A Review of the Commitment and Dispatch of Coal Generators in MISO

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I. Introduction and Summary

Potomac Economics has worked as the independent market monitor for the Midcontinent ISO (MISO), the New York ISO (NYISO), ISO New England, and ERCOT for the past 20 years. In these roles, we monitor the conduct of the generators and competitive performance of the markets. This report addresses questions raised recently about the economic commitment and dispatch of coal-fired resources in MISO.

Importantly, we limited the evaluation in this report to the operating decisions made by resource owners. We do not evaluate the longer-term decisions to retire coal resources or to keep them in operation. Our annual *State of the Market Report* provides a number of analyses that illuminate the performance of the MISO markets in facilitating efficient coal resource retirement decisions.[1]

For this report, we performed an economic analysis of unit commitment and dispatch of all coal-fired resources over two timeframes: from 2016 through 2018 and in 2019. This analysis includes a detailed review of actions taken by coal-fired resources to: a) start up the resources from an offline state and b) remain online each day after starting up.

Our analysis identifies the extent to which the resource owners' operating actions are economically efficient. Efficient actions can appear unprofitable in certain timeframes. Hence, we also separately evaluate the profitability of the decisions made by coal resource owners to start up and shut down the resources. The results of this evaluation are shown in Section II and our conclusions are discussed in Section III.

Summary of Conclusions

We find that the decisions of the owners of coal resources to start them or to keep them online have generally been efficient, even when they are not profitable and are generating negative operating net revenues. These results cast serious doubts on the credibility of the recent studies asserting that MISO's coal-fired resources are routinely starting and operating uneconomically. Other conclusions and recommendations in this report include:

- Coal resources operated by merchant utilities differ from those operated by MISO's integrated utilities, which underscores the fact that regulatory incentives can weaken the natural discipline of the competitive markets.
- The dispatch of coal-fired resources varies significantly among the integrated utilities.
  - A substantial share of the integrated utilities operate almost as efficiently as their merchant counterparts.

[1] See the Existing Capacity at Risk analyses in Chapter 6 in the main body and Analytic Appendix of the *2019 State of the Market Report*, Potomac Economics Ltd., June 2020.

- Unfortunately, a small share of integrated utilities operate much less efficiently than others.

Although we find that the decisions to start and continue operating coal resources in MISO have generally been economic, there is clearly room for improvement. We encourage the integrated utilities that own coal resources to adopt improvements in their operating procedures that increase the efficiency of their commitments and dispatch. We also recommend that MISO consider providing additional information that may facilitate more efficient decisions by the resource owners. Three key improvements include:

i. *Offering Economically in the Day-Ahead Market*. Offering the resources economically more frequently in the day-ahead market would allow the market to guide efficient shutdown decisions. Since MISO's day-ahead market is a reasonably good predictor of upcoming market conditions, allowing the day-ahead market to economically schedule is an efficient means to make decisions that have multi-day implications. This explains why this is the typical approach employed by merchant owners of generating resources.

ii. *Seasonal Outages*. Some of MISO's regulated utilities are beginning to adopt improvements in operating procedures, such as taking extended outages during shoulder seasons when the resources are much less likely to be needed or economic. This would likely be beneficial for a number of utilities to consider.

iii. *Additional Forward Price and Outage Information*. We encourage MISO to consider providing additional forward information on prices and key outages that would improve coal resource owners' ability to determine when their resources will be economic to operate. This could include publishing all 36 hours of prices produced by its day-ahead market, rather than limiting the prices published to the first 24 hours.

II. COAL COMMITMENT AND DISPATCH IN MISO

This section provides an economic evaluation of two principle issues: the actions of coal resource owners to commit their resources from an offline state, and the decisions of these owners to keep these units online after they are committed. We separate these two issues because the economic factors relevant in each context are very different.

A. Evaluation of Commitment Patterns

The first area we evaluate is how offline coal resources have typically been committed and the extent to which these commitments have been profitable. Concerns have been raised that the owners of coal resources in MISO have been compelling MISO to start coal units uneconomically by designating them as "must-run".[2]

We screened every coal unit commitment between 2016 and 2019 and identified commitments as being economic when the committed resources had been:

- Offered economically and scheduled in the day-ahead market; or
- Offered in with a must-run status and were profitable – generating revenues that covered their commitment and variable operating costs by the first full day after the commitment.[3]

Table 1 summarizes the results of this evaluation in two timeframes – 2016 through 2018 and 2019. We separate the timeframes because natural gas prices had been falling and were at relatively low levels in 2019, resulting in a concomitant reduction in energy prices. Since coal prices have not changed substantially, this trend has caused coal resources to be less profitable in 2019, making it more difficult for the owner to determine when they may be profitable to start.

Table 1: Evaluation of Coal Resource Commitments
2016-2019

	2016-2018		2019	
	Starts	**% of Starts**	**Starts**	**% of Starts**
All Coal Resources	5859		1795	
Profitable Starts	5266	90%	1497	83%
Offered Economically	*2552*	*44%*	*730*	*41%*
Must-Run and Profitable	*2714*	*46%*	*767*	*43%*
Unprofitable Starts	593	10%	298	17%
Not Expected to be profitable	*473*	*8%*	*234*	*13%*
Expected to be profitable	*120*	*2%*	*64*	*4%*

2 See: *Playing with Other People's Money*, Sierra Club, October 2019 and *Used, But How Useful,* Union of Concerned Scientists, May 2020.

3 The resources' start-up costs are determined based on how long the resource has been offline – cold vs. hot start-up costs. The start-up costs are amortized over five days – a minimum typical cycle for coal resources.

Profitable Commitments and the Value of a Multi-Day Market

Based on the screens described above, we found that 90 percent of the more than 5,800 resource commitments in the 2016-2018 timeframe were profitable (either committed through the markets or self-committed as must run and profitable by the end of the first day). As energy prices have fallen more recently, this percentage decreased to 83 percent in 2019. In both timeframes, roughly half of the profitable commitments were associated with economic offers scheduled in the day-ahead market, while the other half were profitable must-run commitments.

While some have called for a multi-day market to optimize the commitment of resources that tend to cycle over multiple days, we do not find this to be necessary. The analysis above demonstrates that many coal resource owners are able to commit their resources by offering economically in the day-ahead market. To the extent that conditions are stable, so that tomorrow's prices are a good predictor of future days, one can rely on the day-ahead scheduling optimization to commit resources efficiently that cycle over multiple days. Importantly, we are not confident that the forecasted inputs would be accurate beyond the first day, or that market participation would be sufficiently liquid to produce efficient prices and schedules more than one day out.

Unprofitable Commitments. The remaining commitments that were unprofitable constituted 10 percent in the earlier period and 17 percent in 2019. In some cases, resource owners may have expected that their units would be economic to commit based on the prices that prevailed on the day prior to the commitment. This accounts for roughly one fifth of the unprofitable commitments, which would have earned positive economic margins had the prior day's pricing prevailed.

Hence, less than 10 percent of the coal commitments between 2016 and 2019 were self-commitments by owners on days when the units were not profitable and were not likely to be profitable given prevailing prices. While this indicates room for improvement, we find that the vast majority of coal resource commitments were profitable.

Evaluation of Commitments by Type of Owner

We also evaluated whether the commitments of coal resources owned by vertically-integrated utilities, which constitutes most of the commitments, were efficient relative to commitment of coal resources owned by unregulated merchant utilities. Table 2 shows the same results as Table 1, except that the results are separated by the type of unit owner.

Table 2: Evaluation of Coal Unit Commitments by Type of Owner
2016-2019

	2016-2018		2019	
	Starts	**% of Starts**	**Starts**	**% of Starts**
Integrated Utilities	5324		1629	
Profitable Starts	4756	89%	1331	82%
Offered Economically	*2271*	*43%*	*567*	*35%*
Must-Run and profitable	*2485*	*47%*	*764*	*47%*
Unprofitable Starts	568	11%	298	18%
Not Expected to be profitable	*451*	*8%*	*234*	*14%*
Expected to be profitable	*117*	*2%*	*64*	*4%*
Merchants	535		166	
Profitable Starts	510	95%	166	100%
Offered Economically	*281*	*53%*	*163*	*98%*
Must-Run and profitable	*229*	*43%*	*3*	*2%*
Unprofitable Starts	25	5%	0	0%
Not Expected to be profitable	*22*	*4%*	*0*	*0%*
Expected to be profitable	*3*	*1%*	*0*	*0%*

Only 535 unit commitments in 2016-2018, or roughly 10 percent of all commitments, were made by merchant suppliers. These non-regulated suppliers have stronger incentives to only start their resources when profitable because their revenues are primarily determined by the MISO market outcomes. Our analysis showed that 95 and 100 percent of these merchant resource commitments were profitable in the 2016-2018 and 2019 timeframes, respectively.

One reason the merchant commitments are more often profitable than the commitments made by vertically-integrated utilities is that a much higher share of the merchant coal resources are offered economically in MISO's day-ahead market, allowing MISO to commit them based on day-ahead prices. Indeed, 98 percent of the commitments made in 2019 were offered economically. The increase in this ratio in 2019 was likely due to the fact that it has become more difficult to determine when a coal unit will be profitable as natural gas prices have fallen, bringing many gas-fired resources into economic parity with coal resources.

This change in behavior was not adopted by the integrated utilities in 2019, which continued to rely heavily on the must-run designation when starting their resources. As a result, the unprofitable starts by vertically integrated utilities grew in 2019 to 18 percent.

Overall, this analysis indicates that owners of coal resources generally started them at times when the resources would initially be profitable to operate. However, the efficiency of the commitments would be higher if vertically-integrated utilities were willing to offer their offline coal resources economically in MISO's day-ahead market like their merchant generator counterparts.

B. Evaluation of Daily Decisions to Operate Coal Resources

The prior section focuses specifically on the decision to start up coal-fired resources. While this is an important decision, the vast majority of the energy output and revenues are associated with the days when coal resources are already online. In this subsection, we evaluate the daily decisions by owners of coal-fired resources to operate their resources. This includes making the economic determination regarding when to shut down an online coal resource, which can be much more difficult than the decision to start-up the resource, as we describe in this subsection.

Efficiency and Profitability of Operating Decisions

The various tables we present differentiate these decisions on the basis of whether they are efficient and whether they are profitable. Efficient decisions are generally profitable, but not always. We define the decision to operate a coal unit as efficient based on the following criteria.

- A decision to start a coal resource is efficient on the first day of operation if it was profitable to commit the resource as described in the prior subsection.
- Once online, a daily decision to operate is efficient if any of the following is true:
    i. The unit's net energy and ancillary services revenue is positive (i.e., it is profitable);
    ii. The unit's net energy and ancillary services losses are smaller than its expected cycling costs (as described later in this section);
    iii. The unit was economic to commit and is within its minimum runtime.

Cycling costs are very important to consider when evaluating a resource owner's decision to remain online. Cycling costs include the start-up costs the unit would have to incur to run in future periods, as well as any foregone positive net revenues while the resource is offline for its minimum downtime.

It can be economic for an owner to incur a small loss to stay online and avoid the costs of "cycling the resource", i.e., shutting the unit down and starting it back up later. More precisely, we calculate cycling costs that include the unit's intermediate start-up costs plus anticipated foregone net revenues during the unit's minimum downtime.[4]

In making this daily decision to remain online, the losses a rational owner would be willing to incur to avoid cycling the unit will be lower if it has incurred losses on prior days. Therefore, to evaluate this trade-off, one must determine the portion of the cycling costs the owner will consider in deciding to remain online. This determination must account for whether the resource has been and is expected to be economic to remain online.

[4] The foregone net revenue is based on the net revenue in the prior day if it is positive, or zero if it is not.

In this study, we adopted a methodology based on the trailing five days. We amortized the cycling costs over the number of days in which the unit was unprofitable over the preceding five days. Hence, a resource that has been unprofitable for either 0 or 1 days in the prior 5 days will be deemed efficient to keep online if the daily losses are less than the entire cycling costs. This is reasonable because the owner will likely expect the unit to return to profitability. However, as the number of unprofitable days increases, the portion of the cycling costs included in the test falls. In other words, a rational owner should be willing to tolerate much smaller daily losses if a resource has not been consistently profitable on prior days.

In addition to the screening described above to determine whether it is efficient to operate a coal-fired resource each day, we also determined whether it was profitable. This simply means that the resource's energy and ancillary services revenues exceeded the resource's operating costs. The following table shows the portion of days when resources that remained online did so efficiently and profitably in the two timeframes we studied.

Table 3: Evaluation of Daily Coal Unit Dispatch
All Generators

	2016-2018		2019		
	Efficient	Not Efficient	Efficient	Not Efficient	
Profitable	**84%**	**0%**	**74%**	**0%**	Profitable
Unprofitable	**13%**	**3%**	**21%**	**4%**	Unprofitable
	97%	**3%**	**96%**	**4%**	

These results show that the decisions made by participants to keep their coal resources online were generally efficient – 4 percent or less of these decisions were inefficient in both periods. However, we note that these resources were less profitable in 2019 when natural gas and energy prices were lower and baseload coal resources were less profitable.

Efficient but Unprofitable Days

The analysis shows that a significant share of the efficient decisions to keep coal resources online were unprofitable. In other words, energy and ancillary services revenues did not always cover the costs of operating the coal resources each day. These cases are largely explained by two factors.

Cycling Costs. As described above, costs of re-starting a unit can be avoided if it stays online. Therefore, if any daily losses are smaller than the amortized start-up costs of the resource, it is efficient for the unit to remain online. This explains the bulk of the days that are identified as unprofitable.

Weekend Days. Our approach recognizes that a resource owner that has been earning positive net revenues from the resource will have less incentive to decommit the resource than for a resource that has been earning negative net revenues. Examining the results on days when dispatching the resources were efficient but unprofitable, we found that 40 percent of these days occurred on weekends even though they constitute only 28 percent of all days. This illustrates that it can be efficient for resources running on Friday to remain online unprofitably over the weekend in order to profitably be online Monday without incurring cycling costs.

Daily Operating Decisions by Type of Owner

We also examined whether the behavior of integrated utilities whose incentives are in part governed by their regulatory treatment is consistent with the behavior of merchant utilities whose incentives derive primarily from the MISO markets. Table 4 shows the same results as Table 3, but we have divided them by type of participant for the entire study timeframe from 2016 through 2019.

Table 4: Evaluation of Daily Coal Unit Dispatch by Type of Owner
2016-2019

	Integrated Utilities		Merchants		
	Efficient	Not Efficient	Efficient	Not Efficient	
Profitable	**80%**	**0%**	**95%**	**0%**	Profitable
Unprofitable	**16%**	**3%**	**4%**	**0%**	Unprofitable
	97%	**3%**	**100%**	**0%**	

This analysis shows that merchant generation owners are generally more responsive overall to market signals and more effective at deciding whether their coal-fired resources should remain online. It shows that 95 percent of the days when a merchant coal resource was online, it was both profitable and efficient. It also shows that their resources were almost never operating inefficiently.

The fact that only four percent of days were unprofitable for merchant resources suggests that these owners were less likely to keep their units online because of cycling costs. One difference in conduct that explains this outcome is that merchant unit owners offer their online resources economically in MISO's day-ahead market for a higher portion of the days than do their regulated counterparts. This allows the day-ahead market to determine whether the unit should remain online. This may sometimes cause a resource not to be scheduled that would be expected to be profitable within a short period of time. Nonetheless, we believe that offering online resources economically improves overall the efficiency and profitability of the decommitment decisions. The interests of efficiency would be advanced if regulated owners of coal resources were to more frequently offer resources economically in MISO's day-ahead market, rather than opting for must-run status.

C. Net Operating Revenues Earned by Coal-Fired Resources

In this final subsection, we summarize the net operating revenues earned by coal resource owners that are associated with their decisions to start and operate their resources. Ultimately, these values reflect the aggregate economic impact of the resource owners' decisions. Table 5 shows the summary of the net revenues earned by the coal-fired resources in the two study timeframes, subdivided into whether the participants are regulated integrated utilities or merchant generators.

We also note that it can be difficult to attribute the start-up costs to individual operating days because they are incurred once for the entire commitment time for the resource. In the table below, we show "Operating Net Revenues" that are defined as the operating revenues net of all operating costs except the start-up costs. The table separately shows the total start-up costs. "Total Net Revenues" are the operating net revenues less the start-up costs.

Table 5: Net Revenues of Coal-Fired Resources
($ Millions)

	Operating Net Revenues	Startup Costs	Total Net Revenues
2016-2018	**$5,063**	**$363**	**$4,700**
Integrated Utilities	$4,517	$317	$4,200
Merchants	$546	$46	$500
2019	**$963**	**$134**	**$829**
Integrated Utilities	$855	$122	$733
Merchants	$108	$12	$96
Total - All Periods	**$6,026**	**$498**	**$5,528**
Integrated Utilities	$5,372	$439	$4,933
Merchants	$654	$59	$596

This table shows that the integrated utilities account for almost 90 percent of the operating net revenues in both timeframes. It also shows that the aggregate operating net revenues have been substantially positive, exceeding $5.5 billion over both timeframes (net of start-up costs). The efficiency and profitability screens that are described above were applied to the net operating revenues earned by coal resources. Table 6 shows these aggregate results for all suppliers in the two timeframes.

Table 6: Evaluation of Net Operating Revenues by Coal Resources
All Generators ($ Millions)

	2016-2018		2019		
	Efficient	Not Efficient	Efficient	Not Efficient	
Profitable	**$5,377**	**$0**	**$1,141**	**$0**	Profitable
Unprofitable	**-$230**	**-$84**	**-$128**	**-$50**	Unprofitable
	$5,147	**-$83**	**$1,013**	**-$50**	

These results show the same patterns as shown in Table 3 above, indicating that a very small portion of the net revenues are the result of inefficient losses. These losses were less than two percent of the net operating revenues from efficient dispatch of the coal resources. However, the deteriorating economics of the coal resources cause these ratios to rise to more than five percent in 2019.

Because it is not likely that the declines in natural gas prices and energy prices will be reversed in the near term, the 2019 results are the most relevant to examine for purposes of drawing conclusions and recommendations for potential changes in the upcoming years. Therefore, we begin a further disaggregation of the 2019 results by separating the net operating revenues of the integrated utilities and merchant utilities in Table 7.

Table 7: Evaluation of Net Operating Revenues by Type of Participant
2019 ($ Millions)

	Integrated Utilities		Merchants		
	Efficient	Not Efficient	Efficient	Not Efficient	
Profitable	**$1,032**	**$0**	**$109**	**$0**	Profitable
Unprofitable	**-$128**	**-$50**	**-$1**	**$0**	Unprofitable
	$904	**-$50**	**$108**	**$0**	

Figure 7 is consistent with earlier results demonstrating that merchant utilities who face much stronger market incentives than their regulated counterparts rarely operate inefficiently or unprofitably. However, we also examined whether all regulated utilities operate in a similar manner, which we would not expect given that the regulatory incentives they face can vary state-by-state. Figure 8 disaggregates the results of the integrated utilities by separately showing the five utilities that operated least efficiently in 2019 in comparison to the other 36 integrated utilities that operate coal resources.

Table 8: Evaluation of Integrated Utilities' Net Operating Revenues
2019 ($ Millions)

	Bottom 5 Integrated Utils		Other 36 Integrated Utils		
	Efficient	Not Efficient	Efficient	Not Efficient	
Profitable	**$135**	**$0**	**$897**	**$0**	Profitable
Unprofitable	**-$49**	**-$38**	**-$79**	**-$12**	Unprofitable
	$86	**-$38**	**$818**	**-$12**	

Table 8 confirms that operation of the coal-fired resources are not comparable across various integrated utilities. Many of these utilities operate almost as efficiently as merchant utilities, decommitting resources when they are no longer economic to operate. For example, the value of the inefficient losses are only roughly 1.5 percent of the net operating revenues from efficient operations. This is not true, however, of all integrated utilities.

The five least efficient owners of coal resources accounted for almost 80 percent of the inefficient losses incurred by coal resources among all integrated utilities. For these least efficient utilities, the inefficient losses were almost half of the total efficient net operating revenues they earned in 2019. Three of these five utilities actually incurred negative net operating revenues overall in 2019. In other words, the inefficient losses were larger than the aggregate efficient net operating revenues. This generally indicates that there is substantial room for improvement for these companies in how they commit and dispatch their coal-fired resources.

It is possible that some of these losses are incurred when coal resources must operate to satisfy local reliability requirements in an area. However, given our extensive interactions with these participants regarding their operating requirements, we believe that local reliability requirements do not likely explain a large share of these losses.

III. CONCLUSIONS

This study provides a detailed evaluation of the decision by MISO's coal resource owners to start up their resources and to keep them online once they are started. We examined the daily decisions made by these owners, as well as the economic consequences of these decisions by analyzing the net revenues they generated.

Overall, we believe that the decisions of the owners of coal resources to start them or to keep them online have been efficient, even when they are not profitable and are generating negative operating net revenues. These results cast serious doubts on the credibility of recent studies that have been published asserting that coal resources are routinely operating uneconomically at the expense of MISO's customers. Such studies have not been based on actual cost and other data that underly the analyses presented in this report. Nonetheless, it is difficult to reconcile the conclusions and claims made in those studies with the reality of the coal commitments and dispatch in MISO.

One finding in earlier studies is that coal resources operated by merchant utilities differ from those operated by MISO's integrated utilities, which we find as well. The contrast of results between the integrated utilities and the merchant utilities underscores that regulatory incentives can weaken the natural discipline of the competitive markets.

We also found that the dispatch of coal-fired resources varies significantly among the integrated utilities. A substantial share of the integrated utilities operate almost as efficiently as their merchant counterparts. Unfortunately, a small share of integrated utilities operate much less efficiently than others. We encourage them to adopt improvements in their operating procedures that allow their resources to operate more efficiently when their value to the system exceeds that operating costs. We identify three potential improvements below that could benefit a large portion of MISO's coal fleet.

Offering Economically in the Day-Ahead Market. We encourage integrated utilities that historically not operated efficiently to offer their resources economically more frequently in the day-ahead market to allow the market to guide efficient shutdown decisions. MISO's day-ahead market is a reasonably good predictor of upcoming market conditions. Therefore, offering coal resources with economic offers that are discounted to reflect the costs of cycling would allow the day-ahead market to economically evaluate whether to keep the resources online for the following day.

Some have called for MISO to implement some form of forward procurement model purported to be more consistent with coal resources' operating cycles. We believe such an effort would have little value compared to simply offering coal resources economically in MISO's day-ahead market.

Taking Seasonal Outages. Some of MISO's regulated utilities are beginning to adopt improvements in operating procedures, such as taking extended outages during shoulder seasons when the resources are much less likely to be needed or economic. This would likely be beneficial for a number of utilities to consider.

Providing Additional Forward Price and Outage Information. Finally, MISO's day-ahead market evaluates commitments and schedules over 36 hours, an additional 12 hours beyond the following day. However, MISO does not publish the prices for the remaining 12 hours, which could provide valuable insight to coal resource owners seeking to make the most efficient commitment and operating decisions possible for the following day. Therefore, it may be valuable to publish all 36 hours of prices. Additionally, we encourage MISO to consider the forward information on that is available on key generation and transmission outages that could improve coal resource owners' ability to determine when their resources will be economic to operate.