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Coal's decline: Driven by policy or technology?

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ABSTRACT

The political rhetoric would have it that the dramatic decline in the use of coal in the U.S. since 2008 has been a result of 'Obama's war on coal' – that is, the EPA's Clean Air rules. But the data say otherwise. Rather, enabled by shale drilling, cheap natural gas is outcompeting coal markedly. An analysis that includes gas's techno-economic pluses concludes the trend will continue.

1. Introduction

1.1. Coal has declined sharply

Coal production in the United States peaked in 2008 at 22.5 million MMBtu. ("MMBtu" is millions of British thermal units of energy.) Since then, 2008 through 2015, its production declined sharply to 17.3 million MMBtu – a drop of 23% (Fig. 1). Meanwhile, natural gas production saw a countervailing increase of 51%, from a lower base.[1]

The lion's share of U.S. coal (93%) goes to generating electricity domestically. In much of the 21st Century, electricity demand has been nearly flat, growing just 0.4% from 2008 to 2015, due largely to the stunning success of government-driven conservation efforts. During this time, we have seen the full or partial displacement of coal-fired generators, mostly by combined-cycle gas turbines (CCGT), producing about the same amount of electricity.

1.2. Why? Three questions

In this article, we examine three important questions. First: Why have electric power companies favored gas over coal? Second, the derivative question: Is it due to pressure from the U.S. Environmental Protection Agency (EPA), and therefore reversible with a different U.S. president, or at least with relaxed pollution rules legislated by Congress? And third, if it is driven by a technical/economic nexus instead, is it liable to continue more or less unabated, or be cyclical as competitive drivers underlying the choice of generation fuels leapfrog each other?

Leading observers of the U.S. energy industry have been treating pieces of these questions for some time, as we further examine in detail in Sections 2 and 3. Significant gaps remain, however, namely:

- The U.S. Energy Information Administration (EIA) publishes trend data and projection spreads based on the data. It generally avoids, however, evaluating economic drivers that are outside its charter, such as the macroeconomic in the domain of the Federal Reserve, or the microeconomic, e.g., industry balance sheets intertwined with capital allocations, that are in the domain of the Bureau of Economic Analysis.
- Academia and accounting firms' business consultants tend to leave to the Wall Street analysts the profitability factors in corporate decision-making that affect the energy field.
- The Wall Street analysts look at the corporations and the drivers in energy thru the narrower lens of risk/reward projections in shorter-term investing. And,

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[1] Developed from United States Coal Production and Consumption by Year, Index Mundi: http://www.indexmundi.com/energy.aspx?country=us&graph=production+consumption&product=coal, and Short-Term Energy Outlook, U.S. Energy Information Administration (EIA), Dec. 8, 2015: http://www.eia.gov/forecasts/steo/report/coal.cfm and https://www.eia.gov/forecasts/steo/report/natgas.cfm, and U.S. Natural Gas Marketed Production, EIA, Dec. 31, 2015: https://www.eia.gov/dnav/ng/hist/n9050us2a.htm.

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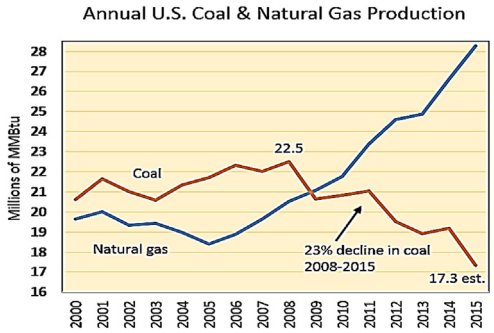

Fig. 1. Since 2008, there has been a sharp decline in coal. About 93% of U.S. coal production is used for electric power, where the use of gas has grown 51% in that time.

- Mainstream media and the trade press tend to the more topical articles, rarely assessing the pros and cons of how the drivers might affect the industry in the future.

1.3. Purpose and methods

In this article, we perform an in-depth analysis of the web of interdependencies that remain largely untreated, we believe, among the various drivers in the decline of coal-fired generation. In our methods, we integrate and crosscheck across the evidentiary data as well as sometimes opposing opinions in the technology, demographics, and micro- and macroeconomics involved with the decline of coal. Our study identifies both the significant and secondary factors across the domains, and draws credible predictions on the future trend of U.S. domestic coal market. Our work represents, we believe, the first comprehensive study in recent years about the causes of the decline of the U.S. coal market, and its long- term trends.

2. Discussion and results

2.1. EPA rules have had little to do with coal's decline

Political figures who promote less regulation or who represent areas dependent on coal mining often characterize the decline in coal as a result of "Obama's war on coal," effected through stricter EPA smokestack emissions rules. Indeed, burning natural gas in power plants does emit none of the mercury of coal that is injurious to health, none of its nitrogen gases and 80% less of the sulfur gases that produce acid rain, and half of coal's CO_2 that promotes global warming.

But today's clean-air rules date to 1990–19 years before the decline in coal began – and actually add little to coal's cost.

In 1990, President George H.W. Bush signed a bill of amendments to the Clean Air Act, which set limits on SO_2 and NO_x gases from power plants. That required smokestack scrubbers costing just $0.01 to $0.03/MMBtu for plants where the coal used was the most sulfur-laden – i.e., Appalachian and Illinois Basin coal. See the line labeled 1 in the margin of the Table 1, where fuel-related costs are in nominal dollars.[2] The costs of compliance for the cleaner coal from the Rockies and the Powder River Basin of Wyoming were less than half of that.

The $0.01–$0.03 to comply with existing emission rules are insignificant compared to the overall generation costs of $2.76–$4.60/MMBtu on the last line of the table.

The EPA rules proposed since 1990 on other air pollutants have been encountering years of delays in court challenges. After rewrites, a limit on CO_2 emissions finally came out on Aug. 3, 2015, in the Clean Power Plan Final Rule (CPP), but it still faces challenges. Meanwhile EPA's separate Mercury and Air Toxics Standards (MATS) were delayed until on 13 June 2016 the U.S. Supreme Court struck down the last of the appeals against it.

In summary, the EPA air-quality rules, largely unchanged since 1990, predate by 19 years and seem detached from the decline of coal.

2.2. Shale-gas competition, however, has decimated coal

In 2007, when shale-gas production was only 1.3 trillion cubic feet (Tcf) of 20.2 Tcf total natural gas production, a nascent Shale Gas Revolution began. In three years, by 2009, shale-gas production had increased by a factor of 2.4, and in the next three years, by 2012, it had increased by another factor of 3.3. The shale-gas revolution has been into full swing since. At the same time, it has attracted investment both in shale gas infrastructure (drill rigs, pipelines, and market structure) and in R&D for higher-productivity extraction. Those in turn provided positive feedback that drove even greater gas production at even lower costs. By 2014, of the 27.3 Tcf from all gas sources, shale gas reached 13.4 Tcf – 10.4 times the level of 2007 – and dropped to half the price.

In the business cases for capital projects involving many millions of dollars – such for fleets of gas-fired electric power plants – both the average price of natural gas and its price spikes need to be low. In reality, that is what happened.

In Fig. 2 we first exclude two extraordinary spikes in 2000–09 so as not to penalize the "before" of the before-and-after comparison.[3] One spike is from the pair of hurricanes of 2005 that occurred in one month's time; the other is due to the Recession. We then draw the two dashed boxes of Fig. 2. The first holds the monthly-average prices in the seven-year pre-revolutionary period ending 2007. The second holds the prices in the seven-year period ending 2015. In comparing the monthly prices in those boxes, we find that the shale-gas revolution is bringing a lower average price (still going lower) and very much lower volatility. Compared to the last line in Table 1, gas at these prices is positioned to easily outcompete coal from four of the five regions – the two Appalachian, the Illinois Basin, and the Rockies – and often from the fifth: the Powder River Basin of Wyoming (PRB).

Fig. 3 provides added detail[4]: In 88% of the 49 months from January 2012 through January 2016, gas was ≤$4.25/MMBtu – bettering the breakeven for all Appalachian coal. For 57% of the 49 months, gas was ≤$3.50/MMBtu – bettering Appalachian, Illinois, and Rockies coal.

Even PRB coal, with its low mine-mouth costs, compared poorly with gas for the great population centers east of the Mississippi. The PRB is 2000 miles from New York and 2200 from Florida or Massachusetts. With rail transport at $0.03 per ton-mile.[5] PRB coal was as disadvantaged in the East as Appalachian coal. Add $40 or so to the circled cost in Table 1 to see that.

There are, however, two caveats with these conclusions:

[2] Table built from SNL Energy slides at U.S Rail Energy Transportation Advisory Committee meeting, 6 Mar. 2014: http://www.stb.dot.gov/stb/docs/RETAC/2014/Mar/RETAC%20SNL%20(coal)%20Mar%206%202014.pdf. Results parallel Jesse Gilbert, Coal-to-Gas Switching: It's All in the Price, Power Magazine, 30 May 2012: http://www.powermag.com/coal-to-gas-switching-its-all-in-the-price/.

[3] Figure built from Today in Energy: Average annual natural gas spot price in 2015 was at lowest level since 1999, 5 Jan 2016, EIA, http://www.eia.gov/todayinenergy/detail.cfm?id=24412#.

[4] Figure built from Henry Hub Natural Gas Spot Price, EIA, 6 Feb 2016: http://tonto.eia.gov/dnav/ng/hist/rngwhhdm.htm.

[5] "Railroads and Coal", Assn of American Railroads, Jul 2015: https://www.aar.org/BackgroundPapers/Railroads%20and%20Coal.pdf.