

Combined Cycles

Middle Age Myths

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Introduction

Combined cycle plants may have fewer moving parts than coal plants, but that doesn't mean that their operations are any easier to analyze.

- ◆ Less experience with the equipment means less data is available to analyze
- ◆ Merchant operators might not report much data at all
- ◆ Data that is available is often housed in tools designed with coal plants in mind



Relatively limited operating experience and sparse data allows beliefs to take root – some well-founded and others less so. This report takes a quick look at three such beliefs and offers some tantalizing, although preliminary, observations on:

- ◆ Do higher capacity factors really result in lower non-fuel costs?
- ◆ Do older units that start more frequently have higher non-fuel costs?
- ◆ Do merchant operators do a better job of cost containment compared to rate base operators?

This is the first in what will be an ongoing series of reports exploring cost and reliability issues in fossil generation.

Gas Fired Combined Cycle Costs by Vintage

For this analysis we examined non-fuel O&M costs¹ for all gas-fired 2x1 combined cycle plants commissioned between 2000 and 2007.

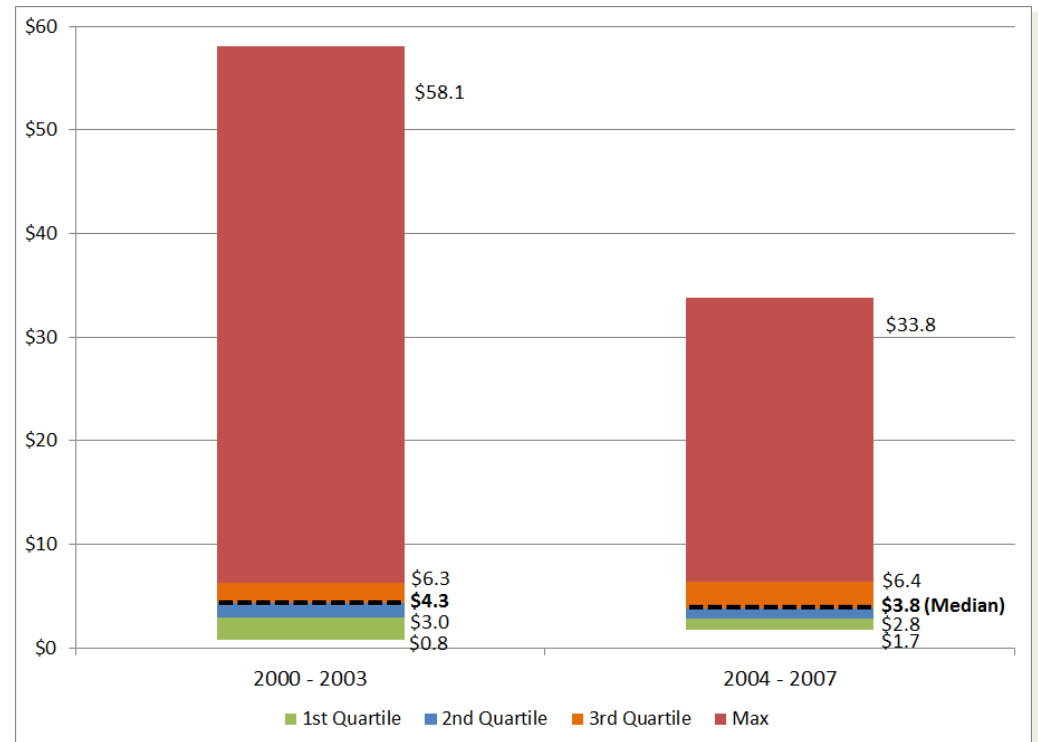
- ◆ We divided the plants into two vintages, corresponding roughly to the initial and later build out cycles
 - 2000-2003 includes 121 plants and 300,000 MWs
 - 2004-2007 includes 52 plants and 130,000 MWs

We expected the analysis to show older plants had higher costs. What we found was that older plants had a greater range of costs – higher and lower than new plants.

- ◆ Were capacity factors influencing the results?
- ◆ How did the vintages differ in the number of starts per year?
- ◆ Were there cost differences between rate-base and competitive market plants?

So, we dug deeper, and what we found was a little surprising...

Five Year Average Annual Non-Fuel O&M (\$/MWh) Costs by Vintage



¹For the remainder of this report, “costs” will refer specifically to five year average (2007-2012) non-fuel O&M costs which includes both fixed and variable components of O&M

Sources: Ventyx Energy Velocity, ScottMadden Analysis

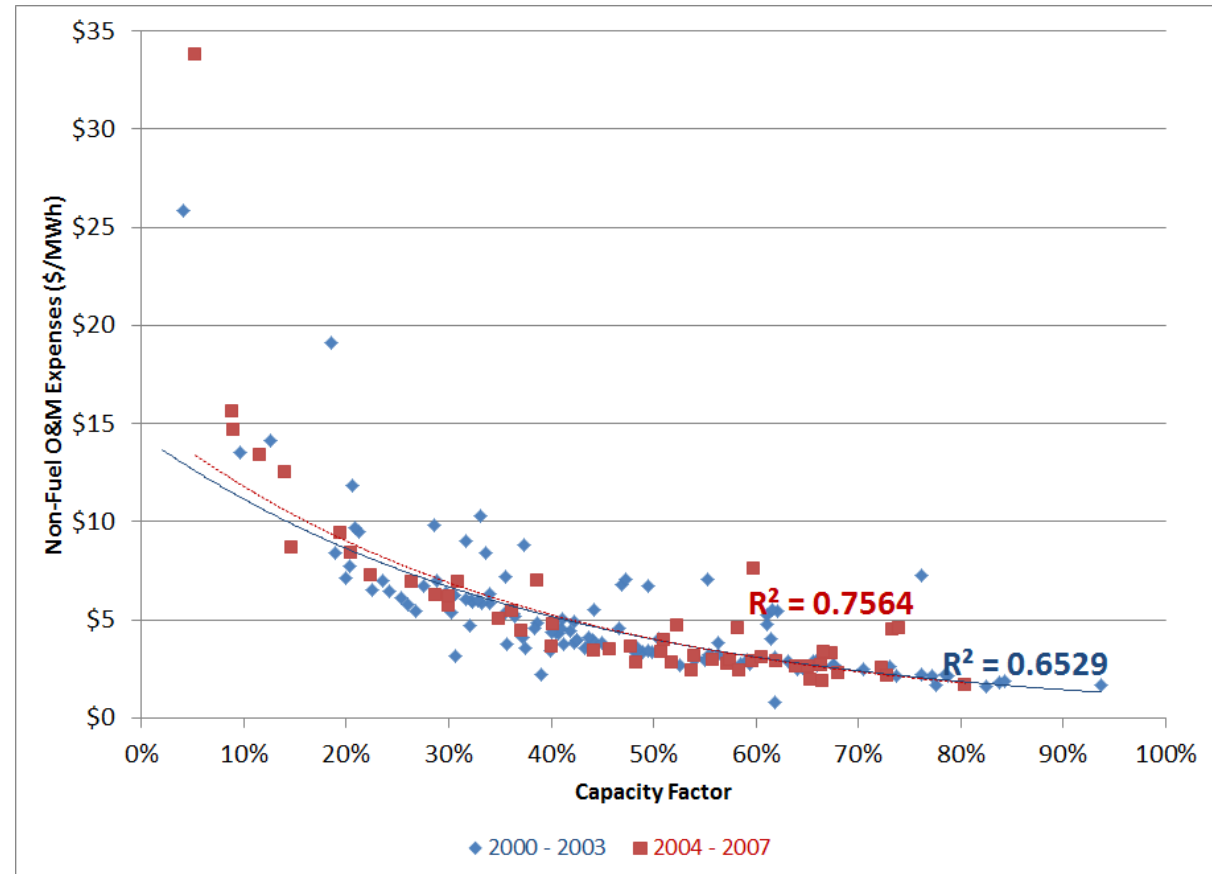
Costs and Capacity Factor

Capacity factors can be complicated to interpret due to dispatch order effects, but in general we would expect to observe some decrease in costs with higher capacity factors (spreading fixed costs over more MWhs).

- ◆ We observed strong relationships between capacity factor and costs for both vintages
- ◆ More high-side variability in costs appeared to occur when capacity factors dropped below 40% for both vintages
- ◆ The strength of this relationship appears stronger for newer plants compared to older plants, perhaps due to less variability in costs in the 20-40% capacity factor range
- ◆ We also investigated heat rates, but we did not observe either a meaningful relationship between heat rate and costs, or a significant difference between vintages

So, yes, higher capacity factors are strongly correlated with lower costs.

Capacity Factor (%) vs. Non-Fuel O&M (\$/MWh)



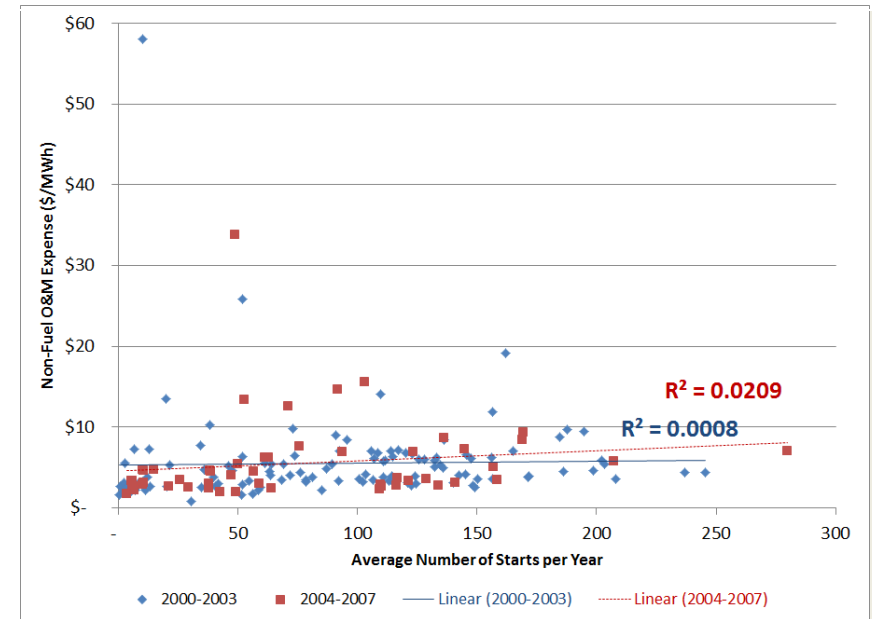
Sources: Ventyx Energy Velocity, ScottMadden Analysis

Cost Implications of Starts and Capacity Factor

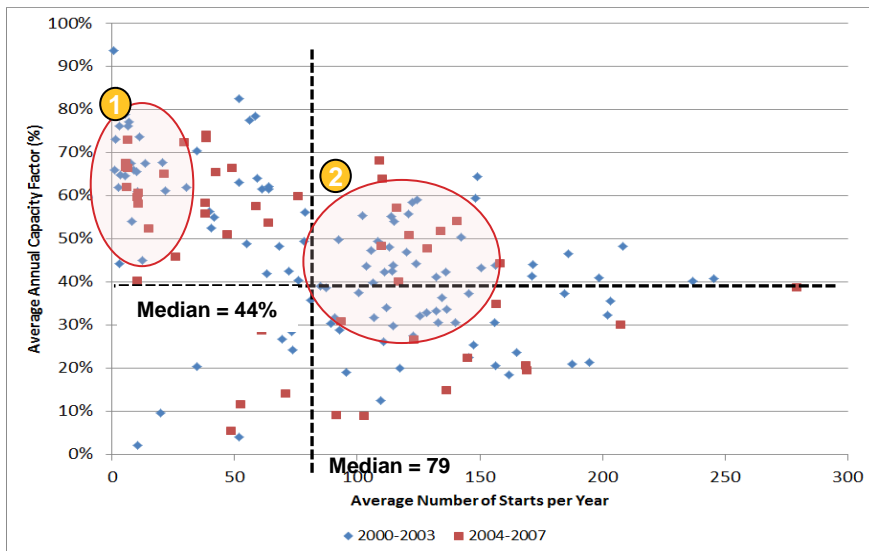
The number of starts per year is cited frequently as a root driver of higher costs, due to thermal cycling stress, accelerated long-term service agreement (LTSA) costs, etc. The data, however, show otherwise.

- ◆ There does not appear to be a meaningful relationship between starts and costs. In fact, there is a surprising degree of variability in costs along all levels of starts
- ◆ Of the plants with costs > \$10/MWh, we found that a disproportionate number are operated by municipalities, cooperatives, and public power. These high cost plants also represent a significant proportion of the fleet operated by this type of utility, which raises some interesting questions
 - Is this due to smaller fleet sizes? Workforce challenges?
 - Is contracting less effective compared to large utilities?

Number of Starts vs. Non-Fuel O&M (\$/MWh)



Number of Starts per Year vs. Capacity Factor (%)



There does not appear to be a strong relationship between the number of starts and capacity factor, but a few potential patterns do emerge – with new and old units equally represented in each.

- ◆ The plants clustered in bubble #1 (n=26) appear to be running in a baseload mode, starting less frequently and running more often
- ◆ The plants clustered in bubble #2 (n=35) appear to be running in more of a cycling pattern, starting between 100-150 times per year and achieving capacity factors of 30 to 60%
- ◆ Properly benchmarking combined cycle plants may be as dependent on dispatch mode as vintage

Sources: Ventyx Energy Velocity, ScottMadden Analysis

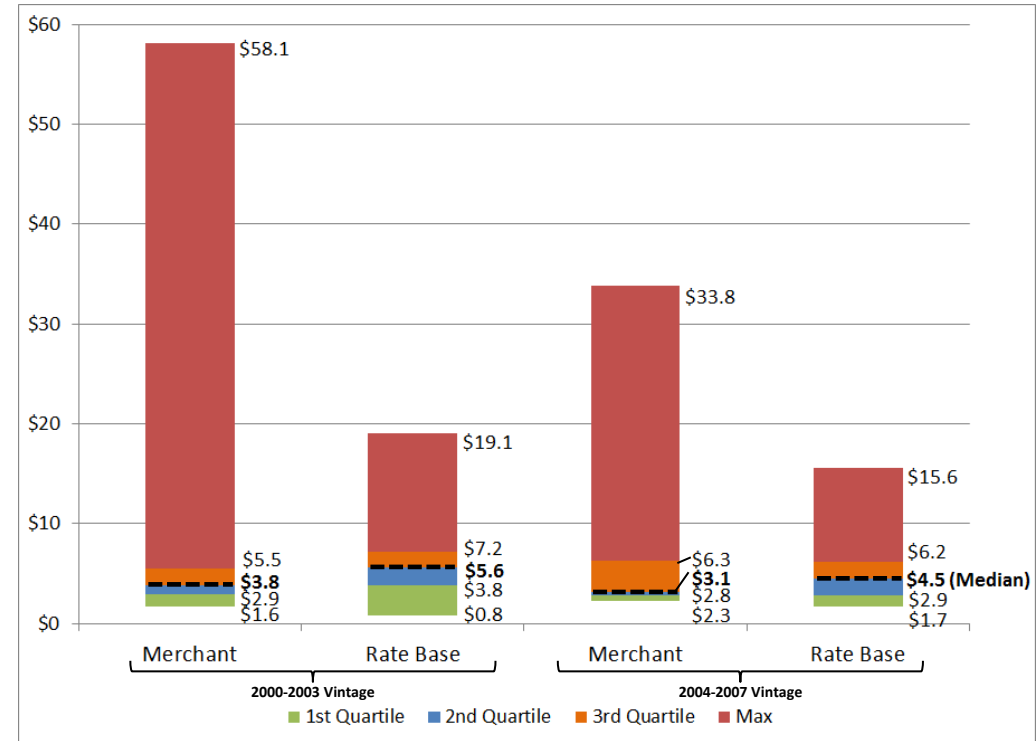
Cost Patterns by Operator Type

It was expected that the highest costs belonged to older plants, though it was interesting to see that those plants belonged to merchant operators.

- ◆ Rate base plants show a smaller range of costs compared to merchant plants, regardless of vintage
 - Median costs for newer rate base plants are approximately 20% lower than older rate base plants
 - Comparing newer plants, rate base median costs were about 45% higher than merchant plant costs

- ◆ Merchant plants as a group exhibited lower median costs than rate base plants, regardless of vintage, but a much wider range of costs, specifically on the high end
 - Older 1st quartile merchant plants showed a substantial cost advantage compared to older 1st quartile rate base plants, but a much smaller advantage compared to newer plants
 - One possible explanation for the more narrow range in costs above the median for rate base plants is that rate base operators could have been more aggressively capitalizing O&M expenditures as maintenance capital

Five-Year Average Cost – Merchant vs. Rate Base



Sources: Ventyx Energy Velocity, ScottMadden Analysis

So, merchant plants show lower median costs than same vintage rate base plants, but merchants also show a greater range in costs compared to rate base plants.

The effects of maintenance practices, lessons learned, dispatch order, and the specifics of power purchase agreements are additional key factors driving costs.

Summary and Close

Summary

- ◆ Capacity factor has a strong positive relationship with costs, which is essentially the same for new plants and older plants alike
- ◆ The number of starts does not demonstrate a meaningful relationship with combined cycle costs
- ◆ The mode of operation appears to have a stronger impact on costs than vintage for combined cycle generators
- ◆ Merchant and rate base plants appear to have very different challenges and opportunities
- ◆ Age is not destiny – A well-planned and executed maintenance strategy likely sets the foundation for long-term low-cost operations
- ◆ This analysis, which contained a few surprises, underlines the importance of thoughtful, fact-based construction of peer groups when benchmarking combined cycle plants

Considerations

- ◆ This is a high-level, illustrative analysis of costs for combined cycle generators in the U.S.
- ◆ Before setting performance targets or engaging in business planning initiatives, ScottMadden recommends a more thorough benchmarking analysis tailored to the unique characteristics of a particular fleet
 - We recognize that benchmarking is both an art and a science, and we typically construct unique peer groups for each unit to ensure defensibility with a like-in-kind basis of comparison
 - We work closely with our clients to ensure buy-in and support of benchmarking analysis results throughout the enterprise
 - We have significant experience, having conducted benchmarking analyses for numerous clients, representing nearly 100 plants throughout North America
- ◆ ScottMadden's [*Quick Fossil Benchmarking Analysis*](#)[®] is designed to help you further explore cost and reliability questions or concerns

To learn more, please contact one of our experts

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