Flexi Ramp Economics and Design Concepts

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Market Surveillance Committee Meeting
September 30, 2011
Folsom, California

Ramp Capability

These comments discuss concepts relating to the design and pricing of a real-time ramp capability product.

- They do not address treatment in the day-ahead market or RUC.
- They do not address cost allocation.

Ramping and Energy Market Dispatch

Traditional security constrained least cost dispatch minimized the cost of meeting load over a five- or ten-minute dispatch period, without regard to the cost of meeting load in subsequent intervals.

- Intemporal optimization of real-time dispatch as implemented by the New York ISO (2005) and California ISO (2009) also optimizes over time to account for *expected* future ramp requirements, such as those associated with top of the hour changes in net-interchange, a pump storage unit going on or off-line, or a generation unit going on or off-line.

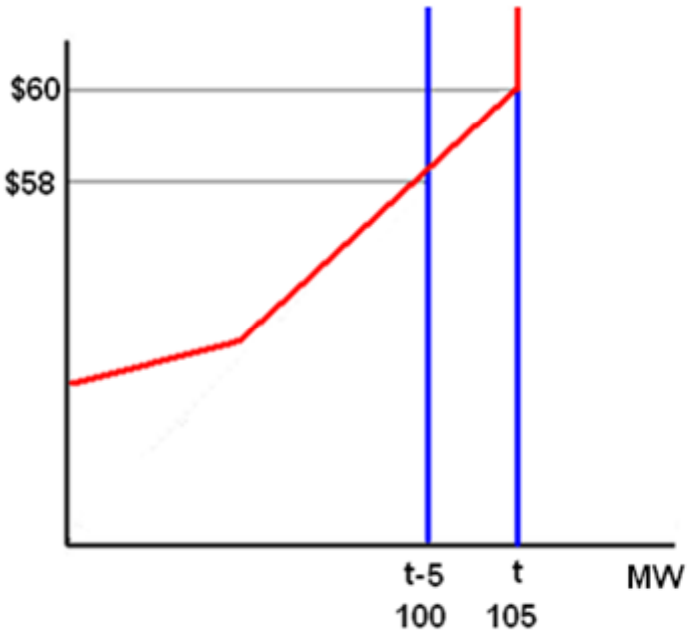
Ramping and Energy Market Dispatch

How can inter-temporal optimization create additional upward (or downward) ramp capability?

- Dispatching down (out of merit) resources whose available upward ramping capability is capacity limited, creates additional upward ramping capability.
- Their output is replaced with the output of higher cost units whose available ramping capability is not capacity constrained.
- Conversely, additional downward ramp capability can be created by dispatching up out-of-merit resources whose downward ramping capability is limited by their minimum load point.

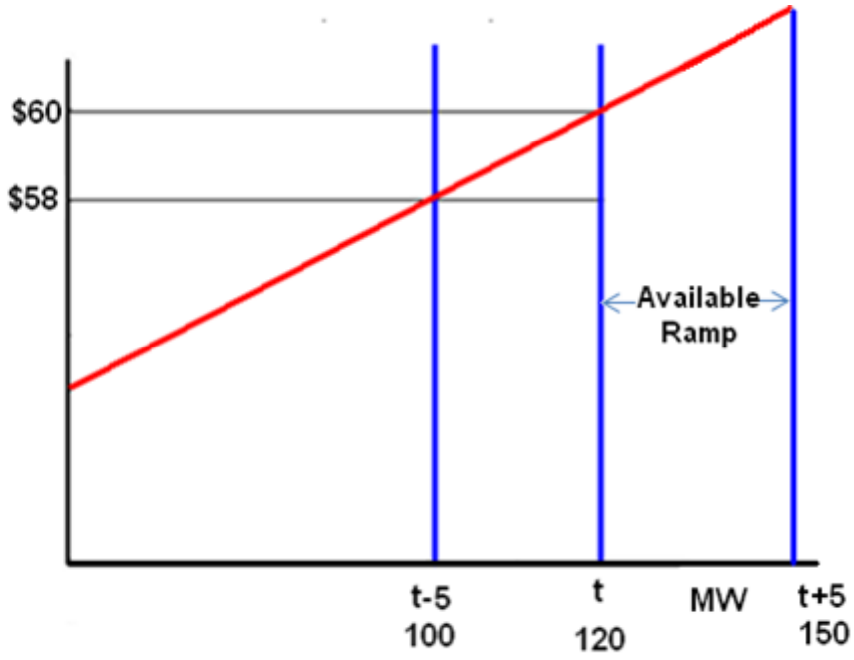
Conventional Dispatch: 30 Megawatts Upward Ramp Available t to t+5

No Ramp Available at t
Capacity Limited Unit



105 megawatt capacity
5 megawatt ramp rate

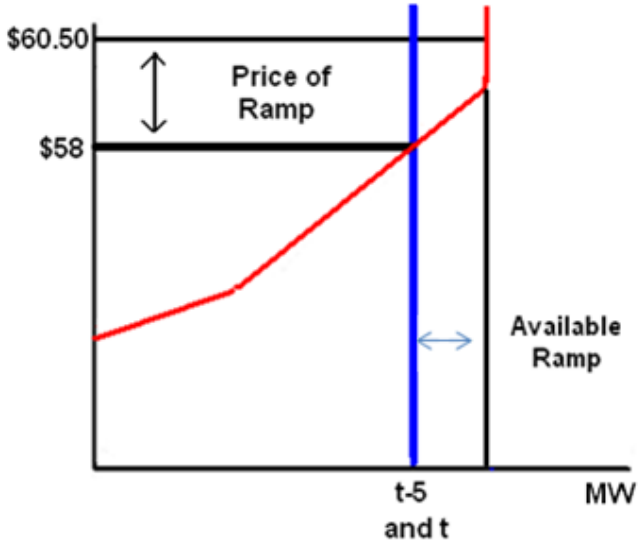
30 Megawatts Available at t
Ramp Limited Unit



200 megawatt capacity
30 megawatt ramp rate

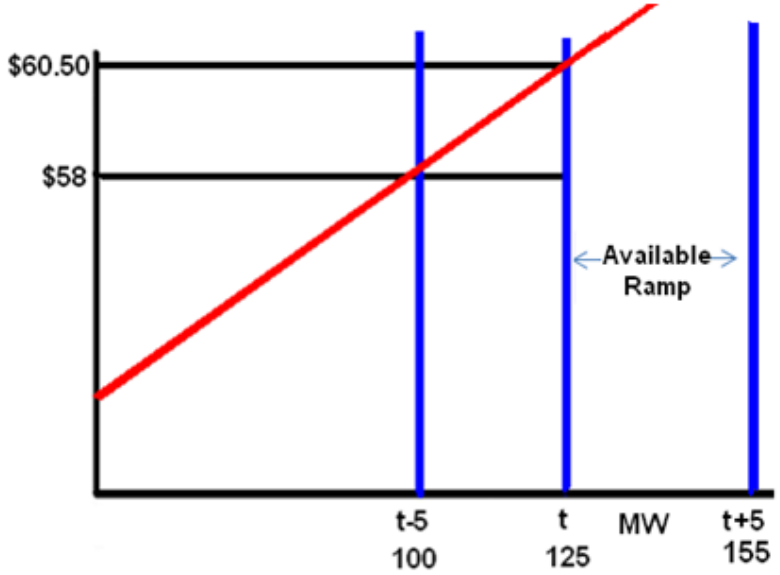
Out of Market Dispatch to Increase Upward Ramp: 35 Megawatts of Upward Ramp Available t to t+5

5 Megawatts Ramp Available at t
Capacity Limited Unit



105 Megawatt Capacity

30 Megawatts Available at t
Ramp Limited Unit



200 Megawatt Capacity

Ramping and Energy Market Dispatch

Current inter-temporal optimization algorithms schedule generation to provide additional ramp capability to avoid ramp constraints that are anticipated for future intervals based on projected future conditions.

- Accommodating intermittent generation entails scheduling additional ramping capability to respond to ramp constraints that cannot be projected, but could arise because of unpredictable changes in load or intermittent generation output.

Ramping and Energy Market Dispatch

If a penalty value for maintaining additional upward or downward ramp capability is included in the objective function for the real-time dispatch, the real-time dispatch will dispatch generation to maintain additional ramp capability if the additional capability is available at a cost lower than the specified penalty value.

- If the transmission system became ramp constrained and the value of ramp rose above the penalty value, ramp capability would be used to meet load and the penalty value for using up the extra ramp capability would be reflected in the spot price of energy for the current interval.

Ramp Capability Design

This ramping capability design has 3 parameters (each for up and down ramp capability) whose values determine the performance of the ramp capability product.

- Ramp capability target
- Ramp capability penalty value(s)
  - –By amount (ie demand curve)
  - – By interval (ie intertemporal weighting)
- Ramp capability offer price cap?

Ramp Capability Target

The Ramp Capability target is the amount of ramp capability that the dispatch for the current interval attempts to preserve for use in future intervals.

- Margin over ramp capability needed to meet forecast load in forward optimization;
- Margin could vary based on time of day, load trajectory, weather conditions, current intermittent resource output, and differ for upward and downward capability.
- No out-of-merit dispatch needed if available ramp exceeds target at zero cost.

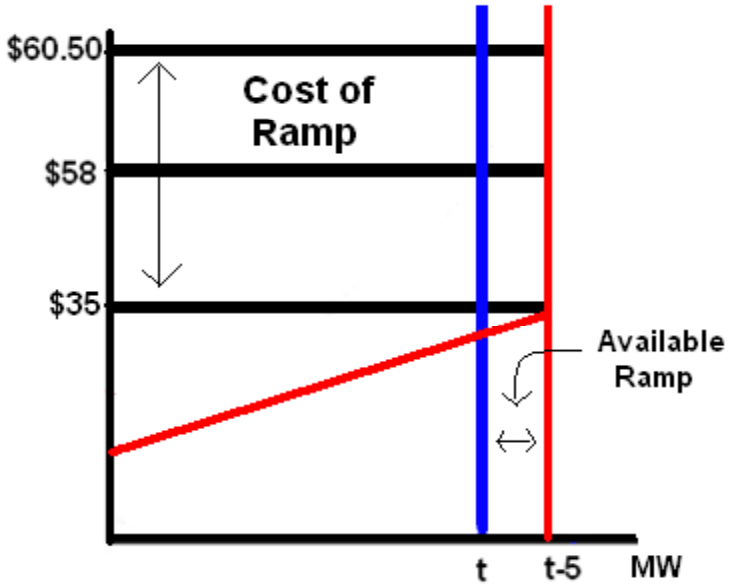
Ramp Capability Design

The ramp penalty value is the cost the ISO would be willing to incur in order to have additional ramp capability available in future intervals.

- This penalty value would differ for ramp up and ramp down, and could take different values for different quantities (ie a demand curve for extra ramp capability).
- They could also differ over future intervals in a multi-interval dispatch optimization.
- The penalty value is very important from two perspectives, it would not make economic sense to incur large costs in the current interval to maintain extra ramp that may never be needed; and it would not make sense to hold back rampable capacity that could be used to materially reduce the cost of meeting load.

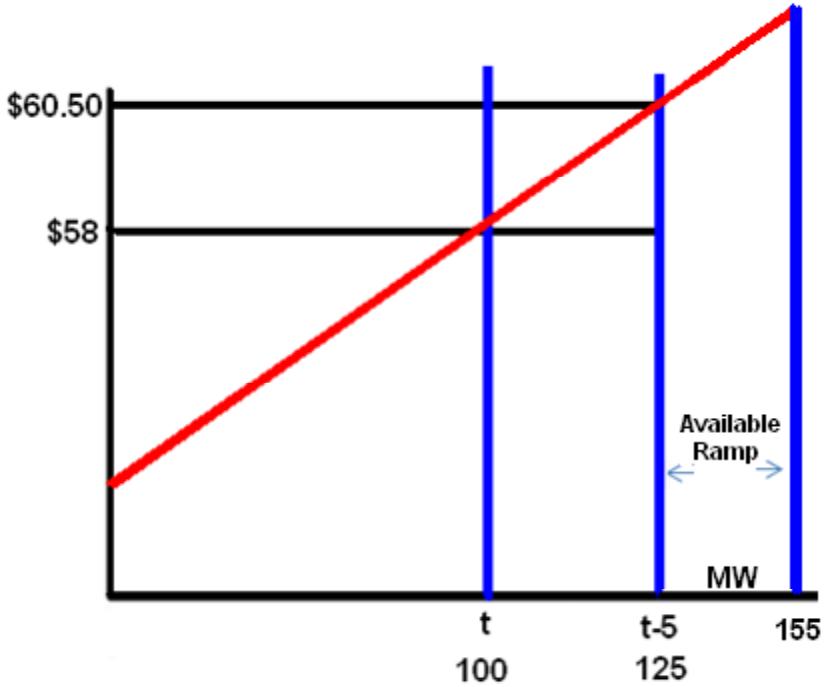
Out of Market Dispatch to Increase Upward Ramp On Marginal Units Can Be Very Expensive

5 Megawatts Ramp Available at t
Capacity Limited Unit



105 Megawatt Capacity

30 Megawatts Available at t
Ramp Limited Unit



200 Megawatt Capacity

Ramp Capability Design

The availability of high cost energy will contribute to maintaining reliability when generation is ramp constrained up but may not contribute much to reducing Production costs.

- It may therefore be desirable to account for the offer price of the rampable capacity counted towards meeting the ramp up target.
- A Ramp Capability offer price cap on the offer price of energy that is be counted towards meeting the ramp up target would be one way to address this.
- There could similarly be a floor on the energy offers counted towards the ramp down target.

Ramp Capability Pricing

In this design there will be a market price of ramp capability in RTD.

- When the target amount of ramp capability is available for less than the penalty price, the price of ramp will be set by the opportunity cost of ramping capability, which could be zero.
- When less than the target amount of ramp capability is scheduled, (because the cost of redisaptching generation to create ramp would exceed the penalty value or would not be available at any price) the price of ramp will be set by the penalty value for scheduling ramp.
- The price of ramp will be paid to all resources with undispatched ramp capability in the physical real-time-dispatch having energy price offers above the floor and below the cap.

Ramp Capability Benefits

It is not a forgone conclusion that use of a ramp capability product will be cost effective.

- It might turn out to be too expensive to schedule extra ramp except when it will be needed.
- It might turn out to be very hard to predict in advance when additional ramp capability will be valuable.

It will still be important to set appropriate penalty values in dispatch software for use of capacity providing reserves or regulation to meet load when the system is ramp constrained.