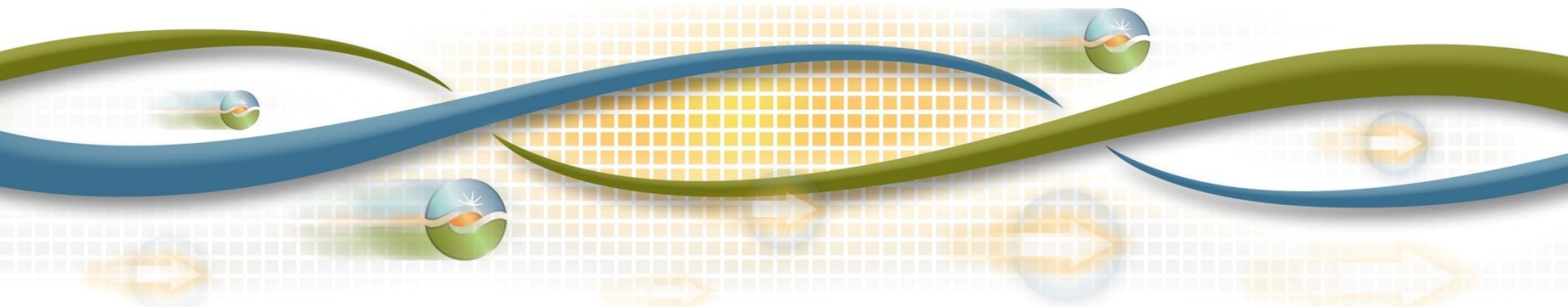




California ISO
Shaping a Renewed Future

Energy Imbalance Market Technical Workshop

Flexible Ramp Capacity Constraints
August 13, 2013



Overview

- Flexible Ramp Sufficiency Test
- Flexible Ramp Capacity Constraints
 - ◆ When Flexible Ramp Sufficiency Test Fails
 - ◆ When Flexible Ramp Sufficiency Test Passes

Flexible Ramp Sufficiency Test

- Performed for each EIM Entity BAA
 - ◆ After $T-75'$, $T-55'$, and $T-40'$ for the Trading Hour starting at T
- Data Used:
 - ◆ Initial schedules at $T-7.5'$
 - ◆ EIM resources energy bids and ramp rates
 - ◆ 15' Flexible Ramp requirements
 - Reduced by any diversity benefit up to available import capability
- Cumulative test for meeting Flexible Ramp requirements for each 15' interval of the hour
 - ◆ 15' ramp from $T-7.5'$ to $T+7.5'$ (1st 15' interval)
 - ◆ 30' ramp from $T-7.5'$ to $T+22.5'$ (2nd 15' interval)
 - ◆ 45' ramp from $T-7.5'$ to $T+37.5'$ (3rd 15' interval)
 - ◆ 60' ramp from $T-7.5'$ to $T+52.5'$ (4th 15' interval)

Flexible Ramp Capacity Constraints

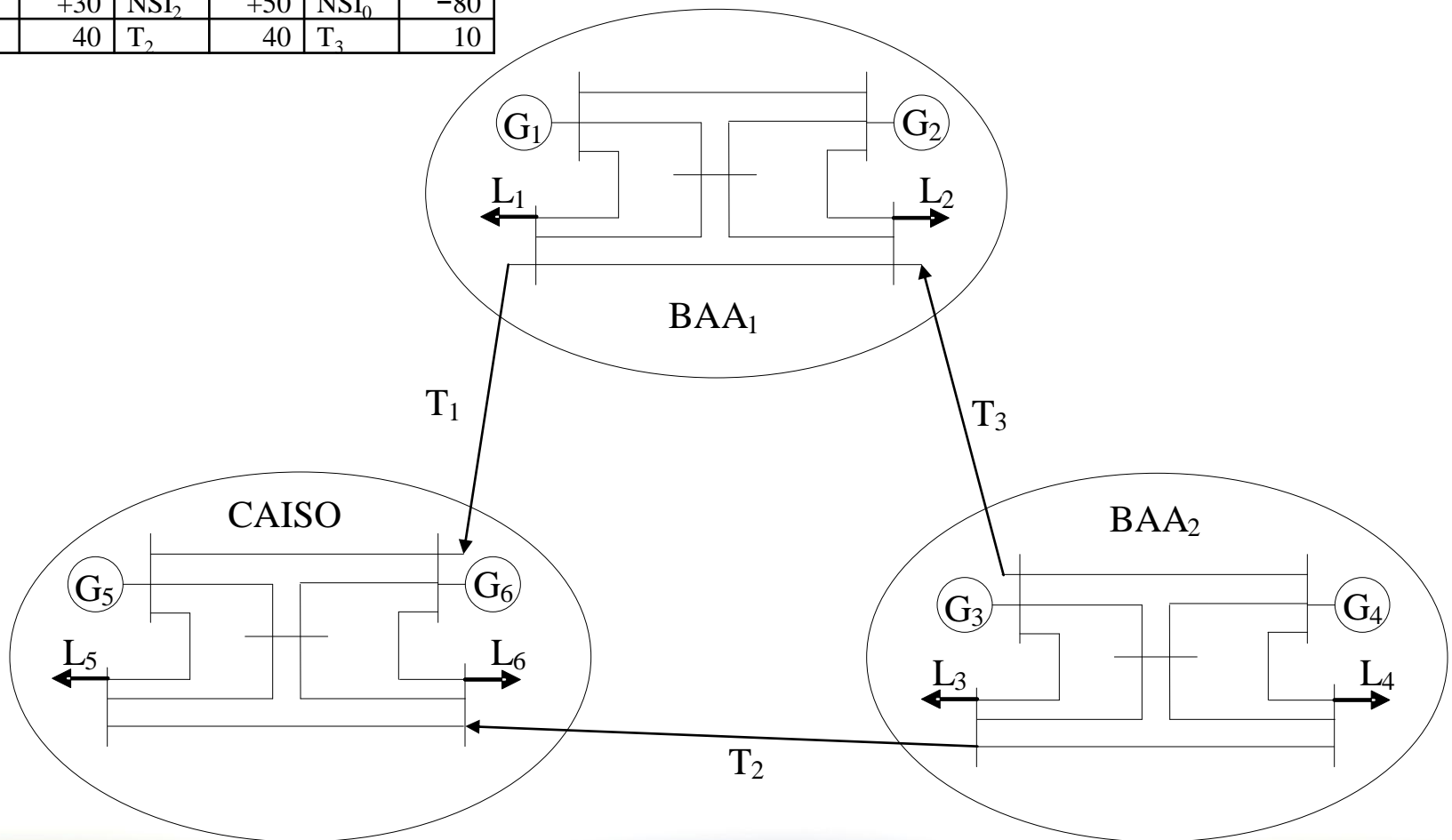
- When Flexible Ramp Sufficiency Test Passes
 - ◆ Bottom-Up hierarchical constraints for all BAA combinations
 - ◆ Requirement reduced by available import capability
- When Flexible Ramp Sufficiency Test Fails
 - ◆ Failed EIM BAA is excluded from group constraints
 - ◆ Net Import Interchange for failed EIM BAA is capped at last schedule for *T-75'*

Example Assumptions

- CAISO BAA and two EIM BAAs
- All inerties rated at 50MW
- Two generators and two loads in each BAA
- Real-Time Unit Commitment run at $T-37.5'$
- No transmission losses
- Only upward Flexible Ramp Capacity
- Flexible Ramp Capacity requirement determined solely by demand forecast change

15' Schedules at $T=7.5'$

BAA ₁		BAA ₂		CAISO	
G ₁	80	G ₃	60	G ₅	60
G ₂	50	G ₄	90	G ₆	60
L ₁	40	L ₃	30	L ₅	100
L ₂	60	L ₄	70	L ₆	100
NSI ₁	+30	NSI ₂	+50	NSI ₀	-80
T ₁	40	T ₂	40	T ₃	10



Case 1: Flexible Ramp Sufficiency Test Pass

BAA	Resource	Initial Schedule	UEL	Ramp Rate	15' FRC	30' FRC	45' FRC	60' FRC
BAA ₁	G ₁	80	100	1	15	20	20	20
	G ₂	50	100	1	15	30	45	50
	<i>Total</i>	130	200		30	50	65	70
BAA ₂	G ₃	60	100	1	15	30	40	40
	G ₄	90	100	1	10	10	10	10
	<i>Total</i>	150	200		25	40	50	50

BAA		T-7.5'	T+7.5'	T+22.5'	T+37.5'	T+52.5'
BAA ₁	L ₁ + L ₂	100	110	120	130	140
	Cumulative Flexible Ramp Requirement		10	20	30	40
	Flexible Ramp Test		✓	✓	✓	✓
BAA ₂	L ₃ + L ₄	100	110	120	130	140
	Cumulative Flexible Ramp Requirement		10	20	30	40
	Flexible Ramp Test		✓	✓	✓	✓

Case 1: Flexible Ramp Capacity Constraints

- $FRC_0 \geq \max(0, FRR_0 - 10 - 10)$
- $FRC_1 \geq \max(0, FRR_1 - 50 - 40)$
- $FRC_2 \geq \max(0, FRR_2 - 50 - 50)$
- $FRC_0 + FRC_1 \geq \max(0, FRR_0 + FRR_1 - 10 - 40)$
- $FRC_0 + FRC_2 \geq \max(0, FRR_0 + FRR_2 - 10 - 50)$
- $FRC_1 + FRC_2 \geq \max(0, FRR_1 + FRR_2 - 50 - 50)$
- $FRC_0 + FRC_1 + FRC_2 \geq FRR_{Tot} \leq FRR_0 + FRR_1 + FRR_2$

Case 2: Flexible Ramp Sufficiency Test Fail

BAA	Resource	Initial Schedule	UEL	Ramp Rate	15' FRC	30' FRC	45' FRC	60' FRC
BAA ₁	G ₁	80	100	1	15	20	20	20
	G ₂	50	100	1	15	30	45	50
	<i>Total</i>	130	200		30	50	65	70
BAA ₂	G ₃	60	100	1	15	30	40	40
	G ₄	90	100	1	10	10	10	10
	<i>Total</i>	150	200		25	40	50	50

BAA		T-7.5'	T+7.5'	T+22.5'	T+37.5'	T+52.5'
BAA ₁	L ₁ + L ₂	100	110	120	130	140
	Cumulative Flexible Ramp Requirement		10	20	30	40
	Flexible Ramp Test		✓	✓	✓	✓
BAA ₂	L ₃ + L ₄	100	130	120	130	140
	Cumulative Flexible Ramp Requirement		30	20	30	40
	Flexible Ramp Test		✗	✓	✓	✓

Case 2: Flexible Ramp Capacity Constraints

- $FRC_0 \geq \max(0, FRR_0 - 10)$
- $FRC_1 \geq \max(0, FRR_1 - 50)$
- $FRC_2 \geq \max(0, FRR_2)$
- $FRC_0 + FRC_1 \geq FRR_{0,1} \leq FRR_0 + FRR_1$
- $NSI_2 \geq \min(0, +50)$