EAS WG – Roadmap Discussion
Flexibility

April 5, 2018

Westin

Agenda

- Context
  - – NDV Results
  - – Objectives
  - – Roadmap steps
- Analysis and Research for discussion
  - – Dispatch tolerance and ramping
  - – AS market products
  - – Next steps
    - (proposal at May WG and rec by June)

Net Demand Variability Results

A snapshot of future flexibility challenges/needs

Refresher – timing for NDV system needs – based on forecast

- The Net Demand Variability (NDV) is increasing materially by 2030 due to the expected increases in variable renewable energy
- However, NDV analysis indicates change may be manageable with current rules <u>assuming no change to average ramp behaviour</u>.

Forecast Assumptions	Change in assuptions
Relied on reference case for LTO	CTG may be more likely – less more flexible than coal but may squeeze out gas which is even more flexible
REP additions set at 400 per year	REP round 1 – 600 by date, REP rounds 2/3 set at 700 by date…
Assumes current dispatch tolerance continues.	No certainty this will continue – creates risk is more variable than historic

- Forecast fleet has capabilities to meet forecasted flexibility needs, but may require tighter dispatch tolerance rules to reflect historic average behaviour as a first step, for existing assets, to ensure certainty.
- Forecast assumptions impact timing for need – 2023-25 but may be earlier or later – need to evaluate and test mitigation needs

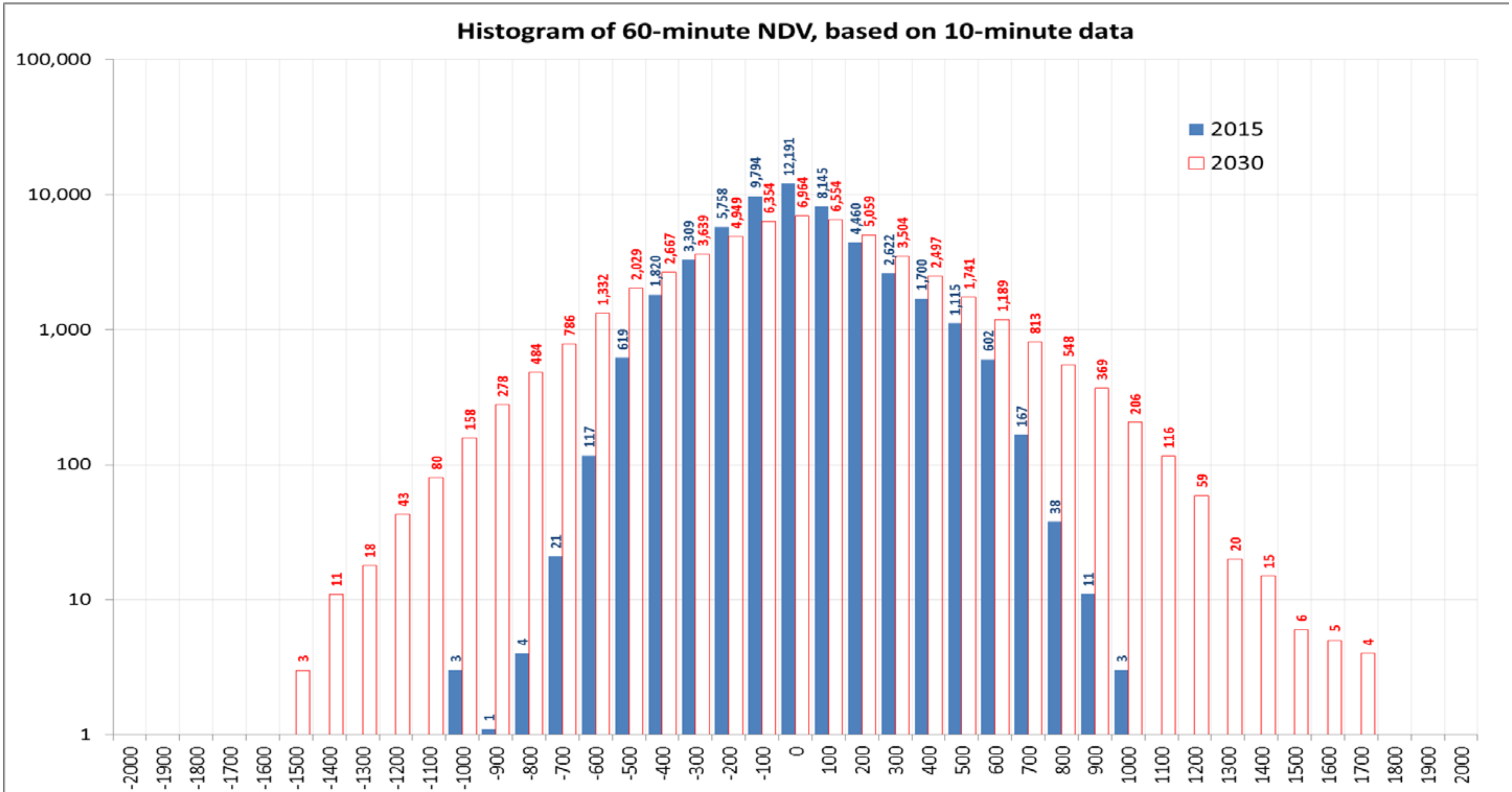
Directional results from NDV work

- Bookend scenarios simulated (Reference, High CTG case)
- Market simulation combined with a Dispatch simulation
- Its directional, to give us ranges of what we may see, it's a simulation
- Directional results
  - – Reliability performance is acceptable, assuming average dispatch response continues into the future
  - – NDV increases by 50% between 2015 to 2030
  - – Load variability remains a significant driver in NDV
    - 68%/32% load/variable gen in 2015; shifts to 50%/50% in 2030

High NDV variability into 2030

- Following graphic displays materially higher variability swings comparing 2015 to 2030
  - There are more events (shown on vertical axis – measured as 10 minute intervals)
  - With increasingly larger ramps (shown on the horizontal axis)
  - Measuring both ramp down (to the left) and ramp up (to the right)
  - With ramp up showing greater difference in future years

60 min NDV variability increases materially into 2030, with new +/- 800 to 1500 MW swings, with +/- 300 to 600 MW swings common



New------------------→40* 11* 3* ←---- s i m i l a r ---- -→2* 5* 15* New -----------------------→

2030 vs 2015 # of events

Existing approaches to managing NDV may not be sufficient in 2030

The AESO currently manages NDV using a combination of:

- Dispatching the merit order; including proactive dispatch where necessary for ramp rate
- Regulating reserve (AGC)
- Wind Power Management (limits wind during extreme ramp up events)

There may be a need to develop tools, processes and/or new products to reliably manage the NDV as we progress to 30% renewable (mostly intermittent) generation by 2030

Changes to operations practices/processes (settlement period, tools, etc.)

- Changes to OR products (more RR, new ramping product, etc.)
- Changes to rules (dispatch tolerance and ramping rules)
- Market pricing options (including possibly shorter settlement)

Managing Dispatch

- Issue is certainty
  - Scenario analysis based on forecast for increasingly flexible fleet
  - BUT premised on historic average dispatch practices – BIG risk if dispatch practices change
  - Market needs incentives, rules to be more flexible BUT also to dispatch based on its capabilities – provide dispatch certainty.
- Pricing – shorter settlement may help
- Other options include:
  - Dispatch certainty through tolerance, ramp
  - Dispatch tools
  - AESO other work on Dispatchable renewables and storage will be part of analysis
  - Ramp product

Flexibility Roadmap

- April WG
  - Present data, research on options
- May WG
  - Proposal on options, including range of implementation scenarios
  - Proposal on further research too including more on Dispatchable Renewables and Storage work.
- June WG
  - Recommendation for Flexibility Roadmap
  - Including next steps for analysis and consultation

Dispatch Rule Approach

Dispatch rule, tolerance, analysis

Ramp uncertainty

- From an operational perspective, uncertainty with respect to ramp response can be difficult manage
  - Recognize that all assets have different characteristics, but want to understand how each / any asset will respond to dispatch to allow efficient dispatch for the system
- Current dispatch tolerance rules create a wide area of uncertainty – system controllers must rely on historical ramp behaviour and knowledge of assets
- Asset to asset, ramp response can vary, however providing system controllers with better information on how assets will respond may help reduce uncertainty when dispatching

Dispatch tolerance rules

- Participants have a fairly wide discretion / range around dispatch instructions
- The dispatch tolerance rule provides ranges around
  - Ramp rate : +/- 40% of submitted ramp rate
  - Time to respond : 0 to 10 minutes
  - Dispatched Target MW : +/- 10 MW if > 200 MW asset

    +/- 5 MW if < 200 MW asset

Current dispatch tolerance rule (Rule 203.4) enables a wide range of possible ramping outcomes

4(1) A pool participant must move the output of a generating source asset which is:

(a) the subject of a dispatch; and

(b) ramping towards the MW level indicated in that dispatch within ten (10) minutes of the time specified in the dispatch but not prior to the time specified in the dispatch.

(2) A pool participant must ensure that each generating source asset reaches generating asset steady state in:

(a) no longer than the period of time calculated as follows:

(i) divide the change in dispatch MW by the ramp rate the pool participant submits;

(ii) add forty percent (40%) of the time calculated in subsection 4(2)(a)(i) or five (5) minutes, whichever is greater; and

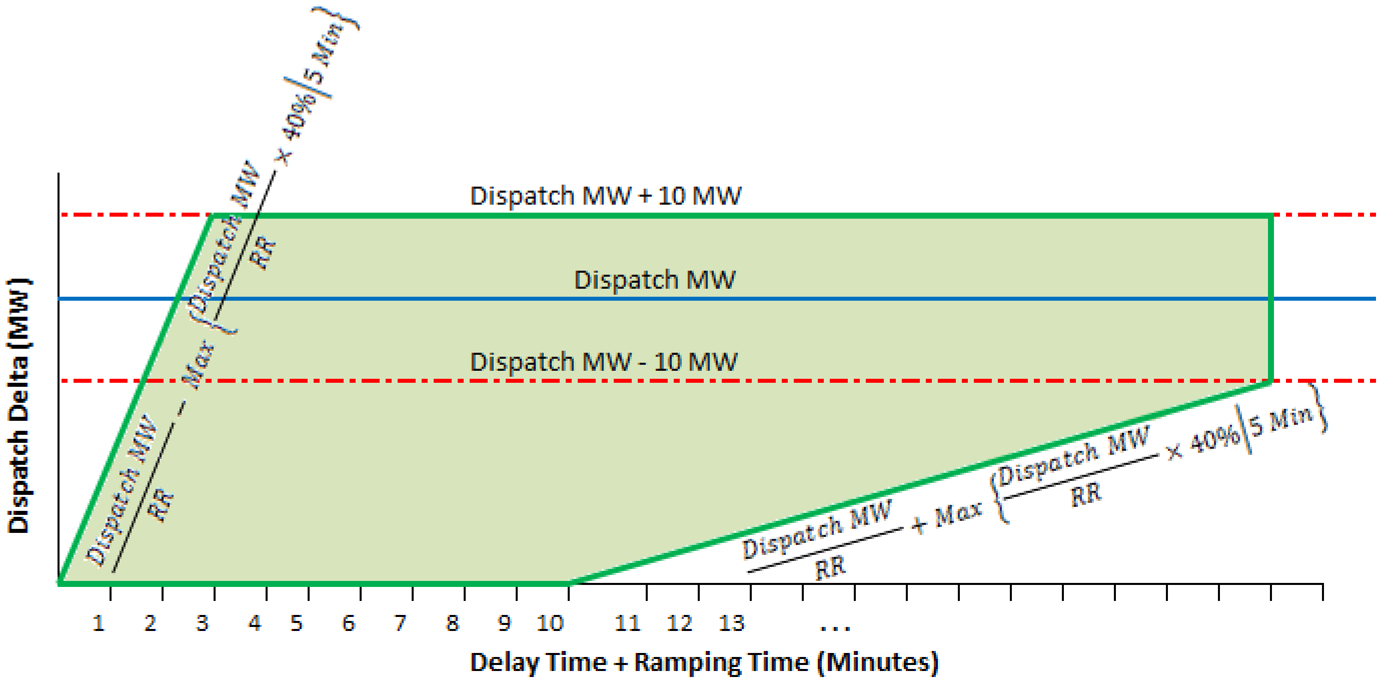
(iii) add the ten (10) minutes referred to in subsection 4(1); and

(b) no sooner than the period of time calculated as follows:

(i) divide the change in dispatch MW by the ramp rate the pool participant submits; and

(ii) subtract forty percent (40%) of the time calculated in subsection 4(2)(b)(i) or five (5) minutes, whichever is greater.

The wide range of ramping outcomes (the dispatch tolerance window) are illustrated by the green region



The green area depicts the dispatch tolerance window created by rule 203.4. Each of the terms used in the chart are explained below.

- Dispatch MW: Dispatch delta or the change in dispatch, which is expressed in MW
- RR: Submitted ramp rate, which is measured in MW/Min
- Dispatch MW ± 10: Allowable dispatch variance (MW); which is 10 MW for assets with maximum capability (MC) greater than 200 MW and 5 MW for assets with MC equal or less than 200 MW

Historic Dispatch Data

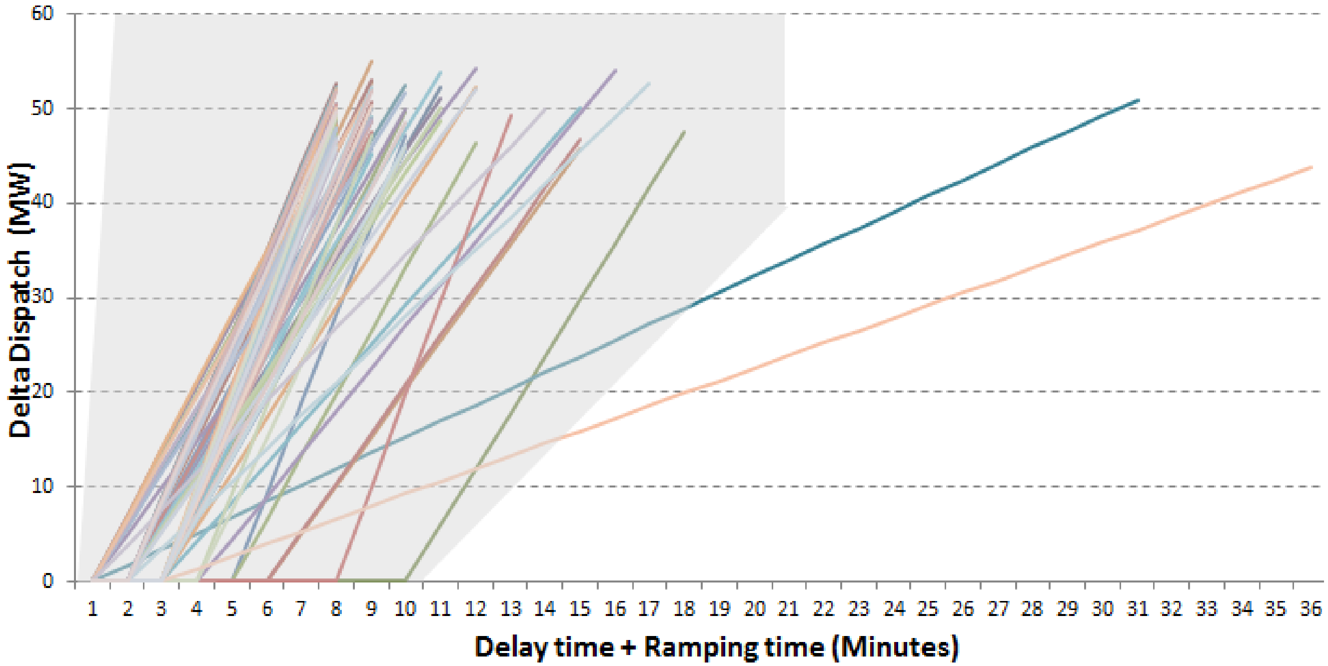
- Analysis in upcoming slides based on historical data from July 1, 2015 to June 30, 2017.
- Ramping events analyzed only apply to dispatch directives with a dispatch delta close to 50 MW.
- Historical ramp up/down behaviour was analyzed for three sample technology types: Coal, Cogen, Simple Cycle

Example #1 – Coal Unit

Coal Unit – Ramping-up above MSG

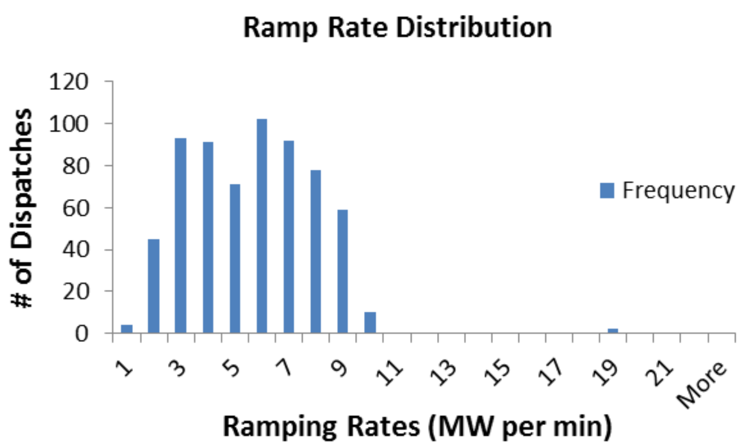
The lines shown in the chart illustrate the historical ramping-up movements and delay times for a coal unit from July 1, 2015 to June 30, 2017. These ramping events only apply to dispatch directives with a dispatch delta close to 50 MW.

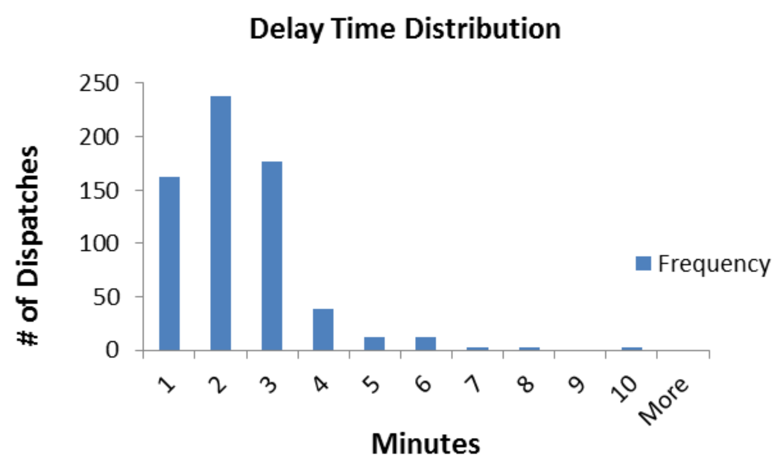
The gray shaded area shows the dispatch tolerance available to the unit, assuming a 50MW dispatch. Historical data show that most of the time the unit ramped up to the required level in 15 minutes or less. There were some exceptions in which the unit deviated from its normal behaviour.



Coal Unit - Ramping-up above MSG

The charts below summarize delay times and ramp rates calculations for all dispatch up instances from July 1, 2015 to June 30, 2017.





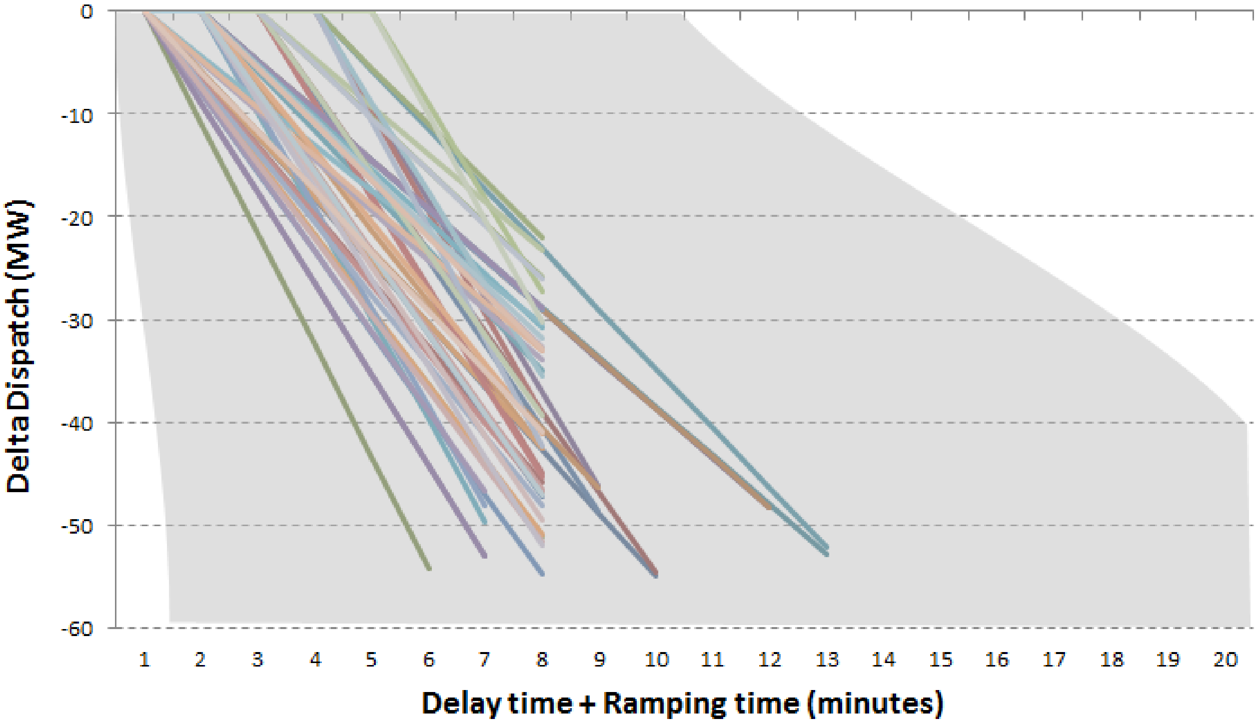
<u>Findings</u>

- The average ramp rate for the unit is 5.14 MW/Min, which is 49% slower than the submitted average ramp rate of 10 MW/min.
- Delay time was 5 minutes or less during 95 percent of the ramping events.

Coal Unit – Ramping-down

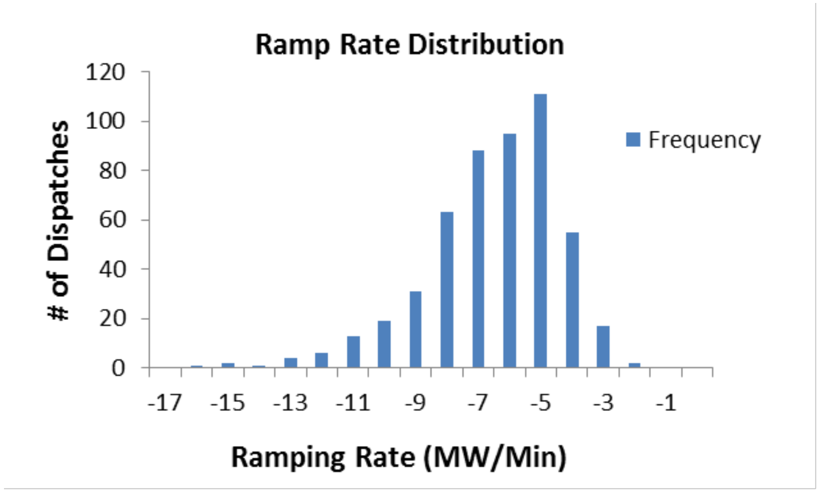
The lines shown in the chart illustrate the historical ramping-down movements and delay times for a coal unit from July 1, 2015 to June 30, 2017. These ramping events only apply to dispatch directives with a dispatch delta close to 50 MW.

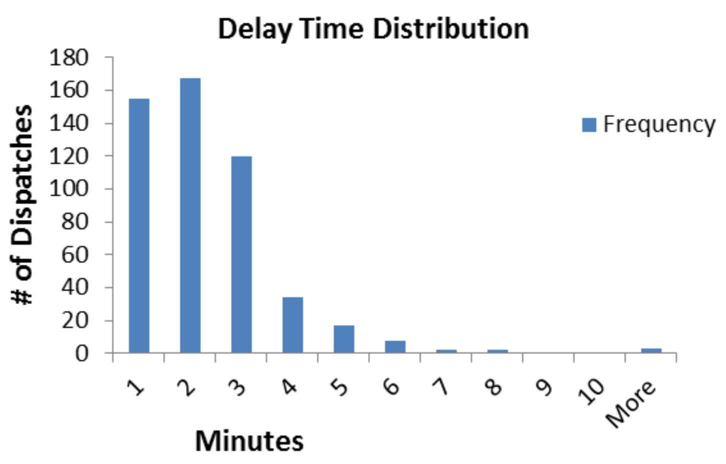
The gray shaded area shows the dispatch tolerance available to the unit, assuming a 50MW dispatch. Historical dispatches show that the unit ramped down to the required level in 13 minutes or less for all dispatch directives.



Coal Unit - Ramping-down above MSG

The charts below summarize delay times and ramp rates calculations for all dispatch down instances from July 1, 2015 to June 30, 2017.





Findings

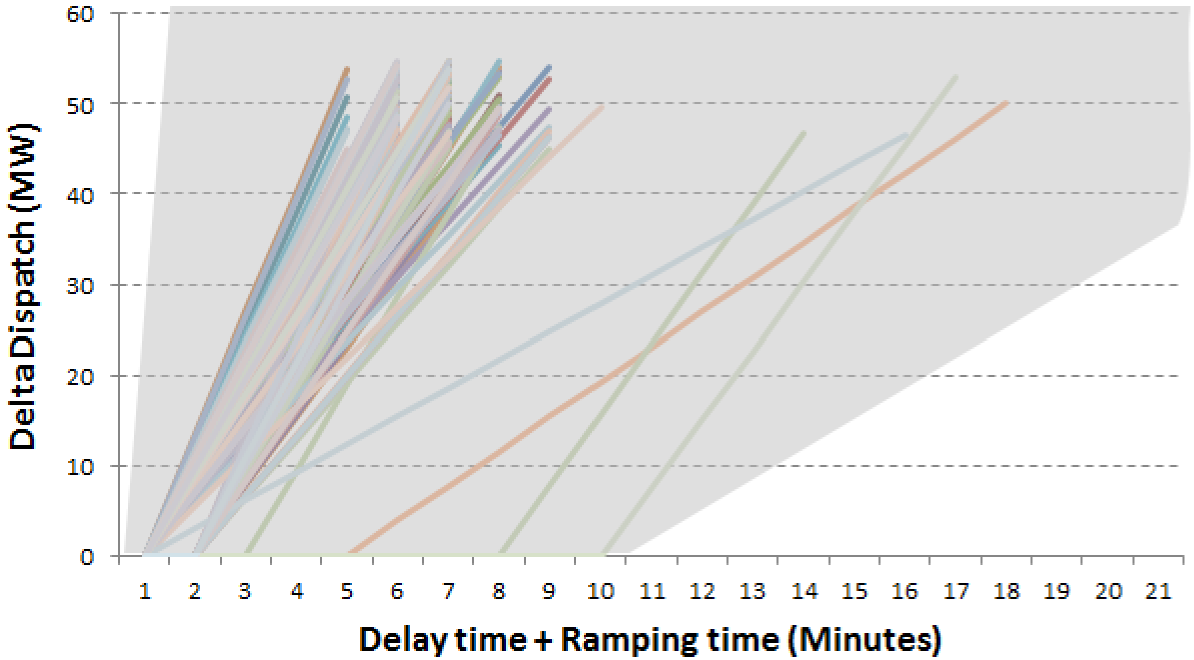
- The average ramp rate for the unit is 7.02 MW/Min, which is 30% slower than the submitted average ramp rate of 10 MW/min.
- Delay time was 5 minutes or less during 97 percent of the ramping events.

Example #2 – Cogen Unit

Cogen Unit – Ramping-up above MSG

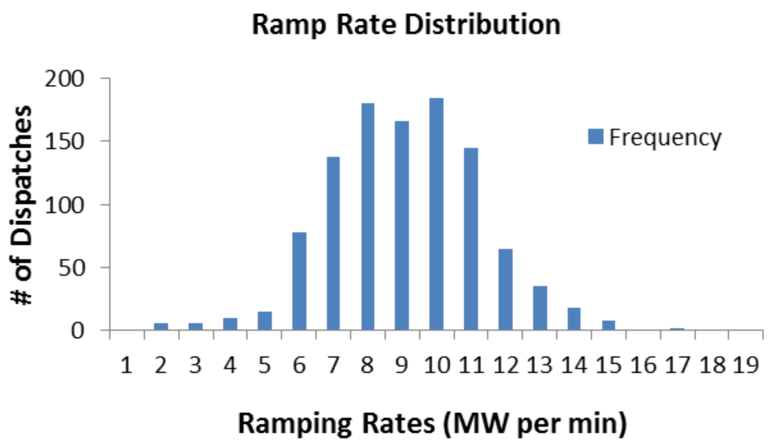
The lines shown in the chart illustrate the historical ramping-up movements and delay times for a cogen unit from July 1, 2015 to June 30, 2017. These ramping events only apply to dispatch directives with a dispatch delta close to 50 MW.

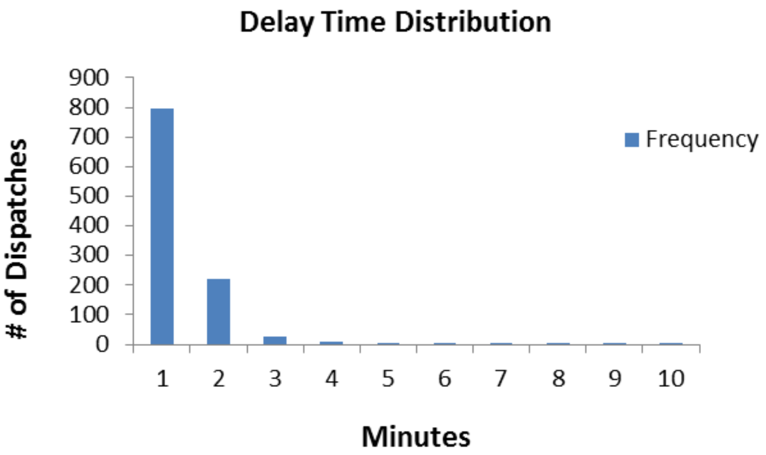
The gray shaded area shows the dispatch tolerance available to the unit, assuming a 50 MW dispatch up directive. Historical data show that the unit ramped up to the required level in 9 minutes or less in most of the cases; there were four exceptions in which the ramping process took longer than 10 minutes.



Cogen Unit - Ramping-up above MSG

The charts below summarize delay times and ramp rates calculations for all dispatch up instances from July 1, 2015 to June 30, 2017.





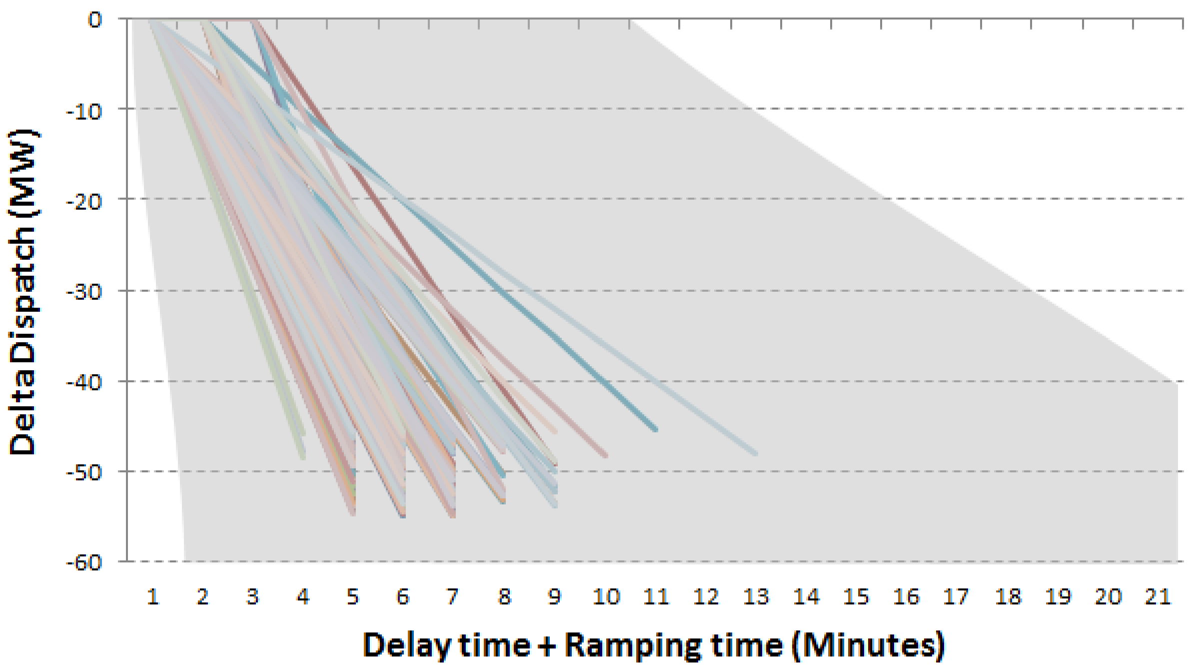
Findings

- The average ramp rate for the unit is 8.61 MW/Min, which is 7.6% faster than the submitted average ramp rate of 8 MW/min.
- Delay time was 5 minutes or less during 99% of the ramping events.

Cogen Unit – Ramping-down

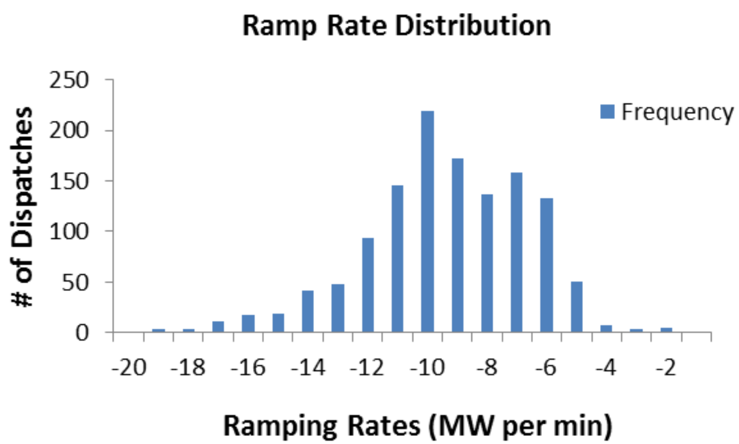
The lines shown in the chart illustrate the historical ramping-down movements and delay times for a cogen unit from July 1, 2015 to June 30, 2017. These ramping events only apply to dispatch directives with a dispatch delta close to 50 MM.

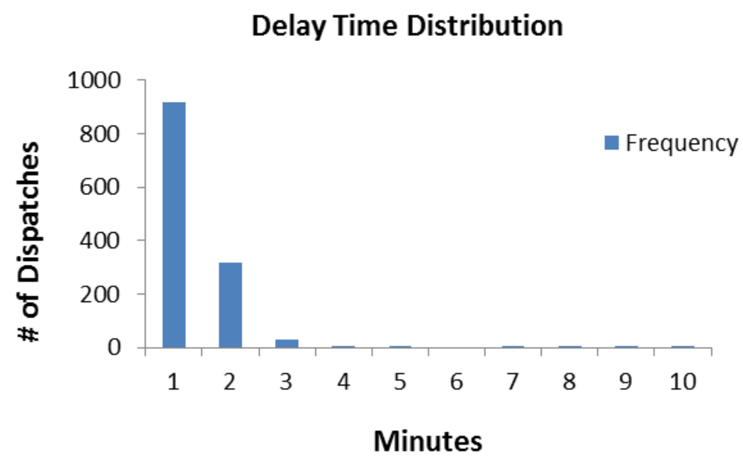
The gray shaded area shows the dispatch tolerance available to the unit, assuming a 50 MW dispatch down directive. Historical dispatches show that the unit ramped down to the required level in 13 minutes or less.



Cogen Unit - Ramping-down

The charts below summarize delay times and ramp rates calculations for all dispatch down instances from July 1, 2015 to June 30, 2017.





Findings

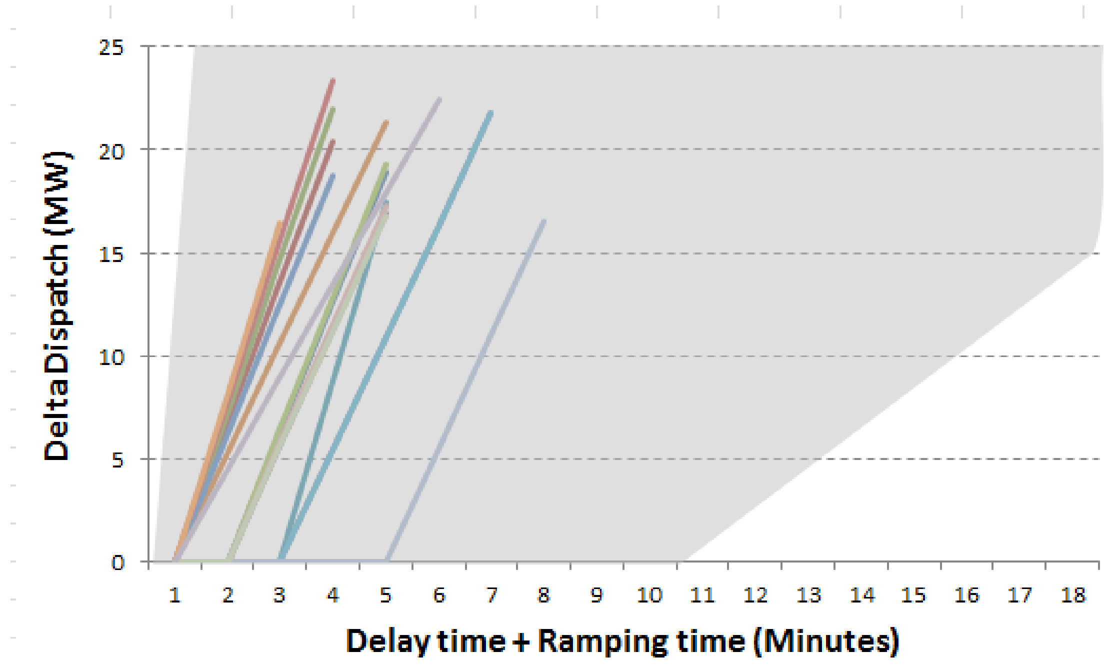
- The average ramp rate for the unit is 9.85 MW/Min, which is 33% faster than the submitted average ramp rate of 8 MW/min.
- Delay time was 5 minutes or less during 99% of the ramping events.

Example #3 – Simple Cycle Unit

Simple Cycle Unit – Ramping-up above MSG

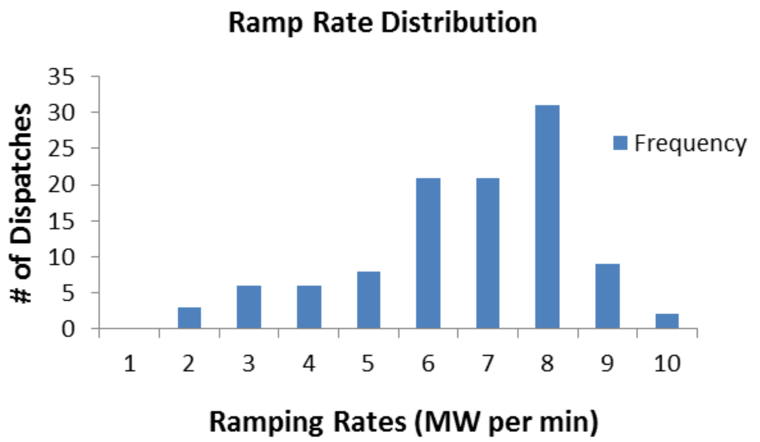
The lines shown in the chart illustrate the historical ramping-up movements and delay times for a sample unit from July 1, 2015 to June 30, 2017. These ramping events only apply to dispatch directives with a dispatch delta close to 20 MW.

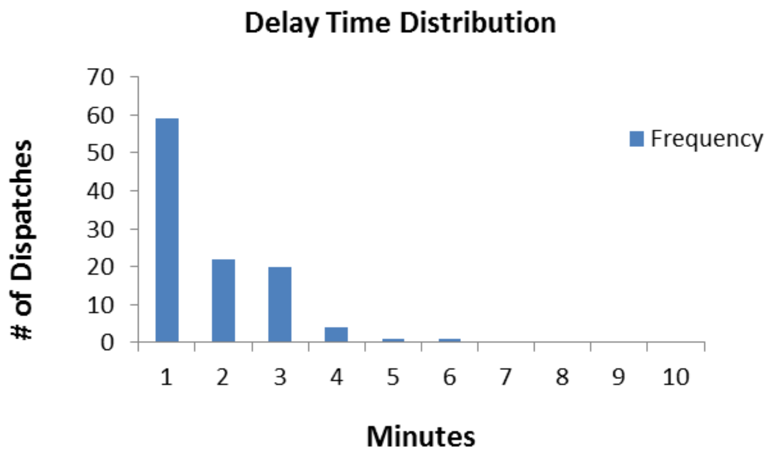
The gray shaded area shows the dispatch tolerance available to the unit, assuming a 20 MW dispatch up directive. Historical data show that the unit ramped up to the required level in 8 minutes or less during all dispatch directives.



Simple Cycle Unit - Ramping-up above MSG

The charts below summarize delay times and ramp rates calculations for all dispatch up instances from July 1, 2015 to June 30, 2017.





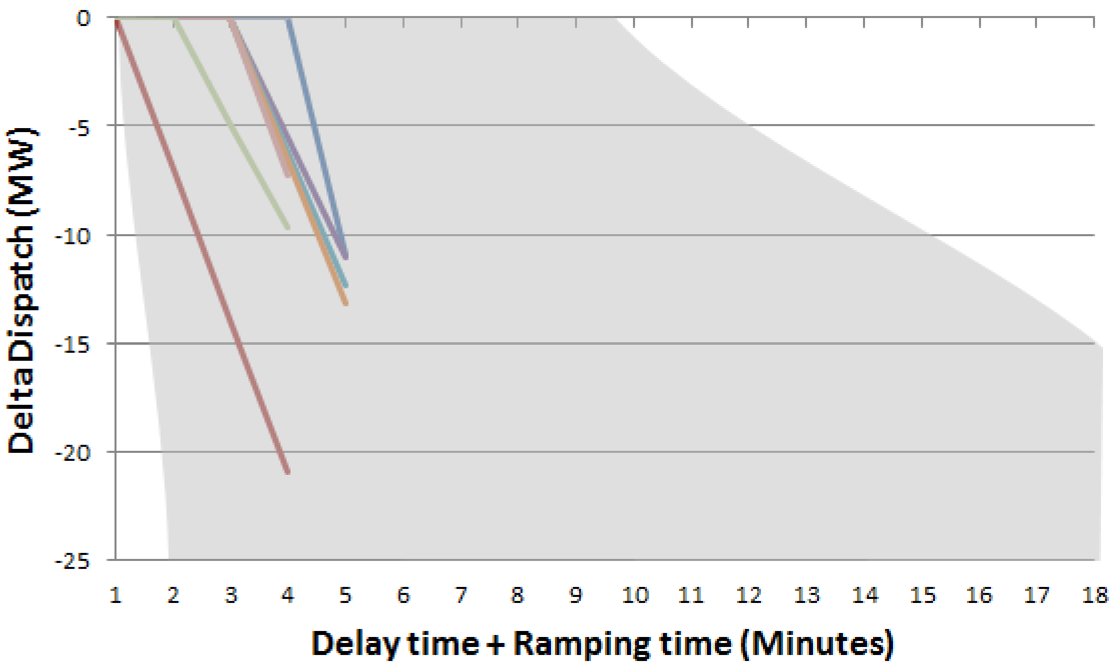
Findings

- The average ramp rate for the unit is 6.16 MW/Min, which is 23% slower than the submitted average ramp rate of 8 MW/min.
- Delay time was 5 minutes or less during 99% of the of the ramping events.

Simple Cycle Unit – Ramping-down

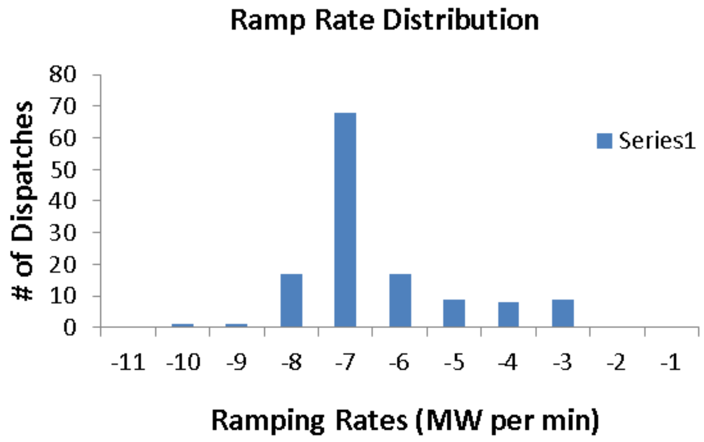
The lines shown in the chart illustrate the historical ramping-down movements and delay times for a sample unit from July 1, 2015 to June 30, 2017. These ramping events only apply to dispatch directives with a dispatch delta close to 20 MM.

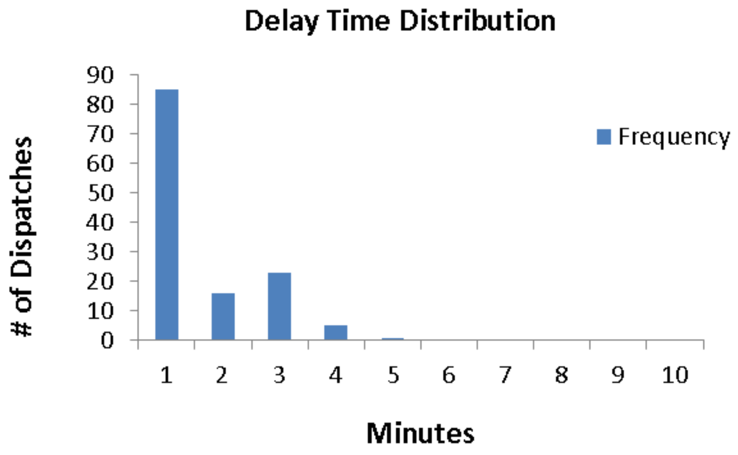
The gray shaded area shows the dispatch tolerance available to the unit, assuming a 20 MW dispatch down directive. Historical dispatches show that the unit ramped down to the required level in 4 minutes or less.



Simple Cycle Unit - Ramping-down

The charts below summarize delay times and ramp rates calculations for all dispatch down instances from July 1, 2015 to June 30, 2017.





Findings

- The average ramp rate for the unit is 6.97 MW/Min, which is 13% slower than the submitted average ramp rate of 8 MW/min.
- Delay time was 5 minutes or less during all ramping down events.

Options for discussion

- We will be looking for feedback on the need for a rule change
- We are developing approaches for a change and would like to use the WG to explore those changes, seek feedback on our approaches for improvement
- Options
  - Ramp by block
  - Compliance table
  - Other?

Ramp by block

- Allows participants to submit a different ramp rate for each P/Q pair in their energy market offer to more accurately reflect the assets capability at each MW level
- Consideration would need to be made if this is both ramp up and down for each P/Q pair
- Assumes that ramp rate differs by block – which may not be the case historically

Calculations for current average ramp submission

- An alternative to “ramp by block” may be a “distribution based tolerance rule” (illustrative example below)
- Ramp rates determined based on the relevant operating state of the asset, with tolerances established at the established lower, expected and upper ranges of the operating state. Would also include start/response time
- May provide a more clear association between operating state and the associated ramp characteristics of that state, rather than linking ramp to offer block

Starting	Response time	Ramp Rate	Lower Range	Expected Range	Upper Range
Cold	X Min	X MW/min	5% within +/- a to b std dev	90% within +/- c to d std dev	5% within +/- e to f std dev
MSG	Y Min	Y MW/min	Etc.	Etc.	Etc.
Hot	Z Min	Z MW/min	Etc.	Etc.	Etc.

Summary

- Rules that create more certainty around delay time and ramp rates can potentially mitigate future operational challenges and reduce need for additional OR products to manage ramping needs.
- The difference between submitted and calculated ramp rates highlights the importance of defining rules that allow the AESO to verify that actual ramp rates remain close to the ramp rates declared in our systems.
- The three units examined seemed to require a delay time of five minutes or less to start ramping in the direction of the dispatch. If this trend applies to most units, then there may be enough evidence to advance a rule change to reduce delay time based on historical ramping behaviour and future ramping needs.

Ancillary Service Approaches

Assessing various ancillary services approaches

- AB currently uses regulating reserve (RR) to manage moment to moment imbalances in supply/demand – procures additional RR for use to manage morning and evening load changes
- Otherwise use proactive dispatch, which is based off of expected ramping of marginal blocks
- Has considered load following and ramp product
  - Both would involve holding capacity aside for use as load following, or to provide capacity that can be called upon in response to a ramp up/down event – conditions and use need to be determined

Assessing various ancillary services approaches

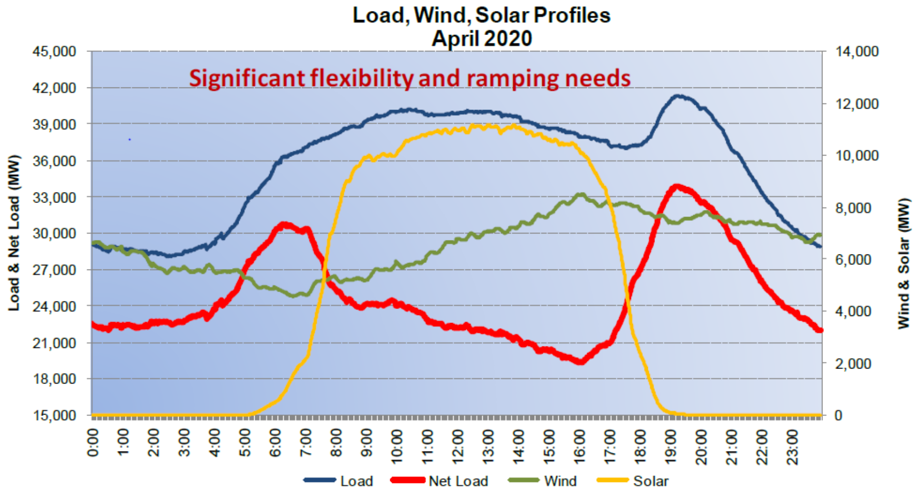
- Assessing needs for additional regulating reserves and value of faster regulating reserve products
  - How well does our existing fleet respond to AGC signals ?
  - Do we need more regulating reserves to deal with wind/load forecast uncertainty and increases in ramps ?
  - Can faster regulating reserve products reduce need for future increases ?
  - Evaluation of a separate Ramp Product
  - Alignment of AS products to expected Energy Market flexibility

Defining a separate ramp product

- Design considerations:
  - What is the trigger for pursuing a ramp product?
  - Would a ramp product incent flexible generation builds any better than other optons?
  - What is the time frame: 10-20 min product, etc.
- Procurement considerations:
  - Day ahead like OR market, or closer to real time?
  - Forecast uncertainty – how much to procure? What happens if our forecast is inaccurate?
- Utilization:
  - When do you use a ramp product? For what timeframe?
  - What triggers the dispatch/use of ramp product, versus EMMO, versus regulating reserve?

CAISO - Flexible Ramping Product

- CAISO implemented two market products in 15 min and 5 min markets: Flexible Ramp Up and Flexible Ramp Down uncertainty awards
- Purpose is to provide additional upward and downward flexible ramping capability to account for uncertainty due to demand and renewable forecasting errors
- CAISO load shape much different but worth looking at learnings from this market



CAISO ramp product to supplement system capabilities

- The flexible ramping product helps the system to maintain and use dispatchable flexibility. Dispatch ramp product after relying on system flexibility
- The flexible ramping product is the 5-minute ramping capability commodity, which will be dispatched to meet 5-minute to 5-minute net system demand changes, or net system movement, in RTD.
- The purpose of the flexible ramping products is to be able to cover the random net system demand in interval t+5 with a spread from the lower limit to the upper limit.
- In Alberta, system capability and needs are different and with more dispatch certainty, may not need / use ramp product. Evaluation in progress, need to determine what triggers will drive the need for a separate ramp product

CAISO – Real Time Market Time Frame

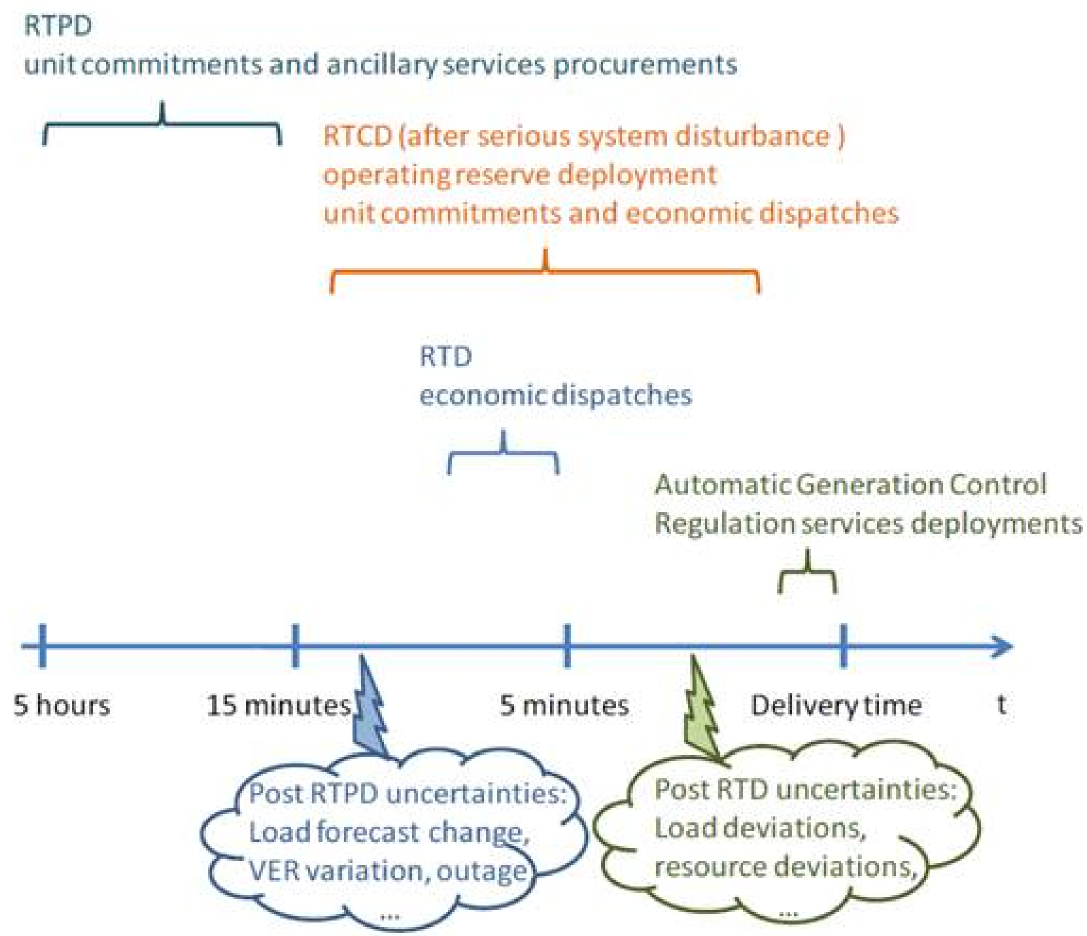


FIGURE 1: REAL-TIME MARKETS TIME FRAME

On November 1, 2016 the ISO implemented two market products in the 15- and 5-minute markets: Flexible Ramp Up and Flexible Ramp Down uncertainty awards. These products provide additional upward and downward flexible ramping capability to account for uncertainty due to demand and renewable forecasting errors. In addition, the existing flexible ramping sufficiency test was extended to ensure feasible ramping capacity for real-time interchange schedules.

Source: http://caiso.com/Documents/FlexibleRampingProductStrawProposal.pdf

Summary

Public

Flexibility options for considerations -- Adding each mechanism incrementally may push out in time NDV related challenges

Each reviewed in discussion material

Proposed Mechanism	Current Status	Issues/further notes
Dispatching the EMMO for ramp	Current practice	Based off of expected ramping of marginal blocks. Valuing ramp is embedded in energy market clearing price.
Shortening the Settlement Interval	Current pricing/settlement interval is 60 minutes	Shortening this period may align dispatch needs with a price signal or get closer – 15 minute settlement under evaluation.
Adjusting Ramp and Delay Tolerances	Requirements currently exist	Often not reflective of operating behavior. Rule could be adjusted to reflect historical ramp behaviour to provide certainty or response
Submitting Ramp by block (and optimizing dispatch accordingly)	Not in use Could adapt ramp field with reconciliation table	Allows greater visibility into the ramp capability of marginal blocks in EMMO. Potentially enables further optimization of dispatch.
Ramp Product	Not in use	Potential extended use of AGC or new product.

Summary

- Dispatch certainty
  - Small steps in moving towards certainty
  - Have participants submit ramp rates that better reflect operational characteristics
  - Adapt tools to better analyze ramp expectations
  - Rule changes – dispatch tolerance, ramp by block (or distribution based)
- Pricing
  - Leave as energy set on dispatch
  - Shorter settlement enhances incentives for load and generator response and value aligned with incentives
- AS products
  - No change to AGC
  - Assess ramp product as a future option – determine trigger

Next steps

- Input on analysis
- WG 3 – proposal
- WG 4 – recommendation
  - Including future consultation and timeline
  - Alignment with dispatchable renewable and storage project.

Thank you