A brief history of coal

The decline of coal-fired power generation in North America has been widely reported. **Garrick Hoops, ABB Enterprise Software, USA,** provides a detailed look at the factors contributing to this decline and its impact on the broader energy markets.

Based on an in-depth analysis by the advisors team at ABB, the future of coal-fired generation appears to be somewhat of a mixed bag over the next several years. As utilities and independent power generators respond to the combined factors facing them, coal-fired generation will decline near term after a modest recovery in 2013 and 2014. The analysis in a recent base case scenario indicates a modest recovery in the latter portion of this decade.[1] Electric power sector (EPS) coal use will rise as dramatically increased demand for gas puts upward pressure on prices. The picture beyond 2020 is more opaque. The US Environmental Protection Agency's (EPA) proposed Clean Power Plan (CPP) aims to cut US greenhouse gas (GHG) emissions 30% by 2030.[2] According to analysis of the EPA's plan, coal's share of North American generation could fall from 35 – 37% today to 22% in 2020 (currently the first year of the plan's implementation) and to 17% by 2030.

The level of uncertainty about how and when the CPP is implemented is high. Questions about whether the EPA overstepped its regulatory authority have legal and policy experts coming down on both sides of the issue. The Republican gains in November 2014 will increase the potential for legislative action to derail or delay implementation of various EPA rules in the 114th US Congress. Perhaps most importantly, though, numerous analyses of the rule indicate that there are serious issues around many of the assumptions the EPA used to calculate state targets and important questions about grid reliability that could require substantial revision in the final version.

For better or worse this article is US-centric, simply because the vast majority of coal-fired electric generation in North America is in the US and by virtue of the potential impact of the EPA's rules on GHG emissions.

Regarding Canada, in September 2012 the Canadian federal government enacted the Reduction of Carbon Dioxide Emissions from Coal-fired Generation of Electricity Regulations. The regulations allows existing coal units up to 50 yr of operational life before they must either retire or retrofit with carbon capture and storage (CCS). The first significant retirements are expected to occur in 2019.

The decline of coal-fired generation

Evolution of natural gas as the preferred fuel for power generation

Recent history has been fraught with challenges for many operators of coal-fired resources in North America. Hydraulic fracturing, coupled with advances in data collection and analytics, as well as a supportive economic and market framework in the US, are all factors that have enabled what many label a revolution in extraction of gas and petroleum liquids from shale and tight sands formations. These geologies have widely varying estimates of ultimately recoverable oil and gas resources, but all of the estimates for gas resources are large: 45 – 90 yr at current levels of consumption. Much of the resource is expected to be available at prices that are only modestly higher than today's US prices, with high volatility made largely a thing of the past.

Of the challenges facing coal-fired power, the steep decline in the price of gas has arguably had the largest impact. Advances on the supply side of the natural gas market have reduced the average cost of gas delivered to US gas-fired power plants from US$7.10/million Btu in 2007 to US$4.35/million Btu in 2013. Gas combined cycle units compete directly with coal in the portion of the supply stack where marginal generation most often falls. They are efficient and can follow load without losing much of that efficiency. The 50+ GW of new gas combined cycle capacity added since 2007 enabled steady improvement in the overall heat rate of the fleet. This improvement in average heat rates contributed about 10% of the nearly 50% reduction in fuel costs from US$60 – 70/MWh in 2007 – 2008 to US$39.50 in 2014.

The EPA is focused on coal

The EPA's efforts to enforce the Clean Air Act over the last decade have primarily focused on cleaning up emissions from coal-fired generation. This has often been referred to as a "war on coal," though the EPA has expressed that it is simply doing its best to enforce the law. The term "war on coal" might be best applied to the very successful effort on the part of environmental organisations to challenge every new coal plant using litigation on every possible front. It is undeniable that EPA rules have made coal more expensive as a source of electric power by further reducing externalities, particularly air

pollution. Although other rules have contributed to the increased expense of owning and operating a coal-fired power plant in the US – and therefore to the decision to retire so much capacity – three rules, in particular, stand out.

The Mercury and Air Toxics Standard (MATS) is the primary factor driving retirements in the coal fleet beyond cheap natural gas. It is designed to reduce emissions of toxic air pollutants from new and existing coal and oil-fired generating facilities. Compliance options are expensive, ranging from US$500 – US$1500/kW, due to the relatively inflexible Maximum Achievable Control Technology mandate of the rule.

Regulations covering NO_X and SO_2 have culminated in the Cross State Air Pollution Rule (CSAPR). These rules have evolved over a period of 10 yr through multiple iterations via litigation and revision. They are designed to curb the transport of these pollutants across state lines and primarily affect states in the Eastern Interconnect, as well as Texas. Even as uncertainty was the reality on the ground during much of the last decade, the industry has seen an emissions control build out, which began in 2008, increase scrubbed capacity by 88 GW, with 65% of the coal fleet scrubbed in 2014. An additional 13 GW of scrubbed capacity is currently either permitted or under construction, which points strongly to continued firm pricing for high sulfur coal in the near future.

In September 2013, the EPA released its proposal for new source performance standards (NSPS) for new power plants under section 111(b) of the Clean Air Act. Under the proposal, any new coal or fossil fuel-fired units would need to meet a limit of 1100 lb of CO_2/MWh over a 12-month operating period – a level that would require the units to install carbon capture technology in order to meet the standard. With CCS technology still immature – and a great deal of uncertainty about potential cost reduction – it can be assumed that NSPS essentially negates the potential for new coal-fired generation over the next 25 yr. In May 2015, the EPA submitted its final NSPS to the Office of Management and Budget (OMB), and our expectation is that the limits for coal will be well above those in the proposal. The picture should be clearer by August.

The EPA Clean Power Plan

In June 2014, the EPA released its proposal for existing source performance standards (ESPS) and modified source performance standards based on section 111(d) of the Clean Air Act. The proposed ESPS programme identifies four building blocks to assist states in their implementation plans. The proposal seeks to reduce GHG emissions based on a CO_2 intensity lb/MWh basis with individual targets for each state by 2030. The plan also seeks interim goals beginning in 2020. The four building blocks are:

- Improve efficiency on existing coal plants by 6%.
- Improve the capacity factor on natural gas combined-cycle resources to 70%.
- Improve energy efficiency by 1.5%/yr on average (varies by state).
- Increase renewable energy generation (varies by state).

Is the first building block reasonable?

All of the building blocks reduce coal-fired generation, but let us focus on the first building block. Some experts have pointed out that the 6% figure is likely an overly optimistic assessment of potential improvements. The Electric Power Research Institute (EPRI) suggests that the actual range is closer to 0.5 – 5% on a unit net generation basis. Some of these improvements could be additive, while many others are unlikely to be.

EPRI and others have pointed out that efficiency improvement potential varies widely across states and regions, raising questions about the application of a nationwide average improvement.[3] They point to the impediment posed by increased cycling of coal plants that would be necessary under the assumptions of increased renewable penetration and increased combined cycle capacity factors. Finally, some efficiency improvements are likely to trigger the New Source Review (NSR), which would inevitably make such improvements more costly – and, in many cases, uneconomic.

Concerns about reliability

Concerns about the CPP's potential impact on reliability have also been raised by several reliability and transmission organisations. A preliminary review by the North American Reliability Corp. (NERC) raised reliability concerns regarding the rapid retirement of coal units and the associated increase in reliance on variable renewable and gas resources. The NERC also raised concerns about the aggressive assumptions on energy efficiency and the potential consequences to reliability if targets are not met, forcing additional reductions from fossil fuel generation. They suggest that the EPA's time frame may be inadequate to make adjustments to maintain bulk power system reliability. In contrast, a recent and extremely detailed PJM study concluded that sufficient grid flexibility would exist in 2026 to accommodate 30% variable renewable generation. Similar studies in California and Minnesota found sufficient grid flexibility at even higher penetrations of variable renewable generation.

Potential impact on coal-fired generation

The potential impact of the EPA's proposal is large and near at hand. If implemented as written, coal-fired generation would likely be nearly 40% lower in 2020 compared with the ABB base case. This reflects both lower capacity factors and an additional 40 GW of retirements beyond the 55 GW retired in the base case. Increased coal retirements and decreased generation could reduce coal consumption from the electric power sector by as much as 160 million t as soon as 2020. Figure 1 illustrates how this could break down among the major coal basins. As written, the plan could also require 10% more natural gas in 2020 at precisely the same time that demand for gas is expected to grow significantly from exports and new industrial demand, adding additional price pressure and volatility.

Given the obstacles to achieving coal efficiency improvements, ABB assumed that coal-fired generation would be

backed down to approximate a 6% improvement in output emissions. ABB also discovered that a US$15/t CO_2 price was necessary to meet the national reduction target. Modelling reflects the ability to retrofit existing coal facilities with CCS based on economics. However, based on current CCS cost assumptions, the level of carbon pricing does not support CCS either on existing or new coal units. This highlights the potential drawback of not providing incentives for all of the available CO_2 reduction mechanisms.

Will the CPP be challenged on a statutory basis?

Legal experts disagree over the extent to which the rule is legally defensible according to the language and precedent of the Clean Air Act. There appear to be two primary legal questions in play. One is whether the EPA has the authority to regulate CO_2 emissions under Section 111(d). The second question, which is connected, is around the definition and the EPA's interpretation of the 'best system of emission reduction.'

The EPA draws its authority to regulate CO_2 emissions based on Section 111(d) of the CAA. Section 111(d) allows the EPA to create a 'standard of performance' for existing sources not already regulated under Section 112. Existing plants are already regulated under Section 112 by the MATS rule. However, when the act was amended in 1990, separate versions of Section 111(d) were drafted and signed into law by the House and Senate. The Senate version states that the EPA does not have the authority to regulate pollutants listed under Section 112, whereas the House version disallows regulation of sources already controlled under Section 112. It is unclear at this point which version would prevail during litigation, but several legal analyses have pointed out that legal precedent does not appear to be in the EPA's favour.[4]

The cornerstone of the EPA's proposal is in its interpretation of the best system of emission reduction. The agency has written the new rule with the intention of reducing emissions from an interconnected electricity system, which allows a great deal of flexibility in how emissions are reduced. Opponents argue that this approach has no real precedent and that the EPA has been inconsistent in applying the definition of a best system, taking a source-specific approach to CO_2 emissions in the NSPS, while applying a different definition of 'system of emission reduction' in the CPP. The impending legal battle will almost certainly delay implementation, but the likely outcome of the courts is far from clear and may depend as much on who is chosen to hear the case as on the content of the legal arguments presented.

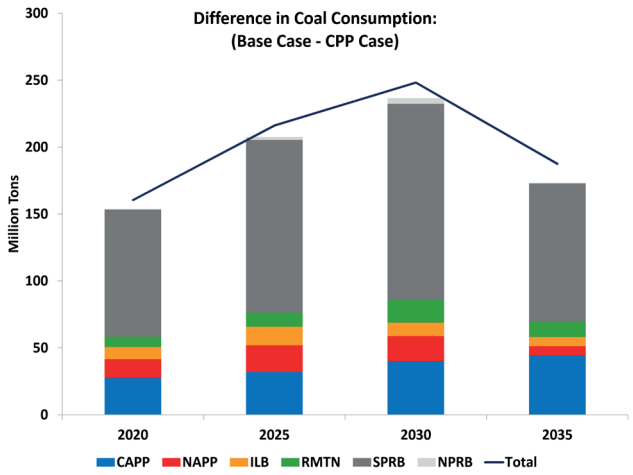

Figure 1. Difference in EPS coal consumption by basin in million short t (Base case - Clean Power Plan Case).
Source: ABB Advisors.

Uncertainty rules the future

Since interest in developing coal-fired generation assets in North America peaked in 2007, uncertainty has been the defining challenge faced by operators of those assets. The high degree of uncertainty and cost pressure show no signs of abating. The developments associated with the decline of coal are beginning to reshape the power generation landscape. Costs for renewable power generation and electricity storage continue to fall. There are competent analyses, which indicate the potential for cost parity with modern coal plants by mid-2020s to early 2030s. The EPA's CPP appears to be far from perfect; it may end up tied up in court battles for some time or may contain substantial revisions when the final version is announced in August. However, even if tied up in litigation, it will pressure coal-fired asset valuations and continue to pressure coal demand and prices. For the foreseeable future, therefore, new coal plants in both the US and Canada are a virtual impossibility without CCS. Yet CCS has little chance of moving to market in the absence of a price signal for capturing and sequestering the CO_2 or substantial additional support for moving to the initial commercial scale-up phase of development . WC

References

1. The ABB Power Reference Case product is a fundamentals-based, 25 yr forecast of the electric power sector in North America. It includes a base case that represents the most probable trajectory for North American power markets.
2. The US also recently signed a bilateral agreement to targets on greenhouse gas emissions where it committed to EPS reductions on par with the requirements in the CPP, adding to the commitment to cut emissions.
3. See EPRI : http://www.epri.com/Pages/EPRI-Comments-On-Proposed-Clean-Power-Plan.aspx
4. POTTS, B, H. and ZOPPO, D, R., 'EPA's Clean Power Play: Who Needs Congress?' (June 10, 2014). *The Electricity Journal* (July 2014). Available at SSRN: http://ssrn.com/abstract=2448217

Editor's Note

This article was written before the US Supreme Court ruled the EPA had been unreasonable in refusing to take the cost of compliance into account when deciding to regulate toxic air emissions from coal-fired power plants. The ruling sends MATS back to the EPA for revision but as the deadline for compliance has already passed, its impact on coal-fired power plant closures is expected to be limited.