Agenda
Draft 2019-2020 Transmission Plan

Isabella Nicosia
Associate Stakeholder Engagement and Policy Specialist

2019-2020 Transmission Planning Process Stakeholder Meeting
February 7, 2020

2019-2020 Transmission Planning Process Stakeholder Meeting Agenda

Topic	Presenter
Introduction	Isabella Nicosia
Overview	Jeff Billinton
Reliability Projects for Approval	Binaya Shrestha Nebiyu Yimer
Frequency Response Study	Ebrahim Rahimi
Policy Assessment	Sushant Barave
Economic Assessment	Yi Zhang
Next Steps	Isabella Nicosia

Overview
Draft 2019-2020 Transmission Plan

Jeff Billinton
Director, Transmission Infrastructure Planning

2019-2020 Transmission Planning Process Stakeholder Meeting
February 7, 2020

2019-2020 Transmission Planning Process

December 2018 | April 2019 | March 2020

Phase 1 – Develop detailed study plan

State and federal policy

CEC - Demand forecasts

CPUC - Resource forecasts and common assumptions with procurement processes

Other issues or concerns

Phase 2 - Sequential technical studies

- Reliability analysis
- Renewable (policy-driven) analysis
- Economic analysis

Publish comprehensive transmission plan with recommended projects

Phase 3 Procurement

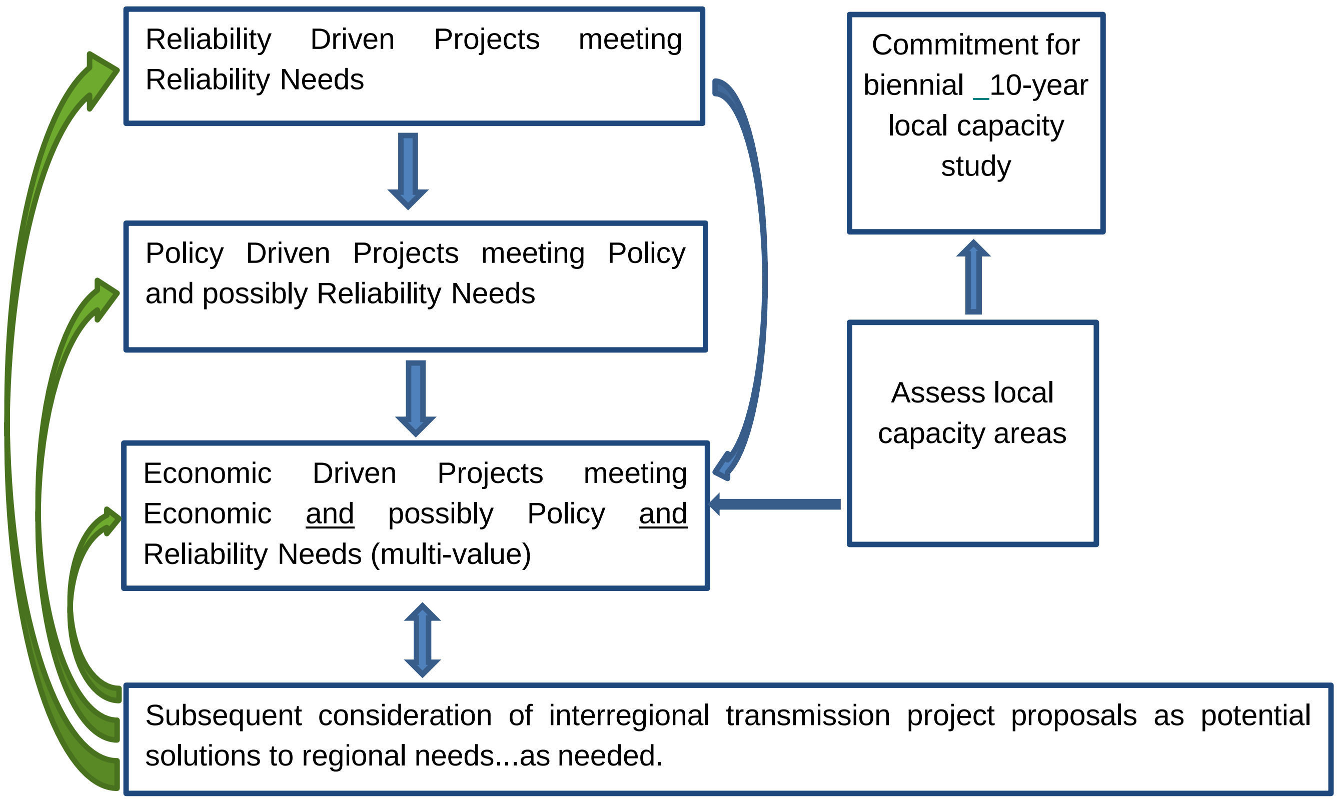
Draft transmission plan presented for stakeholder comment.

ISO Board for approval of transmission plan

2019-2020 Transmission Plan Milestones

- Draft Study Plan posted on February 22
- Stakeholder meeting on Draft Study Plan on February 28
- Comments to be submitted by March 14
- Final Study Plan to be posted on March 31
- Preliminary reliability study results to be posted on August 16
- Stakeholder meeting on September 25 and 26
- Comments to be submitted by October 10
- Request window closes October 15
- Preliminary policy and economic study results on November 18
- Comments to be submitted by December 2
- Draft transmission plan to be posted on January 31, 2020
- Stakeholder meeting on February 7, 2020
- Comments to be submitted February 21, 2020
- Revised draft for approval at March Board of Governor meeting

Studies are coordinated as a part of the transmission planning process



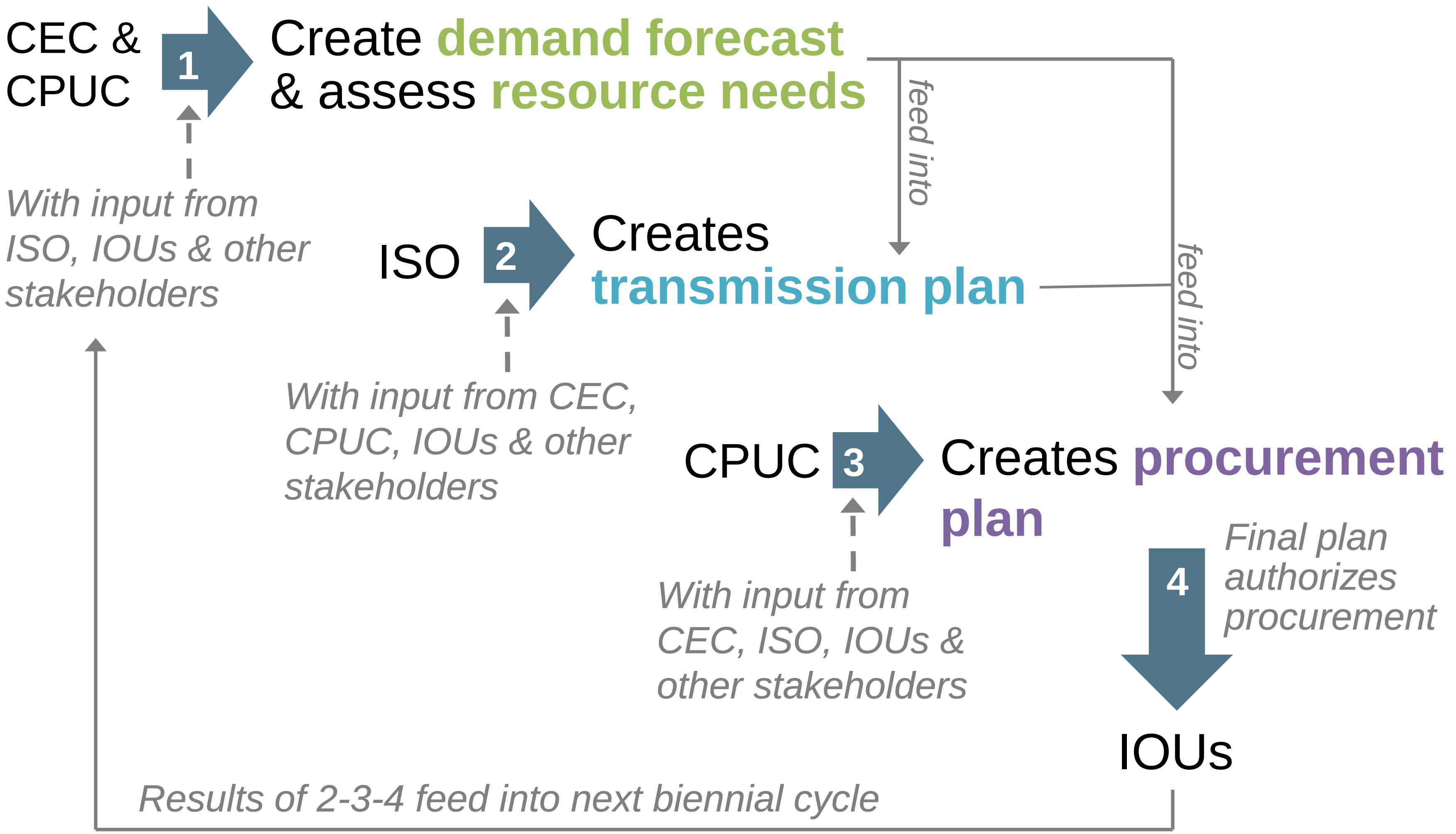
Forecast coordination was continued with CPUC and CEC, with focus on renewable generation:

- Load forecast based on California Energy Demand Updated Forecast 2018-2030 adopted by California Energy Commission (CEC) on January 9, 2019 https://ww2.energy.ca.gov/2018_energypolicy/documents/

- RPS portfolio direction for 2019-2020 transmission planning process was received from the CPUC and CEC
  - The CPUC IRP Base Case portfolio – is used for the reliability, policy and economic assessment
  - Two sensitivity portfolios to be assessed in the policy assessment

  https://www.cpuc.ca.gov/General.aspx?id=6442460548

Planning and procurement overview



California ISO

Key Issues in 2019-2020 Transmission Plan Cycle:

- ISO incorporated renewable portfolios from the CPUC
  - Baseline portfolio
    - Reliability, Policy and Economic Assessments
  - Sensitivity portfolios
    - Policy Assessment
- Interregional Transmission Planning Process
  - In year two (odd year) of 2 year planning cycle
- A number of studies were incorporated into the “other studies”
  - Frequency Response
  - Flexible Capacity Deliverability
- As a follow up to 2018-2019 transmission planning process, the remaining LCR areas were assessed for alternatives to gas-fired generation

Recommendations for New Reliability-Driven Project - PG&E Area
Draft 2019-2020 Transmission Plan

Binaya Shrestha
Regional Transmission - North

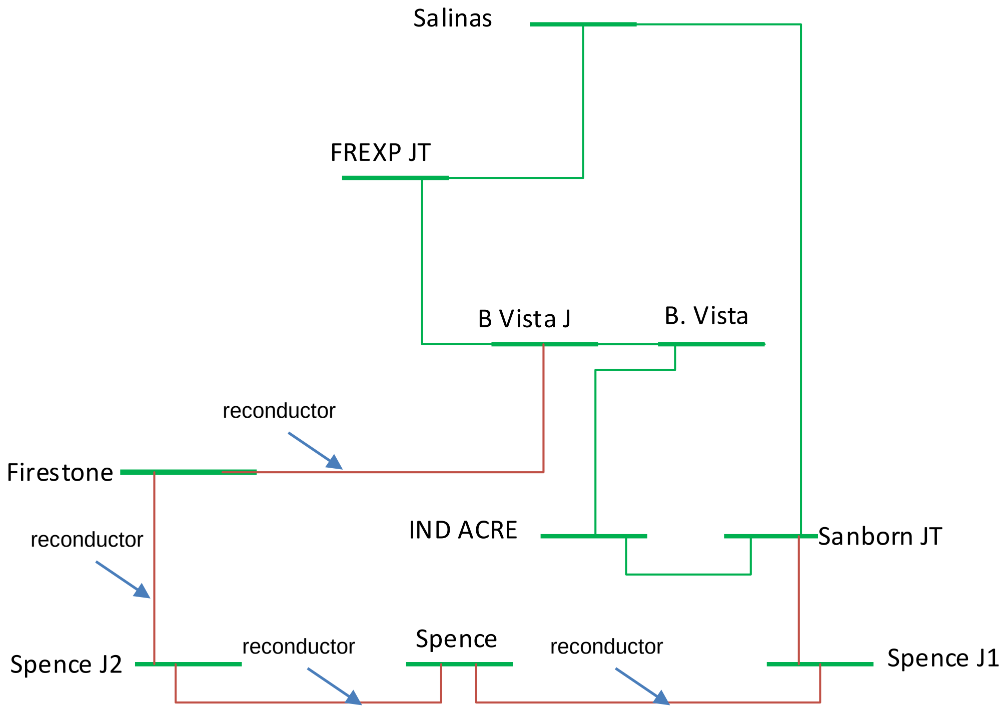
2019-2020 Transmission Planning Process Stakeholder Meeting
February 7, 2020

New Projects Recommended for Approval in 2019-2020 TPP - PG&E Area

Projects	Planning Area	Status
Tulucay-Napa #2 60 kV Line Capacity Increase	North Coast / North Bay	Presented in November meeting
East Shore 230 kV Bus Terminals Reconfiguration	Greater Bay Area	Presented in November meeting
Newark 230/115 kV Transformer Bank #7 Circuit Breaker Addition	Greater Bay Area	Presented in November meeting
Moraga 230 kV Bus Upgrade	Greater Bay Area	Presented in November meeting
Wilson-Oro Loma 115kV Line Reconductoring	Fresno	Presented in November meeting
Borden 230/70 kV Transformer Bank #1 Capacity Increase	Fresno	Presented in November meeting
Salinas-Firestone #1 and #2 60 kV Lines	Central Coast / Los Padres	Included in this presentation

Salinas - Firestone #1 and #2 60 kV Lines

- Reliability Assessment Need
  - Category P1 and P3 overload starting 2021.
- Project Submitter
  - CAISO
- Project Scope
  - Reconductor Sanborn Junction to Spence (about 8 miles).
  - Reconductor Buena Vista Junction to Firestone (about 3 miles)
  - Reconductor Spence to SPNCE J2 (about 0.16 miles).
  - Reconductor SPNCE J2 Firestone (about 1.46 miles).
- Project Cost
  - $19M-$38M
- Alternatives Considered
  - Status quo
    - Not selected due to P1 violation
  - Transmission reconfiguration by radializing the Salinas-Firestone 60kV #1 and #2 lines
    - Not selected due to reliability concern.
- Recommendation
  - Approval



Projects on Hold

Projects	Planning Area	Status
North of Mesa Upgrades	Central Coast / Los Padres	On hold
Moraga-Sobrante 115 kV Line Reconductor	Greater Bay Area	On hold
Wheeler Ridge Junction Station Project	Kern	On hold

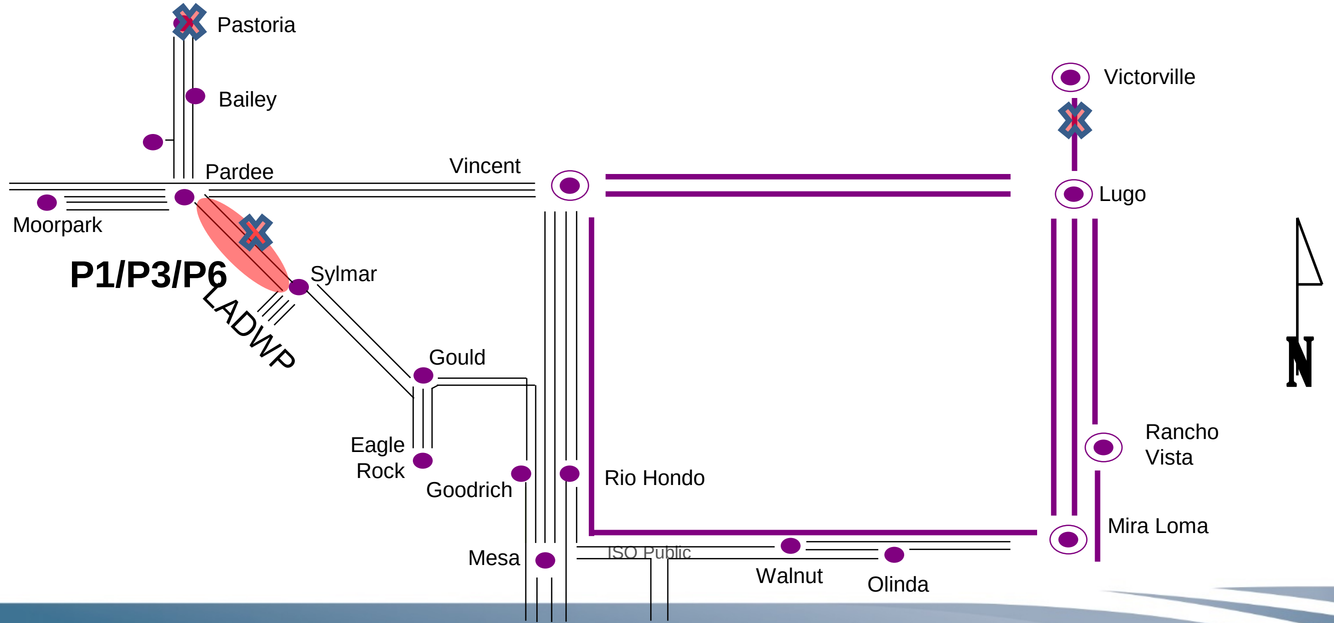
Recommended Reliability Project – SCE Area Draft 2019-2020 Transmission Plan

Nebiyu Yimer
Regional Transmission Engineer Lead

2019-2020 Transmission Planning Process Stakeholder Meeting
February 7th, 2020

Reliability Issue Identified in the SCE Metro Area

- The Pardee–Sylmar No. 1 & No. 2 230 kV lines were found to be overloaded under NERC P1, P3 and P6 outages including
  - One Pardee–Sylmar 230 kV line (P1)
  - Patstoria CC Block 1 & one Pardee–Sylmar 230 kV line (P3)
  - Lugo–Victorville 500 kV line & one Pardee–Sylmar 230 kV line (P6)
- The overloads were identified under HE 20 summer peak conditions beginning in year 2025



Pardee-Sylmar 230 kV Line Rating Increase Project

- Submitted by Southern California Edison
- Involves replacing circuit breakers and other terminal equipment at Pardee (SCE) and Sylmar (LADWP) Substations to increase the rating of the Pardee-Sylmar 230 kV lines
- The project increases the emergency rating of the lines by 145%
- Total cost → $15.4 million
  - SCE portion → $2.8 million
  - LADWP portion → $12.6 million
- SCE-proposed ISD is May 2025 based on the timing of the reliability need
- Earliest achievable ISD is May 2023

Pardee-Sylmar 230 kV Project Evaluation Results

- The project mitigates the Category P1 and P3 overloads
- Considerably reduces P6 overloads which can then be mitigated by dispatching resources including existing and planned preferred resources and energy storage

Worst Contingencies	Category	Pre-Project Loading (%)				Post-Project Loading (%)		
		CAISO 2025 Summer Peak	SCE 2029 Summer Peak	CAISO 2029 Summer Peak		CAISO 2025 Summer Peak	SCE 2029 Summer Peak	CAISO 2029 Summer Peak
Remaining Pardee - Sylmar 230 kV	P1	**118**	97	**129**		81	67	89
Pastoria Block 1 and one Pardee - Sylmar 230 kV line	P3	**133**	**109**	**142**		92	78	99
Victorville - Lugo 500 kV & One Pardee - Sylmar 230 kV line	P6	**158**	**123**	**170**		**109**	86	**117**

Economic Considerations

- The Pardee-Sylmar Project
  - Reduces Big-Creek Ventura Area LCR by 837 MW → $182 - $249 million in present value (PV) of savings
  - PV of production cost savings → $23 million.
- Benefit to Cost Ratio (BCR) → 10.3 - 13.6
- NPV of advancing the project by 2 years → $23 - $32 million

Other Alternatives Considered

- Pacific Transmission Expansion (PTE) HVDC Project
- Local capacity

Recommended for Approval

Project Name	Type of Project	Submitted By	Cost of Project	Recommended ISD
Pardee–Sylmar No. 1 & No.2 Rating Increase	Reliability (with economic benefits)	SCE	$15.4 million	May 2023

Frequency Response Assessment and Data Requirements
Draft 2019-2020 Transmission Plan

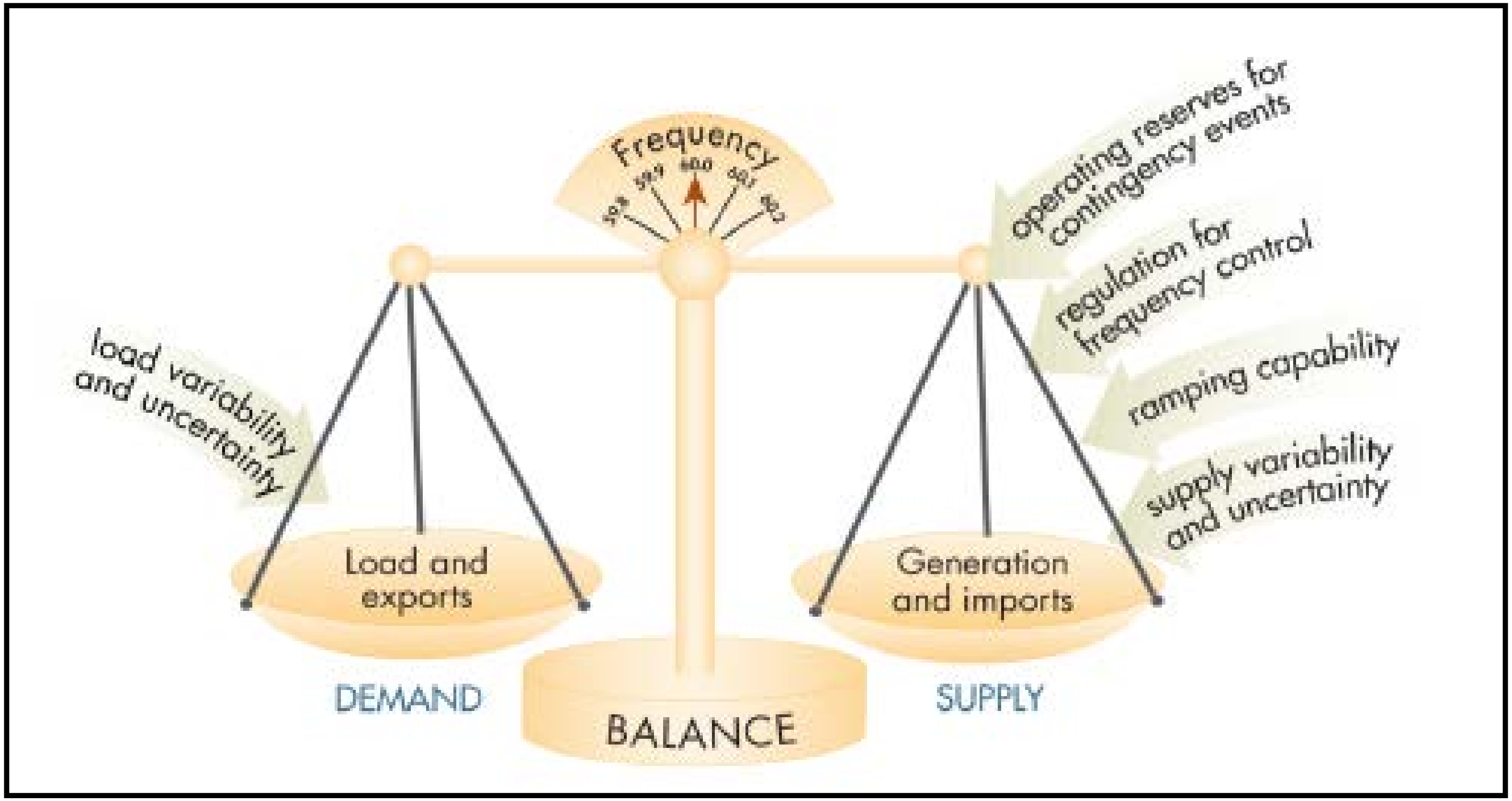
Irina Green, Songzhe Zhu, Ebrahim Rahimi
Regional Transmission

2019-2020 Transmission Planning Process Stakeholder Meeting
February 7, 2020

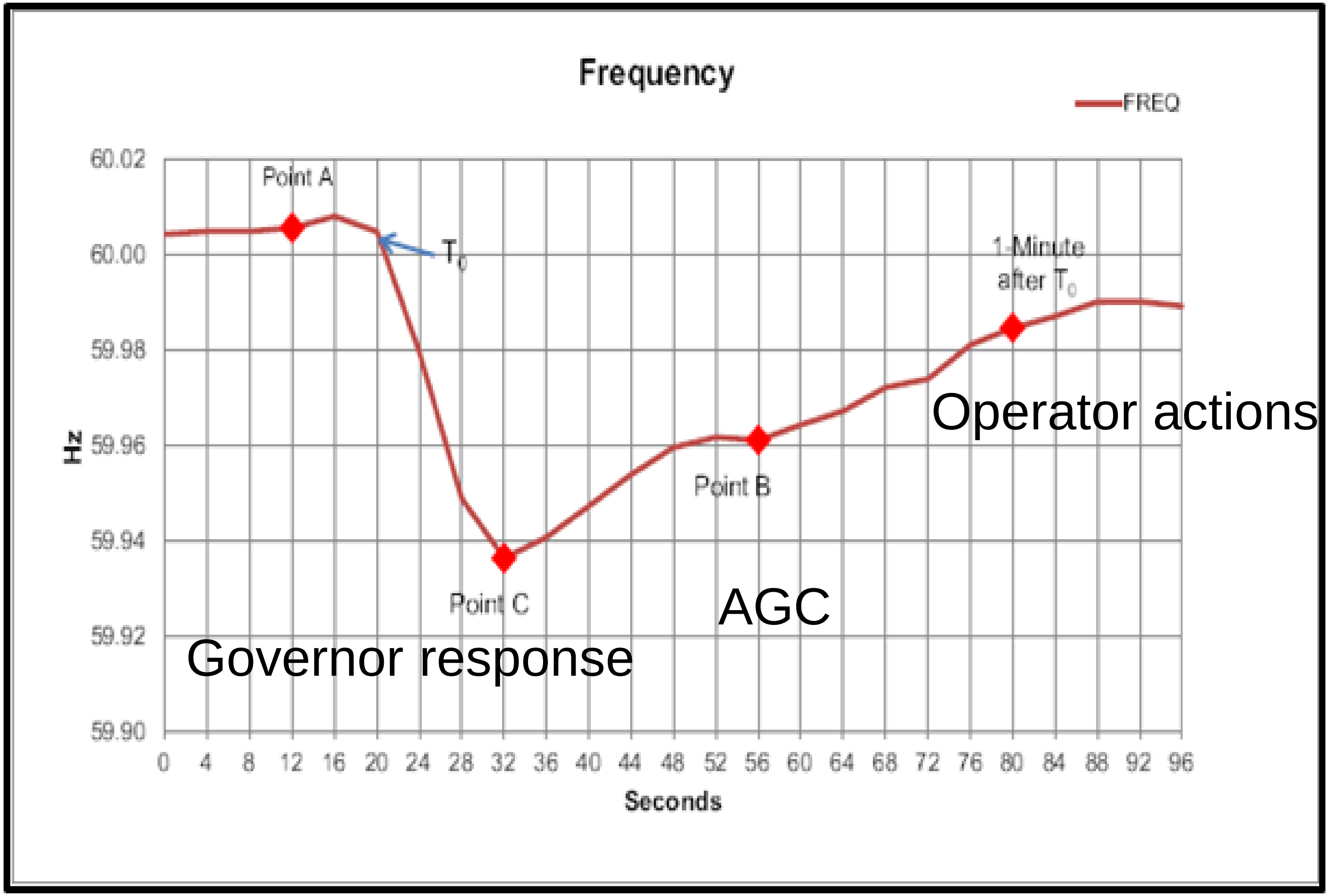
Overview

- Basics of frequency response
- ISO frequency response study results in previous TPPs
- Impact of frequency response from Inverter Based Resources (IBRs)
- Data collection and model improvement efforts

Continuous Supply and Demand Balance



Frequency Events



Point C – nadir
Point B – settling frequency

Nadir needs to be higher than set-point for UFLS (59.5 Hz)

Generator Response to Frequency Events

- Generating units play a major role in controlling system frequency through their governors
- For studies of off-nominal frequency events, it is essential to properly characterize the response of each generator
- The headroom of the generator and the droop and deadband of the governor determine a generator response to frequency events.

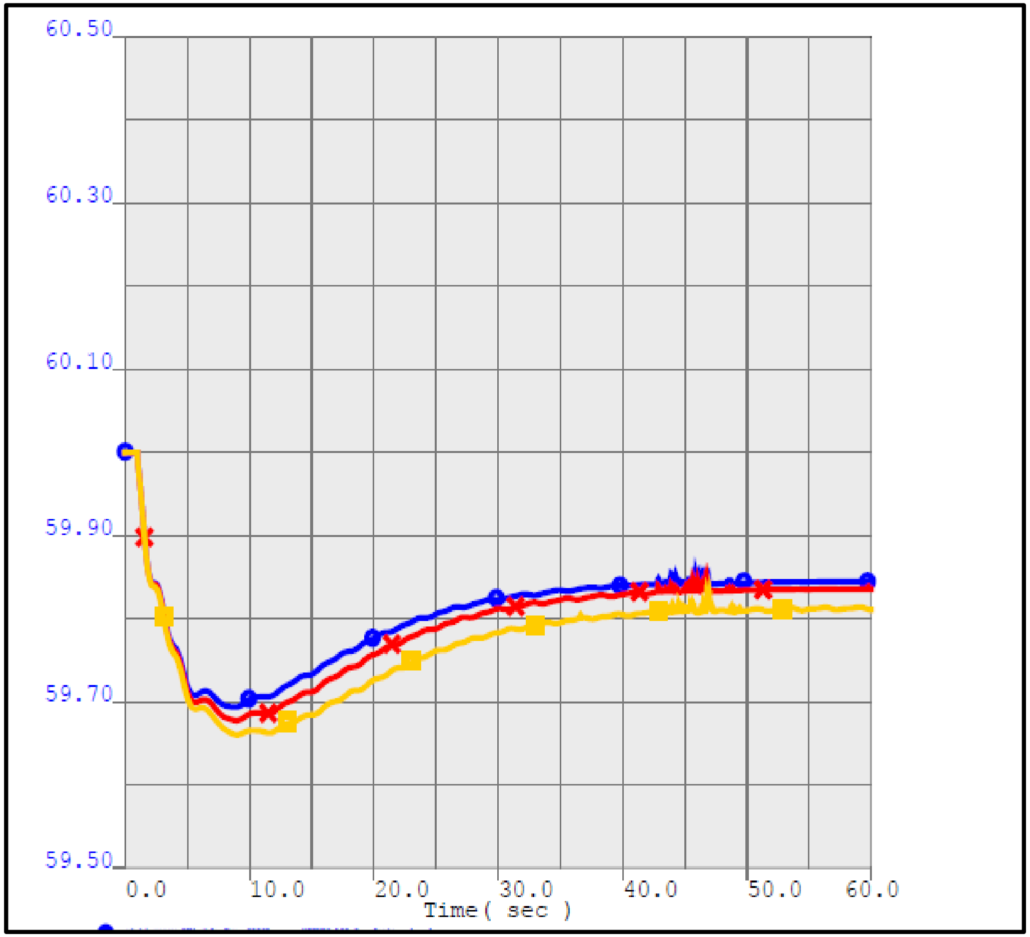
Headroom, Droop, and Deadband

- Headroom is the difference between the maximum capacity of the unit and the unit's output. Units that don't respond to changes in frequency are considered not to have headroom.

- Droop is the ratio of the frequency change to generator output change. The smaller is the droop, the higher is response, but generator may become unstable if it is too small. Droop is typically in the 4%-5% range.

- Deadband is the minimum frequency deviation from 60 Hz before governor responds. Deadband is typically 0.036 Hz.

Frequency on the Midway 500 kV bus following the trip of two Palo Verde units.



Conclusions of Frequency Studies in Previous TPPs

- The WECC base cases and dynamic data include number of frequency-responsive units and the study shows that the ISO system meets BAL-003-1.1 requirements.
- With lower commitment of the frequency-responsive units, frequency response from the ISO could below the FRO specified by NERC.
- With more inverter-based resources (IBR) online, frequency response from the ISO will most likely become insufficient.
- Compared to the ISO's actual system performance during disturbances, the simulation results seem optimistic. A thorough validation of the models is needed.

Frequency Response of Inverter Based Resources (IBRs)

Frequency Response of IBRs

- The total installed transmission-connected IBRs (wind, solar, storage) in the ISO grid is expected to go from around 18 GW today to around 26 GW in 2024.
- NERC has number of standards related to resource and demand balancing which is becoming challenging for the ISO to meet due to the variability of wind and solar generation.
- FERC Order 842 requires all new IBRs to have frequency response capability.
- This study is to evaluate the potential impact of activating the FR of the existing IBRs and changing the droop and frequency deadband settings of the new IBRs on system frequency response.

Study Methodology and Scenario

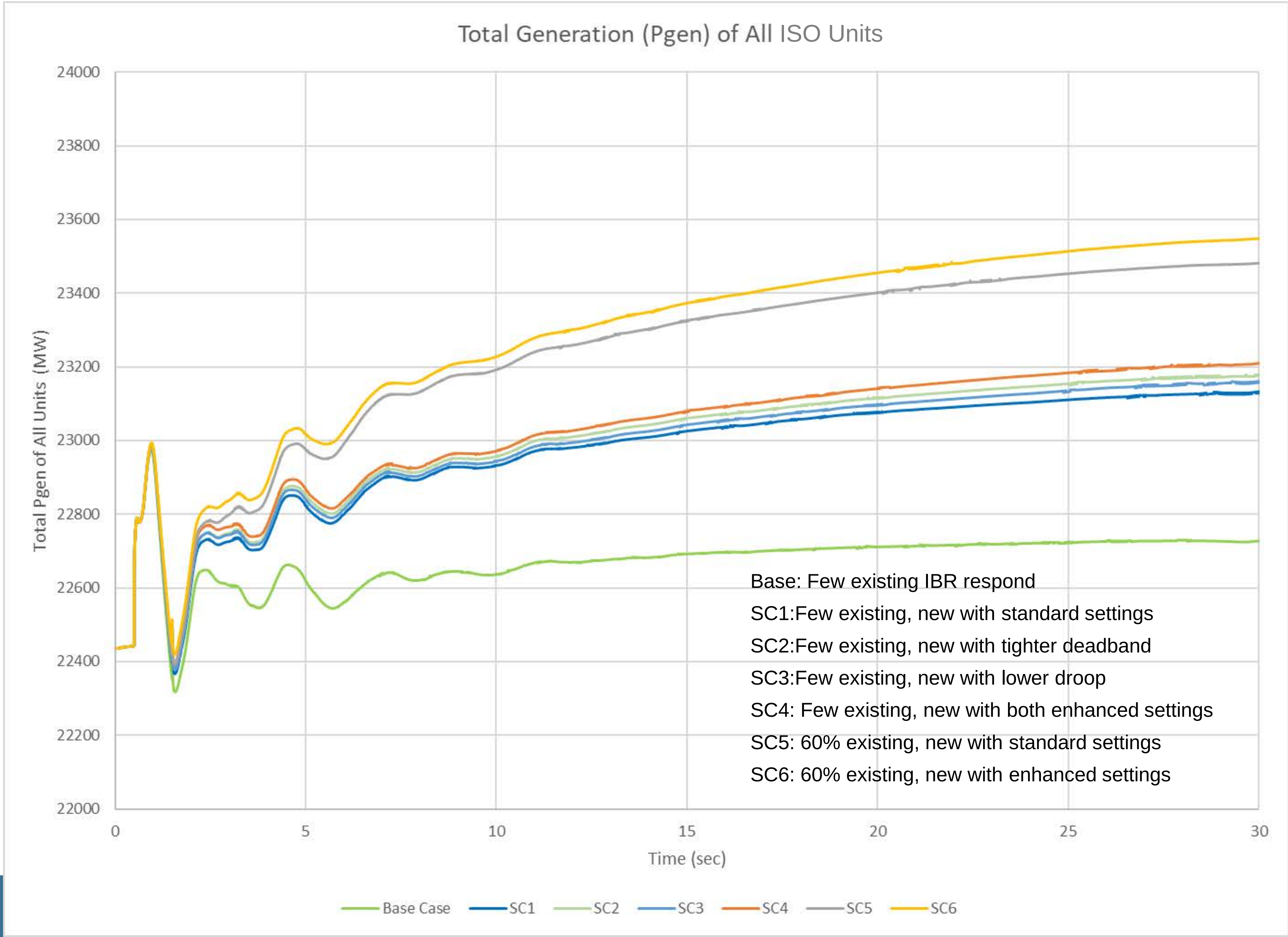
- In this analysis, the trip of two Palo Verde units was simulated under number of scenarios with both the existing and the proposed droop and frequency deadband settings for the new IBRs.

- The scenario selected for this study is an spring off-peak case (middle of the day in early spring) which is the most challenging scenario with regards to meeting FRO requirement.
  - The challenge is due to the low load and high solar generation which results in many gas units that are the main sources of FR to be are switched off.

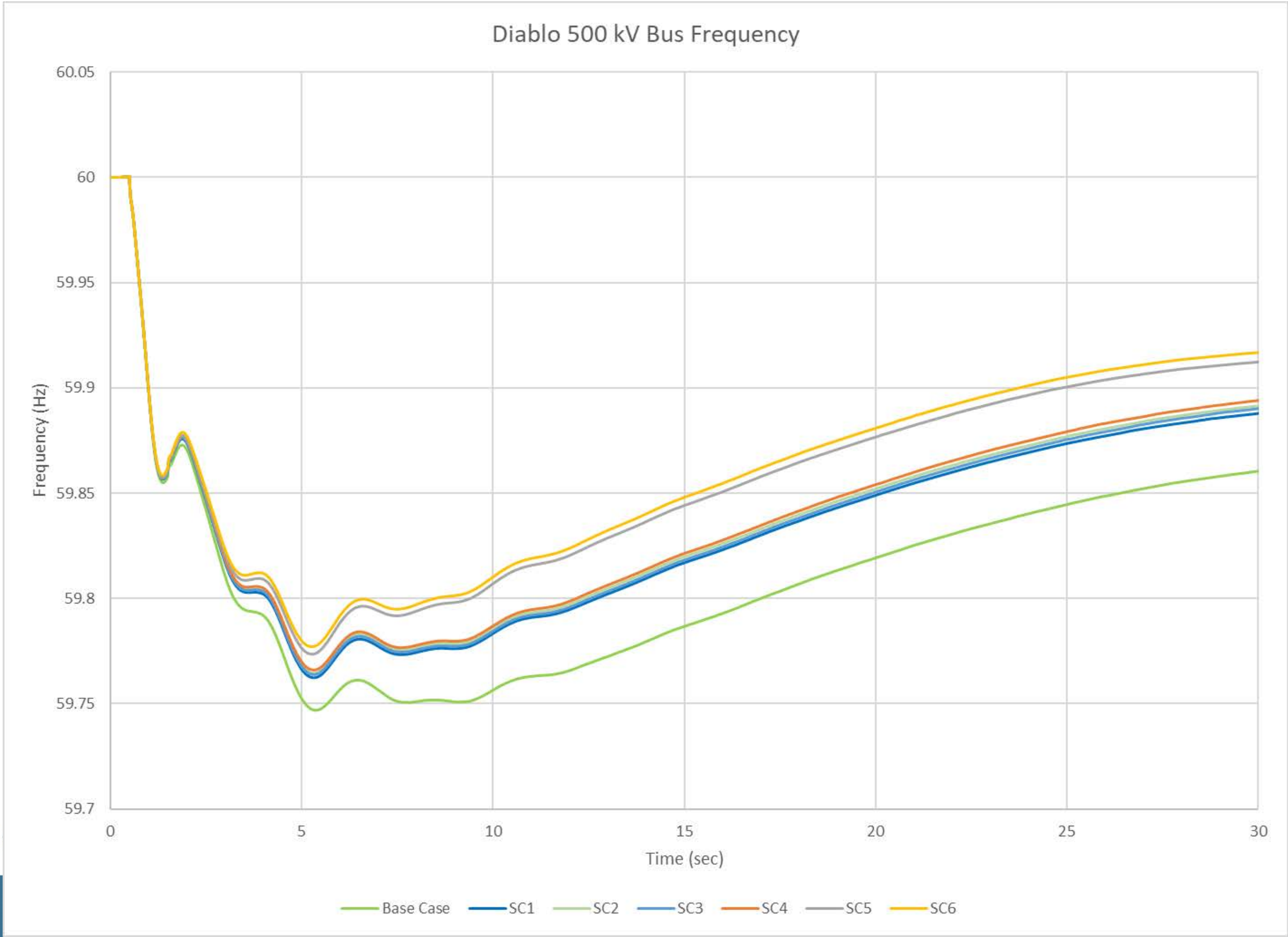
- Study case: WECC spring off peak
  - Solar dispatched at 92% (8% headroom), wind is off, BESS online but dispatched at zero, BTM PV at max. This case resulted in around 8,500 MW net export
- Sensitivity case:
  - Curtail around 6,000 MW solar generation to reduce the ISO net export to around 2,300 MW. This will result in solar to have around 40% headroom.

	Study Scenarios						
	Base	SC1	SC2	SC3	SC4	SC5	SC6
PFR enabled for existing IBRs?	Yes for a few units	Yes for a few units	Yes for a few units	Yes for a few units	Yes for a few units	**Yes for 60%**	**Yes for 60%**
Existing IBRs and other gens droop	5%	5%	5%	5%	5%	5%	5%
Existing IBRs and other gens deadband (Hz)	±0.036	±0.036	±0.036	±0.036	±0.036	±0.036	±0.036
PFR enabled for new IBRs?	No	Yes	Yes	Yes	Yes	Yes	Yes
New IBRs droop	n/a	**5%**	**4%**	5%	**4%**	5%	**4%**
New IBRs deadband (Hz)	n/a	**±0.036**	±0.036	**±0.0167**	**±0.0167**	±0.036	**±0.0167**

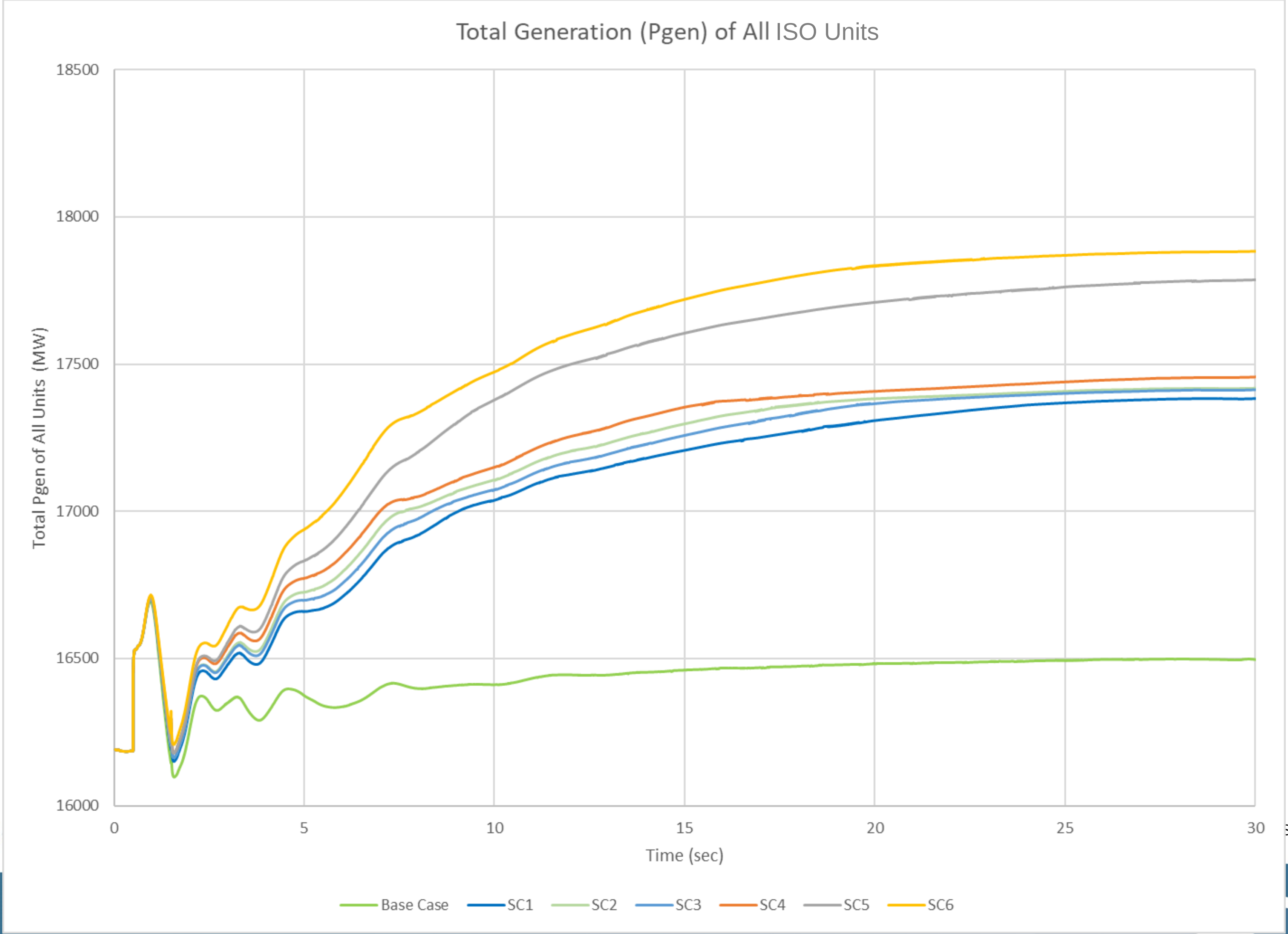
FR Results for case with 8% headroom (1/2)



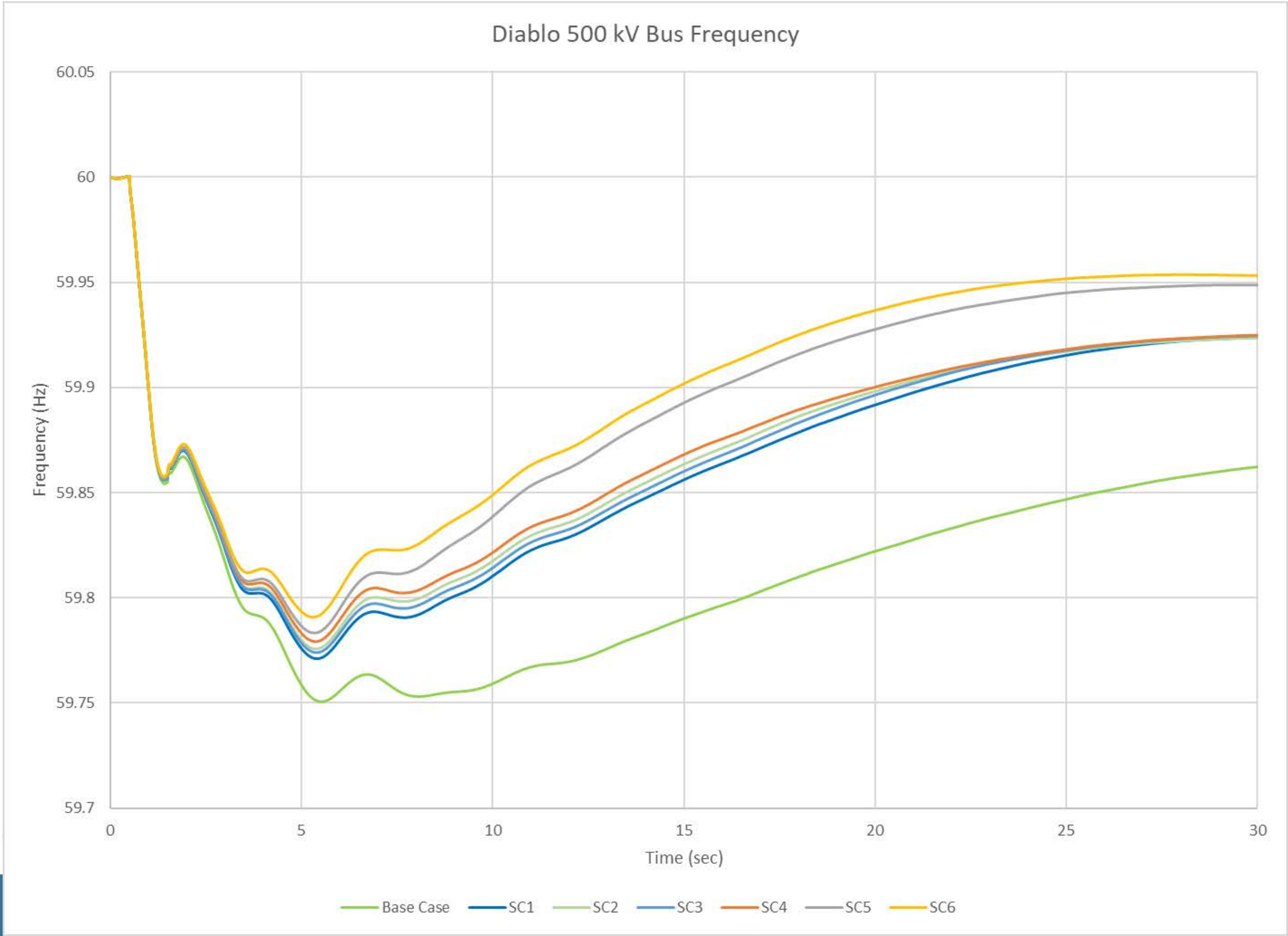
FRO Results for case with 8% headroom (2/2)



FRO Results for case with ~40% headroom (1/2)



FRO Results for case with ~40% headroom (2/2)



Conclusions of FR Impact Assessment

- If there is headroom, just enabling the FR of the IBRs significantly improved frequency response in this study even with 5% droop and ±0.036 Hz deadband.

- 4% droop and ±0.0167 Hz deadband would slightly increased the ISO generator output.

- The reason changing the setting have minimal impact is that the trip of two Palo Verde units causes a significant drop in frequency that results in IBRs responding to almost the same frequency drop, independent of the deadband or droop parameters.

Updating Generators Models

Generator Model Update

- The ISO added a section to the Tranmission Planning Process BPM regarding data collection (Section 10)
- Five categories of participating generators were developed based on size and interconnection voltage
- The ISO developed data templates for the generator owners to provide the data
- ISO is requesting validated modeling data from all generators
- The process started in May 2019 and the plan is to have updated models for all generators by 2022.

Generator Data Template

- Generator data templates have been posted on the CAISO website. [1]

- Generator owners will provide governor data (droop and deadband) as part of their submission.

II.19	Upward frequency response droop (increase output for low frequency)		%
II.20	Downward frequency response droop (reduce output for high frequency)		%
II.21	Frequency response deadband	+/-	Hz

[1] http://www.caiso.com/Pages/documentsbygroup.aspx?GroupID=95422303-C0DD-43DF-9470-5492167A5EC5

Next Steps

- Efforts will continue to collect modeling data and update the dynamic database. Validated models will be sent to WECC.

- Future work will include validation of models based on real-time contingencies and studies with modeling of behind the meter generation.

- Further work will also investigate measures to improve the ISO frequency response post contingency. Other contingencies may also need to be studied, as well as other cases that may be critical for frequency response.

Policy Assessment
Draft 2019-2020 Transmission Plan

Sushant Barave

Team:

RT North	RT South
Abhishek Singh	*Charles Cheung*
Vera Hart	*Emily Hughes*
Yi Zhang	*Luba Kravchuk*
	Songzhe Zhu
	Sushant Barave

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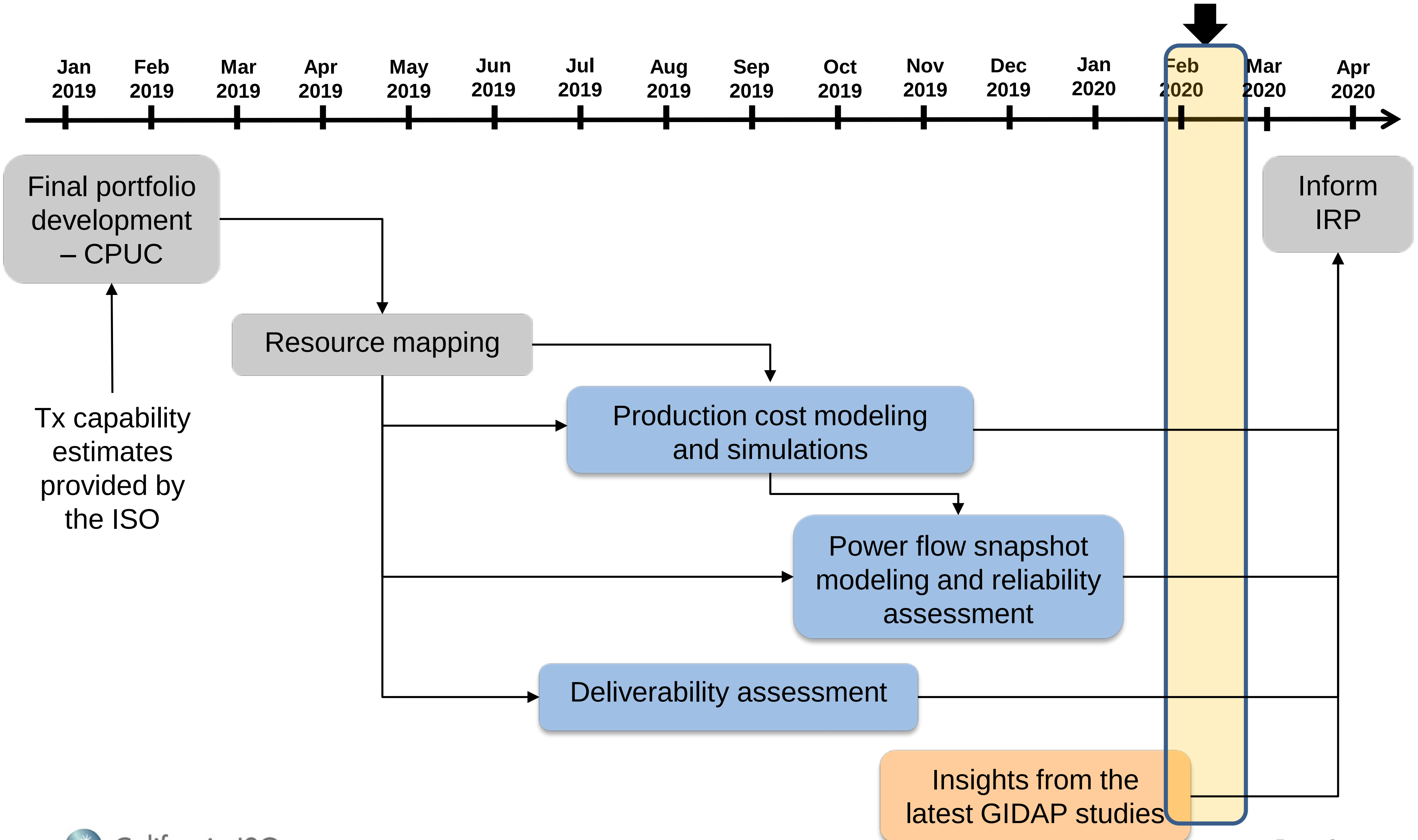
February 07, 2020

2019-2020 policy-driven assessment



California ISO

Agenda

✓ Deliverability assessment results – presented in the Nov, 2019 meeting

✓ Draft production cost simulation (PCM) results – presented in Nov 2019 meeting

- **Portfolio snapshot analysis results**
  - **Southern CA**
  - **Northern CA**
- **Summary of findings – Deliverability, PCM and Snapshot simulations**
- **Next steps**

Total "generic" resource mix (EO + FC) in portfolios

Renewable zone	PCM and snapshot study capacity (MW)												Deliverability study capacity (MW)		
	BASE				SENS 1				SENS 2				BASE	SENS 1	SENS 2
	Solar	Wind	GeoT	Total	Solar	Wind	GeoT	Total	Solar	Wind	GeoT	Total			
Northern California	0		424	424	750		424	1,174	750		424	1,174	424	424	424
Solano	0	643	0	643	0	643	0	643	40	643	0	683	0	581	581
Central Valley and Los Banos	0	146	0	146	0	146	0	146	0	146	0	146	146	146	146
Westlands	0	0	0	0	2,699	0	0	2,699	1,116	0	0	1,116	0	1,996	413
Greater Carrizo	0	160	0	160	0	1095	0	1,095	0	1095	0	1,095	0	895	895
Tehachapi	1,013	153	0	1,166	1,013	153	0	1,166	1,013	153	0	1,166	1,166	1,166	1,166
Kramer and Inyokern	577	0	0	577	577	0	0	577	577	0	0	577	577	577	577
Riverside East and Palm Springs	1,320	42	0	1,362	2,842	42	0	2,884	577	42		619	360	360	42
Greater Imperial*	0	0	1276	1276	1,401	0	1276	2,677	1,401	0	1,276	2,677	624	624	624
Southern CA desert and Southern NV	3,006	0	0	3,006	2,307	442	320	3,069	745	0	320	1,065	802	802	320
None (Distributed Wind)	0	0	0	0	0	253	0	253	0	253	0	253	0	253	253
NW_Ext_Tx (Northwest wind)	0	601	0	601	0	1500	0	1,500	0	1,500	0	1,500	601	966	966
SW_Ext_Tx (Southwest wind)	0	500	0	500	0	500	0	500	0	500	0	500	500	500	500
New Mexico wind (new Tx)	0	0	0	0	0	0	0	0	0	2,250	0	2,250	0	0	326
Wyoming wind (New Tx)	0	0	0	0	0	0	0	0	0	2,000	0	2,000	0	0	481
TOTALS	**5,916**	**2,245**	**1,700**	**9,861**	**11,589**	**4,774**	**2,020**	**18,383**	**6,219**	**8,582**	**2,020**	**16,822**	**5,200**	**9,290**	**7,714**

California ISO

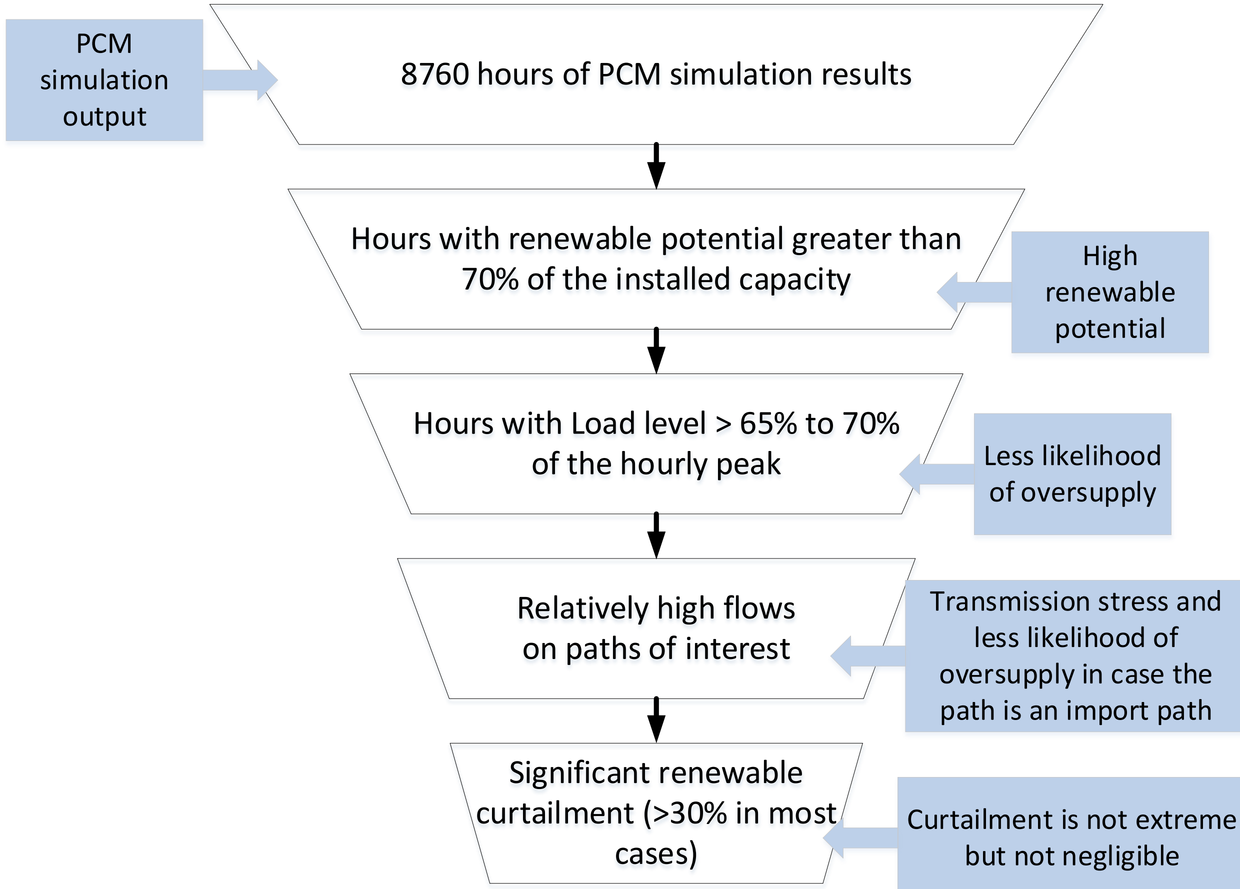
Scope of power flow snapshot assessment of renewable portfolios

- Reliability studies performed in order to identify transmission system limitations above and beyond the constraints monitored in the production cost simulations.

- The 8,760 hours of snapshots created during production cost simulations were used to identify high transmission system usage patterns to be tested using the power flow models.

- Power flow contingency analysis was performed in order to capture any additional area-wide constraints or significant interconnection issues that need to be modeled in the production cost simulations in order to more accurately capture the renewable curtailment caused by transmission congestion.

Identifying study hours when oversupply is unlikely but renewable curtailment is significant



	Northern CA and Southern PG&E	Southern CA
BASE	None	August 17 Hour Ending (HE) 12
SENS-01	March 08 HE 10	August 16 HE 12
SENS-02	July 20 HE 20	July 31 HE 15

Agenda

- **Portfolio snapshot analysis results**
  - **Southern CA**
  - **Northern CA**
- **Summary of findings**
- **Next steps**

Southern CA snapshot assessment – Resource assumptions

Renewable zone	BASE			BASE -Total	SENS-01			SEN-01-Total	SENS-02			SEN-02-Total
	Solar	Wind	GeoT		Solar	Wind	GeoT		Solar	Wind	GeoT	
Tehachapi	1013	153	0	1166	1013	153	0	1166	1013	153	0	1166
Kramer and Inyokern	577	0	0	577	577	0	0	577	577	0	0	577
Riverside East and Palm Springs	1320	42	0	1362	2842	42	0	2884	577	42		619
Greater Imperial	0	0	1276	1276	1401	0	1276	2677	1401	0	1276	2677
Southern NV, Eldorado and Mountain Pass	3006	0	0	3006	2307	442	320	3069	745	0	320	1065
SW wind (assumed to deliver into Riverside East)	0	500	0	500	0	500	0	500	0	500	0	500
New Mexico wind (assumed to deliver into Riverside East)	0	0	0	0	0	0	0	0	0	2250	0	2250
Wyoming wind (assumed to deliver into Eldorado)	0	0	0	0	0	0	0	0	0	2000	0	2000

Snapshot assessment – Tehachapi

- Dispatch assumptions for existing, contracted (future) and portfolio resources (% of nameplate)

BASE	SENS-01	SENS-02
91%	82%	87%

- No reliability issues were identified in the assessment of these snapshots in this zone.

Snapshot assessment – Greater Kramer

- The existing, contracted and portfolio renewable resources in this transmission zone were dispatched to 100% in all three portfolio snapshots.
- Tested SENS-02 portfolio snapshot with non-renewable resources dispatched in addition to the renewable resources.
  – In order to test whether curtailment of non-renewable resources would be adequate to address any issues.
- Approximately 1,200 MW of behind-the-meter (BTM) solar generation modeled and dispatched for daytime snapshot hours in this zone

Transmission constraints – Greater Kramer

Limiting Element	Contingency	Type	Overload (%)		
			BASE	SENS-01	SENS-02
Lugo 500/230 kV transformer bank 1 and 2	Base case	P0	<100%	<100%	125%
Lugo 500/230 kV transformer bank 1 or 2	Lugo 500/230 kV transformer bank 2 or 1	P1	123%	121%	179%
Victor - Lugo 230 kV no. 1, 2, 3 and 4	Base case	P0	<100%	<100%	122%
Victor - Lugo 230 kV no. 1 and 2	Several P1 and P7 contingencies (Worst: P7 of Victor - Ugo 230 kV line 3 and 4)	P1 and P7	107%	124%	182%
Victor - Lugo 230 kV no. 3 and 4	Several P1 and P7 contingencies (Worst: P7 of Victor - Ugo 230 kV line 1 and 2)	P1 and P7	107%	124%	182%
Kramer - Victor 230 kV no. 1 or 2	Kramer - Victor 230 kV no. 2 or 1	P1	103%	114%	116%

Key observations – Greater Kramer

- Potential mitigation:
  - The base case (NERC category P0) overloads in the SENS-02 portfolio could be adequately addressed by curtailment of non-renewable generation.
  - Contingency overloads (under NERC category P1 and P7) would require pre-contingency curtailment of renewable resources in this zone under the conditions represented by the snapshots.

- Reliability issues observed in this zone provide an explanation for most of the renewable curtailment observed in the same zone in PCM studies.

- Due to the nature of this zone, constraints and curtailment in this zone are highly sensitive to the projected output of BTM solar.

Snapshot assessment – Riverside East and Palm Springs

- Dispatch assumptions for existing, contracted (future) and portfolio resources (% of nameplate)

BASE	SENS-01	SENS-02
93%	85%	95%

- No reliability issues were identified in the assessment of these snapshots in this zone.

Snapshot assessment – Greater Imperial

- Dispatch assumptions for existing, contracted (future) and portfolio resources – wind and solar (% of nameplate)

BASE	SENS-01	SENS-02
73%	75%	86%

- Significant amount of Geothermal resources selected in this zone; dispatched to 100% of the nameplate.

- Several base case (NERC category P0) and contingency (NERC category P1 and P7) overloads were observed on the 230 kV lines in the IID system.

- IID needs to be involved in the detailed assessment if portfolio resources likely to be mapped to the IID system

Snapshot assessment – Southern NV, Eldorado and Mountain Pass

- The existing, contracted and portfolio renewable resources in this transmission zone were dispatched to 100% in all three portfolio snapshots.
- The total amount of resources in these zones is similar across all three portfolios.
- Mapping and technology of these resources within the GLW system significantly varies from one portfolio to the other; this helps explain the variation in results across the three portfolios.

Transmission constraints – Southern NV, Eldorado and Mountain Pass

Limiting Element	Contingency	Type	Overload (%)		
			BASE	SENS-01	SENS-02
Mercury to Northwest 138 kV lines (Most limiting facility overload)	Base Case	P0	104%	114%	108%
	Several contingencies on GLW 230 kV system and VEA 138 kV system (Worst contingency: Northwest - Desert View 230 kV)	P1, P4 and P7	246%	268%	259%
Jackass Flats - Mercury Switch 138 kV	Several P1, P4 and P7 contingencies on VEA's 138 kV and on GLW's 230 kV system (Worst: Vista - Johnnie 138 kV)	P1	134%	133%	128%
Amargosa 230/138 kV transformer bank	Any of the Northwest - Desert View 230 kV, Innovation - Desert View, 230 kV, Sloan Canyon - Trout Canyon 230 kV	P1	124%	124%	115%
Pahrump 230/138 kV transformer bank 1 or 2	Pahrump 230/138 kV transformer bank 2 or 1	P1	109%	109%	119%
Pahrump 230/138 kV transformer bank 1 and 2	Several P4 contingencies (Worst: Pahrump 230/138 kV transformer bank + Pahrump - Innovation 230 kV)	P4	149%	124%	132%

Transmission constraints – Southern NV, Eldorado and Mountain Pass

Limiting Element	Contingency	Type	Overload (%)		
			BASE	SENS-01	SENS-02
Pahrump - Gamebird (proposed) 230 kV	Base case	P0	109%	<100%	<100%
	P1 of and P4 contingencies involving Trout Canyon - Sloan Canyon 230 kV	P1 and P4	139%	<100%	<100%
Innovation - Desert View 230 kV	Base case	P0	<100%	103%	<100%
Sloan Canyon - Trout Canyon (proposed) 230 kV	P1 and P4 contingencies involving Pahrump - Gamebird (proposed) 230 kV	P1 and P4	139%	<100%	<100%
	P1, P4 and P7 contingencies involving Pahrump - Innovation 230 kV	P1, P4 and P7	139%	<100%	<100%

Key observations – Southern NV, Eldorado and Mountain Pass

- Potential mitigation:
  - The base case (NERC category P0) overloads are caused by intra-zonal distribution of portfolio resources; a modest renewable curtailment (30 to 150 MW) will mitigate these issues.
  - Contingency overloads (under NERC category P1 and P7) would require congestion management and/or RASs to trip generation post-contingency.

- Reliability issues observed in this zone provide an explanation for most of the renewable curtailment observed in the same zone in PCM studies.

- Intra-zonal constraints in this zone are highly sensitive to the specific mapping locations and amount of resources.

Northern CA snapshot assessment – Resource assumptions

Renewable zone	BASE			BASE-Total	SENS-01			SEN-01-Total	SENS-02			SEN-02-Total
	Solar	Wind	GeoT		Solar	Wind	GeoT		Solar	Wind	GeoT	
Northern California	0	0	424	424	750	0	424	1174	750	0	424	1174
Solano	0	643	0	643	0	643	0	643	40	643	0	683
Central Valley and Los Banos	0	146	0	146	0	146	0	146	0	146	0	146
Westlands	0	0	0	0	2699	0	0	2699	1116	0	0	1116
Greater Carrizo	0	160	0	160	0	1095	0	1095	0	1095	0	1095
NW wind (over existing Tx)	0	601	0	601	0	1500	0	1500	0	1500	0	1500

Snapshot assessment – Solano and Northern CA zone

- SENS-01 and SENS-02 analysis was due to higher amount of total portfolio resources selected in these portfolios compared to the base portfolio.

- The existing, contracted and portfolio wind resources in this transmission zone were dispatched to 74% of nameplate.

- The objective was to identify reliability issues around COI and Solano areas caused by conditions more severe than the ones studied as part of the deliverability assessment.

Transmission constraints – Solano and Northern CA zone

Limiting Element	Contingency	Type	Overload (%)
			SENS-02
Vaca Dixon –Lambie 230 kV line	BDLSWSTA 230KV - MIDDLE BREAKER BAY 2	P2-3	120%
Lambie-Birdslanding 230 line	BDLSWSTA 230KV - MIDDLE BREAKER BAY 2	P2-3	104%

Key observations – Solano and Northern CA zone

- Potential mitigation:
  - post-contingency increased generation curtailment of existing renewable generation or
  - RAS to trip renewable generation as result of a contingency.

- Likely to result in increased existing renewable curtailment because curtailment of non-renewable generation would not be adequate to mitigate the issues.

Snapshot assessment – Westlands and Carrizo

- Only SENS-01 was tested because this portfolio contains the highest amount of resources in these zones and would capture any potential concerns.
- The existing, contracted and portfolio renewable resources in this transmission zone were dispatched to 70% to 75% of nameplate.
- The objective was to identify thermal issues in the Westlands, Los Banos and Carrizo zones.

Transmission constraints – Westlands and Carrizo

Limiting Element	Contingency	Type	Overload (%)
			SENS-01
Moss Landing-Las Aguillas 230kV Line	Base Case	P0	103%
Leprino Sw STa-GWF 115kV Line	P2-3:A14:19:_MUSTANGSS 230kV - Middle Breaker Bay 3	P2-3	115%
GWF-Contandina 115kV Line	P2-3:A14:19:_MUSTANGSS 230kV - Middle Breaker Bay 3	P2-3	115%
Jackson SS-Contandina 115kV line	P2-3:A14:19:_MUSTANGSS 230kV - Middle Breaker Bay 3	P2-3	115%
Leprino Sw STa-GWF 115kV Line	P7-1:A14:4:_MUSTANGSS-GATES #1 230kV & MUSTANGSS-GATES #2 230kV	P7	157%
GWF-Contandina 115kV Line	P7-1:A14:4:_MUSTANGSS-GATES #1 230kV & MUSTANGSS-GATES #2 230kV	P7	157%
Jackson SS-Contandina 115kV line	P7-1:A14:4:_MUSTANGSS-GATES #1 230kV & MUSTANGSS-GATES #2 230kV	P7	157%

Transmission constraints – Westlands and Carrizo

Limiting Element	Contingency	Type	Overload (%)
			SENS-01
Leprino SW Station-Henrietta 115kV Line	P7-1:A14:4:_MUSTANGSS-GATES #1 230kV & MUSTANGSS-GATES #2 230kV	P7	121%
Henrietta 230/115kV TB	P7-1:A14:4:_MUSTANGSS-GATES #1 230kV & MUSTANGSS-GATES #2 230kV	P7	121%
Kingsburg-Jackson SS #1 115kV Line	P7-1:A14:4:_MUSTANGSS-GATES #1 230kV & MUSTANGSS-GATES #2 230kV	P7	109%
Kingsburg-Jackson SS #2 115kV Line	P7-1:A14:4:_MUSTANGSS-GATES #1 230kV & MUSTANGSS-GATES #2 230kV	P7	107%
San Miguel- Estrella 70kV Line	P7-1:A14:14:_TEMPLETON-GATES 230kV & GATES-CALFLATSSS #1 230kV	P7	145%
San Miguel- Coalinga 70kV Line	P7-1:A14:14:_TEMPLETON-GATES 230kV & GATES-CALFLATSSS #1 230kV	P7	127%
Gates-CalFlats 230kV Line	P2-2:A20:26:_TEMPLETN 230kV Section 1D	P2-2	100%

Transmission constraints – Westlands and Carrizo

Limiting Element	Contingency	Type	Overload (%)
			SENS-01
Gates-CalFlats 230kV Line	P7-1:A15:16:_Caliente Sw Sta - Midway #1 & #2 230 kV Lines	P7	142%
Gates-CalFlats 230kV Line	P7-1:A20:15:_MIDWAY-CALNTESS 230 kV Line No. 1 & 2	P7	142%
Gates-CalFlats 230kV Line	P7-1:A10:14:_SOLARSS-CALNTESS 230 kV Line No. 1 & 2	P7	120%
Morro Bay- Estrella 230kV Line	P7-1:A20:15:_MIDWAY-CALNTESS 230 kV Line No. 1 & 2	P7	106%
Morro Bay- Estrella 230kV Line	P7-1:A15:16:_Caliente Sw Sta - Midway #1 & #2 230 kV Lines	P7	106%
Templeton-Paso Robles 70kV Line	P7-1:A20:12:_Morro Bay-CalFlats SS and Templeton-Gates 230 kV Lines	P7	100%

Key observations – Westlands and Carrizo

- Potential mitigation:
  - Post-contingency generation curtailment
  - RAS to trip generation as result of a contingency
  - Reconductor 70 kV lines (partly identified in GIDAP as a local issue in Greater Carrizo)

- Likely to result in renewable curtailment because curtailment of non-renewable generation would be inadequate to mitigate the issues.

Agenda

✓ Deliverability assessment results – presented in the Nov, 2019 meeting

✓ Draft production cost simulation (PCM) results – presented in Nov 2019 meeting

✓ Portfolio snapshot analysis results
  – Southern CA
  – Northern CA

- **Summary of findings – Deliverability, PCM and Snapshot simulations**
- **Next steps**

California ISO

Deliverability assessment summary

Transmission zone	Deliverability assessment
Northern California	Several deliverability constraints were observed in all three portfolios. All these constraints can be mitigated by requiring the portfolio resources to participate in RASs to trip generation
Solano	
Central Valley and Los Banos	
Westlands	In case of SENS-01 portfolio, if most of the resources in Westlands develop on the 230 kV system then an upgrade such as a new Gates 500/230 kV bank will be required.
Greater Carrizo	Several deliverability constraints were observed in all three portfolios. All these constraints can be mitigated by requiring the portfolio resources to participate in RASs to trip generation
Tehachapi	
Kramer and Inyokern (Greater Kramer)	
Riverside East and Palm Springs	
Greater Imperial	
Southern NV, Eldorado and Mountain Pass	

Curtailment results summary

Curtailment ratio = (Renewable curtailment in MWh) / (Renewable curtailment in MWh + Renewable output in MWh)

Transmission Zone	BASE		SENS-01		SENS-02	
	2k MW net export limit **(13%)**	Export limit relaxed **(3%)**	2k MW net export limit **(22%)**	Export limit relaxed **(7%)**	2k MW net export limit **(21%)**	Export limit relaxed **(6%)**
Northern California	2%	0%	9%	0%	9%	1%
Solano	1%	0%	3%	0%	3%	0%
Central Valley and Los Banos	9%	11%	20%	29%	16%	26%
Westlands	12%	5%	24%	15%	21%	11%
Greater Carrizo	16%	8%	21%	15%	19%	15%
Tehachapi	13%	4%	21%	9%	20%	11%
Kramer and Inyokern (Greater Kramer)	21%	12%	32%	25%	32%	22%
Riverside East and Palm Springs	15%	0%	30%	1%	30%	1%
Greater Imperial	20%	0%	41%	7%	42%	8%
Southern NV, Eldorado and Mountain Pass	22%	6%	23%	11%	27%	8%

Snapshot assessment summary - North

Transmission zone	Potential mitigation
Northern California	A combination of congestion management and RAS
Solano	A combination of congestion management and RAS.
Central Valley and Los Banos	No issues.
Westlands	In SENS-01, RAS mitigation may not be adequate due to complexity of the required RAS. Resources selected in SENS-01 if developed at specific 230 kV locations will result in significant curtailment without an upgrade.
Greater Carrizo	In SENS-01, significant curtailment expected without an upgrade.

Snapshot assessment summary - South

Transmission zone	Deliverability assessment
Tehachapi	No issues.
Kramer and Inyokern (Greater Kramer)	Significant transmission bottlenecks → up to 500 MW of curtailment. Sensitive to the high amounts of BTM solar modeled in the base cases.
Riverside East and Palm Springs	No issues.
Greater Imperial	IID needs to be involved in the detailed assessment of transmission issues if the portfolios resources are likely to be mapped to the IID system
Southern NV, Eldorado and Mountain Pass	Minor base case overloads → ~100 MW of curtailment. A combination of congestion management and RASs identified in GIDAP studies.

Conclusion

- The ISO did not identify any Category 1 or Category 2 policy-driven upgrade.
- Although no upgrade needs were identified, a need for the portfolio resources to participate in RASs and/or experience congestion management was evident in several zones.

Agenda

- ✓ Deliverability assessment results – presented in the Nov, 2019 meeting
- ✓ Draft production cost simulation (PCM) results – presented in Nov 2019 meeting
- ✓ Portfolio snapshot analysis results
  - Southern CA
  - Northern CA
- ✓ Summary of findings – Deliverability, PCM and Snapshot simulations
- **Next steps**

Next steps

- Provide the updated transmission capability estimates to the CPUC and assist with incorporating these into the RESOLVE model through remainder of the 2019 IRP cycle.
- Inform IRP with insights regarding zonal renewable curtailment.
- Incorporate findings from this study in coordinating with the CEC staff and the CPUC staff into the busbar mapping process for future portfolios.
- Continue to support the CPUC on siting generic storage resources selected in the IRP process.

Economic Assessment
Draft 2019-2020 Transmission Plan

Yi Zhang
Regional Transmission Engineering Lead

2019-2020 Transmission Planning Process Stakeholder Meeting
February 7, 2020

Summary of key steps since November stakeholder session database development

- Enforced Doublet Tap to Friars 130 kV line rating under N-2 contingency of Sycamore to Penasquitos and Penasquitos to Old Town 230 kV lines in SDG&E area
  - A critical constraint identified in reliability assessment
- Modeled Wilson to El Nido 115 kV line reconductoring in PG&E Fresno area
  - An approved reliability upgrade
- ABB GridView™ v10.2.72 was used to run production cost simulations in the 2019-2020 planning cycle

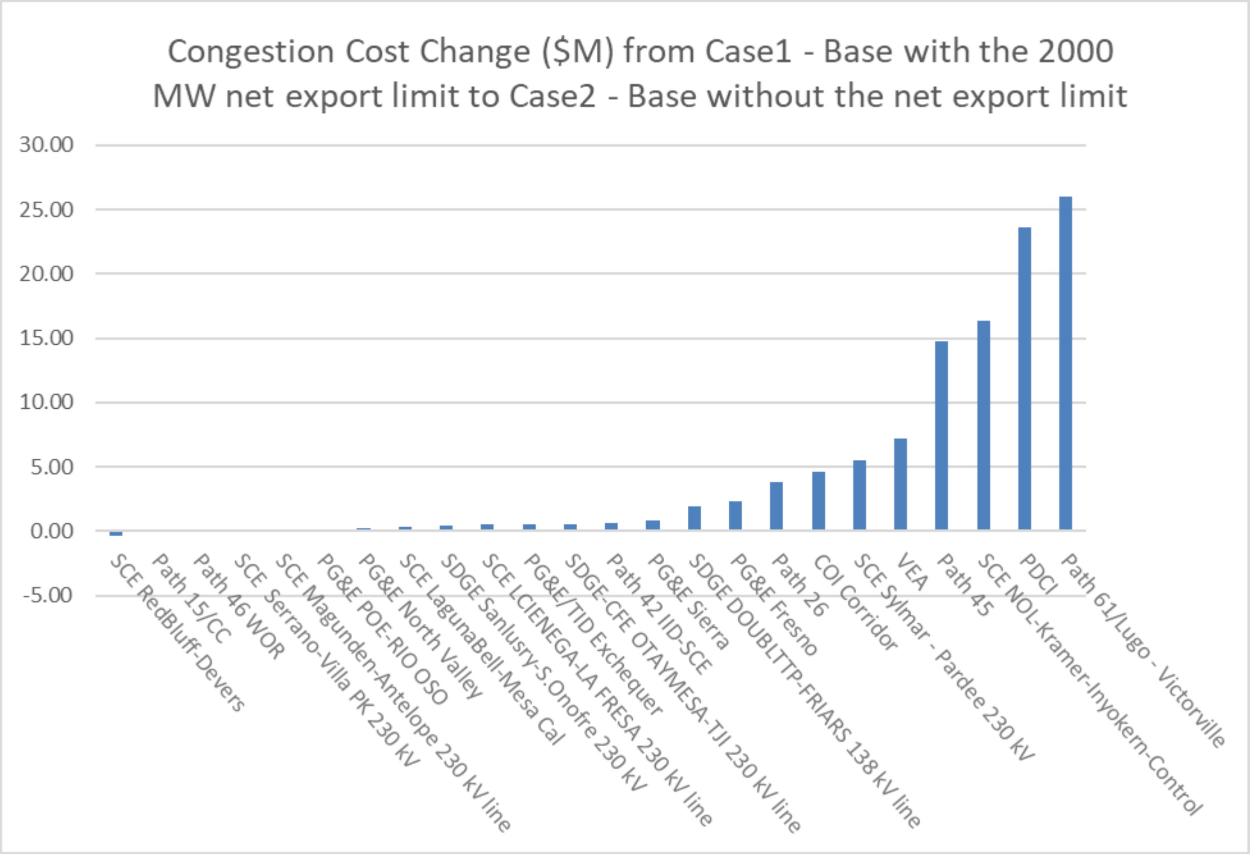
Congestion and curtailment results

Base Portfolio - summary of congestions

- In general renewable portfolio has large impact on congestion pattern
- The new renewable curtailment price model (presented in the last stakeholder meeting) improved robustness of the simulation results
- Selection of congestions for detailed analysis is not solely based on congestion cost or duration

Aggregated congestion	Cost ($M)	Duration (Hr)
Path 26 Corridor	18.36	704
COI Corridor	11.80	430
SCE NOL-Kramer-Inyokern-Control	8.72	1,017
PDCI	5.99	696
PG&E/TID Exchequer	5.84	2,177
SDGE DOUBLTTP-FRIARS 138 kV line	4.79	605
SCE Sylmar - Pardee 230 kV	4.66	299
PG&E Fresno	3.77	3,123
VEA	2.99	534
SDGE-CFE OTAYMESA-TJI 230 kV line	1.73	595
SCE RedBluff-Devers	1.54	25
Path 45	1.09	640
SCE LagunaBell-Mesa Cal	1.01	22
Path 15/CC	0.53	21
IID-SDGE (S line)	0.46	44
Path 42 IID-SCE	0.43	29
SDGE IV-San Diego Corridor	0.38	13
PG&E POE-RIO OSO	0.29	268
San Diego	0.27	101
PG&E Sierra	0.26	173
SCE J.HINDS-MIRAGE 230 kV line	0.18	51
Path 46 WOR	0.12	9
SDGE Sanlusry-S.Onofre 230 kV	0.11	41
SCE Serrano-Villa PK 230 kV	0.05	1
SCE LCIENEGA-LA FRESA 230 kV line	0.03	2
PG&E North Valley	0.03	12
SDGE Hoodoo Wash - N.Gila 500 kV line	0.01	1
PG&E GBA	0.00	1
PG&E Solano	0.00	1
Path 61/Lugo - Victorville	0.00	1
Path 24	0.00	1

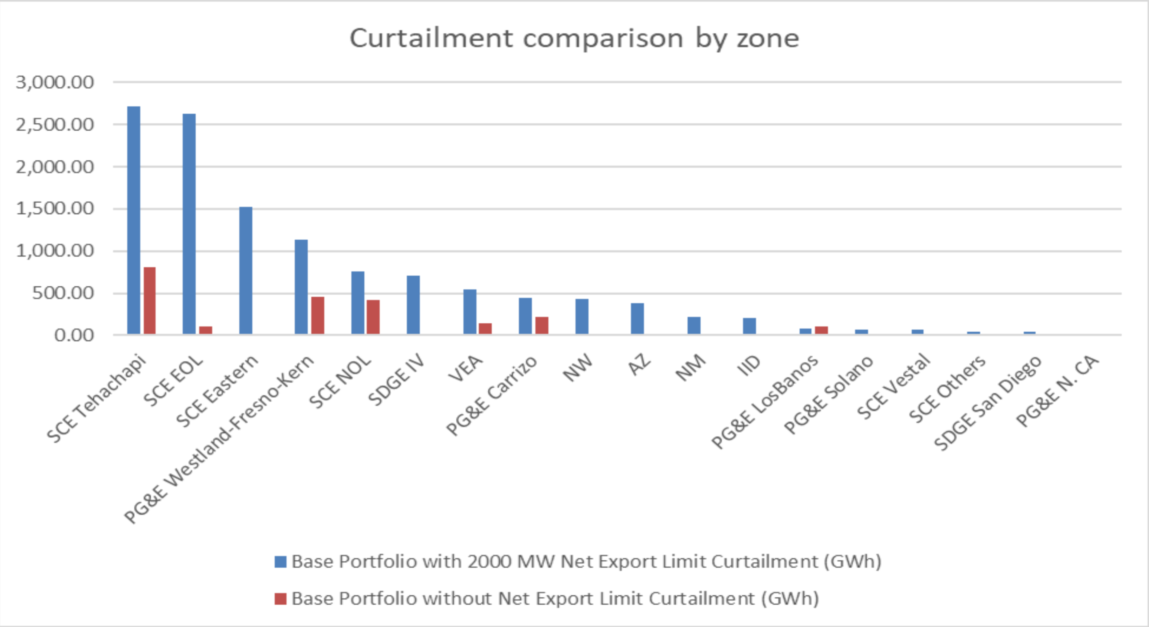
Base Portfolio - congestion changes with and without enforcing the ISO net export limit



- Relaxing the net export limit changed renewable curtailment and generation dispatch pattern; hence the flow and congestion pattern
- Congestion increased in the exporting direction from the ISO system, particularly on Path 61, PDCI, Path 45, and COI,

Base Portfolio – curtailment with and without enforcing the ISO net export limit

- Renewable curtailment in the scenario without the net export limit is mainly attributed to binding transmission constraints
- However, the binding constraint sets in the two scenarios (with and without the net export limit) are different

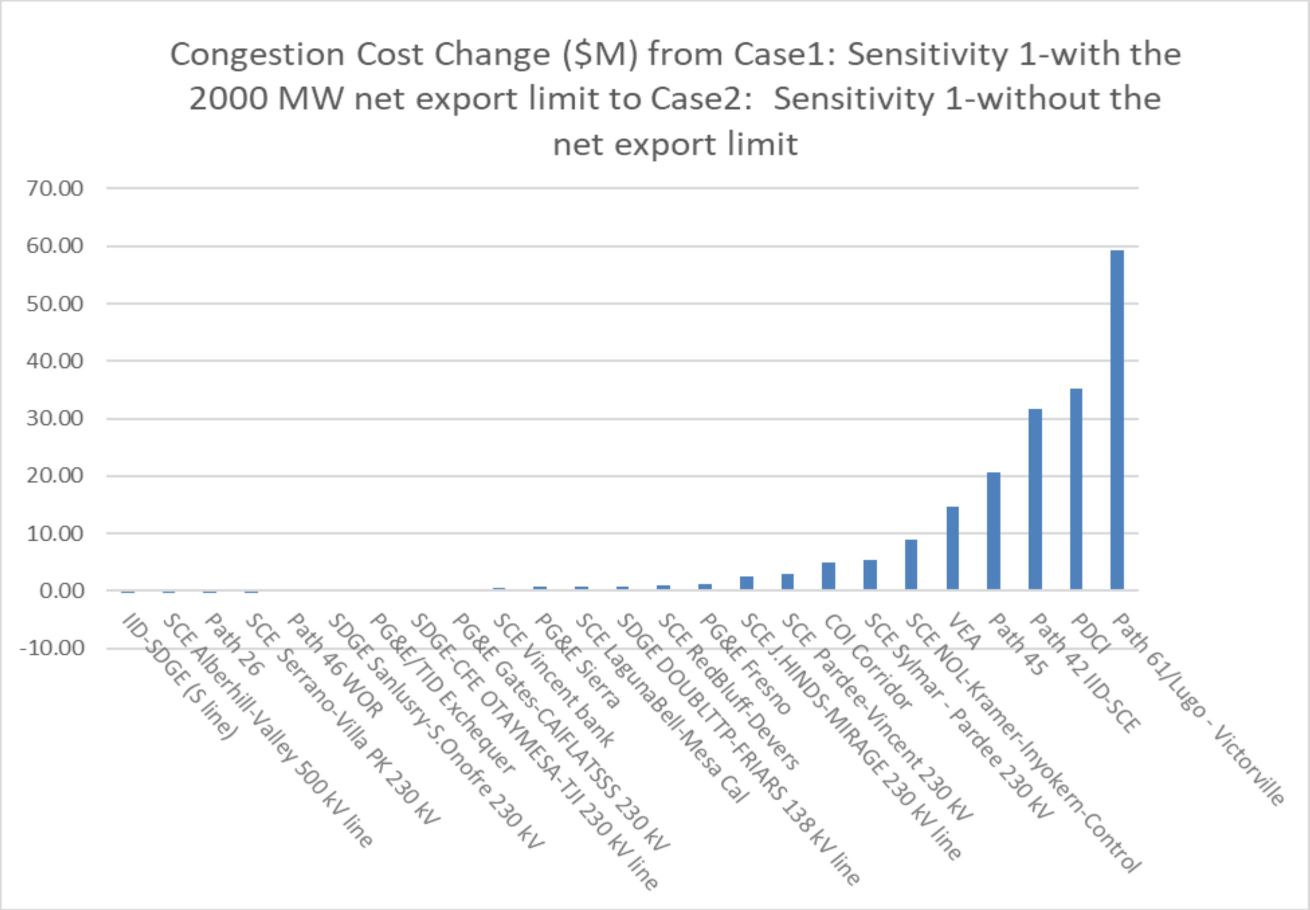


Scenario	Base Portfolio with 2000 MW Net Export Limit	Base Portfolio without Net Export Limit
Total Wind and Solar Generation (TWh)	81.42	91.21
Total Curtailment (TWh)	12.12	2.34

Sensitivity 1 Portfolio - Summary of congestions

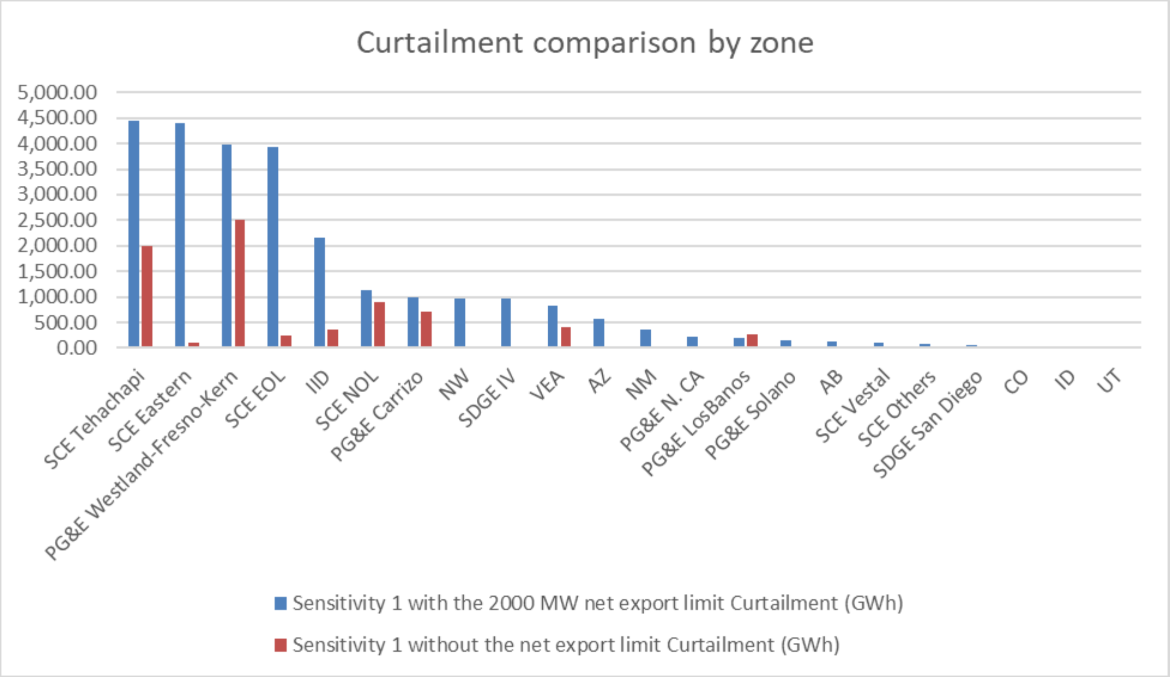
Aggregated Congestion	Cost ($M)	Duration (Hr)
Path 42 IID-SCE	50.00	1,060
COI Corridor	19.85	706
Path 26 Corridor	5.29	257
VEA	5.17	1,017
PG&E/TID Exchequer	5.00	1,856
PDCI	4.41	583
SDGE DOUBLTTP-FRIARS 138 kV line	3.67	478
SCE Sylmar - Pardee 230 kV	3.50	267
SCE RedBluff-Devers	2.80	28
SDGE-CFE OTAYMESA-TJI 230 kV line	1.72	595
SCE Serrano-Villa PK 230 kV	1.41	10
IID-SDGE (S line)	1.40	94
PG&E Fresno	1.39	1,657
SCE NOL-Kramer-Inyokern-Control	1.05	517
SCE LagunaBell-Mesa Cal	1.04	27
Path 45	0.97	573
SDGE Sanlusry-S.Onofre 230 kV	0.45	32
SDGE IV-San Diego Corridor	0.41	14
SCE Alberhill-Valley 500 kV line	0.34	6
Path 46 WOR	0.27	22
San Diego	0.27	81
PG&E POE-RIO OSO	0.24	256
SCE J.HINDS-MIRAGE 230 kV line	0.15	42
PG&E Sierra	0.14	116
SCE LCIENEGA-LA FRESA 230 kV line	0.09	4
Path 61/Lugo - Victorville	0.05	5
Path 15/CC	0.05	6
PG&E North Valley	0.04	11
PG&E Gates-CAIFLATSSS 230 kV	0.02	5
SCE Pardee-Vincent 230 kV	0.02	3
PG&E Tesla-AEC 115 kV	0.01	2
PG&E GBA	0.01	10
Path 24	0.00	3

Sensitivity 1 Portfolio - congestion changes with and without enforcing the ISO net export limit



California ISO

Sensitivity 1 Portfolio - curtailment with and without enforcing the ISO net export limit

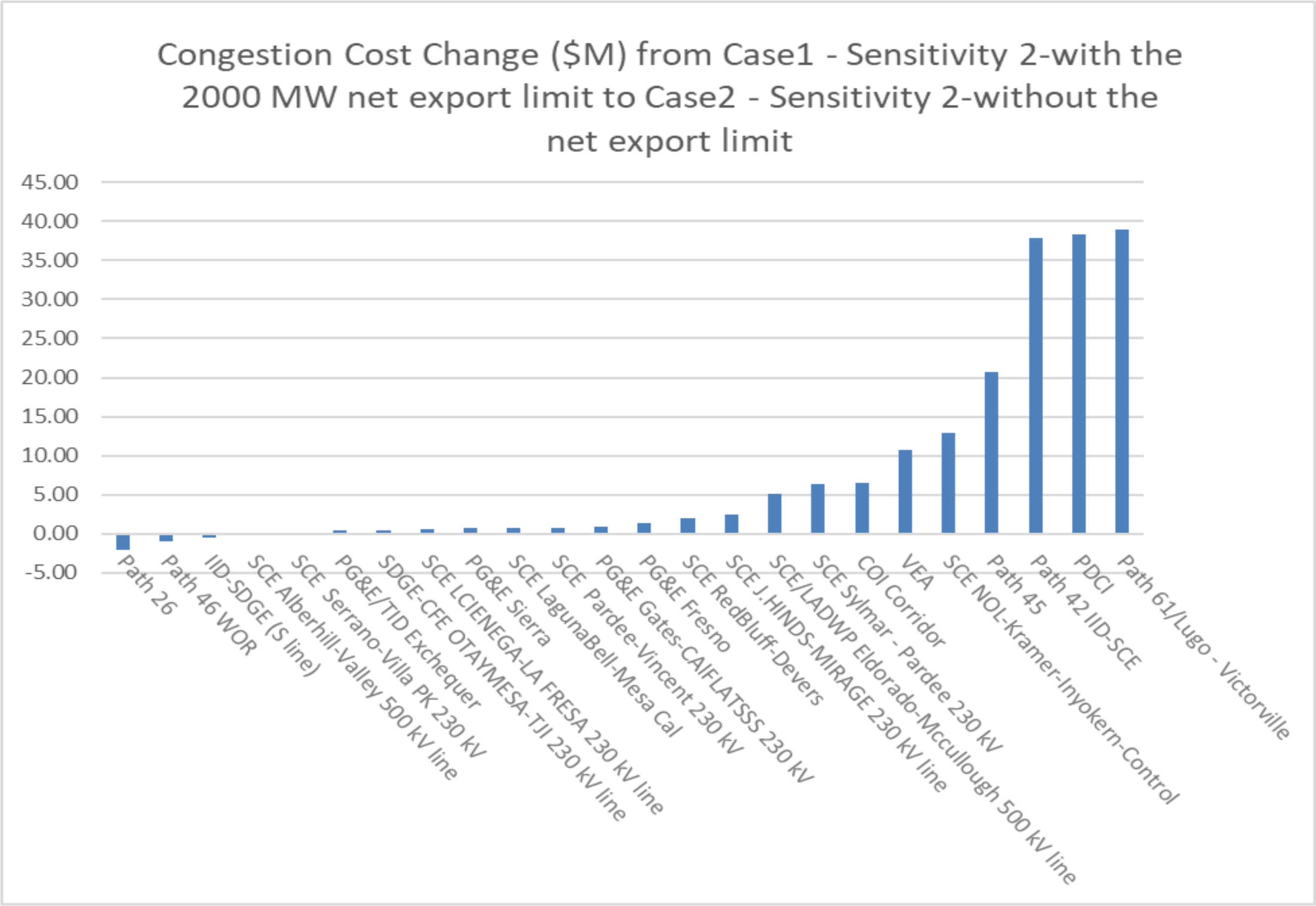


Scenario	Sensitivity 1 with the 2000 MW net export limit	Sensitivity 1 without the net export limit
Total Wind and Solar Generation (TWh)	91.21	109.30
Total Curtailment (TWh)	25.77	7.68

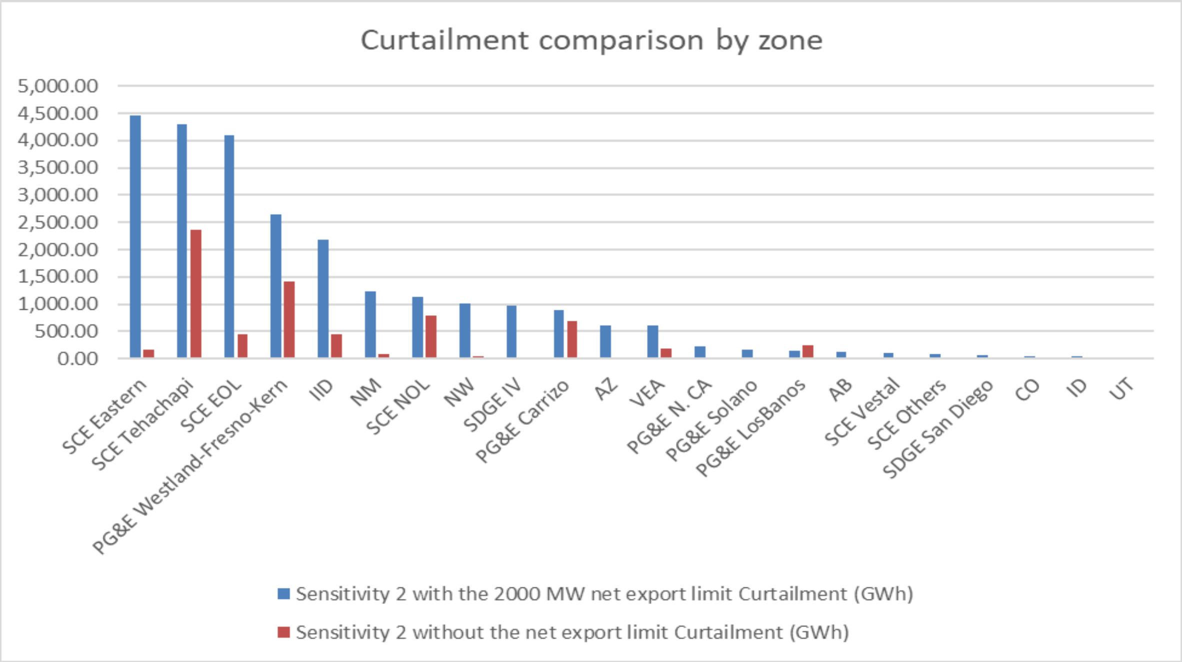
Sensitivity 2 Portfolio - Summary of congestions

Aggregated Congestion	Cost ($M)	Duration (Hr)
Path 42 IID-SCE	46.50	1,018
COI Corridor	18.89	637
Path 26 Corridor	16.59	670
SDGE DOUBLTTP-FRIARS 138 kV line	5.82	615
PG&E/TID Exchequer	4.82	1,864
SCE RedBluff-Devers	4.35	44
PDCI	3.94	554
SCE Sylmar - Pardee 230 kV	3.16	278
SCE Serrano-Villa PK 230 kV	2.53	15
Path 46 WOR	2.22	73
IID-SDGE (S line)	2.14	157
PG&E Fresno	1.64	1,969
SCE NOL-Kramer-Inyokern-Control	1.47	448
SDGE-CFE OTAYMESA-TJI 230 kV line	1.44	530
SCE Alberhill-Valley 500 kV line	1.06	23
VEA	0.74	500
SCE LagunaBell-Mesa Cal	0.63	21
Path 45	0.55	394
SDGE IV-San Diego Corridor	0.39	17
Path 15/CC	0.34	25
SDGE Sanlusry-S.Onofre 230 kV	0.27	27
PG&E POE-RIO OSO	0.24	263
SCE LCIENEGA-LA FRESA 230 kV line	0.16	9
San Diego	0.15	70
PG&E Sierra	0.14	123
SCE/LADWP Eldorado-Mccullough 500 kV line	0.12	2
SCE J.HINDS-MIRAGE 230 kV line	0.12	37
SCE Mesa-Miraloma 500 kV line	0.07	1
PG&E North Valley	0.04	10
PG&E Gates-CAIFLATSSS 230 kV	0.04	19
Path 61/Lugo - Victorville	0.03	3
PG&E GBA	0.02	11
PG&E Tesla-AEC 115 kV	0.01	2
Path 24	0.00	1

Sensitivity 2 Portfolio - congestion changes with and without enforcing the ISO net export limit



Sensitivity 2 Portfolio - curtailment with and without enforcing the ISO net export limit

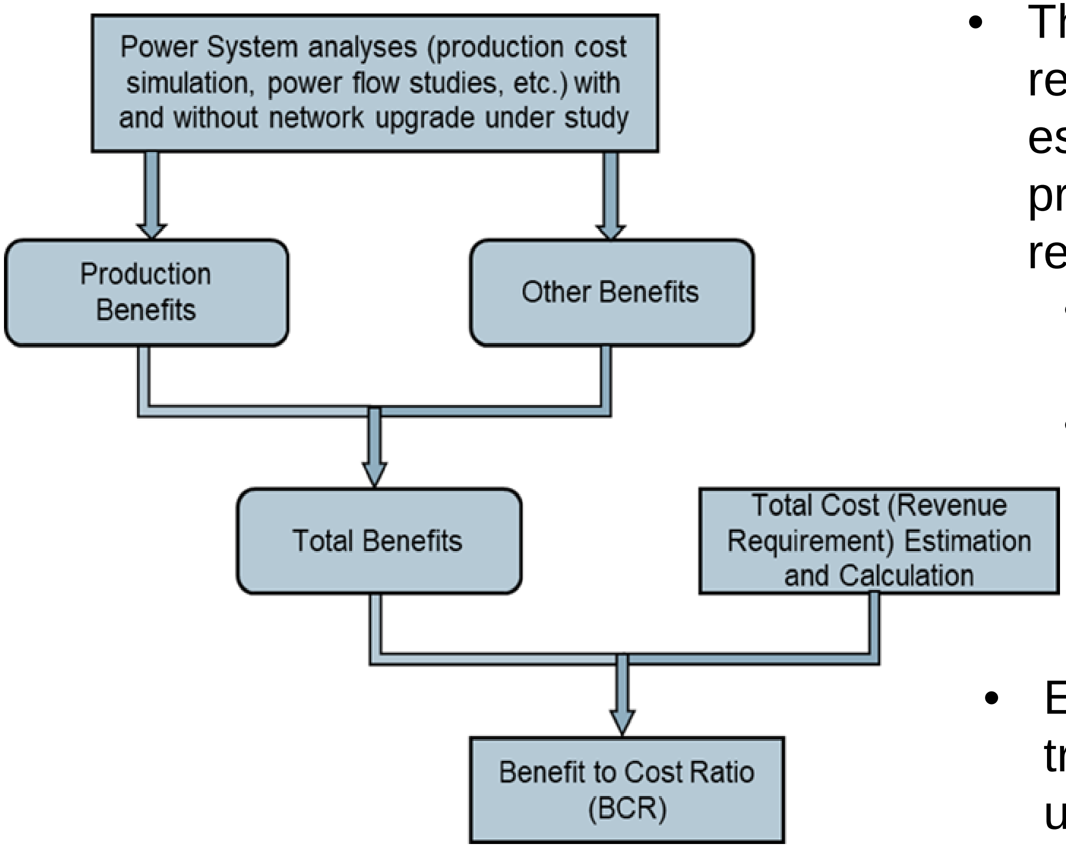


Scenario	Sensitivity 2 with the 2000 MW net export limit	Sensitivity 2 without the net export limit
Total Wind and Solar Generation (TWh)	93.88	112.00
Total Curtailment (TWh)	25.16	7.04

California ISO

Congestion analysis and production benefit economic assessment (based on the Base portfolio)

Technical approach of economic study



- The CC-to-RR multiplier for revenue requirement (total cost) estimation is used for estimating the present value of the revenue requirement of transmission project
  - Revenue requirements =1.3*Capital Cost
  - This multiplier is used for screening purposes

- Economic life: 50 years for new transmission facilities; 40 years for upgraded transmission facilities

Congestion selected for detailed investigation and economic assessment – only based on the Base Portfolio

Detailed investigation	Alternatives	Proposed by	Reason
Path 26 Corridor	PTE HVDC (Multi-terminals DC between Diablo Canyon, Goleta, Redondo Beach, and Huntington Beach)	PTE	A parallel path to Path 26 and can potentially reduce congestion on Path 26 and potential LCR reduction in SCE areas
PG&E Fresno Avenal area Gates toTulare Lake 70 kV line	Reconductoring Kettleman Hills Tap to Gates 70 kV line	PG&E	Potentially mitigate or reduce the identified congestion
PG&E Fresno Huron to CalFlax 70 kV line	Reconductoring Huron to Calflax 70 kV line	ISO	Potentially mitigate or reduce the identified congestion
PG&E Fresno Oro Loma to El Nido 115 kV lines	Reconductoring Oro Loma to El Nido 115 kV line	ISO	Potentially mitigate or reduce the identified congestion
VEA Sloan Canyon to Pahrump 230 kV lines	Reconductoring the existing Sloan Canyon to Pahrump 230 kV lines;	GLW	Potentially mitigate or reduce the identified congestion
	Reconductoring Sloan Canyon to Pahrump 230 kV lines and install two phase shifters between the VEA and NVE 138 kV systems	ISO	Potentially mitigate or reduce the identified congestion

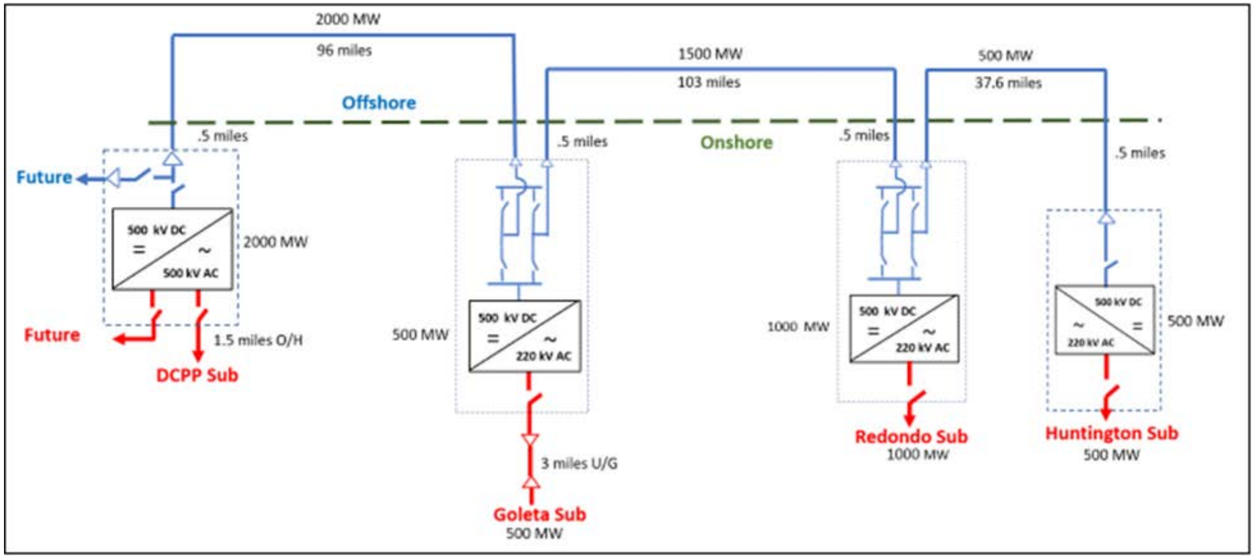
California ISO

Path 26 corridor congestion assessment

- The production cost simulations in this planning cycle showed Path 26 corridor congestion mainly from south to north
  - Pardee to Sylmar 230 kV congestion is related to Path 26 corridor congestion, but will be discussed separately

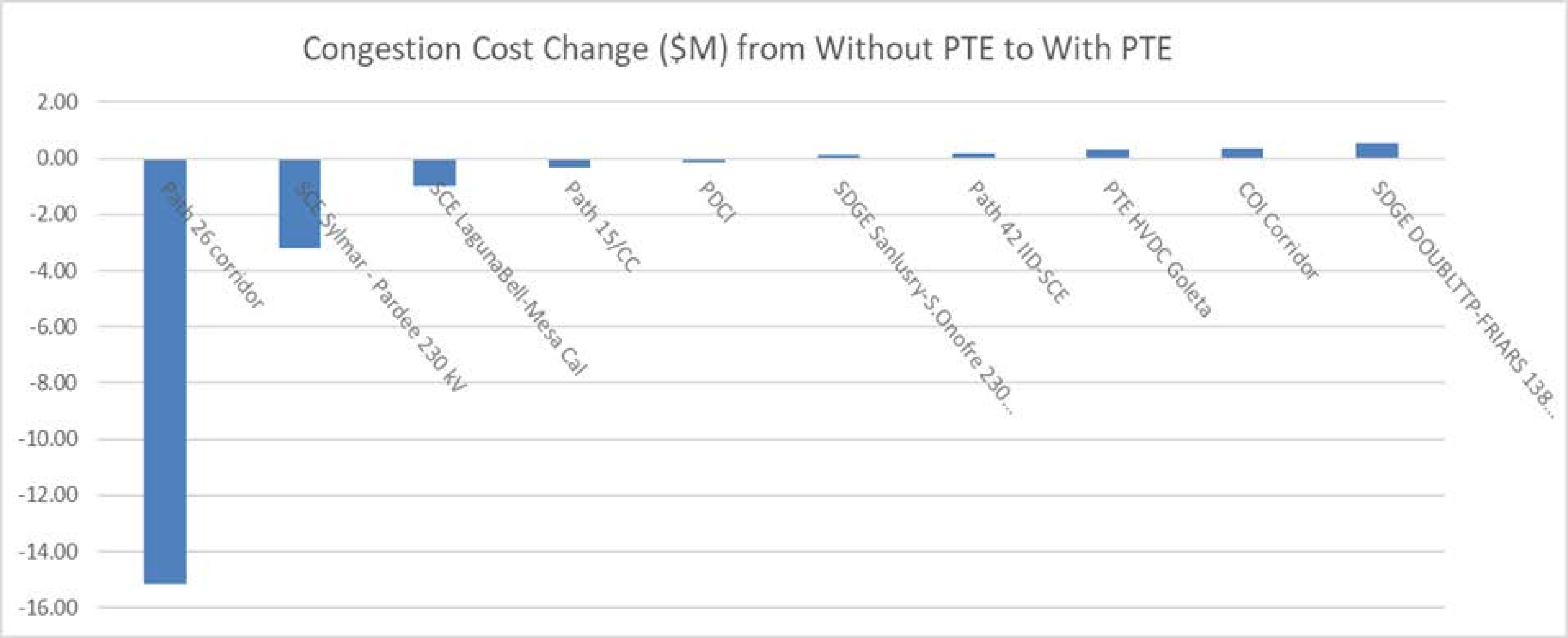
Constraints Name	Congestion Costs ($M)	Congestion Duration (Hrs)
P26 North to South (4000 MW path ration)	0.01	3
P26 South to North (3000 MW path rating)	14.17	586
From MW_WRLWND_31 to MW_WRLWND_32 500 kV line #3	3.52	78
From MW_WRLWND_32 to WIRLWIND 500 kV line, subject to SCE N-1 Midway-Vincent #2 500 kV	0.65	36
From MW_WRLWND_32 to WIRLWIND 500 kV line, subject to SCE N-1 Midway-Vincent #1 500 kV	0	1

Path 26 corridor congestion mitigation – PTE HVDC project



- PTE HVDC project was studied as an alternative to mitigate Path 26 corridor congestion because it provides a parallel path to Path 26
- This project was also studied in local capacity reduction assessment for the Big Creek/Ventura area and Western LA Basin area

Path 26 corridor congestion mitigation – Congestion changes with modeling the PTE HVDC project



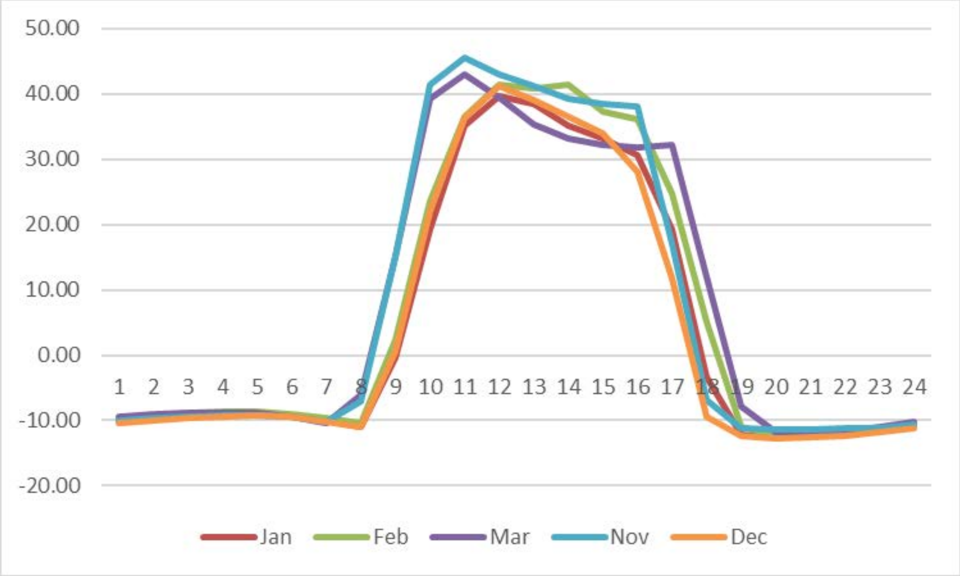
Path 26 corridor congestion mitigation – Production benefits of the PTE HVDC project

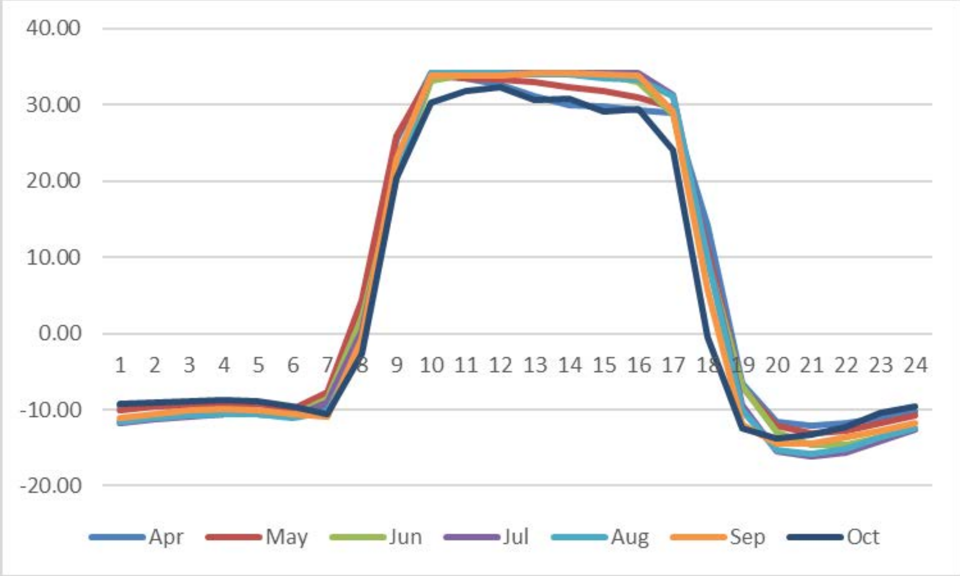
	Pre project upgrade ($M)	Post project upgrade ($M)	Savings ($M)
ISO load payment	7,732.7	7,743.6	-10.8
ISO generator net revenue benefiting ratepayers	3,445.9	3,467.4	21.5
ISO transmission revenue benefiting ratepayers	167.1	147.8	-19.2
ISO Net payment	4,119.8	4,128.4	-8.5
WECC Production cost	14,784.1	14,776.8	7.3

- This project does not provide production benefit to ISO's ratepayers
- LCR reduction study results alone (presented in the last stakeholder meeting) showed that the BCR of this project is less than one
- The BCR considering both production and LCR reduction benefits is still less than one
- No sufficient economic justification on a standalone basis to support the project as an economic-driven project in this planning cycle

PG&E Fresno Avenal Area - Gates to Tulare Lake 70 kV line congestion

- Congestion from Kettleman Hills Tap to Gates 70 kV
- The congestion occurs mainly in the hours when solar generation output is high, especially in the months when the summer rating of the line is applied





PG&E Fresno Avenal Area Gates to Tulare Lake 70 kV line reconductoring economic assessment

	Pre project upgrade ($M)	Post project upgrade ($M)	Savings ($M)
ISO load payment	7,732.7	7,730.6	2.1
ISO generator net revenue benefiting ratepayers	3,445.9	3,444.3	-1.5
ISO transmission revenue benefiting ratepayers	167.1	166.9	-0.2
ISO Net payment	4,119.8	4,119.4	0.4
WECC Production cost	14,784.1	14,788.6	-4.5

- The congestion on this line is related to several key factors including the local load profile and the local solar generator output
- The ISO will coordinate with PG&E to investigate these key factors in future planning cycles

- Reconductoring the congested section can mitigate the congestion
- Cost estimate was based on PG&E per unit cost
- BCR is 0.4

PG&E Fresno Kettleman Hills Tap to Gates 70 kV Reconductoring	
Production cost savings ($million/year)	0.4
Capacity saving ($million/year)	0.0
Capital cost ($million)	11.0
Discount Rate	7%
PV of Production cost savings ($million)	5.7
PV of Capacity saving ($million)	0.0
Total benefit ($million)	5.7
Total cost (Revenue requirement) ($million)	14.3
Benefit to cost ratio (BCR)	0.4

PG&E Fresno area - Huron to Calflax 70 kV line congestion

- Congestion from Huron to Calflax 70 kV under an N-2 contingency of Panoche to Excelsior 115 kV lines
- The congestion occurs mainly in the hours when solar generation output is high, especially in the months when the summer rating of the line is applied

PG&E Fresno area - Huron to Calflax 70 kV line reconductoring economic assessment

	Pre project upgrade ($M)	Post project upgrade ($M)	Savings ($M)
ISO load payment	7,732.7	7,731.1	1.6
ISO generator net revenue benefiting ratepayers	3445.9	3,446.7	0.9
ISO transmission revenue benefiting ratepayers	167.1	166.2	-0.9
ISO Net payment	4,119.8	4,118.2	1.6
WECC Production cost	14,784.1	14,784.8	-0.7

The ISO will continue to coordinate with PG&E to further evaluate

- The N-2 contingency that caused the congestion
- Other alternatives e.g. SPS to mitigate the congestion under contingency
- Other key factors that may impact the congestion, e.g. local load and solar profiles

- Reconductoring can mitigate the congestion
- Cost estimate was based on PG&E per unit cost
- BCR is 1.45

PG&E Fresno Huron to Calflax 70 kV Reconductoring	
Production cost savings ($million/year)	1.6
Capacity saving ($million/year)	0.0
Capital cost ($million)	12.0
Discount Rate	7%
PV of Production cost savings ($million)	22.6
PV of Capacity saving ($million)	0.0
Total benefit ($million)	22.6
Total cost (Revenue requirement) ($million)	15.6
Benefit to cost ratio (BCR)	1.45

PG&E Fresno area - Oro Loma to El Nido 115 kV line congestion

- Congestion from Oro Loma to El Nido 115 kV
- The congestion occurs mainly in the hours when solar generation output is high, especially in the months when the summer rating of the line is applied
- Congestion was observed in total 208 hours in the production cost simulation results

PG&E Fresno area - Oro Loma to El Nido 115 kV line reconductoring economic assessment

- Reconductoring to the same rating of the Wilson to El Nido 115 kV line
  - Wilson to El Nido 115 kV reconductoring was approved as a reliability upgrade in this planning cycle
- Congestion can be reduced from 208 hours to 73 hours
- The reconductoring does not provide positive benefit to ISO ratepayers
- Will be reevaluated in future planning cycles with further clarity of Wilson to El Nido upgrade implementation and local load and renewable generation profiles

	Pre project upgrade ($M)	Post project upgrade ($M)	Savings ($M)
ISO load payment	7,733	7,733	-1
ISO generator net revenue benefiting ratepayers	3,446	3,444	-2
ISO transmission revenue benefiting ratepayers	167	166	-1
ISO Net payment	4,120	4,123	-4
WECC Production cost	14,784	14,788	-4

GridLiance West/VEA area congestion

- Renewable generators in the GLW/VEA area and in the SCE's Eldorado and Ivanpah areas are the main drivers of the congestion
- Loop flow caused by the interchange between the Nevada Energy (NVE) and the ISO systems also contributes to the congestion

Congestion	Congestion cost ($M)	Congestion duration (Hr)
From Carpenter Canyon to Pahrump 230 kV line	2.80	357
From Jackass Flats to Mercury 138 kV line	0.12	120
From Trout Canyon to Sloan Canyon 230 kV line	0.06	57

GridLiance West/VEA area congestion mitigation alternatives

- Alternative 1: The economic study request of reconductoring the Sloan Canyon to Pahrump 230 kV line, which includes three sections from Sloan Canyon to Trout Canyon, from Trout Canyon to Carpenter Canyon, and from Carpenter Canyon to Pahrump
- Alternative 2: Combining Alternative 1 and the installation of two phase shifters on the Lathrop Wells to Jackass Flats 138 kV line and on the Innovation to Mercury 138 kV line. This alternative was identified in the ISO's generation interconnection studies. It can help to limit the loop flow between the NVE and the ISO systems

Alternative 1 can mitigate the identified congestions on all sections of the Sloan Canyon to Pahrump 230 kV line, but slightly increase the congestion on the Jackass Flats to Mercury 138 kV line. Alternative 2 can mitigate the identified congestions in the GLW/VEA area

GridLiance West/VEA area congestion mitigation alternatives economic assessment

		Alternative 1 - Reconductoring		Alternative 2 - Reconductoring plus Phase Shifters	
	Pre project upgrade ($M)	Post project upgrade ($M)	Savings ($M)	Post project upgrade ($M)	Savings ($M)
ISO load payment	7732.7	7720.0	12.7	7732.4	0.3
ISO generator net revenue benefiting ratepayers	3445.9	3440.7	-5.1	3450.6	4.7
ISO transmission revenue benefiting ratepayers	167.1	164.5	-2.6	164.1	-2.9
ISO Net payment	4119.8	4114.8	5.0	4117.7	2.1
WECC Production cost	14784.1	14790.5	-6.5	14785.2	-1.1

GLW/VEA upgrades		
	Alternative 1 - Reconductoring	Alternative 2 - Reconductoring plus Phase Shifters
Production cost savings ($million/year)	5.0	2.1
Capacity saving ($million/year)	0.0	0.0
Capital cost ($million)	96.4	105.4
Discount rate	7%	7%
PV of Production cost savings ($million)	69.1	29.1
PV of Capacity saving ($million)	0.0	0.0
Total benefit ($million)	69.1	29.1
Total cost (Revenue requirement) ($million)	125.3	137.0
Benefit to cost ratio (BCR)	0.55	0.21

This area will be monitored and investigated in future planning cycles with further clarity of the resource assumption and development

Pardee-Sylmar 230 kV line congestion and mitigation

- Pardee-Sylmar 230 kV Line Rating Increase project is a reliability driven project with potential production and LCR reduction benefits
- Congestion was observed from Sylmar to Parded under N-1 contingency of one of the two Sylmar to Pardee 230 kV lines

Constraints Name	Costs_F (K$)	Duration_F (Hrs)	Costs_B (K$)	Duration_B (Hrs)	Costs T (K$)	Duration_T (Hrs)
PARDEE-SYLMAR S 230 kV line, subject to SCE N-1 Sylmar-Pardee 230kV	0	0	4,664	299	4,664	299

- Line rating increase with estimated capital cost of $15.4 million can mitigate the congestion

Pardee-Sylmar 230 kV Line Rating Increase project production benefit assessment

	Pre project upgrade ($M)	Post project upgrade ($M)	Savings ($M)
ISO load payment	7,732.7	7,727.0	5.7
ISO generator net revenue benefiting ratepayers	3,445.9	3,445.7	-0.1
ISO transmission revenue benefiting ratepayers	167.1	163.1	-3.9
ISO Net payment	4,119.8	4,118.2	1.7
WECC Production cost	14,784.1	14,778.7	5.4

- Production benefit of the project to ISO's ratepayers is $1.7 million per year
- Total benefit and justifications of this project was discussed in the presentation for "Reliability Project for SCE area"

Summary of economic studies

- Five congestion related and twelve LCR reduction related economic assessments were conducted in 2019-2020 planning cycle
- No transmission upgrade was recommended for approval as economically driven upgrade in this planning cycle
- Pardee-Sylmar 230 kV Line Rating Increase project is a reliability driven project with economic benefit

Wrap-up
Draft 2019-2020 Transmission Plan

Isabella Nicosia
Associate Stakeholder Engagement and Policy Specialist

2019-2020 Transmission Planning Process Stakeholder Meeting
February 7, 2020

Stakeholder Comments

- Stakeholder comments to be submitted by February 21
  - Stakeholders requested to submit comments to: regionaltransmission@caiso.com
  - Stakeholder comments are to be submitted within two weeks after stakeholder meetings
  - ISO will post comments and responses on website