural gas by compressors and processing equipment, point source emissions that are flared, and fugitive emissions. These flows are shown in the Sankey diagram above.

Conventional and unconventional natural gas extraction methods have different greenhouse gas (GHG) burdens, but the energy conversion facility is the key driver of life cycle environmental burdens. Compared to coal-fired power, natural gas has higher upstream GHG emissions, but the higher efficiency of natural gas power plants results in lower life cycle GHG emissions from natural gas power.

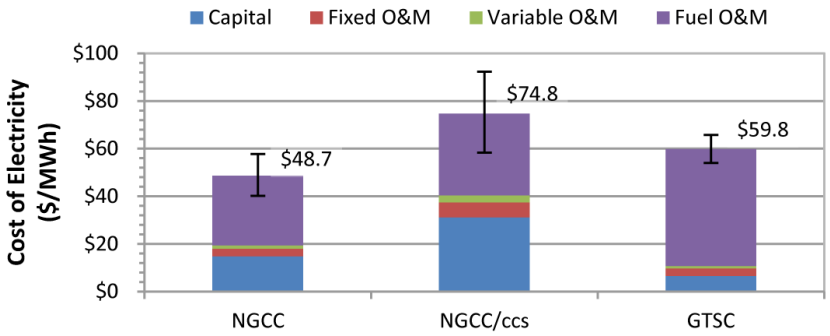
The results in the chart at right do not include GHG emissions from land use change. GHG emissions from land use change are small in comparison to other life cycle GHG emissions. For NGCC power (without carbon capture and sequestration (CCS)) using the 2010 domestic mix of natural gas, land use represents 0.6 percent of total life cycle GHG emissions.



Acronyms: EXPC (Existing Pulverized Coal), IGCC (Integrated Gasification Combined Cycle), SCPC (Supercritical Pulverized Coal), NGCC (Natural Gas Combined Cycle), GTSC (Gas Turbine Simple Cycle)

Costs

A life cycle cost (LCC) analysis was conducted to determine the costs of natural gas power per MWh of electricity delivered to the consumer. Capital and fuel costs are key drivers of the cost of electricity (COE) for NGCC systems. Capital costs are based on the NETL bituminous baseline report (NETL, 2010) and range from $428 to $2,030 per kW; GTSC has the lowest capital costs and NGCC with CCS has the highest capital costs. Operations and maintenance (O&M) costs are dominated by fuel costs; this analysis uses the average 2010 spot price of natural gas ($4.39/million Btu) (EIA, 2012).



The COE for NGCC is $48.7/MWh and $74.8/MWh for NGCC with CCS. CCS adds 54% to the COE of NGCC. The COE of GTSC is $59.8/MWh; GTSC power is less efficient than NGCC systems, so its COE is dominated by fuel costs. The overall uncertainty in COE is dominated by uncertainties in capital and fuel costs.

Barriers

Unconventional natural gas extraction methods could result in the depletion of surface water, deterioration of surface water quality, and relatively high GHG emissions from natural gas wells, although the results of this analysis do not necessarily support this conclusion.

If shale gas production increases in the Northeast U.S., the pipeline industry will have to increase the capacity of its Northeast gas transmission network. The capacity of existing natural gas pipelines can be increased by adding new compressor stations or running new pipelines along existing right-of-ways (Langston, 2011).

Risks

Legislative uncertainty is a non-technical obstacle to the development shale gas plays. New York recently placed a moratorium on horizontal drilling of natural gas wells in 2010 (NYSDEC, 2010). In June 2011, the New York State Department of Environmental Conservation released new recommendations that favored high-volume fracking on privately-owned land as long as it is not near aquifers (NYSDEC, 2011). These new recommendations were faced with opposition, including a New York State Supreme Court ruling in February 2012 that enforced the right of municipalities to use zoning laws to prohibit oil and natural gas drilling (Navarro, 2012). Pennsylvania's legislature is also grappling with issues related to shale gas extraction, including the decision on whether to impose an impact fee on gas extraction (Maher, 2011).

Expert Opinions

According to some researchers, the life cycle GHG emissions from natural gas power could be higher than other fossil energy technologies (Howarth et al, 2011). Other research shows water quality impacts from poor extraction processes (Osborn et al, 2011).

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