Agenda
Preliminary Policy and Economic Assessment and Study Updates

James Bishara
Senior Stakeholder Engagement and Policy Specialist

2021-2022 Transmission Planning Process Stakeholder Meeting
November 18, 2021

Reminders

- Stakeholder calls and meetings related to Transmission Planning are not recorded.
  - Given the expectation that documentation from these calls will be referred to in subsequent regulatory proceedings, we address written questions through written comments, and enable more informal dialogue at the call itself.
  - Minutes are not generated from these calls, however, written responses are provided to all submitted comments.
- To ask a question, press #2 on your telephone keypad. Please state your name and affiliation first.
- Calls are structured to stimulate an honest dialogue and engage different perspectives.
- Please keep comments friendly and respectful.

2021-2022 Transmission Planning Process Stakeholder Call – Agenda

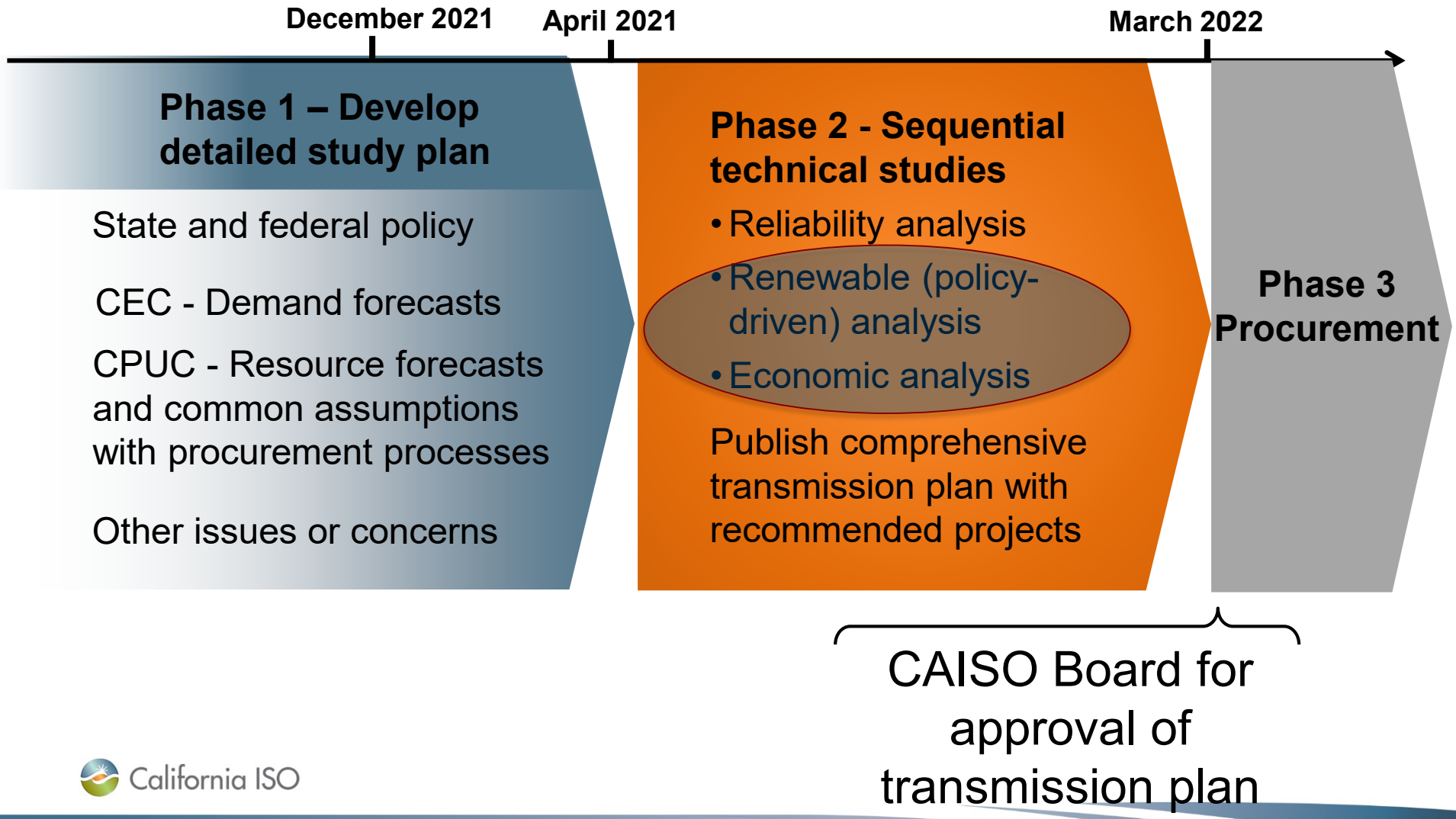
Topic	Presenter
Overview & Key Issues	Jeff Billinton
Preliminary Policy Assessment	Nebiyu Yimer & Area Planners
Preliminary Economic Assessment	Yi Zhang
Reliability Projects less than $50 million	Area Planners
PG&E Area High Voltage Assessment – Update	Ebrahim Rahimi
PG&E Area NCNB Area Wildfire Assessment - Update	Bryan Fong
20 Year Transmission Outlook - Update	Jeff Billinton
Next Steps	James Brashir

Introduction and Overview
Preliminary Reliability Assessment Results

Jeff Billinton
Director, Transmission Infrastructure Planning

2021-2022 Transmission Planning Process Stakeholder Meeting
November 18, 2021

2021-2022 Transmission Planning Process

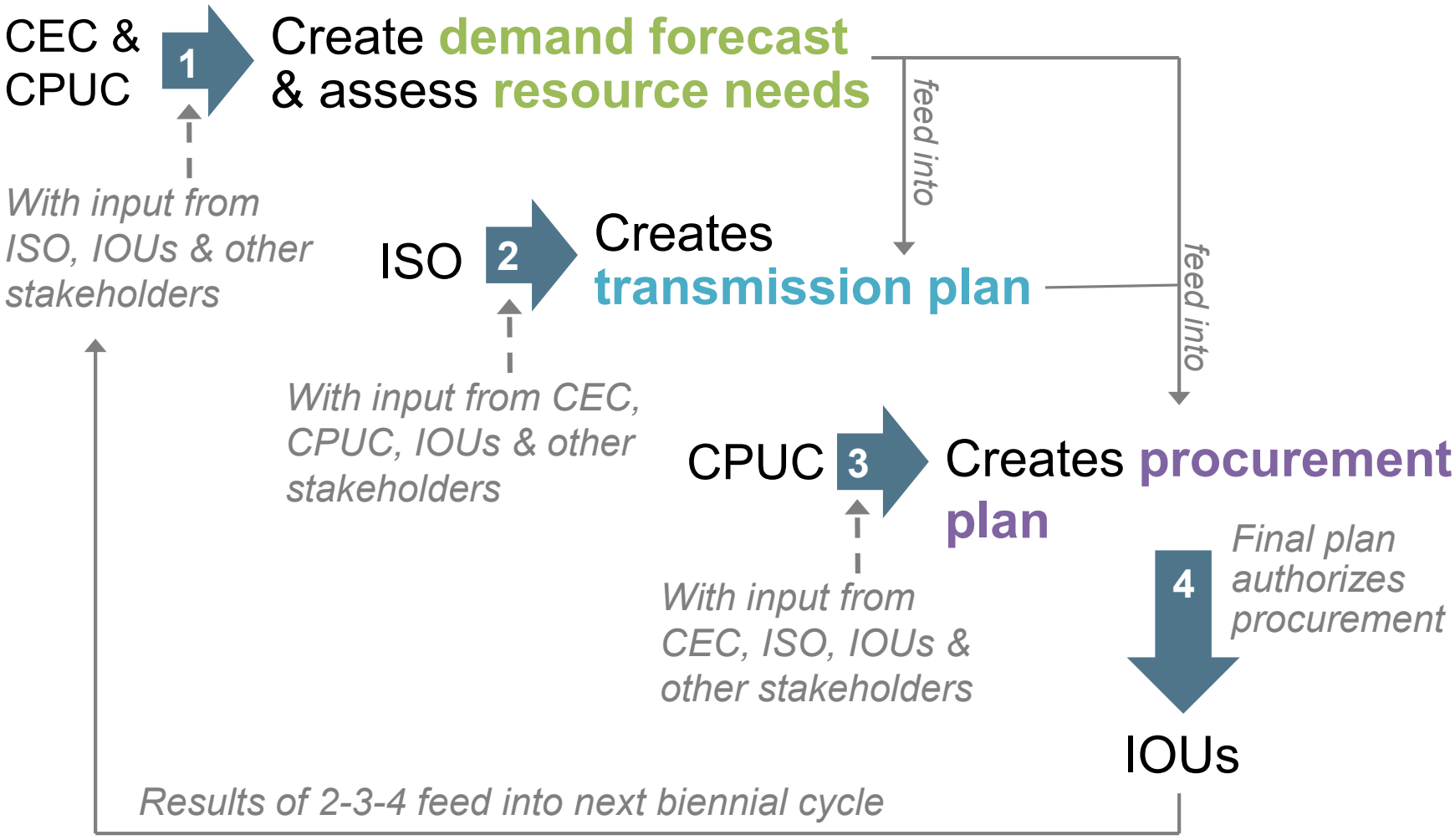


California ISO

2021-2022 Transmission Plan Milestones

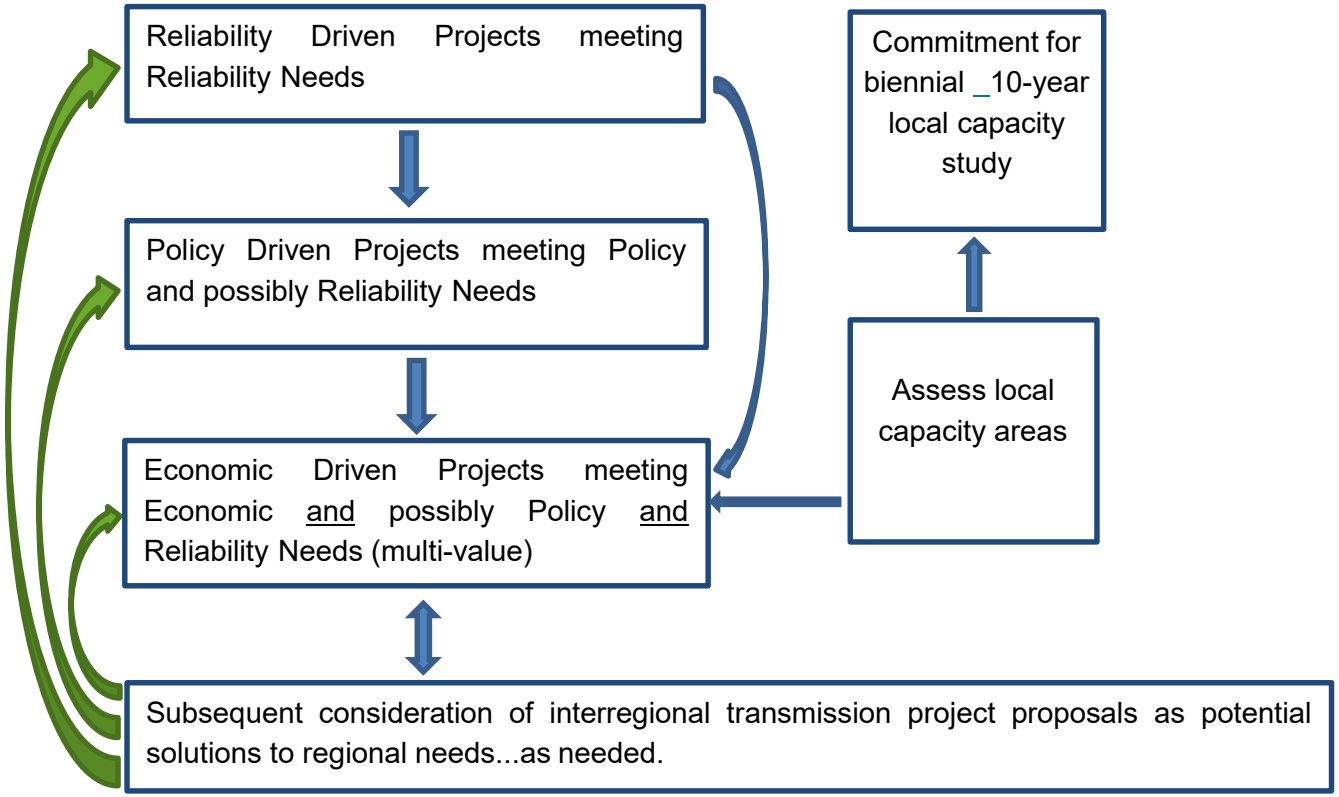
- Draft Study Plan posted on February 18
- Stakeholder meeting on Draft Study Plan on February 25
- Final Study Plan posted on March 31
- Stakeholder meeting May 14
- Stakeholder meeting July 27
- Preliminary reliability study results posted and open Request Window on August 13
- Stakeholder meeting on September 27 and 28
  - Comments to be submitted by October 12
- Request window closes October 15
- Preliminary policy and economic study results on November 18
- Comments to be submitted by December 6
- Draft transmission plan to be posted on January 31, 2022
- Stakeholder meeting in February
- Comments to be submitted within two weeks after stakeholder meeting
- Revised draft for approval at March Board of Governor meeting

Planning and procurement overview



California ISO

Studies are coordinated as a part of the transmission planning process



2021-2022 Transmission Planning Process
Reliability Assessment - Update

- ISO recommended projects have two paths for approval:
  - For management approval, reliability projects less than $50 million can be presented at November stakeholder session
  - For Board of Governor approval of reliability projects over $50 and projects not approved by management, are included in draft plan to be issued for stakeholder comments by January 31, 2022

2021 Request Window Submissions

Project Name	Submitter	Review of Submission
New ML-SCR 500kV line	SDGaE	May be considered for reliability alternative
Friars – Doublet Tap Reconductor	SDGaE	May be considered for reliability alternative
GLW Upgrade	GLW	May be considered for reliability alternative
Devers 230 kV Reconfiguration Project	SCE	May be considered for reliability alternative
Victor 230 kV Reconfiguration Project	SCE	May be considered for reliability alternative
Laguna Bell-Mesa No. 1 230 kV Line Rating Increase Project	SCE	May be considered for reliability alternative
New Serrano 4AA 500/230 kV Transformer Bank	SCE	May be considered for reliability alternative
Contra Costa PP 230 kV Line Terminals Reconfiguration Project	PGAE	May be considered for reliability alternative
Coppermine 70 kV Reinforcement Project	PGAE	May be considered for reliability alternative
Cortina 23011560 kV Transformer Bank No. 1 Replacement Project	PGAE	May be considered for reliability alternative
Manteca-Ripon-Riverbank-Melones Area 115 kV Line Reconductoring Project	PGAE	May be considered for reliability alternative
South Bay 115 kV Reinforcement Conceptual Project	PGAE	May be considered for reliability alternative
Vasona-Metcalf 230 kV Line Limiting Elements Removal Project	PGAE	May be considered for reliability alternative
Weber-Mormon Jct Line Section Reconductoring Project	PGAE	May be considered for reliability alternative

2021 Request Window Submissions

Project Name	Submitter	Review of Submission
Lake Elsinore Advanced Pumped Storage	Leaps hydro	Not considered as reliability alternative as the submission does not meet a reliability need identified in the CAISO reliability assessment results
Ames-Palo Alto 115 kV Line Project Submission	City of Palo Alto	May be considered for reliability alternative
SCE Laguna Bell – Mesa Series Reconductor Project	Smartwires	May be considered for reliability alternative
Pacific Transmission Expansion Project (PTEP)	California western Grid Development LLC	Not considered as reliability alternative as the submission does not meet a reliability need identified in the CAISO reliability assessment results
PG&E - Santa Clara Area Series Compensation Project	Smartwires	May be considered for reliability alternative

Comments

- Comments due by end of day December 6, 2021

- Submit comments through the ISO's commenting tool, using the template provided on the process webpage:
- https://stakeholdercenter.caiso.com/RecurringStakeholderProcesses/2021-2022-Transmission-planning-process

2021-2022 TPP Policy-driven Assessment

Regional Transmission South:

Nebiyu Yimer, Meng Zhang, Lyubov Kravchuk

Regional Transmission North:

Lindsey Thomas, Ebrahim Rahimi, Bryan Fong, Preethi Rondla

2021-2022 Transmission Planning Process Stakeholder Meeting

November 18, 2021

Agenda

- **Policy-driven assessment context and objectives**
- **Portfolio descriptions and modeling**
- **Deliverability assessment methodology and results**
- **Production cost simulation results**

  (To be presented separately with the Preliminary Economic Study Results)
- **Summary of results and next steps**

Agenda

- **Policy-driven assessment context and objectives**
- Portfolio descriptions and modeling
- Deliverability assessment methodology and results
- Production cost simulation results

  (To be presented separately with the Preliminary Production Cost Simulation Results)
- Summary of results and next steps

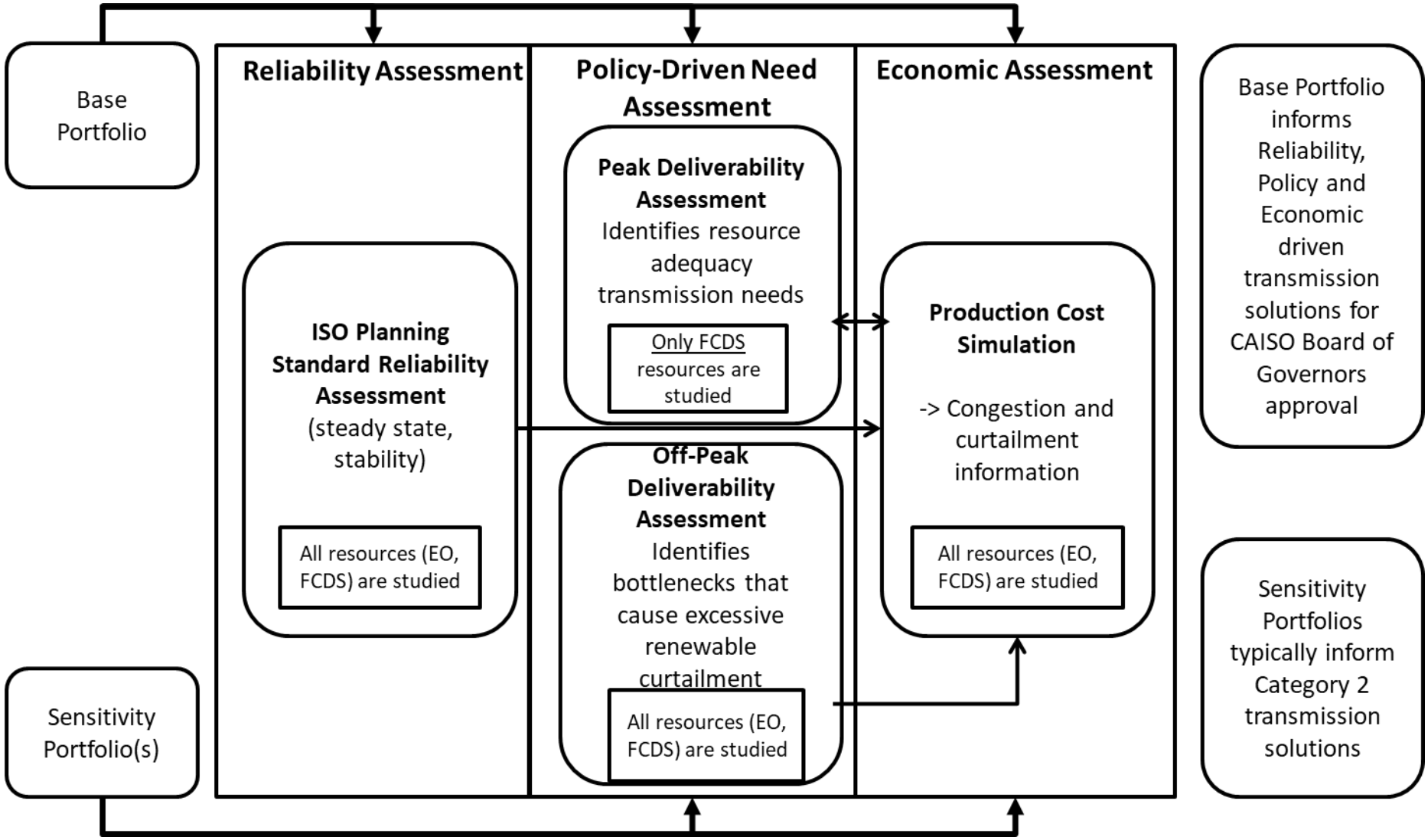
February Presentation on the Policy Driven Assessment

- We presented the study plan for the Policy-driven Assessment including objectives and methodology
- Provided a description of portfolios transmitted by the CPUC
- Outlined the additional guidance from the CPUC

Objectives and methodology

- Overarching objective is to ensure alignment between resource planning (CPUC) and transmission planning (CAISO)
- Deliverability assessment (on-peak) supports deliverability of FCDS resources selected to meet resource adequacy needs
- Production cost simulation supports the economic delivery of renewable energy over the course of all hours of the year
- Reliability assessment and off-peak deliverability assessment are used to identify constraints for further evaluation using production cost simulation
- Assessment is used to identify transmission upgrades or other solutions needed to achieve objectives
- Gain further insights to inform future portfolio development

Overview of the policy-driven assessment



California ISO

Agenda

- Policy-driven assessment context and objectives
- **Portfolio descriptions and modeling**
- Deliverability assessment methodology and results
- Production cost simulation results

  (To be presented separately with the Preliminary Production Cost Simulation Results)
- Summary of results and next steps

The CPUC transmitted a base portfolio and two sensitivity portfolios for the 2021-2022 TPP

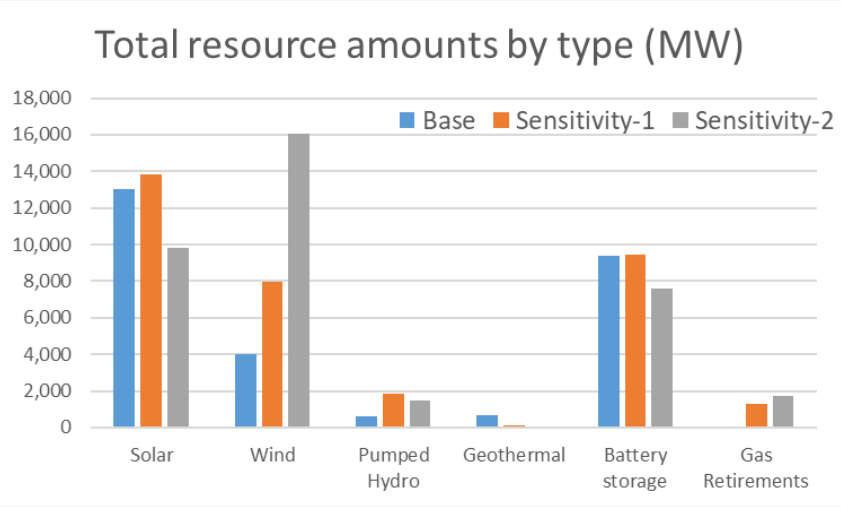
- Base Portfolio – 2031 portfolio based on 46 MMT by 2030 GHG target to be used to determine transmission investments needed
- Sensitivity-1 Portfolio – 2031 portfolio based on 38 MMT GHG target
- Sensitivity-2 Portfolio – Offshore Wind (OSW) Portfolio based on 30 MMT GHG target intended to test the transmission needs associated with offshore wind
- CPUC provided the portfolios complete with mapping at the substation bus level for each portfolio resource
- Current base portfolio includes significantly more resources than the base portfolio studied in the 2020-2021 TPP
- A retirement list was provided for applying retirement assumptions in the sensitivity portfolios

CPUC portfolio documentation for the 2021-2022 TPP

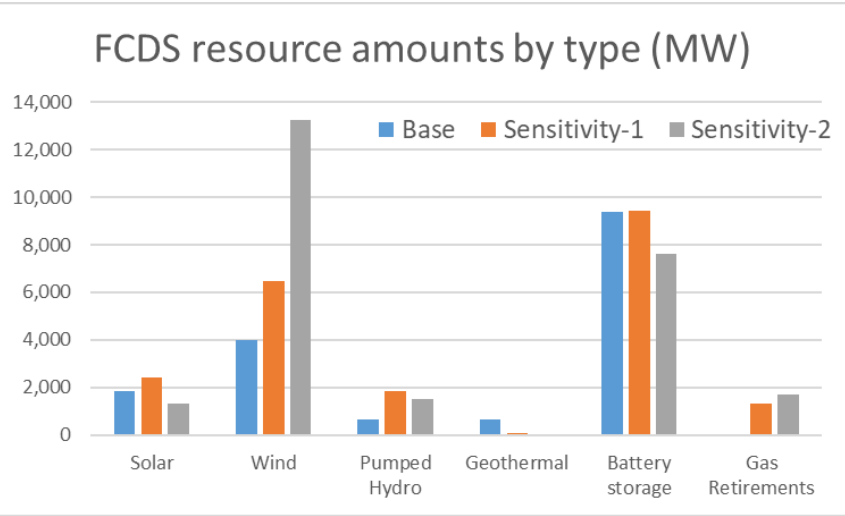
- CPUC decision transferring the portfolios:
  https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M366/K426/366426300.PDF
- Modeling Assumptions for the 2021-2022 TPP
  ftp://ftp.cpuc.ca.gov/energy/modeling/Modeling_Assumptions_2021_22_TPP_Final.pdf
- Final busbar mapping results for non-battery resources for the base and sensitivity portfolios
  https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/2019-2020-irp-events-and-materials/mappingsummary_bysubstation_allportfolios_2021_22tpp_ver2.xlsx
- Final busbar mapping results for battery storage for the base and sensitivity portfolios
  ftp://ftp.cpuc.ca.gov/energy/modeling/Battery_Mapping_Dashboard_All_Portfolios_Final.xlsx
- Retirement list for the policy-driven sensitivity
  ftp://ftp.cpuc.ca.gov/energy/modeling/Retirement_List_for_Sensitivity_Portfolios.xlsx

Total and FC generic resource mix in the three portfolios

Total (FC+EO) generic resource additions and retirements (MW)			
	Base	Sensitivity-1	Sensitivity-2
Solar	13,044	13,817	9,807
Wind	4,005	7,955	16,039
Pumped Hydro	627	1,843	1,495
Geothermal	651	105	0
Battery storage	9,368	9,447	7,604
Gas Retirements	0	1,319	1,718
Total (FC+EO)	**27,695**	**31,848**	**33,227**



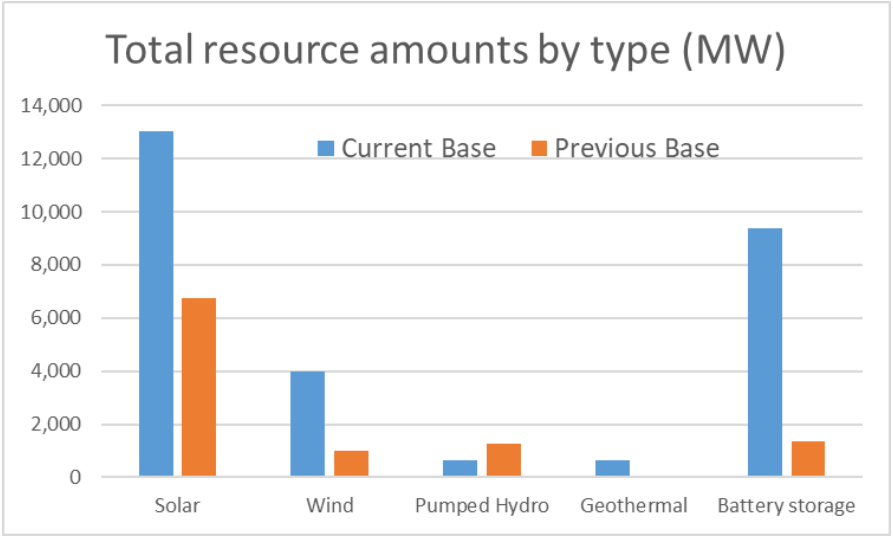
FC generic resource additions and retirements (MW)			
	Base	Sensitivity-1	Sensitivity-2
Solar	1,832	2,422	1,332
Wind	3,971	6,451	13,250
Pumped Hydro	627	1,843	1,495
Geothermal	651	57	0
Battery storage	9,368	9,447	7,604
Gas Retirements	0	1,319	1,718
Total FC	**16,448**	**18,901**	**21,963**



Comparison of current and previous TPP base portfolios

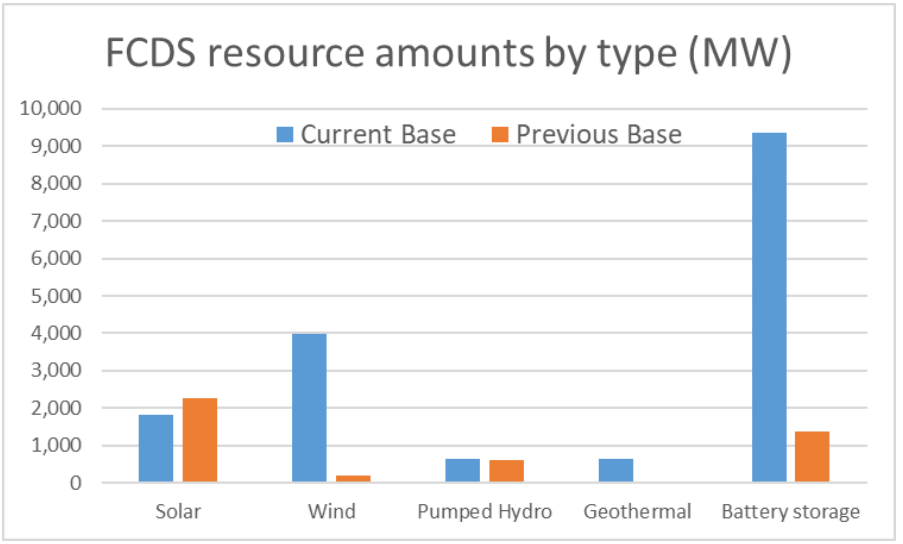
Total (FC+EO) generic resource additions and retirements (MW)		
	Current Base	Previous Base
Solar	13,044	6,763
Wind	4,005	992
Pumped Hydro	627	1,256
Geothermal	651	0
Battery storage	9,368	1,376
Gas Retirements	0	0
Total (FC+EO)	**27,695**	**10,387**

Note: Battery storage amount shown for previous TPP base case is 4-hour equivalent



FC generic resource additions and retirements (MW)		
	Current Base	Previous Base
Solar	1,832	2,273
Wind	3,971	188
Pumped Hydro	627	604
Geothermal	651	0
Battery storage	9,368	1,376
Gas Retirements	0	0
Total FC	**16,448**	**4,441**

- Battery storage amount shown for previous TPP base case is 4-hour equivalent



Total and FCDS non-battery resources by location

- NW_Ext_Tx_Wind – modeled in Washington without MIC expansion
- SW_Ext_Tx_Wind – modeled in New Mexico without MIC expansion
- New_Mexico_Wind – modeled at Paloverde 500 kV on top of MIC
- Wyoming_Wind – modeled at Eldorado 500 kV on top of MIC
- Humboldt_Bay_Offshore_Wind – three Points of Interconnection (POI) options evaluated
- Morro_Bay_Offshore_Wind – modeled with a new 500 kV substation looping into Diablo–Gates 500 kV line as the POI
- Asterisks(*) denote adjustments made in coordination with CPUC staff to include storage resources that were identified as mitigation for transmission issues in the 2020-2021 TPP

			Base Portfolio (MW)		Sensitivity-1 (MW)		Sensitivity-2 (MW)	
RESOLVE Resource	**Tx Deliv. Zone**	**Substation**	**Total**	**FCDS**	**Total**	**FCDS**	**Total**	**FCDS**
Arizona_Solar	SCADSNV-Riverside_Palm_Springs	Hassayampa 500kV	871		600		707	
		Delaney-Colorado 500kV	1,482	-	981		1,203	
Carrizo_Wind	SPGE-Kern_Greater_Carrizo-Carrizo	Templeton 230kV	187	187	287	287	287	287
Carrizo_Wind	SPGE-Kern_Greater_Carrizo-Carrizo	Mesa 115 kV*	55		55		55	
Central_Valley_N._Los_Banos_Wind	Central_Valley_North_Los_Banos-SPGE	Los Banos 230kV	173	173	173	173	173	173
Greater_Imperial_Solar	Greater_Imperial-SCADSNV	Imperial Valley 230kV	333		697	365	697	365
		Ocotillo Express 230kV	215		451	235	451	235
Humboldt_Wind	Sacramento_River-Humboldt	Bridgeville 115kV	34		34		34	
Kern_Greater_Carrizo_Solar	SPGE-Kern_Greater_Carrizo	Arco 230kV	144		165			
		Midway 230kV	140		160			
		Renfro 115kV	143		164	21		
		Stockdale 230kV	144		165	21		
		Wheeler Ridge 230kV	129		147			
		Lamont 115 kV*	106		106		106	
Kern_Greater_Carrizo_Wind	SPGE-Kern_Greater_Carrizo	Cholame 70 kV	20	20	20	20	20	20
Mountain_Pass_El_Dorado_Solar	Mountain_Pass_El_Dorado	El Dorado 230kV	83		83		83	
		EL Dorado 500kV	165		165		165	
North_Victor_Solar	North_Victor-Greater_Kramer	Victor 230kV	215	159	215	159	215	159
		Coolwater 230kV	85	85	85	85	85	85
Northern_California_Ex_Wind	Sacramento_River	Glenn 230kV	354	354	354	354	354	354
		Delevan 230kV	83	83	83	83	83	83
		Thermalito 230kV	178	178	178	178	178	178
		Rio Oso 230kV	152	152	152	152	152	152
Pisgah_Solar	Pisgah	Calcite	140		140		140	
		Lugo	47	47	47	47	47	47
		Pisgah 230kV	14	14	14	14	14	14
Sacramento_River_Solar	Sacramento_River	Delevan 230kV			43			
		Glenn 230kV			47			
		Palmero 230kV			46			
		Rio Oso 230kV			49			
		Thermalito 230kV			46			
SCADSNV_Solar	SCADSNV	Mohave 500kV	568		740		410	
Solano_Geothermal	Solano-Sacramento_River	Sonoma 3 230kV	51	51	105	57		
Solano_Solar	Solano-Sacramento_River	Fulton 230kV			159			
		Contra Costa 230kV			156			
		Tulucay 230kV			137			
		Vaca-Dixon & GC Yard 500kV			170			
Solano_Wind	Solano-Sacramento_River	Lakeville 230kV	194	194	194	194	194	194
		Tulucay 230kV	20	20	20	20	20	20
		Vaca-Dixon & GC Yard 500kV	146	146	146	146	146	146
		Shilo III 230kV	72	72	72	72	72	72
		Lone Tree 230kV	30	30	30	30	30	30
Southern_Nevada_Solar	SCADSNV-GLW_VEA	Innovation 230kV	445		40		40	
		Desert View 230kV	344	106	31	31	31	31
		Crazy Eyes 230kV	1,234	242	111		111	
Southern_Nevada_Wind	SCADSNV-GLW_VEA	Innovation 230kV			97	97	97	97
		Desert View 230kV			75	75	75	75
		Crazy Eyes 230kV			270	270	270	270
Tehachapi_Solar	Tehachapi	WindHub 230kV	1,153		1,398		1,153	
		Whirlwind 500kV	1,277		1,549		1,277	
		Antelope 230kV	1,247	395	1,512	660	1,247	395
		Vincent 230kV	1,003		1,217		1,003	
Tehachapi_Wind	Tehachapi	WindHub 230kV	275	275	275	275	275	275
Westlands_Solar	Central_Valley_North_Los_Banos-SPGE	Gates 230kV	151		151			
		Helm 230kV	176	176	176	176		
		Henrietta 230kV	163	163	163	163		
		Mc Call 230kV	204	204	204	204		
		Mc Mullin 230kV	190	190	190	190		
		Panoche 230kV	160	50	160	50		
		Gates 500kV*	218		883		567	
Pumped Hydro Storage	Pumped Hydro Storage	Lee Lake 500kV	313	313	500	500	500	500
		Sycamore Canyon 230kV	314	314	500	500	500	500
		Red Bluff 500kV			843	843	495	495
Baja_California_Wind	Greater_Imperial-SCADSNV	East County 500kV	495	495	495	495	495	495
Greater_Imperial_Geothermal	Greater_Imperial-SCADSNV	Bannister	600	600				
New_Mexico_Wind	SCADSNV-Riverside_Palm_Springs	Palo Verde 500kV			1,500	1,500	1,500	1,392
Wyoming_Wind	SCADSNV-Mountain_Pass_El_Dorado	El Dorado 500kV	1,062	1062	1,500	1,500	1,500	
NW_Ext_Tx_Wind	Sacramento_River	Round Mountain 500kV	530	530	1,500	530	1,500	587
SW_Ext_Tx_Wind	SCADSNV-Riverside_Palm_Springs	Palo Verde 500kV			500		234	
Diablo_Canyon_Offshore_Wind	N/A	Diablo Canyon 500kV					4,419	4,419
Humboldt_Bay_Offshore_Wind	N/A	Humboldt 230kV					1,607	1,607
Morro_Bay_Offshore_Wind	N/A	Morro Bay 230kV					2,324	2,324
		Portfolio Total (non-battery)	**18,327**	**7,080**	**23,720**	**10,773**	**27,341**	**16,077**

Battery resources by location (MW)

- Asterisks (*) denote adjustments made in coordination with CPUC staff to include storage resources that were identified as mitigation for transmission issues in the 2020-2021 TPP

Substation Name	Tx Deliv. Zone	Base (MW)	Sensitivity 1 (MW)	Sensitivity 2 (MW)
ANTELOPE 230KV	Tehachapi	575.0	575	575
PANOCHE	SPGE_Z1_Westlands	99.0	99	-
WHEELER RIDGE	SPGE_Z2_KernAndGreaterCarrizo	-	16	-
ARCO	SPGE_Z2_KernAndGreaterCarrizo	-	19	-
MIDWAY 230KV	SPGE_Z2_KernAndGreaterCarrizo	-	18	-
BIRDS LANDING	Norcal_Z4_Solano	5.4	-	-
GATES 230KV	SPGE_Z1_Westlands	135.9	136	-
DELANEY	SCADSNV_Z4_RiversideAndPalmSprings	426.2	331	-
DELANEY				
VINCENT	Tehachapi	808.6	941	748
WINDHUB (B)	Tehachapi	1,007.6	1,081	860
WHIRLWIND 230KV	Tehachapi	1,645.2	1,198	953
WHIRLWIND 230KV				
GATES 500KV*	SPGE_Z1_Westlands	186.0	186	500
VICTOR	GK_Z3_NorthOfVictor	50.0	50	50
HASSAYAMPA	SCADSNV_Z4_RiversideAndPalmSprings	268.7	53	-
MOHAVE 500KV	SCADSNV_Z5_SCADSNV	228.1	369	98
MOHAVE 500KV				
CALCITE	GK_Z4_Pisgah	126.0	126	126
INNOVATION	SCADSNV_Z2_GLW_VEA	123.3	36	36
ELDORADO 230KV	SCADSNV_Z1_EldoradoAndMtnPass	74.7	75	75
ELDORADO 500KV	SCADSNV_Z5_SCADSNV	148.5	149	149
RED BLUFF	SCADSNV_Z4_RiversideAndPalmSprings	-	278	-
COLORADO RIVER	SCADSNV_Z4_RiversideAndPalmSprings	-	278	-
CRAZY EYES/Trout Cany	SCADSNV_Z2_GLW_VEA	125.0	100	100
Mesa 115 kV*	SPGE-Carrizo	50.0	50	50
Lamont 115*	SPGE-Kern	95.0	95	95
Kettleman*	SPGE_Z1_Westlands	10.0	10	10
GOLD HILL	NorCalOutsideTxConstraintZones	58.8	59	59
MARTIN	NorCalOutsideTxConstraintZones	250.0	250	250
WALNUT	TehachapiOutsideTxConstraintZones	200.0	200	200
HINSON	TehachapiOutsideTxConstraintZones	200.0	200	200
ETIWANDA	KramerInyoOutsideTxConstraintZones	101.0	101	101
LAGUNA BELL	TehachapiOutsideTxConstraintZones	500.0	500	500
WALNUT	TehachapiOutsideTxConstraintZones	200.0	200	200
SILVERGATE	GreaterImpOutsideTxConstraintZones	200.0	200	200
MOORPARK	TehachapiOutsideTxConstraintZones	500.0	500	500
ESCONDIDO	GreaterImpOutsideTxConstraintZones	50.0	50	50
SYCAMORE CANYON	GreaterImpOutsideTxConstraintZones	300.0	300	300
TALEGA 138KV	GreaterImpOutsideTxConstraintZones	200.0	200	200
TRABUCO 138KV	GreaterImpOutsideTxConstraintZones	250.0	250	250
ENCINA 138KV	GreaterImpOutsideTxConstraintZones	160.0	160	160
KEARNY	GreaterImpOutsideTxConstraintZones	10.0	10	10
	Total	**9,368**	**9,447**	**7,604**

Additional guidance from the CPUC

- The 1062 MW OOS wind resource in the base portfolio will be studied with Palo Verde (Wyoming Wind) and Eldorado (New Mexico Wind) as alternative injection points
- The CAISO should consult with CPUC before moving forward with any new policy-driven transmission needs associated specifically with storage mapping in this planning cycle
- CPUC staff would expect to coordinate with CAISO to enable small adjustments in the CPUC's mapping of storage resources to allow for the inclusion of storage resources that are identified as mitigation for transmission issues in CAISO's 2020-2021 TPP

Additional guidance from the CPUC - OSW Portfolio

- The expected product would include the cost of upgrading transmission to accommodate the 8.3 GW OSW in the portfolio with the potential to increase to up to 21.1 GW

- The CAISO is to conduct an outlook assessment for 21.2 GW of OSW to ensure potential transmission development for early offshore wind resources is “least regrets”

Agenda

- Policy-driven assessment context and objectives
- Portfolio descriptions and modeling
- **Deliverability assessment methodology and results**
- Production cost simulation results

  (To be presented separately with the Preliminary Production Cost Simulation Results)
- Summary of results and next steps

On-peak deliverability assessment

- Assessment examines deliverability of portfolio resources selected as FCDS in accordance with the on-peak deliverability methodology

- Identifies transmission upgrades or other solutions needed to ensure deliverability of FCDS renewable portfolio resources
  - Other alternatives considered include: RAS and relocating undeliverable portfolio battery storage

- Gain further insights to inform future portfolio development

Study scenarios in on-peak deliverability assessment

- Highest system need (HSN) scenario
  - Represents the scenario when capacity shortage is most likely to occur
  - Transmission upgrades identified for the base portfolio are recommended as policy driven upgrades

- Secondary system need (SSN) scenario
  - Represents the scenario when capacity shortage risk increases if variable resources are not deliverable during periods when the system depends on their high output for resource adequacy.
  - Transmission upgrades identified for the base portfolio will go through a comprehensive economic, policy, and reliability benefit analysis to be considered for approval as a policy driven or economic upgrade.

Modeling assumptions for HSN scenario

Selected Hours	HE18 ~ 22 in summer month and (loss of load event in ELCC simulation by CPUC or UCM < 6% in CAISO summer assessment)
Load	1-in-5 peak sale forecast by CEC
Non-Intermittent Resources	Study amount set to highest summer month Qualifying Capacity in last three years
Intermittent Resources	Study amount set to 20% exceedance level during the selected hours
Import	MIC data with expansion approved in TPP

Modeling assumptions for SSN scenario

Select Hours	HE15 ~ 17 in summer month and (loss of load event in ELCC simulation by CPUC or UCM < 6% in CAISO summer assessment)
Load	1-in-5 peak sale forecast by CEC adjusted to peak consumption hour
Non-Intermittent Generators	Study amount set to highest summer month Qualifying Capacity in last three years
Intermittent Generators	Study amount set to 50% exceedance level during the selected hours, but no lower than the average QC ELCC factor during the summer months
Import	Highest import schedules for the selected hours

On-peak assessment maximum resource dispatch

Resource type	HSN			SSN		
	SDG&E	SCE	PG&E	SDG&E	SCE	PG&E
Solar	3.0%	10.6%	10.0%	40.2%	42.7%	55.6%
Wind	33.7%	55.7%	66.5%	11.2%	20.8%	16.3%
New Mexico Wind	67%			35%		
Wyoming Wind	67%			35%		
Diablo OSW	100%			37%		
Morro Bay OSW	100%			49%		
Humboldt Bay OSW	100%			53%		
Energy storage	100% or 4-hour equivalent if duration is < 4-hour					
Non-Intermittent resources	100%					

Off-peak deliverability assessment of portfolios

- Identify transmission constraints that might result in excessive renewable curtailment in accordance with the off-peak deliverability methodology as used in GIDAP

- Identify potential transmission upgrades needed to relieve excessive renewable curtailment
  - Other alternatives considered include: RAS and adding new battery storage (subject to on-peak deliverability)

- Provide inputs to Production Cost Model for a more thorough evaluation of renewable curtailment

Modeling assumptions in off-peak deliverability assessment

Load	55% ~ 60% of summer peak load
Imports	~6000 MW total
System-Wide Generator Dispatch Level	
Wind	44%
Solar	68%
Energy Storage	0
Hydro	30%
Thermal	15%

Increase Local Area Renewable Output

- After balancing load and resource under the system-wide conditions, the renewable generation in a local study area is increased to identify transmission constraints.
- General local study areas include
  - PG&E : North, Fresno and Kern
  - SCE/VEA/GWL/DCRT: Northern, North of Lugo, East of Pisgah, Eastern
  - SDGE: Inland and East of Miguel
- Off-peak deliverability assessment is performed for each study area separately.

Study Area Wind/Solar Dispatch Assumptions

- The study area wind/solar dispatch assumptions are based on the 90% energy production level of existing generators inside the study area.
- If more than 70% of the study area capacity is wind, then the study area is deemed a wind area; otherwise it is treated as a solar area.

Wind/Solar Dispatch Assumptions in Wind Area

	Wind	Solar
SDG&E	69%	68%
SCE	64%	
PG&E	63%	

Wind/Solar Dispatch Assumptions in Solar Area

	Solar	Wind
SDG&E	79%	44%
SCE	77%	
PG&E	79%	

Offshore Wind	100%
New Mexico Wind	67%
Wyoming Wind	67%

Preliminary results for SCE area

Portfolio resources likely to impact SCE area (FC+EO)

Transmission Zone/Location	Full Capacity and Energy Only (MW)			
	Base Portfolio		Sensitivity 1 (S1)	Sensitivity 2 (S2)
	Base A	Base B		
Wyoming	1062 Wind	--	1500 Wind	1500 Wind
New_Mexico	--	1062 Wind	1500 Wind	1500 Wind
Tehachapi	8991 (4680 Solar, 275 Wind, 4036 BESS)		9745 (5676 Solar, 275 Wind, 3794 BESS)	8091 (4680 Solar, 275 Wind, 3136 BESS)
Ventura	500 BESS		500 BESS	500 BESS
Greater_LA	1514 (313 PSH, 1201 BESS)		1701 (500 PSH, 1201 BESS)	1701 (500 PSH, 1201 BESS)
North of Lugo	397 (347 Solar, 50 BESS)		397 (347 Solar, 50 BESS)	397 (347 Solar, 50 BESS)
Pisgah	280 (154 Solar, 126 BESS)		280 (154 Solar, 126 BESS)	280 (154 Solar, 126 BESS)
Mohave_Eldorado	1268 (816 Solar, 452 BESS)		1581 (988 Solar, 593 BESS)	979 (658 Solar, 321 BESS)
GLW/VEA	2272 (2024 Solar, 248 BESS)		760 (182 Solar, 442 Wind, 136 BESS)	760 (182 Solar, 442 Wind, 136 BESS)
Riverside_Palm_Springs	--		1399 (843 PSH, 556 BESS)	495 PSH
Greater Imperial (IID)	600 Geothermal		--	--
Arizona (CAISO BA)	3047 (2352 Solar, 695 BESS)		1963 (1580 Solar, 383 BESS)	1910 Solar
SW_Ext_Tx	--		500 Wind	234 Wind

Portfolio resources likely to impact SCE area (FC Only)

Transmission Zone/Location	Full Capacity Only (MW)			
	Base Portfolio		Sensitivity 1 (S1)	Sensitivity 2 (S2)
	Base A	Base B		
Wyoming	1062 Wind	--	1,500 Wind	--
New_Mexico	--	1062 Wind	1,500 Wind	1,392 Wind
Tehachapi	4706 (395 Solar, 275 Wind, 4036 BESS)		4729 (660 Solar, 275 Wind, 3794 BESS)	3806 (395 Solar, 275 Wind, 3136 BESS)
Ventura	500 BESS		500 BESS	500 BESS
Greater_LA	1514 (313 PSH, 1201 BESS)		1701 (500 PSH, 1201 BESS)	1701 (500 PSH, 1201 BESS)
North of Lugo	341 (291 Solar, 50 BESS)		341 (291 Solar, 50 BESS)	341 (291 Solar, 50 BESS)
Pisgah	140 (14 Solar, 126 BESS)		140 (14 Solar, 126 BESS)	140 (14 Solar, 126 BESS)
Mohave_Eldorado	452 BESS		593 BESS	321 BESS
GLW/VEA	596 (348 Solar, 248 BESS)		609 (31 Solar, 442 Wind, 136 BESS)	609 (31 Solar, 442 Wind, 136 BESS)
Riverside_Palm_Springs	--		1399 (843 PSH, 556 BESS)	495 PSH
Greater Imperial (IID)	600 Geothermal		--	--
Arizona (CAISO BA)	695 BESS		383 BESS	--

On-peak Mesa–Laguna Bell No.1 230 kV Constraint

Overloaded Facility	Contingency	Scenario	Flow		
			Base (A&B)	S1	S2
Mesa–Laguna Bell No.1 230 kV	Mesa–Lighthipe & Mesa - Laguna Bell No.2 230 kV (P7)	HSN	114.1%	111.8%	109.0%
		SSN	104.6%	101.1%	99.3%

Affected transmission zones		Northern LA Basin, Tehachapi (Vincent 230 kV), Ventura		
		Base (A & B)	S1	S2
Non-battery portfolio MW behind constraint		0 MW	0 MW	0 MW
Battery portfolio MW behind constraint		500 MW	500 MW	500 MW
Deliverable Portfolio MW w/o mitigation		0 MW	0 MW	0 MW
Total undeliverable baseline and portfolio MW		3,098 MW	3,048 MW	2,329 MW
Mitigation Options	RAS	Not applicable		
	Re-locate portfolio BESS (MW)	Not adequate		
	Transmission upgrade including cost	• Reconductor Laguna Bell-Mesa No. 1 230 kV line ($15 million) or • Smart Wires' Laguna Bell – Mesa Series Compensation Project ($6.7–$8 million)		
Recommended Mitigation		Transmission upgrade TBD after further evaluation		

On-peak Windhub 500/230 kV transformer Constraint

Overloaded Facility	Contingency	Scenario	Flow		
			Base (A&B)	S1	S2
Windhub #3 or #4 500/230 kV transformer	Windhub #3 or #4 500/230 kV transformer	HSN	154.0%	160.0%	142.3%
		SSN	127.0%	132.8%	116.4%
Windhub #1 or #2 500/230 kV transformer	Windhub #1 or #2 500/230 kV transformer	HSN	115.6%	122.1%	115.6%
		SSN	<100%	<100%	<100%

Affected transmission zones		Tehachapi (Windhub 230 kV)		
		Base (A & B)	S1	S2
Non-battery portfolio MW behind constraint		275 MW	275 MW	275 MW
Battery portfolio MW behind constraint		1008 MW	1081 MW	860 MW
Deliverable Portfolio MW w/o mitigation		568 MW	569 MW	566 MW
Total undeliverable baseline and portfolio MW		715 MW	787 MW	569 MW
Mitigation Options	RAS	Planned Windhub CRAS		
	Re-locate portfolio BESS (MW)	Not needed		
	Transmission upgrade	Not needed		
Recommended Mitigation		Planned Windhub CRAS		

On-Peak Red Bluff – Devers 500kV Constraint

Overloaded Facility	Contingency	Condition	Loading (%)		
			Base Portfolio (A and B)	S1	S2
Red Bluff - Devers 500 kV No.1 line	Red Bluff – Devers 500kV No.2 line	HSN	<100%	101%	<100%
		SSN	<100%	111%	<100%
Red Bluff – Devers 500kV No.2 line	Red Bluff – Devers 500kV No.1 line	HSN	<100%	101%	<100%
		SSN	<100%	108%	<100%

Affected transmission zones		Riverside and Palm Springs			
		Base		S1	S2
		A	B		
Non-battery portfolio MW behind the constraint		0	1,062	2,343	1,887
Battery portfolio MW behind the constraint		695	695	940	0
Deliverable portfolio MW without mitigation		695	1,757	2,635	1,887
Total undeliverable baseline and portfolio MW		0	0	648	0
Mitigation Options	RAS	Not needed		Not needed	Not needed
	Re-locate portfolio battery storage (MW)	Not needed		West of Colorado River CRAS	Not needed
	Transmission upgrade	Not needed		Not needed	Not needed
Recommended Mitigation		Not needed		West of Colorado River CRAS	Not needed

Off-Peak Windhub 500/230 kV transformer Constraint

Overloaded Facility	Contingency	Loading (%)		
		Base (A&B)	S1	S2
Windhub 500/230kV No. 3 & 4 transformers	Windhub 500/230kV No. 3 or 4 transformer	140.1%	154.1%	140.5%
Windhub 500/230kV No. 1 & 2 transformers	Windhub 500/230kV No. 1 or 2 transformer	105.3%	104.4	105.0%

Affected renewable transmission zones		Tehachapi (Windhub 230 kV)		
		Base (A&B)	S1	S2
Renewable portfolio MW behind constraint		1,428	1,673	1,428
Energy storage (ES) portfolio MW behind constraint		1,008	1081	860
Renewable curtailment without mitigation (MW)		538	736	548
Mitigation Options	Portfolio ES (in charging mode) (MW)	390	520	350
	RAS	Planned Windhub RAS		
	Additional battery storage (MW)	Not needed		
	Transmission upgrades	Not needed		
Recommended Mitigation		Planned Windhub RAS/ Baseline and portfolio battery		

Off-Peak Midway–Whirlwind 500 kV line Constraint

Overloaded Facility	Contingency	Loading (%)		
		Base (A&B)	S1	S2
Midway–Whirlwind 500 kV line (PG&E's segment of the line)	Base Case	121.8%	129.5%	121.7%

Affected renewable transmission zones		Tehachapi		
		Base (A&B)	S1	S2
Renewable portfolio MW behind constraint		3,952	4,734	3,952
Energy storage (ES) portfolio MW behind constraint		3,228	2,854	2,389
Renewable curtailment without mitigation (MW)		1,593	2,029	1,622
Mitigation Options	Portfolio ES (in charging mode) (MW)	0 (There is sufficient baseline BESS)		
	RAS	Not applicable		
	Additional battery storage (MW)	Not needed		
	Transmission upgrades	• Re-rate overloaded segment or • Bypass series capacitor on the line		
Recommended Mitigation		TBD		

- While the off-peak assessment indicates the constraint can be mitigated by dispatching available energy storage in charging mode, PCM results indicate that the constraint has the highest congestion cost in the system.

Preliminary results for VEA/GLW area

Portfolio resources likely to impact VEA/GLW area

TX Zone / Location	Full Capacity Only (MW)		
	Base Portfolio (A and B)	Sensitivity-1 (S1)	Sensitivity 2 (S2)
Southern_Nevada_Solar	348	31	31
Southern_Nevada_Wind	-	442	442
SCADSNV_Z2_GLW_VEA (BESS)	248.3	136	136

TX Zone / Location	Full Capacity and Energy Only (MW)		
	Base Portfolio (A/B)	Sensitivity-1 (S1)	Sensitivity 2 (S2)
Southern_Nevada_Solar	2,024	182	182
Southern_Nevada_Wind	-	442	442
SCADSNV_Z2_GLW_VEA (BESS)	248.3	136	136

On-Peak Deliverability Assessment Results VEA/GLW area

- No on-peak deliverability constraints were identified in the VEA/GLW area under Base, Sensitivity 1 or Sensitivity 2 scenarios

Off-Peak VEA/GLW Area Constraints

Overloaded Facility	Contingency	Loading (%)		
		Base	S1	S2
Trout Canyon – Sloan Canyon 230kV	Base Case	234	<100	<100
Amargosa 230/138kV transformer	Base Case	196	<100	<100
NVE 138kV Tie-line	Base Case	183	<100	<100
Innovation – Desert View 230kV	Base Case	177	<100	<100
Gamebird – Trout Canyon 230kV	Base Case	173	<100	<100
Pahrump – Gamebird 230kV	Base Case	134	<100	<100
Northwest – Desert View 230kV	Base Case	127	<100	<100
Amargosa – Sandy 138kV	Base Case	123	<100	<100
Sandy – Gamebird 138kV	Base Case	110	<100	<100
NVE 138kV Tie-line	Northwest – Desert View 230kV	Ncov	181	181
Amargosa 230/138kV transformer	Northwest – Desert View 230kV	Ncov	116	116
Trout Canyon – Sloan Canyon 230kV	Gamebird – Trout Canyon 230kV	Ncov	105	105
Gamebird – Trout Canyon 230kV	Trout Canyon – Sloan Canyon 230kV	Ncov	105	105

Mitigation Option

- **GLW Upgrade**
  - ❑ Project Scope:
    - Trout Canyon – Sloan Canyon 230kV rebuild
    - New Trout Canyon – Sloan Canyon #2 230kV line
    - Pahrump – Gamebird – Trout Canyon 230kV rebuild
    - New Pahrump – Gamebird – Trout Canyon #2 230kV line
    - New Innovation – Desert View 230kV line
    - Desert View- Northwest 230kV rebuild
    - New Desert View – Northwest #2 230kV line
    - Upgrade existing Sloan Canyon substation to 500/230kV substation and loop into Harry Allen – Eldorado 500kV line
    - 2nd Amargosa 230/138kV transformer
    - NVE Mercury SW – Northwest 138kV line upgrade
  - ❑ Cost estimate: $213 million *

* Excluding NVE Mercury SW – Northwest 138kV line upgrade which will be sponsored by NV Energy

Mitigation Option (Cont)

- **GLW Upgrade**
  - ❑ Evaluation:
    - The project was able to mitigate all normal overloads and majority of the contingency overloads.
    - In the Off-Peak deliverability study with the GLW Upgrade modeled, the Eldorado-McCullough 500 kV tie-line overloaded with all elements in-service and under contingency conditions. Congestion management, establishing an emergency rating for the tie-line and RAS are under investigation as alternative mitigations.
    - This tie-line overload was worse with the 1062 MW at Eldorado instead at Palo Verde.
    - Part of the mitigation scope is outside of the GLW territory and will require coordination with LADWP, NV Energy and WAPA
  - ❑ Recommendation: Based on the above evaluation, further analysis and coordination is needed before a final recommendation can be made.

Summary of VEA/GLW Constraint and Mitigation Options

Affected transmission zones		Southern Nevada (CAISO)			
		Base		S1	S2
		A	B		
Renewable portfolio MW behind the constraint		2,024	2,024	624	624
Energy storage (ES) portfolio MW behind the constraint		248	248	136	136
Renewable curtailment without mitigation (MW)		1,482	1,482	130	130
Mitigation Options	Portfolio ES (in charging mode) (MW)	Not sufficient		36	
	RAS	N/A		Innovation RAS Sloan Canyon RAS	
	Additional battery storage (MW)	Not feasible		100	
	Transmission upgrades	GLW Upgrade		N/A	
	Recommended Mitigation	TBD		RAS	

Preliminary results for SDG&E area

Portfolio resources likely to impact SDG&E area

TX Zone / Location	Full Capacity Only (MW)		
	Base Portfolio (A and B)	Sensitivity-1 (S1)	Sensitivity 2 (S2)
Arizona Solar	-	-	-
Arizona BESS	695	383	-
Greater Imperial Solar	-	600	600
Greater Imperial Geothermal (Bannister)	600	-	-
Baja California Wind	495	495	495
Pumped Hydro Storage (Sycamore Canyon)	314	500	500
SDGE BESS	1,170	1,170	1,170

TX Zone / Location	Full Capacity and Energy Only (MW)		
	Base Portfolio (A and B)	Sensitivity-1 (S1)	Sensitivity 2 (S2)
Arizona Solar	2,352	1,580	1,910
Arizona BESS	695	383	-
Greater Imperial Solar	548	1,148	1,148
Greater Imperial Geothermal	600	-	-
Baja California Wind	495	495	495
Pumped Hydro Storage (Sycamore Canyon)	314	500	500
SDGE BESS	1,170	1,170	1,170

On-Peak Doublet Tap-Friars 138 kV Constraint

Overloaded Facility	Contingency	Condition	Loading (%)		
			Base Portfolio (A and B)	S1	S2
Doublet Tap-Friars 138 kV	Old Town-Penasquitos and Sycamore Penasquitos 230 kV	HSN	<100	108	101
		SSN	101	115	113

Affected transmission zones		Greater Imperial Solar, SDGE BESS		
		Base Portfolio (A and B)	S1	S2
Renewable portfolio MW behind the constraint		314	500	500
Energy storage portfolio MW behind the constraint		500	500	500
Deliverable Portfolio MW w/o mitigation		764	370	425
Total undeliverable baseline and portfolio MW		50	630	575
Mitigation Options	RAS	Planned RAS to trip Otay Mesa area generation		
	Re-locate portfolio battery (MW)	N/A		
	Transmission upgrade	Option 1: Reconductor TL13810A Friars - Doublet Tap 138 kV line to 204 MVA ($5.5M) Option 2: Reconductor TL13810A Friars - Doublet Tap 138 kV line to 325 MVA ($48M)		
Recommended Mitigation		Planned RAS to trip Otay Mesa area generation		

On-Peak San Marcos-Melrose Tap 69 kV constraint

Overloaded Facility	Contingency	Condition	Loading (%)		
			Base Portfolio (A and B)	S1	S2
San Marcos-Melrose Tap 69 kV	Encina-San Luis Rey 230 kV and Encina-San Luis Rey-Palomar 230 kV	HSN	116	134	126
		SSN	149	170	168
	Encina-San Luis Rey-Palomar 230 kV and Palomar-Artesian 230 kV	HSN	<100	<100	<100
		SSN	<100	101	101

On-Peak San Marcos-Melrose Tap 69 kV constraint - cont'd

Affected transmission zones		Greater Imperial Solar, SDGE BESS		
		Base Portfolio (A and B)	S1	S2
Renewable portfolio MW behind the constraint		314	500	500
Energy storage portfolio MW behind the constraint		710	710	710
Deliverable Portfolio MW w/o mitigation		0	0	0
Total undeliverable baseline and portfolio MW		1103	1403	1382
Mitigation Options	RAS	Existing/modified TL684 RAS to open Melrose Tap-San Marcos 69 kV line	Existing/modified TL684 RAS to open Melrose Tap-San Marcos 69 kV line and planned RAS to trip Encina	
	Re-locate portfolio battery storage (MW)	N/A		
	Transmission upgrade	Reconductor TL680C San Marcos - Melrose Tap 69 kV line ($28M)		
Recommended Mitigation		Existing/modified TL684 RAS to open Melrose Tap-San Marcos 69 kV line	Existing/modified TL684 RAS to open Melrose Tap-San Marcos 69 kV line and planned RAS to trip Encina	

On-Peak Encina-San Luis Rey 230 kV constraint

Overloaded Facility	Contingency	Condition	Loading (%)		
			Base Portfolio (A and B)	S1	S2
Encina-Encina Tap 230 kV	Encina-San Luis Rey 230 kV	HSN	<100	<100	<100
		SSN	106	119	118
Encina Tap-San Luis Rey 230 kV		HSN	112	126	118
		SSN	137	154	152
Encina-San Luis Rey 230 kV	San Luis Rey-Encina-Palomar 230 kV	HSN	<100	112	105
		SSN	<100	137	135
Encina-San Luis Rey 230 kV	San Luis Rey-Encina-Palomar 230 kV and - Palomar-Batiquitos 138 kV or - Encina-Palomar 138 kV or - Batiquitos-Shadowridge 138 kV	HSN	100	112	105
		SSN	122	137	135
	San Luis Rey-Encina-Palomar 230 kV and Palomar-Artesian 230 kV	HSN	100	114	106
		SSN	122	139	138

On-Peak Encina-San Luis Rey 230 kV constraint - cont'd

Overloaded Facility	Contingency	Condition	Loading (%)		
			Base Portfolio (A and B)	S1	S2
Encina-San Luis Rey 230 kV	San Luis Rey-Mission 230 kV #1 and #2	SSN	<100	<100	<100
		SSN	<100	103	102
Encina Tap-San Luis Rey 230 kV		HSN	<100	<100	<100
		SSN	<100	111	110
Mission-San Luis Rey 230 kV #1	Encina-San Luis Rey 230 kV and Encina-San Luis Rey-Palomar 230 kV	HSN	<100	<100	<100
		SSN	<100	108	107
Mission-San Luis Rey 230 kV #2		HSN	<100	<100	<100
		SSN	<100	110	108

On-Peak Encina-San Luis Rey 230 kV constraint - cont'd

Affected transmission zones		Baja California Wind, Greater Imperial Solar, SDGE BESS		
		Base Portfolio (A and B)	S1	S2
Renewable portfolio MW behind the constraint		809	1595	1595
Energy storage portfolio MW behind the constraint		720	720	720
Deliverable Portfolio MW w/o mitigation		27	0	0
Total undeliverable baseline and portfolio MW		1502	2496	2431
Mitigation Options	RAS	Planned RAS to trip Encina	Planned RAS to trip Encina not sufficient in SSN scenario	
	Re-locate portfolio battery storage (MW)	N/A		
	Transmission upgrade	New Encina-San Luis Rey 230 kV line ($102M)		
Recommended Mitigation		Planned RAS to trip Encina	New Encina-San Luis Rey 230 kV line ($102M)	

On-Peak San Luis Rey-San Onofre 230 kV constraint

Overloaded Facility	Contingency	Condition	Loading (%)		
			Base Portfolio (A and B)	S1	S2
San Luis Rey-San Onofre 230 kV #1	San Luis Rey-San Onofre 230 kV #2 and #3	HSN	<100	108	100
		SSN	127	145	142

Affected transmission zones		Baja California Wind, Greater Imperial Solar, SDGE BESS		
		Base Portfolio (A and B)	S1	S2
Renewable portfolio MW behind the constraint		809	1595	1595
Energy storage portfolio MW behind the constraint		720	720	720
Deliverable Portfolio MW w/o mitigation		317	233	311
Total undeliverable baseline and portfolio MW		1212	2082	2004
Mitigation Options	RAS	Planned RAS to trip Encina	Planned RAS to trip Encina not sufficient in SSN scenario	
	Re-locate portfolio battery storage (MW)	N/A		
	Transmission upgrade	New San Luis Rey-San Onofre 230 kV line ($237M)		
Recommended Mitigation		Planned RAS to trip Encina	New San Luis Rey-San Onofre 230 kV line ($237M)	

Off-Peak Deliverability Assessment Results SDG&E area

- There are no off-peak deliverability constraints identified in the SDG&E area under Base, Sensitivity 1 or Sensitivity 2 scenarios

Preliminary results for PG&E area

Overview of portfolio resources likely to impact PG&E area

Transmission Delivery Zone	Full Capacity Only (MW)				
	Base	SENS-01	SENS-02		
			Option 1	Option 2	Option 3
Northern California	589 Wind	589 Wind	589 Wind		
Solano	107.4 (102 Wind + 5.4 BESS)	102 Wind	102 Wind		
Westlands	733 Solar	733 Solar	-		
Humboldt OSW	-	-	1,607		
Diablo Canyon OSW	-	-	4,419		
Morro Bay OSW	-	-	2,324	2,324	2,324

Transmission Delivery Zone	Full Capacity and Energy Only (MW)				
	Base	SENS-01	SENS-02		
			Option 1	Option 2	Option 3
Westlands	244.9 BESS	244.9 BESS	10 BESS		
Greater Carrizo	379.8 (234.8 Solar + 145 BESS)	416 (253 Solar + 163 BESS)	251 (106 Solar + 145 BESS)		
Diablo Canyon OSW	4,419 OSW	4,419 OSW	4,419 OSW		
Morro Bay OSW	2,324 OSW	2,324 OSW	2,324 OSW		

On-Peak Round Mountain-Fern Road #1 and #2 500kV lines constraint

Overloaded Facility	Contingency		Loading				
			BASE	SENS-01	SENS-02		
					Option 1	Option 2	Option 3
Round Mountain-Fern Road #1 and #2 500kV lines	Round Mountain-Fern Road #2 or #1 500kV lines	HSN	113%	116%	104%	111%	111%
		SSN	<100%	<100%	<100%	<100%	<100%

Affected transmission zones		Northern California				
		Base Portfolio	S1 Portfolio	S2 Portfolio		
				Option 1	Option 2	Option 3
Renewable portfolio MW behind the constraint		437 Wind	437 Wind	437 Wind	437 Wind	437 Wind
Energy storage portfolio MW behind the constraint		0	0	0	0	0
Deliverable Portfolio MW w/o mitigation		0	0	0	0	0
Total undeliverable baseline and portfolio resources, MW		1,393	1,957	579	1,155	1,232
Mitigation Options	RAS	Yes, previously identified in TPP				
	Re-locate portfolio battery storage (MW)	N/A				
	Transmission upgrade	No				
Recommended Mitigation		RAS to bypass the series capacitor on the remaining line				

On-Peak Delevan-Cortina 230kV line constraint

Overloaded Facility	Contingency		Loading				
			BASE	SENS-01	SENS-02		
					Option 1	Option 2	Option 3
Delevan-Cortina 230kV line	Base Case	HSN	101%	102%	107%	100%	<100%
		SSN	<100%	<100%	<100%	<100%	<100%
	Olinda-Tracy 500kV Line	HSN	114%	116%	122%	112%	109%
		SSN	<100%	<100%	<100%	<100%	<100%
	Delevan-Vaca Dixon #2 and #3 230kV lines	HSN	118%	120%	126%	118%	114%
		SSN	<100%	<100%	101%	<100%	<100%

Affected transmission zones		Northern California				
		Base Portfolio	S1 Portfolio	S2 Portfolio		
				Option 1	Option 2	Option 3
Renewable portfolio MW behind the constraint		437 Wind	437 Wind	437 Wind	437 Wind	437 Wind
Energy storage portfolio MW behind the constraint		0	0	0	0	0
Deliverable Portfolio MW w/o mitigation		0	0	0	0	0
Total undeliverable baseline and portfolio resources, MW		564	588	713	538	479
Mitigation Options	RAS	No, N-0 overload				
	Re-locate portfolio battery (MW)	N/A				
	Transmission upgrade	Reconductor the line ($41.39 million)				
Recommended Mitigation		Transmission Upgrade				

On-Peak Cayetano-North Dublin 230kV line constraint

Overloaded Facility	Contingency		Loading				
			BASE	SENS-01	SENS-02		
					Option 1	Option 2	Option 3
Cayetano-North Dublin 230kV line	Contra Costa-Morago #1 and #2 230kV lines	HSN	106%	107%	110%	<100%	<100%
		SSN	<100%	<100%	<100%	<100%	<100%

Affected transmission zones		Solano				
		Base Portfolio	S1 Portfolio	S2 Portfolio		
				Option 1	Option 2	Option 3
Renewable portfolio MW behind the constraint		102 Wind	102 Wind	102 Wind	102 Wind	102 Wind
Energy storage portfolio MW behind the constraint		5.4	0	0	0	0
Deliverable Portfolio MW w/o mitigation		0	0	0	102	102
Total undeliverable baseline and portfolio resources, MW		260	299	422	0	0
Mitigation Options	RAS	No, remote monitoring (RAS Guideline violation)				
	Re-locate portfolio battery storage (MW)	No				
	Transmission upgrade	Reconductor the line ($42.4 million) or northern area new 500 kV source.				
Recommended Mitigation		Transmission Upgrade				

On-Peak Lone Tree-USWP-JRW-Cayetano 230kV line constraint

Overloaded Facility	Contingency		Loading				
			BASE	SENS-01	SENS-02		
					Option 1	Option 2	Option 3
Lone Tree-USWP-JRW-Cayetano 230kV line (Lonetree-USWP JRW)	Contra Costa-Morago #1 and #2 230kV lines (also Base Case overload)	HSN	100%	101%	105%	<100%	<100%
		SSN	<100%	<100%	<100%	<100%	<100%
Lone Tree-USWP-JRW-Cayetano 230kV line (USWP JRW-Cayetano)	Base Case	HSN	101%	101%	103%	<100%	<100%
		SSN	<100%	<100%	<100%	<100%	<100%
	Contra Costa-Las Positas 230kV Line	HSN	104%	104%	106%	<100%	100%
		SSN	<100%	<100%	<100%	<100%	<100%
	Contra Costa-Morago #1 and #2 230kV lines	HSN	111%	112%	115%	105%	104%
		SSN	<100%	<100%	<100%	<100%	<100%

On-Peak Lone Tree-USWP-JRW-Cayetano 230kV line constraint - cont'd

Affected transmission zones		Solano				
		Base Portfolio	S1 Portfolio	S2 Portfolio		
				Option 1	Option 2	Option 3
Renewable portfolio MW behind the constraint		102 Wind	102 Wind	102 Wind	102 Wind	102 Wind
Energy storage portfolio MW behind the constraint		5.4	0	0	0	0
Deliverable Portfolio MW w/o mitigation		0	0	0	0	0
Total undeliverable baseline and portfolio resources, MW		500	533	642	218	201
Mitigation Options	RAS	No, N-0 overloads				
	Re-locate portfolio battery storage (MW)	No				
	Transmission upgrade	Reconductor the line ($55.1 million) or northern area new 500 kV source.				
Recommended Mitigation		Transmission Upgrade				

On-Peak Las Positas-Newark 230kV line constraint

Overloaded Facility	Contingency		Loading				
			BASE	SENS-01	SENS-02		
					Option 1	Option 2	Option 3
Las Positas-Newark 230kV line	Contra Costa-Delta Switchyard 230kV Line	HSN	103%	101%	106%	<100%	<100%
		SSN	<100%	<100%	<100%	<100%	<100%
	Contra Costa-Morago #1 and #2 230kV lines	HSN	116%	115%	121%	102%	107%
		SSN	<100%	<100%	<100%	<100%	<100%

Affected transmission zones		Solano				
		Base Portfolio	S1 Portfolio	S2 Portfolio		
				Option 1	Option 2	Option 3
Renewable portfolio MW behind the constraint		102 Wind	102 Wind	102 Wind	102 Wind	102 Wind
Energy storage portfolio MW behind the constraint		5.4	0	0	0	0
Deliverable Portfolio MW w/o mitigation		0	0	0	0	0
Total undeliverable baseline and portfolio resources, MW		510	476	638	116	253
Mitigation Options	RAS	No, remote monitoring				
	Re-locate portfolio battery storage (MW)	No				
	Transmission upgrade including cost	Reconductor the line ($47.65 million) or northern area new 500 kV source.				
Recommended Mitigation		Transmission Upgrade				

On-Peak Rio Oso-SPI Jct-Lincoln 115kV constraint

Overloaded Facility	Contingency		Loading				
			BASE	SENS-01	SENS-02		
					Option 1	Option 2	Option 3
Rio Oso-SPI Jct-Lincoln 115kV line	Rio Oso-Atlantic and Rio Oso-Gold Hill 230kV lines	HSN	115%	115%	122%	114%	115%
		SSN	<100%	<100%	<100%	<100%	<100%

Affected transmission zones		Northern California				
		Base Portfolio	S1 Portfolio	S2 Portfolio		
				Option 1	Option 2	Option 3
Renewable portfolio MW behind the constraint		152 Wind	152 Wind	152 Wind	152 Wind	152 Wind
Energy storage portfolio MW behind the constraint		0	0	0	0	0
Deliverable Portfolio MW w/o mitigation		0	0	0	0	0
Total undeliverable baseline and portfolio resources, MW		396	403	615	368	395
Mitigation Options	RAS	No, remote monitoring				
	Re-locate portfolio battery storage (MW)	No				
	Transmission upgrade including cost	Reconductor the line ($30.62 million)				
Recommended Mitigation		Transmission Upgrade				

On-Peak Borden-Storey #2 230kV line constraint

Overloaded Facility	Contingency		Loading				
			BASE	SENS-01	SENS-02		
					Option 1	Option 2	Option 3
Borden-Storey #2 230kV line	Borden-Storey #1 230kV line	HSN	<100%	<100%	<100%	<100%	<100%
		SSN	104%	105%	<100%	<100%	<100%

Affected transmission zones		Westlands				
		Base Portfolio	S1 Portfolio	S2 Portfolio		
				Option 1	Option 2	Option 3
Renewable portfolio MW behind the constraint		733 Solar	733 Solar	N/A	N/A	N/A
Energy storage portfolio MW behind the constraint		0	0	N/A	N/A	N/A
Deliverable Portfolio MW w/o mitigation		659	552	N/A	N/A	N/A
Total undeliverable baseline and portfolio resources, MW		44	181	N/A	N/A	N/A
Mitigation Options	RAS	No, remote monitoring		Not Needed		
	Re-locate portfolio battery storage (MW)	No		Not Needed		
	Transmission upgrade including cost	Reconductor the line ($24.24 million)		Not Needed		
Recommended Mitigation		Transmission Upgrade		Not Needed		

On-Peak Fulton 60kV lines constraint

Overloaded Facility	Contingency		Loading				
			BASE	SENS-01	SENS-02		
					Option 1	Option 2	Option 3
Fulton 60kV Lines	Geysers #9-Lakeville and Eagle Rock-Fulton-Silverado 115kV lines	HSN	112%	115%	117%	105%	<100%
		SSN	110%	108%	112%	105%	<100%

Affected transmission zones		N/A				
		Base Portfolio	S1 Portfolio	S2 Portfolio		
				Option 1	Option 2	Option 3
Renewable portfolio MW behind the constraint		N/A	N/A	N/A	N/A	N/A
Energy storage portfolio MW behind the constraint		N/A	N/A	N/A	N/A	N/A
Deliverable Portfolio MW w/o mitigation)		N/A	N/A	N/A	N/A	N/A
Total undeliverable baseline and portfolio resources, MW		40	40	38	13	0
Mitigation Options	RAS	No, Cost Prohibitive				Not Needed
	Re-locate portfolio battery storage (MW)	No				Not Needed
	Transmission upgrade	Reconductor the line ($28.38 million)				Not Needed
Recommended Mitigation		TBD				Not Needed

Off-Peak Kettlemen-Gates 70kV line constraint

Overloaded Facility	Contingency	Loading				
		BASE	SENS-01	SENS-02		
				Option 1	Option 2	Option 3
Kettlemen-Gates 70kV Line	Base Case	126%	125%	125%	125%	125%

Affected renewable transmission zones		Westlands				
		BASE	SENS-01	SENS-02		
				Option 1	Option 2	Option 3
Renewable portfolio MW behind the constraint		0	0	0	0	0
Energy storage portfolio MW behind the constraint		10	10	10	10	10
Renewable MW curtailment		10 Solar	10 Solar	10 Solar	10 Solar	10 Solar
Portfolio energy storage MW re-dispatched in charging mode		10	10	10	10	10
Potential Options	RAS	Not needed				
	Add battery storage	Not needed				
	Transmission upgrade	Not needed				
Recommended Mitigation		Turn on Portfolio Battery Storage				

Off-Peak Kern-Tevis-Stockdale 115kV area constraint

Overloaded Facility	Contingency	Loading				
		BASE	SENS-01	SENS-02		
				Option 1	Option 2	Option 3
Kern-Tevis-Stockdale 115kV Lines	Remaining Kern-Tevis-Stockdale-Lamont 115kV Line	123%	121%	121%	121%	121%

Affected renewable transmission zones		Greater Carrizo				
		BASE	SENS-01	SENS-02		
				Option 1	Option 2	Option 3
Renewable portfolio MW behind the constraint		106 Solar	106 Solar	106 Solar	106 Solar	106 Solar
Energy storage portfolio MW behind the constraint		95	95	95	95	95
Renewable MW curtailment		34 Solar	32 Solar	33 Solar	31 Solar	31 Solar
Portfolio energy storage MW re-dispatched in charging mode		34	32	33	31	31
Potential Options	RAS	N/A				
	Add battery storage	N/A				
	Transmission upgrade and cost	N/A				
Recommended Mitigation		Turn on Portfolio Battery Storage				

Off-Peak Weedpatch 70kV area constraint

Overloaded Facility	Contingency	Loading				
		BASE	SENS-01	SENS-02		
				Option 1	Option 2	Option 3
Weedpatch 70kV Area	Midway-Wheeler Ridge #1 and #2 230kV Lines	406%	441%	145%	145%	146%

Affected renewable transmission zones		Greater Carrizo				
		BASE	SENS-01	SENS-02		
				Option 1	Option 2	Option 3
Renewable portfolio MW behind the constraint		128.8 Solar	147 Solar	0	0	0
Energy storage portfolio MW behind the constraint		0	18	0	0	0
Renewable MW curtailment		178 Solar	51 Solar	0	0	0
Portfolio energy storage MW re-dispatched in charging mode		0	18	0	0	0
Potential Options	RAS	No, too many elements		Not needed		
	Add battery storage	N/A		Not needed		
	Transmission upgrade and cost	TBD		Not needed		
Recommended Mitigation		TBD		Not needed		

Off-Peak Gates 500/230kV Bank 12 area constraint

Overloaded Facility	Contingency	Loading				
		BASE	SENS-01	SENS-02		
				Option 1	Option 2	Option 3
Gates 500/1230kV Bank 12	Gates 500/230kV Bank 11	102.1	<100%	<100%	<100%	<100%

Affected renewable transmission zones		Greater Carrizo, Westlands				
		BASE	SENS -01	SENS-02		
				Option 1	Option 2	Option 3
Renewable portfolio MW behind the constraint		1,243 Solar 207 Wind	NA	NA	NA	NA
Energy storage portfolio MW behind the constraint		294.9	NA	NA	NA	NA
Renewable MW curtailment		60 Solar	NA	NA	NA	NA
Portfolio energy storage MW re-dispatched in charging mode		60	NA	NA	NA	NA
Potential Options	RAS	N/A	NA	NA	NA	NA
	Add battery storage	N/A	NA	NA	NA	NA
	Transmission upgrade and cost	N/A	NA	NA	NA	NA
Recommended Mitigation		Turn on Portfolio Battery Storage	Not needed			

Preliminary results for PG&E Area – Offshore Wind

Outline

- Offshore wind (OSW) sensitivity study
  - Detailed studies for 8,350 MW
  - Outlook assessment for 21,171 MW
- Summary of interconnection options
- Results of Deliverability study for 8,350 MW Offshore wind
- Next Steps

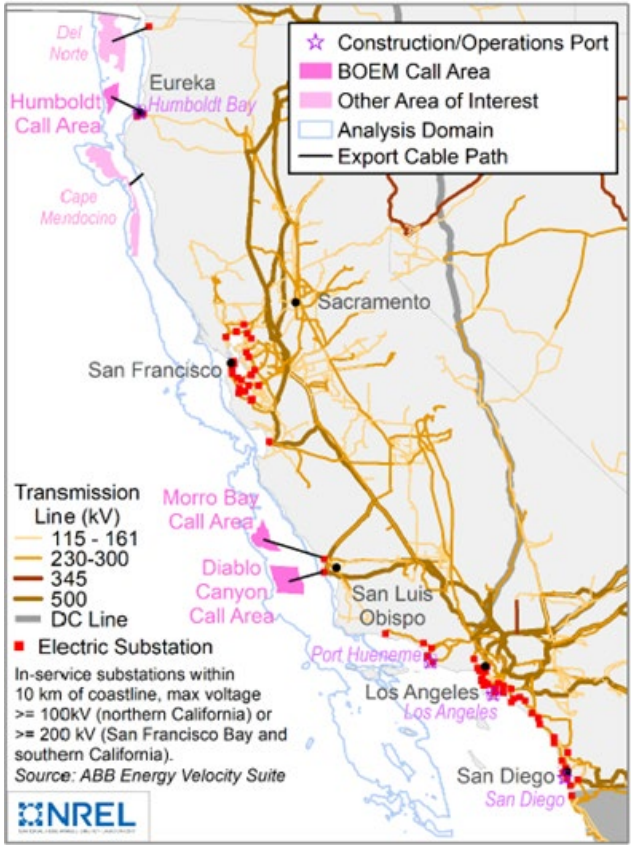
Portfolios for 2021-2022 TPP

- The CPUC transmitted a base portfolio and two sensitivity portfolios for the 2021-2022 TPP policy studies:
  - Base portfolio with 46 MMT GHG target
  - Sensitivity 1 portfolio with 38 MMT GHG target
  - Sensitivity 2 portfolio with 30 MMT GHG target
    - To assess the transmission needs for potential offshore wind development

Modeling Assumptions for the 2021-2022 Transmission Planning Process
ftp://ftp.cpuc.ca.gov/energy/modeling/Modeling_Assumptions_2021_22_TPP_Final.pdf

Description of Sensitivity 2 Portfolio

- Sensitivity 2 includes the following OSW resources:
  - Humboldt: 1.6 GW
  - Diablo Canyon: 4.4 GW
  - Morro Bay: 2.3 GW
- In addition, an outlook assessment will be performed to accommodate the remaining OSW resource potential:
  - Del Norte: 6.6 GW
  - Cape Mendocino: 6.2 GW
- The total OSW in the outlook is 21,171 MW

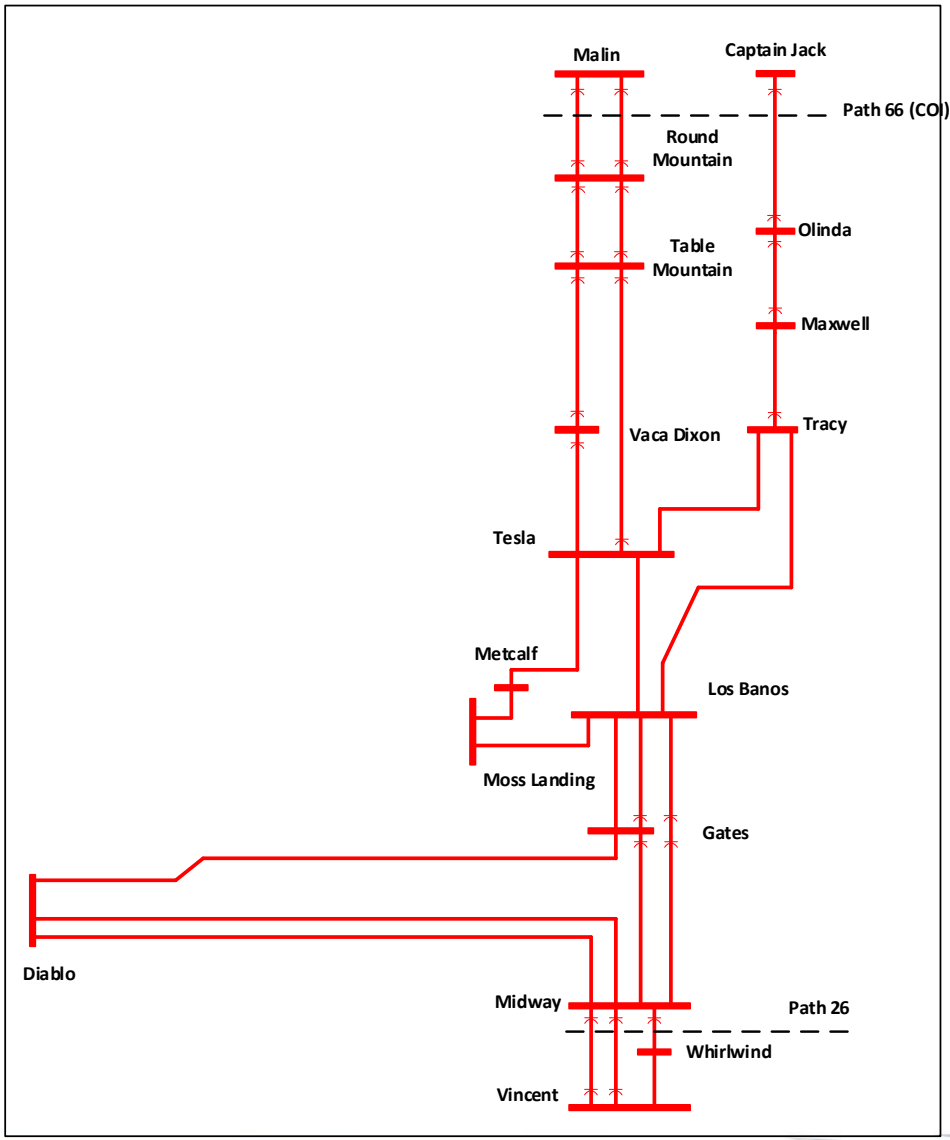


Source: [The Cost of Floating Offshore Wind Energy in California Between 2019 and 2032 (nrel.gov)] (Page 39)

OSW and the existing bulk transmission system

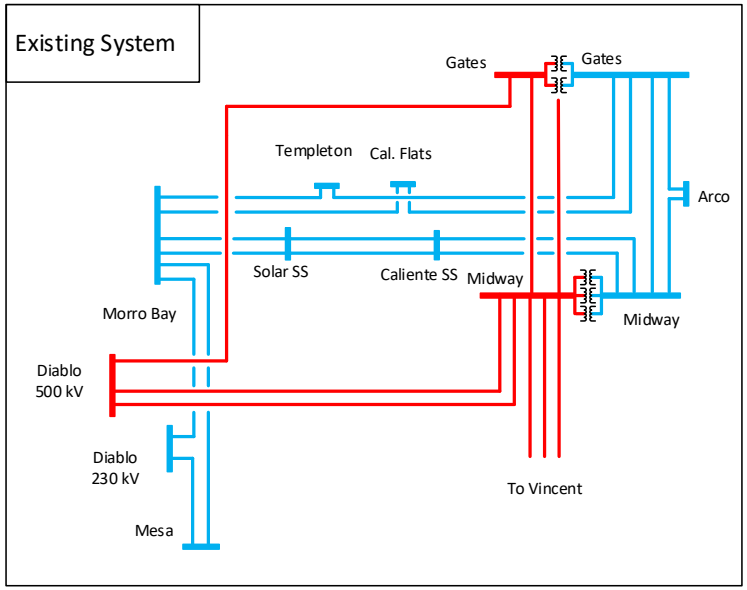
Offshore wind ~20-30 mi from shore (14,428 MW)

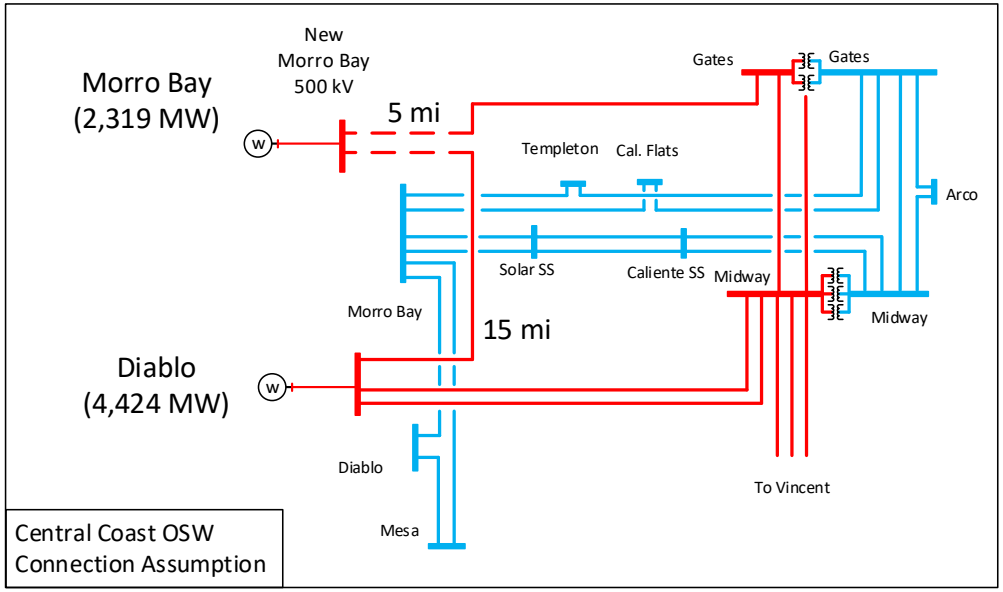
Offshore wind ~30 mi from shore (6,743 MW)



Onshore Network Assumptions in Central Coast

- The 4.3 GW Diablo Canyon OSW will be connected to the Diablo 500 kV substation
- Morro Bay 230 kV does not have the capability to accommodate 2.3 GW of OSW. Therefore, Morrow Bay OSW will be connected to a new 500 kV substation at Morrow Bay with Diablo – Gates 500 kV line looped into it

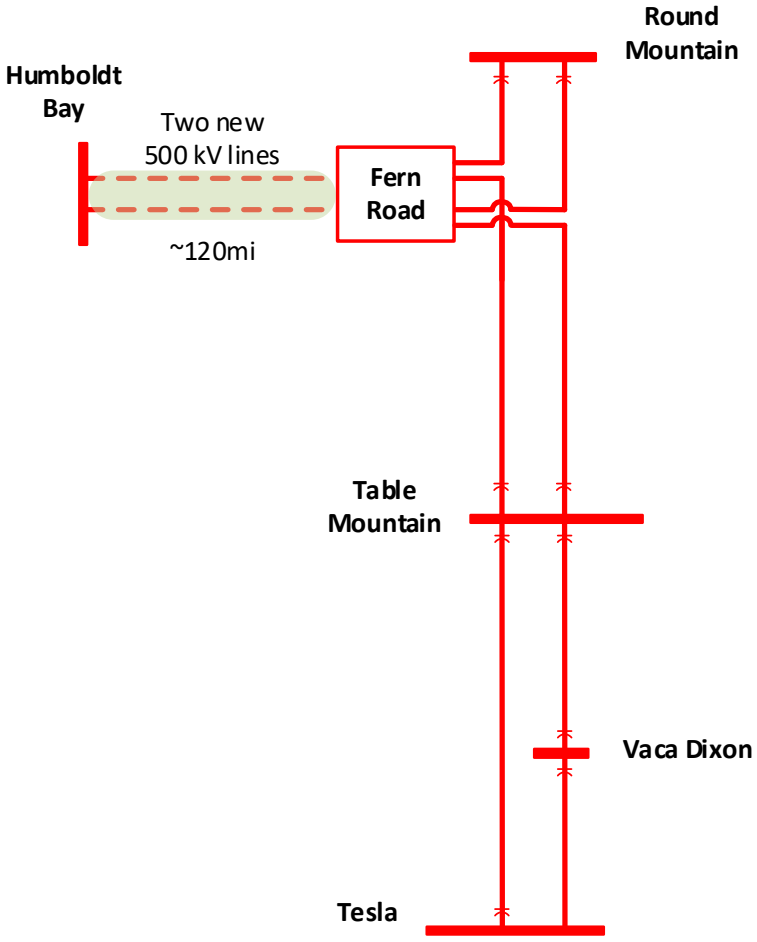




Interconnection Options for 1,607 MW Offshore wind at Humboldt Bay

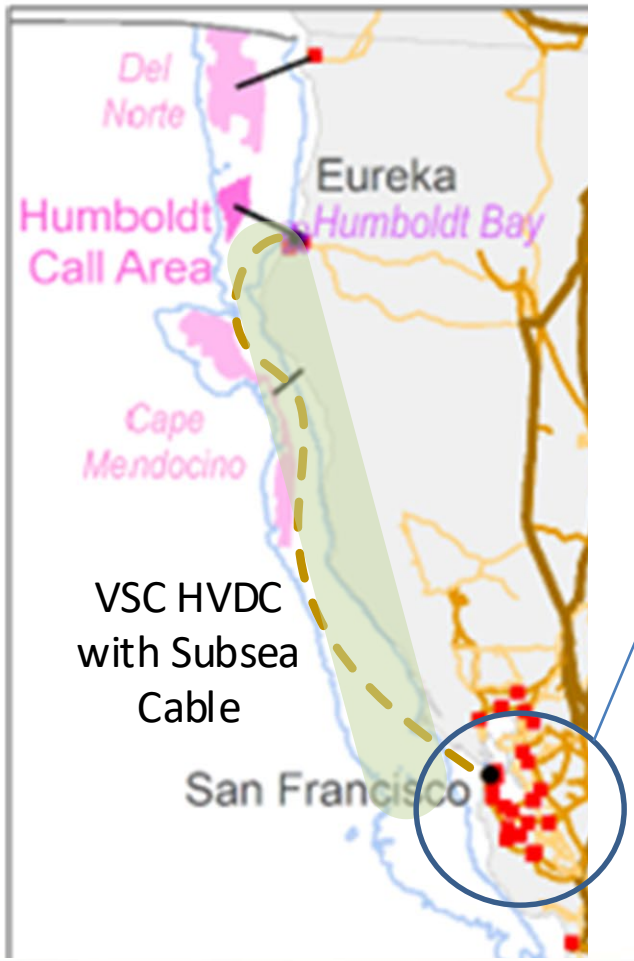
Humboldt 1.6 GW Interconnection Alternatives (1/3)

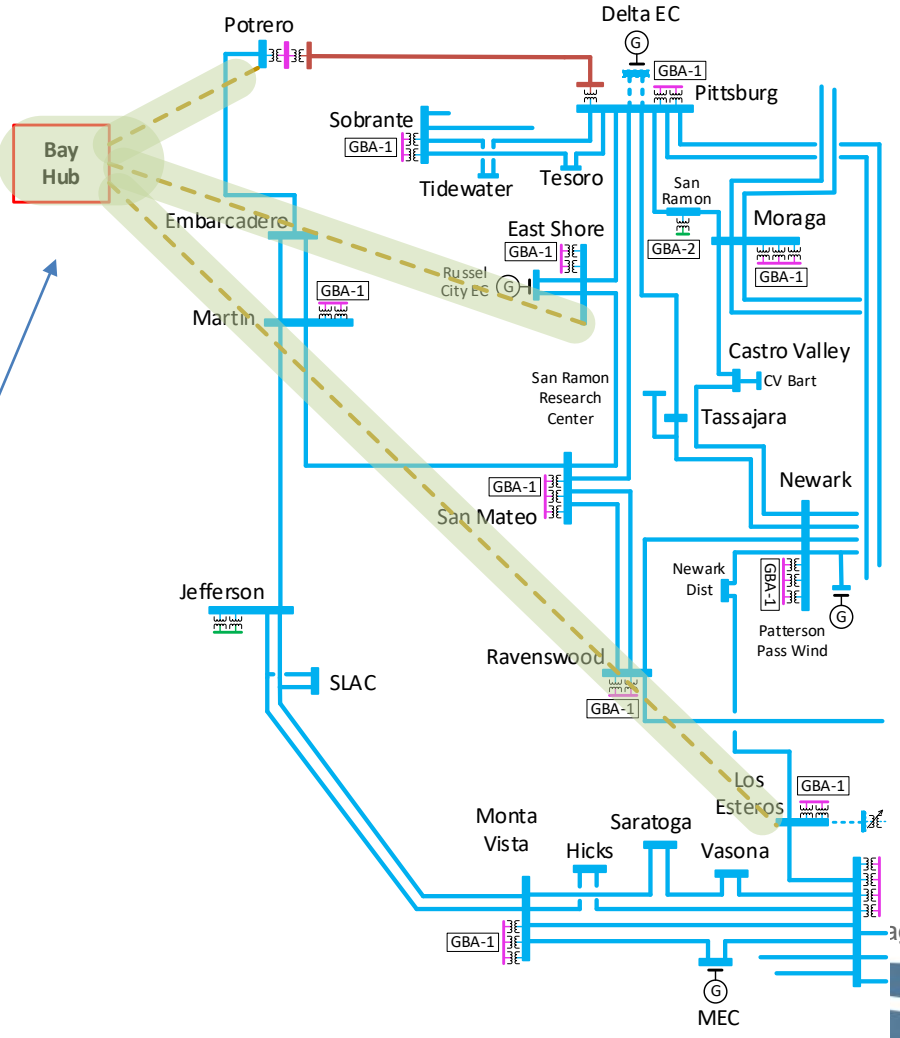
- Option 1: 500 kV AC line to Fern Road 500 kV substation.
  - Fern Road 500 kV substation is planned to be in service by June 2024 as part of Round Mountain DRS project and is located 11 miles south of Round Mountain substation.



Humboldt 1.6 GW Interconnection Alternatives (2/3)

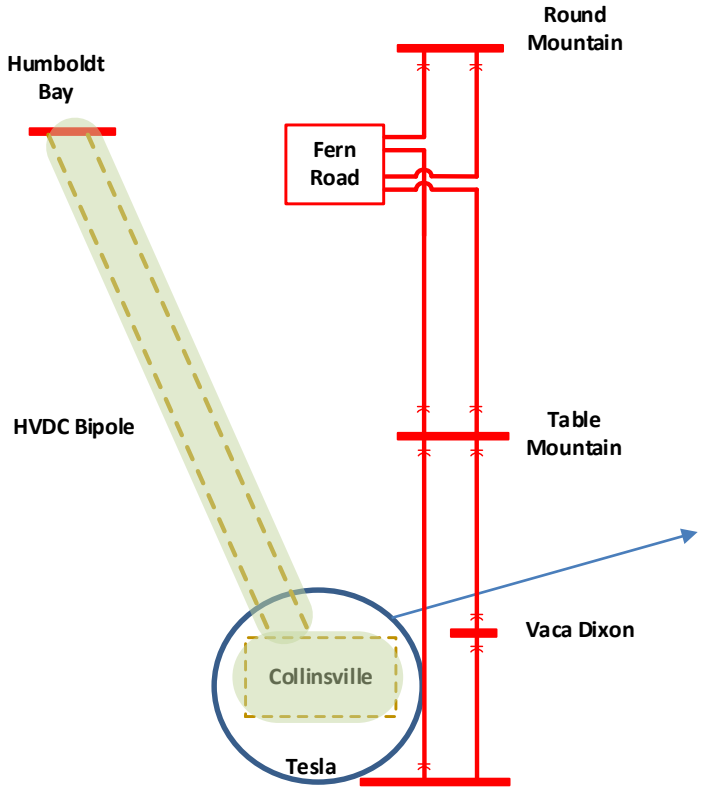
- Option 2: VSC-HVDC subsea cable to a converter station in the Bay area with 3 AC connections to Potrero, East Shore, and Los Esteros

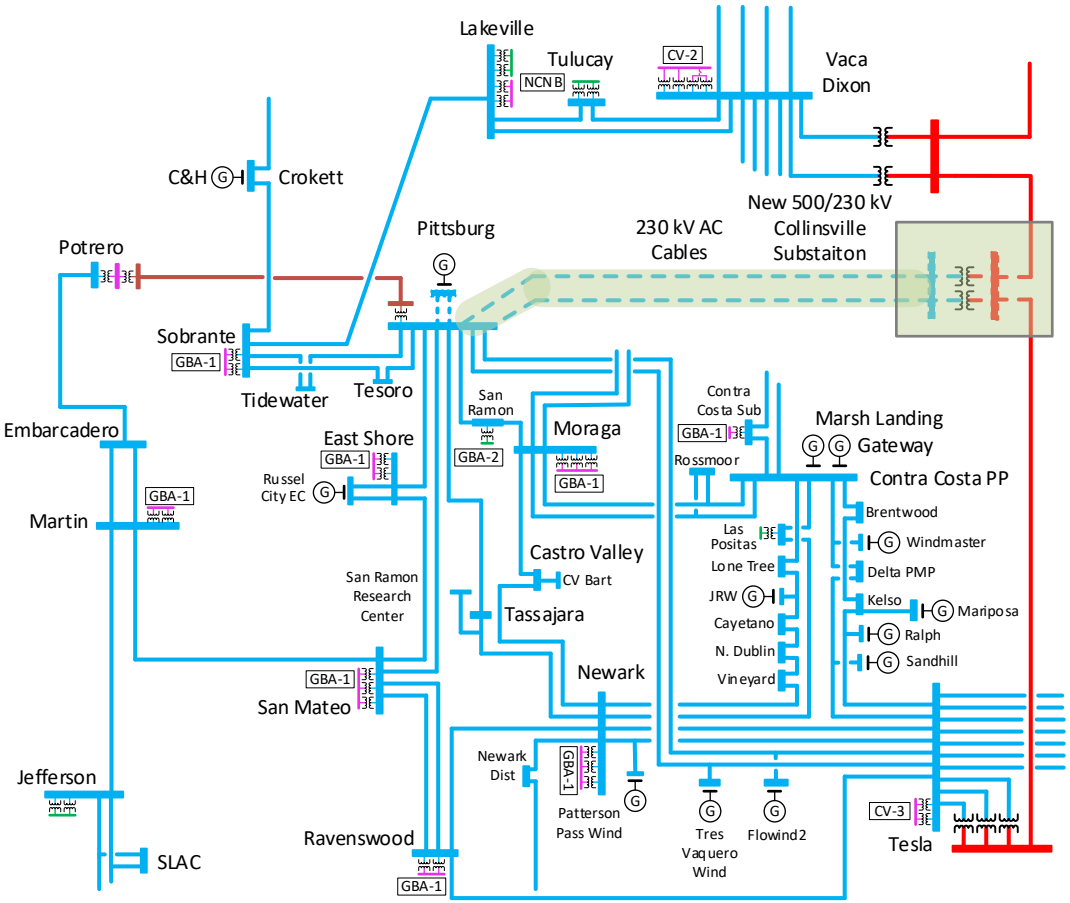




Humboldt 1.6 GW Interconnection Alternatives (3/3)

- Option 3: HVDC Bipole to Collinsville 500/230 kV substation.





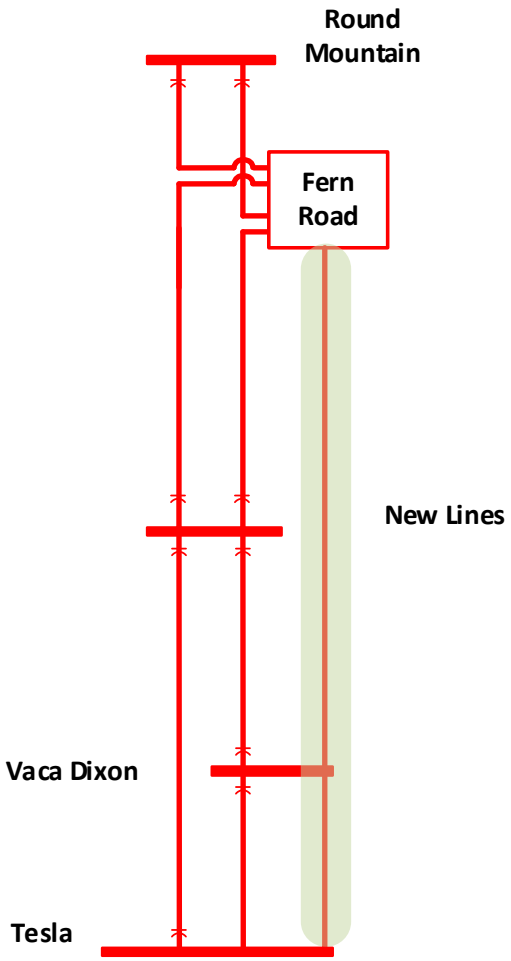
On-Peak Fern Road-Table Mountain #1, #2, and Table Mountain-Vaca Dixon 500 kV line constraints (1/2)

Overloaded Facility	Contingency		Loading				
			BASE	SENS-01	SENS-02		
					Option 1	Option 2	Option 3
Fern Road-Table Mountain #1 and #2 500kV lines	Base Case	HSN	<100%	<100%	112%	<100%	<100%
		SSN	<100%	<100%	<100%	<100%	<100%
Table Mountain-Vaca Dixon 500 kV Line	Base Case	HSN	<100%	<100%	116%	<100%	<100%
		SSN	<100%	<100%	<100%	<100%	<100%
Fern Road-Table Mountain #1 and #2 500kV lines	Fern Road-Table Mountain #2 or #1 500kV lines	HSN	<100%	<100%	138%	<100%	<100%
		SSN	<100%	<100%	<100%	<100%	<100%
Table Mountain-Rio Oso 230 kV Line	Table Mountain-Vaca Dixon 500 kV Line	HSN	<100%	<100%	112%	<100%	<100%
		SSN	<100%	<100%	<100%	<100%	<100%
Round Mountain-Cottonwood #3 230 kV Line	Table Mountain-Vaca Dixon 500 kV Line	HSN	<100%	<100%	101%	<100%	<100%
		SSN	<100%	<100%	<100%	<100%	<100%
North Dublin-Vineyard 230 kV line	Contra Costa-Morago #1 and #2 230kV lines	HSN	<100%	<100%	101%	<100%	<100%
		SSN	<100%	<100%	<100%	<100%	<100%

On-Peak Fern Road-Table Mountain #1, #2 and Table Mountain-Vaca Dixon 500 kV line constraints (2/2)

Affected transmission zones		Northern California and Humboldt Bay Off-Shore Wind (Fern Road)				
		Base Portfolio	S1 Portfolio	S2 Portfolio		
				Option 1	Option 2	Option 3
Renewable portfolio MW behind the constraint		0	0	437 Wind 1607 OSW	N/A	N/A
Energy storage portfolio MW behind the constraint		0	0	0	N/A	N/A
Deliverable Portfolio MW w/o mitigation		0	0	0	N/A	N/A
Total undeliverable baseline and portfolio resources, MW		0	0	2,305	N/A	N/A
Mitigation Options	RAS	Not Needed		N/A, N-0 Overload	Not Needed	
	Re-locate portfolio battery storage (MW)	Not Needed		N/A	Not Needed	
	Transmission upgrade including cost	Not Needed		Build a new 500 kV line from Fern Road to Tesla	Not Needed	
Recommended Mitigation		Not Needed		TBD	Not Needed	

Potential Mitigation for Overload on Fern Road-Table Mountain #1 and #2 500kV lines and Table Mountain-Vaca Dixon 500 kV Line



On-Peak Diablo-Midway #2, #3 and Morro Bay-Gates 500 kV line constraints (1/2)

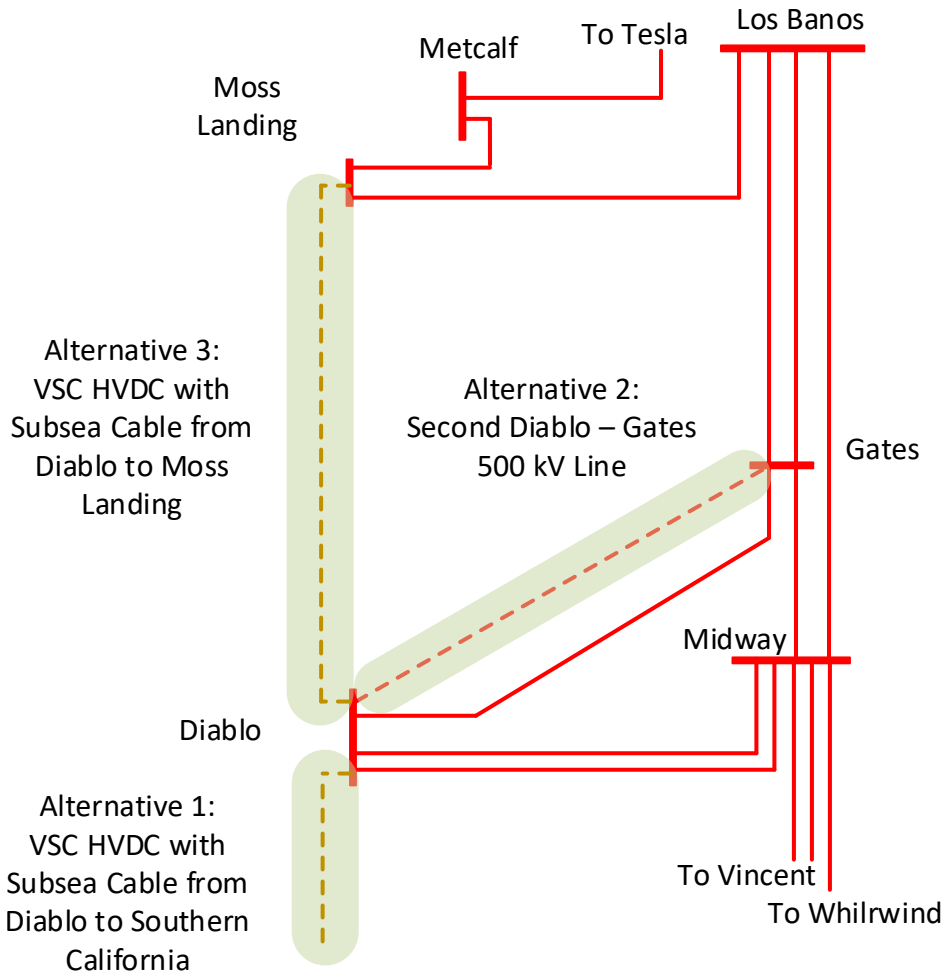
Overloaded Facility	Contingency		Loading				
			BASE	SENS-01	SENS-02		
					Option 1	Option 2	Option 3
Diablo-Midway 500 kV Lines	Base Case	HSN	<100%	<100%	112%	112%	112%
		SSN	<100%	<100%	<100%	<100%	<100%
	Remaining Diablo-Midway 500 kV Line	HSN	<100%	<100%	114%	114%	114%
		SSN	<100%	<100%	<100%	<100%	<100%
Morro Bay-Gates 500 kV Line	Base Case	HSN	<100%	<100%	125%	125%	125%
		SSN	<100%	<100%	<100%	<100%	<100%
	Diablo-Midway 500 kV Line	HSN	<100%	<100%	136%	136%	136%
		SSN	<100%	<100%	<100%	<100%	<100%

On-Peak Diablo-Midway #2, #3 and Morro Bay-Gates 500 kV line constraints (2/2)

Affected transmission zones		Northern California and Humboldt Bay Off-Shore Wind (Fern Road)				
		Base Portfolio	S1 Portfolio	S2 Portfolio		
				Option 1	Option 2	Option 3
Renewable portfolio MW behind the constraint		0	0	6,743 OSW	6,743 OSW	6,743 OSW
Energy storage portfolio MW behind the constraint		0	0	0	0	0
Deliverable Portfolio MW w/o mitigation		0	0	5,355	5,379	5,380
Total undeliverable baseline and portfolio resources, MW		0	0	1,388	1,364	1,363
Mitigation Options	RAS	Not Needed		N/A, N-0 Overload		
	Re-locate portfolio battery storage (MW)	Not Needed		N/A		
	Transmission upgrade including cost	Not Needed		• Diablo – Moss Landing HVDC • Diablo – South HVDC • Second Diablo – Gates 500 kV line		
Recommended Mitigation		Not Needed		TBD		

Potential Mitigations for Overload on Diablo-Midway #2 and #3 500 kV Lines and Morro Bay-Gates 500 kV Line

Three alternatives considered to address capacity issue to transfer offshore wind out of Diablo/Morro Bay area



Off-Peak Diablo-Midway #2, #3 and Morro Bay-Gates 500 kV line constraints (1/2)

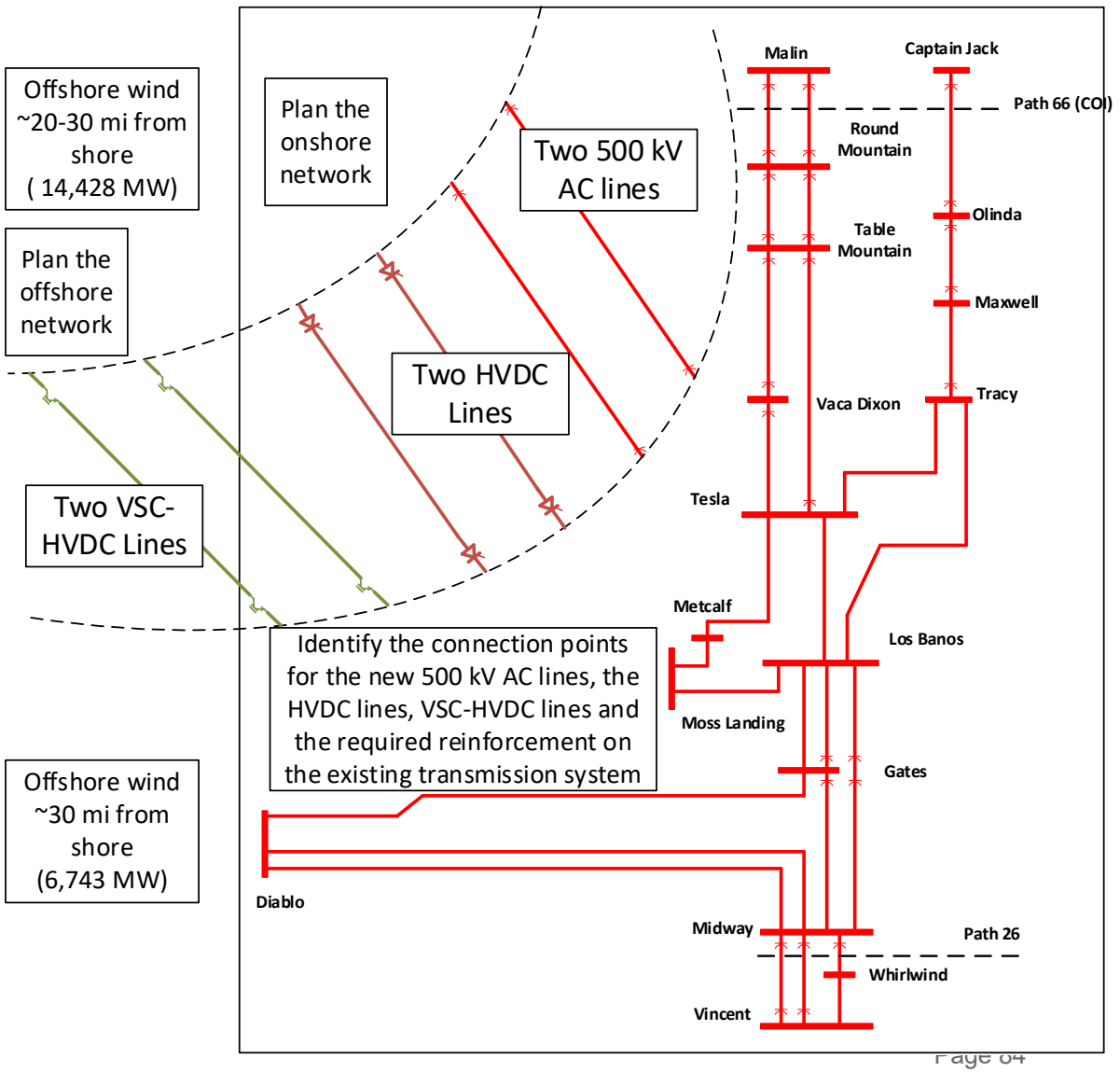
Overloaded Facility	Contingency	Loading				
		BASE	SENS-01	SENS-02		
				Option 1	Option 2	Option 3
Diablo-Midway 500 kV Lines	Base Case	<100%	<100%	106%	121%	121%
	Remaining Diablo-Midway 500 kV Line	<100%	<100%	109%	121%	121%
Morro Bay-Gates 500 kV Line	Base Case	<100%	<100%	127%	121%	121%
	Either Diablo-Midway 500 kV Line	<100%	<100%	131%	121%	121%

Off-Peak Diablo-Midway #2, #3 and Morro Bay-Gates 500 kV line constraints (2/2)

Affected transmission zones		Northern California and Humboldt Bay Off-Shore Wind (Fern Road)				
		Base Portfolio	S1 Portfolio	S2 Portfolio		
				Option 1	Option 2	Option 3
Renewable portfolio MW behind the constraint		0	0	6,743 OSW	6,743 OSW	6,743 OSW
Energy storage portfolio MW behind the constraint		0	0	0	0	0
Renewable MW curtailment		0	0	1,344 OSW	1,349 OSW	1,219 OSW
Portfolio energy storage MW re-dispatched in charging mode		0	0	0	0	0
Mitigation Options	RAS	Not Needed		N/A, N-0 Overload		
	Re-locate portfolio battery storage (MW)	Not Needed		N/A		
	Transmission upgrade including cost	Not Needed		• Same as on-peak		
Recommended Mitigation		Not Needed		TBD		

Outlook Assessment with 14.4 GW OSW in North Coast

- Considering the study results with 1.6 GW at Humboldt, further evaluations will be performed for interconnection of 14.4 GW of wind under outlook assessment.
- A review of possible technology options and configurations will be performed to integrate 14.4 GW of offshore wind in the north coast.



Agenda

- Policy-driven assessment context and objectives
- Portfolio descriptions and modeling
- Deliverability assessment methodology and results
- **Production cost simulation results**

  (To be presented separately with the Preliminary Production Cost Simulation Results)
- Summary of results and next steps

Agenda

- Policy-driven assessment context and objectives
- Portfolio descriptions and modeling
- Deliverability assessment methodology and results
- Production cost simulation results

  (To be presented separately with the Preliminary Production Cost Simulation Results)
- **Summary of results and next steps**

Summary of on-peak deliverability assessment results

- Remedial action schemes (RAS), reducing portfolio storage and transmission upgrades were considered to address constraints identified
- RAS was recommended as a mitigation for several deliverability constraints. Reducing portfolio battery storage was not found to be a viable mitigation for any of the constraints identified
- The table below summarizes the constraints for which transmission upgrades are found to be needed (other than purely for OSW in Sensitivity 2, which are summarized separately).
- Transmission upgrades found to be needed for the Base Portfolio will be recommended for approval, subject to further evaluation.

Summary of on-peak results – cont'd

Constraint	Contingency	Portfolio Resources Behind Constraint (MW)		Total Undeliverable MW	Recommended/Potential Mitigation	Portfolio for which Mitigation is Needed		
		Renewables (Base/Sens-	Battery Storage (Base/Sens-			Base	Sens-01	Sens-02
Mesa–Laguna Bell No.1 230 kV line	P7	0	500	3098/3048/2329	- Reconductor Laguna Bell-Mesa No. 1 230 kV line (SCE, $15M) or - Laguna Bell – Mesa Series Compensation (Smart Wires, $6.7M–$8M)	✓	✓	✓
Encina–San Luis Rey 230 kV line	P1/P7	809/1595/1595	720	1502/2496/2431	New Encina-San Luis Rey 230 kV line ($102M)		✓	✓
San Luis Rey-San Onofre 230 kV constraint	P7	809/1595/1595	720	1212/2082/2004	New San Luis Rey-San Onofre 230 kV line ($237M)		✓	✓
Delevan-Cortina 230kV line	P0/P1/P7	437	0	564/588/479-713	Reconductor Delevan-Cortina 230kV line ($41.4 M)	✓	✓	✓
Cayetano-North Dublin 230kV line	P7	102	5.4/0/0	260/299/0-422	Reconductor Cayetano-North Dublin 230kV line (42.4M) or new northern area 500 kV source	✓	✓	✓
Lone Tree-USWP-JRW-Cayetano 230kV line	P0/P1/P7	102	5.4/0/0	500/533/201-642	Reconductor Lone Tree-USWP-JRW-Cayetano 230kV line ($55.1M) or new northern area 500 kV source	✓	✓	✓
Las Positas-Newark 230kV line	P1/P7	102	5.4/0/0	510/476/116-638	Reconductor Las Positas-Newark 230kV line (47.7M) or new northern area 500 kV source	✓	✓	✓
Rio Oso-SPI Jct-Lincoln 115kV line	P7	152	152	396/403/368-615	Reconductor Rio Oso-SPI Jct-Lincoln 115kV line ($30.6M)	✓	✓	✓
Borden-Storey #2 230kV line	P1	733/733/0	0	44/181/0	Reconductor Borden-Storey #2 230kV line ($24.2M)	✓	✓	
Fulton 60kV lines	P7	0	0	40/40/0-38	Reconductor Fulton 60kV lines	✓	✓	✓*

* Not needed under interconnection Option 3 for Humboldt OSW wind

Summary of off-peak deliverability assessment results

- Remedial action schemes (RAS), dispatching portfolio battery storage in charging mode, adding new battery storage and transmission upgrades were considered as alternatives to address off-peak constraints identified
- RAS and dispatching portfolio battery storage mitigated several off-peak constraints. Adding new battery storage was not found to be a viable mitigation for any of the remaining constraints identified
- The table below summarizes the constraints for which transmission upgrades are found to be the preferred mitigation (transmission requirements for OSW in Sensitivity 2 are summarized separately).
- Transmission upgrades identified for the Base Portfolio in the off-peak assessment will be recommended for approval if they are found to be economic.
- The Off-Peak deliverability assessment identified worse overloads on the Eldorado-McCullough 500 kV tie-line with 1062 MW OOS wind at Eldorado (Base A) in the Base Portfolio compared with that injection at Palo Verde (Base B).

Summary of off-peak results – cont'd

Constraint	Contingency	Portfolio Resources Behind Constraint (MW)		Renewable Curtailment (MW) (Base/Sens-1/Sens-2)	Potential Mitigation	Portfolio for which Mitigation is Needed		
		Renewables (Base/Sens-1/Sens-2)	Battery Storage (Base/Sens-1/Sens-2)			**Base**	**Sens-01**	**Sens-02**
Midway–Whirlwind 500 kV line	P0	3952/4734/3952	3228/2854/2389	1593/2029/1622	• Re-rate the PG&E segment of the Midway–Whirlwind 500 kV line (~$0) or • Bypass series capacitor on the line (~$0)	✓	✓	✓
GLW/VEA area constraints	P0/P1	2024/624/624	248/136/136	1482/130/130	GLW Upgrades ($213M)	✓		
Weedpatch 70kV Area	P7	129/147/0	0/18/0	178/51/0	TBD	✓	✓	

Summary of OSW transmission assessment

- Three connection options for the 1607 MW Humboldt Bay OSW are evaluated:
  - Option 1: Two 500 kV AC lines to the planned Fern Road 500 kV substation
  - Option 2: VSC-HVDC subsea cables to a converter station in the Bay Area with 230 kV AC connections to Potrero, East Shore, and Los Esteros substations
  - Option 3: HVDC bi-pole line to a new Collinsville 500/230 kV substation that loops into the Vaca Dixon – Tesla 500 kV line and from Collinsville to Pittsburg two 230 kV AC lines
- The 2324 MW Morro Bay OSW is injected into a new 500 kV substation looping into the Diablo – Gates 500 kV line
- The 4419 MW Diablo OSW is injected into the existing Diablo 500 kV substation
- The following slides summarize the deliverability constraints associated with OSW along with the potential transmission upgrade alternatives considered.
- ISO is working with PG&E to develop OOM cost estimates for the connection facilities and the potential network upgrades

Summary of OSW on-peak & off-peak results

On- peak Constraint	Contingency	Portfolio Resources Behind Constraint (MW)		Total Undeliverable MW (Opt-1/Opt-2/Opt-3)	Potential Mitigation Option	Portfolio for which Mitigation is Needed		
		Renewables (Opt-1/Opt-2/Opt-3)	Battery Storage (Opt-1/Opt-2/Opt-3)			Option 1 (Fern Road 500 kV)	Option 2 (Subsea)	Option 3 (New Collinsville 500 kV
Fern Road-Table Mountain #1, #2 500 kV lines	P0/P1	2044/0/0	0	2305/0/0	Build a new 500 kV line from Fern Road to Tesla (Cost TBD)	✓		
Table Mountain-Vaca Dixon 500 kV line	P0							
Table Mountain-Rio Oso and Round Mountain-Cottonwood #3 230 kV lines	P1							
North Dublin-Vineyard 230 kV line	P7							
Diablo-Midway #2, #3 and Morro Bay-Gates 500 kV Line	P0/P1	6,743	0	1,388	• Diablo – Moss Landing HVDC **or** • Diablo – South HVDC **or** • Second Diablo – Gates 500 kV line Cost - TBD	✓	✓	✓

Off-peak Constraint	Contingency	Sen-2 Portfolio Resources Behind Constraint		Renewable Curtailment (MW) (Opt-1/Opt-2/Opt-3)	Potential Mitigation	Humbolt OSW Option		
		Renewables (MW) (Opt-1/Opt-2/Opt-3)	Battery Storage (MW) (Opt-1/Opt-2/Opt-3)			Option-1	Option-3	Option-3
Diablo-Midway #2, #3 and Morro Bay-Gates 500 kV Line	P0/P1	6,743	0	1,344	Same as on-peak	✓	✓	✓

Summary of production simulation results

(To be presented with the Preliminary Production Cost Simulation Results)

Next steps

- Refine preliminary assessment as needed
- Perform further evaluation of transmission alternatives to identify the preferred solution including using PCM as needed.
- Identify policy-driven transmission upgrades for approval by the ISO Board.
- Determine ranking of transmission alternatives for OSW
- Document the policy-driven assessment results and conclusions in the draft 2021-2022 Transmission Plan

Preliminary Economic Assessment Results

Yi Zhang

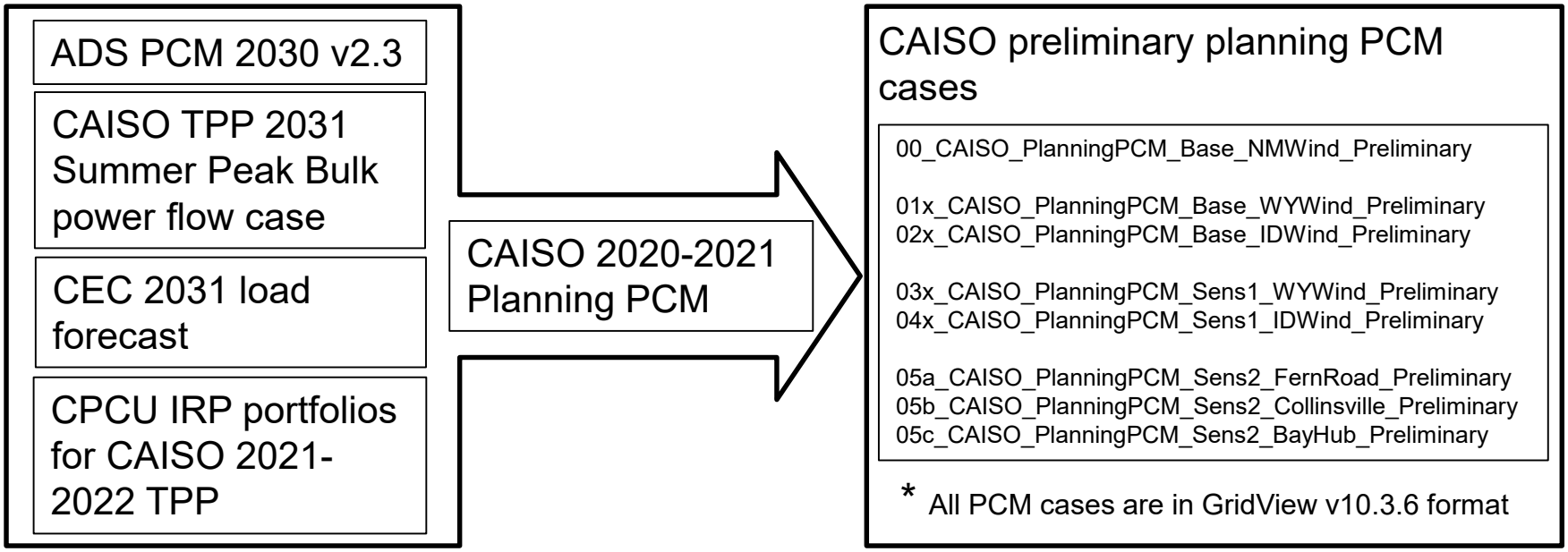
2021-2022 Transmission Planning Process Stakeholder Meeting
November 18, 2021

Outline of the presentation

- PCM development
- Base portfolio PCM preliminary results
- OOS wind study preliminary results
  - Base portfolio
  - Sensitivity 1 portfolio
- Sensitivity 2 portfolio (offshore wind) PCM preliminary results
- Economic study requests and preliminary high priority study areas

Planning PCM development

ISO Planning PCM Development



- The preliminary PCM cases will be posted after this stakeholder meeting
  - The cases are posted for database review purpose only, and must not be used to produce economic assessment results
- The preliminary PCM cases have the 5000 MW CAISO net export limit enforced

Description of the preliminary cases

Preliminary PCM case	Description
00_CAISO_PlanningPCM_Base_NMWind_Preliminary	Base portfolio, the 1062 MW of OOS wind using new transmission is NM wind modeled at the Pinal C 500 kV bus.
01a_CAISO_PlanningPCM_Base_WYWind_Preliminary_CrossTie	Base portfolio, the 1062 MW of OOS wind using new transmission is WY wind modeled at the Aeolus 500 kV bus (for CrossTie and SWIPN) or the TWE_WY 230 kV bus (for TWE).
01b_CAISO_PlanningPCM_Base_WYWind_Preliminary_SWIPN	
01c_CAISO_PlanningPCM_Base_WYWind_Preliminary_TWE	
02a_CAISO_PlanningPCM_Base_IDWind_Preliminary_CrossTie	Base portfolio, the 1062 MW of OOS wind using new transmisison is WY wind modeled at the Midpoint 500 kV bus in Idaho. This case is used as an alternative to the WY wind case in the ITP study
02b_CAISO_PlanningPCM_Base_IDWind_Preliminary_SWIPN	
02c_CAISO_PlanningPCM_Base_IDWind_Preliminary_TWE	
03a_CAISO_PlanningPCM_Sens1_WYWind_Preliminary_CrossTie	Sensitivity 1 portfolio, 1500 MW NM wind using new transmission at the Pinal C 500 kV bus, and 1500 MW WY wind using new transmission at the Aeouls 500 kV bus or the TWE_WY 230 kV bus (for TWE).
03b_CAISO_PlanningPCM_Sens1_WYWind_Preliminary_SWIPN	
03c_CAISO_PlanningPCM_Sens1_WYWind_Preliminary_TWE	
04a_CAISO_PlanningPCM_Sens1_IDWind_Preliminary_CrossTie	Sensitivity 1 portfolio, 1500 MW NM wind using new transmission at the Pinal C 500 kV bus, and 1500 MW WY wind using new transmission at the Midpoint 500 kV bus in Idaho. This case is used as an alternative to the WY wind case in the ITP study
04b_CAISO_PlanningPCM_Sens1_IDWind_Preliminary_SWIPN	
04c_CAISO_PlanningPCM_Sens1_IDWind_Preliminary_TWE	
05a_CAISO_PlanningPCM_Sens2_FernRoad_PTE_Preliminary	Sensitivity 2 portfolio, Humboldt Bay offshore wind modeled at the FernRoad 500 kV bus (close to Round Mountain), Morro Bay offshore wind modeled at the new proposed MorroBay_OSW 500 kV bus that loops in to the Gates-Diablo 500 kV line. The PTE project is modeled as transmission mitigation for Morro Bay and Diablo offshore wind.
05b_CAISO_PlanningPCM_Sens2_Collinsville_PTE_Preliminary	Sensitivity 2 portfolio, Humboldt Bay offshore wind modeled at the Collinsvile 500 kV bus (new proposed) Morro Bay offshore wind modeled at the new proposed MorroBay_OSW 500 kV bus that loops in to the Gates-Diablo 500 kV line. The PTE project is modeled as transmission mitigation for Morro Bay and Diablo offshore wind.
05c_CAISO_PlanningPCM_Sens2_BayHub_PTE_Preliminary	Sensitivity 2 portfolio, Humboldt Bay offshore wind modeled at the BayHub 230 kV bus (new proposed). Morro Bay offshore wind modeled at the new proposed MorroBay_OSW 500 kV bus that loops in to the Gates-Diablo 500 kV line. The PTE project is modeled as transmission mitigation for Morro Bay and Diablo offshore wind.

Base portfolio preliminary results – congestion and curtailment

Base portfolio PCM (NM wind case) congestion – summary

* Only listed congestions with congestion cost more than $0.5M

Index	Area or Branch Group	Congestion Cost ($M)	Congestion Duration (Hr)
1	Path 26 Corridor	125.17	3,413
2	SCE Lugo 500 kV Transformer	44.19	1,156
3	GridLiance/VEA	39.88	3,136
4	SCE NOL	22.25	1,689
5	COI Corridor	15.75	348
6	SCE LagunaBell-Mesa Cal 230 kV	14.41	450
7	PG&E Mosslanding-Las Aguilas 230 kV	12.83	242
8	Path 42 IID-SCE	8.72	320
9	Path 45	8.05	1,125
10	PDCI	6.40	648
11	Path 60 Inyo-Control 115 kV	6.11	1,807
12	Path 61/Lugo-Victorville	5.86	470
13	SCE RedBluff-Devers 500 kV	3.95	38
14	PG&E Fresno	3.89	465
15	PG&E Tesla 500 kV Transformer	3.61	20
16	PG&E Ripon-Manteca 115 kV	3.38	101
17	Path 15 Corridor	3.27	89
18	Path 15 Corridor - Panoche-Gates 230 kV	2.87	177
19	Path 46 WOR	2.56	51
20	SCE LCIENEGA-LA FRESA 230 kV	2.20	19
21	SCE Antelope 66 kV system	2.16	981
22	Path 25 PACW-PG&E 115 kV	1.80	202
23	SDGE-CFE OTAYMESA-TJI 230 kV	1.45	262
24	PG&E USWP JRW-Cayetano 230 kV	1.25	31
25	SDGE North	1.02	147
26	SCE J.HINDS-MIRAGE 230 kV	0.87	54
27	Path 41 Sylmar transformer	0.79	67
28	PG&E Delevn-Cortina 230 kV	0.66	14
29	SCE Tehachapi Windhub 500 kV Xfmr	0.64	337
30	SDGE N.Gila-Imperial Valley 500 kV	0.54	43

Base portfolio PCM (NM wind case) curtailment

Zone	Generation (GWh)	Curtailment (GWh	Ratio
SCE Tehachapi	32,620	2,392	7%
PG&E Fresno-Kern	12,383	2,216	15%
SCE Eastern	12,755	915	7%
NM	7,603	638	8%
SDGE IV	7,854	223	3%
VEA	3,765	1,934	34%
AZ	4,431	1,006	18%
PG&E Solano	5,235	58	1%
SCE EOL	4,570	432	9%
SCE NOL	3,697	863	19%
PG&E Carrizo	2,979	220	7%
PG&E N. CA	2,986	47	2%
NW	2,447	55	2%
SCE Vestal	1,181	97	8%
IID	753	29	4%
SCE Others	499	34	6%
SDGE San Diego	264	10	4%
PG&E Central	105	6	5%
PG&E Bay	52	4	6%
Total	**106,178**	**11,179**	**10%**

Base portfolio PCM congestion (NM wind) – SCE Path 26 corridor

Constraints Name	Costs_F (K$)	Duration_F	Costs_B (K$)	Duratio	Costs T (K$	Duration_T
MW_WRLWND_31-MW_WRLWND_32 500 kV line #3	0	0	66,330	1,790	66,330	1,790
P26 WECC Northern-Southern California	2	3	58,224	1,594	58,226	1,597
MW_WRLWND_32-WIRLWIND 500 kV line, subject to SCE N-1 Midway-Vincent #2 500kV	0	0	616	26	616	26

- Path 26 corridor congestion was observed mainly when the flow was in the south to north direction
- Path 26 corridor congestion is assessed in the OOS wind study as well

Base portfolio PCM congestion (NM wind) - GridLiance/VEA area

Constraint Name	Costs_F (K$)	Duration_F	Costs_B (K$)	Duratio	Costs T (K$)	Duration_T
TROUT CANYON-SLOAN CANYON 230 kV line #1	30,166	2,110	0	0	30,166	2,110
GAMEBIRD-TROUT CANYON 230 kV line #1	0	0	9,044	863	9,044	863
NWEST-DESERT VIEW 230 kV line #1	0	0	577	131	577	131
INNOVATION-DESERT VIEW 230 kV line #1	68	30	0	0	68	30
MEAD S-SLOAN CANYON 230 kV line #1	0	0	29	2	29	2

- Congestions in this area were mainly observed under normal condition and in the hours when solar generation was high

Base portfolio PCM congestion (NM wind) – COI corridor

Constraint Name	Costs_F (K$)	Duration_F	Costs_B (K$)	Duratio	Costs T (K$)	Duration_T
P66 WECC COI	11,689	253	0	0	11,689	253
TM_VD_11-TM_VD_12 500 kV line #1	2,728	35	0	0	2,728	35
RM_TM_11-RM_DRS 500 kV line #1	485	20	0	0	485	20
TABLE MT-TM_TS_11 500 kV line #1	360	18	0	0	360	18
TM_TS_11-TM_TS_12 500 kV line #1	203	8	0	0	203	8
RM_TM_21-RM_DRS 500 kV line #2	157	11	0	0	157	11
TM_TS_12-TESLA 500 kV line #1	129	3	0	0	129	3

- COI corridor congestion did not change significantly from the previous planning cycle
- Majority of COI corridor congestion is attributed to the Path 66 path rating binding in the north to south direction
- Downstream 500 kV lines may also be binding occasionally
- COI corridor congestion is assessed in the OOS wind study as well

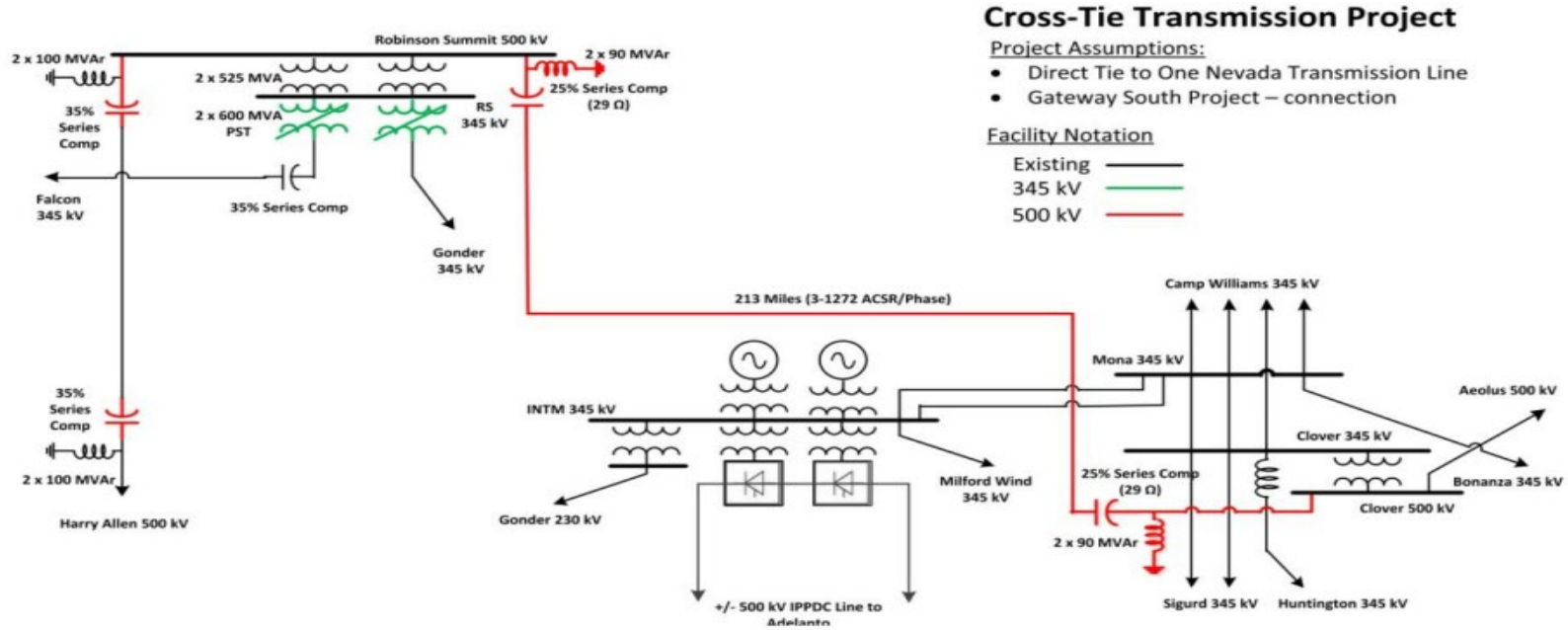
Base portfolio PCM congestion (NM wind) – other congestions require further assessment

Index	Area or Branch Group	Congestion Cost ($M)	Congestion Duration (Hr)	Note
6	SCE LagunaBell-Mesa Cal 230 kV	14.41	450	From Mesa Cal to LagunaBell, evaluated in policy study
7	PG&E Mosslanding-Las Aguilas 230 kV	12.83	242	From Las Aguilas to Mosslanding, a economic study request
14	PG&E Fresno	3.89	465	Several congestions on 115 kV or lower voltage lines
15	PG&E Tesla 500 kV Transformer	3.61	20	From 500 kV to 230 kV
16	PG&E Ripon-Manteca 115 kV	3.38	101	PG&E proposed reliability upgrade at this area
17	Path 15 Corridor	3.27	89	From south to north, correlated with Path 26 congestion. Panoche-Gates congestion is under contingency condition.
18	Path 15 Corridor - Panoche-Gates 230 kV	2.87	177	
32	PG&E Sierra	0.36	26	Included Path 24 congestion
42	SDGE DOUBLTTP-FRIARS 138 kV	0.09	13	Modeled the extended RAS in the model, evaluated in reliability and policy studies

- Some of these congestions may be mitigated or eliminated, as incorporating reliability and policy upgrades in the final PCM case
- PG&E Sierra congestion needs to be reevaluated in the final PCM, in coordination with ADS PCM process to review the Path 24 model
- PG&E Las Aguilas – Mosslanding congestion, Fresno area congestion, and Path 15 corridor congestions are correlated with Fresno area solar curtailment

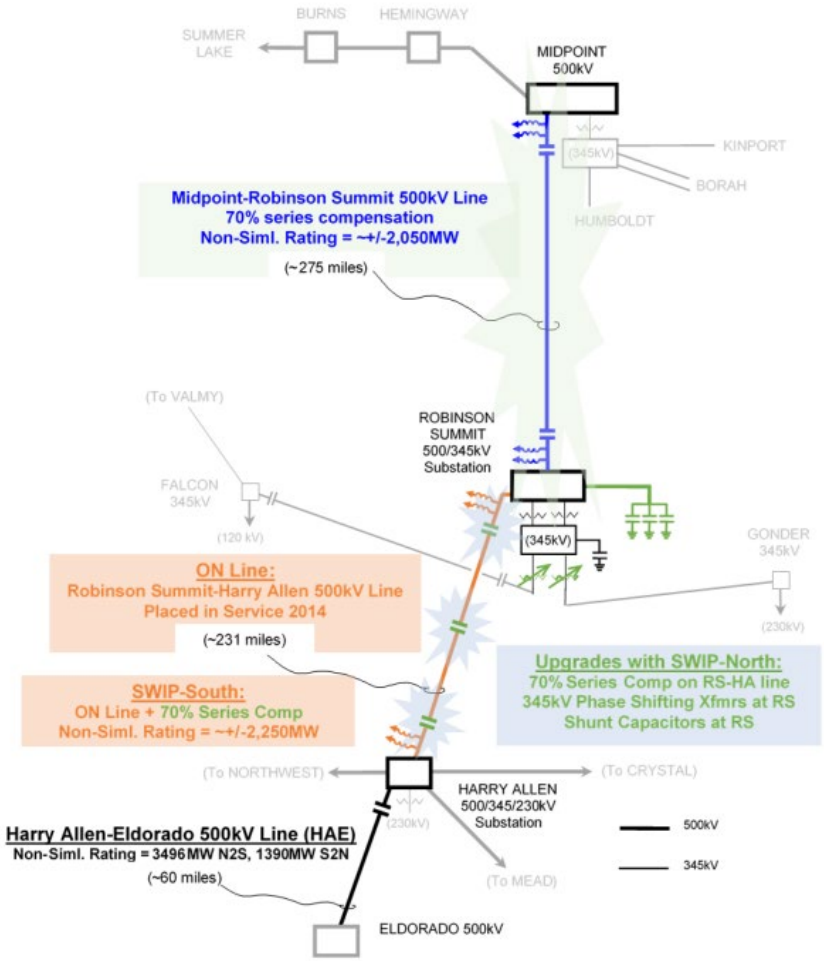
Out of state wind study – Base portfolio and Sensitivity 1 portfolio

Project overview – Cross-Tie



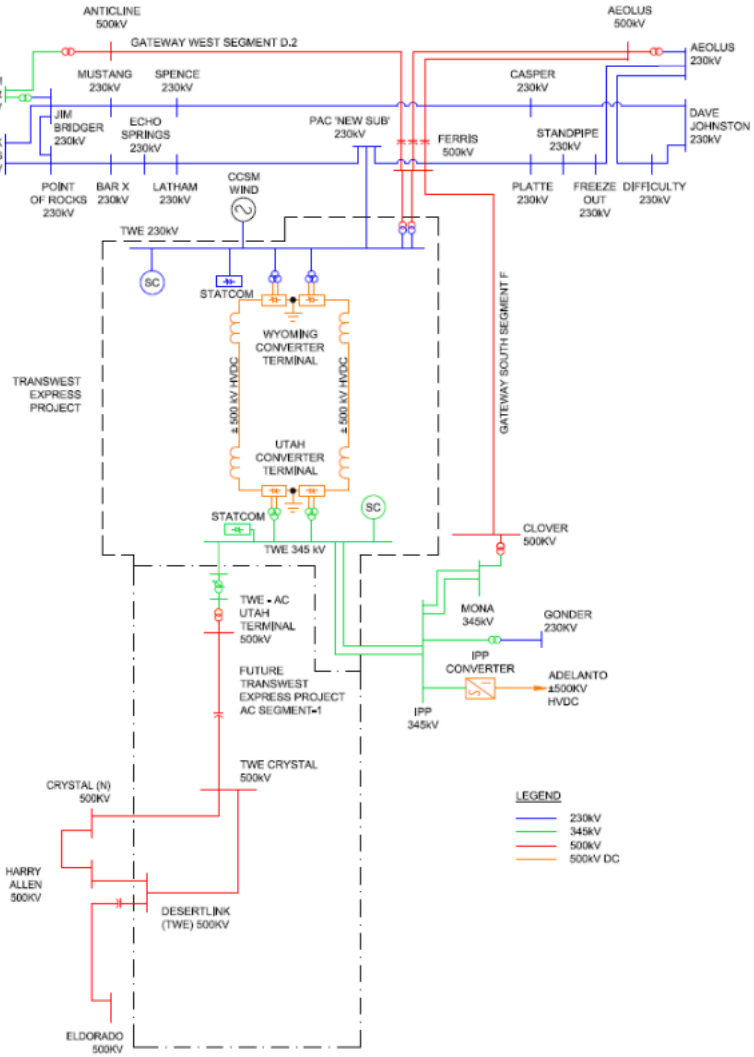
- The diagram was copied from the TransCanyon's 2020 ITP submittal
- TransCanyon modified the Robinson – Harry Allen (SWIP-South) configuration to a five-segment configuration with the same compensation ratio in its 2021 update
- TransCanyon indicated the SWIP-South path rating can be increased from the current 900 (N-S)/600 (S-N) MW to 2000/2000 MW
- Estimated cost: $667M (2015 dollar, based on 2020 ITP submission)

Project overview – SWIP North



- The diagram was copied from LS Power's economic study request in the 2021-2022 TPP cycle
- LS Power updated the impedances of the SWIP-North conductor and series capacitors
- SWIP-South path rating can be increased from 900 (N-S)/600 (S-N) MW to 2000/2000 MW
- About 1000 MW transmission right from Midpoint to Harry Allen available for the CAISO
- Estimated cost: $635M (2020 dollar, based on 2020 ITP submission)

Project overview – TransWest Express



- TransWest Express (TWE) submitted the TWE project to the 2020-2021 ITP, and updated the scope in September 2021
- TWE indicated that the TWE project would use subscriber model
- Three segments in the project
  1. Loop-in to the Gateway West and Gateway South 500 kV lines, and the Platte - Latham 230 kV line in Wyoming
  2. Bi-poles HVDC lines with 3000 MW capacity and a 345 kV connection to the LADPW's Intermountain 345 kV bus
  3. 500 kV connection between the TWE-IPP substation and the Crystal North and the Harry Allen – Eldorado 500 kV line, with PST at the TWE-IPP substation. The capacity of this segment is 1500 MW
- Estimated cost: Segments 1~2: $2.1B, Segment 4: $660M~$840M, based on the 2020 ITP submission

Study scenarios

Scenario	OOS Scenario	Alternative	OOS wind location	Transmission Upgrade	PST angle cost	PST initial angle	Note
0	00-Base-NM	00-Base-NM	NM - Pinal C 500 kV	N/A	N/A	N/A	Pinal C is the AZ terminal of the SunZia project
1	01-Base-WY	01-CrossTie-0cost	WY - Aeolus 500 kV	Cross-Tie	0	0	Robinson PST $0 cost allows the angle to move frequently in simulation
2	01-Base-WY	02-CrossTie-Neg48	WY - Aeolus 500 kV	Cross-Tie	100	-48	High cost restrict the angle movement in simulation; Negative angle pushes flow to the Robinson 500 kV direction
3	01-Base-WY	03-CrossTie-0deg	WY - Aeolus 500 kV	Cross-Tie	100	0	Similar to no PST
4	01-Base-WY	04-SWIPN-0cost	WY - Aeolus 500 kV	SWIP-N	0	0	Robinson PST $0 cost allows the angle to move frequently in simulation
5	01-Base-WY	05-SWIPN-Neg48	WY - Aeolus 500 kV	SWIP-N	100	-48	High cost restrict the angle movement in simulation; Negative angle pushes flow to the Robinson 500 kV direction
6	01-Base-WY	06-SWIPN-0deg	WY - Aeolus 500 kV	SWIP-N	100	0	Similar to no PST
7	01-Base-WY	07-TWE-IPPPST-0cost	WY - TWE 230 kV	TWE	0	0	TWE-IPP PST
8	01-Base-WY	08-TWE-IPPPST-Neg45	WY - TWE 230 kV	TWE	100	-45	Negative angle pushes flow to the TWE-IPP 500 kV direction
9	01-Base-WY	09-TWE-IPPPST-0deg	WY - TWE 230 kV	TWE	100	0	Similar to no PST
10	02-Base-ID	01-CrossTie-0cost	ID - Midpoint 500 kV	Cross-Tie	0	0	Robinson PST $0 cost allows the angle to move frequently in simulation
11	02-Base-ID	02-CrossTie-Neg48	ID - Midpoint 500 kV	Cross-Tie	100	-48	High cost restrict the angle movement in simulation; Negative angle pushes flow to the Robinson 500 kV direction
12	02-Base-ID	03-CrossTie-0deg	ID - Midpoint 500 kV	Cross-Tie	100	0	Similar to no PST
13	02-Base-ID	04-SWIPN-0cost	ID - Midpoint 500 kV	SWIP-N	0	0	Robinson PST $0 cost allows the angle to move frequently in simulation
14	02-Base-ID	05-SWIPN-Neg48	ID - Midpoint 500 kV	SWIP-N	100	-48	High cost restrict the angle movement in simulation; Negative angle pushes flow to the Robinson 500 kV direction
15	02-Base-ID	06-SWIPN-0deg	ID - Midpoint 500 kV	SWIP-N	100	0	Similar to no PST
16	02-Base-ID	07-TWE-IPPPST-0cost	ID - Midpoint 500 kV	TWE	0	0	TWE-IPP PST
17	02-Base-ID	08-TWE-IPPPST-Neg45	ID - Midpoint 500 kV	TWE	100	-45	Negative angle pushes flow to the TWE-IPP 500 kV direction
18	02-Base-ID	09-TWE-IPPPST-0deg	ID - Midpoint 500 kV	TWE	100	0	Similar to no PST

- Different phase shifter settings (Robinson PST for CrossTie and SWIP-N, IPP PST for TWE) were studied

Out of state wind model in PCM

- OOS wind generators in the planning PCM use the hourly profiles included in the ADS PCM
  - The profiles were originally provided by NREL, as a part of the ADS PCM development
- Selection of OOS wind profiles
  - Calculate average capacity factor of the wind profiles at locations close to the project terminals
  - Select the profiles with CF equal to or close to the average CF

OOS wind location	Average capacity factor of the hourly profiles at the location close to the project terminals	Capacity factor of OOS wind profile in planning PCM
NM	41.4%	41.5%
WY	41.9%	42.0%
ID	33.9%	33.8%

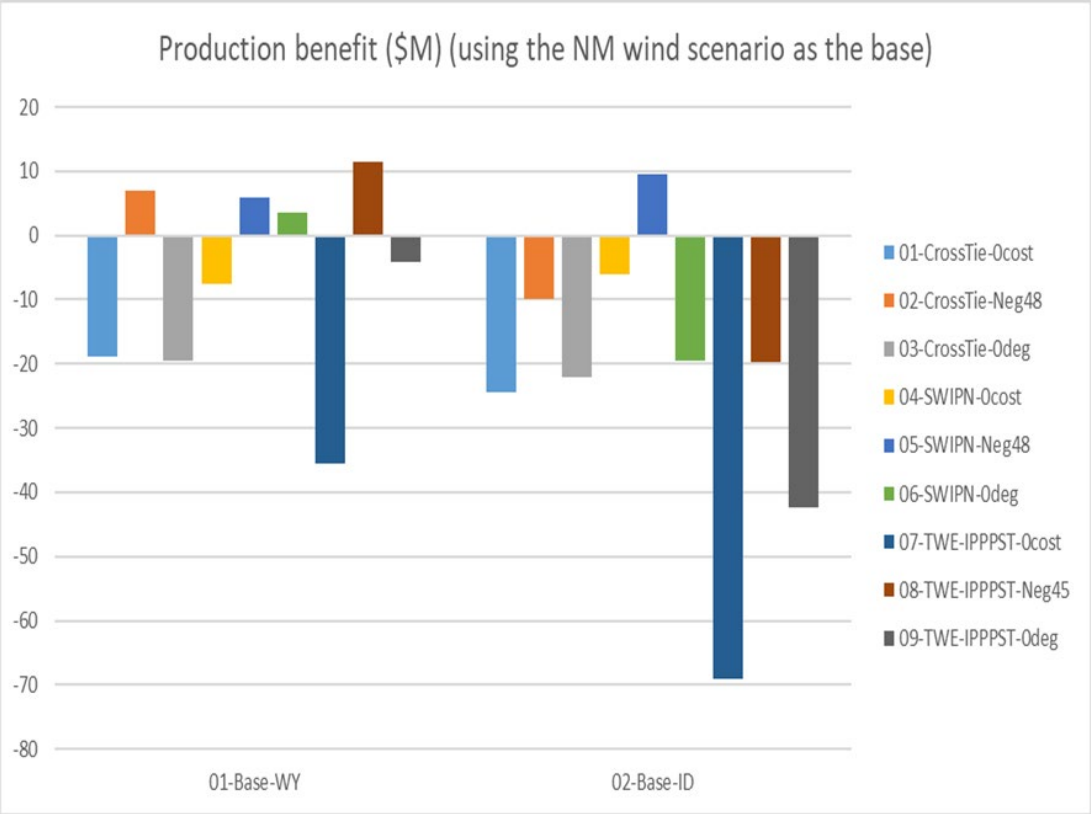
Base portfolio study – CAISO ratepayer production benefit ($M) of the alternative projects

- The NM wind scenario was used as the base for production benefit calculation in the Base portfolio studies
- Positive benefit means the WY or ID wind plus project upgrade can help to reduce the CAISO net payment, compared with the NM wind scenario
- PST settings impacted the results significantly

OOS Scenario	Alternative	LoadPayment	GenProfit	TransRevenue	NetPayment	Benefit
00-Base-NM	00-Base-NM	9,304	4,191	534	4,580	
01-Base-WY	01-CrossTie-0cost	9,349	4,212	539	4,598	-19
01-Base-WY	02-CrossTie-Neg48	9,314	4,184	557	4,573	7
01-Base-WY	03-CrossTie-0deg	9,363	4,223	541	4,599	-20
01-Base-WY	04-SWIPN-0cost	9,300	4,172	540	4,587	-8
01-Base-WY	05-SWIPN-Neg48	9,287	4,160	552	4,574	6
01-Base-WY	06-SWIPN-0deg	9,295	4,175	544	4,576	4
01-Base-WY	07-TWE-IPPPST-0cost	9,305	4,182	508	4,615	-35
01-Base-WY	08-TWE-IPPPST-Neg45	9,259	4,136	555	4,568	12
01-Base-WY	09-TWE-IPPPST-0deg	9,269	4,162	523	4,584	-4
02-Base-ID	01-CrossTie-0cost	9,374	4,233	538	4,604	-24
02-Base-ID	02-CrossTie-Neg48	9,374	4,227	558	4,590	-10
02-Base-ID	03-CrossTie-0deg	9,378	4,236	541	4,602	-22
02-Base-ID	04-SWIPN-0cost	9,330	4,208	536	4,586	-6
02-Base-ID	05-SWIPN-Neg48	9,331	4,203	558	4,570	9
02-Base-ID	06-SWIPN-0deg	9,366	4,227	541	4,599	-19
02-Base-ID	07-TWE-IPPPST-0cost	9,374	4,217	509	4,649	-69
02-Base-ID	08-TWE-IPPPST-Neg45	9,357	4,203	555	4,599	-20
02-Base-ID	09-TWE-IPPPST-0deg	9,359	4,215	522	4,622	-42

Base portfolio study – CAISO ratepayer production benefit ($M) of alternative projects (cont.)

- In general, the Wyoming wind scenario showed better production benefit than the Idaho wind scenario for the same transmission project and PST setup
  - Partially because the WY wind has better capacity factor than the ID wind in the PCM cases



Base portfolio study – COI and Path 26 congestion

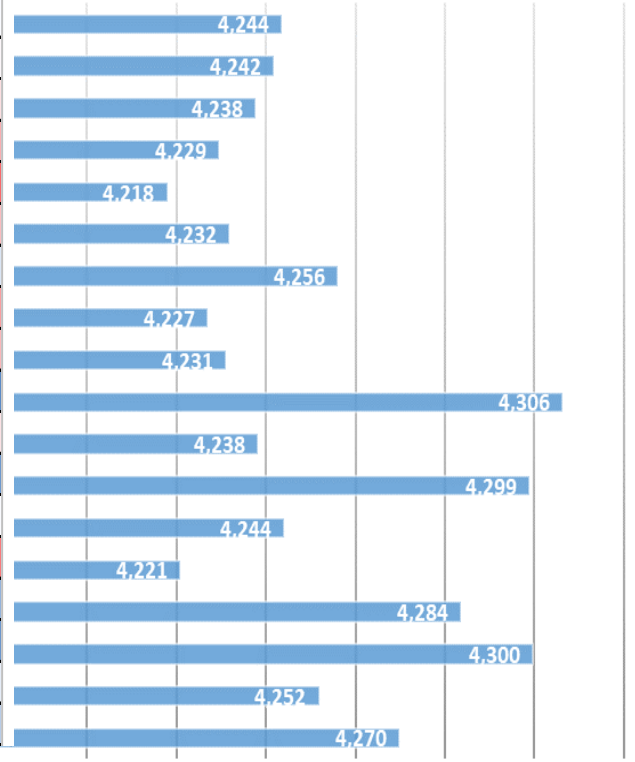
- This table only showed the congestions due to the path rating binding
  - Some 500 kV lines in these corridors were congested as well
- Depending on the PST setting in the PCM, COI and Path 26 congestions may increase or decrease, and normally in opposite directions

OOS Scenario	Alternative	Congestion Cost COI ($M)	Congestion Hour COI	Congestion Cost Path26 ($M)	Congestion Hour Path26
Base-NM	Base-NM	11.69	253	58.23	1,597
01-Base-WY	01-CrossTie-0cost	17.58	306	57.56	1,622
01-Base-WY	02-CrossTie-Neg48	9.42	170	69.07	1,918
01-Base-WY	03-CrossTie-0deg	12.63	224	60.53	1,701
01-Base-WY	04-SWIPN-0cost	16.64	285	55.39	1,554
01-Base-WY	05-SWIPN-Neg48	9.55	154	63.83	1,719
01-Base-WY	06-SWIPN-0deg	12.50	207	56.61	1,583
01-Base-WY	07-TWE-IPPPST-0cost	15.84	293	44.40	1,295
01-Base-WY	08-TWE-IPPPST-Neg45	6.19	118	71.52	2,116
01-Base-WY	09-TWE-IPPPST-0deg	14.31	248	50.68	1,505
02-Base-ID	01-CrossTie-0cost	16.52	283	56.21	1,632
02-Base-ID	02-CrossTie-Neg48	10.75	182	70.71	1,974
02-Base-ID	03-CrossTie-0deg	12.91	215	59.64	1,692
02-Base-ID	04-SWIPN-0cost	15.97	262	53.82	1,484
02-Base-ID	05-SWIPN-Neg48	9.50	153	63.41	1,674
02-Base-ID	06-SWIPN-0deg	13.56	236	57.30	1,516
02-Base-ID	07-TWE-IPPPST-0cost	15.32	288	42.94	1,285
02-Base-ID	08-TWE-IPPPST-Neg45	7.67	130	66.72	2,043
02-Base-ID	09-TWE-IPPPST-0deg	15.20	284	48.43	1,460

- Some elements of the alternative project upgrades may be congested, which can contribute to ratepayer benefit if the CAISO owned the transmission right
- Other congestions on the CAISO internal transmission system were also impacted by the alternative project upgrades and OOS wind

Sensitivity 1 portfolio study – CAISO net payment ($M) with alternative projects modeled

OOS Scenario	Alternative	LoadPaym	GenProf	TransReve	NetPaym
03-Sens1-WY	01-CrossTie-0cost	9,188	4,450	495	4,244
03-Sens1-WY	02-CrossTie-Neg48	9,250	4,496	512	4,242
03-Sens1-WY	03-CrossTie-0deg	9,188	4,453	498	4,238
03-Sens1-WY	04-SWIPN-0cost	9,141	4,406	505	4,229
03-Sens1-WY	05-SWIPN-Neg48	9,139	4,399	522	4,218
03-Sens1-WY	06-SWIPN-0deg	9,137	4,398	508	4,232
03-Sens1-WY	07-TWE-IPPPST-0cost	9,160	4,426	478	4,256
03-Sens1-WY	08-TWE-IPPPST-Neg45	9,124	4,395	502	4,227
03-Sens1-WY	09-TWE-IPPPST-0deg	9,143	4,422	490	4,231
04-Sens1-ID	01-CrossTie-0cost	9,380	4,575	498	4,306
04-Sens1-ID	02-CrossTie-Neg48	9,245	4,492	515	4,238
04-Sens1-ID	03-CrossTie-0deg	9,380	4,579	502	4,299
04-Sens1-ID	04-SWIPN-0cost	9,230	4,488	498	4,244
04-Sens1-ID	05-SWIPN-Neg48	9,214	4,470	523	4,221
04-Sens1-ID	06-SWIPN-0deg	9,335	4,547	504	4,284
04-Sens1-ID	07-TWE-IPPPST-0cost	9,263	4,489	475	4,300
04-Sens1-ID	08-TWE-IPPPST-Neg45	9,237	4,487	499	4,252
04-Sens1-ID	09-TWE-IPPPST-0deg	9,248	4,495	483	4,270



- Did not calculate ratepayer's benefit in the Sensitivity 1 portfolio study, since there was not a "pre" case. The net payments were compared among all alternatives

Sensitivity 1 portfolio study – COI and Path 26 congestion

OOS Scenario	Alternative	Congestion Cost COI ($M)	Congestion Hour COI	Congestion Cost Path26 ($M)	Congestion Hour Path26
03-Sens1-WY	01-CrossTie-0cost	16.35	324	36.06	1,276
03-Sens1-WY	02-CrossTie-Neg48	9.82	196	43.27	1,492
03-Sens1-WY	03-CrossTie-0deg	13.36	247	38.29	1,335
03-Sens1-WY	04-SWIPN-0cost	19.18	312	37.64	1,305
03-Sens1-WY	05-SWIPN-Neg48	9.47	160	44.09	1,421
03-Sens1-WY	06-SWIPN-0deg	12.72	213	39.88	1,360
03-Sens1-WY	07-TWE-IPPPST-0cost	13.73	274	29.38	1,079
03-Sens1-WY	08-TWE-IPPPST-Neg45	5.48	129	50.37	1,804
03-Sens1-WY	09-TWE-IPPPST-0deg	13.58	266	33.90	1,250
04-Sens1-ID	01-CrossTie-0cost	13.92	269	34.13	1,207
04-Sens1-ID	02-CrossTie-Neg48	10.64	194	43.62	1,440
04-Sens1-ID	03-CrossTie-0deg	13.45	249	37.33	1,285
04-Sens1-ID	04-SWIPN-0cost	13.12	227	35.28	1,207
04-Sens1-ID	05-SWIPN-Neg48	9.48	153	43.63	1,404
04-Sens1-ID	06-SWIPN-0deg	12.03	212	37.02	1,237
04-Sens1-ID	07-TWE-IPPPST-0cost	13.94	274	27.28	1,027
04-Sens1-ID	08-TWE-IPPPST-Neg45	8.63	162	45.09	1,628
04-Sens1-ID	09-TWE-IPPPST-0deg	13.73	268	30.50	1,143

- Only showed congestion due to path rating binding
- The pattern of the congestion change in the Sensitivity 1 portfolio PCM is similar to the Base portfolio PCM

Further observations and discussions for the OOS wind studies

- OOS wind scenarios (WY or ID) have large impact on the results
  - Further clarity of OOS wind assumption would be needed
- Operation of the phase shifters of the alternative projects has large impact on results as well
- Congestion on the alternative project elements impacts the economic benefit calculation depending on the transmission right arrangement
  - 1000 MW of transmission right to the CAISO was considered in the SWIP-N benefit calculation

Sensitivity 2 portfolio preliminary results – congestion and curtailment

Sensitivity 2 portfolio PCM preliminary results – overview of the offshore wind model in PCM

- Assumed the capacity of the offshore wind generators in the CPUC Sensitivity 2 portfolio is the capacity at their injection points
- Used the offshore wind hourly profiles provided by NREL
  - Profiles of the year of 2009 were used, consistent with the ADS PCM

OSW	Humboldt	Diablo	Morro Bay
Capacity (MW)	1,607	4,419	2,324
Capacity factor of profile	53.09%	58.59%	55.54%

Sensitivity 2 portfolio PCM preliminary results – offshore wind injection and transmission assumptions

- Three Humboldt OSW injection and transmission alternatives

	Injection	Transmission upgrade
1	Fern Road 500 kV bus	Fern Road – Table Mtn – Vaca Dixon 500 kV line
2	Collinsville 500 kV bus	Collinsville 500 kV loops in the Tesla – Vaca Dixon 500 kV line, and two Collinsville-Pittsburg 230 kV lines
3	Bay Hub 230 kV bus	Bay Hub - Potrero, Bay Hub - E. Shore, and Bay Hub - Los Esteros 230 kV lines

- Morro Bay OSW injects at the new proposed MorroBay_OSW 500 kV bus looping in to the Gates-Diablo 500 kV line
- Diablo OSW injects at the Diablo 500 kV bus
- Two transmission alternatives for the Morro Bay and Diablo OSW:
  - New HVDC line from the Diablo 500 kV to Southern California
  - New HVDC line from the MorroBay_OSW 500 kV bus to the Mosslanding 500 kV bus
- These assumptions are the same as in the Policy deliverability study, except the PCM used the PTE project model for the alternative of the HVDC line from Diablo to southern CA alternative

Sensitivity 2 portfolio PCM preliminary results – High level observations in all studied scenarios

- Table Mountain 500/230 kV transformer was congested when the flow was from 230 kV to 500 kV, and the COI flow was from south to north
  - Mainly happened in Spring
  - A possible mitigation is to add the second transformer at Table Mountain
  - PG&E Sierra congestion is related to the Table Mt. congestion
- OSW injected at the PG&E buses helped to reduce the Path 26 and COI congestions
- The Diablo and Morro Bay OSW contribute to the Path 15 congestion
- Humboldt OSW contributes to the Vaca Dixon-Tesla 500 kV congestion
- Curtailment of OSW was observed in all studied scenarios
  - Curtailment ratio was less than 10%

Sensitivity 2 portfolio PCM preliminary results – Humboldt OSW at Fern Road - congestion

- The Humboldt OSW was modeled at Fern Road
- Two transmission alternative for the Morro Bay and Diablo OSW
  - The PTE project
  - The MorroBay_OSW – Mosslanding HVDC line
- The PCM with the PTE alternative has higher Table Mt and Tesla transformer congestions, which are correlated with the higher Path 15 congestion as the flow is in the south to north direction
- The PTE project can help to reduce the Path 26 and Vaca Dixon-Tesla congestions

Area or Branch	Congestion cost ($M) Sens2: FernRoad-PTE	Congestion cost ($M) Sens2: FernRoad-MorroBayDC	Congestion cost change ($M)
PG&E Table Mt 500/230 kV transformer	978.64	950.27	-28.37
PG&E Gates-MorroBay_OSW 500 kV	173.37	17.73	-155.65
Path 15 Corridor	118.27	26.89	-91.38
PG&E VacaDixon-TESLA 500 kV	54.63	103.24	48.60
PG&E Sierra	31.85	29.24	-2.60
Path 26 Corridor	25.52	66.97	41.45
PG&E Tesla 500/230 kV Transformer	19.01	14.48	-4.53
PG&E Eight Mile-Tesla 230 kV	16.64	22.80	6.16
SCE LagunaBell-Mesa Cal 230 kV	7.85	43.98	36.13
COI Corridor	7.02	5.49	-1.53
PG&E Fresno	7.02	7.58	0.56
PG&E Ripon-Manteca 115 kV	6.34	7.27	0.93
PG&E Mosslanding-Las Aguilas 230 kV	5.55	0.77	-4.77
PDCI	4.83	5.83	1.01
Path 15 Corridor - Panoche-Gates 230 kV	4.09	1.49	-2.60
SCE RedBluff-Devers 500 kV	4.01	3.15	-0.86
PG&E North Valley	2.00	3.29	1.29
SCE Pardee-S.Clara 230 kV	1.80	0.03	-1.77
SCE LCIENEGA-LA FRESA 230 kV	1.61	2.90	1.29
SCE Vincent 500 kV Transfomer	0.03	1.41	1.38
PG&E Tesla-Los Banos 500 kV	0.02	4.45	4.43
PG&E MorroBay_OSW-Diablo 500 kV	0.01	0.56	0.55
PG&E Diablo-Midway 500 kV	0.00	11.58	11.58

Sensitivity 2 portfolio PCM preliminary results – Humboldt OSW at Fern Road - curtailment

	Sens2 - Humboldt OSW at Fern Road; PTE			Sens2 - Humboldt OSW at Fern Road; MorroBay DC		
Zone	Generation (GWh)	Curtailment (GWh)	Ratio	Generation (GWh)	Curtailment (GWh)	Ratio
SCE Tehachapi	30,433	4,578	13%	30,518	4,494	13%
OSW_Diablo	19,036	1,551	8%	18,864	1,723	8%
SCE Eastern	11,671	1,328	10%	11,833	1,167	9%
PG&E Fresno-Kern	9,205	2,471	21%	9,155	2,520	22%
OSW_MorroBay	10,436	936	8%	10,421	951	8%
NM	9,345	1,355	13%	9,309	1,392	13%
SDGE IV	9,042	512	5%	9,112	441	5%
OSW_Humboldt	7,972	241	3%	7,940	274	3%
NW	5,435	335	6%	5,427	343	6%
WY	4,863	655	12%	4,845	673	12%
PG&E Solano	5,109	184	3%	5,092	201	4%
AZ	3,541	1,503	30%	3,487	1,557	31%
SCE EOL	4,094	514	11%	4,166	442	10%
SCE NOL	3,515	1,045	23%	3,555	1,005	22%
PG&E Carrizo	2,573	488	16%	2,563	498	16%
PG&E N. CA	2,879	154	5%	2,866	167	5%
VEA	1,275	39	3%	1,281	34	3%
SCE Vestal	1,088	189	15%	1,096	182	14%
IID	721	61	8%	737	45	6%
SCE Others	464	70	13%	469	64	12%
SDGE San Diego	257	17	6%	258	15	6%
PG&E Central	91	20	18%	90	21	19%
PG&E Bay	46	10	17%	46	10	18%
Total	**143,091**	**18,256**	**11%**	**143,130**	**18,217**	**11%**

Sensitivity 2 portfolio PCM preliminary results – Humboldt OSW at Bay Hub - congestion

- Compared with the scenario with Humboldt OSW at Fern Road, injecting Humboldt OSW at Bay Hub helped to mitigate the Vaca Dixon – Tesla congestion, and the Tesla transformer congestion
- Between the PTE and MorroBay_OSW – Mosslanding HVDC alternatives, the PTE alternative resulted in higher Table Mt. and Path 15 congestions, and lower Path 26 congestion

Area or Branch	Congestion cost ($M) Sens2: Collinsville-PTE	Congestion cost ($M) Sens2: Collinsvile-MorroBayDC	Congestion cost change ($M)
PG&E Table Mt 500/230 kV transformer	940.36	894.28	-46.08
PG&E Gates-MorroBay_OSW 500 kV	169.25	17.81	-151.44
Path 15 Corridor	125.18	52.16	-73.02
PG&E Sierra	28.81	26.19	-2.61
Path 26 Corridor	27.65	70.23	42.58
PG&E Eight Mile-Tesla 230 kV	18.01	30.31	12.30
COI Corridor	10.33	9.61	-0.73
SCE LagunaBell-Mesa Cal 230 kV	7.82	44.48	36.66
PG&E VacaDixon-TESLA 500 kV	7.00	17.45	10.45
PG&E Fresno	6.88	7.68	0.80
PDCI	6.73	8.47	1.74
PG&E Ripon-Manteca 115 kV	6.18	6.82	0.64
Path 15 Corridor - Panoche-Gates 230 kV	3.88	1.40	-2.48
PG&E Mosslanding-Las Aguilas 230 kV	3.60	0.46	-3.14
SCE Pardee-S.Clara 230 kV	1.89	0.06	-1.83
SCE LCIENEGA-LA FRESA 230 kV	1.66	4.01	2.35
PG&E Tesla-Los Banos 500 kV	0.02	5.28	5.26
PG&E MorroBay_OSW-Diablo 500 kV	0.00	0.55	0.55
PG&E Diablo-Midway 500 kV	0.00	11.89	11.89

Sensitivity 2 portfolio PCM preliminary results – Humboldt OSW at Bay Hub - curtailment

	Sens2 - Humboldt OSW at Bay Hub; PTE			Sens2 - Humboldt OSW at Bay Hub; MorroBay DC		
Zone	Generation (GWh)	Curtailment (GWh)	Ratio	Generation (GWh)	Curtailment (GWh)	Ratio
SCE Tehachapi	30,413	4,599	13%	30,442	4,569	13%
OSW_Diablo	18,990	1,596	8%	18,832	1,755	9%
SCE Eastern	11,744	1,256	10%	11,908	1,091	8%
PG&E Fresno-Kern	9,189	2,486	21%	9,143	2,533	22%
OSW_MorroBay	10,414	958	8%	10,402	970	9%
NM	9,385	1,315	12%	9,366	1,335	12%
SDGE IV	9,066	487	5%	9,134	419	4%
OSW_Humboldt	7,634	580	7%	7,606	608	7%
NW	5,461	309	5%	5,443	327	6%
WY	4,912	606	11%	4,899	620	11%
PG&E Solano	5,115	178	3%	5,097	196	4%
AZ	3,582	1,462	29%	3,536	1,508	30%
SCE EOL	4,123	485	11%	4,204	405	9%
SCE NOL	3,526	1,034	23%	3,563	997	22%
PG&E Carrizo	2,571	490	16%	2,562	498	16%
PG&E N. CA	2,888	145	5%	2,876	157	5%
VEA	1,275	39	3%	1,281	33	3%
SCE Vestal	1,089	188	15%	1,094	184	14%
IID	731	51	6%	748	34	4%
SCE Others	466	67	13%	470	63	12%
SDGE San Diego	257	17	6%	259	15	5%
PG&E Central	91	20	18%	90	22	20%
PG&E Bay	46	10	17%	46	10	18%
Total	**142,968**	**18,379**	**11%**	**143,000**	**18,347**	**11%**

Sensitivity 2 portfolio PCM preliminary results – Humboldt OSW at Collinsville - congestion

- Injecting Humboldt OSW at Collinsville had similar impact on transmission congestion as the Bay Hub alternative, although the Collinsville alternative is not as effective in mitigating the VacaDixon - Tesla 500 kV congestion

Area or Branch	Congestion cost ($M) Sens2: Collinsville-PTE	Congestion cost ($M) Sens2: Collinsvile-MorroBayDC	Congestion cost change ($M)
PG&E Table Mt 500/230 kV transformer	940.36	894.28	-46.08
PG&E Gates-MorroBay_OSW 500 kV	169.25	17.81	-151.44
Path 15 Corridor	125.18	52.16	-73.02
PG&E Sierra	28.81	26.19	-2.61
Path 26 Corridor	27.65	70.23	42.58
PG&E Eight Mile-Tesla 230 kV	18.01	30.31	12.30
COI Corridor	10.33	9.61	-0.73
SCE LagunaBell-Mesa Cal 230 kV	7.82	44.48	36.66
PG&E VacaDixon-TESLA 500 kV	7.00	17.45	10.45
PG&E Fresno	6.88	7.68	0.80
PDCI	6.73	8.47	1.74
PG&E Ripon-Manteca 115 kV	6.18	6.82	0.64
Path 15 Corridor - Panoche-Gates 230 kV	3.88	1.40	-2.48
PG&E Mosslanding-Las Aguilass 230 kV	3.60	0.46	-3.14
SCE Pardee-S.Clara 230 kV	1.89	0.06	-1.83
SCE LCIENEGA-LA FRESA 230 kV	1.66	4.01	2.35
PG&E Tesla-Los Banos 500 kV	0.02	5.28	5.26
PG&E MorroBay_OSW-Diablo 500 kV	0.00	0.55	0.55
PG&E Diablo-Midway 500 kV	0.00	11.89	11.89

Sensitivity 2 portfolio PCM preliminary results – Humboldt OSW at Collinsville - curtailment

	Sens2 - Humboldt OSW at Collinsville; PTE			Sens2 - Humboldt OSW at Collinsville; MorroBay DC		
Zone	Generation (GWh)	Curtailment (GWh)	Ratio	Generation (GWh)	Curtailment (GWh)	Ratio
SCE Tehachapi	30,369	4,643	13%	30,403	4,608	13%
OSW_Diablo	18,976	1,611	8%	18,827	1,760	9%
SCE Eastern	11,746	1,254	10%	11,875	1,125	9%
PG&E Fresno-Kern	9,181	2,495	21%	9,156	2,519	22%
OSW_MorroBay	10,400	972	9%	10,395	977	9%
NM	9,372	1,329	12%	9,362	1,338	13%
SDGE IV	9,067	486	5%	9,116	437	5%
OSW_Humboldt	7,789	424	5%	7,792	422	5%
NW	5,464	306	5%	5,428	342	6%
WY	4,904	615	11%	4,883	635	12%
PG&E Solano	5,110	183	3%	5,095	198	4%
AZ	3,564	1,480	29%	3,535	1,509	30%
SCE EOL	4,128	481	10%	4,193	416	9%
SCE NOL	3,525	1,035	23%	3,557	1,003	22%
PG&E Carrizo	2,569	492	16%	2,561	499	16%
PG&E N. CA	2,883	151	5%	2,872	161	5%
VEA	1,276	38	3%	1,283	31	2%
SCE Vestal	1,087	190	15%	1,091	186	15%
IID	733	49	6%	743	39	5%
SCE Others	465	68	13%	469	64	12%
SDGE San Diego	257	16	6%	258	15	6%
PG&E Central	91	21	18%	90	22	19%
PG&E Bay	46	10	17%	46	10	18%
Total	**143,000**	**18,346**	**11%**	**143,030**	**18,317**	**11%**

Sensitivity 2 portfolio PCM preliminary results – additional observations and discussions

- Transmission upgrades impact OSW curtailment
  - The Fern Road alternative has the least Humboldt OSW curtailment among the three Humboldt OSW alternatives
  - The PTE alternative has less Morro Bay and Diablo OSW curtailment than the MorroBay_OSW - Mosslanding HVDC alternative
- The offshore wind at Morro Bay and Diablo resulted in congestion on the 500 kV lines coming out of the Diablo 500 kV bus
- The PTE project helped to reduce the Path 26 congestion, but aggravated the Table Mt. and Tesla transformers congetions and the Path 15 congestions, compared with the MorroBay_OSW – Mosslanding HVDC alternative
- Offshore wind generators also impact congestions at different local areas depending on the OSW injection point and transmission alternatives

Next Steps

Economic planning study requests received

No.	Study Request	Submitted By	Location
1	Moss Landing – Las Aguilas 230 kV line congestion mitigation	Vistra	Northern CA
2	SWIP-North	LS Power	Idaho/Nevada
3	GLW Upgrade Project	GridLiance West	Southern Nevada
4	Pacific Transmission Expansion Project	Western Grid Development	Northern/Southern CA

- GridLiance West updated the scope for the GLW Upgrade Project

Preliminary list of high priority study areas to receive detailed consideration

- Preliminary high priority study areas were proposed based on the preliminary production cost simulation results for the base portfolio and the economic study requests:
  - PG&E Fresno area and Path 15 corridor congestions
    - Include Mosslanding - Las Aguilas and Gates - Panoche congestions
  - Path 26 corridor congestion
  - GridLiance/VEA area congestions
- The list may change with considering stakeholder comments and detailed planning study results

Next steps of simulation and economic assessment

- Continue to develop the CAISO Planning PCM
- Conduct production cost simulations using updated PCM for the Base and Sensitivity portfolios
- Conduct economic assessment for identified high priority upgrades or studies
- Update the OOS wind study results
- Update the Sensitivity 2 portfolio and offshore wind study results
  - May study additional transmission alternatives based on the policy deliverability study results
- Provide update in the next TPP Stakeholder Meeting

2021-2022 Transmission Planning Process
PG&E Area
Less than $50 Million Project Approvals and Project for Concurrence

2021-2022 Transmission Planning Process Stakeholder Meeting

November 18, 2021

Contra Costa 230 kV Line Terminals Reconfiguration (Greater Bay Area)

- Reliability Assessment Need
  - NERC Category P2 starting 2023.
- Project Submitter
  - PG&E
- Project Scope
  - Swap Lone Tree – Contra Costa PP 230 kV line and Birds Landing – Contra Costa PP 230 kV line terminal positions at Contra Costa PP 230 kV Substation and relocate Windmaster from Section F to Section E.
- Project Cost
  - $5M - $10M
- Alternatives Considered
  - Status quo, which is not acceptable due to identified reliability issues.
  - Converting to BAAH not recommended due to the space limitation high cost.
  - Add sectionalizing breaker not recommended as the fourth section would be beyond PG&E's standard.
- Recommendation
  - Approval

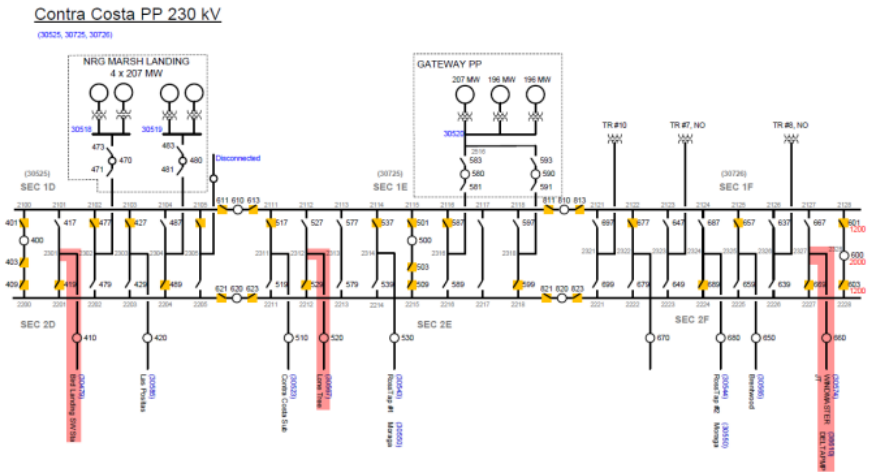


Figure 3: Existing System Diagram

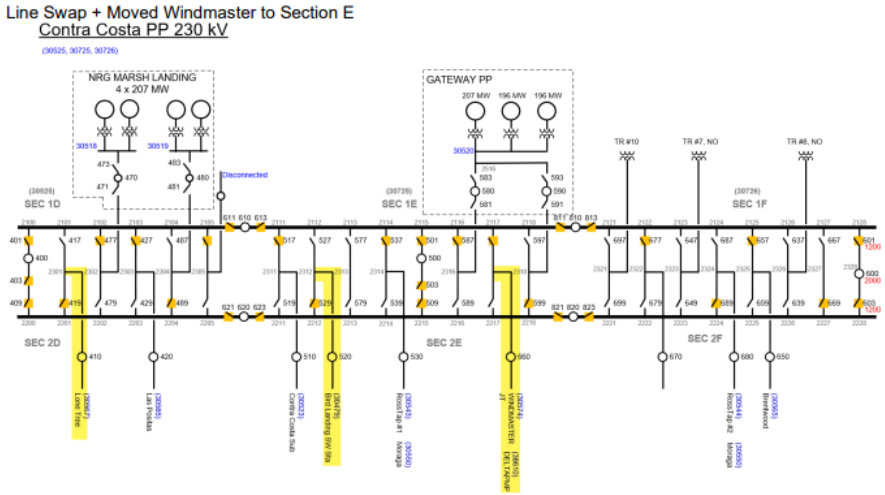


Diagram source: PG&E 2021-2022 TPP RW submission

Vasona-Metcalf 230 kV Line Limiting Elements Removal Project (Greater Bay Area)

- Reliability Assessment Need
  - NERC Category P2 and P7 starting 2023.
- Project Submitter
  - PG&E
- Project Scope
  - At Metcalf substation, upgrade Vasona-Metcalf line terminal conductors from single 1113 conductor into bundled 1113 conductors. With this upgrade, the line summer normal rating will be restored to 1600 Amps.
  - At both Metcalf Substation and Vasona Substation, replace the wave traps and any other terminal conductors that limit the line summer rating to 1600 Amps. With this upgrade, the overall line rating is expected to be increased to 1743 Amps..
- Project Cost
  - $0.6M - $1.2M
- Alternatives Considered
  - Status quo, which is not acceptable due to identified reliability issues.
  - Energy storage, which is not recommended because a roughly 152 MW*4 hour energy storage will be required to mitigate all the identified overloads and it will not be cost-effective.
- Recommendation - Approval

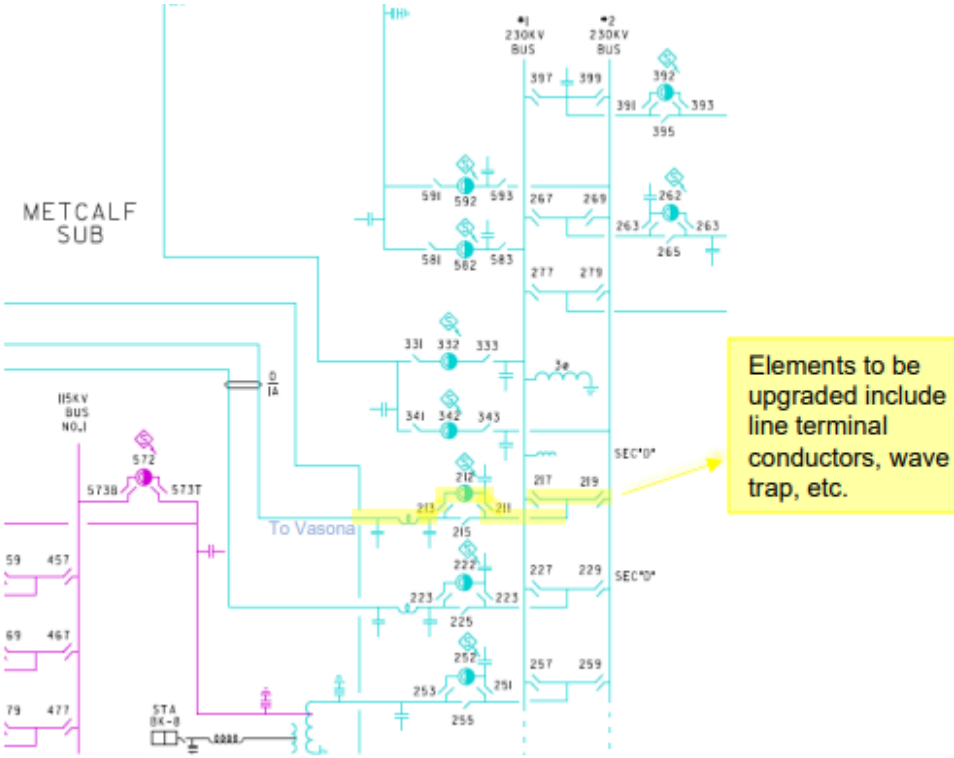


Diagram source: PG&E 2021-2022 TPP RW submission

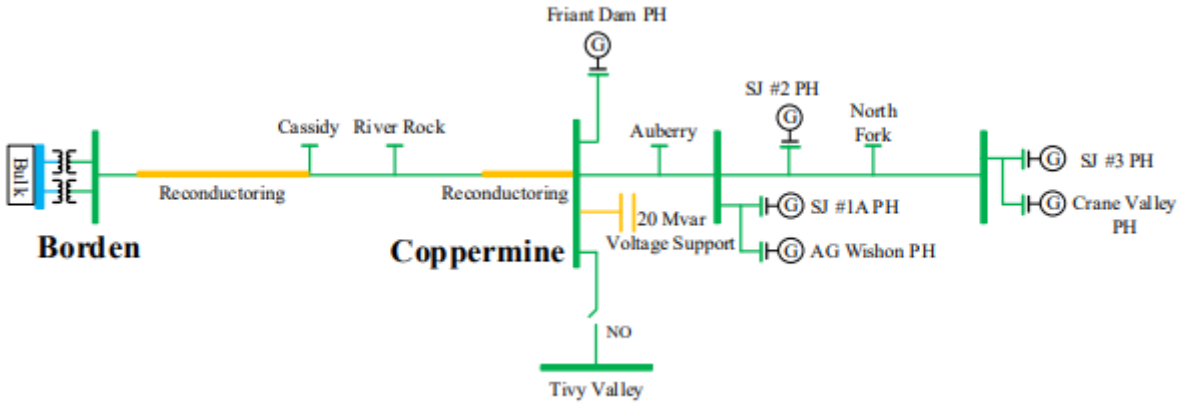
Coppermine 70 kV Reinforcement Project(Greater Fresno Area)

- Reliability Assessment Need
  - P0 overloads based on historical data.
- Project Submitter
  - PG&E
- Project Scope
  - Re-conductor between Borden-Cassidy and Cassidy-Coppermine Substations on the Borden-Coppermine 70kV line to achieve at least 700 Amps and 500Amps of summer normal rating respectively.
  - Remove any limiting components to achieve the full conductor capacity
  - Install 20 MVAR voltage support at Coppermine Substation.
- Project Cost
  - $21.8M - $43.6M
- Alternatives Considered
  - Status quo which is not acceptable due to identified reliability issues.
  - Introduction of 115 kV source is not recommended because it will not be as cost-effective as the recommended scope.
  - Energy Storage is not recommended as it will also trigger a complete 70 kV bus upgrade at Coppermine Substation that costs around $35M - $70M
- Recommendation
  - Approval

Diagram source: PG&E 2021-2022 TPP RW submission

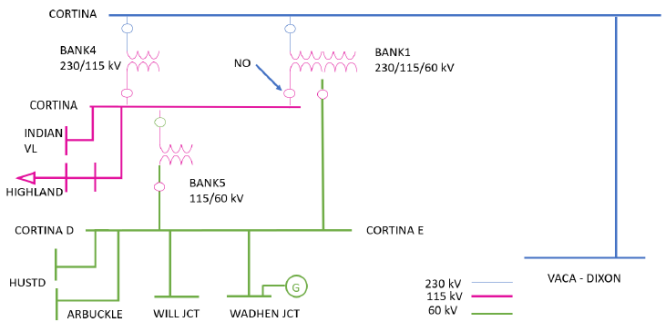
Coppermine 70 kV Reinforcement Project(Greater Fresno Area)

Proposed Solution - Re-conductoring sections highlighted in yellow

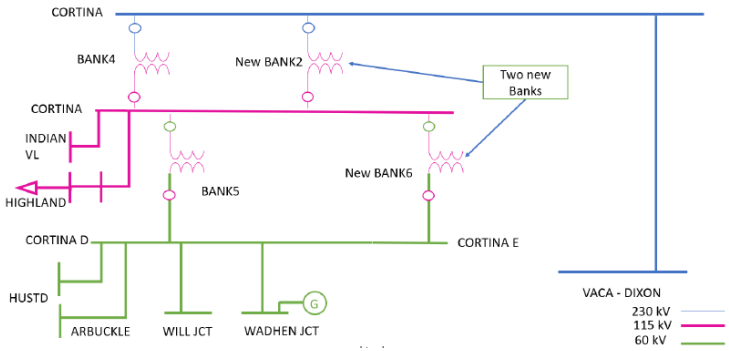


Cortina 230/115/60 kV Bank #1 Replacement (Sacramento Division)

- Reliability Assessment Need
  - NERC Category P1 starting 2023.
- Project Submitter
  - PG&E
- Project Scope
  - Replace the existing Cortina 230/115/60 kV Bank #1 with one 230/115 kV and one 115/60 kV transformer banks.
- Project Cost
  - $21M - $42M
- Alternatives Considered
  - Status quo: To rely on operation Procedure to open Cortina 115/60 kV Bank #5. This will result in load tripping following N-1 which is not acceptable for the long term.
  - Converting Existing Cortina 230/115/60 kV Bank #1 to 115/60 kV and adding one new 230/115 kV. The cos is higher than the proposed project ($25M - $50M)
  - Keeping existing Cortina 230/115/60 kV bank #1 and add one new 230/115 kV bank. The cost is higher than the proposed project ($22M - $44M)
- Recommendation - Approval



ıre 3- Existing Single Line Diagram

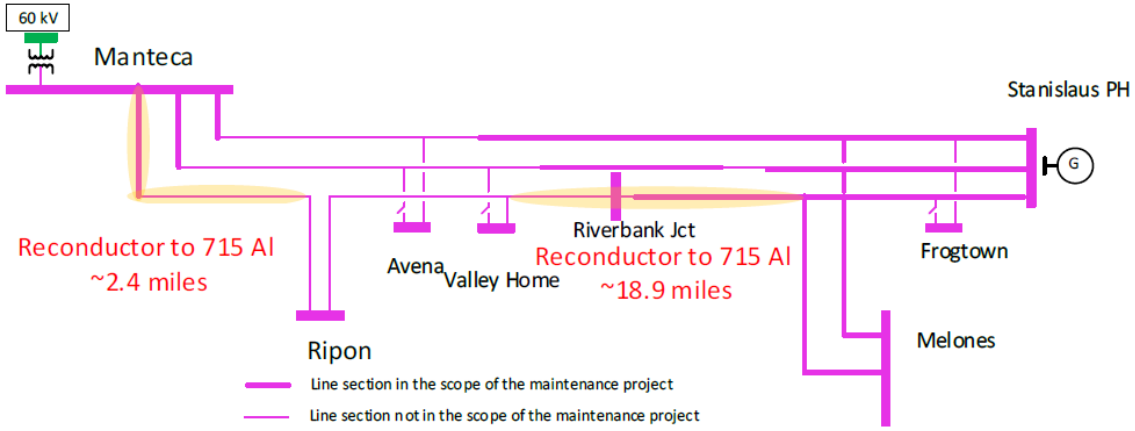


Proposed Project Single Line Diagram

Diagram source: PG&E 2021-2022 TPP RW submission

Manteca-Ripon-Riverbank-Melones Area 115 kV Line Reconductoring (Stockton)

- Reliability Assessment Need: NERC Category P1 starting 2023.
- Project Submitter: PG&E
- Project Scope: Reconductor 2.4 miles between Manteca and Ripon Jct and 1.8 miles between Riverbank SW STA and Valley Home Tap.
- Project Cost: $6.8M - $13.6M
- Alternatives Considered
  - Status quo: This alternative is not acceptable as there are N-1 contingency issues.
  - Line Re-rate: This is not applicable in the area as the re-rate is only up to 7pm while the peak load in the area occurs after 7pm.
- Other considerations:
  - There is an ongoing PG&E maintenance project active in the area that re-conductors 17.1 miles of the 115 kV lines in the area. Reconductoring 4.2 additional miles as part of this proposed project will address reliability needs.
- Recommendation - Approval

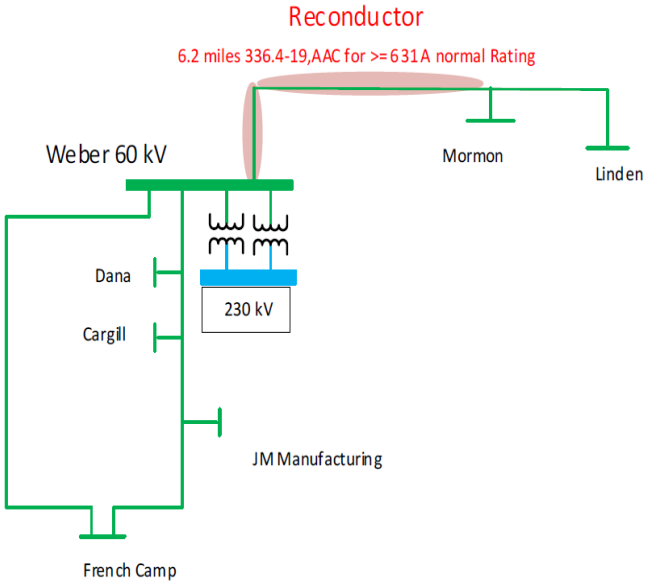


Proposed Project and Maintenance Single Line Diagram

Diagram source: PG&E 2021-2022 TPP RW submission

Weber - Mormon Jct 60 kV Line Section Reconductoring (Stockton Division)

- Reliability Assessment Need
  - NERC Category P0 starting 2023.
- Project Submitter
  - PG&E
- Project Scope
  - To reconductor 6.2 circuit miles of the Weber - Mormon Jct 60 kV Line.
- Project Cost
  - $9.3M - $18.6M
- Alternatives Considered
  - Status quo: This alternative is not acceptable as there are P0 overloads.
  - Line Re-rate: This is not applicable in the area as the re-rate is only up to 7pm while the peak load in the area occurs after 7pm.
  - Install 2x15 MW BESS: Just the interconnection cost, excluding the battery cost, is $13M - $26M which is more than the proposed project.
- Recommendation - Approval



Proposed Project Single Line Diagram

Diagram source: PG&E 2021-2022 TPP RW submission

High Voltage Assessment in PG&E System
Status Update

Ebrahim Rahimi
Senior Advisor - Regional Transmission North

2021-22 Transmission Planning Process Stakeholder Meeting
November 18, 2021

High Level Summary of the Preliminary Results Presented in the September Stakeholder Meeting

High Level Summary of the Preliminary Results

- With implementation of Round Mountain and Gates STATCOM projects, there are no high voltage issues at the 500 kV system under normal conditions.

- Based on the initial review of the feasibility of adjustments to the existing system to address high voltage issues, the following areas may require voltage support upgrades and are further reviewed to identify optimum size and type of voltage support:
  - Atlantic 60 kV area
  - Exchequer 115 kV area
  - Tesla 115 kV area
  - Melones 115 kV area
  - Mendocino 115 kV area
  - Colgate 60 kV area
  - Gualala 60 kV area
  - Cotati 60 kV area

Next Steps

- Further analysis of the areas with potential need for voltage support upgrade
  - Analysis of more sensitivity scenario
  - Review of historical data
  - Determine the optimum size and technology
  - Implementation feasibility assessment

- Continue system adjustment feasibility assessment and model validation for the rest of the PG&E system
  - Update the mitigation measures if system adjustments are not feasible and propose projects if all the required analysis are complete.

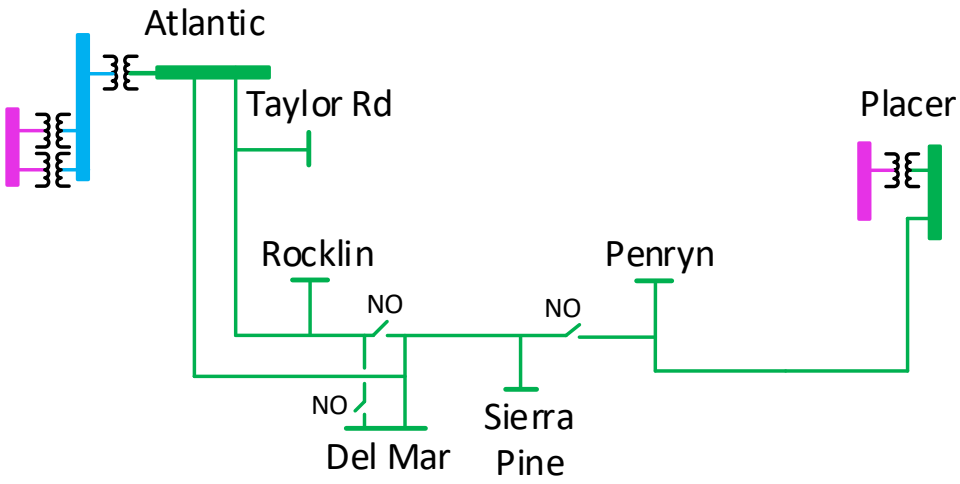
Results of Further Assessment

Issues with Higher Priority

- In discussions with Operations team, the high voltage issues in the following areas were selected for more detailed analysis in this planning cycle:
  - Atlantic 60 kV area
  - Exchequer 115 kV area
  - Table Mountain/ Palermo 230 kV area

Atlantic 60 kV area

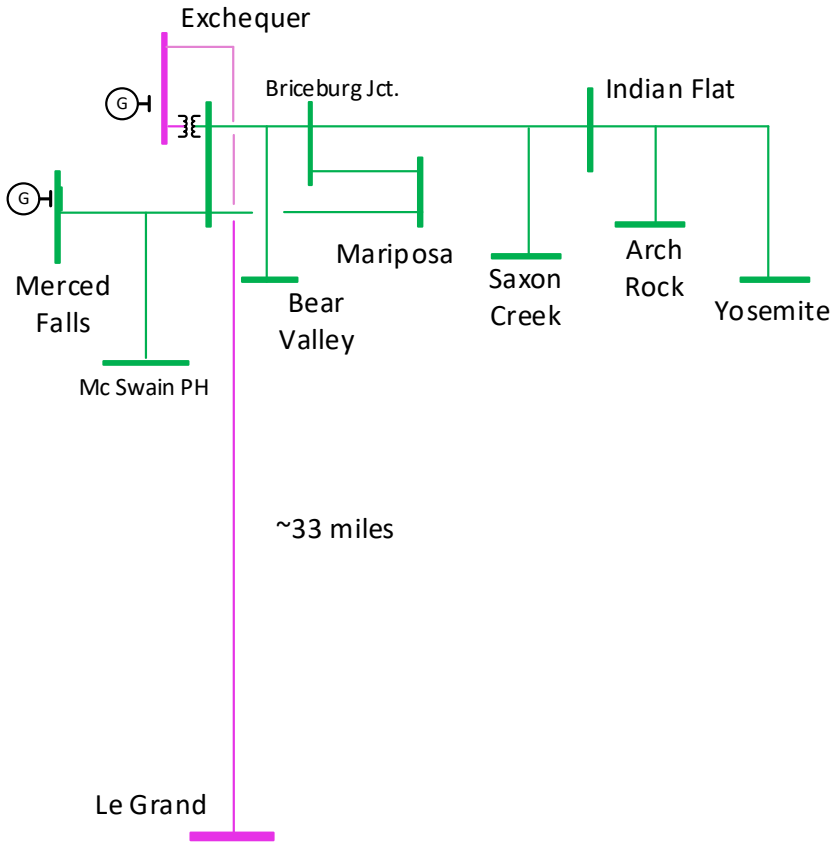
- There are 3 single phase transformers with one spare transformer supplying the Atlantic 60 kV area.
- The transformer doesn't have LTC to control the voltage resulting in high voltages under light load conditions observed in real time.



- Alternatives considered to address the issue:
  - Install a voltage regulator
  - Replace the transformer with one with LTC
- Feasibility, cost, and operational flexibility of these alternatives are being evaluated.

Exchequer 115 kV area

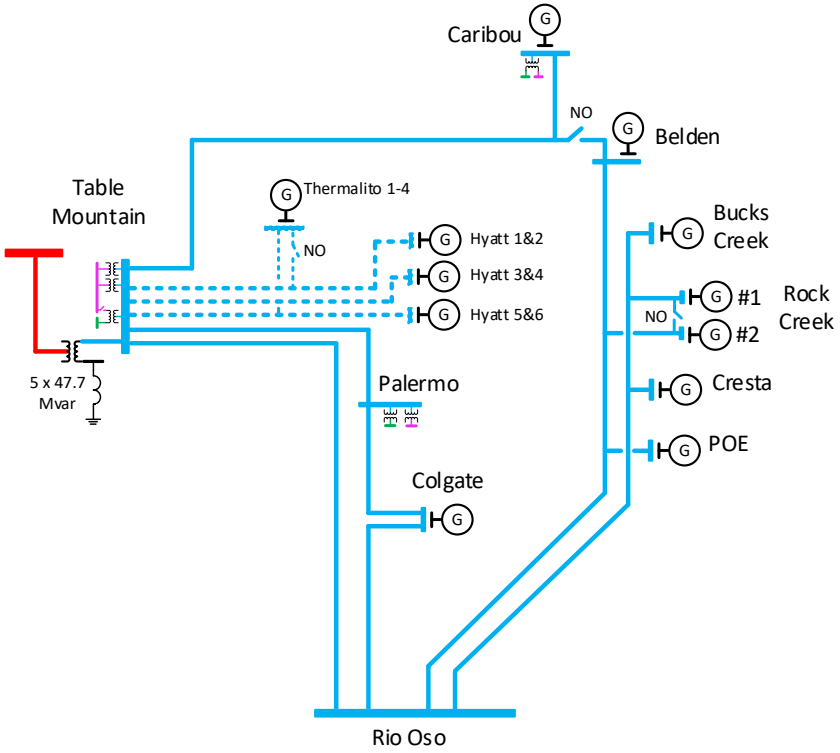
- High voltage issues have been observed in real time at Exchequer 115 kV bus
- TPP study results indicate that the issue exists in the long term mainly due to long 115 kV line supplying the area
- Alternative considered to address the issue:
  - Install 2 blocks of shunt reactors at Exchequer 115 kV substation



- Optimum size of the shunt reactors along with its feasibility and cost are being evaluated.

Table Mountain/Palermo 230 kV area

- High voltage issues have been observed in real time at Table Mountain / Palermo 230 kV area under low hydro conditions, when Table Mountain 500/230kV transformer is out for maintenance
- TPP study results indicate that the issue exists in the long term following the P1-4 contingency of Rio Oso SVC
- Further analysis is being performed to identify potential mitigations considering broader plan for the area in the long term.



Next Steps

- Atlantic 60 kV area
  - Evaluate the feasibility and cost of the potential alternatives
- Exchequer 115 kV area
  - Optimum size of the shunt reactors along with its feasibility and cost are being evaluated.
- Table Mountain/Palermo 230 kV area
  - Further analysis to be performed to identify potential mitigations in the long term.

2021-2022 TPP Wildfire Impact Assessment – North Coast North Bay Area Update

Bryan Fong
Regional Transmission North

2021-22 Transmission Planning Process Stakeholder Meeting
November 18, 2021

Discussion Items

- Background
- Updated scenarios
- Study approach
- Observations
- Conclusion and next step

Background

- In 2020-2021 TPP, the ISO performed an assessment for PG&E service territory to provide insight into the potential range of load impacts if different combinations of transmission lines within fire threat zones are included in the scope of PSPS event.

- Different scenarios were developed by taking out different combinations of transmission lines in fire zones within various planning areas. PG&E also provided additional scenarios developed based on the historical weather conditions.
  - The historical weather scenarios were studied by creating a single scenario by including all the lines included in one or more historical scenarios.

- This year, PG&E provided updated historical ‘lookback’ scenarios based on the weather data, past mitigations and refined methodology.
  - The ISO reassessed the potential range of impact in the North Coast North Bay area based on the new set of scenarios provided by PG&E within the 2021-2022 TPP.
  - This year, the ISO assessed each historical weather scenarios separately.

Updated scenarios

There are 12 scenarios that include different combinations of North Coast North Bay Area transmission lines within the historical lookback weather scenarios provided by PG&E this year.

ETL	Line Name	Planning Area	Voltage	Total Count	1	2	3	4	5	6	7	8	9	10	11	12
ETL.4780	GEYSERS #9-LAKEVILLE	North Coast North Bay	230	10	1		1		1	1	1	1	1	1	1	1
ETL.4750	GEYSERS #12-FULTON	North Coast North Bay	230	5			1		1		1		1			1
ETL.4770	GEYSERS #17-FULTON	North Coast North Bay	230	5			1		1		1		1			1
ETL.4781	GEYSERS #13 TAP	North Coast North Bay	230	4			1				1		1			1
ETL.4950	FULTON-LAKEVILLE	North Coast North Bay	230	2							1		1			
ETL.4680	FULTON-IGNACIO #1	North Coast North Bay	230	1									1			
ETL.4392	EAGLE ROCK-FULTON-SILVERADO	North Coast North Bay	115	10	1		1		1	1	1	1	1	1	1	1
ETL.1330	CORTINA-MENDOCINO #1	North Coast North Bay	115	3			1						1			1
ETL.2410	MENDOCINO-REDBUD	North Coast North Bay	115	3			1						1			1
ETL.1650	GEYSERS #3-CLOVERDALE	North Coast North Bay	115	2			1						1			
ETL.1680	GEYSERS #7-EAGLE ROCK	North Coast North Bay	115	2			1						1			
ETL.3810	SONOMA-PUEBLO	North Coast North Bay	115	2			1						1			
ETL.4050	UKIAH-HOPLAND-CLOVERDALE	North Coast North Bay	115	2			1						1			
ETL.1470	EAGLE ROCK-CORTINA	North Coast North Bay	115	1									1			
ETL.1480	EAGLE ROCK-REDBUD	North Coast North Bay	115	1									1			
ETL.1600	FULTON-PUEBLO	North Coast North Bay	115	1									1			
ETL.1481	LOWER LAKE-HOMESTAKE	North Coast North Bay	115	1									1			
ETL.6880	FULTON-CALISTOGA	North Coast North Bay	60	10			1	1	1	1	1	1	1	1	1	1
ETL.6890	FULTON-HOPLAND	North Coast North Bay	60	7		1	1		1		1	1	1		1	
ETL.6852	CLEAR LAKE-KONOCTI	North Coast North Bay	60	2									1			1
ETL.8365	GARBERVILLE-LAYTONVILLE	North Coast North Bay	60	2			1								1	
ETL.6979	MONTE RIO-FORT ROSS	North Coast North Bay	60	2			1						1			
ETL.6980	FORT ROSS-GUALALA	North Coast North Bay	60	1									1			
ETL.7140	IGNACIO-BOLINAS #1	North Coast North Bay	60	1									1			
ETL.7360	LAKEVILLE #1	North Coast North Bay	60	1									1			
ETL.7390	LAYTONVILLE-COVELO	North Coast North Bay	60	1									1			
ETL.6981	SALMON CREEK TAP	North Coast North Bay	60	1									1			
ETL.8180	TULUCAY-NAPA #1	North Coast North Bay	60	1									1			

Updated scenarios (cont'd)

- Within the 12 scenarios, the four 230 kV gen-tie lines (connecting to Geysers generation) have relatively higher frequency in-terms of being included in the most number of scenarios.

- One 115 kV and two 60 kV lines also have relatively high frequency. However, the lines by itself don't have direct load impact other than to one 60 kV substation.

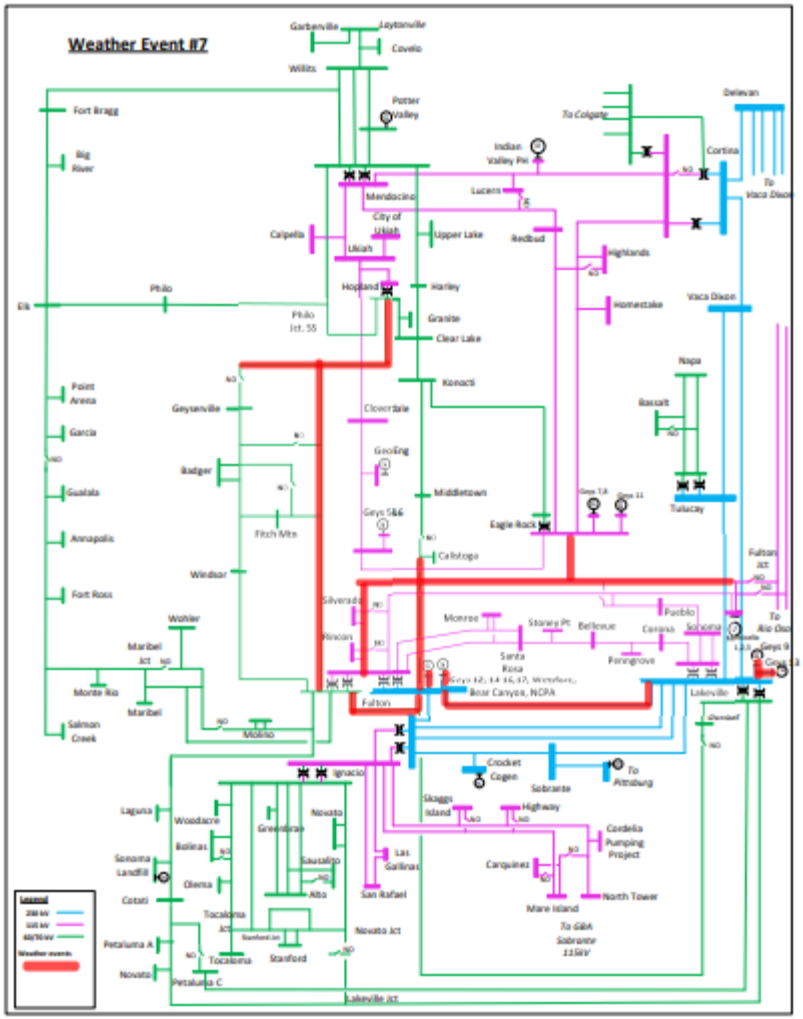
- Following the above observations in regards to the composition of different scenarios, the ISO's this year's assessment is focused on two events as identified below:
  - Weather Event 7 – Event with high frequency of transmission lines impacting local generation,
  - Weather Event 9 – Event with most number of North Coast North Bay transmission lines resulting in the large amount of direct load loss.

Study approach

The study approach included assessing following sequence of impacts as a result of the transmission lines within the individual weather event being de-energized concurrently.

- Direct: Loss of load resulting from substations isolated by opening of the lines within the event. (i.e. radial supply)
- Indirect-thermal: Overloading of the remaining lines supplying the area resulting from opening of the lines within the event.
- Indirect-contingency: Overloading of the remaining lines supplying the area under the next N-1 contingency condition.

Weather Event 7



Line Name	Voltage	Total Count	Generation Impact
FULTON-LAKEVILLE	230 KV	2	
GEYSERS #12-FULTON	230 KV	5	Yes
GEYSERS #13 TAP	230 KV	4	Yes
GEYSERS #17-FULTON	230 KV	5	Yes
GEYSERS #9-LAKEVILLE	230 KV	10	Yes
EAGLE ROCK-FULTON-SILVERADO	115 KV	10	
FULTON-CALISTOGA	60 KV	10	
FULTON-HOPLAND	60 KV	7	

Observations - Weather Event 7

Direct Impact

- GEYSERS #9-LAKEVILLE 230 kV line is a radial line that is a non-ISO controlled PG&E line that is a generation interconnection for the following resources Geysers 9&10 (retired), SMUD, Geyser 13, Geyser 18, NCPA 1 and NCPA 2.
- GEYSERS #12-Fulton 230 kV line is a radial line that is a non-ISO controlled PG&E line that is a generation interconnection for the following resources Geysers 12 and 14.
- GEYSERS #17-Fulton 230 kV line is a radial line that is a non-ISO controlled PG&E line that is a generation interconnection for the following resources Geysers 17 and Bottle Rock.
- EAGLE ROCK-FULTON-SILVERADO 115 kV line results in loss of supply to the following substations Rincon, Silverado, Monticello and Monticello PH. However, these stations can be served from the alternate (Fulton-Pueblo) 115 kV line.
- Fulton-Calistoga 60 kV line results in loss of supply to Calistoga substation

Indirect Impact Thermal (Base Case overload)

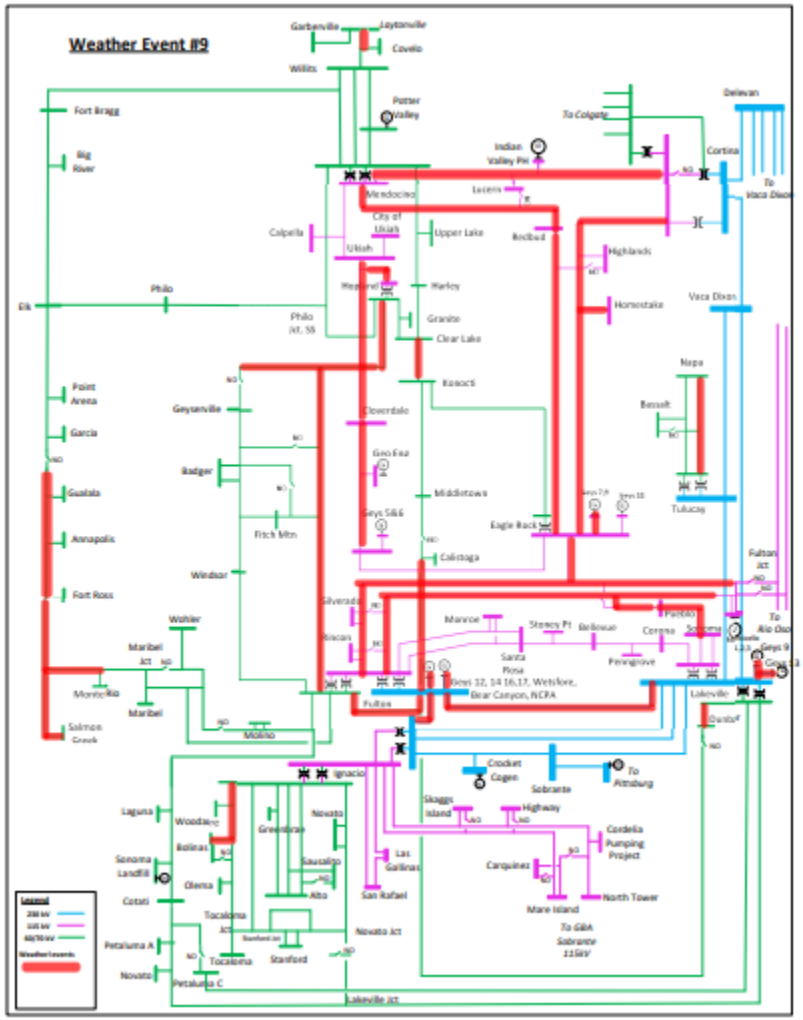
- To identify the Indirect Thermal Impact, a base case was developed by scaling load in the North Coast North Bay area to represent load level during typical wildfire risk season. Following facilities were identified to have the Indirect Thermal Impact:
  - Vaca Dixon-Lakeville 230 kV line
  - Vaca Dixon –Tulucay 230kV line

Observations - Weather Event 7 cont'd

Indirect Impact Contingency

- Contingency of Fulton-Windsor 60 kV line results in loss of supply to the following substations: Windsor, Fitch Mtn, Badger and Geyserville.
- Contingency of Windsor-Fitch Mtn-Badger 60 kV line results in loss of supply to the following substations: Windsor, Fitch Mtn, Badger and Geyserville.

Weather Event 9



Line Name	Voltage	Total Count	Generation Impact
FULTON-IGNACIO #1	230 KV	1	
FULTON-LAKEVILLE	230 KV	2	
GEYSERS #12-FULTON	230 KV	5	Yes
GEYSERS #13 TAP	230 KV	4	Yes
GEYSERS #17-FULTON	230 KV	5	Yes
GEYSERS #9-LAKEVILLE	230 KV	10	Yes
CORTINA-MENDOCINO #1	115 KV	3	
EAGLE ROCK-CORTINA	115 KV	1	
EAGLE ROCK-FULTON-SILVERADO	115 KV	10	
EAGLE ROCK-REDBUD	115 KV	1	
FULTON-PUEBLO	115 KV	1	
GEYSERS #3-CLOVERDALE	115 KV	2	Yes
GEYSERS #7-EAGLE ROCK	115 KV	2	Yes
LOWER LAKE-HOMESTAKE	115 KV	1	
MENDOCINO-REDBUD	115 KV	3	
SONOMA-PUEBLO	115 KV	2	
UKIAH-HOPLAND-CLOVERDALE	115 KV	2	
CLEAR LAKE-KONOCTI	60 KV	2	
FORT ROSS-GUALALA	60 KV	1	
FULTON-CALISTOGA	60 KV	10	
FULTON-HOPLAND	60 KV	7	
GARBERVILLE-LAYTONVILLE	60 KV	3	
IGNACIO-BOLINAS #1	60 KV	1	
LAKEVILLE #1	60 KV	1	
LAYTONVILLE-COVELO	60 KV	1	
MONTE RIO-FORT ROSS	60 KV	2	
SALMON CREEK TAP	60 KV	1	
TULUCAY-NAPA #1	60 KV	1	

Observations - Weather Event 9

Direct Impact

- GEYSERS #9-LAKEVILLE 230 kV line is a radial line that is a non-ISO controlled PG&E line that is a generation interconnection for the following resources Geysers 9&10 (retired), SMUD, Geyser 13, Geyser 18, NCPA 1 and NCPA 2.
- GEYSERS #12-Fulton 230 kV line is a radial line that is a non-ISO controlled PG&E line that is a generation interconnection for the following resources Geysers 12 and 14.
- GEYSERS #17-Fulton 230 kV line is a radial line that is a non-ISO controlled PG&E line that is a generation interconnection for the following resources Geysers 17 and Bottle Rock.
- EAGLE ROCK-FULTON-SILVERADO 115 kV line results in loss of supply to the following substations Rincon, Silverado, Monticello and Monticello PH. However, these stations can be served from the alternate (Fulton-Pueblo) 115 kV line.
- Eagle Rock-Cortina 115 kV line results in loss of supply to Highlands and Homestake.
- Geyser 7-Eagle Rock 115 kV line results in loss of Geyser 7 resource.

Observations - Weather Event 9 cont'd

Direct Impact cont'd

- Geyser 7-Eagle Rock 115 kV line results in loss of Geyser 7 resource.
- Fulton-Calistoga 60 kV line results in loss of supply to Calistoga substation
- Mendocino-Cortina 115 kV line results in loss of supply to Lucern and Indian Valley PH.
- Mendocino-Redbud and Eagle Rock-Redbud 115 kV lines result in loss of supply to Redbud
- Loss of supply to Eagle Rock Substation due to Fulton-Silverado-Eagle Rock, Eagle Rock-Mendocino, Eagle Rock-Cortina and Hopland-Cloverdale 115 kV lines and Clear Lake-Konocti 60 kV line results in additional loss of supply to Cloverdale, Geo Eng, Geyser 5&6 and Geyser 11 115 kV stations and Konocti and Middletown 60 kV stations.
- Laytonville-Covelo 60 kV line results in loss of supply to Covelo

Indirect Impact Thermal

- Along with the loss of local generation similar to the Event 7, significant amount of load is also lost as a direct load impact due to the large number of 60 and 115 kV lines included within the scope.
- No significant indirect impact.

Conclusion & Next Step

- For the events which include outage of the high frequency 230 kV gen-tie lines (like the Event 7) causing significant loss of local generation; while most 60 kV and 115 kV loads remain, results in overloading of the remaining 230 kV lines supplying the North Coast North Bay areas. More severe and additional overloads could occur in the contingency scenarios.
  - Hardening the high-frequency 230 kV non ISO controlled gen-tie lines to prevent loss of the local generation would address alleviate overloads on the supply lines.
  - Additionally, closing normally open connection from the Fulton Jct to Pueblo line can also be explored to bring supply into the North Coast North Bay area.
- The Event 9 is a widespread extreme event in the area, which results in loss of multiple 230 kV lines with Geyser generation supply and 115 and 60 kV lines supplying the local load. This event includes a large number of low-frequency transmission lines as well that has a low probability of occurrence.
  - No obvious transmission mitigation is available for this event, as any additional supply without hardening local lines doesn't bring much benefit from the direct load loss perspective.
  - Also impact from distribution-only outages need to be considered before looking into transmission mitigations.
- As a next step, the ISO will continue to work with PG&E to evaluate possibility of hardening the 230 kV gen-tie lines and to prevent loss of load served from Fulton-Calistoga 60 kV, one the high frequency lines.

20 Year Transmission Outlook Update

Jeff Billinton
Director, Transmission Infrastructure Planning

2021-2022 Transmission Planning Process Stakeholder Meeting
November 18, 2021

The 20-year transmission outlook will provide a "baseline" vision for future planning activities:

- Including high level technical studies to test feasibility of alternatives, focusing on the bulk transmission system
- Using a "Starting Point" scenario:
  - diverse resources known to require transmission development such as offshore wind energy, out-of-state resources, and geothermal
  - gas power plant retirements that may require transmission development to reduce local area constraints.
- Will help:
  - scope the challenges we face,
  - allow the state to further refine resource planning,
  - and provide longer term context for decisions made in the 10 year transmission plan process.

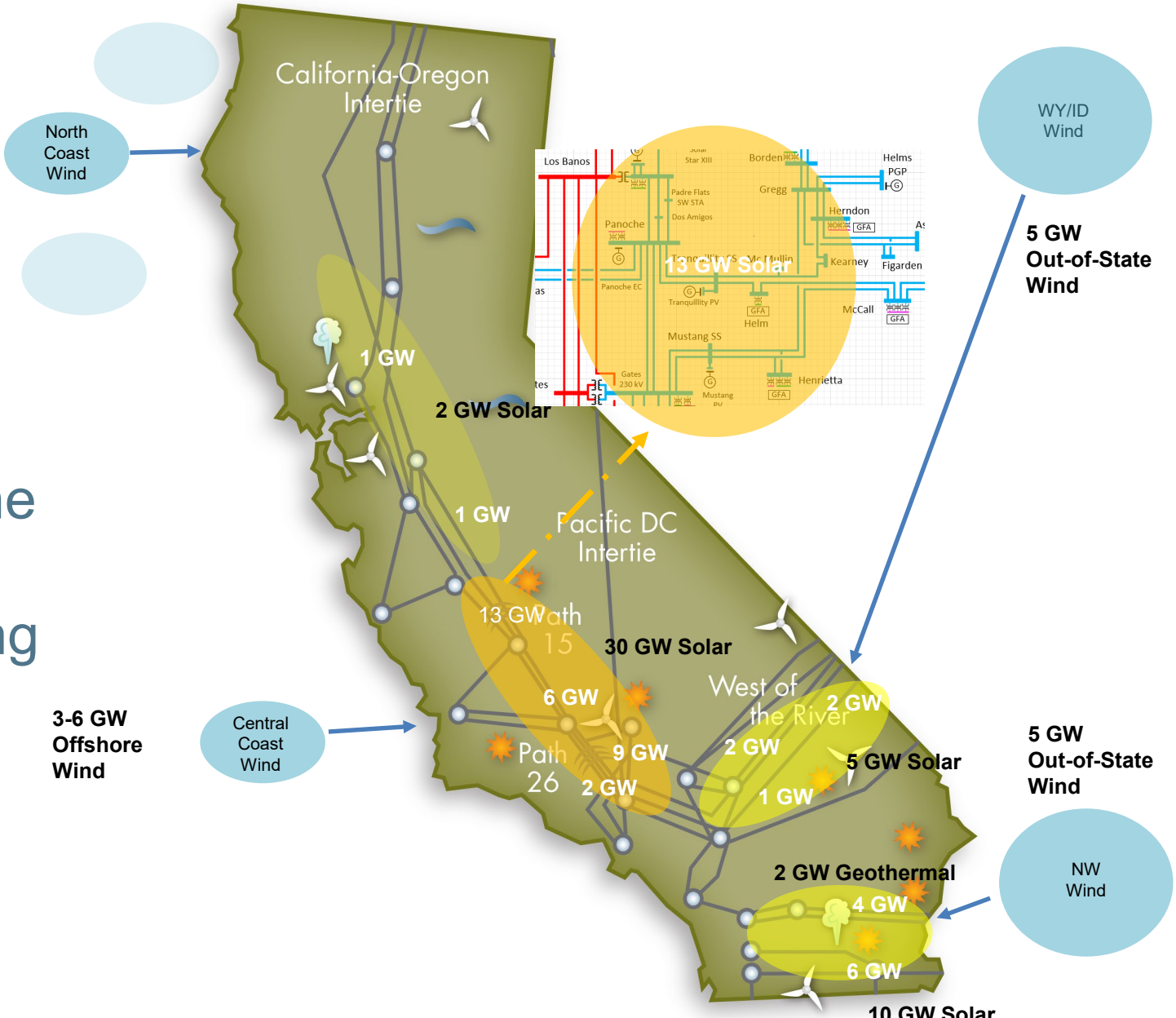
20 Year Outlook – SB100 Starting Point Scenario

	Portfolios for 2020-2021 Plan (2030)	Portfolios for 2021-2022 Plan (2031)	*Authorized near and mid term (2025) procurement*	*Draft Preferred System Plan (2025)*	Draft Preferred System Plan (2032)	SB 100 Starting Point Scenario (2040)
Solar	6,763	13,044	*12,800 **	*11,000*	18,833	53,212
Wind	992	4,005		*3,553 in state* *0 OOS* *0 offshore*	3,553 in state 1,500 OOS 1,708 offshore	2,237 in state 12,000 OOS 10,000 offshore
Battery storage	1,376	9,368		*12,553*	14,751	37,000
Gas-fired					1	
Biomass				*107*	134	
Geothermal	0	651	*1,000 likely beyond 2026*	*114*	1,160	2,332
Pumped Hydro / Long Duration	1,256	627	*1,000 likely beyond 2026*	*196*	1,000	4,000
Total	**10,387**	**27,695**	***14,800***	***27,287***	**42,690**	**120,781**
Gas retirements	0	0			~950	-15,000

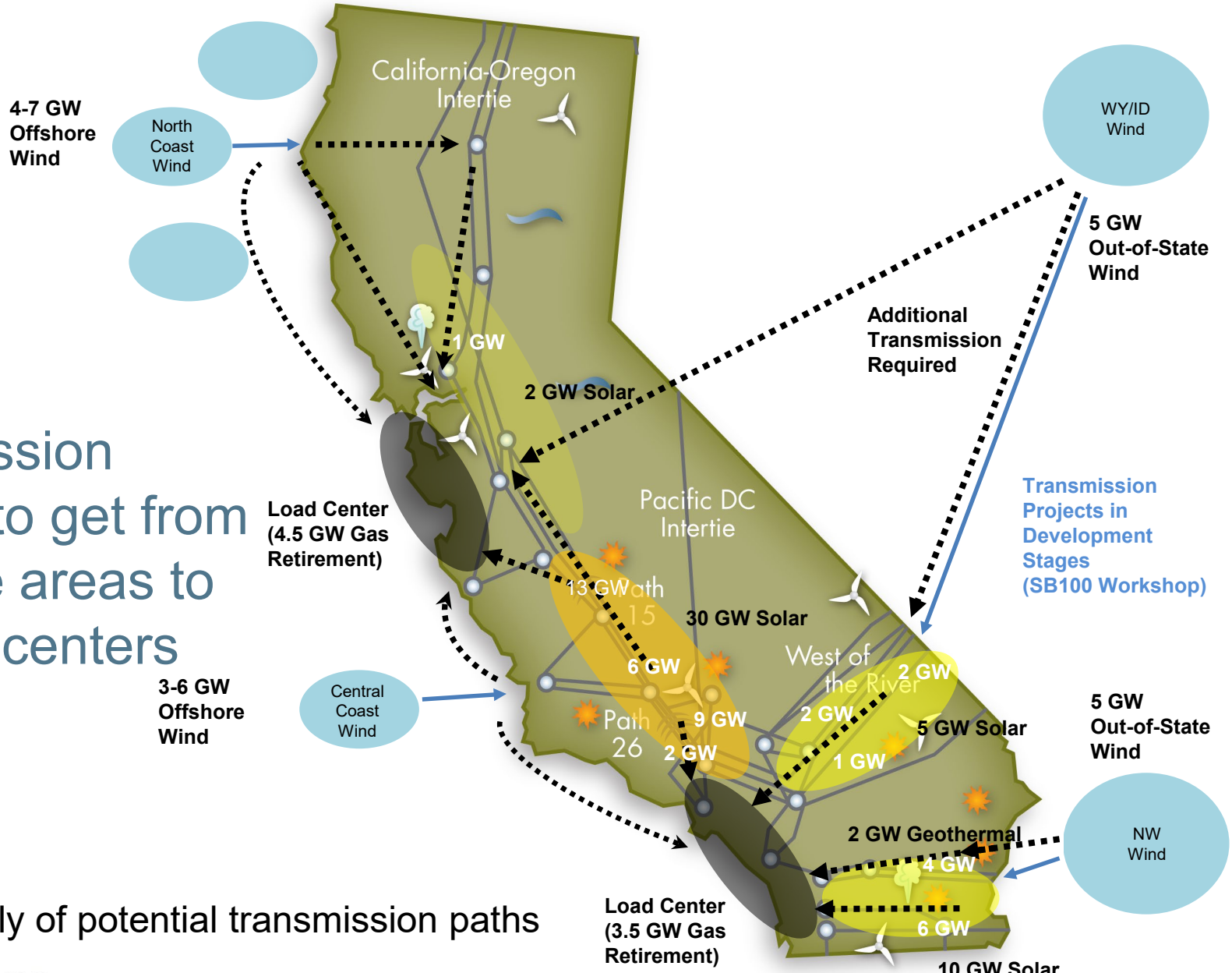
* NQC value as opposed to installed capacity

Step 1 Transmission to integrate the resources in SB100 Starting Point

Step 1 Transmission to integrate the resources in SB100 Starting Point



Step 2 Transmission needed to get from resource areas to the load centers



Illustrative only of potential transmission paths

High Level Analysis to Determine Feasible Transmission Alternatives

- Load scaled to high electrification levels
- Bulk system assessment case development
  - Peak consumption
  - Net Peak
  - Off Peak
- High level assessment of local area (focus on Bay and LA Basin) needs with gas retirement
  - Building off of 2018-2019, 2019-2020 and 2020-2021 TPP assessment of gas retirement in local capacity areas and storage potential
- Storage mapping (i.e. co-located and load centers)

Wrap-up
Preliminary Policy and Economic Assessment and Study Updates

James Bishara
Senior Stakeholder Engagement and Policy Specialist

2021-2022 Transmission Planning Process Stakeholder Meeting
November 18, 2021

Comments

- Comments due by end of day December 6, 2021

- Submit comments through the ISO's commenting tool, using the template provided on the process webpage:
- https://stakeholdercenter.caiso.com/RecurringStakeholderProcesses/2021-2022-Transmission-planning-process

Comments will be submitted to the ISO using the online stakeholder commenting tool

- Ability to view all comments with a single click.
- Ability to filter comments by question or by entity.
- Login, add your comments directly to the template and submit.
  - You can save and return to your entry anytime during the open comment period.

NOTE

Submitting comments in the tool will require a one-time registration.

Find a video on how to use the commenting tool on the Recurring Stakeholder Processes landing page.