Natural Gas and Electricity Costs and Impacts on Industry

DOE/NETL-2008/1320

White Paper on Expected Near-Term Cost Increases

April 28, 2008

Disclaimer

Natural Gas and Electricity Costs and Impacts on Industry

DOE/NETL-2008/1320

A White Paper on Expected Near-Term Cost Increases
April 28, 2008

NETL Contact:

Peter C. Balash
Office of Systems, Analyses, and Planning

National Energy Technology Laboratory
www.netl.doe.gov

This page intentionally left blank

Table of Contents

List of Figures

Prepared by:

Peter C. Balash
NETL/OSAP

Kenneth C. Kern
NETL/OSAP

Acknowledgements

We would like to thank Erik Shuster and Christopher Nichols of NETL's Office of Systems, Analyses, and Planning (OSAP) for supporting work. All opinions and conclusions, however, are solely those of the authors.

Natural Gas and Electricity Costs and Impacts on Industry

Summary: Natural gas prices continue their recent upward trend. High natural gas prices hurt all natural gas consumers, especially households and natural gas-intensive industry, with recent prices three to four times higher than a decade ago. Trade-exposed industry has been hurt the most. Regions of the country dependent on natural gas fired generation have experienced large increases in the cost of power. Coal-fired generation has restrained the price of electricity and has constrained the price of natural gas from matching the rise in the price of oil. Currently, opposition to coal plants and uncertainty over nuclear power has stymied the construction of new baseload generation. This threatens a capacity shortage in many areas of the country, in the near term. Additionally, should climate change legislation pass, the "dash to gas" will be exacerbated, doubling natural gas consumption for power generation, increasing dependence on foreign energy sources, and sending natural gas and power prices skyward across the country.

Background

In the early part of this decade, natural gas optimism was high. EIA reflected industry consensus with projections of over 29 trillion cubic feet (Tcf) by 2010 and nearly 35 Tcf by 2020. The projections were based on the extrapolation of high growth rates of natural gas use in power generation, underpinned by assumptions of continued growth in domestic U.S. natural gas production and available Canadian imports.

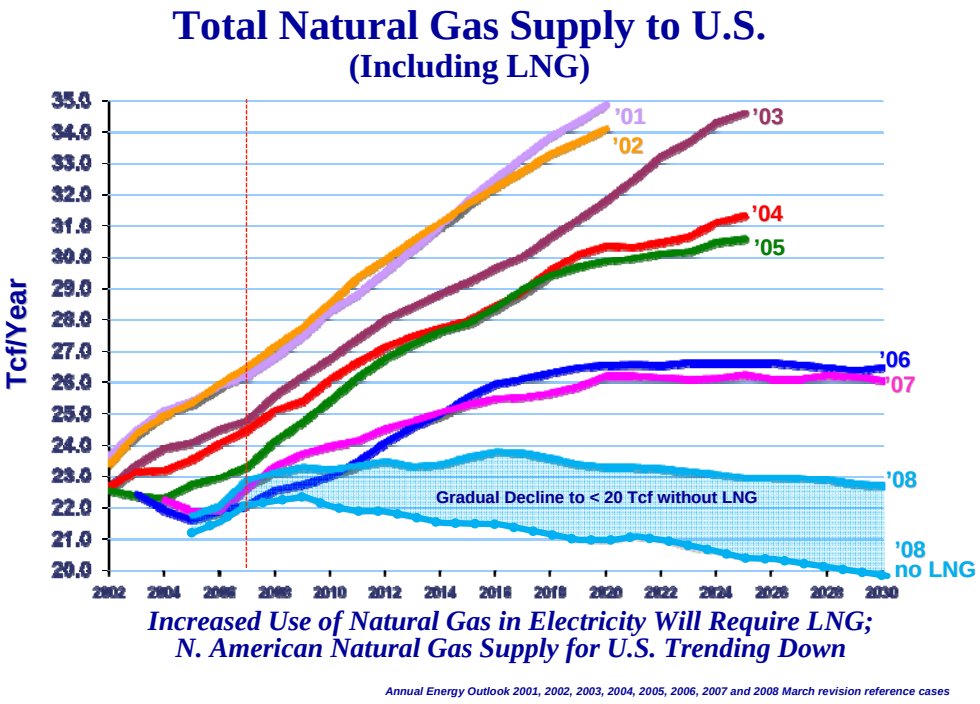
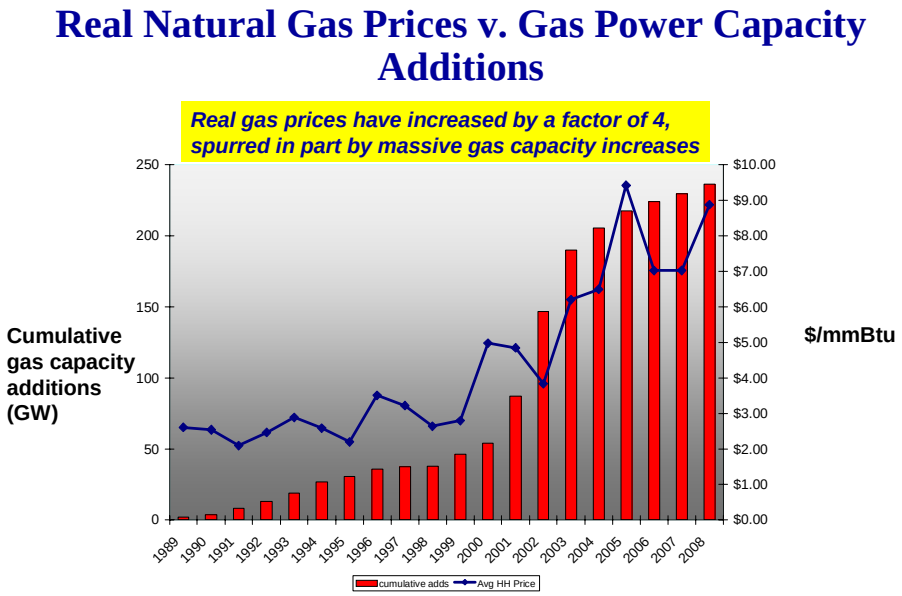


Figure 1

The decline in the FY08 forecast from the FY01 forecast for year 2020 alone, excluding LNG, is roughly 13Tcf, or nearly equivalent to the expected annual supply from ten Alaskan

pipelines. The main driver has been the increase in natural gas price and the availability of substitutes, especially coal, embedded in the model. For U.S. natural gas supply to remain flat, growth in LNG supply is required. Domestic production is projected to decline steadily, falling below 20 Tcf by 2030 (Figure 1). This implies that significant energy security issues will arise for the supply of natural gas, in addition to long-standing issues for secure petroleum supply.

Installation of a large amount of natural gas-fired capacity – combined cycle units and combustion turbines - drove natural gas demand much higher. However, disappointing U.S. production, declining Canadian imports, minimal LNG imports to date, and the continued rise in the price of oil have caused natural gas prices to more than triple between 2002 and today (Figure 2).

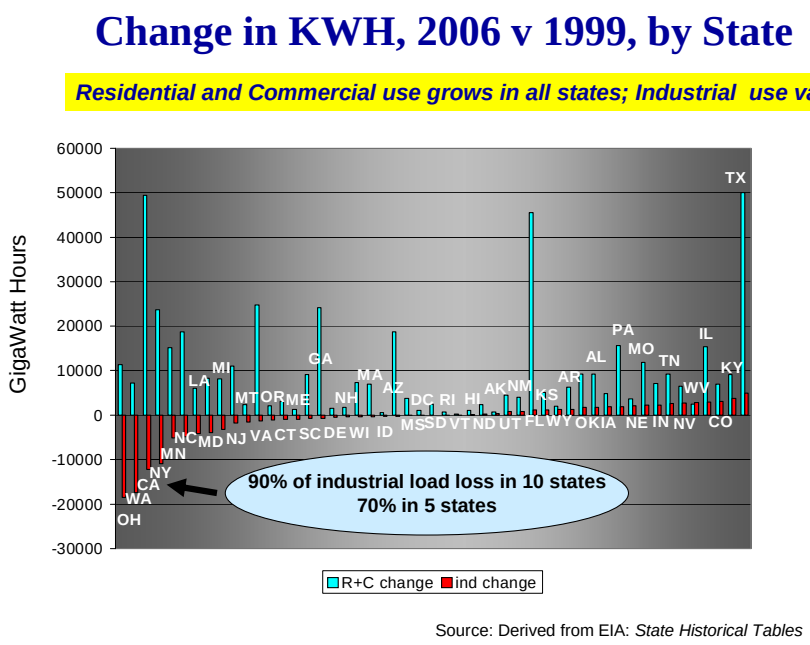


Source: EIA Natural gas Navigator, Annual Energy Review 2006, Annual Energy Outlook 2008; BEA: GDP deflator; NETL calculations

Figure 2

Natural gas has not matched price the percentage increase in the price of oil because of competition offered by coal, and favorable weather in two of the past three winters. That is, in previous projections natural gas was assumed to take market share away from coal due to competitive electricity costs. However, high natural gas prices caused the cost of electricity from natural gas to be higher than that from coal. Because of this, and because in many regions there was surplus electricity capacity, electricity prices were not high enough to make natural gas generation economic. As a result, natural gas combined cycle (NGCC) units averaged about 40% capacity factors in 2007 compared to well over 70% in 2002. The warm winters of 2005-2006 and 2006-2007 meant that residential space heating consumption was much lower than normal, preventing the natural gas price from rising along with oil, but not enough for the price to significantly displace coal. As of mid-April 2008, the price of oil is $115/barrel while the price of natural gas is $10.30/mmBtu. An historic 8:1 oil/natural gas price ratio implies a natural gas price of $14/mmBtu; strict energy equivalence implies a natural gas price of $19/mmBtu.

In trade-exposed sectors of industry, especially aluminum, fertilizer, and chemicals, the rise in natural gas prices, which in the first part of the decade was U.S.-centric, caused production to be shut in or moved offshore.[1] Middle East production of chemicals, especially, threatens the competitive position of U.S. industry because of cheap natural gas reserves in the Persian Gulf area. In addition, natural gas-centered production in the U.S. is also disadvantaged relative to coal-based industry in China.



Source: Derived from EIA: *State Historical Tables*

Figure 3

Forecast Electricity Growth

Current projections of electricity generation growth, and in particular sales to industry, are only 1.1% and 0.1% per year, respectively, according to EIA *Annual Energy Outlook 2008*[2]. In fact, industrial sales growth is deemed to turn negative after 2017. This appears to be an extrapolation of the most recent period, encompassing the blows to industry caused by the fuel price run-up, a manufacturing recession centered in Ohio, and industrial retrenchment in California and New York (see Figure 3).

[1] See, for instance, American Chemistry Council, "Impact of High Energy Costs on Consumers and Public," testimony before the U.S. House of Representatives, Energy and Mineral Resources Subcommittee, May 19, 2005. Available at http://www.americanchemistry.com/s_acc/sec_policyissues.asp?CID=311&DID=1137

[2] EIA, *Annual Energy Review 2008*, annual tables, Table 8.

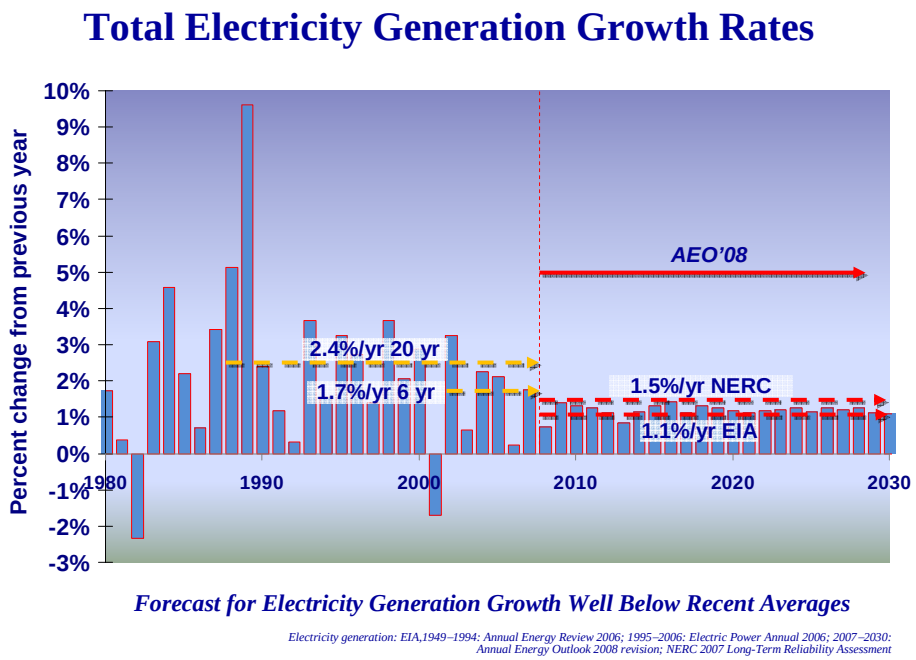


Figure 4

Even then the growth rate used for the projection (1.1%) does not reflect recent averages (1.7% - Figure 4). Extrapolating based on a time period with these embedded events will likely underestimate electricity consumption over the next few years, once the current economic slowdown is resolved. Worse, underestimation of industrial growth over the longer term risks becoming a *self-fulfilling prophecy*, as demand uncertainty may lead to failure to install enough electricity generation capacity, causing the price of electricity to rise needlessly and further weakening U.S. industry.

Opposition to New Coal Plants and Natural Gas Prospects

The current push by certain interest groups to forestall the construction of coal fired power plants, reminiscent of opposition to nuclear power, threatens to:

a. reduce already precarious reserve margins, raising the risk of blackout, and
b. increase the demand for natural gas in the short to medium term.

Expecting natural gas generation to displace coal-fired generation is, at best, problematic. By 2016, in the absence of 18 GW of currently forecast new coal-fired plants, the addition of natural gas plants to supplant these kWh would demand 1.4 Tcf/year, or almost all of the presently forecasted LNG growth. If electricity growth is higher, in line with AEO'05 estimates, due to better macroeconomic performance, an additional 2.3 Tcf of natural gas for gas-fired generation would be needed.

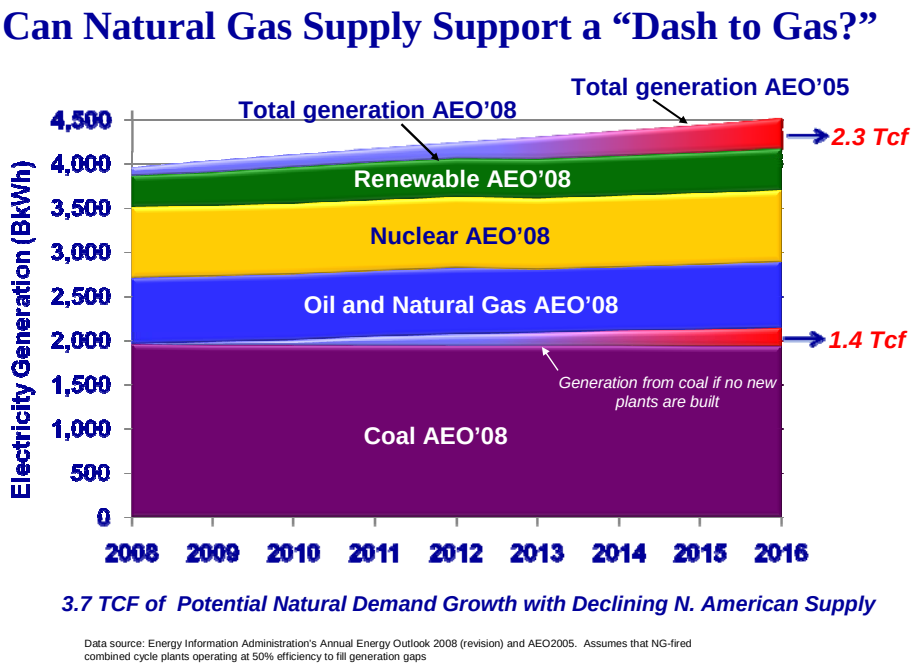
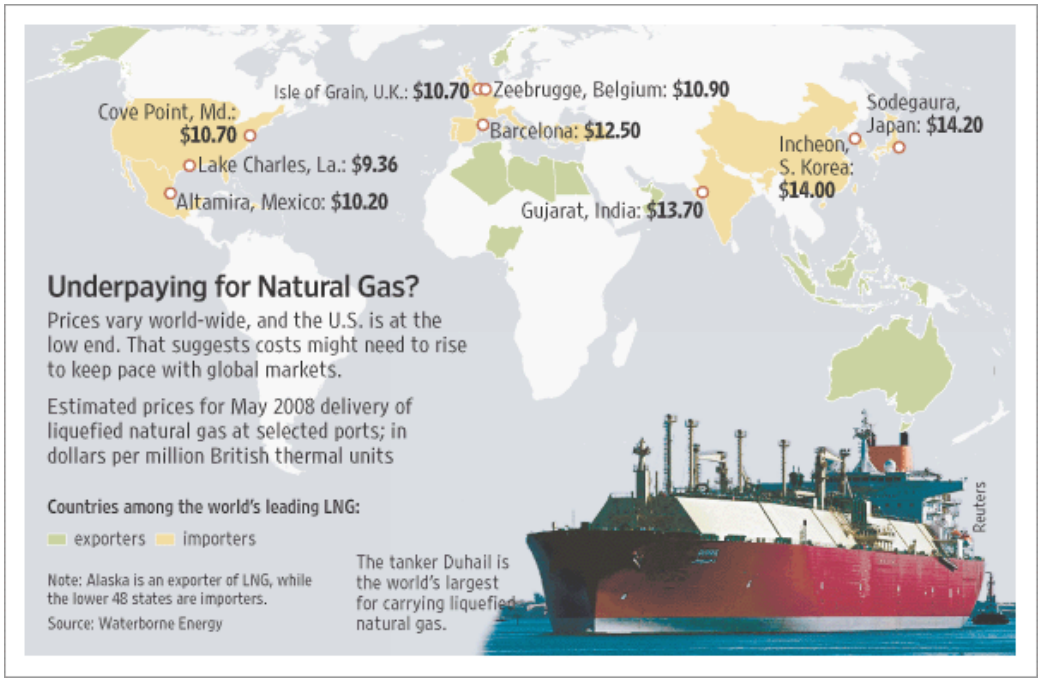


Figure 5

Although LNG regasification capacity could grow by as much as 15 bcf/d, only 5 bcf/d is certain to appear. Currently LNG capacity is 5 bcf/d, and EIA only expects 3.2 bcf/ of LNG imports by 2010, implying significantly underutilized regas capacity. Industry's perception of likely prices for LNG has also changed. In 2003, Deutsche Bank as well as other energy analyst groups expected LNG to cause world prices of natural gas to clear at $3.50/mmBtu. In 2008, the bank notes the success of the United Kingdom in bidding away surplus LNG cargoes, even though U.S. prices are above $10/mmBtu.[3] At the same time, U.S. domestic production is not expected to grow, and Canadian imports are expected to decline.

[3] Deutsche Bank AG, *Natural Gas Outlook* 13 June 2003, p. 2; *Commodities Weekly* 18 April 2008.



***Wall Street Journal*, April 18, 2008**

Thus, the likely way for LNG to increase natural gas supply to the US is for price to rise substantially. This increase could happen, thanks to the confluence of the pressure on coal utilization and the related possibility of climate change bills.

Theoretical Coal Displacement by Gas

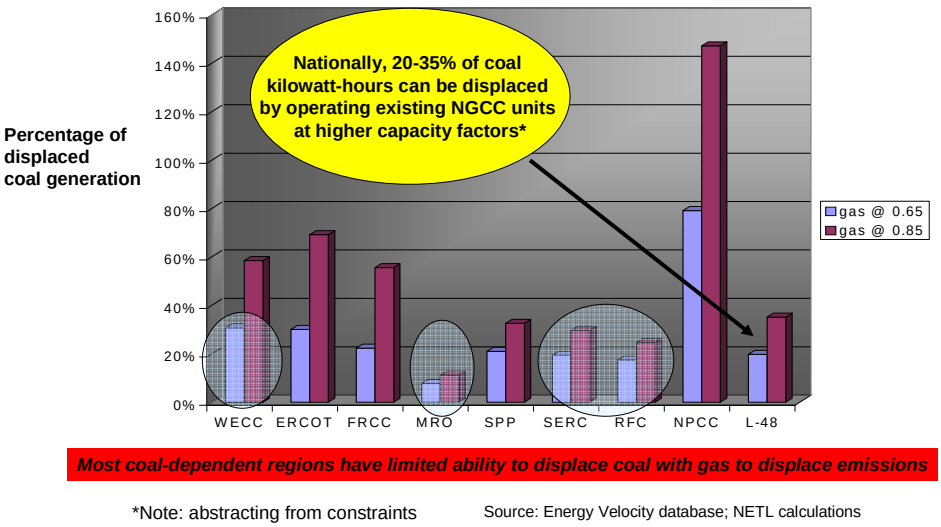


Figure 6

Nationally, up to a third of coal kilowatt-hours could be displaced by higher utilization of natural gas combined cycle units (NGCC), as shown in Figure 6. Coal-dependent regions

such as SERC and RFC drive this result, with limited available NGCC capacity. While it may appear NPCC has enough combined cycle capacity to replace its modest coal use, that surplus does not exist during peak months.

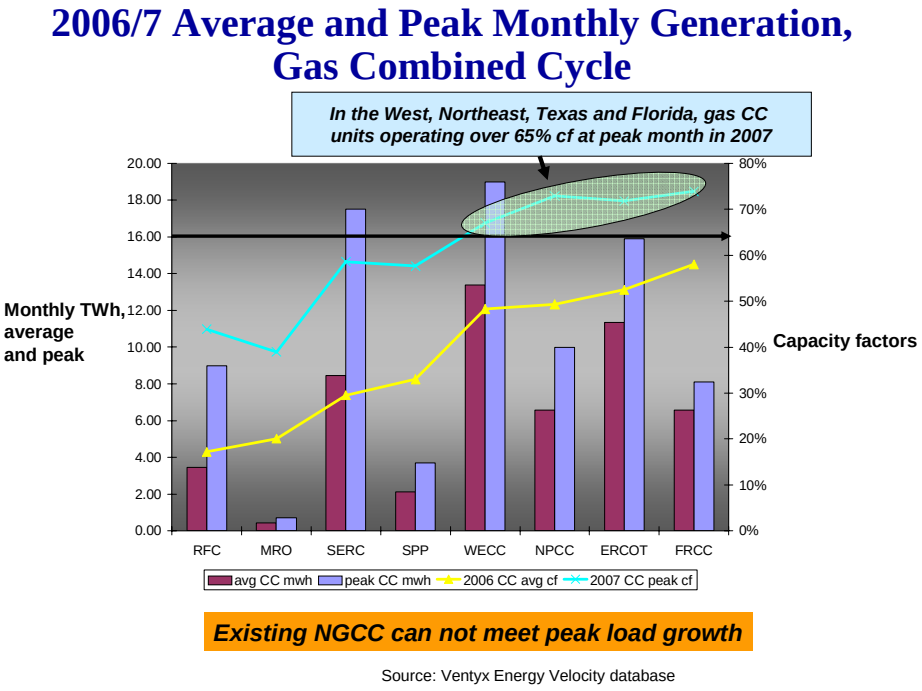
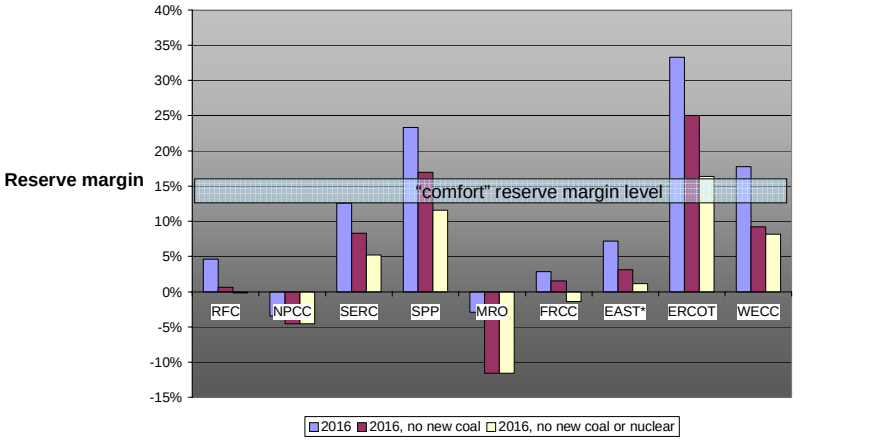


Figure 7

Other, more natural gas-centric regions such as NPCC have limited ability to displace coal with existing natural gas plants because these plants already operate at high capacity factors during peak months (Figure 7). More capacity is clearly needed.

Expected Reserve Margins by Region, 2016

Most of the country will be in precarious situation in 2016 w/o new baseload; the East will be vulnerable even with expected plants



*East = combination of RFC, NPCC, SERC, SPP, MRO, and FRCC

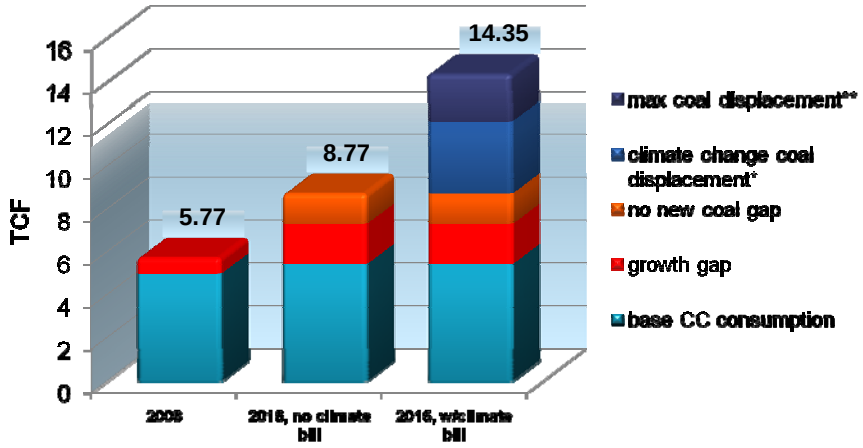
Source: Ventyx Energy Velocity database, 4/15/2008

Figure 8

The Eastern Interconnect (all regions excluding ERCOT and WECC) is in dire need of new capacity to ensure safe reserve margins by 2016 (Figure 8). The loss of new coal plants will reduce reserve margins well below these levels for most of the country, other than ERCOT (Texas) and SPP. However, since SPP is in the "East" its surplus will be drawn off by the grid. Should nuclear power also not be available before 2016, the entire Lower-48, save ERCOT, will be at high risk of power shortages, a present-day South African-like, electricity supply situation.

The compound influence of these factors could more than double current U.S. power generation consumption of natural gas, just from running existing combined cycle units at higher rates, and with incremental new gas-fired additions.

Incremental Natural Gas Demand w/ Higher Growth, No New Coal, and Climate Legislation



*existing gas CC plants at 65% capacity factor
** existing CC at 85% cf.

Figure 9

In Figure 9, consumption in 2008 of natural gas by combined cycle units will be about 5.1 Tcf. From Figure 5, an additional 3.7 Tcf of natural gas would be needed to replace expected coal plants and accommodate higher growth. In the event of climate change legislation, running existing natural gas combined cycle units at higher capacity factors can displace 20-35% of current coal kilowatt-hours (Figure 6). Such substitution requires another 5.4 Tcf per year. Clearly, the existing natural gas fleet cannot meet the growth in peak demand expected before 2016 and also substitute for coal to meet carbon caps. More plants would be needed, resulting in the incremental natural gas requirements of Figure 9.

Since the approximate 9 Tcf increase in natural gas consumption would be occurring at high prices, the impact on the economy would be severe. Since both power and heating prices would escalate, no sector would be exempt, but energy-intensive industry and residential sectors would certainly bear the heaviest burden.

Effect of Possible Climate Legislation

There is however, one scenario, becoming increasingly likely, that could bring to pass high natural gas plant utilization, low to dangerous reserve margins, and the collapse of U.S. industrial competitiveness. A climate change bill with relatively strict cap and trade provisions, such as S.2191, combined with the attempted moratorium on coal and likely delay of nuclear would severely impact the U.S. economy as it attempts to adjust.

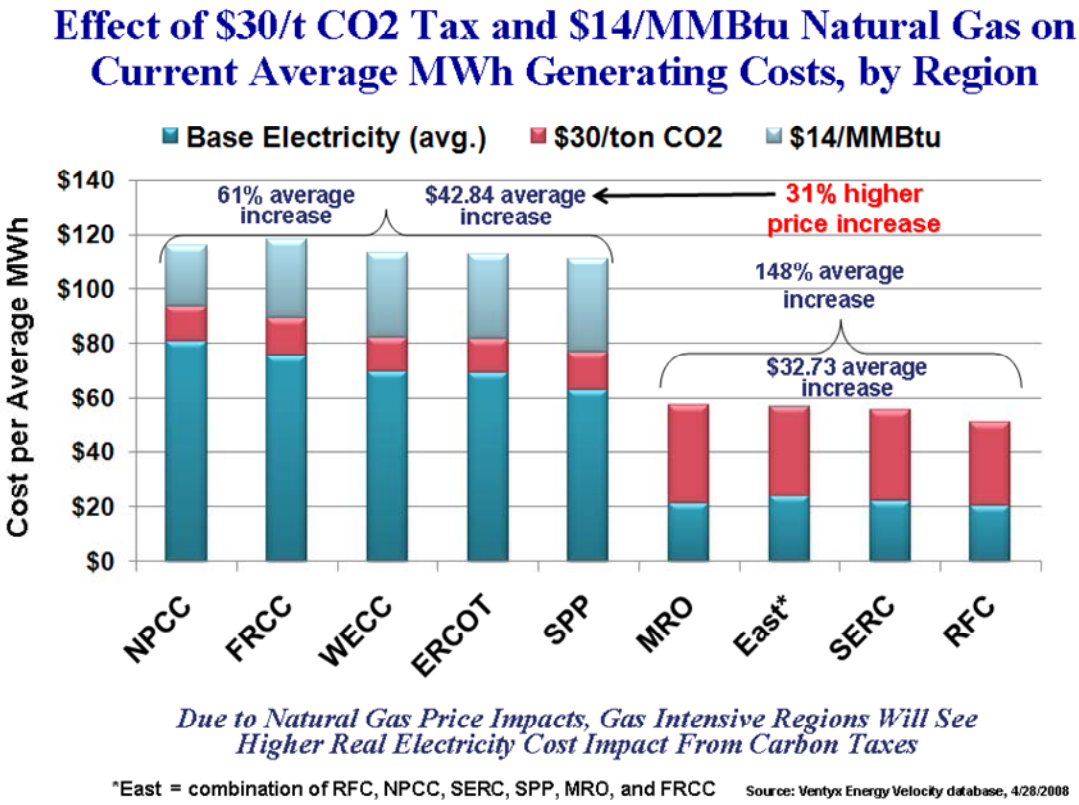


Figure 10

Electricity and natural gas-intensive industry will be targeted. These effects have been minimized by most analyses because they neglect the vicious cycle between the prices of natural gas and of carbon dioxide; in the short term, under a cap and trade, the price of carbon must be high enough to displace coal kilowatt-hours. Only natural gas generation can do this at sufficient scale. Most analyses assume cheap and plentiful natural gas, early nuclear, or unlimited biomass, each a problematic assumption. While states with high rates of coal use will be most immediately affected, the knock-on natural gas demand effects will be widespread. Due to the increase in natural gas demand as coal power is backed down, the price of natural gas will rise dramatically across the country, not only in coal-using regions. *As the natural gas price rises, coal plants regain competitiveness, necessitating a further rise in the carbon dioxide allowance price, in order to meet the cap.* A price of $14/mmBtu, usually seen only in peak days in the Northeast, could be come commonplace. (This price equates to a price of oil of $84/barrel at a 6:1 energy equivalence ratio and $112/b at a more normal 8:1 ratio). The combined effect of high fossil fuel prices and a carbon dioxide allowance price of $30/ton would drive the average MWh cost to well over $110/MWh in natural gas-heavy regions (Figure 10). In fact, in Figure 10, the absolute cost increase of electricity is 31% higher in natural gas-intensive regions than in coal-intensive ones. On top of the already precarious reliability situation, shortages of natural gas and power may occur before relief arrives with advanced, but expensive, power generation technologies.

Conclusion

Since 2001, perceptions of natural gas supply and consumption have been successively ratcheted down, without any assurance the decline has halted. Nonetheless, recognition of the extremely difficult natural gas supply situation facing the United States has not been fully appreciated in recent energy and climate change analyses. Policies that encourage the use of natural gas to substitute for coal in power generation could very well lead to spectacular price increases for households and industry. As prices are pushed higher the need for more LNG will create closer links to the world oil price, setting the stage for the marginal price of U.S. electricity to be set by the whims of foreign oil/LNG suppliers, for the first time in U.S. history. This blind eye towards U.S. energy security extends to the inability to recognize that the nation's coal supply could help the U.S. forestall this situation. The current opposition to baseload power, and in particular coal-fired plants, in anticipation of climate change legislation, will have serious and damaging implications for the reliability of electricity supply and the viability of the U.S. economy in the initial, costly period of adjustment to a carbon control paradigm.