

ENERGY

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GKS INSIGHT REPORT: COAL UNIT 10-YEAR COST & PERFORMANCE ANALYSIS

REPORT BACKGROUND

The electric generation industry has seen enormous challenges and undergone significant change in the last several years. In particular, coal units have been impacted as much as any sector. Currently, the average age of operating coal units is well over 40 years old and the construction of new coal-fired plants will be rare, given the new regulations in place. With few new coal plants coming online, the average age of the US coal fleet will continue to increase.

Environmental regulations represent one area that has driven significant change for these units, requiring additional capital investment, increased operating costs, and reduced usage. Additionally, the advent of lower natural gas prices from the fracking-generated "gas renaissance," the growth and use of renewables, and general market demands for lower costs and more flexibility in dispatch regimes have had additional impacts on how coal plants are operated. These developments have driven coal units to seek new ways to reduce costs, maintain reliability, and continue to remain profitable.

Using our proprietary Generation Knowledge Service (GKS) database, Navigant Consulting, Inc. (Navigant) has analyzed the 10-year (2004–2013) cost and performance trends for US coal plants. While the headlines for this analysis will not come as a shock to anyone (usage and maintenance spending at coal units has gone down and unplanned outages have gone up), the actual quantification of these changes places the impact in a different perspective regarding the current operating challenges, system reliability, and potential future of coal generation in this country. It is also important to view these operating changes from an industry perspective. If not planned and prepared for, the changes can adversely affect available capacity and system reliability. For example, American Electric Power reported to shareholders that of the coal plants slated to be shut down in 2015¹, 89 percent ran during the 2013/2014 polar vortex.

Europe provides an even better understanding of what the potential impact could be if industry changes are not factored into the overall planning horizon. The European community has been ahead of the United States in the use of variable renewable resources, primarily wind generation, which has contributed to the curtailment of coal-fired generation. The United Kingdom has experienced the impact of fewer operating coal-fired plants as recent as the 2013/2014 winter season, when reserve margins dropped to levels that are concerning from a reliability standpoint. This drop in reserve

^{1/} <http://www.americaspower.org/sounding-alarm-epa-s-reliability-claims>

margins was driven, in large part, by the shutdown or retirement of operating coal units either directly related to the cost of meeting environmental standards or due to the lack of a well-defined capacity market. This loss of capacity drove National Grid to implement their Supplemental Balancing Reserve program, which provides economic incentives to power plant owners to bring mothballed or closed power stations back online, to increase the forecast reserve margin of 4.1 percent to 6.1 percent and improve overall system reliability.

Similarly, emphasizing the necessity of keeping various energy options in the market, Tony Alexander, CEO of FirstEnergy, told an audience at the US Chamber of Commerce, “We need to maintain a diverse fleet — including real generating assets such as coal, nuclear, and natural gas — to ensure reliable, affordable service over the long term.”

ANALYSIS METHODOLOGY

In conducting this analysis of the cost and performance trends for coal units, Navigant selected all US coal units within GKS with continuous cost and performance data for the 10-year period (2004–2013). This resulted in data for 316 operating coal units representing more than 127,000 megawatts (MW) of capacity. Table 1 shows the various groups analyzed.

Table 1. Coal Unit Characteristics

SIZE GROUP	# OF UNITS	MEDIAN AGE	MEDIAN SIZE	TOTAL MW
All Coal	316	48	301	127,500 MW
0–200 MW	102	59	138	13,400 MW
201–500 MW	103	49	271	32,300 MW
>500 MW	111	39	676	81,800 MW

In analyzing the data, Navigant used a capacity weighted 12-month moving average method to provide a smoothing impact on the analysis results. To mitigate the potential impact of inflation we adjusted all costs to 2013 constant dollars.

Using the cost and performance data from GKS, Navigant prepared an estimate of the average production impact of these changes for each size grouping, which identifies the opportunities to generate revenue and thus provides an overall impact to unit economics.

In a subsequent analysis, Navigant will look at the trends for planned outages and the major drivers of unplanned outages to discern potential insights into how the coal plant operators are responding to these regulatory and market changes and what the primary drivers of the reduced availability might be.

ANALYSIS SUMMARY

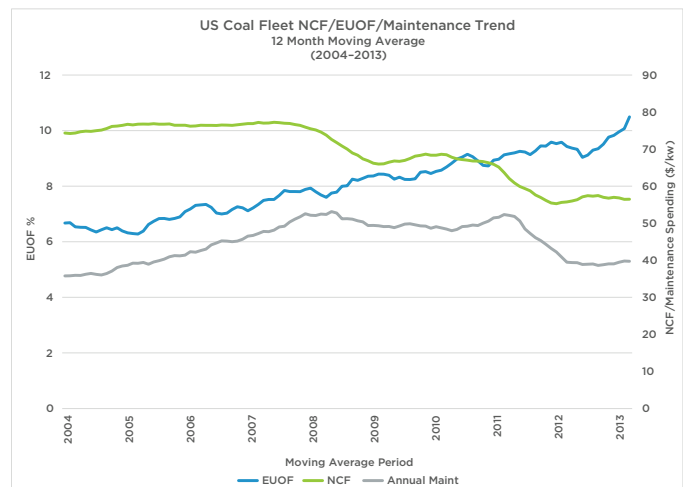
The analysis representing all 316 coal units resulted in the following major findings:

1. Overall coal plant usage as measured by Net Capacity Factor (NCF) has declined from 74.3 percent in 2004 to 56.5 percent at the end of 2013. The smaller units saw the largest decrease, as the group of large units experienced a more muted impact.
2. Overall maintenance spending (in dollars per kilowatt \$/kW) was \$35.77/kW in 2004, rose to \$52.07/kW in 2008 and dropped to \$39.74/kW in 2013.
3. The level of unplanned outages, as measured by Equivalent Unplanned Outage Factor (EUOF), has risen from 6.7 percent in 2004 to 10.5 percent in 2013, an increase of over 57 percent.

It appears that increased EUOF, due in part to the aging of the units and overall decline in maintenance spending, and market conditions (i.e., market pricing, consumer demand, environmental requirements, etc.) are the primary drivers of changes in usage. These impacts on average unit production for the US coal fleet equates to nearly a 24 percent decline over the last 10 years with the majority of that decline occurring since 2008. While all three size categories were negatively impacted, the majority of this decline was seen in the small and mid-size units, with the large group dropping nearly 19 percent, the mid-size group falling nearly 30 percent and the small group falling over 45 percent, in the 10-year period. Figure 1 provides the graphical representation of the analysis for the overall US coal fleet on the three measures of NCF, EUOF, and maintenance spending.

It is difficult to imagine any other industry absorbing a production decline of this magnitude without requiring major changes in how assets are managed. Excellence in operation and maintenance of these units will be required for coal plants to remain an economically viable portion of electricity production going forward.

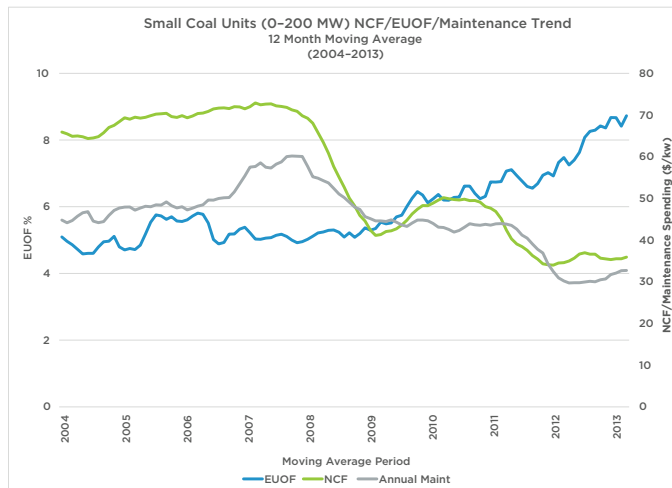
Figure 1. NCF/EUOF/Maintenance Spending Trends



SMALL COAL UNIT (0 – 200 MW) RESULTS

The small coal unit group consisted of 102 units representing 13,400 MW of capacity, a median Net Maximum Capacity (NMC) of 138 MW, and a median age of 59 years. As one could expect, the smaller and older units showed the steepest decline in NCF levels, falling from a high of nearly 66 percent in 2004 to 36 percent in 2013. During this period, these same units had a 27 percent decline in maintenance spending. However, the drop in maintenance spending from 2008–2013 was nearly 41%, falling from \$55.19/kW to \$32.71/kW. Unplanned outages, as measured by EUOF, rose from just over 5 percent in 2004 to nearly 9 percent in 2013, over a 70 percent increase. Figure 2 shows that approximately a year after maintenance spending started to decline, EUOF steadily increased to the current level.

Figure 2. Small Coal Units NCF/EUOF/Maintenance Spending Trends



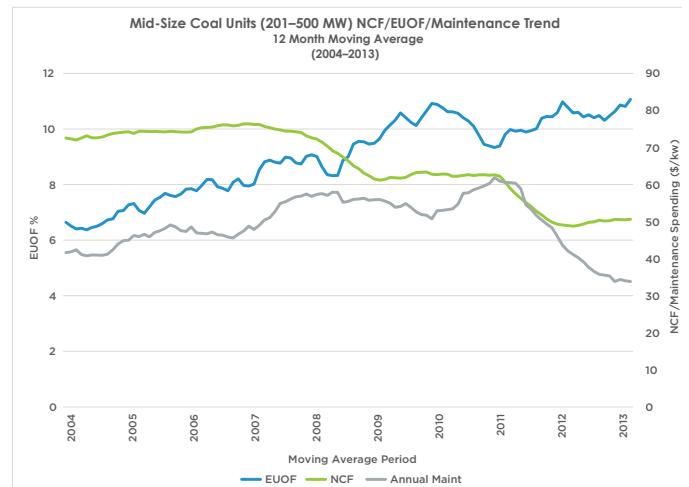
Planned outages for this group had remained relatively steady around 5 to 6 percent until 2012 when they began declining to the current level of 2.5 percent. The decline in NCF levels for these smaller units equates to a 45 percent reduction in gross production opportunities. Absent a robust capacity market, this decline will certainly play into the economic viability calculations of many, if not most, of these units.

MID-SIZE COAL UNIT (201 – 500 MW) RESULTS

The mid-size coal unit group consisted of 103 units representing 32,300 MW of capacity, with a median NMC of 271 MW, and an average age of 49 years. The usage of the mid-size units dropped over 30 percent (73 percent to 51 percent), EUOF increased 67 percent (6.6 percent to 11.1 percent) and maintenance spending

declined by 19 percent (nearly \$42 to \$34). Figure 3 shows the largest portion of these changes began in 2010, with changes occurring more gradually from 2004 to 2010.

Figure 3. Mid-Size Coal Units NCF/EUOF Maintenance Spending Trends



LARGE COAL UNIT (> 500 MW) RESULTS

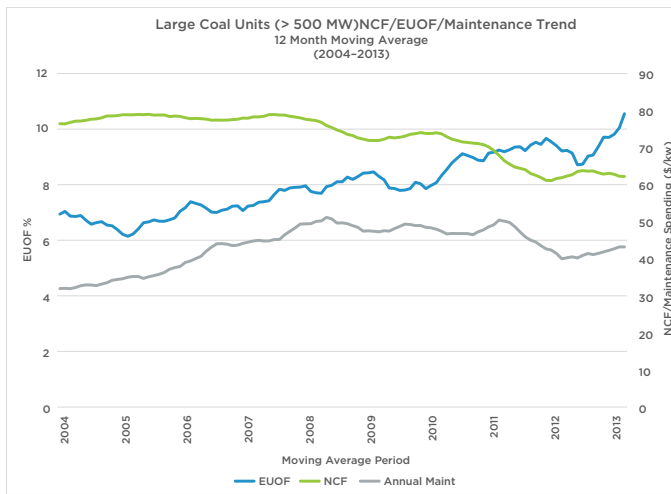
The large coal unit group consisted of 111 units representing 81,800 MW of capacity, with a median NMC of 676 MW, and an average age of 39 years. The large coal units have seen the least decline of overall usage and an actual increase in maintenance spending.

The reduction of NCF levels for the 10-year period dropped only 19 percent (76.4 percent to 62.2 percent). Maintenance spending for this group actually increased by more than 35 percent, from \$31.95/kW in 2004 to \$43.21/kW in 2013.

However, in the last five years (2008–2013) maintenance spending actually declined by nearly 13 percent dropping from \$49.48/kW to \$43.21/kW.

Even with the overall increase in maintenance spending, EUOF levels increased by 52 percent — rising to 10.55 percent in 2013 from 6.9 percent in 2004. Planned outages during the period rose from 7.0 percent to 8.8 percent. Even with a moderate decline in levels of usage, this rise in EUOF would seem to offer generators an opportunity to seek ways to reduce the level of unplanned outages, and improve availability and overall profitability.

Figure 4. Large-Size Coal Units NCF/EUOF Maintenance Spending Trends



CONCLUSIONS

As demonstrated in this report, coal units of all sizes have seen and will continue to see challenges in successfully managing their assets. The decline in overall usage and thus a decline in the opportunity to generate revenues, seems destined to continue.

While coal-fired plants will be part of the generation mix in this country for the foreseeable future, absent a significant reduction in natural gas production, an easing in environmental regulations (clean air, carbon, etc.) or some other significant event, there will be continued cost and performance pressures on coal plant operators. Operators who demonstrate performance excellence in the following areas are most likely to survive:

- Minimizing fixed costs (especially staffing)
- Minimizing variable costs (especially operational heat rate and scrubber efficiency)
- Maximizing operating flexibility, including low load operation, load following and starting reliability
- Maximizing commercial, as opposed to technical, availability
- Allocating scarce capital resources to the most commercially viable projects
- Preventing failure through implementation of an effective condition based maintenance program

The larger coal units would seem to offer the best alternative for coping with these challenges, while the small units will be the most likely group to see continued decline in usage and value, driving an increased number of unit retirements. The mid-size group may also hold an opportunity for value in the market place if a robust capacity market exists to derive value from these assets.

Finally, as the use of coal plants decline and retirements rise, an increase in gas-fired generation is likely to occur. However, in the next several years any central generation station will likely see a significant change in its role as distributed generation and renewable resource technology drive fundamental change in this part of the industry.

As noted earlier, a follow-up data analysis focused on the more detailed performance drivers will be completed by Navigant with an expected publication of the results in the second quarter of this year.

NAVIGANT'S GLOBAL ENERGY PRACTICE

Navigant's Global Energy Practice includes more than 400 experts focused on issues across the entire energy value chain including renewables, climate change, energy efficiency, demand response, emerging technologies, global oil and gas, generation, resource procurement, transmission, markets, performance improvement, fuel sourcing, rates, and regulation, as well as providing energy market research reports in the areas of clean technologies, smart grid, and emerging energy-related markets. More information about Navigant's Energy Practice can be found at navigant.com/energy.