20 Year Transmission Outlook Update

Stakeholder Call

April 18, 2024

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 as a question, select the raised hand icon at the bottom of your screen. If you dialed into the phone-only line, press #2. 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.

Stakeholder Call - Agenda

Topic	Presenter
Introduction	Yelena Kopylov-Alford
20 Year Transmission Outlook Update	Jeff Billinton Ebrahim Rahimi
Wrap-up & Next Steps	Yelena Kopylov-Alford

California ISO

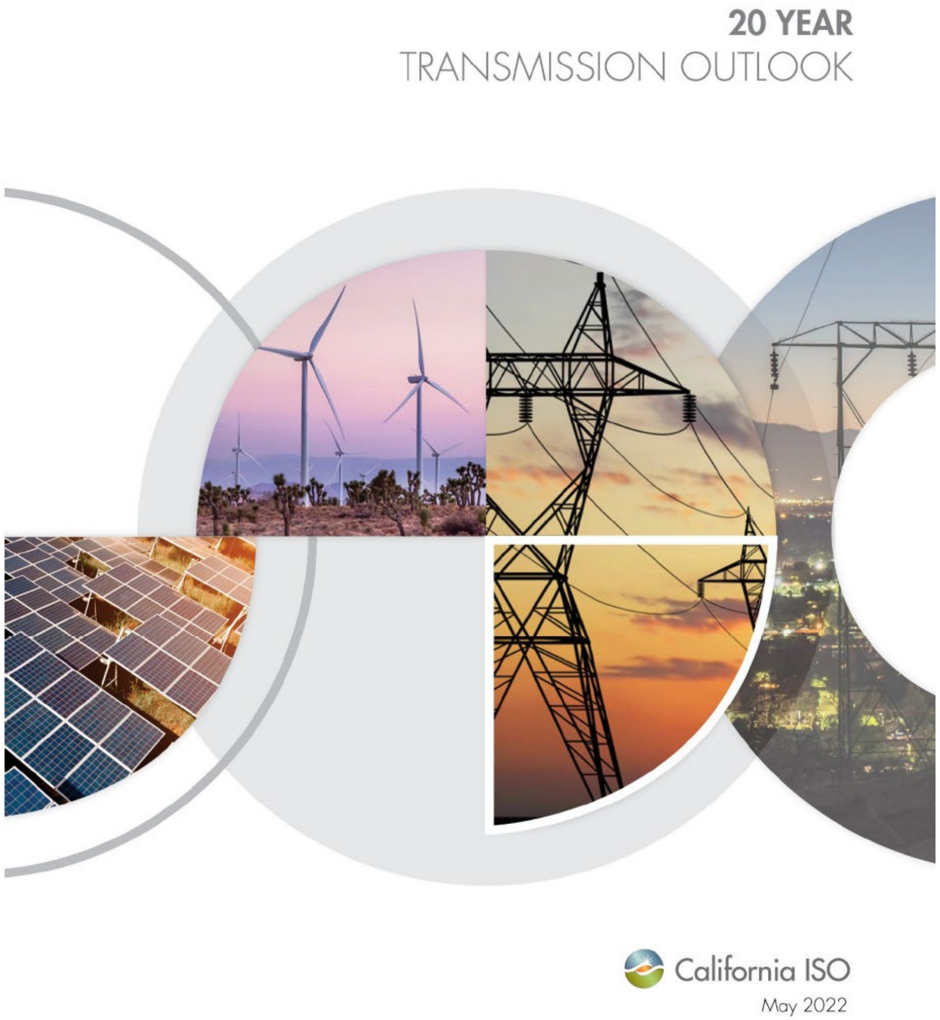
20-Year Transmission Outlook - Update

Jeff Billinton
Director, Transmission Infrastructure Planning

Ebrahim Rahimi
Sr. Advisor, Transmission Infrastructure Planning

20-Year Transmission Outlook

- The ISO produced its first ever 20-Year Transmission Outlook focused on providing a longer term view of transmission needed to reliably meet state clean energy goals
- Issued in May 2022 and posted on the ISO website
  http://www.caiso.com/InitiativeDocuments/20-YearTransmissionOutlook-May2022.pdf



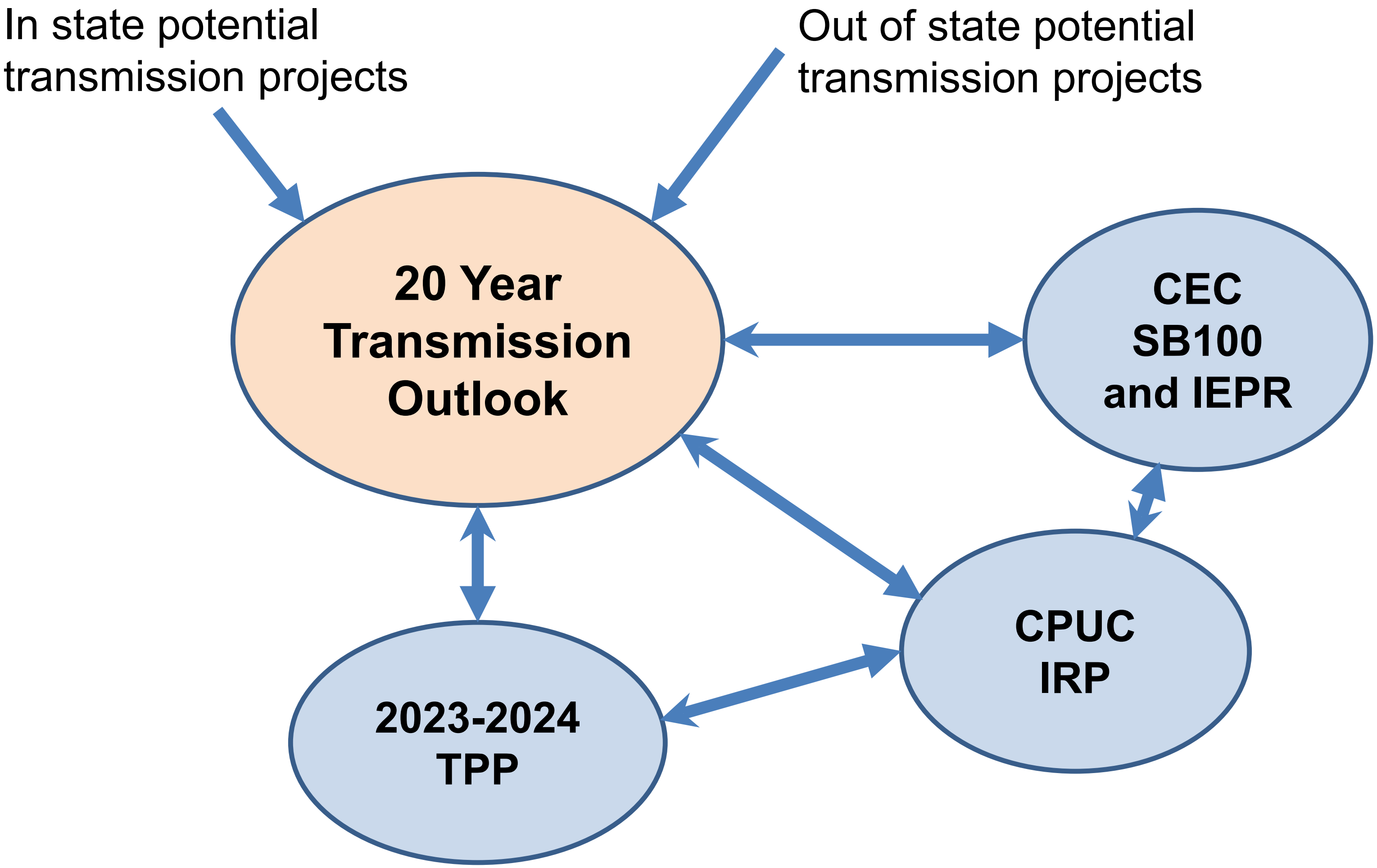
20 YEAR
TRANSMISSION OUTLOOK

California ISO
May 2022

The 20-year transmission outlook provides a “baseline” architecture setting stage for future planning activities:

- Is intended to:
  - help the state to further refine resource planning,
  - scope the challenges we face, and
  - provide longer term context for decisions made in the 10 year transmission plan process
- Included high level technical studies to test feasibility of alternatives, focusing on the bulk transmission system
- The May 2022 Outlook used a “Starting Point” scenario docketed that:
  - had 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

Primary Paths for Coordination with Other Initiatives



In state potential transmission projects

Out of state potential transmission projects

20 Year Transmission Outlook

CEC SB100 and IEPR

CPUC IRP

2023-2024 TPP

20-Year Transmission Outlook - Update

- The ISO is undertaking an update of the 20-Year Transmission Outlook in parallel with ISO's 2023-2024 transmission planning process
- The update is looking out to 2045 and will incorporate:
  - Updated portfolio
  - Updated load forecast
- Includes high level technical studies to test feasibility of alternatives, focusing on the bulk transmission system

CEC Docketed - 2045 Scenario for the Update of the 20-Year Transmission Outlook

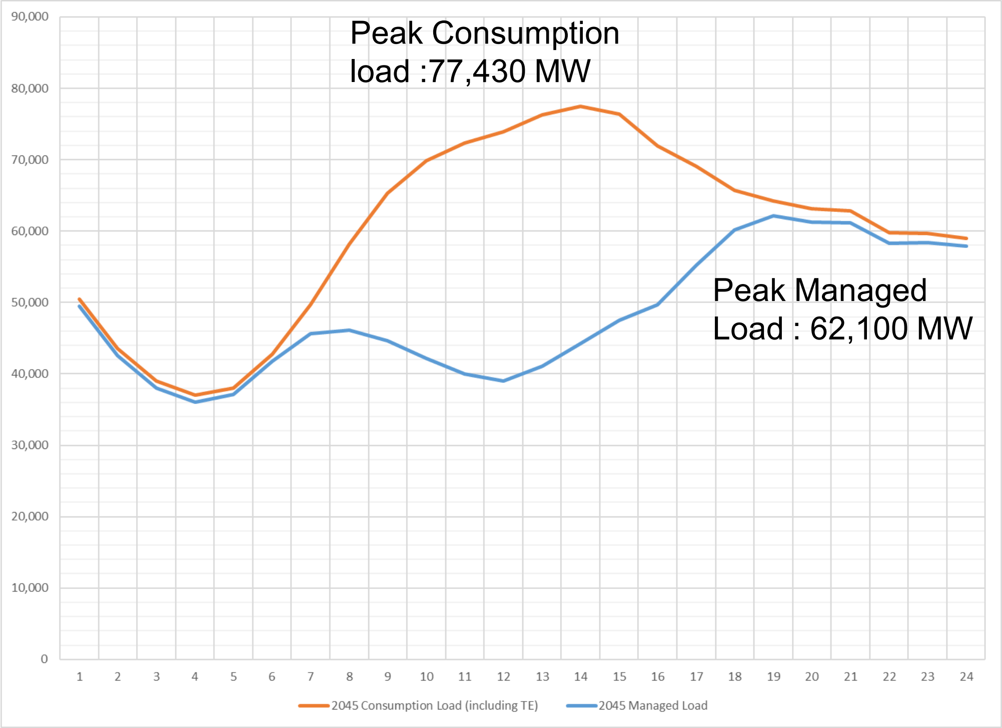
- Describes a 2045 demand and resource scenario for use by the CAISO in the update of the 20-Year Transmission Outlook.
- Outlines the demand and resource assumptions within the scenario.
- Details the method for resource mapping the new renewable resource and energy storage capacity within the scenario.

https://www.energy.ca.gov/publications/2023/2045-scenario-update-20-year-transmission-outlook

Energy Demand Forecast

- CEC provided hourly forecasts for each PTO area (PG&E, SCE & SDG&E)
- Includes approximately 42 GW of BTM PV capacity in 2045
- For the additional achievable components of the forecast CEC has provided disaggregation to 2035
  - For 2036 through 2045, the ISO will disaggregate the load from the TAC area to busbar using a weighting approach

2045 CAISO Peak Day Hourly Profile



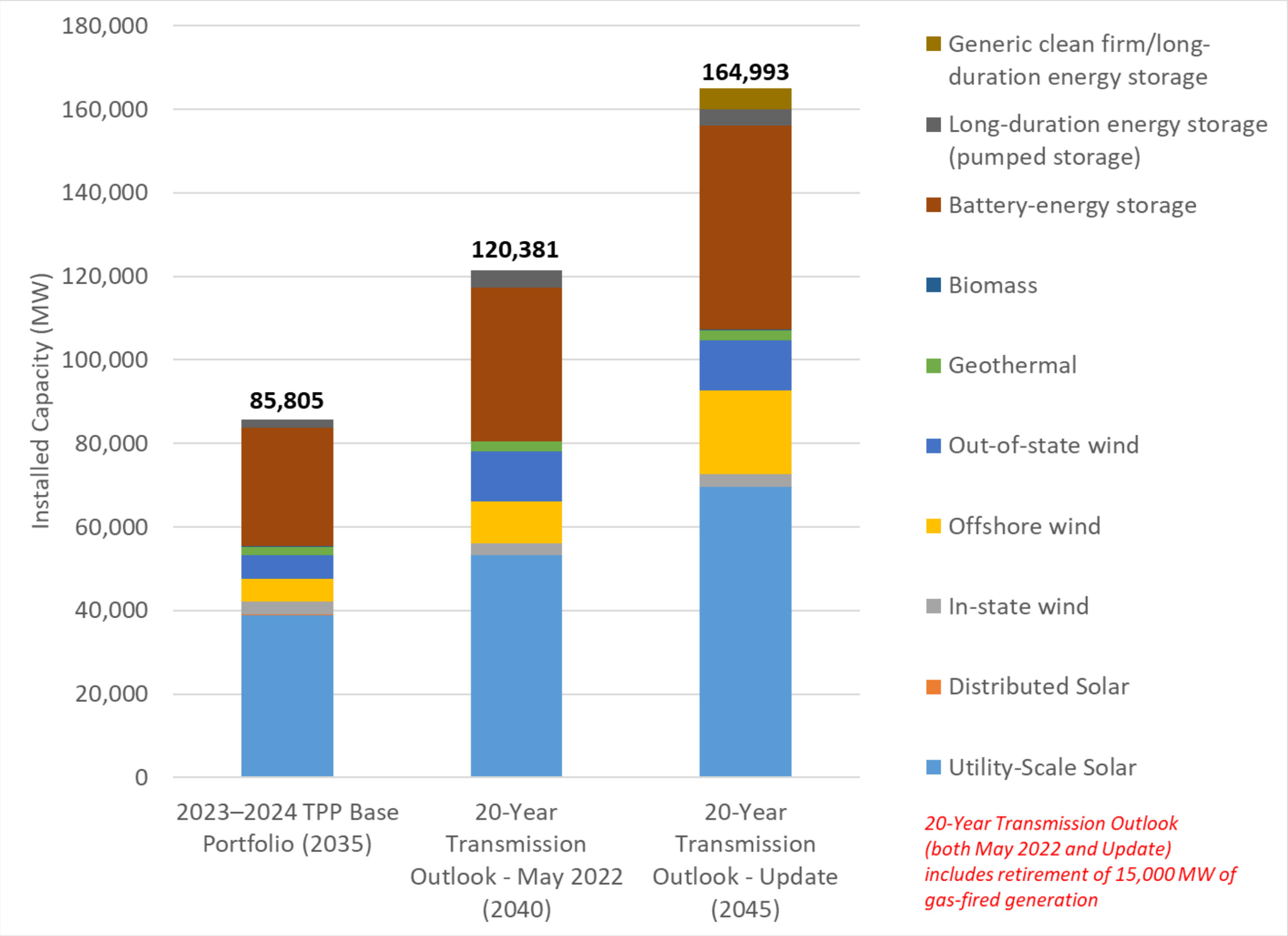
Peak Consumption load :77,430 MW

Peak Managed Load : 62,100 MW

Portfolios – 2023-2024 Transmission Planning Process and 20-Year Transmission Outlook

Resource Type (MW)	**2023-2024 Transmission Planning Process**		**20-Year Transmission Outlook**	
	Base Portfolio (2035)	**OSW Sensitivity (2035)**	**May 2022** **2040 SB100 Starting Point Scenario (MW)**	**Update** **New Resource Assumption in the 2045 Scenario (MW)**
Natural Gas Fired Power Plants	-	-	(-15,000)	(-15,000)
Utility-Scale Solar	38,947	25,746	53,212	69,640
Distributed Solar	125	125	-	125
In-state wind	3,074	3,074	2,837	3,074
Offshore wind	5,497	13,400	10,000	20,000
Out-of-state wind	5,618	5,618	12,000	12,000
Geothermal	2,037	1,149	2,332	2,332
Biomass	134	134	-	134
Battery-energy storage	28,373	23,545	37,000	48,813
Long-duration energy storage (pumped storage)	2,000	1,000	4,000	4,000
Generic clean firm/long-duration energy storage	-	-	-	5,000

Portfolios – 2023-2024 Transmission Planning Process and 20-Year Transmission Outlook



20-Year Transmission Outlook (both May 2022 and Update) includes retirement of 15,000 MW of gas-fired generation

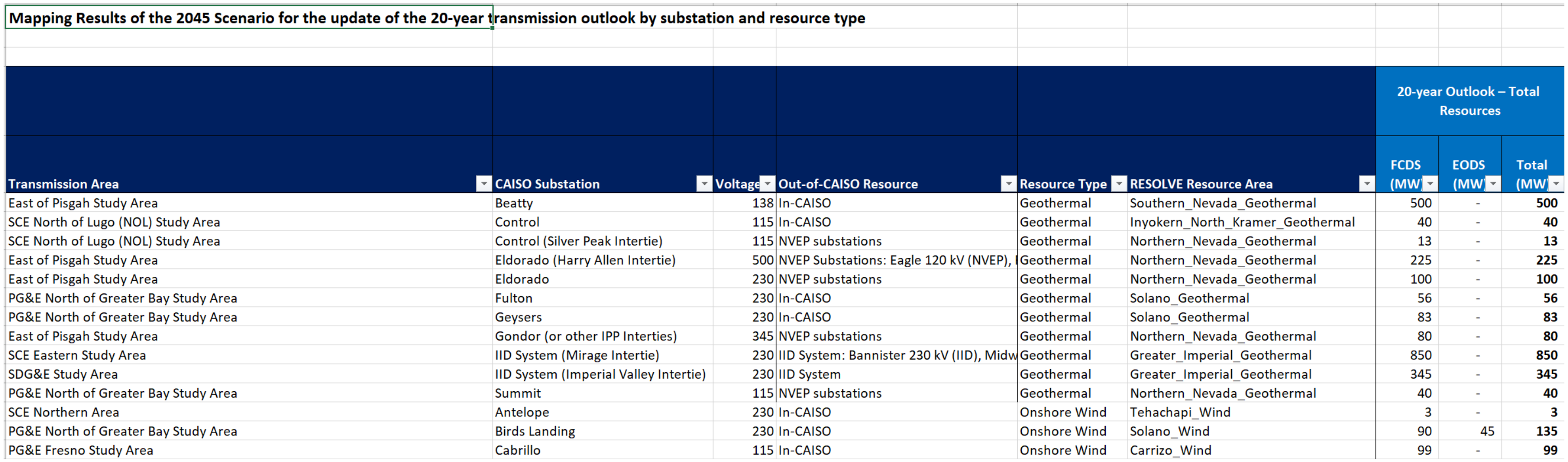
Natural Gas Power Plant Retirements

- The 2045 Scenario retains the assumption from the 2021 Starting Point Scenario that 15,000 MW of natural gas power plant capacity would be retired by 2040
- Assumed gas-fired generation retired by local capacity area

Local Capacity Area	**Capacity (MW)**
Greater Bay Area	4427
Sierra	153
Stockton	361
Fresno	669
Kern	407
LA Basin	3,632
Big Creek-Ventura	695
San Diego-IV	131
ISO System	3,933
Total	**14,408**

Geographic Allocation of Resources

- The 20-year outlook requires geographically mapping of resources to specific locations, to the extent feasible
- Wherever possible, the mapping criteria aligns with the current CPUC integrated resource plan (IRP) portfolios being studied within the 2023-2024 TPP
- All MW values are assumed to occur by 2045
- Mapping of resources to substations within the transmission zones

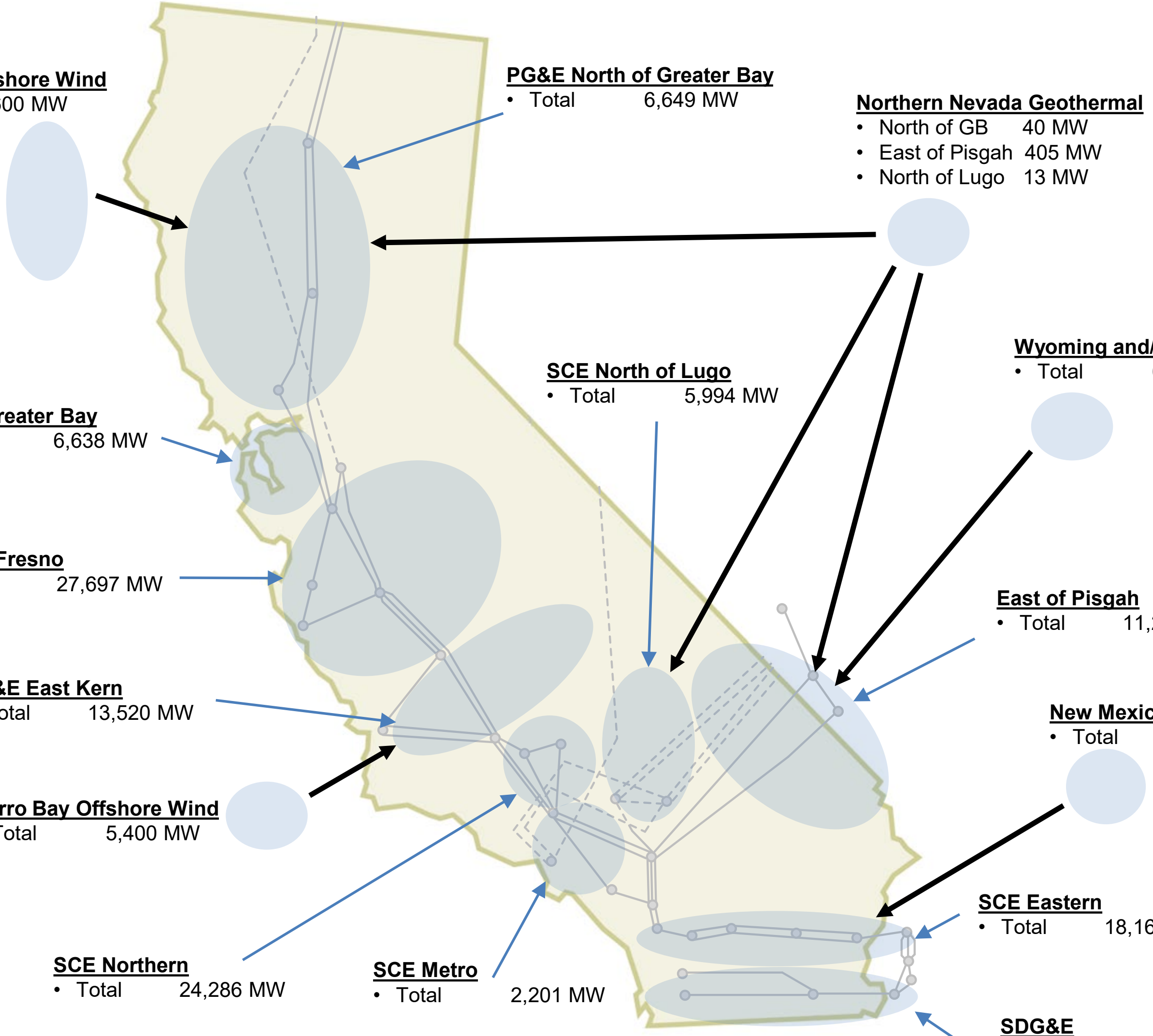


Mapping Results of the 2045 Scenario for the update of the 20-year transmission outlook by substation and resource type

						20-year Outlook – Total Resources		
Transmission Area	**CAISO Substation**	**Voltage**	**Out-of-CAISO Resource**	**Resource Type**	**RESOLVE Resource Area**	**FCDS (MW**	**EODS (MW**	**Total (MW**
East of Pisgah Study Area	Beatty	138	In-CAISO	Geothermal	Southern_Nevada_Geothermal	500	-	**500**
SCE North of Lugo (NOL) Study Area	Control	115	In-CAISO	Geothermal	Inyokern_North_Kramer_Geothermal	40	-	**40**
SCE North of Lugo (NOL) Study Area	Control (Silver Peak Intertie)	115	NVEP substations	Geothermal	Northern_Nevada_Geothermal	13	-	**13**
East of Pisgah Study Area	Eldorado (Harry Allen Intertie)	500	NVEP Substations: Eagle 120 kV (NVEP), I	Geothermal	Northern_Nevada_Geothermal	225	-	**225**
East of Pisgah Study Area	Eldorado	230	NVEP substations	Geothermal	Northern_Nevada_Geothermal	100	-	**100**
PG&E North of Greater Bay Study Area	Fulton	230	In-CAISO	Geothermal	Solano_Geothermal	56	-	**56**
PG&E North of Greater Bay Study Area	Geysers	230	In-CAISO	Geothermal	Solano_Geothermal	83	-	**83**
East of Pisgah Study Area	Gondor (or other IPP Interties)	345	NVEP substations	Geothermal	Northern_Nevada_Geothermal	80	-	**80**
SCE Eastern Study Area	IID System (Mirage Intertie)	230	IID System: Bannister 230 kV (IID), Midw	Geothermal	Greater_Imperial_Geothermal	850	-	**850**
SDG&E Study Area	IID System (Imperial Valley Intertie)	230	IID System	Geothermal	Greater_Imperial_Geothermal	345	-	**345**
PG&E North of Greater Bay Study Area	Summit	115	NVEP substations	Geothermal	Northern_Nevada_Geothermal	40	-	**40**
SCE Northern Area	Antelope	230	In-CAISO	Onshore Wind	Tehachapi_Wind	3	-	**3**
PG&E North of Greater Bay Study Area	Birds Landing	230	In-CAISO	Onshore Wind	Solano_Wind	90	45	**135**
PG&E Fresno Study Area	Cabrillo	115	In-CAISO	Onshore Wind	Carrizo_Wind	99	-	**99**

https://efiling.energy.ca.gov/GetDocument.aspx?tn=251044&DocumentContentId=85982

Resources mapped to the transmission zones



Northern CA Offshore Wind
- Total 14,600 MW

PG&E North of Greater Bay
- Total 6,649 MW

Northern Nevada Geothermal
- North of GB 40 MW
- East of Pisgah 405 MW
- North of Lugo 13 MW

Wyoming and/or Idaho Wind
- Total 6,671 MW

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- Total 12,266 MW

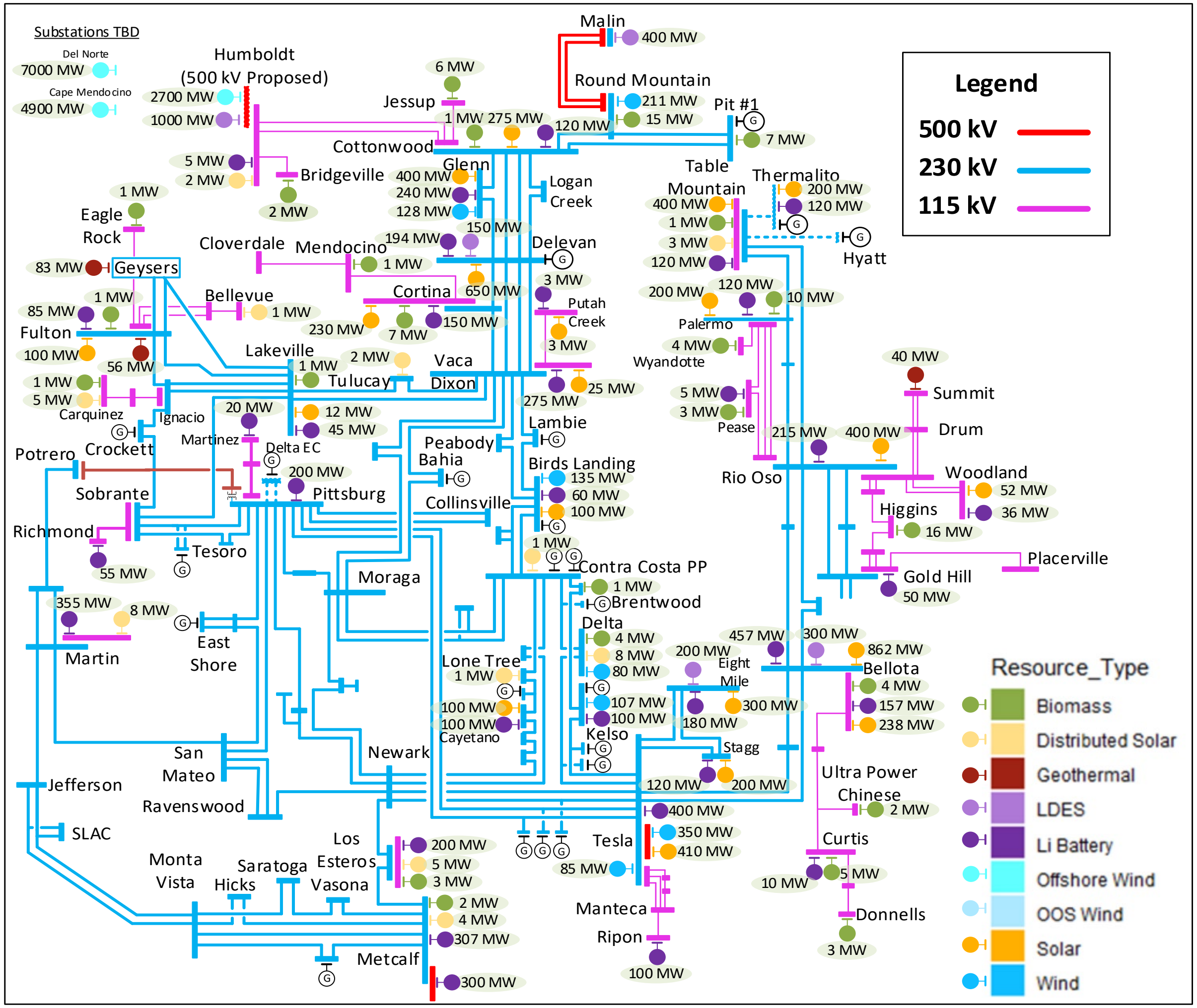
IID
- Total 4,001 MW

Portfolio Mapping

- Final dashboard for the mapping results of the 2045 Scenario for the update to the 20-Year Transmission Outlook
  - https://efiling.energy.ca.gov/GetDocument.aspx?tn=251044&DocumentContentId=85982

- Updated mapping based on CAISO defined and studied Transmission Areas were presented in the ISO Stakeholder meeting on September 27, 2023
  - http://www.caiso.com/InitiativeDocuments/CAISOPresentation-2023-2024TransmissionPlanningProcess-Sep27-2023.pdf

2045 Scenario: PG&E Greater Bay and North of Greater Bay (example)



FCDS

24,274 MW

Total

27,927 MW

Out-of-State Wind Modelling Approach (1/2)

- 12,000 MW of Out of State wind is included in the 20-year outlook portfolio which is the same amount as the last 20-year outlook
- New transmission projects will be needed to bring 3,500 MW of Wyoming wind and ~2,900MW of New Mexico wind to the CAISO system

Study	**Substation**	**Resource Type/ Location**	**Out-of-CAISO Transmission Utilized**	**Generation (MW)**
2023-2024 TPP	Mead 230 kV	SW Wind Ext Tx	Existing Tx	300
	Palo Verde 500 kV	SW Wind Ext Tx	Existing Tx	119
	Eldorado 500 kV	SW Wind Ext Tx	Existing Tx	371
	Eldorado 500 kV	Wyoming Wind	New Tx (TransWest Express)	1,500
	Harry Allen 500 kV	Idaho Wind	New Tx (SWIP North)	1,000
	Palo Verde 500 kV	New Mexico Wind	New Tx (SunZia)	2,328
20-year outlook mapping additions	Unknown Substation(s)	Wyoming Wind	New Tx (TBD)	3,500
	Unknown Substation(s)	New Mexico Wind	New Tx (TBD)	2,882
			Total	**12,000**

California ISO

Out-of-State Wind Modelling Approach (2/2)

- The new transmission projects could either bring the out-of-state wind to the border of the ISO system, requiring additional transmission within the ISO system, or could be brought to interconnection points within the ISO, such as Tesla and Lugo substations as examples.
- New transmission projects could potentially facilitate coordination with LADWP and BANC to bring in additional out-of-state wind that they may be required for their resource portfolios.
- A high level assessment on both alternatives will be performed as part of the 20-year outlook assessment

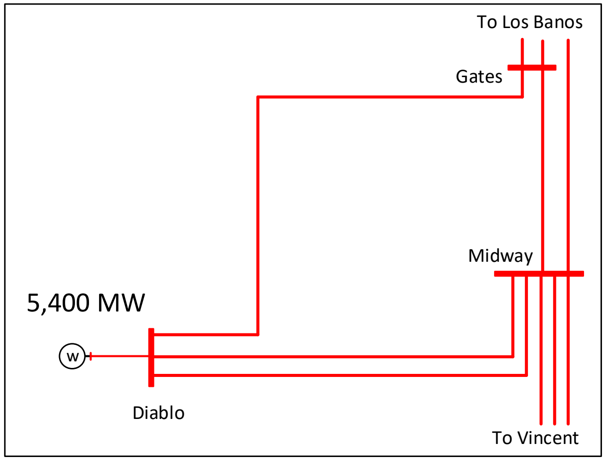
Offshore Wind Resources

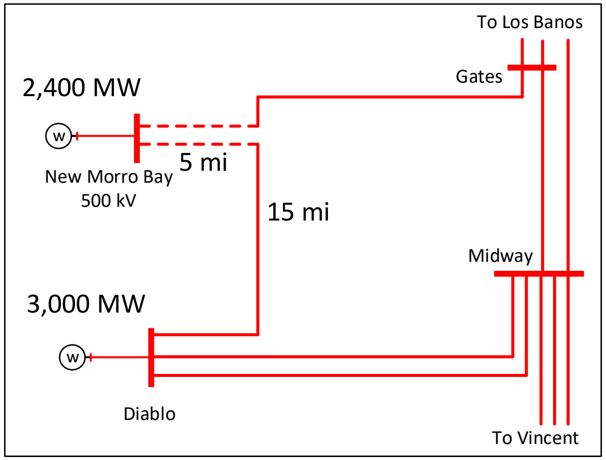
- 20,000 MW of offshore wind is included in the 20-year outlook portfolio

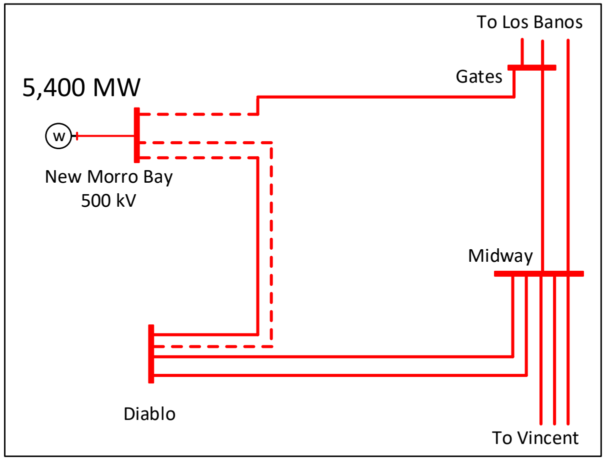
CAISO Substation	Resource Area	Generation (MW)
Diablo 500 kV or proposed Morro Bay 500 kV	Morro Bay Offshore Wind	5,400
Humboldt 500 kV (Proposed)	Humboldt Bay Offshore Wind	2,700
Unknown Substation(s)	Del Norte Offshore Wind	7,000
Unknown Substation(s)	Cape Mendocino Offshore Wind	4,900
	Total	**20,000**

Central Coast Offshore Wind Interconnection

- 5,400 MW of offshore wind is mapped to Diablo or proposed Morro Bay 500 kV substations.
- With the retirement of Diablo Canyon Nuclear Power Plant, three potential alternatives to interconnect the 5,400 MW OSW in Central Coast could be considered



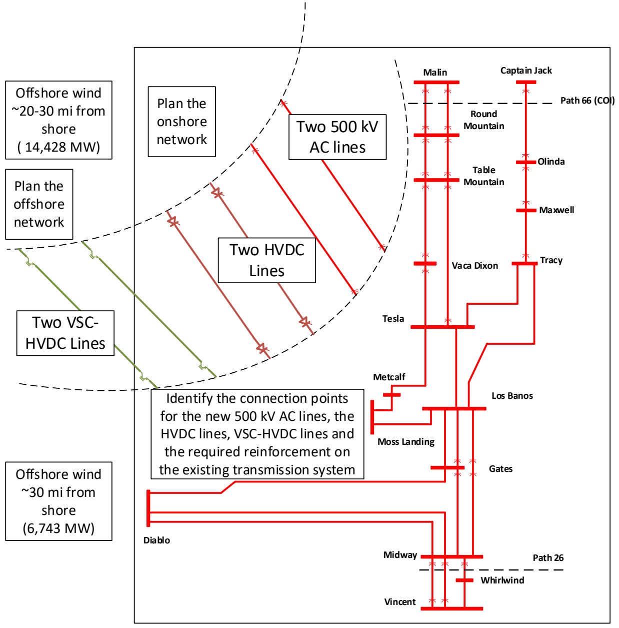




Transfer Path for North Coast OSW in the 20-year Outlook

- Based on ISO Planning Standards
  - Maximum generation tripping under N-1 contingency is 1,150 MW
  - Maximum generation tripping under DCTL (N-2) is 1,400 MW
- The hybrid AC/DC solution will provide sufficient capacity as the transfer path for the 14,600 MW North Coast OSW in the portfolio for the updated 20-year outlook

High level assessment of a hybrid transfer path	
500 kV AC line to Fern Road	2
Onshore overhead VSC-HVDC to Collinsville	2
Offshore sea cable VSC-HVDC to Bay Area	2



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

Plan the onshore network

Two 500 kV AC lines

Plan the offshore network

Two HVDC Lines

Two VSC-HVDC Lines

Identify the connection points for the new 500 kV AC lines, the HVDC lines, VSC-HVDC lines and the required reinforcement on the existing transmission system

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

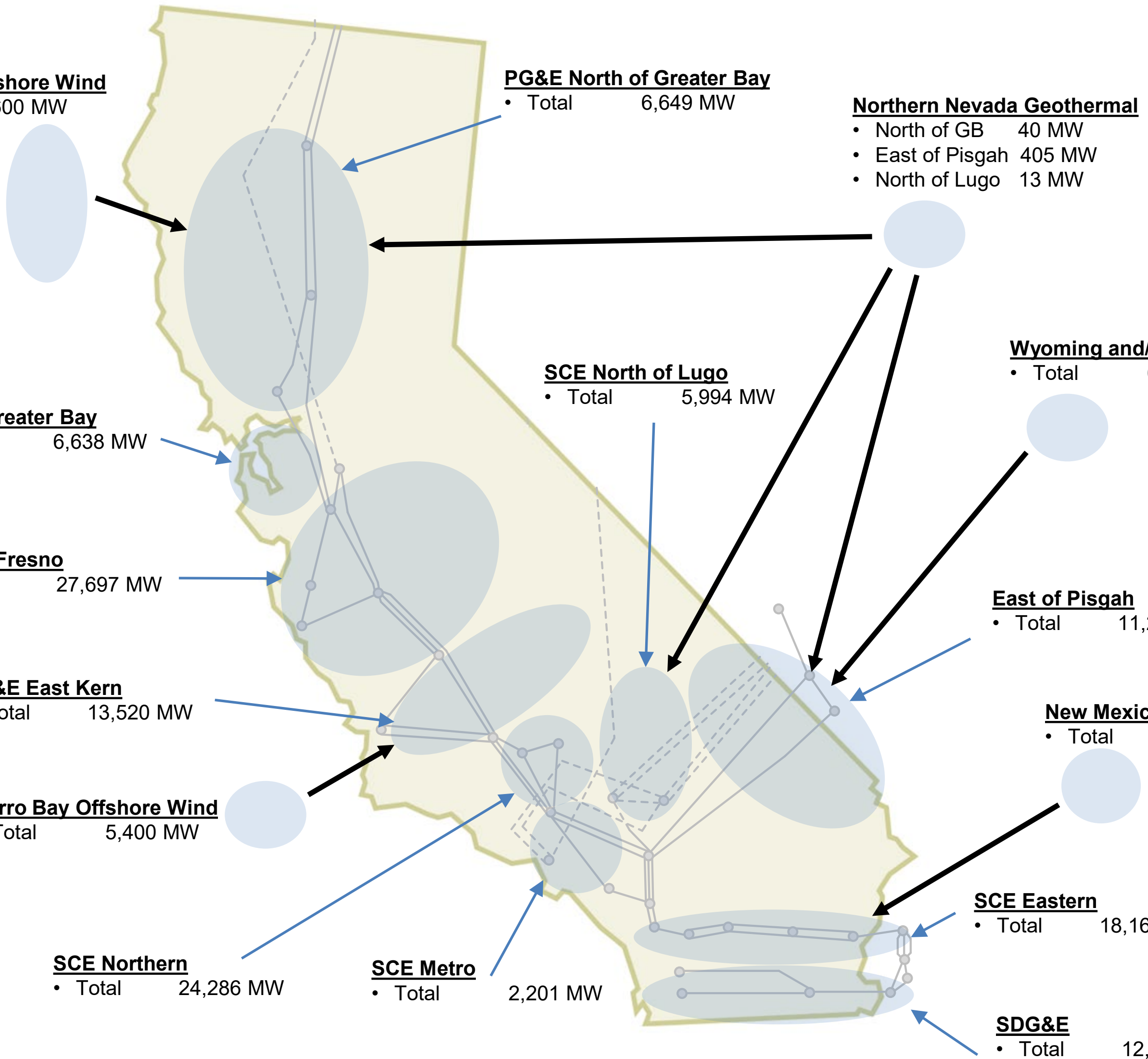
Reference: 2021-2022 Transmission Plan (page 255) http://www.caiso.com/Documents/ISOBoardApproved-2021-2022TransmissionPlan.pdf

High Level Technical Assessment

Study Scenarios

- Three base cases will developed for the contingency analysis to identify the potential transmission enhancement requirements.
  - Net Peak (HSN)
    - based on the HSN in deliverability studies and reflects the system in early evening summer conditions
  - Peak consumption (SSN)
    - based on the SSN in deliverability studies and reflects the system in early afternoon summer conditions
  - Off Peak
    - reflects the system in the middle of the day in spring when electricity consumption is low while the solar and BTM PV generation is high

Resources mapped to the transmission zones



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Load Forecast in 2045

Study Scenario	Date/Time	TAC Area	Baseline_ Consumption	BTM_PV	BTM_ Storage	LDV3	MDHD3	AAEE3	AAFS3	System Load (1-in-2)	System Load (1-in-5)
Net Peak Load (HSN)	9/5/2045 HE19	PG&E	24,520	-45	-647	3,546	828	-1,402	732	27,532	28,758
		SCE	26,612	-2	-363	3,190	698	-1,600	412	28,948	30,279
		SDG&E	5,163	0	-156	652	63	-290	32	5,464	5,723
		CAISO	56,450	-46	-1,166	7,388	1,589	-3,291	1,176	62,100	**64,923**
Peak Consumption (SSN)	9/5/2045 HE14	PG&E	26,043	-15,980	36	5,804	1,383	-1,452	302	16,136	17,438
		SCE	30,503	-10,439	-1	4,824	1,239	-1,986	307	24,445	25,970
		SDG&E	5,653	-3,642	2	1,588	200	-376	33	3,459	3,741
		CAISO	62,356	-30,061	37	12,216	2,822	-3,815	642	44,197	**47,315**
Off Peak	4/15/2045 HE13	PG&E	13,993	-16,744	34	3,615	1,134	-935	358	1,455	1,455
		SCE	12,683	-11,550	3	3,110	1,015	-1,027	290	4,524	4,524
		SDG&E	2,737	-3,944	-2	942	163	-215	29	-291	-291
		CAISO	29,489	-32,238	35	7,666	2,312	-2,177	677	5,764	**5,764**

- The forecast installed BTM-PV in 2045 is ~41,000 MW
- The load forecast under HSN condition in 2045 is 13%-14% higher than 2035
- Starting with 2035 base cases developed in the 2023-2024 TPP, the baseline and load modifiers will be scaled to match the 2045 forecast

Dispatch and high level technical studies

- Resource dispatch based upon dispatch in policy studies in 2023-2024 transmission planning process for different study cases

- Contingency analysis will be performed based on the following methodology and assumptions:
  - N-0 base case with no contingency
  - 500 kV contingencies were evaluated for N-1 and N-1-1 analysis
  - 230 kV contingencies were evaluated for N-1 analysis across the system and only for Bay Area and LA Basin for N-1-1 analysis
  - No RAS action was modelled in this study
  - Generators were not re-dispatched before or after the contingencies
  - Only power flow analysis was performed focusing on thermal overloads.
  - It is assumed that local area overloads are addressed with local transmission upgrades

Generation scenarios for HSN

- The high level assumptions on HSN generation scenarios
  - The CAISO load is around ~65,000 MW
  - No solar generation and no BTM-PV under HSN scenario
  - The remaining gas will only be dispatched when wind and other resources are not sufficient to supply the load
  - Other generation such as hydro are kept at the same level as the starting point base case (2035 summer peak case)

	Wind	**Import**	**BESS**	**Gas**
2045-HSN_00	High	Ave	Ave	~0
2045-HSN_01	High	Low	High	~0
2045-HSN_02	High	Low	Ave	As needed
2045-HSN_03	Low	Low	~Max	As needed

Load and Generation in GBA and LA Basin

	Greater Bay Area		LA Basin	
Base Case	**Load**	**Generation**	**Load**	**Generation**
2035 SP	12,804	5,949	20,937	6,221
2045-HSN-00	14,166	3,255	23,692	2,964
2045-HSN-01		3,732		4,592
2045-HSN-02		5,838		4,817
2045-HSN-03		4,949		6,449

	Wind	**Import**	**BESS**	**Gas**
2045-HSN_00	High	Ave	Ave	~0
2045-HSN_01	High	Low	High	~0
2045-HSN_02	High	Low	Ave	As needed
2045-HSN_03	Low	Low	~Max	As needed

Summary of thermal overloads identified in preliminary study Results

Fern Road to Tesla 500 kV lines	Eldorado - McCullough 500 kV	Panoche - Las Aguilas - Moss Landing 230 kV lines	Eagle Rock - Gould and Eagle Rock - Sylmar 230 kV
Vaca Dixon 500/230 kV Txes and the 230 kV lines out of Vaca Dixon (Lakeville, Bahia, Parkway)	Hassayampa - North Gila - Imperial Valley	Monta Vista - Hicks, Saratoga - Vasona, Metcalf - Hicks	La Fresa - El Nido #3 or #4 230 kV
Tesla 500/230 kV Txes	Lugo - Victorville 500 kV	Delta - Contra Costa 230 kV line	Del Amo - Hinson 230 kV
Metcalf 500/230 kV Txes	Pisgah - Lugo 230 kV	Metcalf - Moss Landing 230 kV #1 or #2	La Fresa - Hinson 230 kV
Moss Landing 500/230 kV Tx	Calcite - Lugo 230 kV	Eldorado - Lugo 500 kV	La Fresa - La Cienega 230 kV
Tracy 500/230 kV Txes	Tesla - Los Banos	Lugo - Mira Loma #2 or #3 500 kV	Lighthipe - Mesa 230 kV
Round Mountain - Cottonwood 230 kV	Manning - Los Banos	Eco - Miguel 500 kV	Overload on the underlying 230 kV in San Diego area
Table Mountain - Palermo 230 kV	Warnerville - Wilson 230 kV	Serrano - Mira Loma #2 500 kV	
Tesla - Metcalf 500 kV	Moss Landing - Las Aguilas – Panoche 230 kV	Devers 500/230 kV Tx #1 or #2	
Tesla - Sand Hill - Delta, Tesla - Newark, Tesla - Eight Mile	Los Banos - Westly 230 kV	Rancho Vista #3 or #4 500/230 kV Tx	
Birds Landing – Contra Costa	Tracy - Los Banos 500 kV	Third Transformer at N. SONGS	
Embarcadero - Potrero 230 kV	Metcalf – Los Esteros 230 kV	Talega - S. ONOFRE #2	
East Shore - San Mateo	Gates – Manning 500 kV	Barre - Ellis #1 or #2	

http://www.caiso.com/InitiativeDocuments/Presentation-20-Year-Transmission-Outlook-Jan42024.pdf

Overview of updates

- Scope of mitigation measures to address identified overloads
- Preliminary results of alternative connections of out of state wind
- Scope of offshore wind interconnection options
- High level cost estimates

Per Unit Cost Estimates

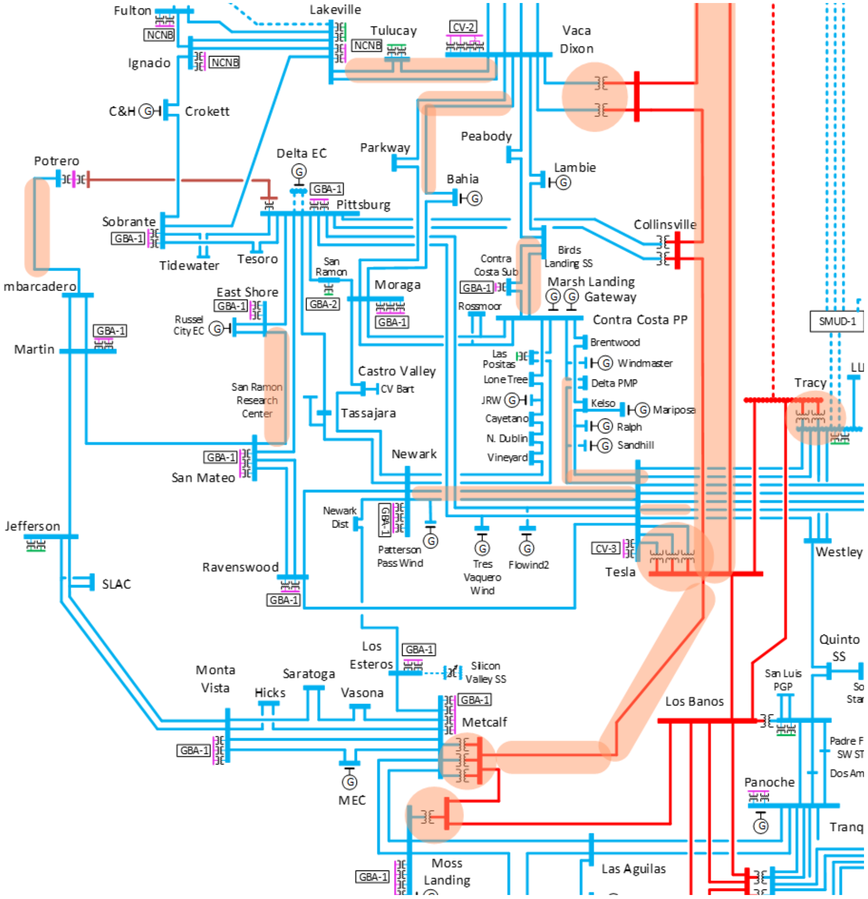
Transmission Infrastructure	**Cost Estimate**
500 kV Substation/expansion	$100 M - $150 M
500 kV AC line in the mountain	$7 M - $10 M/mi
500 kV AC line in the valley	$5 M - $7 M/mi
HVDC line onshore in the mountain	$7 M - $10 M/mi
HVDC converter station (2GW)	$400 M - $600M
HVDC converter station (3GW)	$600 M - $900M
HVDC offshore cable (2GW)	$7 M - $10 M/mi
High capacity 230 kV Cable	$15 M - $20 M/mi
Reconductor 230 kV Lines	$3.5 M – $4.5 M/mi
Reconductor 500 kV Lines	$3.5 M – $5 M/mi

Mitigation Measures

(Upgrades to the existing ISO footprint)

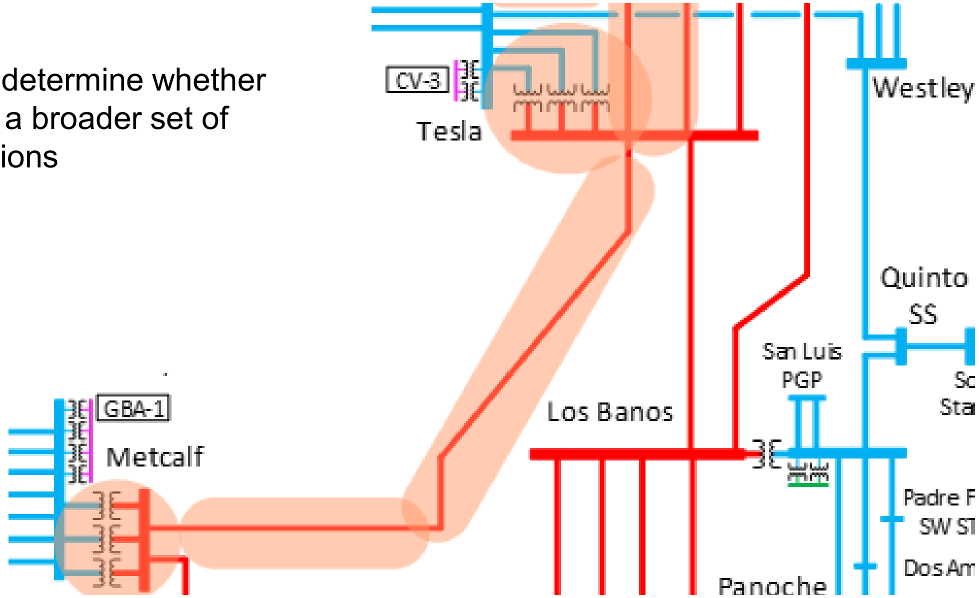
Greater Bay Area 500/230 kV Transformers and 230 kV lines upgrades

- Reliability Assessment Need
  - There are eleven 500/230 kV transformers supplying power to the Greater Bay area that are overloaded under normal or contingency conditions under certain scenarios.
  - Nine 230 kV line overloads are identified under normal or contingency conditions. These lines transfer power from 500 kV to 230 kV system to serve the load under low local generation scenarios.
- Project Scope
  - Upgrade the 500/230 kV transformers
  - Reconductor overloaded 230 kV lines (total of around 238 miles) with advanced conductors
- Estimated Project Cost
  - \$0.55 B – \$1.1 B for transformers upgrades
  - \$0.83 B – \$1.07 B for line reconductoring
- Further analysis
  - Detail local studies may identify that additional upgrades may be required on 230/115 kV transformers and 115 kV lines in the area



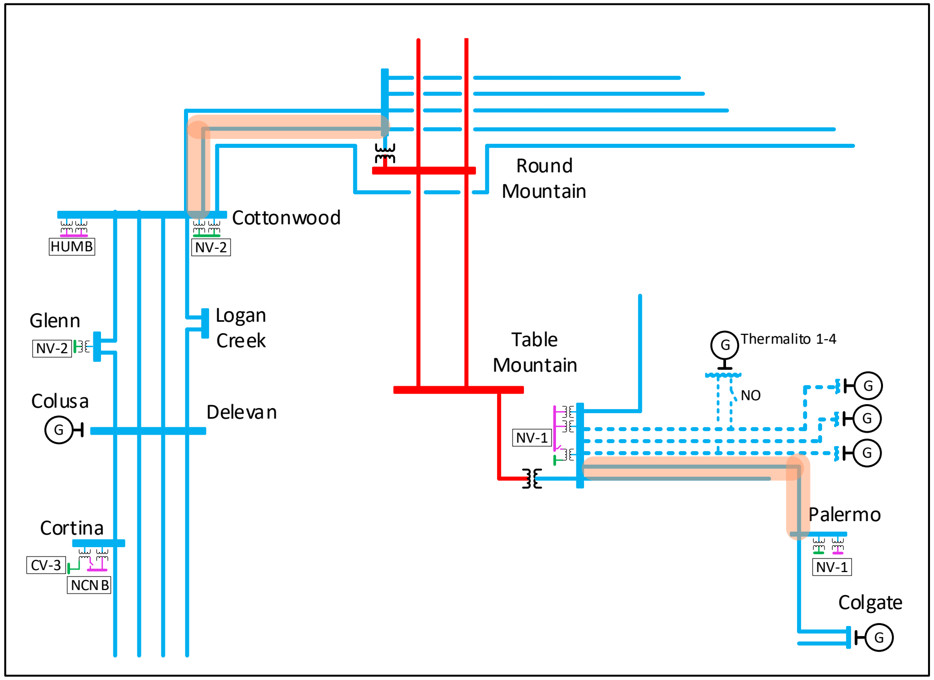
Tesla – Metcalf 500 kV Line

- Reliability Assessment Need
  - The line overloads under N-1 contingency under no gas scenarios (HSN-00 and HSN-01)
- Project Scope
  - Either build a second Tesla – Metcalf 500 kV line or reconductor the 36 miles line with advanced conductors
- Estimated Project Cost (second 500 kV line)
  - $0.21B - $0.28B
- Further analysis
  - Detailed studies will be required to determine whether reconductoring will be sufficient for a broader set of contingencies and operating conditions



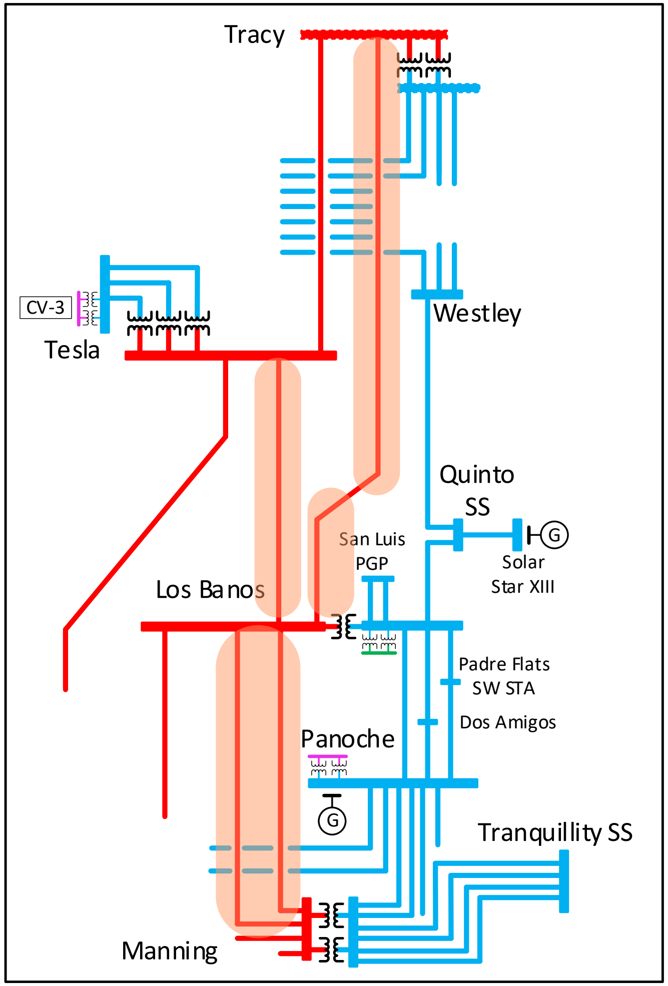
Round Mountain – Cottonwood 230 kV line Table Mountain – Palermo 230 kV Line Upgrades

- Reliability Assessment Need
  - The Round Mountain – Cottonwood 230 kV line and Table Mountain – Palermo 230 kV lines are overloaded under a scenario with no gas and average BESS (HSN-00) scenario
- Project Scope
  - Reconductor Round Mountain – Cottonwood 230 kV line (~34mi) and Table Mountain – Palermo 230 kV line (~15 mi) with advanced conductors
- Estimated Project Cost
  - \$0.17 B – \$0.22 B for line reconductoring
- Further analysis
  - Detail local studies may identify that additional upgrades may be required on 230/115 kV transformers and 115 kV lines in the table mountain area



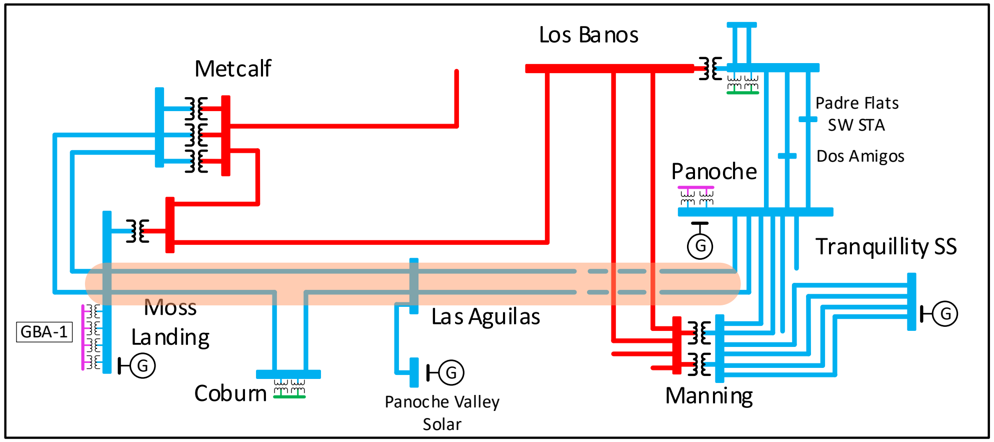
Manning – Los Banos – Tracy 500 kV Line

- Reliability Assessment Need
  - The Los Banos – Tracy, Los Banos – Tesla and both Los Banos – Manning 500 kV lines are overloaded under a scenario with low wind, low import and max BESS (HSN-03) scenario under normal and contingency conditions
- Project Scope
  - Build a new 500 kV line from Manning to Los Banos and from Los Banos to Tracy 500 kV substations. Total line length will be ~107 mi
- Estimated Project Cost
  - $0.58 B – $0.8 B
- Further analysis
  - In addition to this project, the Manning – Moss Landing 500 kV line project will also be required to help address the identified overloads in the area.



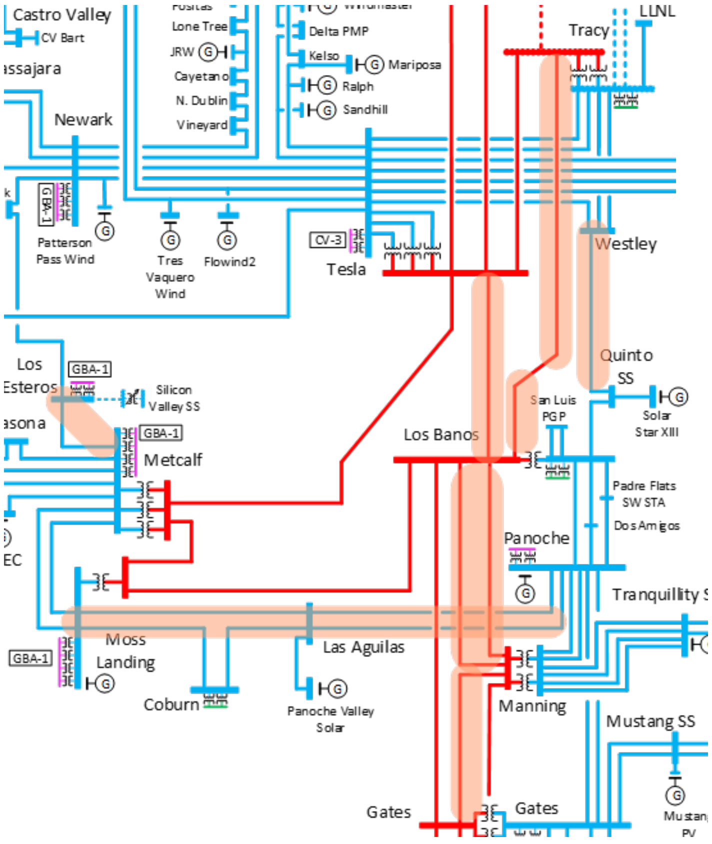
Manning – Moss Landing 500 kV Line

- Reliability Assessment Need
  - The Moss Landing – Las Aguilas 230 kV lines and Panoche – Las Aguilas 230 kV lines are overloaded under a scenario with low wind, low import and max BESS (HSN-03) scenario under normal and contingency conditions
- Project Scope
  - Build a new ~70 mi, 500 kV line from Manning to Moss Landing 500 kV substations.
- Estimated Project Cost
  - $0.38 B – $0.52 B
- Further analysis
  - More detailed analysis would be required to study whether the existing 230 kV lines from Panoche to Moss Landing are still needed after the implementation of the above project. Also a detailed analysis may identify that the flow control from an HVDC link from Manning to Moss Landing would be an optimal overall solution as compared to an 500 kV AC line.



Loop in Midway – Manning 500 kV line into Gates Add series compensation to Gates – Los Banos #3

- Reliability Assessment Need
  - The Gates – Manning 500 kV line is overloaded under a scenario with low wind, low import and max BESS (HSN-03) under normal and contingency conditions. Manning – Los Banos 500 kV lines are also overloaded under such scenario.
- Project Scope
  - Loop-in the Midway – Manning 500 kV line into Gates substation and add series capacitors on the Gates – Los Banos 500 kV line.
- Estimated Project Cost
  - $0.06 B – $0.08 B
- Further analysis
  - A more detailed feasibility analysis would be required to determine the feasibility of looping-in the Midway – Manning 500 kV line into Gates substation regarding room for expansion and potential short circuit issues. A substation engineering assessment would be required to determine whether there is room for addition of series capacitors at Los Banos and Gates substations.



Out of State Wind Interconnection

Wyoming Wind

- A total of 5,000 MW Wyoming wind is identified in the portfolio
  - 1,500 MW is mapped to Eldorado with TransWest Express
  - 3,500 MW is not mapped to any substation
    - 1,500 MW to Tesla and 2,000 MW to Eldorado
      - Two new ~ 750 mi HVDC lines will be required for interconnection (one to Tesla and one to Eldorado)
      - Trout Canyon – Lugo would be required as mitigation measure
      - Cost estimate: $8.1 B – $10.4 B

New Mexico Wind

- A total of 5,210 MW New Mexico wind is identified in the portfolio
  - 2,328 MW is mapped to Palo Verde with SunZia
  - 2,882 MW is not mapped to any substation
    - Option 1: 2,882 MW to Palo Verde
      - One new ~ 550 mi HVDC lines will be required for interconnection
      - Palo Verde – Devers or Lugo 500 kV AC line would be required as mitigation measure
      - Cost estimate: $4.9 B – $6.0 B
    - Option 2: 2,882 MW at Lugo
      - One new HVDC line will be required for interconnection
      - Cost estimate: $3.5 B – $4.8 B

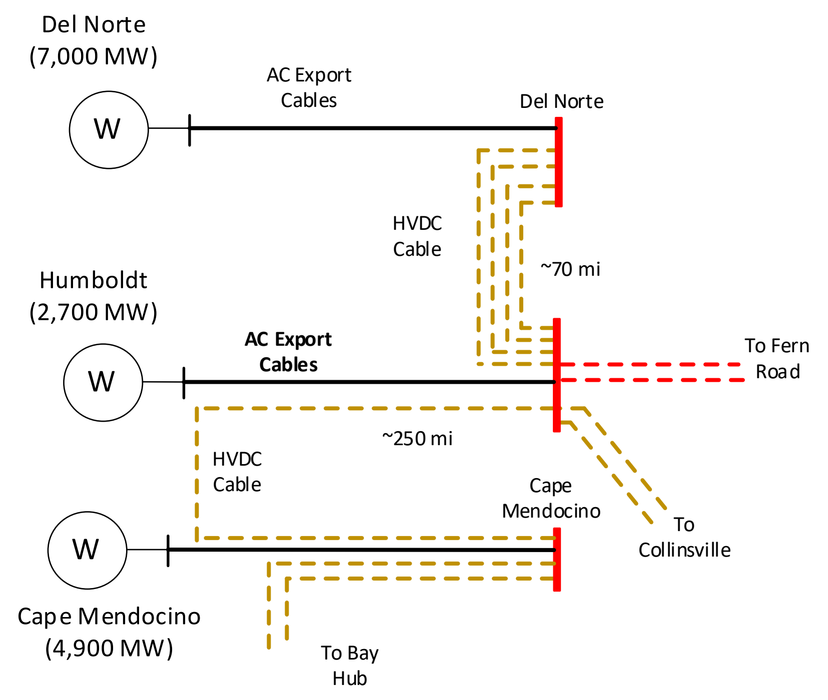
Offshore Wind Interconnection

Transmission Options for Integration of North Coast Offshore Wind (1/2)

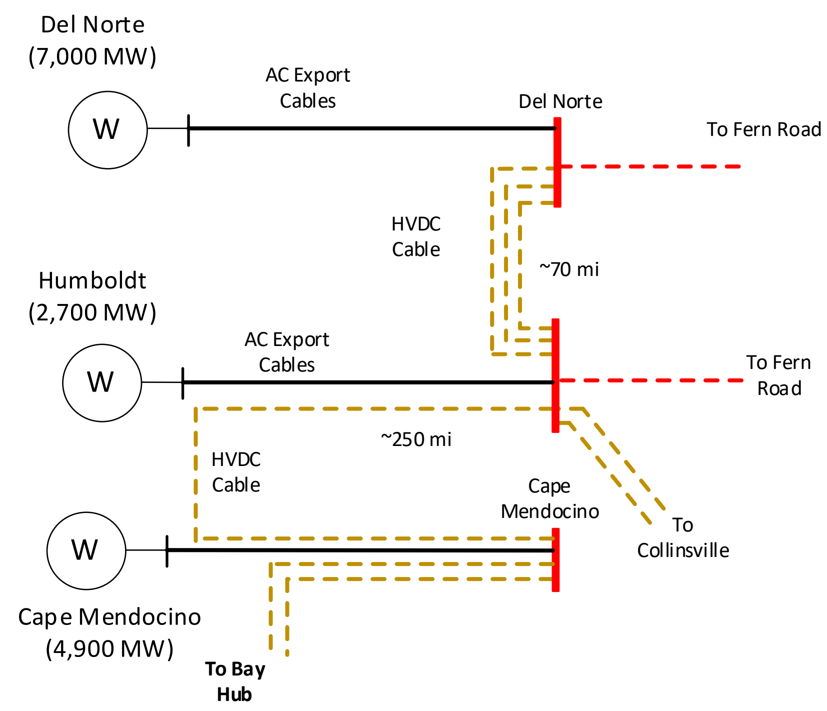
- The CPUC Modelling Assumptions for the 2023-2024 TPP provided the following guidance regarding offshore wind development in the North Coast:
- "... offshore wind have been mapped to ... three separate locations on the North Coast (Humboldt, Del Norte, and Cape Mendocino) to allow CAISO to identify transmission upgrades and cost information necessary to further advance offshore wind planning in line with the state's offshore wind policy goals."

Transmission Options for Integration of North Coast Offshore Wind (2/2)

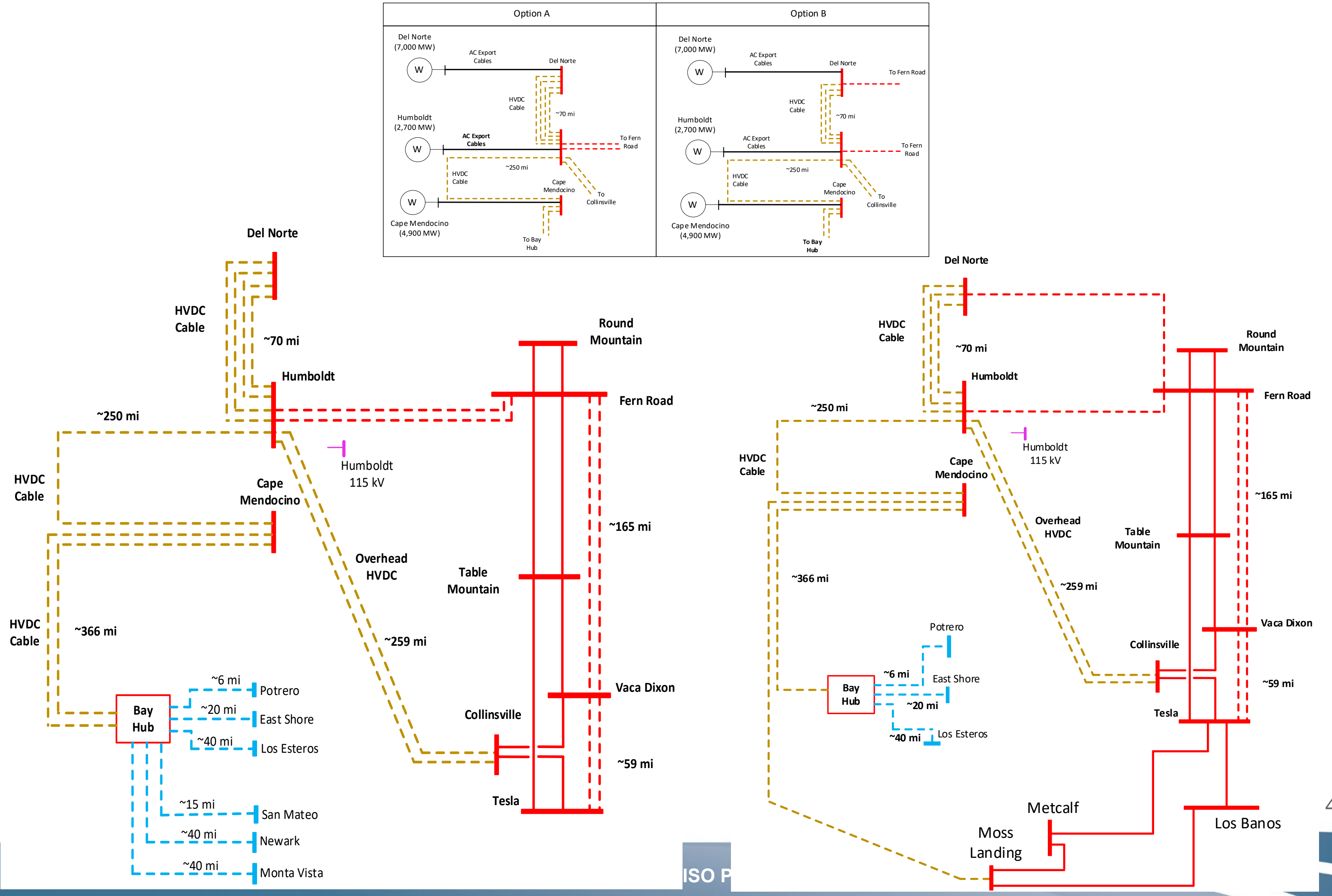
Option A



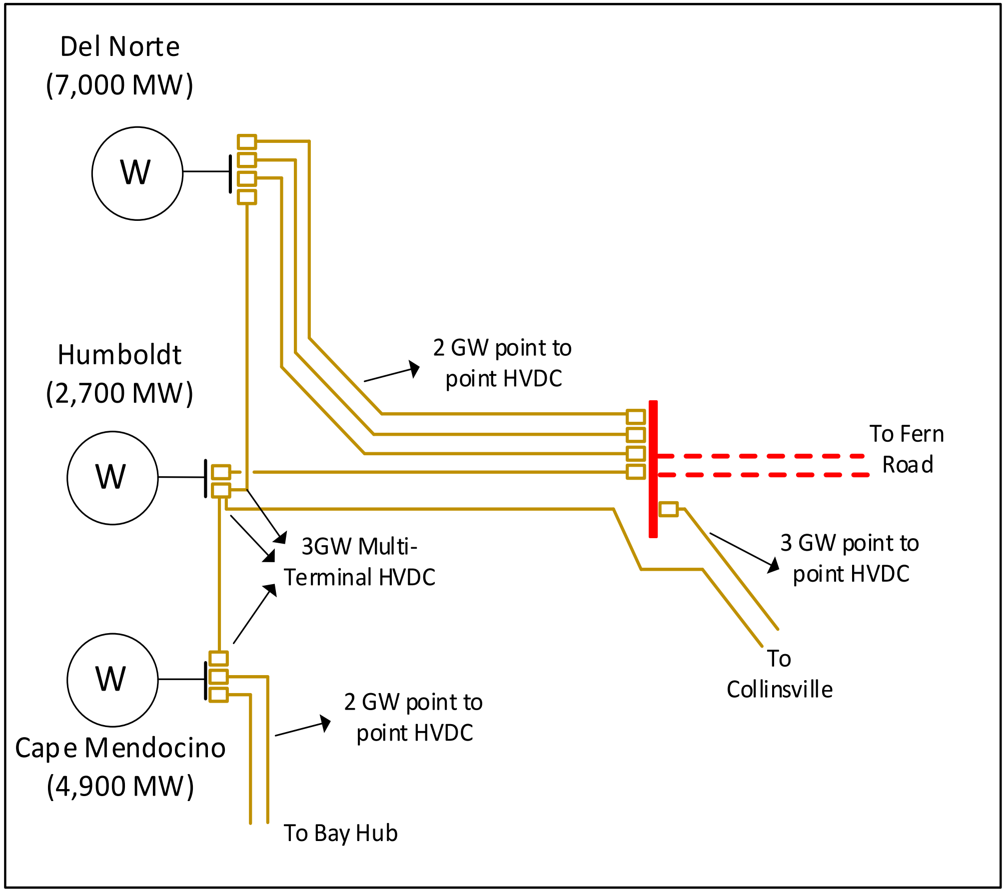
Option B



Overall Transmission Concept for Connecting North Coast Offshore Wind



Example of Overall Transmission Concept based on Floating Offshore HVDC Technology



High Level Cost estimate for Offshore wind Interconnection

- Four transmission alternatives for integration of north cost offshore wind are considered based on:
  - Interconnection of one subsea HVDC to Moss Landing or both going to Bay Hub
  - Interconnection of one 500 kV AC line from Fern Road going to Del Norte or both going to Humboldt
- All cost components are provided in the table

	Cost ($M)
2nd 500 kV line From Humboldt to Fern Road	980 – 1,400
500 kV line From Del Norte to Fern Road	1,540 – 2,200
Cape Mendocino to Bay Hub HVDC	2,562 – 3,660
Cape Mendocino – Moss Landing HVDC line	2,996 – 4,280
2GW HVDC converter station (12 – 14)	4,800 – 8,400
Del Norte to Humboldt HVDC (3 – 4 HVDC lines)	1,470 – 2800
Cape Mendocino - Humboldt HVDC line	1,750 – 2,500
500 kV HVDC line to Collinsville	1,813 – 2,590
3GW HVDC converter station (4)	2,400 – 3,600
230 kV AC cables to Potrero, East Shore, Los Esteros	990 – 1,320
230 kV AC cables to San Mateo, Newark, Monta Vista	1,425 – 1,900
Fern Road to Vaca Dixon to New Tesla (2 x 500 kV lines)	2,532 – 3,545

High Level Cost estimate for Offshore wind Interconnection

- Four transmission alternatives for integration of north cost offshore wind are considered based on:
  - Interconnection of one subsea HVDC to Moss Landing and one to Bay Hub or both going to Bay Hub
  - Interconnection of one 500 kV AC line from Fern Road going to Del Norte and one to Humboldt or both going to Humboldt
- Cost components for all alternatives are provided in the table

Cape Mendocino Connection	Cost ($M)
Cape Mendocino to Bay Hub HVDC	2,562 – 3,660
Cape Mendocino – Moss Landing HVDC line	2,996 – 4,280
2 GW HVDC converter station (6)	2,400 – 3,600
Cape Mendocino - Humboldt HVDC line	1,750 – 2,500
230 kV AC cables to Potrero, East Shore, Los Esteros	990 – 1,320
230 kV AC cables to San Mateo, Newark, Monta Vista	1,425 – 1,900

Del Norte Connection	Cost ($M)
2nd 500 kV line From Humboldt to Fern Road	980 – 1,400
500 kV line From Del Norte to Fern Road	1,540 – 2,200
2 GW HVDC converter station (6 – 8)	2,400 – 4,800
Del Norte to Humboldt HVDC (3 – 4 HVDC lines)	1,470 – 2800

Onshore Transmission	Cost ($M)
500 kV HVDC line to Collinsville	1,813 – 2,590
3 GW HVDC converter station (4)	2,400 – 3,600
Fern Road to Vaca Dixon to New Tesla (2 x 500 kV lines)	2,532 – 3,545

Summary and Conclusions

- A number of alternatives were studied to connect the offshore wind in the north coast to the CAISO system.
- A number of mitigation measures were tested to confirm they address the identified overloads across the system
- Following the implementation of the mitigation measures identified by the HSN scenarios, no reliability issues were identified in the SSN and Off peak scenarios that could not be addressed by redispatching of the generators. Detailed economic studies would be required to identify any potential economic project
- From high level cost estimate perspective, connection of the out-of-state wind to a substation closer to the load centers in CAISO system could potentially be beneficial as compared to interconnecting out of state wind power to a substation at CAISO border and then reinforcing CAISO system to deliver power from the border to the load centers. Such benefits could be significant if the project to deliver power from the CAISO border to CAISO load centers are HVDC lines.
- Further studies would be required to identify any potential transmission enhancement required for no/low gas scenario to enable BESS charging

20-Year Transmission Outlook - Update

- CEC Docketed “Final Staff Paper for the 2045 Scenario for the 20-Year Transmission Outlook” – July 13
- ISO stakeholder call – August 16
- The ISO provided updates at the 2023-2024 transmission planning stakeholder meetings:
  - September 26 and 27
- ISO stakeholder call – January 4, 2024
  - Comments due January 18, 2024
- ISO stakeholder call – April 18, 2024
  - Comments due May 2, 2024
- 20-Year Transmission Outlook Report – June 2024

Next Steps

Comments

- Comments due by end of day May 2, 2024

- Submit comments through the ISO's commenting tool, using the template provided on the process webpage:
  https://stakeholdercenter.caiso.com/RecurringStakeholderProcesses/20-Year-transmission-outlook-2023-2024

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.

Save the Date - California New Resource Implementation

We will host a hybrid California New Resource Implementation (NRI) stakeholder meeting on May 1, 2024.

We aim to bolster collaboration with our stakeholder community in preparation for the upcoming summer operations. Our objective is to improve transparency surrounding the NRI process and outline expectations.

If you plan to attend the working group in person, please **register** by end of day April 26, 2024.

The final agenda and a presentation will be available prior to the meeting on the **public forums webpage**.

The California ISO Stakeholder Symposium will be held on Oct. 30, 2024 at the Safe Credit Union Convention Center in Sacramento, California.

A welcome reception for all attendees will be held the evening of Oct. 29.

Additional information, including event registration and sponsorship opportunities, will be provided in a future notice and on the ISO’s website.

Please contact Symposium Registration at **symposiumreg@caiso.com** with any questions.