Assessing the impact of Felxible Ramping Products in MISO

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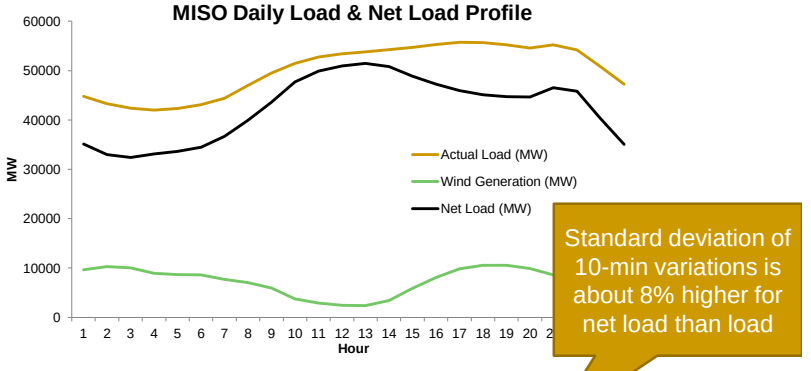
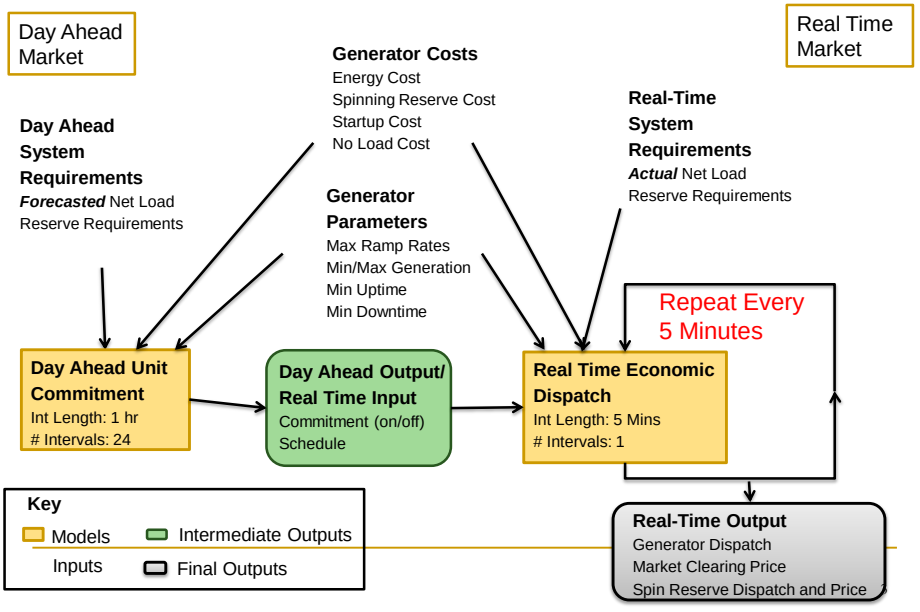
Net Load and Ramp requirements



Background | Problem | Method | Results | Discussion

MISO Unit Commitment/Economic Dispatch Model



Background | Problem | Method | Results | Discussion

Example of ramping problem

- Simple 2-Generator Example
  - G1: Cheap slow-ramping plant
  - G2: Expensive flexible plant

	Cost ($/MWh)	Ramp Rate (MW/min)	Max Gen (MW)	Min Gen (MW)
G1	10	1	100	20
G2	15	5	100	20
Wind	0	-	-	-

Economic Dispatch, 5 Minute Interval

Dispatch for Single Interval

With Foresight

5-minute Interval	1	2	1	2
Load (MW)	140	120	140	120
Wind Available (MW)	20	30	20	30
Net load (MW)	120	90	120	90
G1 Generation (MW)	100	95	95	90
G2 Generation (MW)	20	0	25	0
Wind Curtailed (MW)	0	-5	0	0
Interval Cost ($)	108.33	79.17	110.42	75
Total Cost ($)		187.50		185.42

MISO's response to ramping shortages

- Check ramping capacity in the commitment analysis
- Manually dispatch out-of-merit-order generators (expensive fast ramping Combustion Turbines)
- Wind curtailment

Approach is not optimal because

- Does not affect Day-Ahead Market dispatch so it requires out-of-market "uplift" payments to generators whose costs are higher than clearing price
  - Different for each resource / no public pricing transparency
    - Does not create incentives to invest in fast ramping resources
- May make scarcity events and price spikes more likely

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MISO's proposed approach: Add ramp capability products to UC-ED

- Product 1: Up-Ramp Capability (URC)
- Product 2: Down-Ramp Capability (DRC)

- Generators get re-dispatched to ensure there is sufficient ramp capability in system
  - Generators do not bid to provide ramp capability
  - Paid only their opportunity cost if they are re-dispatched

- URC/DRC Prices:
  - Cost to the system of adding one more MW of RC
  - If ramp capability within the system is enough: $0 cost
  - Demand Curve: sets a maximum price ($10/MWh) to ensure that future ramping requirements are ***not*** provided at the expense off not meeting current energy or reserve needs

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Research questions:

- Is flexiramp a solution?
  - Does it result in less scarcity-pricing events, higher reliability, less emissions, less wind curtailment?
  - How can the ramping targets (demand curves) be better determined

Preliminary results presented today

- How does flexiramp compare to other potential solutions like:
  - "Look ahead" real time dispatch
  - Stochastic optimization

Not included in today's presentation

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Method

- Develop Baseline Model
  - Based on existing practices
  - Day Ahead Unit Commitment
  - Real Time Economic Dispatch
- Modify Model with MISO's Proposed Ramp Capability Products
  - Additional constraints
  - Additional terms in the objective functions
- Run Baseline and Ramp Capability models on test grids
  - Same inputs for both models
- Compare Results

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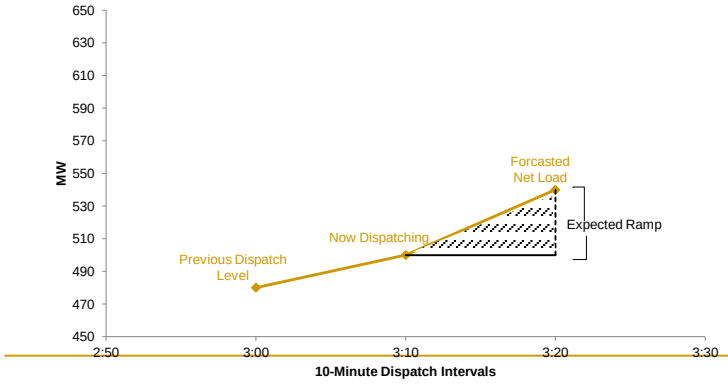
How much ramp capability to procure?

- Consider expected ramp:
  - Dispatching for 3:10 pm
  - Consider net load forecast for 3:20



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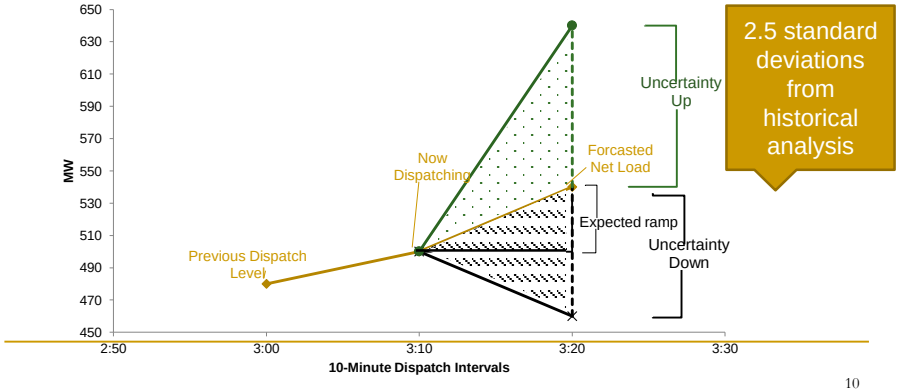
How much ramp capability to procure?

- consider uncertainty surrounding forecast in both directions



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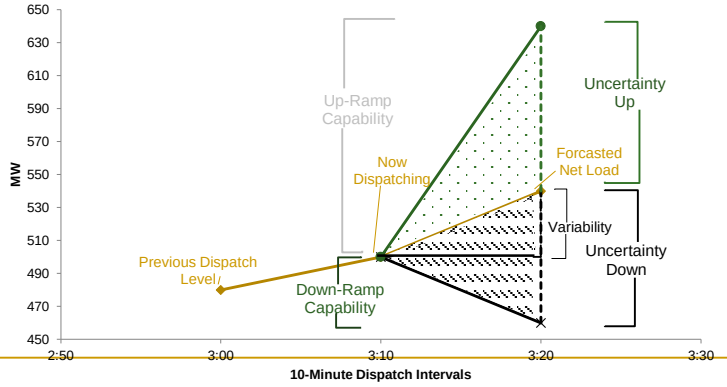
How much ramp capability to procure?

- Procure enough Up-Ramp and Down Ramp Capability to meet uncertainty levels
- Quantity will vary by season & time of day



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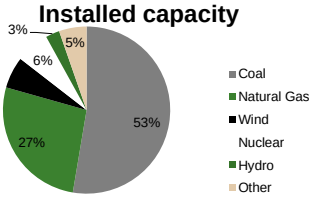
Test Grid

- ~6% Scaled version of 2009 MISO System

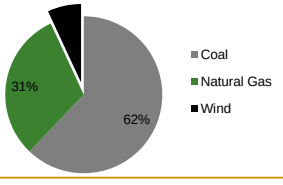
Actual 2009 MISO Installed capacity



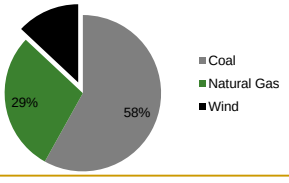
MISO Territory

● Wind Locations

Low Wind Scenario



High Wind Scenario



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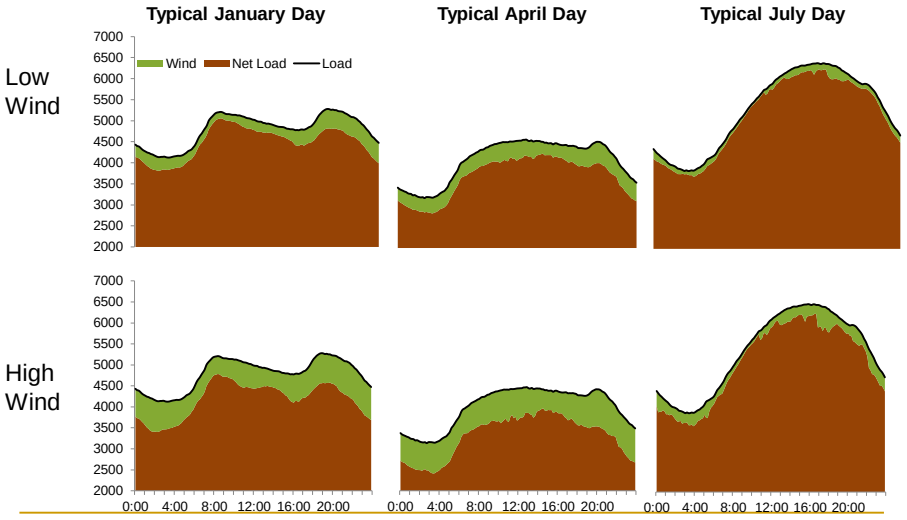
Load data



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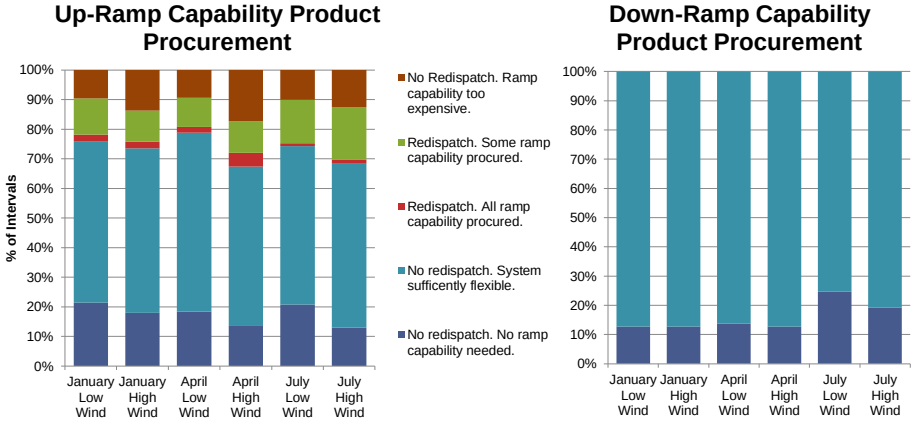
Ramp Capability procurement in real-time economic dispatch



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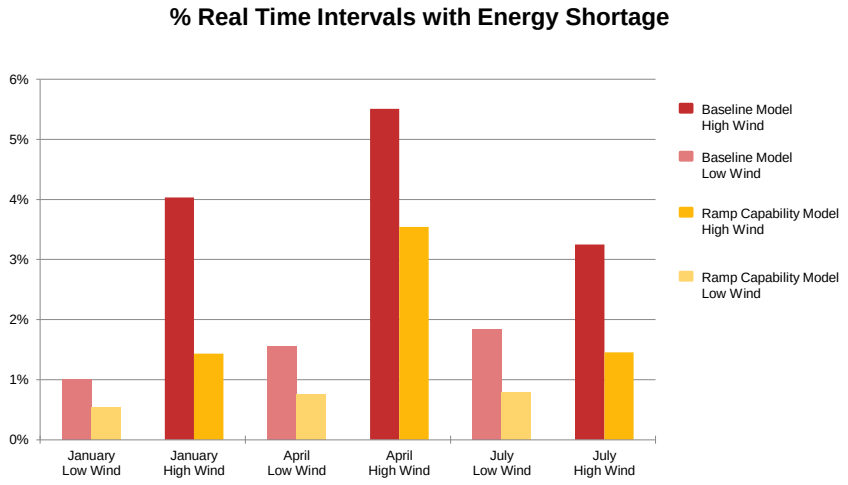
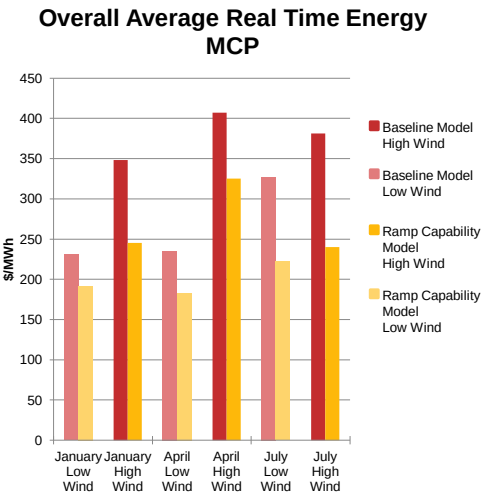
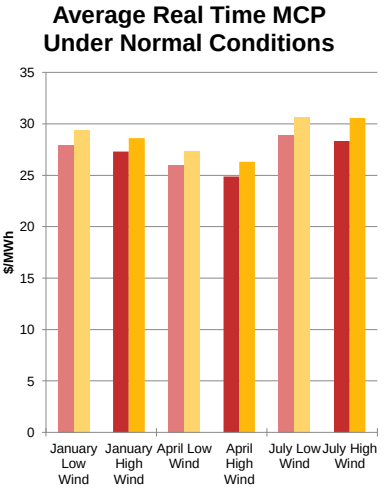
Reliability

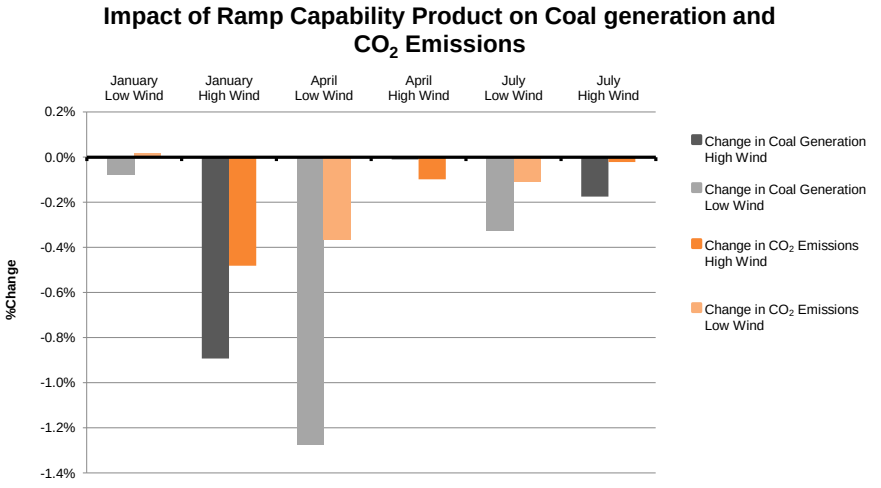


Energy Market Clearing Price (MCP)





Coal Generation, CO_2 Emissions



Conclusions

- Up-ramp capability provides reliability benefits
  - Fewer shortages
  - Especially with high wind
- Up-ramp capability reduced costs
  - Much lower average prices
  - Fewer price spikes
  - Slightly higher prices under normal (non-shortage) conditions
- Small decrease in coal generation
- Small decrease in CO_2 emissions
- Ongoing work to make sure model better represents MISO (and current wind curtailment situation):
  - Better estimations of coal generator ramp rates
  - Add transmission constraints

Thanks to my students

- Adam Cornelius (MEM – 2014)
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Thank you!

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