California ISO
Shaping a Renewed Future

Contingency Modeling Enhancements

Issue Paper Discussion

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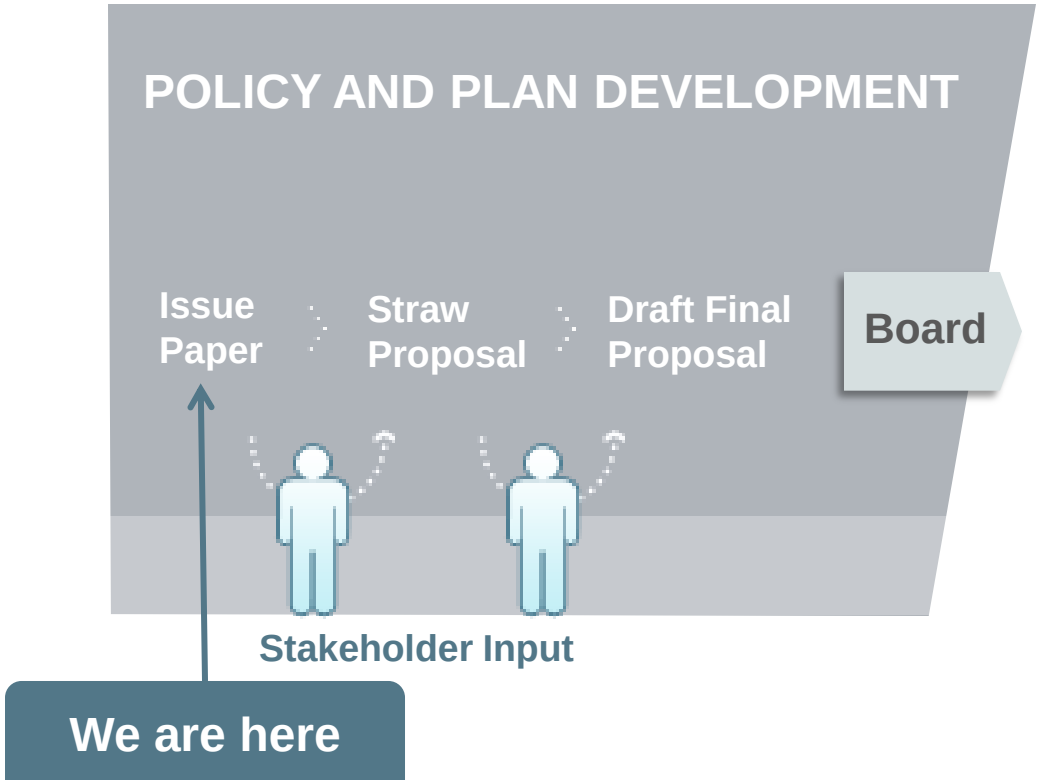
Agenda

Time	Topic	Presenter
10:00 – 10:05	Introduction	Tom Cuccia
10:05 – 10:15	Background and Purpose	Delphine Hou
10:15 – 11:45	Preventive-Corrective Constraint	Delphine Hou
11:45 – 12:00	Next Steps	Tom Cuccia

ISO Policy Initiative Stakeholder Process



Background and purpose

- 2012 Stakeholder Initiatives Catalog: *Additional Constraints, Processes, or Products to Address Exceptional Dispatch*
  - Highly ranked by stakeholders and ISO
  - Priority issue: 30 minute operating reserve
- NERC/WECC standard to transition the system back to a secure state within 30 minutes after a system disturbance
  - ISO currently relying on combination of exceptional dispatches and minimum online commitment constraints (MOC) to meet standard
- This initiative seeks alternatives to the use of exceptional dispatch and MOC constraints to address NERC/WECC standard and generation contingencies

Issue paper

- Includes technical explanation of a proposed preventive-corrective constraint to facilitate discussion with stakeholders

- The preventive-corrective constraint is proposed because:
  - It can model post-contingency need in market optimization (rather than determining need on a static basis pre-contingency)
  - Compensates affected generators through LMP and potentially through a separate capacity payment when applicable
  - Is a framework that can consider both post-contingency preventive-corrective constraints and generation contingencies

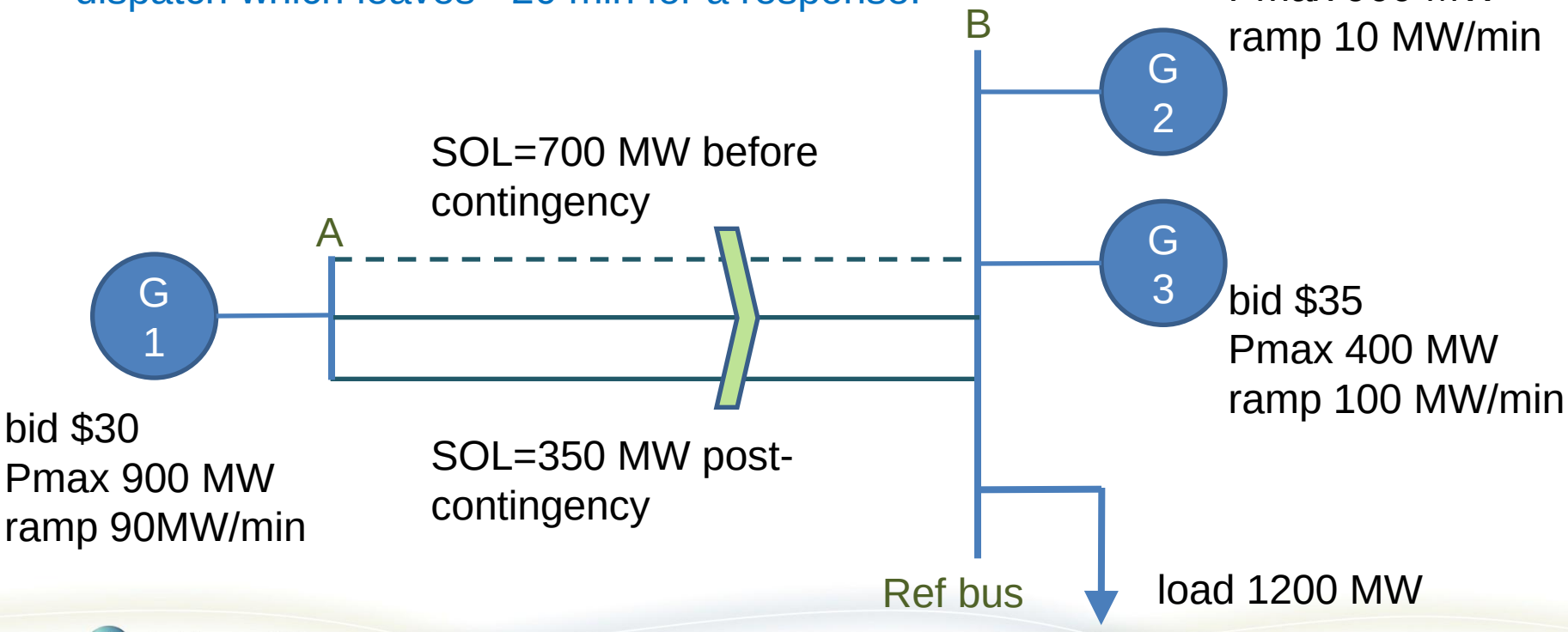
Why a preventive-corrective constraint to address WECC/NERC standard?

- Comparison amongst potential solutions

	Addresses:	Procurement of capacity	Locational definition	Bid
10 min contingency reserves	NERC/WECC operating reserve requirements	Based on NERC/WECC standards	System-wide – does not consider deliverability	Reflected in LMP
Exceptional dispatch	As specified in ISO tariff	Operator judgment	Location specific based on operator judgment	Not reflected in LMP
MOC constraint	NERC/WECC 30 min contingency and non-flow-based constraints	Predefined static region and requirement	Pre-defined static location	Not reflected in LMP
Preventive-corrective constraint	NERC/WECC 30 min contingency and generation contingencies	Co-optimized solution	Location specific based on transmission constraints	Reflected in LMP and potential capacity payment

An example

There are 3 lines each with thermal rating of 400 MW. Assume N-1 secure system operating limit (SOL)=700 MW with all 3 lines in service. One line trips (dashed line) but SOL of 700 MW keeps the system in a normal state, albeit insecure. Based on NERC/WECC standard, the ISO must transition to a secure state within 30 minutes to the new SOL of 350 MW.
Assume ISO operators need ~10 min to run contingency dispatch which leaves ~20 min for a response.



ISO's current model: weak preventive model solution

Pre-contingency

Gen	Dispatch	Bid	Ramp rate	LMP^{EN}	LMP^{CONG}	LMP	Bid cost	Revenue	Profit
G1	700	$30	90	$50	–$20	$30	$21,000	$21,000	$0
G2	100	$50	10	$50	$0	$50	$5,000	$5,000	$0
G3	400	$35	100	$50	$0	$50	$14,000	$20,000	$6,000
total	1,200	N/A	N/A	N/A	N/A	N/A	$40,000	$46,000	$6,000

- Pre-contingency merit order:
  - G1 (constrained by SOL of 700 MW)
  - G3 (constrained by Pmax)
  - G2
- A-B congestion shadow price $20/MWh

ISO's current model: weak preventive model solution

Pre-contingency (modeled)

Gen	Dispatch	Bid	Ramp rate	LMP	Profit
G1	700	$30	90	$30	$0
G2	100	$50	10	$50	$0
G3	400	$35	100	$50	$6,000
total	1,200	N/A	N/A	N/A	$6,000

Post-contingency (not-modeled)

Gen	Dispatch	Bid	Ramp rate	LMP	Profit
G1	**350**	$30	90	$30	$0
G2	**300**	$50	10	$50	$0
G3	400	$35	100	$50	$6,000
total	**1,050**	N/A	N/A	N/A	$6,000

- If contingency occurs, within 20 minutes the following happens:
  - G1 will ramp down to 350 MW (constrained by new SOL of 350 MW)
  - G2 will ramp up to 300 MW limited by ramp rate (which can only ramp 10 MW/min x 20 min = 200 MW)
  - G3 stays at 400 MW (Pmax)
  - However, 350+300+400 = 1,050 MW < 1,200 MW load, so the system is short 150 MW upward corrective capacity at location B

Proposed: Preventive-corrective model solution

Pre-contingency weak preventive model solution

Gen	Dispatch	Bid	Ramp rate	LMP	Profit
G1	700	$30	90	$30	$0
G2	100	$50	10	$50	$0
G3	400	$35	100	$50	$6,000
total	1,200	N/A	N/A	N/A	$6,000

- Since G2 is ramp limited, to create upward capacity, the preventive-corrective model will dec G3 down to 250 MW to provide the 150 MW corrective capacity
- This opportunity cost of $15 is reflected in the locational marginal capacity price (LMCP) at location B

Preventive-corrective model solution

	Pre-contingency energy schedule					Corrective capacity				
	[A]				[1]	[B]		[2]	= [A] + [B]	= [1] + [2]
Gen	Scheduled MW	Bid	Ramp rate	LMP	Energy profit	Re-dispatch	LMCP	LMCP profit	Post-cont. schedule MW	Total profit
G1	700	$30	90	$30	$0	–350	$0	$0	350	$0
G2	250	$50	10	$50	$0	200	$15	$3,000	450	$3,000
G3	250	$35	100	$50	$3,750	150	$15	$2,250	400	$6,000
total	1,200	N/A	N/A	N/A	$3,750	0	N/A	$5,250	1,200	$9,000

Preventive-corrective model solution: LMCP versus opportunity cost

	Energy		Corrective capacity - LMCP		Total w/ LMCP	Corrective capacity – Opp. cost		Total w/ opp. cost
Gen	Dispatch	Energy profit	LMCP	Profit LMCP	**Total Profit**	Opp. cost	Profit opp. cost	**Total Profit**
G1	700	$0	$0	$0	**$0**	$0	$0	**$0**
G2	250	$0	$15	$3,000	**$3,000**	$0	$0	**$0**
G3	250	$3,750	$15	$2,250	**$6,000**	$15	$2,250	**$6,000**
total	1,200	$3,750	N/A	$5,250	**$9,000**	N/A	$2,250	**$6,000**

- The table above compares the total profit based on either the LMCP or an opportunity cost only approach.
- Like LMPs, LMCP will be paid to all generators at location B (uniform market clearing price). Both G2 and G3 are compensated and total profit under this solution is higher than current weak preventive solution.
- On the other hand, only G3 has an opportunity cost and only G3 is compensated (similar to pay as bid). Total profit under this solution is the same as the current weak preventive solution.

MSC observations

- Preventive-corrective constraint is a more efficient approach to address contingencies than current procurement methodology for operating reserves. It is flow-based so it will address regional needs versus a system-wide requirement.
- Prices should be higher in a constrained node and generators at that node should be compensated at the nodal price.
- The corrective capacity is separate from energy and (like the flexi-ramp product) should be compensated.
- While we may be able to identify each unit's opportunity cost, we still want to incentivize the infra-marginal unit to improve its flexibility (*i.e.,* ramping capability).

Issues to be addressed

- Should the compensation for corrective capacity be akin to a market clearing price (LMCP) or pay as bid to the resource(s) incurring an opportunity cost?
- What are the cost implications to load over the short-term? Over the long-term?
- What are the compensation implications to generation over the short-term? Over the long-term?
- How can compensation incentivize real-time performance?
- What should the appropriate cost allocation be? To whom?

Next Steps

Item	Date
Post Issue Paper	3/11/2013
MSC presentation*	3/19/2013
Stakeholder Conference Call	3/26/2013
Stakeholder Comments Due	4/9/2013
Post Straw Proposal	5/15/2013
Stakeholder Meeting	5/22/2013
Stakeholder Comments Due	6/4/2013
Post Draft Final Proposal	7/1/2013
Stakeholder Call	7/9/2013
Stakeholder Comments Due	7/24/2013
Board Meeting	9/12-13/2013

Please submit comments to ContingencyModeling@caiso.com

*Will bring this issue to another MSC meeting closer to the draft final proposal

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Date	Training
April 9	Introduction to ISO Markets
April 10-11	Market Transactions
April 18	Welcome to the ISO (webinar)
April 23	Settlements 101
April 24	Settlements 201

Training calendar - http://www.caiso.com/participate/Pages/Training/default.aspx
Contact us - markettraining@caiso.com