20 Year Transmission Outlook and Approach to Offshore Wind

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Stakeholder Engagement and Policy Specialist

August 16, 2023

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.

Stakeholder Call - Agenda

Topic	Presenter
Introduction	Caitlin McGee
20 Year Transmission Outlook	Jeff Billinton
Approach to Offshore Wind	Ebrahim Rahimi
Wrap-up & Next Steps	Catilin McGee

20-Year Transmission Outlook - Update

Jeff Billinton

Director, 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

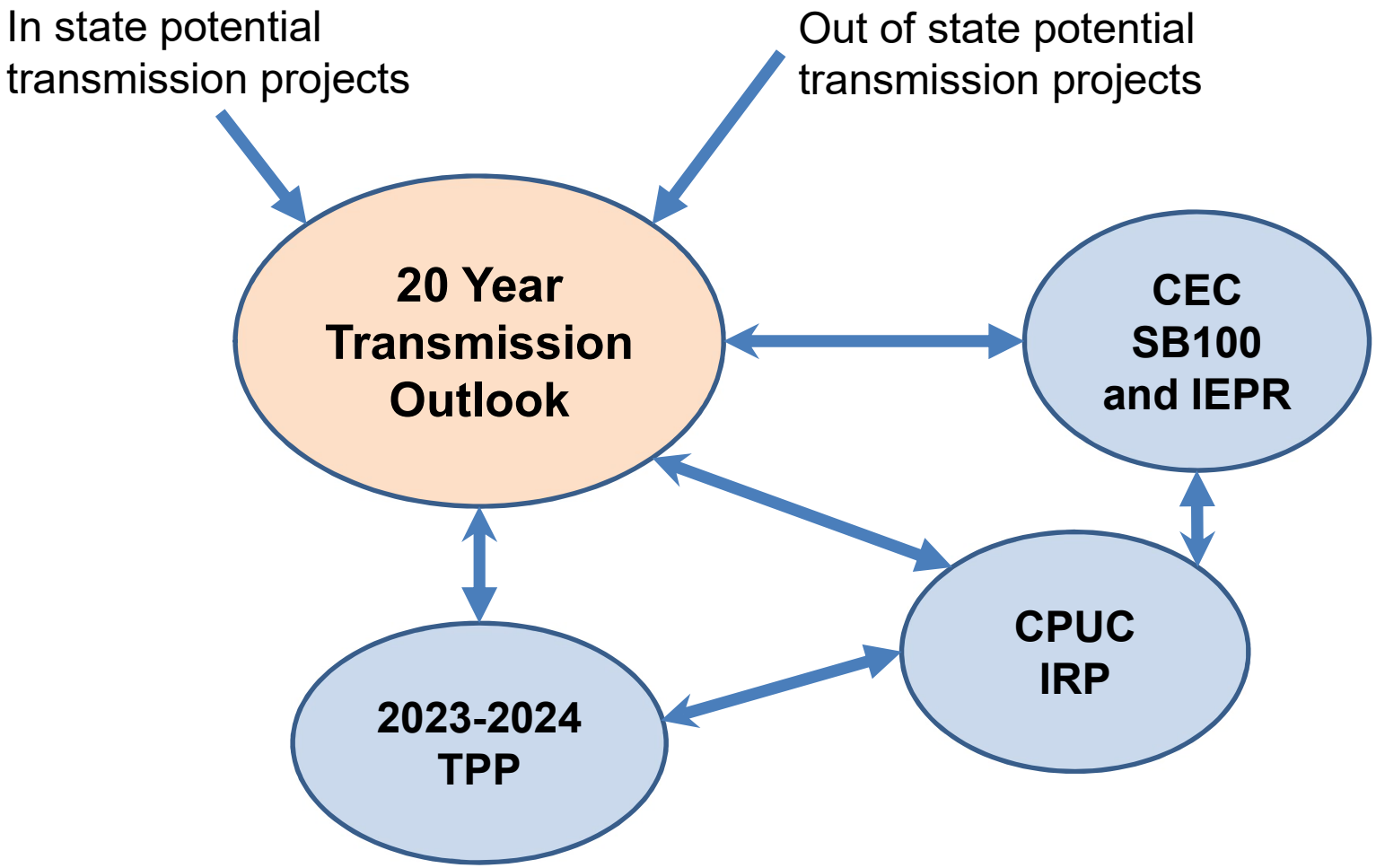
The 20-year transmission outlook provides a “baseline” architecture setting stage for future planning activities:

- 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

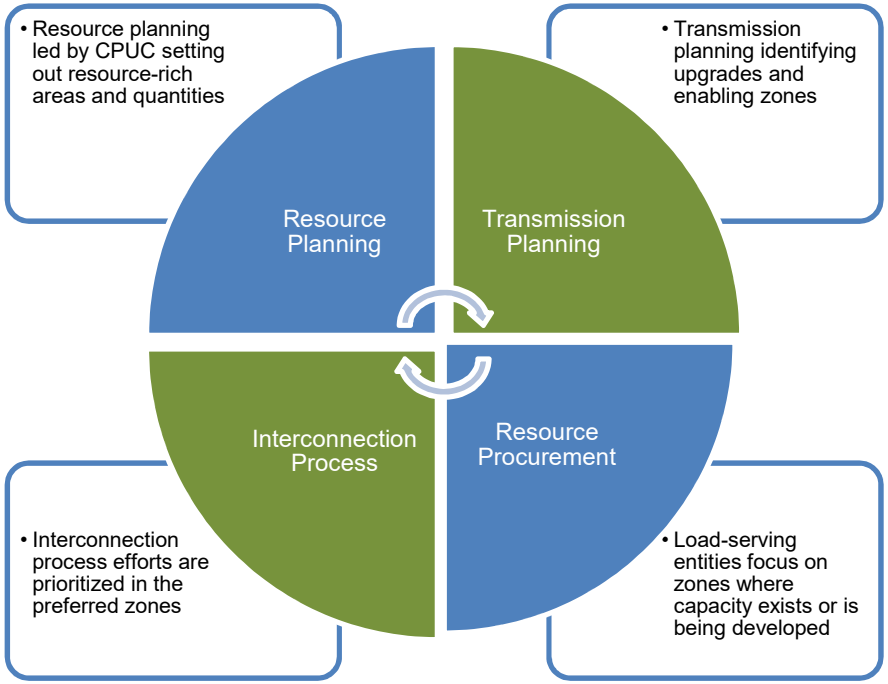
The 20-year transmission outlook update will be coordinated with the 2023-2024 transmission planning process

- The Outlook will include higher level technical studies to test feasibility of alternatives, and not the detailed level of comprehensive analysis that underpins the 10-Year Transmission Plan
- Accordingly the Outlook will coordinate with currently scheduled 10-Year Transmission Plan stakeholder sessions to the extent possible, and hold separate stakeholder sessions as appropriate
- Coordination with the California Energy Commission SB100 and California Public Utilities Commission IRP
- The process welcomes and will incorporate stakeholder input and consultation

Primary Paths for Coordination with Other Initiatives



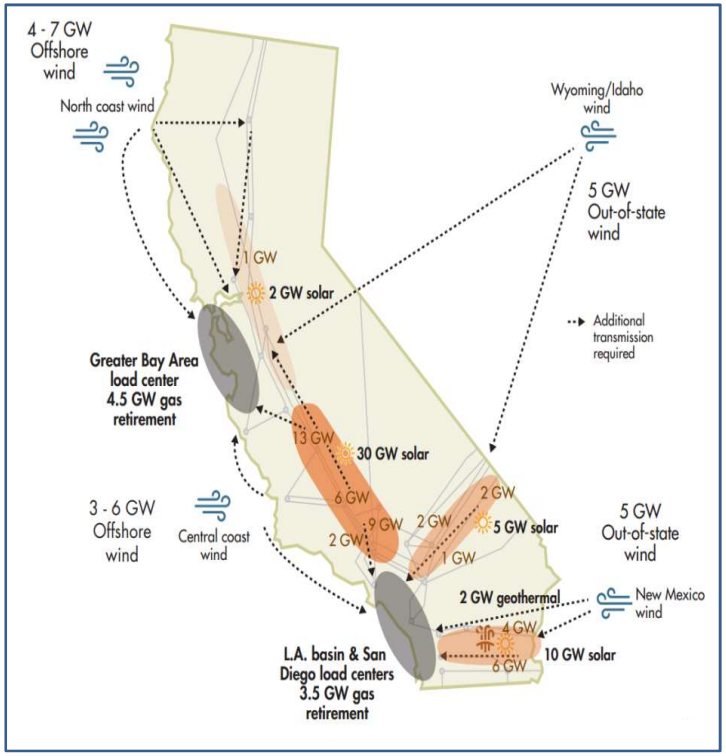
The 2022-2023 Transmission Plan addresses the rapidly escalating need for new resources and sets the foundation for a focused zonal approach to resource development



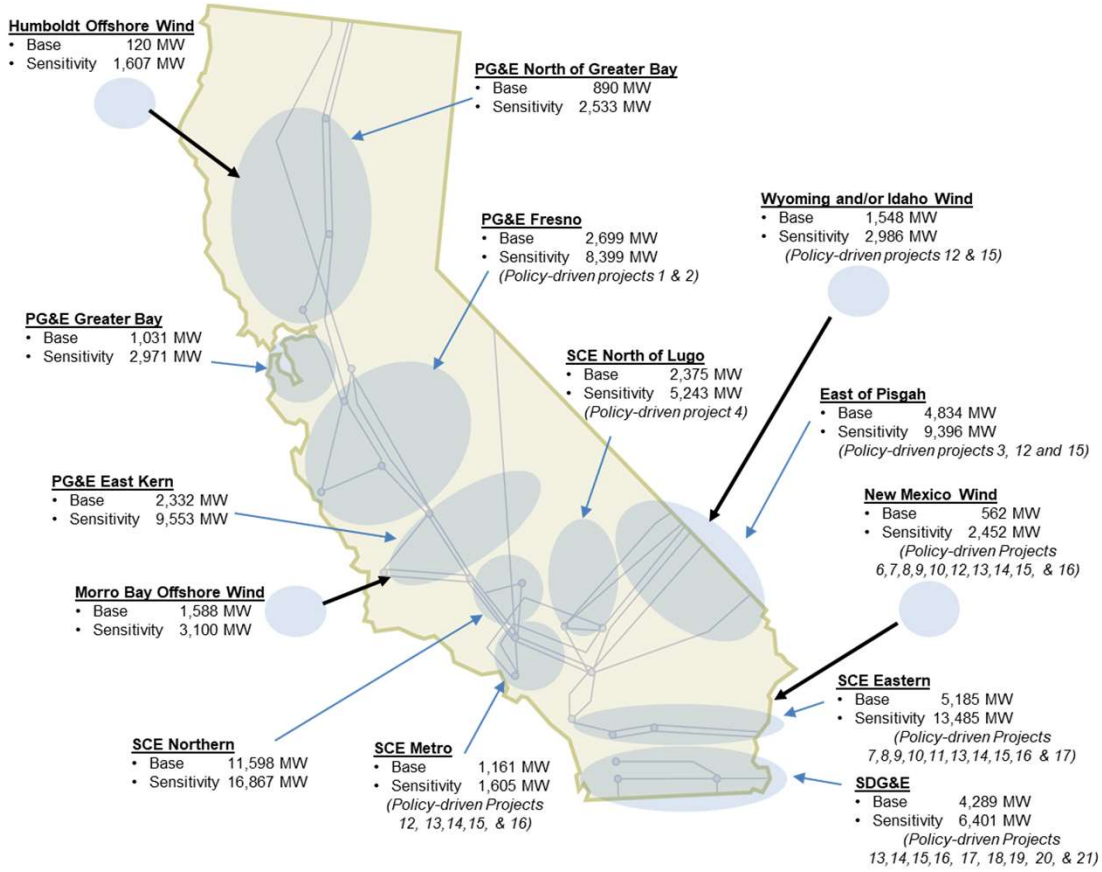
The strategic direction for transformational change in process alignment was established in the CPUC/CEC/ISO Memorandum of Understanding signed in December, 2022 to:

- Tighten the linkage between resource and transmission planning, procurement direction, and the ISO interconnection process to the greatest extent possible.
- Create formal linkage between CEC SB 100/IEPR activities and the ISO and CPUC processes
- Reaffirm the existing state agency and single forecast set coordination

2022-2023 transmission plan used a zonal approach which enables clear direction and prioritization



CAISO 20-year Transmission Outlook - 2022



CAISO 2022-2023 Transmission Plan

20-Year Transmission Outlook - Update

- The ISO will be undertaking an update of the 20-Year Transmission Outlook in parallel with ISO's 2023-2024 transmission planning process
- The update will be looking out to 2045 and will incorporate:
  - Updated portfolio
  - Updated load forecast
- Will include 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

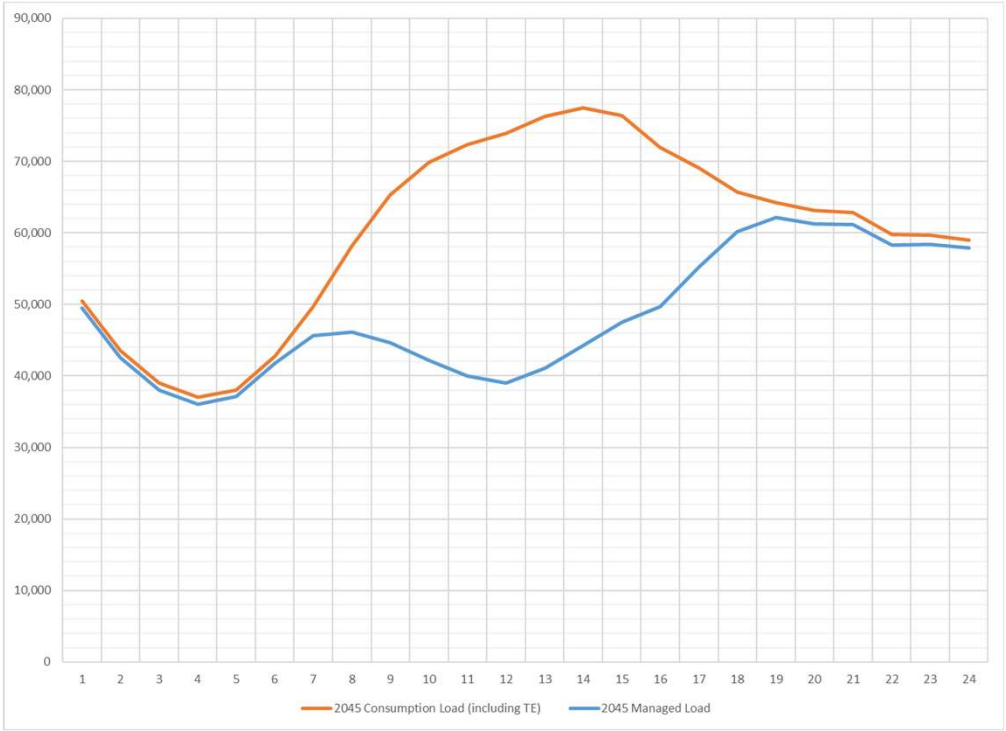
"The 2045 Scenario for the Update of the 20-Year Transmission Outlook staff paper describes a 2045 demand and resource scenario for use by the California Independent System Operator (California ISO) in the update of the 20-Year Transmission Outlook. The staff paper outlines the demand and resource assumptions within the scenario. The staff paper 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

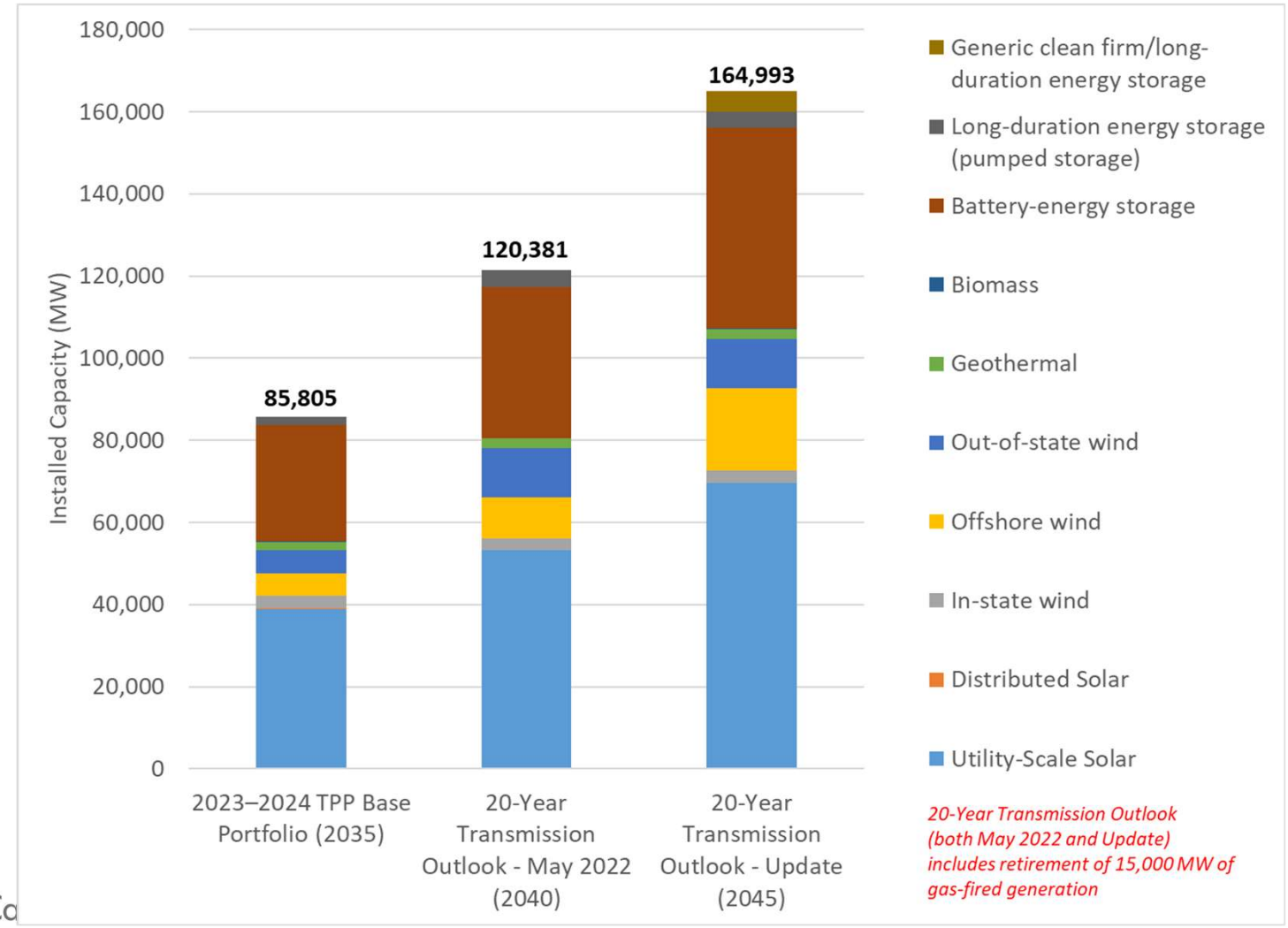
2045 CAISO Peak Day Hourly Profile



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



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

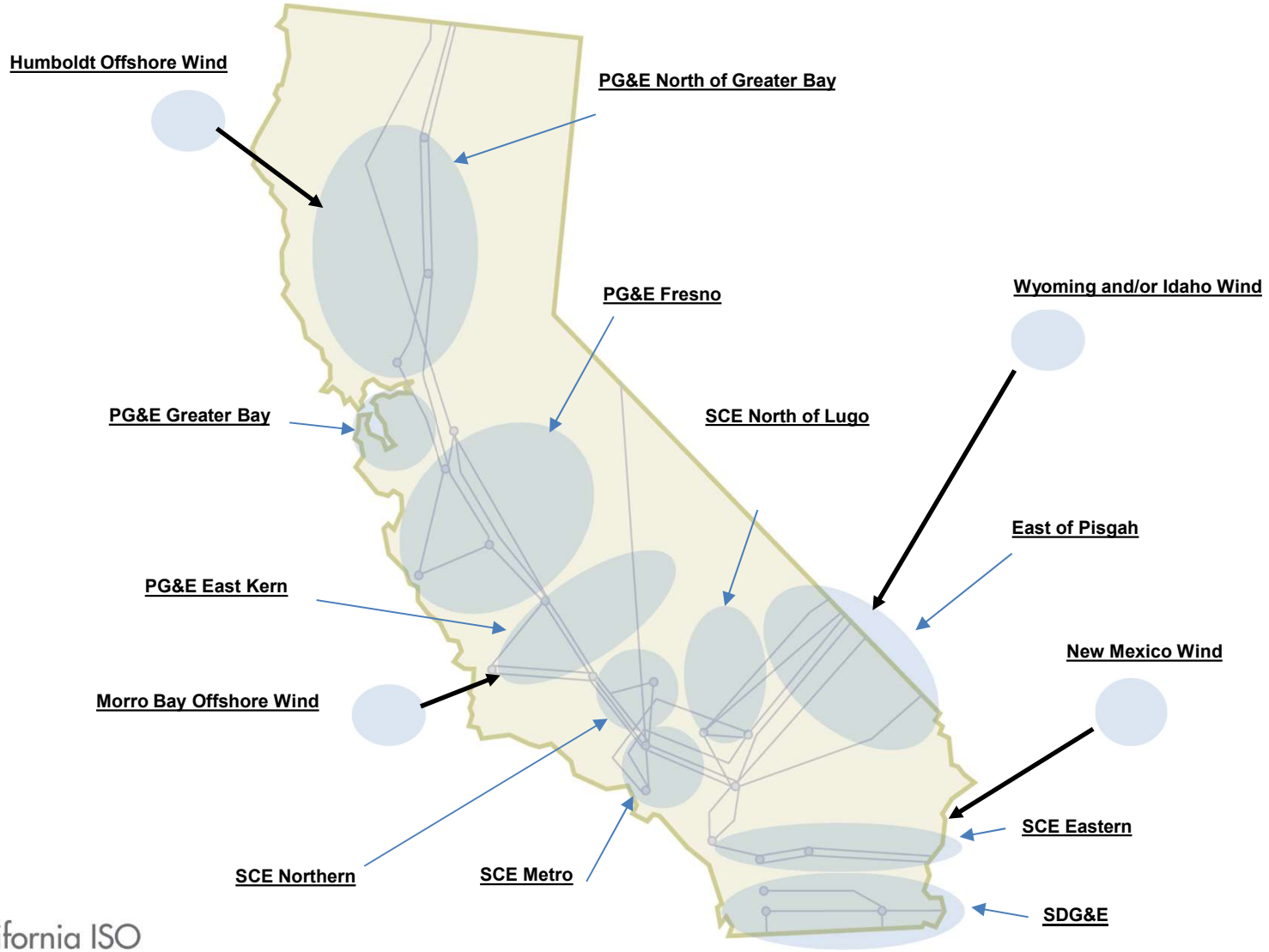
- The 20-year outlook requires geographically mapping of resources to specific locations, to the extent feasible
- Wherever possible, the mapping criteria aligns with the current CPUC integrated resource plan (IRP) portfolios being studied within the 2023-2024 TPP
- All MW values are assumed to occur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

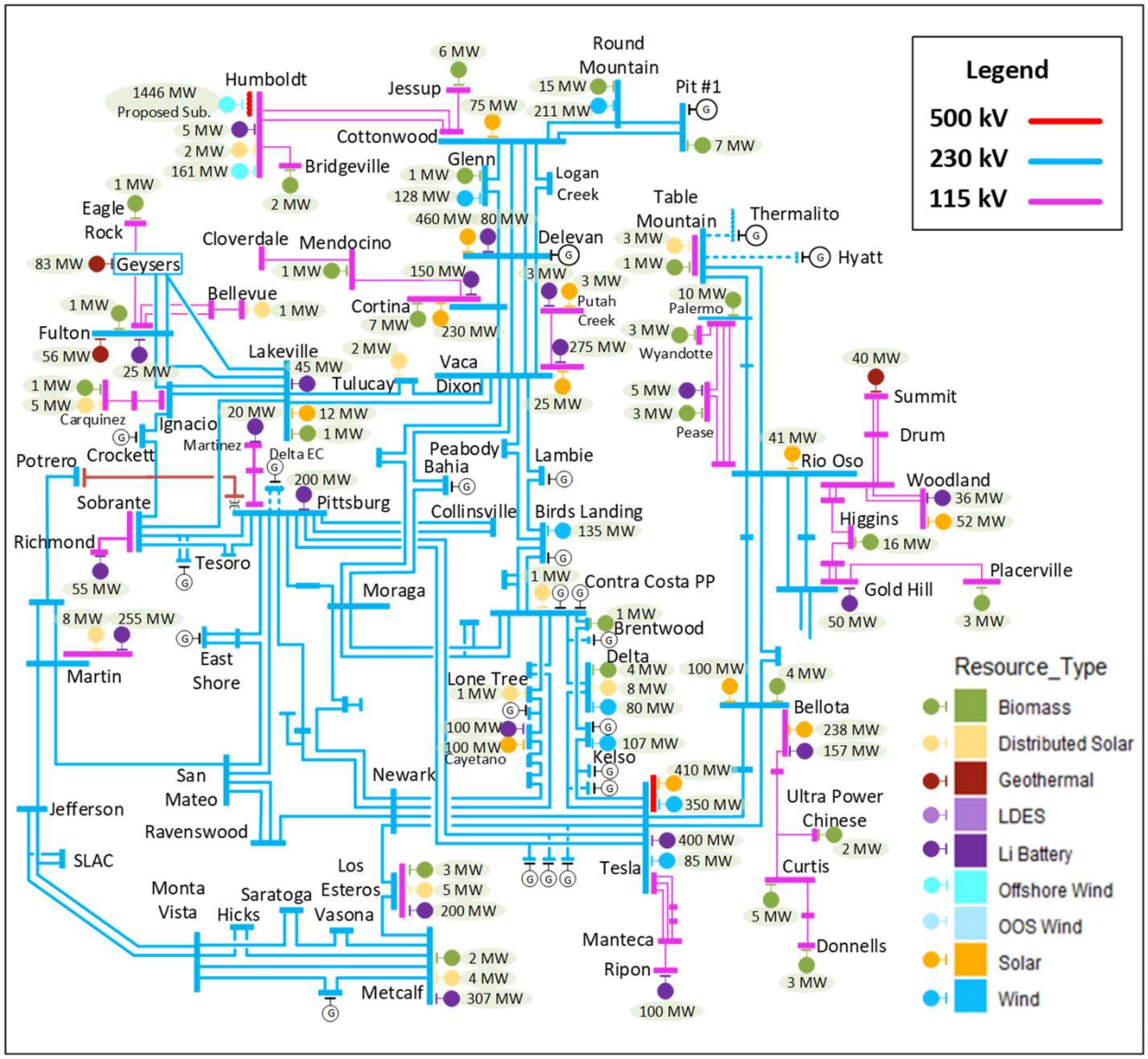
Resources will be mapped to the transmission zones



California ISO

Mapping resources to transmission zones

- Example of PG&E North of Greater Bay
- Update to include resources by 2045



Coordination with 2023-2024 transmission planning process

- The process is expected to include higher level technical studies to test feasibility of alternatives, and not the detailed level of comprehensive analysis that underpins the 10-Year Transmission Plan
- Accordingly we will coordinate with currently scheduled 10-Year Transmission Plan stakeholder sessions to the extent possible, and hold separate stakeholder sessions as appropriate.
- The process welcomes and will incorporate stakeholder input and consultation.

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 will provide updates at the 2023-2024 transmission planning stakeholder meetings:
  - September 26 and 27
  - November 16
  - Additional may be added as required
- Draft 20-Year Transmission Outlook – March 31, 2024
- Finalize 20-Year Transmission Outlook – May 2024

California ISO

Approach to Offshore Wind

Ebrahim Rahimi

Sr. Advisor, Transmission Infrastructure Planning

Offshore Wind Portfolios provided by CPUC for the ISO Transmission Planning Studies

	2022-2023 TPP		20232-2024 TPP		20-Year Outlook	
	Base Portfolio	Sensitivity Portfolio	Base Portfolio	Sensitivity Portfolio	May 2022	2024 Update
Morro Bay Call Area	1,588	3,100	3,100	5,355	6000 [1]	5,400
Humboldt Call Area	120	1,607	1,607	2,600	4000 [2]	2,700
Del Norte Area	-	-	-	3,445		7,000
Cape Mendocino Area	-	-	-	2,000		4,900
Total	1,708	4,707	4,707	13,400	10,000	20,000

[1] Central Coast

[2] North Coast

The ISO recommends for approval transmission projects that are found needed to meet the needs of the base portfolio

Annual Transmission Planning Process Links
https://stakeholdercenter.caiso.com/RecurringStakeholderProcesses/2022-2023-Transmission-planning-process

https://stakeholdercenter.caiso.com/RecurringStakeholderProcesses/2023-2024-Transmission-planning-process

20-Year Transmission Outlook Link
https://stakeholdercenter.caiso.com/RecurringStakeholderProcesses/20-Year-transmission-outlook

2045 Scenario for the Update of the 20-Year Transmission Outlook Link
2045 Scenario for the Update of the 20-Year Transmission Outlook | California Energy Commission

Study Approach

- **Step 1**: Perform high level assessment in the 20-year outlook to identify system enhancements required for the OSW
  - 14,600 MW in the North Coast
  - 5,400 MW in the Central Coast
- **Step 2**: Perform detailed studies on the sensitivity portfolio in the 2023-2024 TPP to identify system enhancements required to integrate OSW:
  - 8,045 MW in the North Coast
  - 5,355 MW in the Central Coast
- **Step 3**: Perform detailed studies on the base portfolio to recommend projects to integrate OSW
  - 1,607 MW in the North Coast
  - 3,100 MW in the Central Coast

Offshore Wind Installed Capacity Assumptions

		2023-2024 TPP	
	20-Year Outlook	Sensitivity Portfolio	Base Portfolio
Del Norte	7,000	3,445	0
Humboldt Call Area	2,700	2,600	1,607
Cape Mendocino	4,900	2,000	0
Total	14,600	8,045	1,607

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

		2023-2024 TPP	
	20-Year Outlook	Sensitivity Portfolio	Base Portfolio
Morro Bay	5,400	5,355	3,100
Total	5,400	5,355	3,100

Offshore Wind Dispatch in Deliverability Studies(1/2)

- Based on NREL data, the offshore wind generation was dispatched at 100% in earlier sensitivity studies.
- High level assessment was performed to evaluate the potential impact of offshore wind dispatch assumptions in deliverability studies

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%		
Idaho Wind	67%			35%		
Morro Bay OSW	100%			49%		
Humboldt OSW	100%			53%		
Diablo OSW	100%			37%		
Energy storage	100% or 4-hour equivalent if duration is < 4-hour			50% or 4-hour equivalent if duration is < 4-hour		
Non-Intermittent resources	NQC					

http://www.caiso.com/InitiativeDocuments/Presentation-2023-2024-Transmission-Planning-Process-%20Feb282023.pdf

Offshore Wind Dispatch in Deliverability Studies(2/2)

- NREL provided CAISO with updated offshore wind generation estimates based on wind model information for year 2007-2013
- CAISO reviewed the wind generation data for the hours with high historical CAISO load for the same years
- The data analysis indicates that the average offshore wind generation is 83% of installed capacity for HSN hours and 45% for SSN hours.
- CAISO is working with NREL to obtain offshore wind generation estimates for up to 20 years. The OSW dispatch at HSN and SSN hours will be modified if needed.

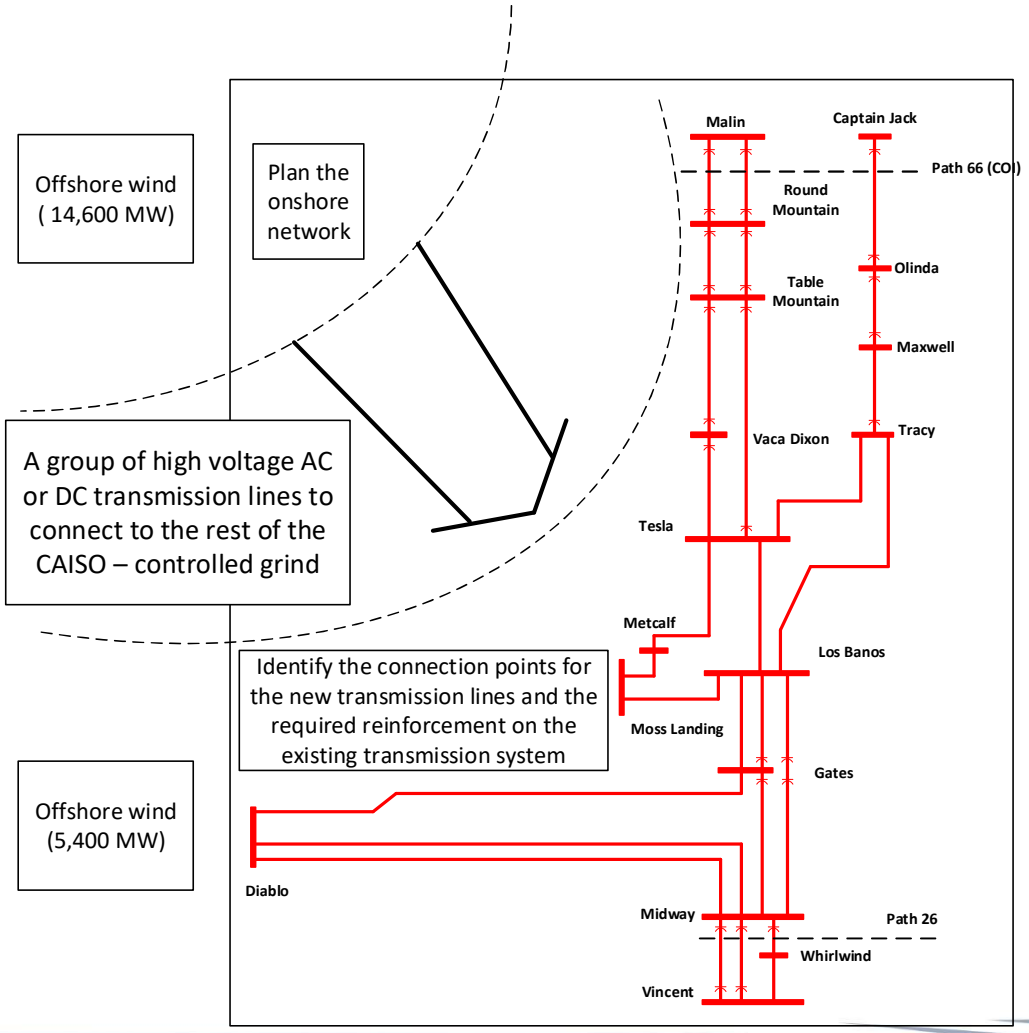
Offshore Wind in the 20-year Outlook

- 5,400 MW in Central Coast
- 14,600 MW in North Coast

Offshore wind assumptions in the 20-year outlook

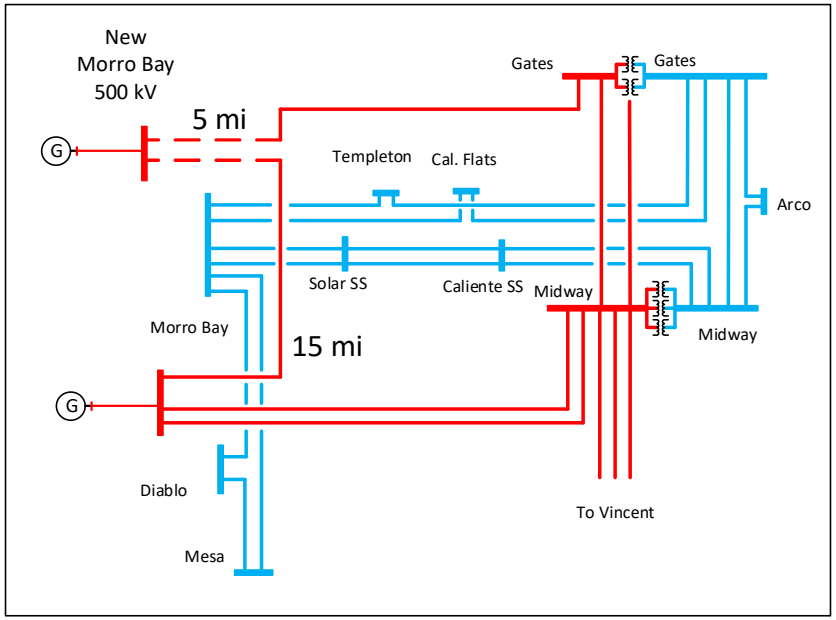
Offshore Wind in the New 20-year Outlook (20,000 MW):

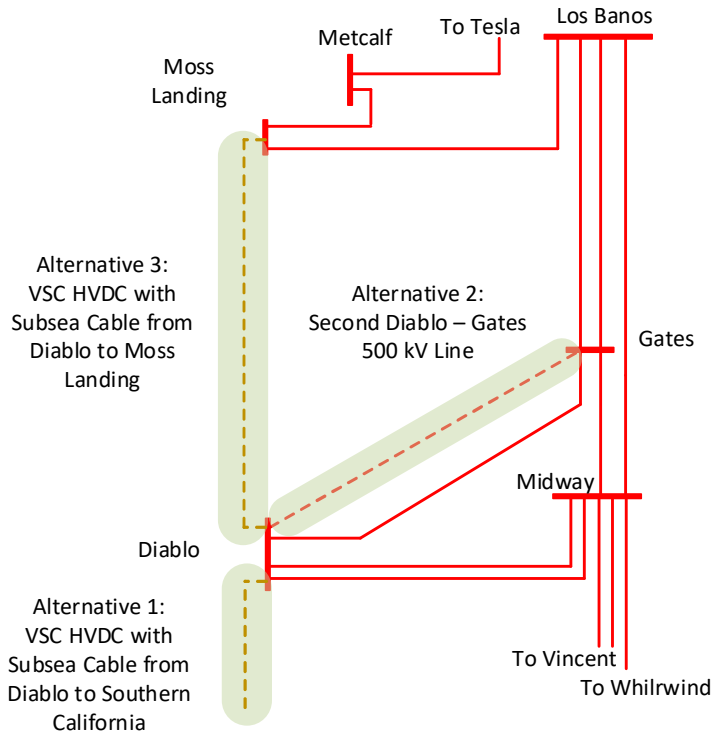
North Coast: 14,600 MW
Central Coast: 5,400 MW



Central Coast Offshore Wind Interconnection

- It the 2021-2022 Transmission Plan it was identified that up to 5.3 GW of generation could be integrated into the 500 kV system in Morro Bay / Diablo area.
- Depending on the status of the DCPP and the total generation in the area, a new 500 kV substation and further system enhancements might be required in the area to integrate the OSW in Central Coast in 20-year outlook (5,400 MW), sensitivity portfolio (3,355 MW) and base portfolio (3,100 MW).

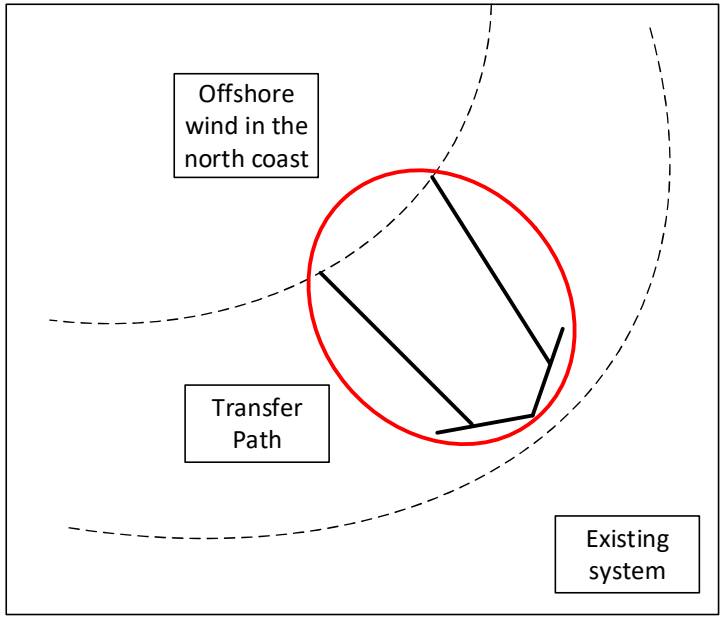




California ISO

Transmission Technology Assumptions for the Transfer Path to Interconnect 14,600 MW OSW in the North Coast

Technology	Normal Rating Assumptions (MVA)	Emergency Rating Assumptions (MVA)
500 kV AC line to Fern Road	3,500	4,500
Onshore overhead VSC-HVDC to Collinsville Substation	3,000	3,500
Offshore sea cable VSC-HVDC to a Substation in the Bay Area	2,000	2,500

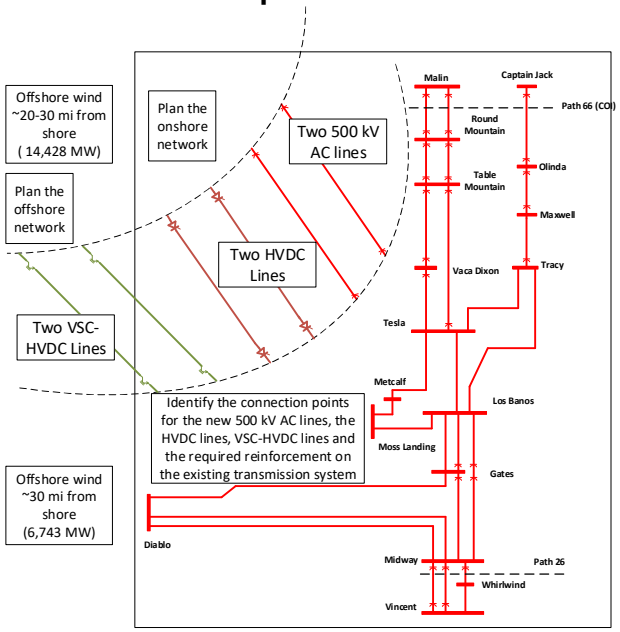


- Based on ISO Planning Standards
  - Maximum generation tripping under N-1 contingency is 1,150 MW
  - Maximum generation tripping under DCTL (N-2) is 1,400 MW

Transfer Path for North Coast OSW in the 20-year Outlook (1/2)

- In the offshore wind sensitivity study in the 2021-2022 Transmission Plan a hybrid solution was evaluated to integrate 14,428 MW of OSW in the North Coast
- Same solution is expected to 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



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

Transfer Path for North Coast OSW in the 20-year Outlook (2/2)

Normal and Contingency Conditions	Total Path Capacity [1] with Hybrid Solution (2x 500 kV AC + 2 x onshore HVDC + 2 x offshore HVDC)
N-0	2 x 3,500 + 2 x 3,000 + 2 x 2,000 = 17,000 MW
N-1 of one 500 kV AC line	1 x 4,500 + 2 x 3,500 + 2 x 2,500 = 16,500 MW
Path N-2 capacity (Loss of an onshore bipole HVDC)	2 x 4,500 + 1 x 3,500 + 2 x 2,500 = 17,500 MW
Path N-1-1 capacity (after the first contingency of one 500 kV AC line, the total wind generation should be reduced in preparation for the contingency of the second 500 kV AC line)	0 x 4,500 + 2 x 3,500 + 2 x 2,500 + 1,200 Curtailment + 1,400 RAS = 14,600 MW

Transfer path capabilities are estimated based on a high level assessment with simplifying assumptions considering the maximum generation tripping allowed under N-1 and N-2 contingencies, not taking into account the system losses and the overloads in the rest of the system

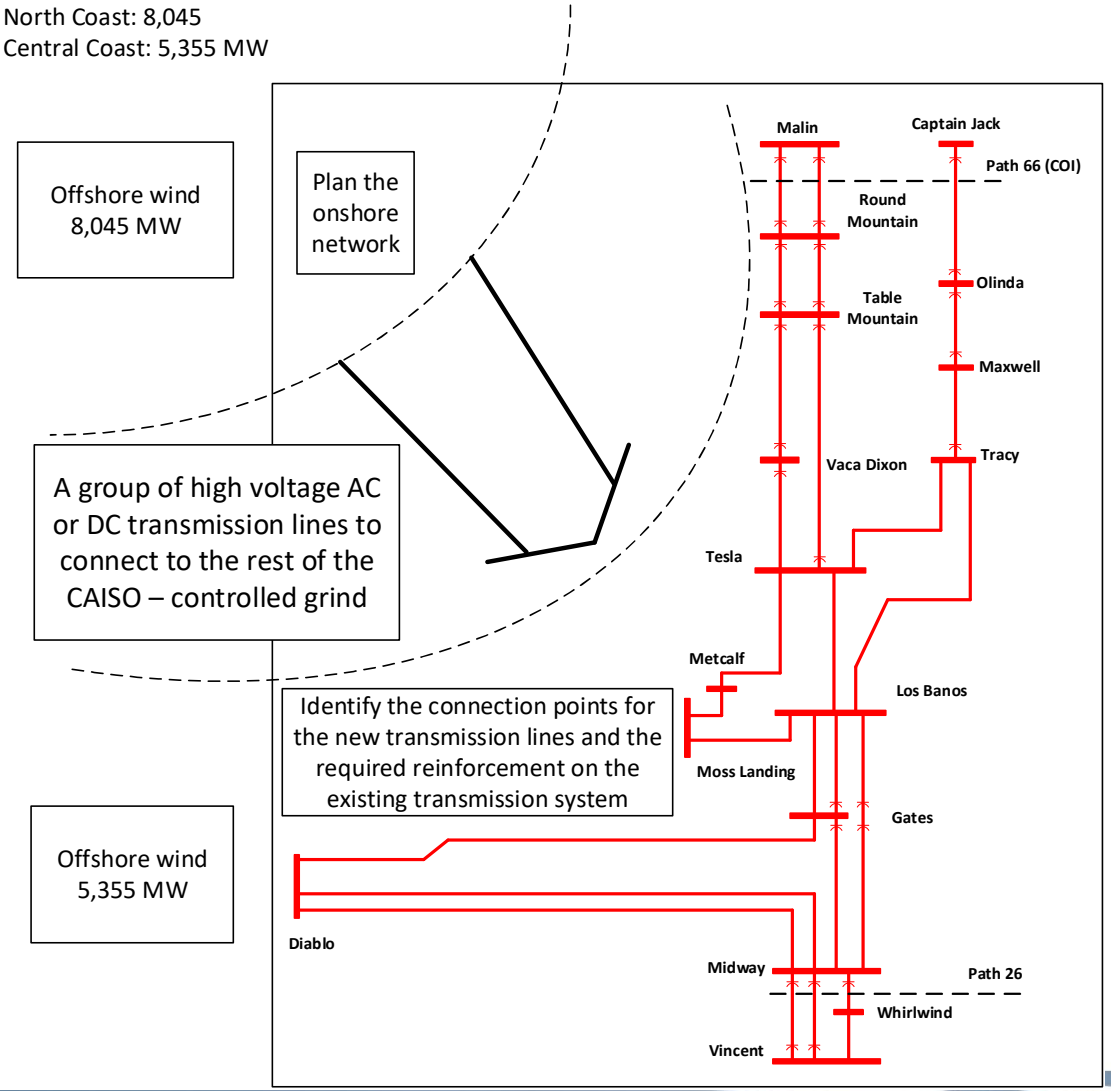
Offshore Wind in the 2023-2024 Sensitivity Portfolio

- 5,355 MW in Central Coast
- 8,045 MW in North Coast

Offshore wind assumptions in the 2023-2024 Sensitivity Portfolio

Offshore Wind in the 2023-2024 TPP Sensitivity Portfolio (13,400MW):

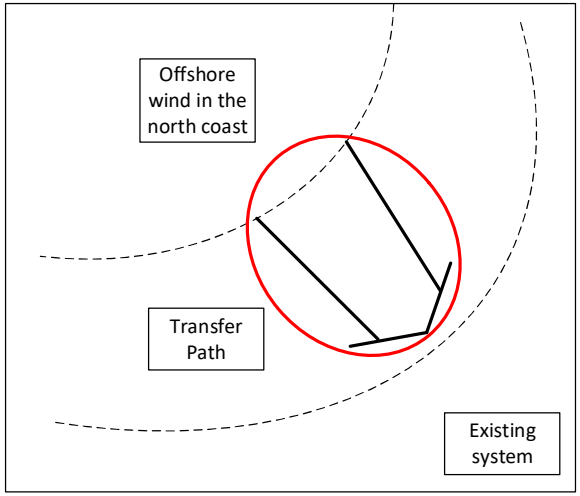
North Coast: 8,045
Central Coast: 5,355 MW



Transfer Path Alternatives for North Coast OSW in the 2023-2024 Sensitivity Portfolio (8,045 MW)

Transfer path alternatives based on the number of links from each transmission technology			Transfer Path Capability [1] (MW)
500 kV AC (Fern Road)	Onshore HVDC (Collinsville)	Offshore HVDC (Bay area)	
2	0	1	8,500
3	0	0	9,000
0	3	0	8,400
1	1	1	7,150
1	2	0	8,000
2	1	0	8,000
0	2	1	7,400
1	0	2	6,150
0	1	2	6,400
0	0	3	6,000

[1] Transfer path capabilities are estimated based on a high level assessment with simplifying assumptions considering N-0, N-1, and N-2 contingencies and the maximum generation tripping allowed under N-1 and N-2 contingencies, not taking into account the system losses and the overloads in the rest of the system



Impact of OSW Dispatch Assumptions on Viable Alternatives to Meet Deliverability Requirements for 2023-2024 Sensitivity Portfolio

Transfer path alternatives based on the number of links from each transmission technology			Transfer Path Capability [1] (MW)	Alternatives performance under different OSW dispatch assumptions in deliverability study for 2023-2024 **sensitivity portfolio**: Green: Meets performance requirements Red: Doesn't meet performance requirements	
500 kV AC (Fern Road)	Onshore HVDC (Collinsville)	Offshore HVDC (Bay area)		OSW Dispatch Assumptions for HSN Hours	
				83%	100%
2	0	1	8,500		
3	0	0	9,000		
0	3	0	8,400		
1	1	1	7,150		
1	2	0	8,000		
2	1	0	8,000		
0	2	1	7,400		
1	0	2	6,150		
0	1	2	6,400		
0	0	3	6,000		

[1] Transfer path capabilities are estimated based on a high level assessment with simplifying assumptions considering N-0, N-1, and N-2 contingencies and the maximum generation tripping allowed under N-1 and N-2 contingencies, not taking into account the system losses and the overloads in the rest of the system

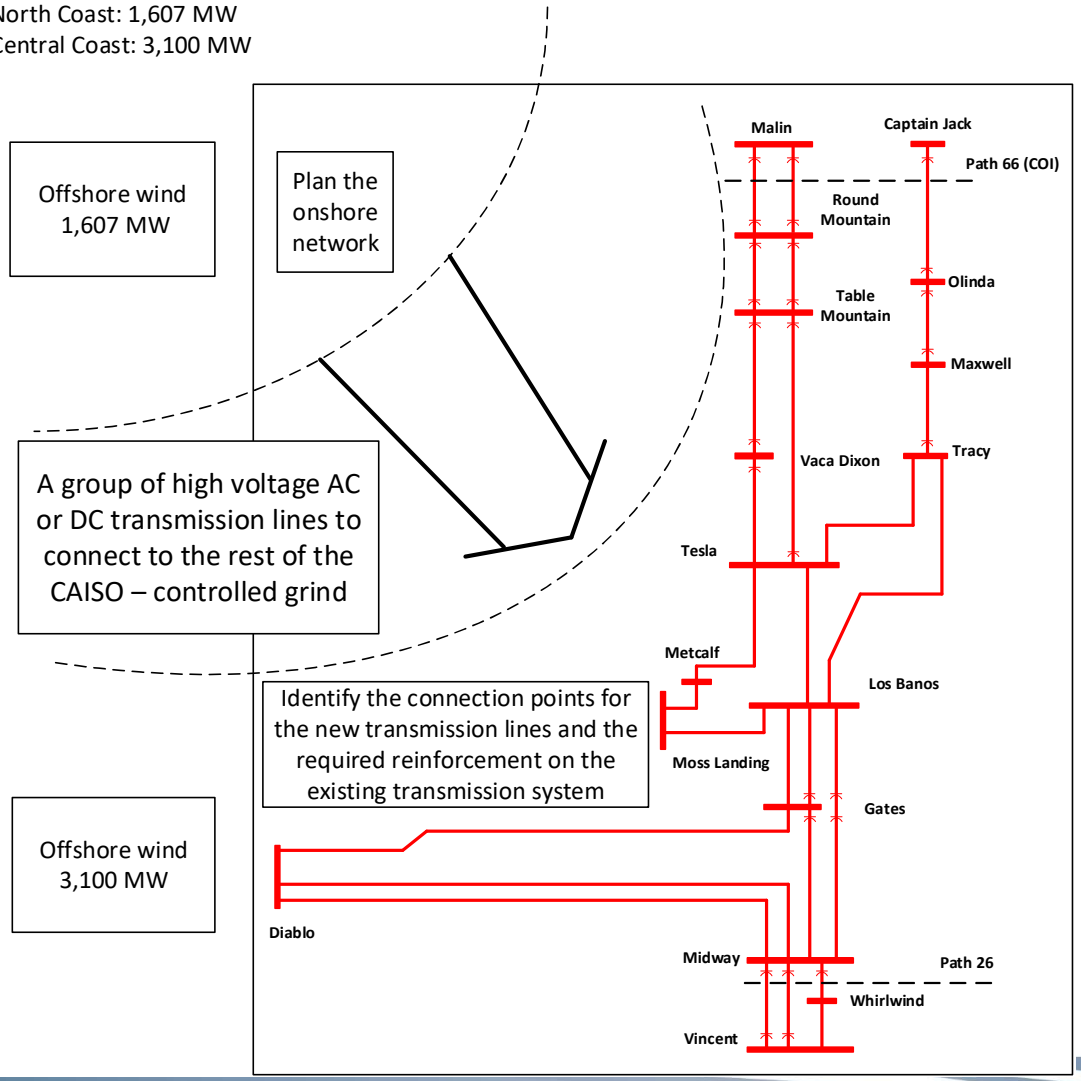
Offshore Wind in the 2023-2024 Base Portfolio

- 3,100 MW in Central Coast
- 1,607 MW in North Coast

Offshore wind assumptions in the 2023-2024 Base Portfolio

Offshore Wind in the 2023-2024 TPP Base Portfolio (4,707MW):

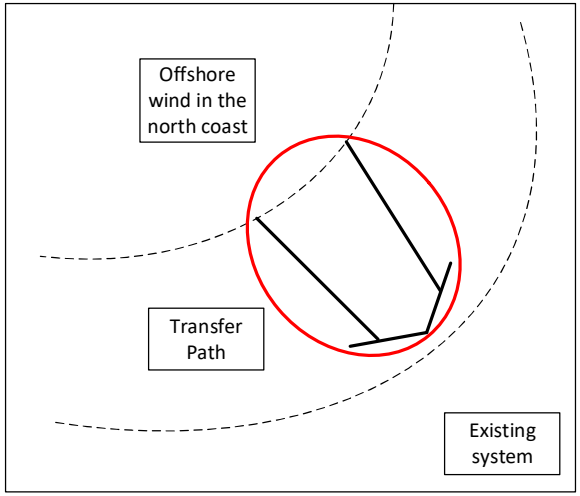
North Coast: 1,607 MW
Central Coast: 3,100 MW



Transfer Path Alternatives for North Coast OSW in the 2023-2024 Base Portfolio (1,607 MW)

Transfer path alternatives based on the number of links from each transmission technology			Transfer Path Capability [1] (MW)
500 kV AC (Fern Road)	Onshore HVDC (Collinsville)	Offshore HVDC (Bay area)	
2	0	0	4,500
1	1	0	3,500
1	0	1	2,500
0	0	1	2,000

[1] Transfer path capabilities are estimated based on a high level assessment with simplifying assumptions considering N-0, N-1, and N-2 contingencies and the maximum generation tripping allowed under N-1 and N-2 contingencies, not taking into account the system losses and the overloads in the rest of the system



Impact of OSW Dispatch Assumptions on Viable Alternatives to Meet Deliverability Requirements for 2023-2024 Base Portfolio

Transfer path alternatives based on the number of links from each transmission technology			Transfer Path Capability [1] (MW)	Alternatives performance under different OSW dispatch assumptions in deliverability study for 2023-2024 **base portfolio**: Green: Meets performance requirements Red: Doesn't meet performance requirements	
				OSW Dispatch Assumptions for HSN Hours	
500 kV AC (Fern Road)	Onshore HVDC (Collinsville)	Offshore HVDC (Bay area)		83%	100%
2	0	0	4,500		
1	1	0	3,500		
1	0	1	2,500		
0	0	1	2000 [2]		
0	1	0	1400 [3]		
1	0	0	1150 [4]		

[1] Transfer path capabilities are estimated based on a high level assessment with simplifying assumptions considering N-0, N-1, and N-2 contingencies and the maximum generation tripping allowed under N-1 and N-2 contingencies, not taking into account the system losses and the overloads in the rest of the system.

[2] It is assumed that the sea cables are far enough that a bipole outage (P7) is not considered credible.

[3] Path capability is limited due to maximum generation allowed to trip under P7 (N-2) contingency

[4] Path capability is limited due to maximum generation allowed to trip under N-1 contingency

Next Steps on Offshore Wind Studies

- Perform studies to identify system enhancements required for the integration of the offshore wind under 20-year outlook, 2023-2024 sensitivity portfolio, and 2023-2024 base portfolio.
- Continue to work with NREL on wind data for 20 years and assess potential impact of additional information on dispatch assumptions on deliverability studies
- Provide update in upcoming stakeholder meetings
- Propose project for approval for the integration of the offshore wind as part of 2023-2024 transmission plan
    - The overall objective is to propose a project that would have the capacity to integrate the offshore wind in the base portfolio, and has the flexibility for expansion to higher levels in the sensitivity portfolio and the 20-year outlook

Next Steps

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Stakeholder Engagement and Policy Specialist

August 16, 2023

Comments

- Comments due by end of day August 30, 2023
- 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.