Contingency Modeling Enhancements

Prototype Analysis with Production Cases
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Agenda

Time	Topic	Presenter
1:00-1:05	Introduction & background	Perry Servedio
1:05-2:00	Analysis results	Dr. Lin Xu

Background

- In 2013, ISO began building the CME prototype to test how the preventive-corrective constraint would perform in practice.
  - One simple goal: does the constraint work?
- Presented technical analysis preliminary results to MSC on 2/3/2017
  - MSC had questions about how the prototype behaves when it cannot economically clear less load
  - MSC had questions about if we verified benefits of using the CME vs. MOC
- Presented more technical analysis results to MSC on 7/10/2017
  - Finalized results from stressed scenarios
  - Results from parallel operations
  - Began to answer question related to load-clearing behavior

EXECUTIVE SUMMARY

Executive summary

- The CME constraint ensures that effective unloaded capacity is available to meet the reliability standard via unit commitments and positioning units, and CME may also leverage bid-in demand

- Under realistic system conditions, even when the system is stressed, CME is unlikely to bind

- When the CME constraint is binding, it sends correct market price signals to the system

- Generally, CME commits less units and costs less to the market than MOC, and CME can increase market efficiency

PURPOSE

Purpose

- We broke from the initial simple objective for three specific purposes:
  - We wanted to see if corrective capacity is sufficient in the system, and when its not, observe how CME resolves the reliability concern.
  - We wanted to observe how CME may impact the market in terms of commitment and cost, particularly compared with the minimum online commitment (MOC) constraint
  - We wanted to get a sense of how frequently CME constraint may bind in the market on a day-to-day basis

- The following analyses address these purposes:
  - Analysis of stressed system scenarios
  - Analysis of MOC commitment and CME commitment
  - Analysis of reliability constraint efficiency
  - Parallel operations

ANALYSIS OF STRESSED SYSTEM SCENARIOS

Analysis of stressed system scenarios

Methodology

- Selected 12 scenarios to test
  - Chose six different network conditions
    - Major path outages
  - Test each network condition in two seasons
    - Spring
    - Summer

Network condition	Season 1	Season 2
N0. All lines in service	N0S1	N0S2
N1. Path 26 outage	N1S1	N1S2
N2. Path 15 outage	N2S1	N2S2
N3. COI (PACI) outage	N3S1	N3S2
N4. SCIT outage	N4S1	N4S2
N5. SDGE IMP BG outage	N5S1	N5S2

Analysis of stressed system scenarios
Methodology

- Built CME cases
  - Selected day-ahead production cases matching the scenarios
  - Built the CME cases
    - Defined and enabled all CME contingencies in all scenarios
    - Used appropriate ratings for system condition and season
    - Set 20 minute corrective timeframe
    - Created outages to further stress the case
    - Removed relevant MOCs
- Compared CME cases to same case but without CME enabled and without MOC enforced

Analysis of stressed system scenarios

Analysis results

- CME constraint binds in 1 of 12 scenarios
  - SDGE Import Limit (Summer)
- CME confirms enough unloaded 20-minute capacity in 11 of 12 scenarios
- CME confirms/allows reliable transmission system without using MOC in all 12 scenarios

Analysis of stressed system scenarios

Analysis results – non-binding scenarios

Non-binding scenarios

- CME confirms enough capacity to meet the reliability standard

Scenario	Date:hour (GMT)	CME case	Path	Path Flow	Post-Contingency Rating	Capacity Required	Unloaded Capacity
N0S1	02FEB2015:02	CME_PACI	PACI_MSL	2523	1834	689	1282
N0S2	30MAR2015:22	CME_PACI	PACI_MSL	3288	1834	1454	3846
N1S1	31MAY2015:03	CME_PATH26	PATH26_BG	1301	1000	301	714
N1S2	04OCT2015:01	CME_PATH26	PATH26_BG	3343	1000	2343	4481
N2S1	02JUN2015:14	CME_PATH15	PATH15_BG	2008	2650	0	1267
N2S2	30MAR2015:07	CME_PATH15	PATH15_BG	3079	2650	429	1404
N3S1	05DEC2014:04	CME_PACI	PACI_MSL	2175	1633	542	2435
N3S2	06OCT2015:16	CME_PACI	PACI_MSL	2382	1333	1049	1552
N4S1	04MAY2015:16	CME_SCIT	SCIT_BG	8722	13750	0	3870
N4S2	09OCT2015:23	CME_SCIT	SCIT_BG	13541	14920	0	392
N5S2	06OCT2015:19	CME_SDGE	CME_SDGE	1943	1400	543	910

Analysis of stressed system scenarios

Analysis results – binding scenario

Binding scenario

- CME binds in four hours under SDGE contingency
- CME procures enough corrective capacity in binding scenario
- CME lowers pre-contingency flows
- CME de-commits El Cajon to award corrective capacity

Scenario	Date:hour (GMT)	CME case	Path	CME Flow	Post-Contingency Rating	Capacity Required	Corrective Capacity	Shadow Price	No CME Flow	No CME Available Capacity
N5S1	23JUL2016:00	SDGE	SDGEIMP_BG	1919	1400	519	531	18.87	2264	275
N5S1	23JUL2016:01	SDGE	SDGEIMP_BG	1921	1400	521	521	11.64	2183	273
N5S1	23JUL2016:02	SDGE	SDGEIMP_BG	1906	1400	506	517	7.06	2066	273
N5S1	23JUL2016:03	SDGE	SDGEIMP_BG	2065	1400	665	674	6.16	2170	363

Analysis of stressed system scenarios

Analysis results – binding scenario

Price impact

- SDGE DLAP sees higher LMP than SCE
- LMPs higher than non-CME/non-MOC cases by the cost of corrective capacity

	PG&E				SCE				SDGE				VEA			
	LMP		Congestion		LMP		Congestion		LMP		Congestion		LMP		Congestion	
	CME	*No CME*	*CME*	*No CME*	*CME*	*No CME*	*CME*	*No CME*	*CME*	*No CME*	*CME*	*No CME*	*CME*	*No CME*	*CME*	*No CME*
23JUL2016:00	51.32	50.48	-7.28	-7.51	63.03	65.77	1.69	4.85	84.19	68.2	20.35	4.56	60.57	62.88	1.06	3.98
23JUL2016:01	60.18	60.25	-2.38	-1.65	65.11	65.92	-0.26	1.11	79.57	68.77	11.33	1.05	63.62	64.21	-0.41	0.92
23JUL2016:02	59.98	60	-2.09	-1.26	65.28	65	0.32	0.81	75.16	67.95	7.31	1.03	63.76	61.78	0.15	-0.94
23JUL2016:03	49.98	50	-0.6	-1.76	52.27	55	-0.6	1.09	60.79	57.98	5.56	1.6	50.93	50.09	-0.6	-2.4

Analysis of stressed system scenarios

Analysis results – binding scenario

Ancillary services impact

- Minor impact on A/S procurement between CME case and non-CME/non-MOC case.

Scenario	Date:hour (GMT)	Commodity	Region	MW with CME	MW without CME	Price with CME	Price without CME
N5S1	23JUL2016:00	En	SDGE	4195	4364	84.19	68.20
N5S1	23JUL2016:01	En	SDGE	4107	4276	79.57	68.77
N5S1	23JUL2016:02	En	SDGE	4061	4145	75.16	67.95
N5S1	23JUL2016:03	En	SDGE	4056	4090	60.79	57.98
N5S1	23JUL2016:01	Up AS	SP26	982	963	0	0
N5S1	23JUL2016:02	Up AS	SP26	1076	961	0	0
N5S1	23JUL2016:03	Up AS	SP26	928	818	0	0
N5S1	23JUL2016:04	Up As	SP26	655	578	0	0

Analysis of stressed system scenarios
Analysis results – other observations

Other observations

- How does the constraint behave if it cannot economically clear less load?
- Does CME commit more units to meet the reliability concern as expected?
- Used the binding N5S1 scenario
  - Base case with no-CME/no-MOC to get cleared demand
  - Fixed the demand to this level in a CME case
- Optimization commits three more units and de-commits one unit to provide corrective capacity

ANALYSIS OF MOC COMMITMENT AND CME COMMITMENT

Analysis of MOC commitment and CME commitment
Methodology

- How does CME impact unit commitment? Does CME commit more resources than the associated MOC?

- Selected a non-binding CME day

- Compared CME commitment of resources in the MOC definition to the MOC requirement
  - Some of the MOC requirements are conservatively defined to meet the reliability criteria
  - CME resolves the reliability criteria with less commitments
  - The CME constraints are not over-committing units to result in the non-binding outcome

Analysis of MOC commitment and CME commitment

Results

Date	Hour	MOC	MOC Requirement	CME MOC Supply
4-Dec-14	10	MOC NP15	3,350	3,211
4-Dec-14	11	MOC NP15	3,315	3,211
4-Dec-14	14	MOC NP15	3,297	3,213
4-Dec-14	8	SCIT MOC	4,600	4,205
4-Dec-14	9	SCIT MOC	4,600	4,205
4-Dec-14	10	SCIT MOC	4,600	4,205
4-Dec-14	11	SCIT MOC	4,600	4,249
4-Dec-14	12	SCIT MOC	4,600	4,249
4-Dec-14	13	SCIT MOC	4,600	4,249
4-Dec-14	14	SCIT MOC	4,600	4,249
4-Dec-14	15	SCIT MOC	4,600	4,249
4-Dec-14	16	SCIT MOC	4,600	4,249
4-Dec-14	17	SCIT MOC	4,600	4,249
4-Dec-14	18	SCIT MOC	4,600	4,358
4-Dec-14	19	SCIT MOC	4,600	4,358
4-Dec-14	20	SCIT MOC	4,600	4,358
4-Dec-14	21	SCIT MOC	4,600	4,249

ANALYSIS OF RELIABILITY CONSTRAINT EFFICIENCY

Analysis of Reliability constraint efficiency

- How does the constraint impact the market in terms of total production cost?
- Directly compared total cost of CME constraints versus their equivalent MOC constraints to estimate the market efficiency improvements that the CME may provide
- We wanted to isolate the cost difference that can be attributed to CME, not difference in load or other complicating factors
  - Ran MOC case with fixed bid-in demand
  - Ran CME case with same fixed bid-in demand
- CME constraint meets the reliability criteria at less cost

Model	Minimum cost to meet load
CME	$7,168,661
MOC	$7,179,846
CME cost saving	$11,185

PARALLEL OPERATIONS

Parallel operations

- To support policy decision related to the CRR market: how frequent might this constraint bind in practice?
- CME in parallel operations for two week period at the end of March through the beginning of April
- Enforced constraints consistent with the system conditions
- Over the period of parallel operations, the preventive-corrective constraint did not bind
- Further indicates that there may be a low likelihood of the constraint binding in practice

CONCLUSION

Conclusion

- Stressed scenarios and parallel operations indicate that under realistic conditions, CME is unlikely to bind
  - In these cases, MOCs are not necessary for meeting the reliability standard

- Generally, CME would commit less capacity than MOC and can replace the MOC with higher market efficiency
  - When CME constraints are not binding, CME commits less capacity than what MOC requires
  - CME saves total production cost than MOC in meeting the same load

- Under stressed scenario where corrective capacity is required, CME performs as expected from a pricing, capacity procurement, and commitment standpoints

- CME constraints are more precise and efficient than the MOC constraints to manage the reliability criteria, and CME can increase market efficiency

QUESTIONS