OMS-RSC Seams Study: Joint Dispatch Evaluation

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EXECUTIVE SUMMARY

This draft report presents initial estimates of potential savings from joint dispatch of generating resources between the Midcontinent Independent System Operator (MISO) and the Southwest Power Pool (SPP). This effort is being undertaken at the request of the OMS Seams Committee and the SPP RSC and represents joint efforts of the Potomac Economics, the MISO IMM, and MISO staff, in collaboration with the SPP MMU.

The analysis for this report was performed using a production cost model (PROMOD) and was initialized with the 2018 base case Model used by MISO in a number of applications including the MISO Annual Value Proposition estimates and the MISO Transmission Expansion Planning (MTEP) analyses. Three scenarios are presented including a:

- **Base case** – which was developed from the PROMOD simulation used to support the MISO Value Proposition 2018 base case;

- **Joint Dispatch scenario** – where joint dispatch between MISO and SPP was simulated by settling pool to pool hurdle rates for dispatch changes to support interchange to zero;

- **Joint Dispatch and Commitment scenario** – which was simulated by setting both commitment and dispatch hurdle rates to zero.

The simulations did not include any change or reduction in capacity requirements or operating reserve requirements and each RTO continued to meet reserve requirements within the region.[1]

The study results show that joint dispatch between MISO and SPP would yield approximately $17 Million/year of benefits and that joint dispatch and joint commitment together (while maintaining separate reserve requirements) would yield approximately $29 Million/year. These savings represent 0.1 percent and 0.2 percent of the region's total production costs, respectively.

These modest savings are likely understated because actual operations of the Regional Transmission Operators MISO and SPP are enormously complex and cannot be represented with precision in a PROMOD simulation. While the PROMOD simulation can reasonably be used to provide a rough estimate of the potential benefits of a joint real-time dispatch and/or

1 In the MISO Value Proposition the Joint Dispatch and Commitment sensitivity includes a reduction in operating reserves which is the source of significant benefits. See https://www.misoenergy.org/about/miso-strategy-and-value-proposition/miso-value-proposition/.

commitment process, it cannot fully capture all potential benefits (and may in some cases overstate the benefits).

The factors that cause production cost models to fail to fully capture real-time RTO operation include:[2]

1. *Hourly Simulation versus 5 Minute Dispatch*: hourly simulation versus a 5 minute real-time market results in much lower simulated LMP than observed in the market.

2. *Forecast Uncertainty*: perfect forecasting in the production cost model versus uncertain forecasting in reality.

3. *Interval Ramp Restrictions and Operational Deviations*: the production cost model does not recognize 5-minute ramp restrictions or operational uncertainties such as generator deviations and uncertain transmission flows (i.e., "loop flows").

4. *Outages and Derates*: the model assumes expected levels of outages/derates, while the RTOs must manage unexpected and lumpy actual outages and derates.

5. *Hourly interchange restrictions*: the model assumes unlimited hourly interchange changes, in contrast to the actual limits applied in operations that reflect limited ramping capability.

6. *Inter-RTO Congestion Management*: the model allows inter-RTO optimization via commitment and dispatch. The production cost model will only be accurate to the extent constraints are managed via market-to-market coordination. However, not all constraints are coordinated and there is no requirement or compensation for commitments to be made to manage congestion.[3]

Because PROMOD and similar production cost models do not reflect important factors present in actual RTO operations, it generally leads to lower estimates of production costs, LMPs, and system congestion in both the base case and in the simulation cases. Hence, the simulated benefits are generally lower than could be achieved in reality. While the PROMOD simulations are useful for providing an initial estimate of benefits, we believe the benefits can be more precisely estimated through the market-to-market study and some of the Tier Two studies that are based on actual market outcomes.

2 These factors are discussed in more detail in Appendix B.

3 Additional constraints were added to the final PROMOD simulations to reflect intraregional constraints that may limit economic interchange and reduce the estimated benefits.

I. Joint Dispatch Study

A. Purpose and Approach

RTOs plan, commit, and dispatch their systems separately. Currently, some of the potential benefits of a joint commitment and dispatch are achieved through market-to-market coordination and interchange scheduling. However, these processes have not been optimal and the monitors have identified areas that could be improved. The OMS and SPP RSC have requested an evaluation of the potential savings that might be achieved through the joint dispatch of the MISO and SPP systems.

To estimate these benefits, we worked with MISO to leverage the existing modeling MISO uses to assess a similar question, the Value Proposition. The Value Proposition analysis is performed annually. In this analysis, MISO estimates the benefits to their members of RTO participation, including the joint dispatch of the various areas that are consolidated under MISO's markets.

In that assessment, MISO compares estimates of production costs from individual member area commitment and dispatch to joint MISO commitment and dispatch. The component of the Value Proposition study related to Joint Dispatch shares very similar objectives with this project. MISO performs its Value Proposition analysis with the PROMOD production cost model, which simulates and optimal commitment and dispatch of resources to minimize production costs. The PROMOD model represents the Eastern Interconnection with some electrically distant areas simplied through equivalent networks. The model is primarily based on public data sources and assumptions described below:

- *Generation.* Generation data is primarily sourced from the ABB data release and publicly available information. Generation outages are based on NERC's published Generating Data Availability System (GADS) information. Planned maintenance is based on the class average annual maintenance requirement. Forced outages are captured based on the class average forced outage rate and mean time for outage. Generation retirements and new interconnected generators are included.

- *Fuel Prices.* The model inputs include plant level monthly average coal prices for January – September 2018. Gas prices are taken from Henry Hub monthly average natural gas price for January – September 2018. Oil prices are based on the ABB database.

- *Peak Demand and Annual Energy.* Demand and energy data are based on the January – September 2018 timeframe for each MISO load-serving entity (LSE) are obtained from internal market data. Demand and energy's monthly ratio (or spread) is based on the existing January – September data and projected for the October – December timeframe. Demand and energy for areas outside MISO system were based on the ABB data release.

- *Transmission Topology.* Topology is based on the 2018 summer peak MTEP powerflow model from MISO's Model-on-Demand (MOD) application is used for transmission topology. Planned or actual transmission outages are not captured in the model. Initial flowgates are based on the current year most congested flowgates within MISO and key external constraints. SPP then nominated additional flowgates that were added to the model. Flowgate ratings are updated to the season ratings of the facilities.

- The Regional Directional Transfer (RDT) constraint is modeled similar to how it is modeled in the MISO market.[4]

- *Energy Market Representation.* The model primarily represents energy markets. Although spinning reserve and operating reserves are modeled as a constraint, co-optimization is not performed for the energy and ancillary service markets. Seven pools are included in study region: MISO, SPP, PJM, the SERC region, Tennessee Valley Authority (TVA), the AECI and LGEE regions, and Manitoba Hydro (MHEB).

For this study, we began with the same base case, which represents the current RTO systems operated independently. To simulate the separation of the two systems and the fact the imports and exports are not scheduled efficiently, the model includes a "hurdle rate", which is an economic value that must be exceeded before an import or export is scheduled by the model. For example, a hurdle rate of $10 per MWh would prevent incremental imports or exports in any hour where the price difference between the RTO areas is less than $10 per MWh. The hurdle rate concept is commonly used in modeling to reflect a combination of all impediments to efficient transactions.

There are two hurdle rates in the study, a dispatch hurdle rate and a commitment hurdle rate. The dispatch hurdle rate prevents the model from ramping up online units to support additional exports, while the commitment hurdle rate prevents the model from starting a unit that would be economic to support additional exports.

The base case is derived from MISO's 2018 Value Proposition/MTEP Model, which assumes:

- SPP and MISO are separate pools, no joint commitment or dispatch; and
- Hurdle rates for both dispatch and commitment interchange between the RTOs were set based on the MISO 2018 Value Proposition model

The joint dispatch case is modeled by reducing the dispatch hurdle rate to zero. This allows the model to adjust the dispatch of online units economically to support efficient interchange between the areas. However, the commitment hurdle rate remains the same as in the base case.

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4 Under an agreement with SPP and other neighboring regions, MISO limits scheduled transfers between the MISO Midwest and South regions to 3000 MW from the north-to-south and 2500 MW from the south-to-north.

In the joint dispatch and commitment case, MISO reduces the commitment hurdle rate rate to zero, which enables each RTO to commit resources to support efficient transactions as if they were one system.

B. Joint Dispatch Study Results

The results of the PROMOD simulations are discussed in this section. Enabling joint dispatch and/or commitment will primarily achieve savings by facilitating more efficient movement of power between areas (i.e., change in net interchange). The first table shows the base case net imports (column 1) and the changes caused by joint dispatch (column 2), and by joint commitment and dispatch (column 3).

		Change from Base Case	
	Base Case Net Imports	Joint Dispatch	Joint Dispatch and Commitment
Net Imports from SPP to MISO (MW/Hour)	180	1,363	2,376
Net Imports from Other Areas (MW/Hour)	887	222	247

This shows that in both scenarios, a large amount of additional power transfers from SPP to MISO. It also results in a small increase in net imports to the joint area (row 2 in the table). These increases in net imports into MISO from SPP are the result of allowing fully optimal interchange between the two areas. The increases are greater in the Joint Commitment and Dispatch case because the PROMOD model can commit units economically, which facilitate additional transfers.

By improvement the interchange between the areas through joint dispatch, efficiency savings are achieved in the form of lower production costs. The next table shows the production cost savings in the two cases. The first column shows the total production costs in the base case, while the values in the second and third columns are changes from the base case. Positive values represent savings (reductions in production costs) while negative values represent increased production costs.

	Production Costs ($Mill/Year)		
	Base Case	Joint Dispatch Savings	Joint Dispatch and Commitment Savings
SPP Production Costs	$3,665	-$151	-$317
MISO Production Costs	$11,968	$172	$351
Net Total Pooled Production Costs	$15,633	$22	$34
Adjusted Prod. Costs Savings (@ $20/MWH)		**$17**	**$29**
Adjusted Savings (% of total)		***0.1%***	***0.2%***

The table shows that in both scenarios, the production costs in SPP increase because it produced more power to support increased exports. The production costs fall in MISO as output decreases. On net, the annual savings range from $22 million in the joint dispatch case to $34 million in the joint dispatch and commitment case. However, these savings are overstated because they do not account for the production costs of producing power in other regions to support the increased aggregate imports into the joint MISO-SPP region. These costs are accounted for in the adjusted production cost savings (row 4 in the table). The adjusted production costs savings accounts for the costs of the increased imports by assuming an average costs of producing power in neighboring regions $20 per MWh.

The savings in this case range from $17 million to $29 million. The savings are 70 percent larger when commitment is optimized along with dispatch, but the total savings in both cases are relatively small. In aggregate, these savings represent 0.1 to 0.2 percent of the regions total production costs.

However, these savings are likely understated. As discussed further in Appendix B, there are many reasons why the modeled benefits from a joint dispatch and a joint commitment might be understated due to simplifying assumptions in the production cost model compared to actual operations. Given the perfect foresights and lack of uncertainty inherent in the production cost model, the total congestion, LMPs and total production costs are all substantial lower than in reality. Hence, the simulated savings are also likely lower than is available in reality.

More realistic savings are likely to be quantified both in the market-to-market analyses to be conducted later in the seams study, and in the analysis of coordinated transaction scheduling. Hence, the fact that the production cost model does not capture all of these savings is not a substantial concern. Nonetheless, the analysis shows that the total savings that can only be achieved by merging the dispatch and commitment of SPP and MISO are relatively small.

II. Conclusions

The PROMOD simulation results show that joint dispatch between MISO and SPP would yield approximately $17 million/year of benefits and that joint dispatch and joint commitment together (while maintaining separate reserve requirements) would yield approximately $29 million/year.

While these benefits of reduced production costs are modest compared to the total annual production costs (a small fraction of a percentage), they do indicate the opportunity to achieve savings by improving seams coordination between the RTOs. Separate targeted analyses focused on specific inefficiencies (i.e. physical scheduling limts, congestion management, capacity sharing) will likely be more effective in accurately estimating benefits of specific potential solutions. Improved market-to-market coordination along with Coordinated Transaction Scheduling (CTS) would capture these types of benefits that will be calculated based on actual operating conditions. We look forward to expanding this study by estimating the benefits of these solutions.

APPENDIX A

HURDLE RATES AND RTO-TO-RTO INTERCHANGE

RTO-to-RTO interchange is adjusted using hurdle rates between various control areas:

Interface Name	Forward Energy	Off-Peak Forward Energy	Backward Energy	Off-Peak Backward Energy	Commit Forward Energy	Off-Peak Commit Forward Energy	Commit Backward Energy	Off-Peak Commit Backward Energy
MHEB-MISO	0	0	0	0	0	0	0	0
MISO-PJM	8	8	1	1	10	10	3	3
MISO-SERC	8	8	10	10	10	10	10	10
MISO-SPP	7.5488	5.3939	5.0933	5.0933	10	10	10	10
MISO-TVA	7.5488	5.3939	30	30	10	10	30	30
MISO-TVA other	7.5488	5.3939	8.29	8.29	10	10	10	10
SPP-TVA	5.0933	5.0933	30	30	10	10	30	30
SPP-TVA other	5.0933	5.0933	8.29	8.29	10	10	10	10

APPENDIX B

SIMPLIFICATIONS IN THE PROMOD MODEL

The PROMOD modeling platform is very useful. However, comparing certain results (i.e. LMPs, Congestion Costs) to actual results indicate that the base case produces costs that well below those observed from actual data. The following list details factors likely to contribute to these differences.

1. *Hourly Simulation versus 5 Minute Dispatch*: PROMOD is an hourly simulation versus a 5 minute real-time market. Shorter real-time market horizons are needed for relaiblity but necessarily produce greater volatility and higher prices. This is substantiated by the PROMOD results much lower LMP than observed in the market.

2. *Forecast Uncertainty*: PROMOD optimizes over the entire time horizon with perfect forecasting versus uncertain forecasting in reality which increases production costs and estimated LMPs.

3. *Interval Ramp Restrictions*: PROMOD models hourly period to period ramp restrictions but actual market operations ramp restrictions are based on 5 minute dispatch, and are limited by actual operations including uninstructed deviations which necessarily adds to actual production costs than the simulation.

4. *Outages and Derates*: PROMOD uses broad statistical/class results to estimate outages/derates. Actual outages and derates are lumpy and tend to produce much more severe local congestion and higher production costs.

5. *Congestion*: the PROMOD model produces congestion values that are much lower than marginal congestion values actual produced in the Real-time markets. This is substantiated as PROMOD produces much lower congestion than observed in the markets.

6. *Hourly interchange restrictions*: In actual operations, for reliability and due to lack of ramping capability, markets restrict interchange scheduling changes between periods (both interval and hourly limits). PROMOD has no such restrictions and so PROMOD results produces much higher hourly interchange deltas than are permitted in reality.

7. *Pool-to-Pool Congestion Management*: The simulation allows interpool optimization via commitment and dispatch limited only by the interchange hurdle rates. To the extent constraints are managed via market-to-market coordination the dispatch optimization would mimic reality well, but there is no requirement or compensation for congestion management via commitment.