

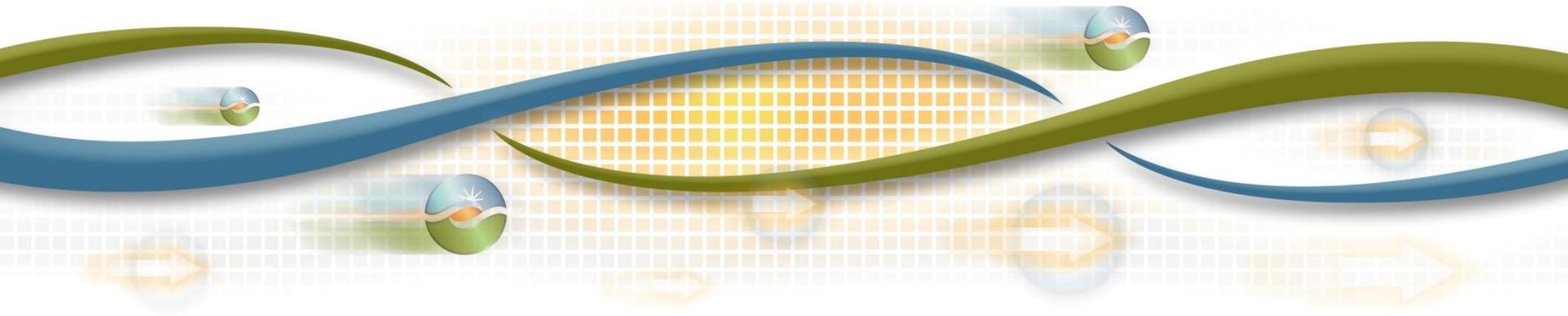


Introduction and Overview

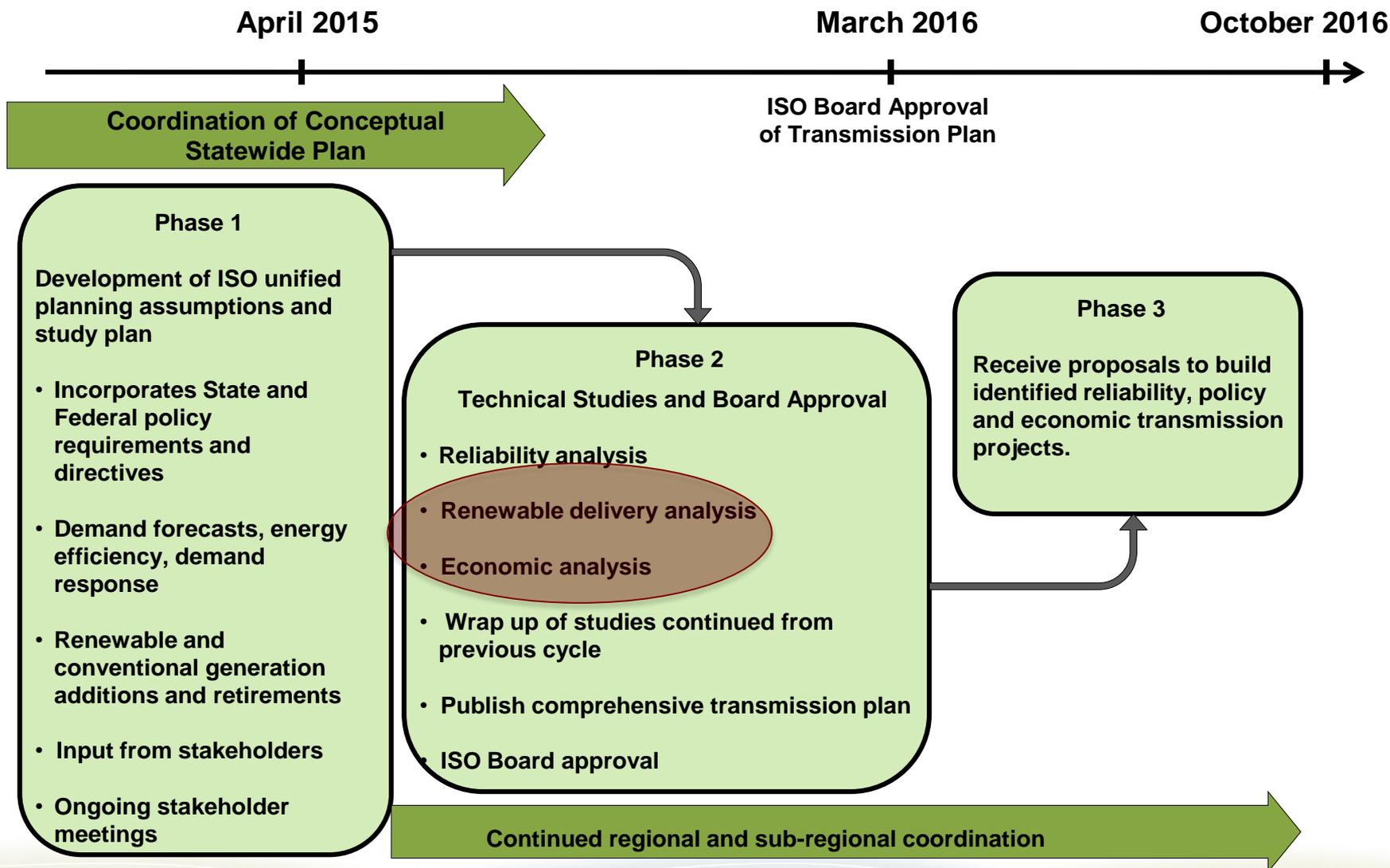
Policy-Driven and Economic Assessment

Neil Millar
Executive Director, Infrastructure Development

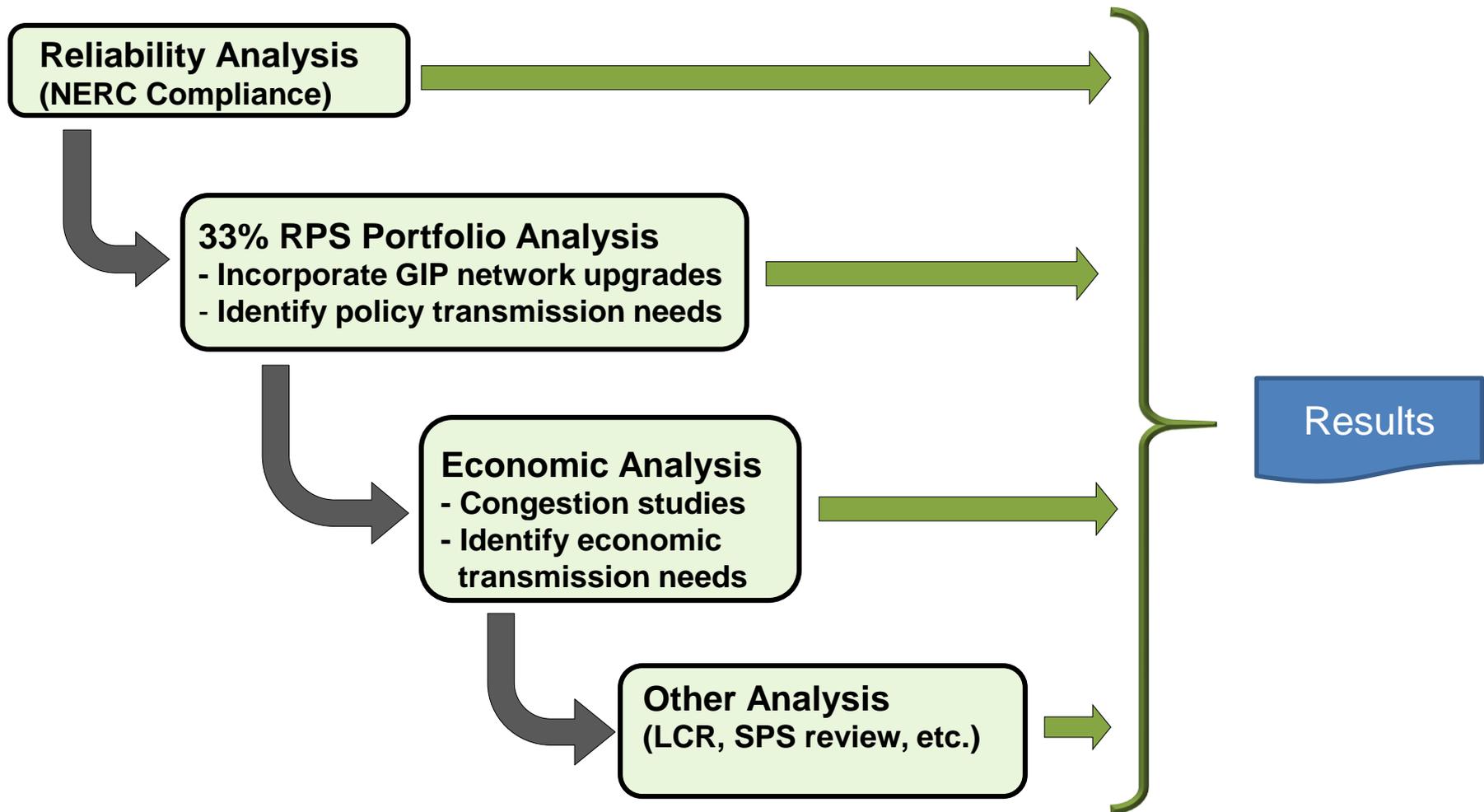
2015-2016 Transmission Planning Process Stakeholder Meeting
November 16, 2015



2015-2016 Transmission Planning Cycle



Development of 2015-2016 Annual Transmission Plan



2014-2015 Ten Year Plan Milestones

- Preliminary reliability study results were posted on August 14, supplemental results on August 31
- Stakeholder session September 21st and 22nd
- Comments received October 6 and request window closed October 15
- **Today's session - preliminary policy and economic study results**
- Comments due by December 1
- Draft plan to be posted January, 2015

Other Issues

- Management approval of certain reliability projects less than \$50 million
 - Addressing some previously approved PG&E projects less than \$50 million
- Updates on other studies of interest:
 - ISO 50% special study – update today
 - Work in progress – no update at this time
 - Continuation of frequency response studies
 - Gas/electric reliability in southern California
 - Large scale energy storage study – still in progress

Management is considering approving a number of reliability transmission projects less than \$50 million

- Approving these projects allows streamlining the review and approval process of the annual transmission plan in March
- Only those projects less than \$50 million are considered for management approval that:
 - Can reasonably be addressed on a standalone basis
 - Are not impacted by policy or economic issues that are still being assessed.
 - Are not impacted by the approval of the transmission plan (and reliability projects over \$50 million) by the Board of Governors in March, 2015
- Management will only approve these projects after the December Board of Governors meeting
- Other projects less than \$50 million will be identified in January and dealt with in the approval of the comprehensive plan in March.

Renewable Portfolio Standard Policy Assumptions

- Portfolios received from the CPUC and CEC:
 - Initial portfolios on March 13
 - Revised portfolios on April 29
- As in previous cycles, a “commercial interest” portfolio was the base – focusing on the mid-AAEE scenario as the current trajectory.
- Portfolios to be used in the ISO’s informational 50% RPS special studies were provided by CPUC staff.



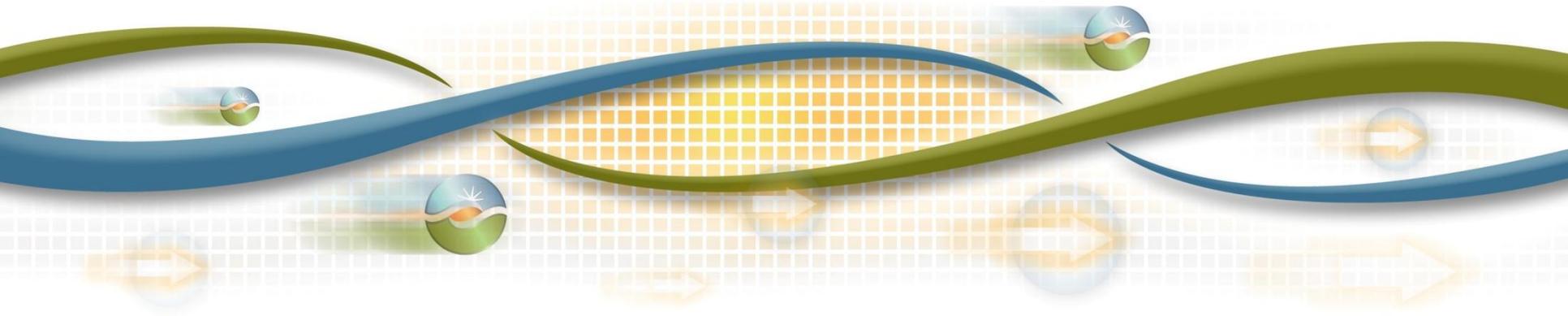
Reliability Projects less than \$50 Million Recommended for Approval and Recommended for Cancellation *Pacific Gas & Electric Area*

Vera Hart

Jeff Billinton

Regional Transmission – North

*2015-2016 Transmission Planning Process Stakeholder Meeting
November 16, 2015*



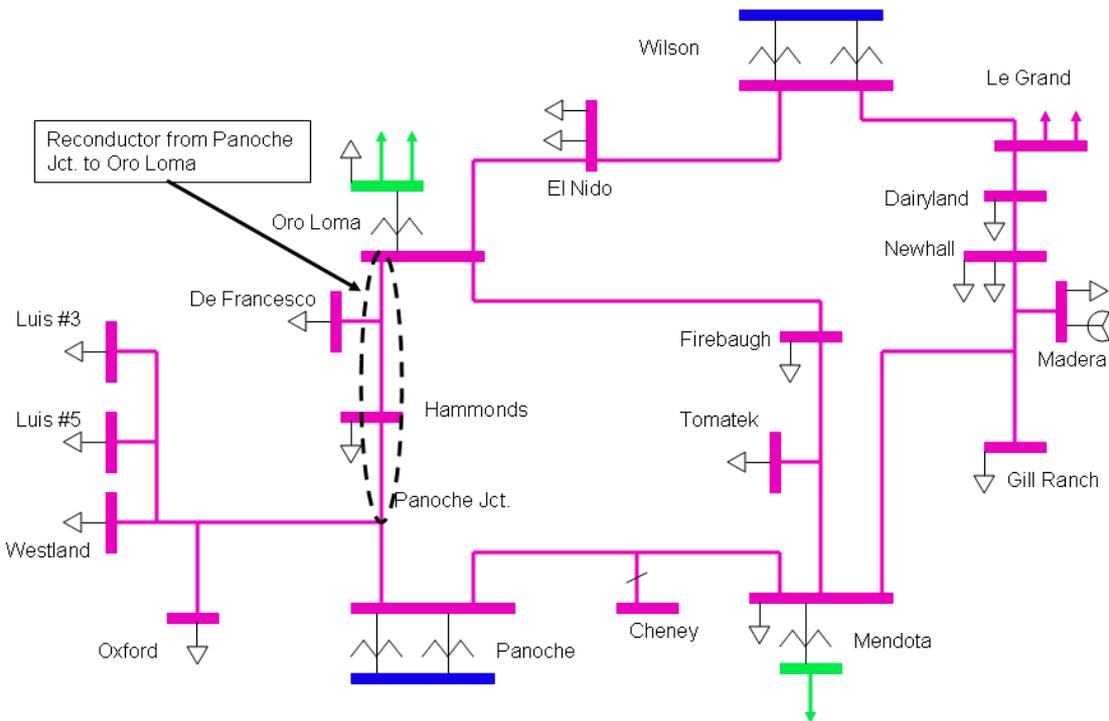
Overview

- Projects less than \$50 million recommended for approval
- Previously approved projects less than \$50 million to be cancelled

ISO Recommendations on Proposed Projects

Project Name	Type of Project	Submitted By	Cost of Project	Is Project Found Needed
Panoche-Oro Loma 115kV Line Reconductoring	Reliability	PGE	\$20M	Yes

Panoche-Oro Loma 115kV Reconductoring



Need: NERC Category P1, P2-1, P3,P6 overloads up to 134% (2017, 2020, 2025)

Project Scope:

- Reconductor 17 miles of the Panoche-Oro Loma 115 kV Line between Panoche Jct. and Oro Loma 115 kV Substation with conductors rated to handle at least 825 Amps and 975 Amps under normal and emergency conditions, respectively.
- Upgrade circuit breaker and switches at Panoche Substation
- Upgrade switches and bus conductor at Hammonds Substation.

Cost: \$20 M

Other Considered Alternatives:

Status Quo

SPS – Not feasible.

Expected In-Service: 2021

Interim Plan: Operations action plans until project in-service

Assessment Methodology

- Reviewed the need based upon:
 - Reliability Standards
 - NERC, WECC and ISO Planning Standards
 - LCR requirements
 - Deliverability
- Analysis conducted on topology of system in 2017 base case (with only projects already moving forward in-service) with load escalated to 2025 forecast
 - Assessment done with and without AAEE

Projects Recommended for Cancellation

- There are 11 projects that were found to be no longer required based on reliability, LCR and deliverability assessment that are recommended for cancellation:
 - Bay Meadows 115 kV Reconductoring
 - Cooley Landing - Los Altos 60 kV Line Reconductor
 - Del Monte - Fort Ord 60 kV Reinforcement Project
 - Kerckhoff PH #2 - Oakhurst 115 kV Line
 - Mare Island - Ignacio 115 kV Reconductoring Project
 - Monta Vista - Los Altos 60 kV Reconductoring
 - Potrero 115 kV Bus Upgrade
 - Taft 115/70 kV Transformer #2 Replacement
 - Tulucay 230/60 kV Transformer No. 1 Capacity Increase
 - West Point - Valley Springs 60 kV Line Project (Second Line)
 - Woodward 115 kV Reinforcement
- Recommendation is to cancel the above projects in the 2015-2016 TPP based
 - All of the above projects were approved by ISO Executive in past Transmission Planning Cycles

Projects identified as still being required

- There are 102 projects that have been identified as being required for mitigation of reliability standard violations, LCR requirements and deliverability
- The ISO is continuing to review 19 previously approved projects and will include in the draft transmission plan in January 2015 if there are any additional projects recommended for cancelling.

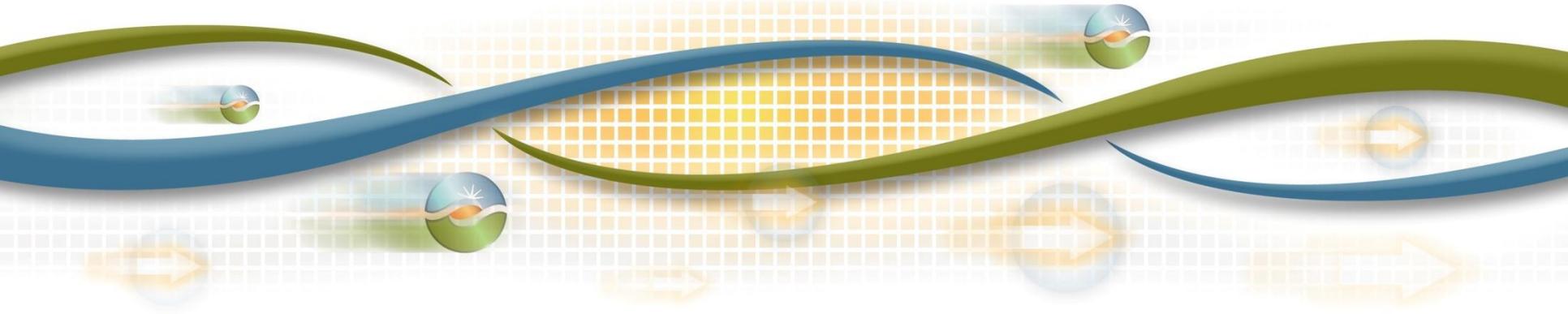


Recommendations for Management Approval of Reliability Projects less than \$50 Million

SCE Eastern Area

*Charles Cheung
Sr. Regional Transmission Engineer*

*2015-2016 Transmission Planning Process Stakeholder Meeting
November 16, 2015*

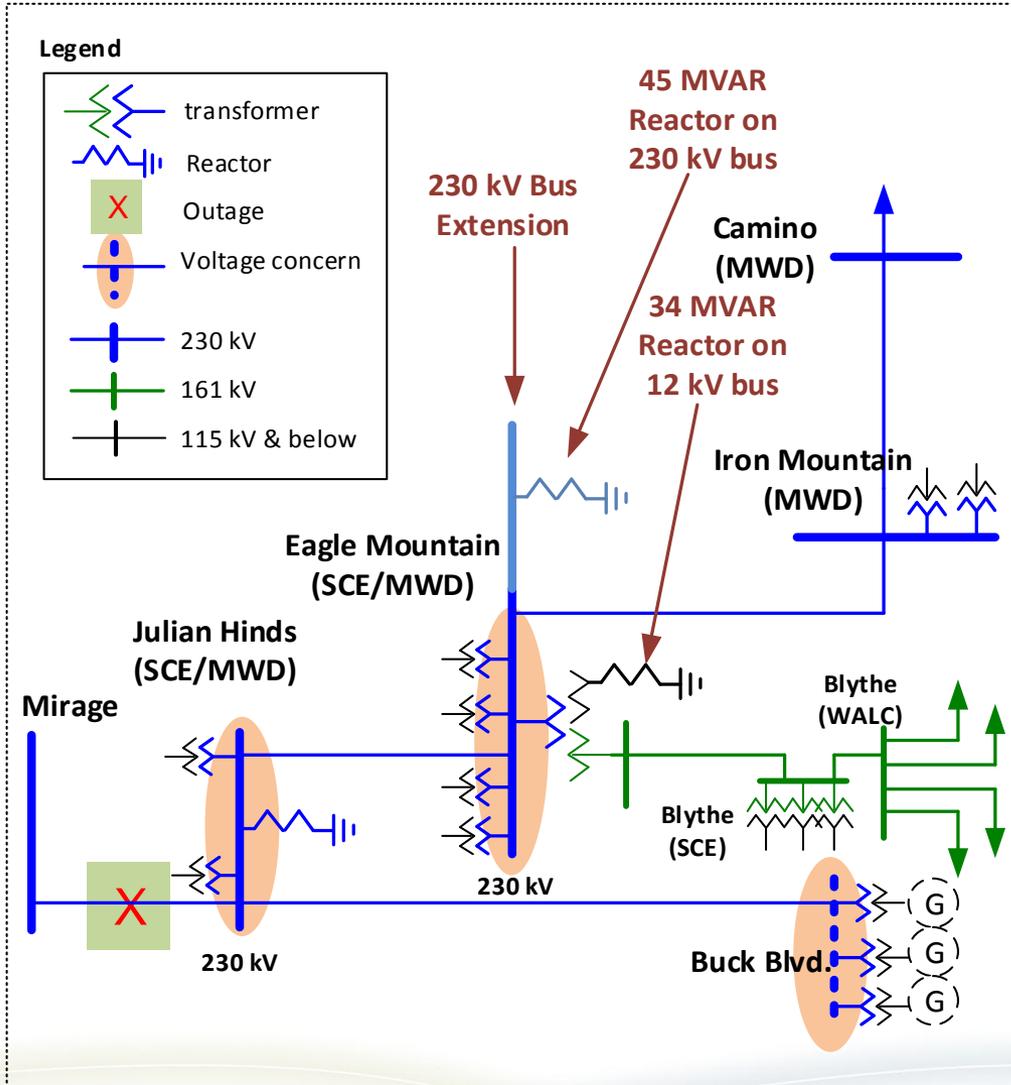


ISO Recommendations on Proposed Projects

SCE Eastern Area

Project Name	Type of Project	Submitted By	Cost of Project	Is Project Found Needed
Eagle Mountain Shunt Reactors	Reliability	SCE	\$10 Million	Yes

Eagle Mountain Shunt Reactors



Need: Category P1 (N-1) and P6 (N-1-1) high voltages exceed circuit breaker limits at Julian Hinds and Eagle Mountain substations in 2020 Light Load case

Project Scope:

The project will install two shunt reactors at SCE's Eagle Mountain Substation to address high voltages at Julian Hinds and Eagle Mountain Substations. One 34 MVAR reactor will be connected to the 12 kV tertiary winding of the existing 5A Bank and one 45 MVAR reactor will be connected to the 230 kV bus.

Cost: \$10 million

Other Considered Alternatives: No comparable alternatives identified

Expected In-Service: December 2018

Interim Plan: Disconnect Blythe Generation Tie to decrease voltage

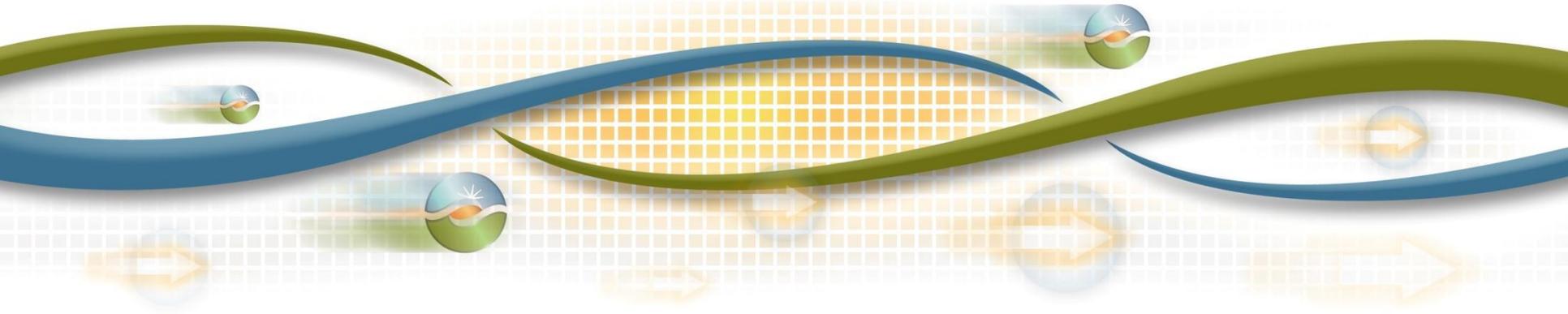


Recommendations for Management Approval of Reliability Projects less than \$50 Million

San Diego Gas & Electric Area Sub-Transmission

*Charles Cheung
Sr. Regional Transmission Engineer*

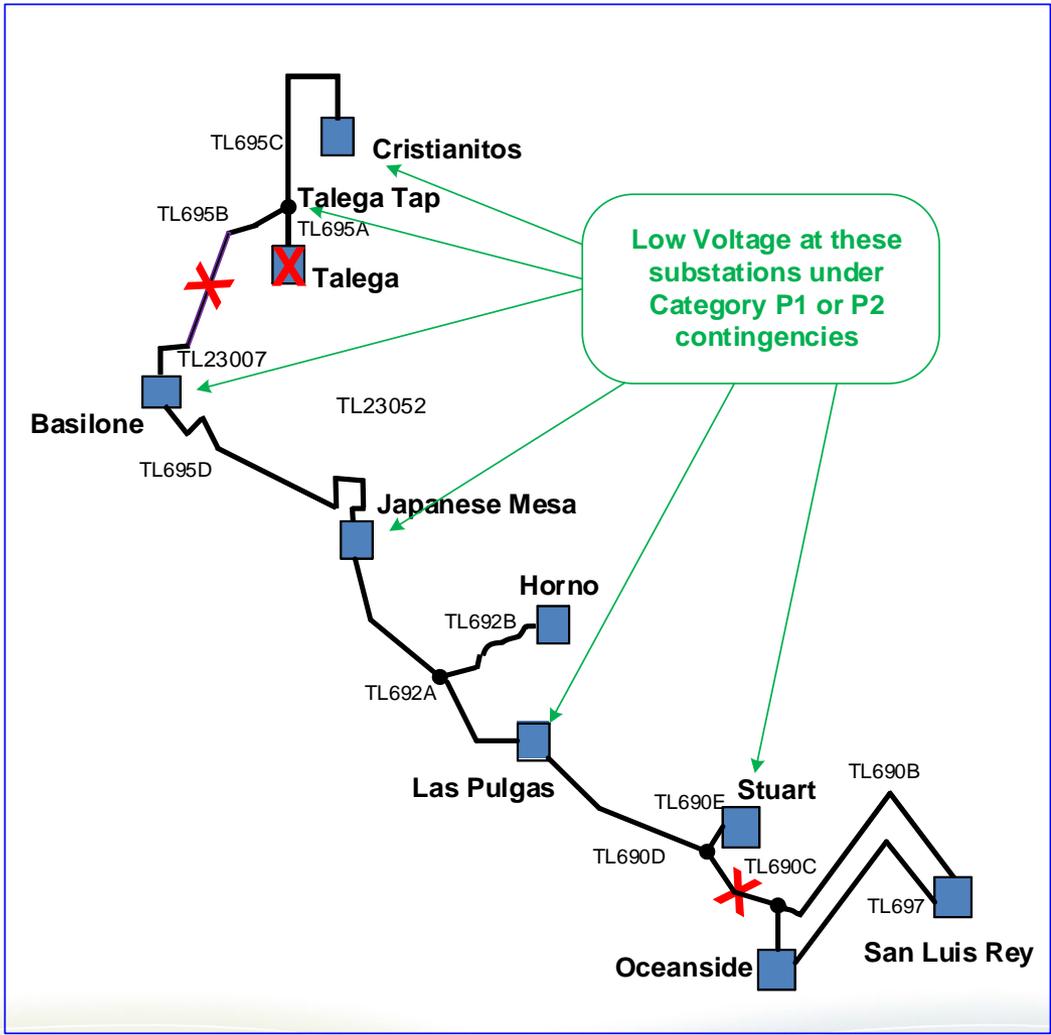
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ISO Recommendations on Proposed Projects San Diego Gas & Electric Area

Project Name	Type of Project	Submitted By	Cost of Project	Is Project Found Needed
New 15 MVAR Capacitor at Basilone Substation	Reliability	SDG&E	\$1.5~2 M	Yes
New 30 MVAR Capacitor at Pendleton Substation	Reliability	SDG&E	\$2~3 M	Yes

New 15 MVAR Capacitor at Basilone Substation



Need: Category P1 or P2 of either TA Bank 50, TL695 or TL690c causes low voltage and voltage deviation in 2017 Peak case when using actual load power factor, No reactive support from Talega to Oceanside Tap for about 22 miles

Project Scope: Install 15MVAR Capacitor at Basilone Sub

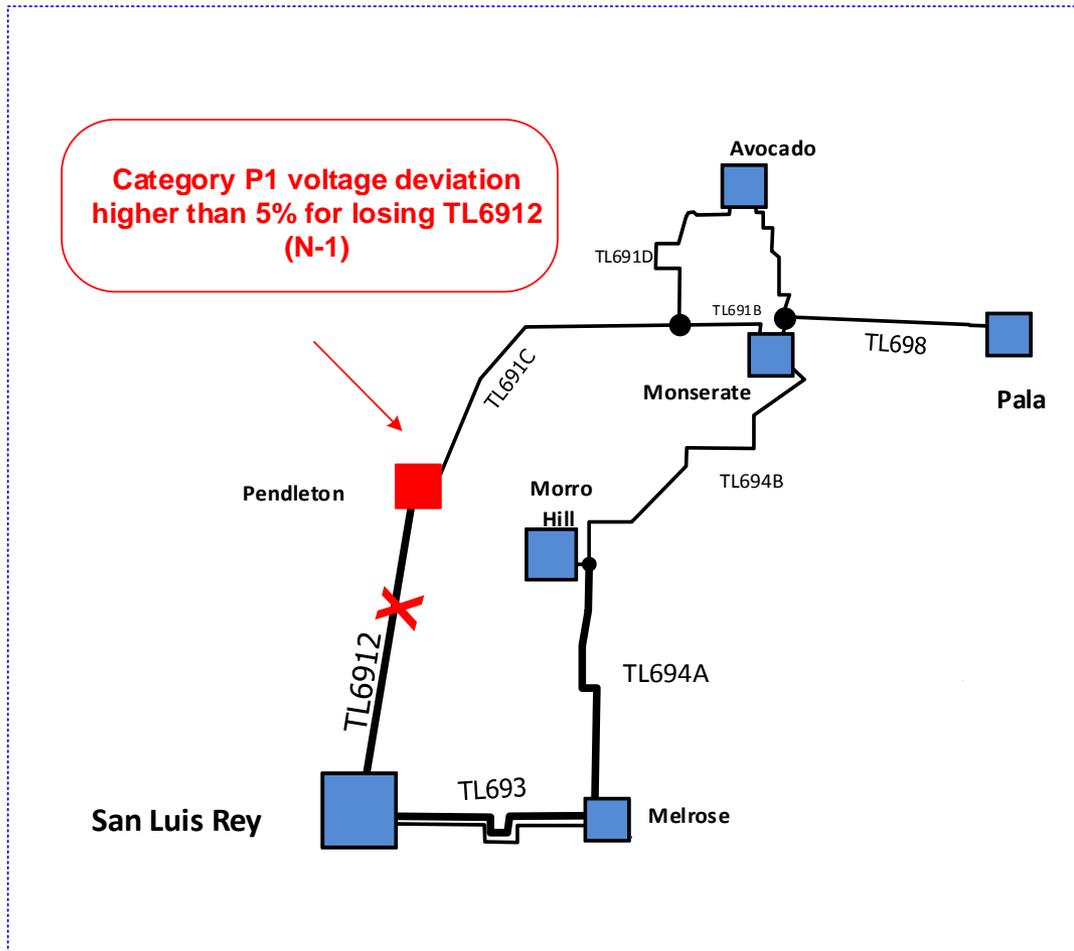
Cost: \$1.5~\$2 million

Other Considered Alternatives: No alternatives identified

Expected In-Service: June 2016

Interim Plan: Load Shedding, Existing Talega SPS to open TL695

New 30 MVAR Capacitor at Pendleton Substation



Need:

- Category P1 (N-1) of TL6912 results in voltage deviation greater than 5% in 2017 peak case when using actual load power factor
- No reactive support in the Fallbrook Load Pocket consisting of 40 miles of circuit and 110 MW of load

Project Scope: Install 30 MVAR capacitor at Pendleton

Cost: \$2-3 million

Other Considered Alternatives:

No alternatives identified

Expected In-Service: June 2017

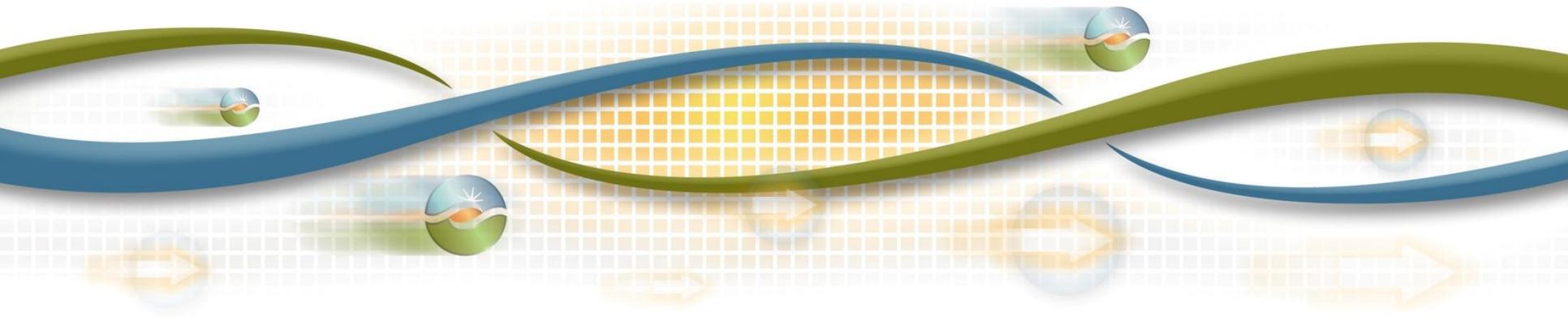
Interim Plan: Drop Load in Pendleton



Policy Driven Assessment Results – Overview

Sushant Barave
Sr. Regional Transmission Engineer

2015-2016 Transmission Planning Process Stakeholder Meeting
November 16, 2015



Overview of the 33% RPS Transmission Assessment in 2015-2016 Planning Cycle

- Objective
 - To identify the policy driven transmission upgrades needed to meet the 33% renewable resource goal
- Portfolio
 - Formally transmitted to CAISO on April 29, 2015
- Methodology
 - Power flow and stability assessments
 - Production cost simulations
 - Deliverability assessments

2015-2016 RPS portfolio

- Initial base portfolio formally transmitted to CAISO – March 11, 2015
- Need for updating the 33% portfolios due to
 - Imperial zone transmission capability improvements
 - Coolwater – Lugo Transmission Project removal
- RPS calculator v5 was re-run
- Updated portfolio formally transmitted to CAISO – April 29, 2015

2015-2016 RPS portfolio

CREZ	2015-2016 Portfolio	2014-2015 Portfolios	
	Base	Commercial Interest (base)	Sensitivity
Riverside East	3017	3800	1400
Imperial	1750	1000	2500
Tehachapi	1653	1653	1483
Distributed Solar - PG&E	984	984	984
Carrizo South	900	900	900
Nevada C	516	516	516
Mountain Pass	658	658	658
Distributed Solar - SCE	565	565	565
NonCREZ	185	185	182
Westlands	475	484	484
Arizona	400	400	400
Alberta	300	300	300
Kramer	250	642	642
Distributed Solar - SDGE	143	143	143
Baja	100	100	100
San Bernardino - Lucerne	87	87	42
Merced	5	5	5

Study areas

- Northern CA: No changes in any CREZ since 2014-2015 TPP
- Southern CA: Focus on Imperial, Riverside and Kramer CREZs
- Imperial and Riverside were studied together and Kramer CREZ was studied as a stand-alone case

RPS reliability results for Southern CA area: Lugo – Victorville 500 kV overload

Overloaded Facility	Contingency	Overload
Lugo-Victorville 500kV line	Eldorado-Lugo 500 and Lugo-Mohave 500	123.7 %

Mitigation

- Modify the Lugo – Victorville N-1 SPS and N-2 Safety Net to trip any RPS generation that materializes in this area

RPS Reliability Results for Southern CA Area – Eldorado 5AA bank contingency

Overloaded Facility	Contingency	Overload
Case divergence	Eldorado 500/230 kV 5AA transformer bank	-

Mitigation

- Modify the existing Ivanpah SPS to include the T-1 contingency of Eldorado 500/230 kV 5AA transformer bank to trip new generation

Conclusions

- Previously identified SPSs may need to be modified to accommodate new generation
- The mitigations recommended in 2014-2015 TPP and projects approved in prior planning cycles largely restore overall deliverability from the Imperial area to pre-SONGS retirement levels
- Generation recently operational or under construction is relying on some of that deliverability
- Deliverability constraint: Lugo-Victorville 500 kV overload (This overload was also observed in Southern CA reliability assessment in 2015-2016 TPP)

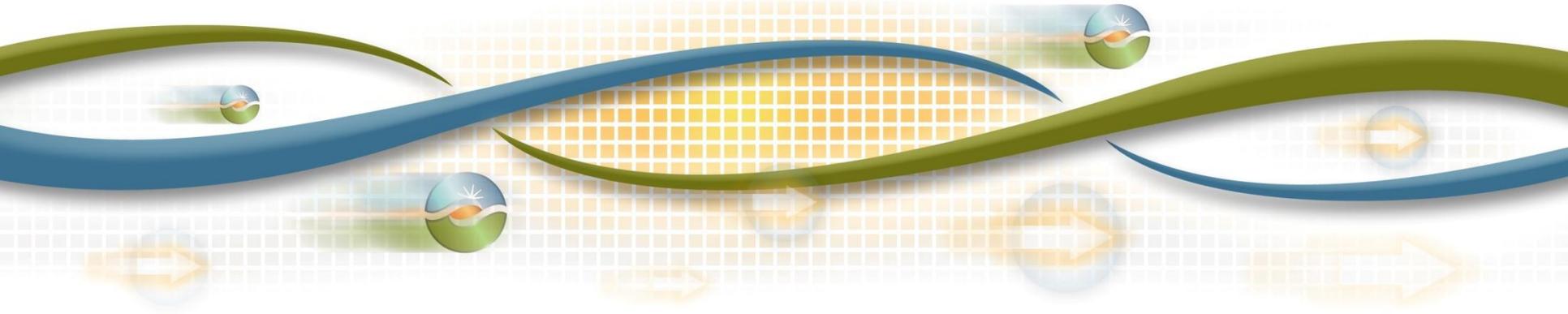
Questions?



Policy Driven Planning Deliverability Assessment Assumptions

*Luba Kravchuk
Sr. Regional Transmission Engineer*

*2015-2016 Transmission Planning Process Stakeholder Meeting
November 16, 2015*



Overview

- Deliverability assessment is performed for the base portfolio
- Follow the same on-peak deliverability assessment methodology as used in generation interconnection study

Objectives of Portfolio Deliverability Assessment

- Determine deliverability of the Target Maximum Import Capability (MIC)
- Determine deliverability of renewable resources inside CAISO BAA
- Identify transmission upgrades to support full deliverability of the renewable resources and Target MIC

Import Assumptions

- Maximum summer peak simultaneous historical import schedules (2016 Maximum RA Import Capability)
- Historically unused Existing Transmission Contracts are initially modeled by equivalent generators at the tie point
- IID import through IID-SCE and IID-SDGE branch groups is increased from 2016 MIC to support portfolio renewables in IID

Generation Assumptions

- Deliverability assessment is performed for generating resources in the base portfolio
- Generation capacity tested for deliverability
 - Existing non-intermittent resources: most recent summer peak NQC
 - New non-intermittent resources: installed capacity in the base portfolio
 - Intermittent resources: 50% (low level) and 20% (high level) exceedance during summer peak load hours

Load and Transmission Assumptions

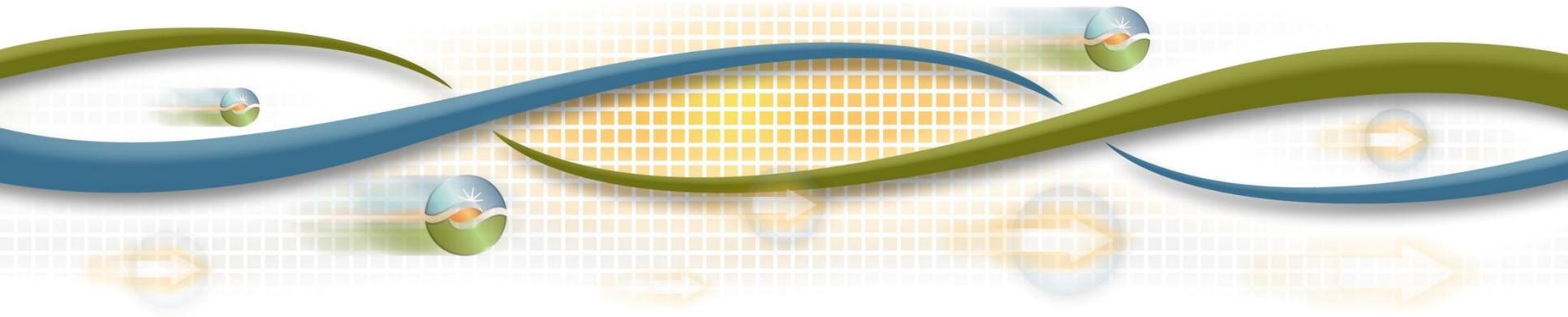
- ISO 2025 1-in-5 load
- Same transmission assumptions as power flow studies
 - Existing transmission
 - Approved transmission upgrades



Policy Driven Planning Deliverability Assessment Results – SCE/VEA Area

2015/2016 Transmission Planning Process Stakeholder Meeting

*Luba Kravchuk
Sr Regional Transmission Engineer
November 16-17, 2015*



Overview of renewable zones that impact SCE area

Renewable Zone	Base Portfolio MW
Distributed Solar - SCE	565
Imperial	1,750
Kramer	250
Mountain Pass	658
Nevada C	516
Non-CREZ	48
Riverside East	3,017
San Bernardino - Lucerne	87
Tehachapi	1,653

Deliverability Assessment Results for SCE Area – Desert Area

Overloaded Facility	Contingency	Flow
Lugo – Victorville 500kV	Lugo - Eldorado 500kV	111.87%

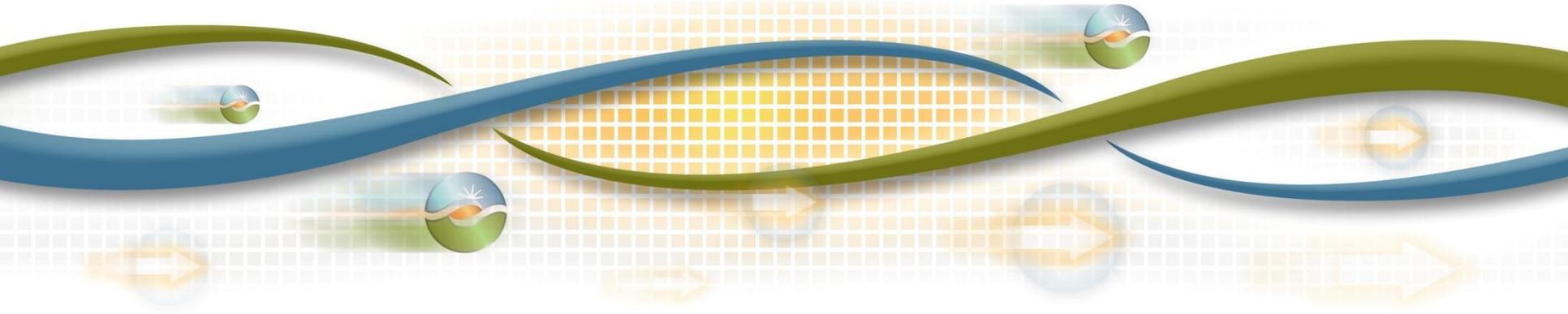
Desert Area Deliverability Constraint	
Constrained Renewable Zones	Riverside East, Imperial, Mountain Pass, Nevada C, non-CREZ (Big Creek/Ventura)
Total Renewable MW Affected	4566 MW
Deliverable MW w/o Mitigation	2700 ~ 3800 MW
Mitigation	Increase rating of the Lugo – Victorville 500kV line or install flow control devices to reduce flow on Lugo – Victorville 500kV line



Policy Driven Planning Deliverability Assessment Results – SDG&E Area

Luba Kravchuk
Sr. Regional Transmission Engineer

2015-2016 Transmission Planning Process Stakeholder Meeting
November 16, 2015



Overview of renewable zones that impact SDG&E area

Renewable Zone	Portfolio MW
Arizona	400
Baja	100
Distributed Solar – SDG&E	143
Imperial	1,750

Deliverability Assessment Results for SDG&E Area – Miguel 500/230 kV transformers

Overloaded Facility	Contingency	Flow
Miguel 500/230 kV #1	Miguel 500/230 kV #2	122%
Miguel 500/230 kV #2	Miguel 500/230 kV #1	122%

Constrained Renewable Zones	Baja, Imperial
Total Renewable MW Affected	1,000 MW
Mitigation	Use 30 minute rating of transformers and SPS to trip generation at Imperial Valley and ECO/Boulevard East or Open parallel transformer and ECO-Miguel 500 kV line and rely on SPS associated with line outage

Deliverability Assessment Results for SDG&E Area – Miguel-Bay Boulevard 230 kV line

Overloaded Facility	Contingency	Flow
Miguel-Bay Boulevard 230 kV	Miguel-Mission 230 kV #1 and #2	100%

Constrained Renewable Zones	Baja, Imperial
Total Renewable MW Affected	1,000 MW
Mitigation	New SPS to trip generation at Otay Mesa, ECO/Boulevard East, and Imperial Valley – identified in GIP studies

Deliverability Assessment Results for SDG&E Area – ECO-Miguel 500 kV line

Overloaded Facility	Contingency	Flow
ECO-Miguel 500 kV	Ocotillo-Suncrest 500 kV	100%
	Sycamore-Suncrest 230 kV #1 and #2	100%
	Imperial Valley-Ocotillo 500 kV	99%

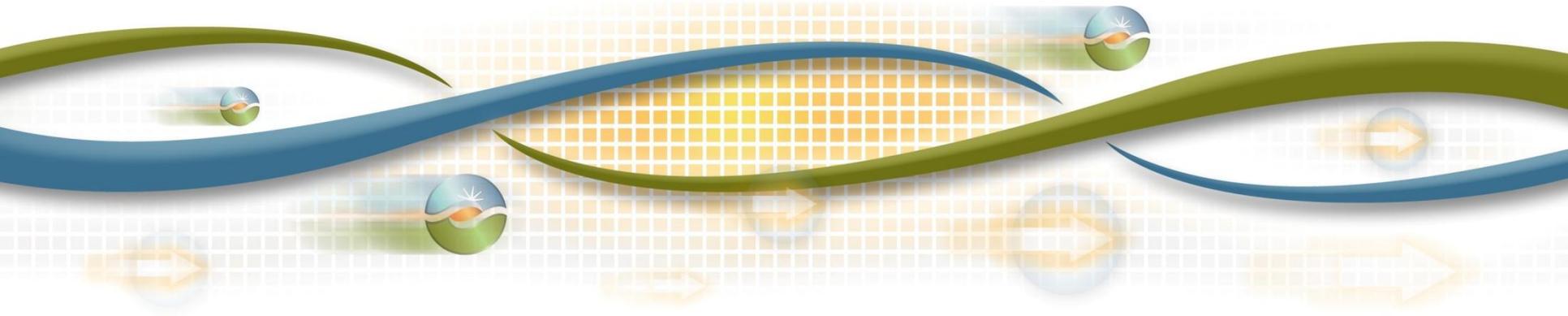
Constrained Renewable Zones	Baja, Imperial
Total Renewable MW Affected	1,000 MW
Mitigation	SPS to trip generation at Imperial Valley and ECO/Boulevard East



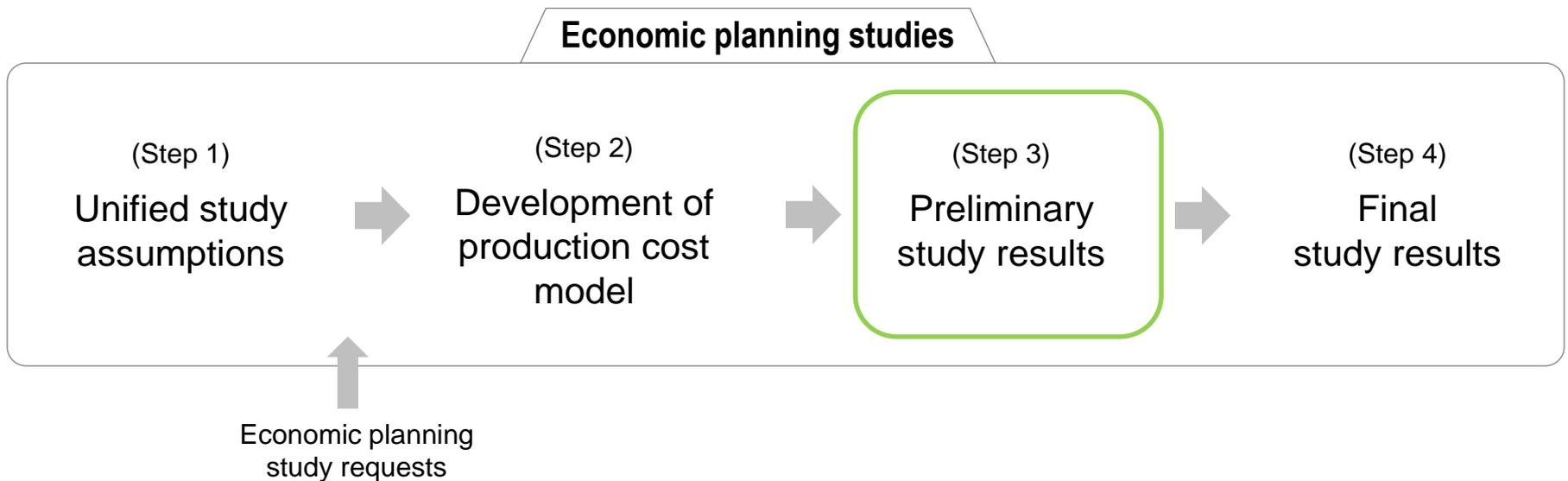
Economic Planning- Preliminary Results of Congestion and Economic Assessments

Yi Zhang
Regional Transmission Engineer Lead

2015-2016 Transmission Planning Process Stakeholder Meeting
November 16, 2015



Steps of economic planning studies



Database development

- Starting point
 - TEPPC 2024 Common Case V1.5 released at April, 2015
- Major updates
 - CEC forecast
 - Load: 2014 IEPR Mid AAEE Feb. 9, 2015
 - GHG: Preliminary 2015 IEPR Mid Energy Feb.11, 2015
 - NG: Estimating NG BT price Nov. 2014
 - Zero MW net export for CAISO
 - Frequency response requirements for the CAISO BAA
 - Energy imbalance market
 - Transmission constraints (from LCR and reliability studies)
 - All ISO approved transmission projects
 - 33% RPS portfolio provided by CPUC for 2015~2016 TPP
 - OTC schedules

Summary of congestions

Constraint	2020 Cost (K\$)	2020 Duration (Hour)	2025 Cost (K\$)	2025 Duration (Hour)
Path 26	7,007	578	3,460	231
Exchequer	1,741	1,125	2,416	1,286
POE-RIO OSO	1,240	79	1,436	75
PG&E LCR (aggregated)	281	32	733	55
Path 15/CC	91	13	333	20
Path 45	163	135	298	237
COI	718	266	252	94
Lugo - Victorville	9	1	32	3
Path 60 (Inyo-Control/Info Phase Shifter)	28	26	28	27
Path 24	0	0	16	17
Path 25	7	13	2	4
West of Devers	26,959	752	0	0
WARNERVL - WILSON	24	4	0	0
SCIT	66	1	0	0
SCE LCR (aggregated)	3,024	71	0	0
Delevn-Cortina	28	2	0	0

* Ranked by 2025 cost

Candidates of congestions for further evaluation

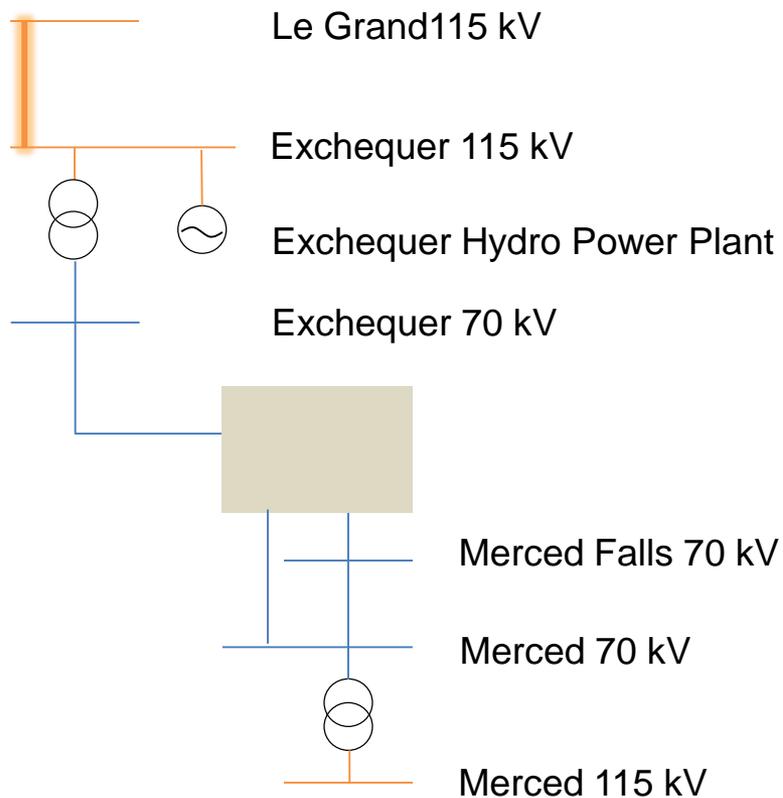
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Path 26	7,007	578	3,460	231
Exchequer	1,741	1,125	2,416	1,286
POE-RIO OSO	1,240	79	1,436	75
Path 15/CC	91	13	333	20
COI	718	266	252	94

* Ranked by 2025 cost

High level analyses

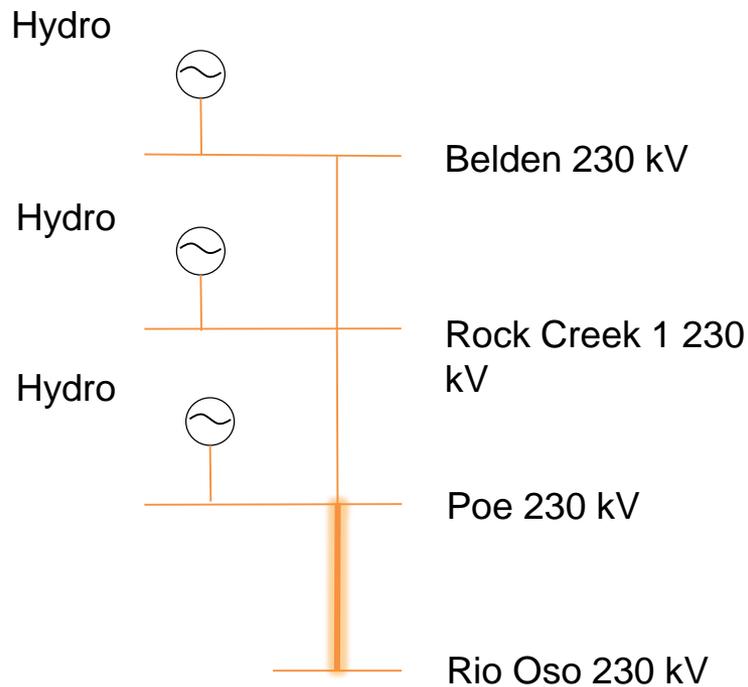
- Path 26 and Path 15/CC congestions
 - Congestion costs did not change significantly from previous cycles
 - No economic justifications for network upgrades in previous cycles
- COI congestion
 - Congestion cost is relatively small (\$0.25M in 2025)
 - Highly related to NW and N. CA hydro and renewable
- POE-RIO OSO and Exchequer congestions
 - Local gen-tie connecting hydro power plants to the system

Exchequer congestion



- Exchequer – Le Grand 115 kV line congestion under contingency conditions
- Mitigating the congestion may increase the utilization of Exchequer hydro power plant hence potentially have benefit to the CAISO's ratepayers

Poe-Rio Oso congestion



- Poe – Rio Oso 230 kV line congestion under normal condition
- Mitigating the congestion may increase the utilization of the hydro power plants hence potentially have benefit to the CAISO's ratepayers

Economic planning study requests

#	Study request	Areas
1	Buck-Colorado River-Julian Hinds 230 kV Loop-in	Southern CA eastern area
2	Southwest Intertie Project – North (SWIP North, Midpoint to Robinson Summit 500 kV AC)	Idaho/Nevada
3	Diablo Offline sensitivity study	Central California
4	Path 15 Study	Central California
5	Path 26 Study	Central/South California
6	North Gila – Imperial Valley #2 Transmission Project	Southern CA Imperial Valley area/Arizona
7	Bishop Area Reconfiguration Study	Southern CA North of Lugo area
8	California – Wyoming Grid Integration	Southern CA/Wyoming
9	MAP upgrades (Marketplace – Adelanto 500 kV HVDC conversion)	Southern CA/Nevada

Next steps

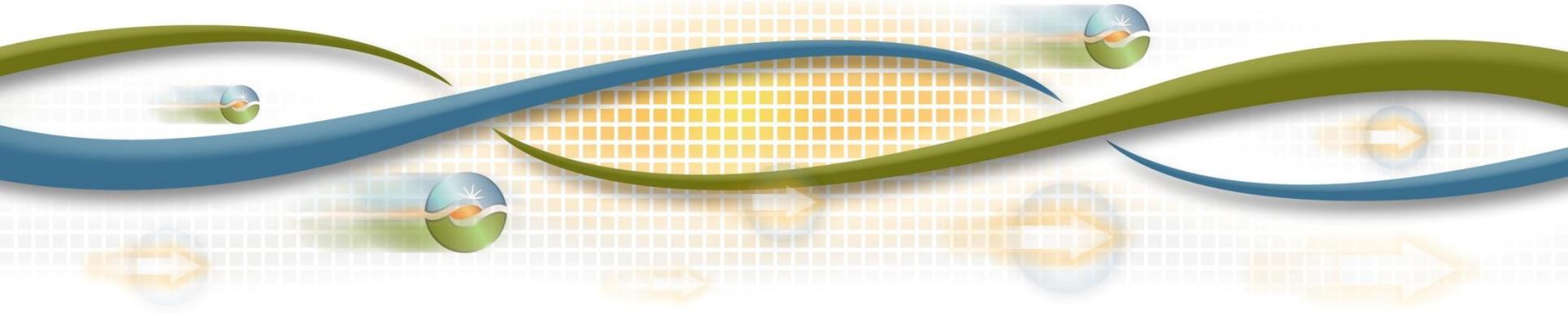
- Perform detail production cost simulation and economic assessment for high priority studies
- Review study requests and perform economic assessment if needed
- Present the final results and recommendations in the fourth SH meeting of 2015~2016 planning cycle



Overview of the 50% Special Study

Sushant Barave
Sr. Regional Transmission Engineer

2015-2016 Transmission Planning Process Stakeholder Meeting
November 16, 2015



Objective

- ❑ Carry out a preliminary investigation into the feasibility and implications of moving beyond 33% using Energy Only (EO) procurement

- ❑ Test the transmission capability numbers used in RPS calculator v6 and update these for the next release of RPS calculator

- ❑ Strictly an informational effort –
 - will not provide basis for procurement/build decisions in 2015-16 TPP cycle
 - Will be used to develop portfolios for consideration by CAISO in future TPP cycles

Study Scope

- ❑ Two portfolios are being studied
 - In-state Energy Only
 - Out-of-state Energy Only

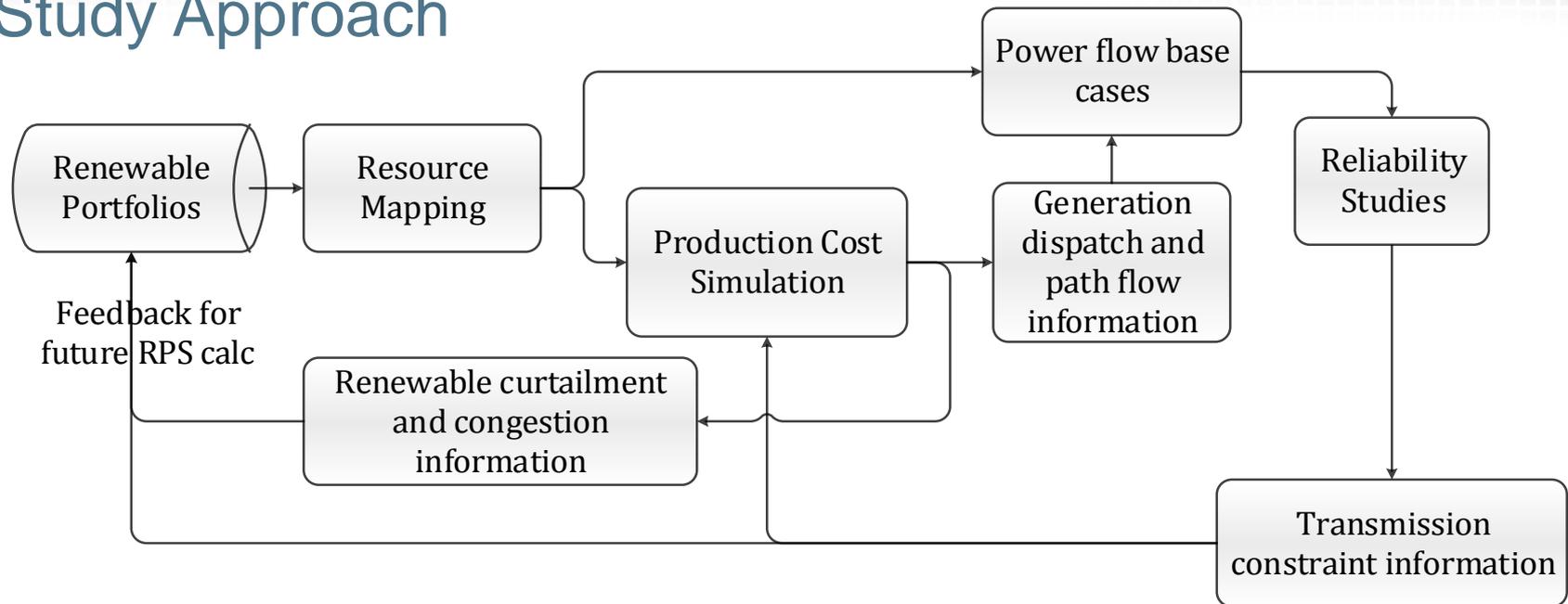
- ❑ Resource mapping

- ❑ Production cost simulation to identify the extent of renewable curtailment

- ❑ Reliability studies (Power flow, post-transient, transient stability)

- ❑ Identification of renewable curtailment, congestion and transmission constraints that may limit renewable generation development

Study Approach

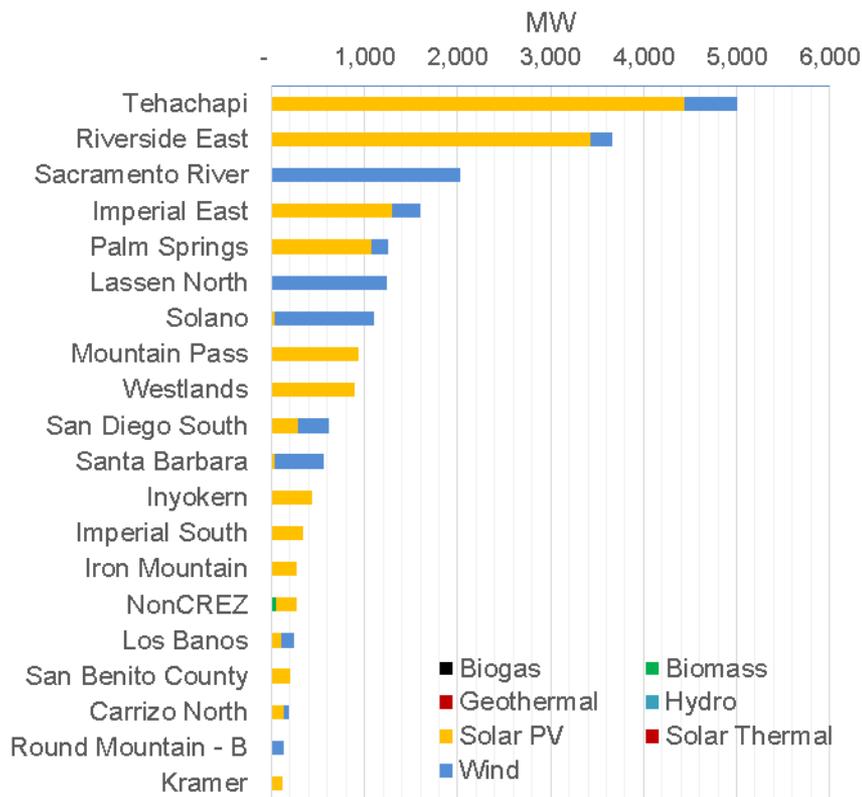


- ❑ Resource mapping used the information from the existing ISO queue and geographical information provided by CPUC
- ❑ Resources incremental to 33% RPS are treated like EO for study purpose
- ❑ Production cost simulation output is used to
 - Inform power flow cases (generation dispatch and major path flows)
 - Inform us about overall renewable curtailment in the in-state and out-of-state portfolio
- ❑ Reliability assessment – main objective is to identify new constraints not modeled in production cost simulations
- ❑ Such constraints will form the basis for the transmission inputs to the RPS calculator for future use

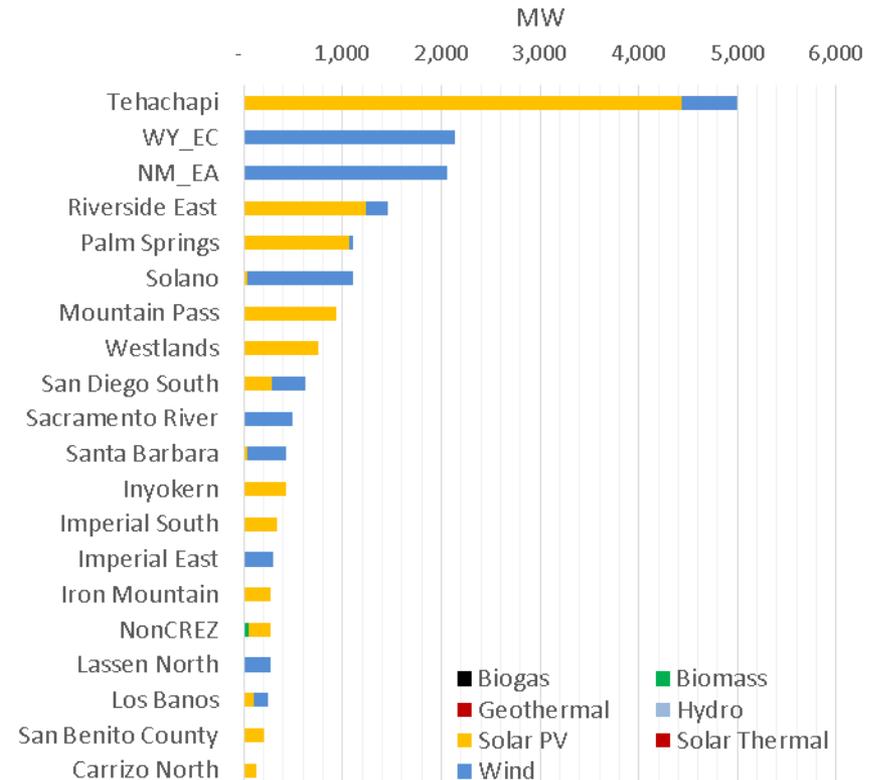
A brief look at the portfolios

- RPS calculator v6 was used to generate the portfolios

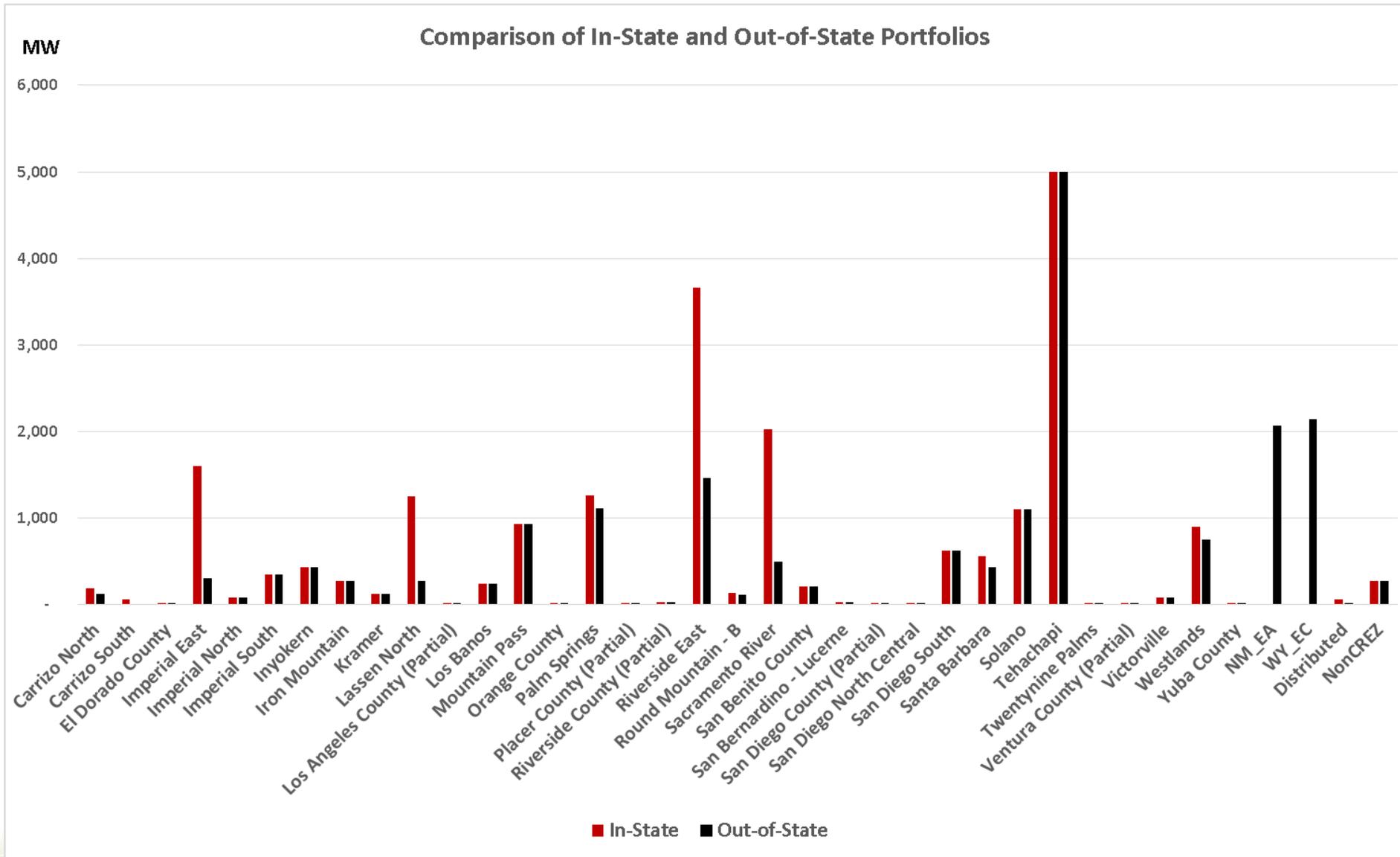
In-state 50% Portfolio



Out-of-State 50% Portfolio



Comparison of portfolios



Current status and next steps

- Preliminary curtailment results are being looked at with different export limit assumptions
- These production simulation results will be used to identify snapshots for stability and power flow simulations
- These studies will help us identify any additional constraints which may cause more curtailment (may trigger another iteration of production cost simulation)
- CAISO will provide an initial feedback to CPUC by mid-December

Questions?



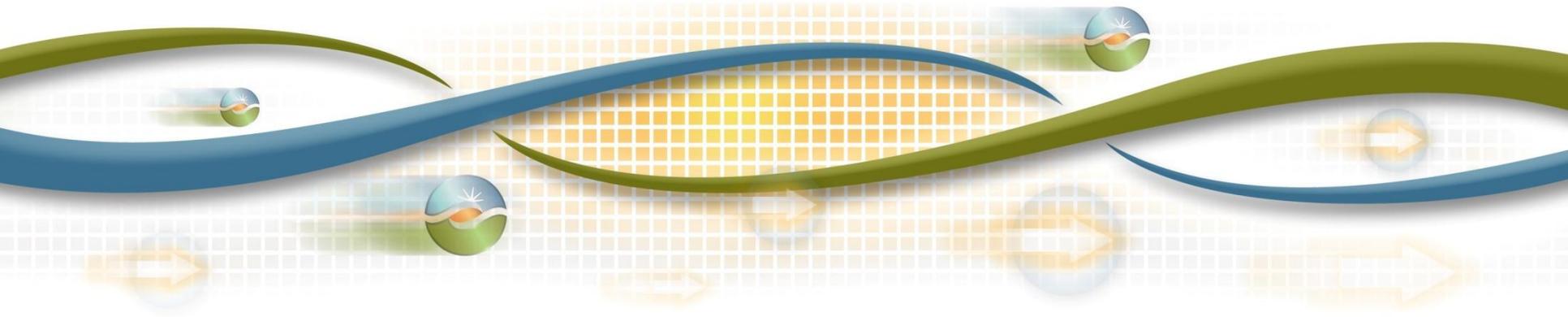
Next Steps

Kim Perez

Stakeholder Engagement and Policy Specialist

2015-2016 Transmission Planning Process Stakeholder Meeting

November 16, 2015



Next Steps

Date	Milestone
November 16 – December 1	Stakeholder comments to be submitted to regionaltransmission@caiso.com
January 2016	Draft 2015-2016 Transmission Plan posted
February 2016	Stakeholder Meeting on contents of the Draft Transmission Plan