Proposed Electricity Resource Portfolios for the 2023-2024 Transmission Planning Process

Workshop

October 20, 2022

California Public Utilities Commission

Introduction

Logistics & Scope

- Workshop slides will be available on the IRP webpage on the 2023-2024 TPP
- The workshop will be recorded, with the recording posted to the same webpage
- The objectives of this webinar are to:
  - Familiarize stakeholders with the content of the October 7th Ruling on the Proposed Portfolios for the 2023-24 Transmission Planning Process which included:
    - The proposed policy and reliability driven base case portfolio and proposed policy driven sensitivity portfolios
    - The busbar mapping methodology
    - Preliminary mapping results for the proposed base case portfolio
  - Give opportunity to stakeholders to ask clarifying questions, in order to support preparation for their Ruling comments.

Questions

- We invite *clarifying* questions using the "Q&A" feature of this Webex
- If time allows, we invite verbal clarifying questions at regular intervals throughout this webinar.
  - All attendees have been muted. To ask questions:
    - In Webex:
      - Please “raise your hand”
      - Webex host will unmute your microphone and you can proceed to ask your question
      - Please “lower your hand” afterwards
    - For those with phone access only:
      - Dial *3 to “raise your hand”. Once you have raised your hand, you'll hear the prompt, "You have raised your hand to ask a question. Please wait to speak until the host calls on you“
      - WebEx host will unmute your microphone and you can proceed to ask your question
      - Dial *3 to “lower your hand”
- The discussion in this webinar will be recorded and posted online, as well as the written portion of the Q&A transcript
- Stakeholders are encouraged to file formal comments to the Ruling. Comment deadline is October 31, 2022, and reply comment deadline is November 10, 2022.

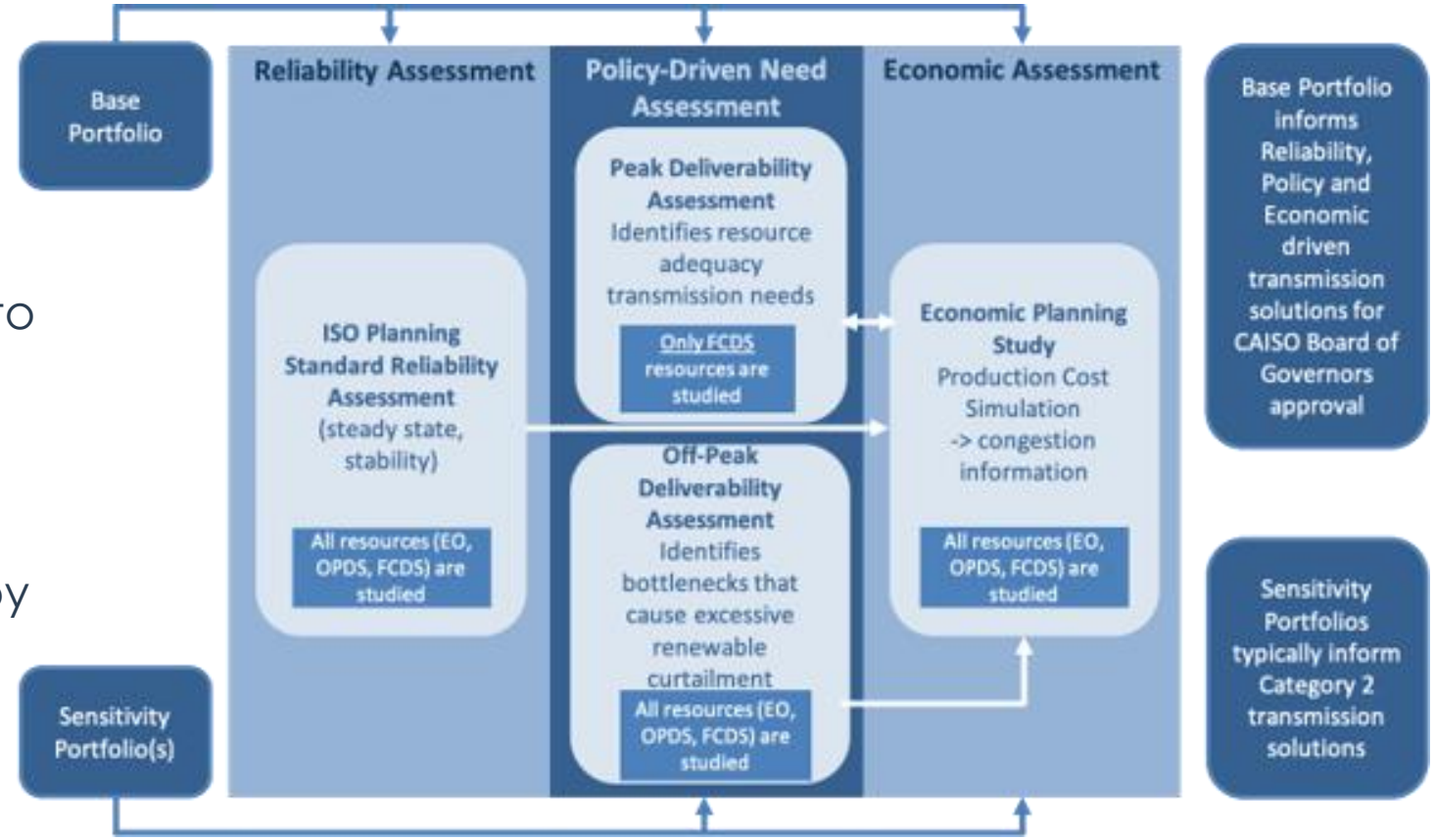
Agenda

Timing (PDT)	Topic	Presenter
9:00 AM	Introduction	Nathan Barcic
9:10 AM	TPP and Busbar Mapping Overview & Background	Karolina Maslanka
9:20 AM	Overview of Proposed TPP Portfolios	Jared Ferguson
9:25 AM	RESOLVE Modeling and Results	Femi Sawyerr
9:45 AM	Busbar Mapping Methodology	Jared Ferguson
10:05 AM	CEC Mapping & Land-use Analysis	Erica Brand
	Out-of-State Land-use Analysis	Emily Leslie
10:35 AM	Preliminary Mapped Results for Proposed Base Case	Jared Ferguson

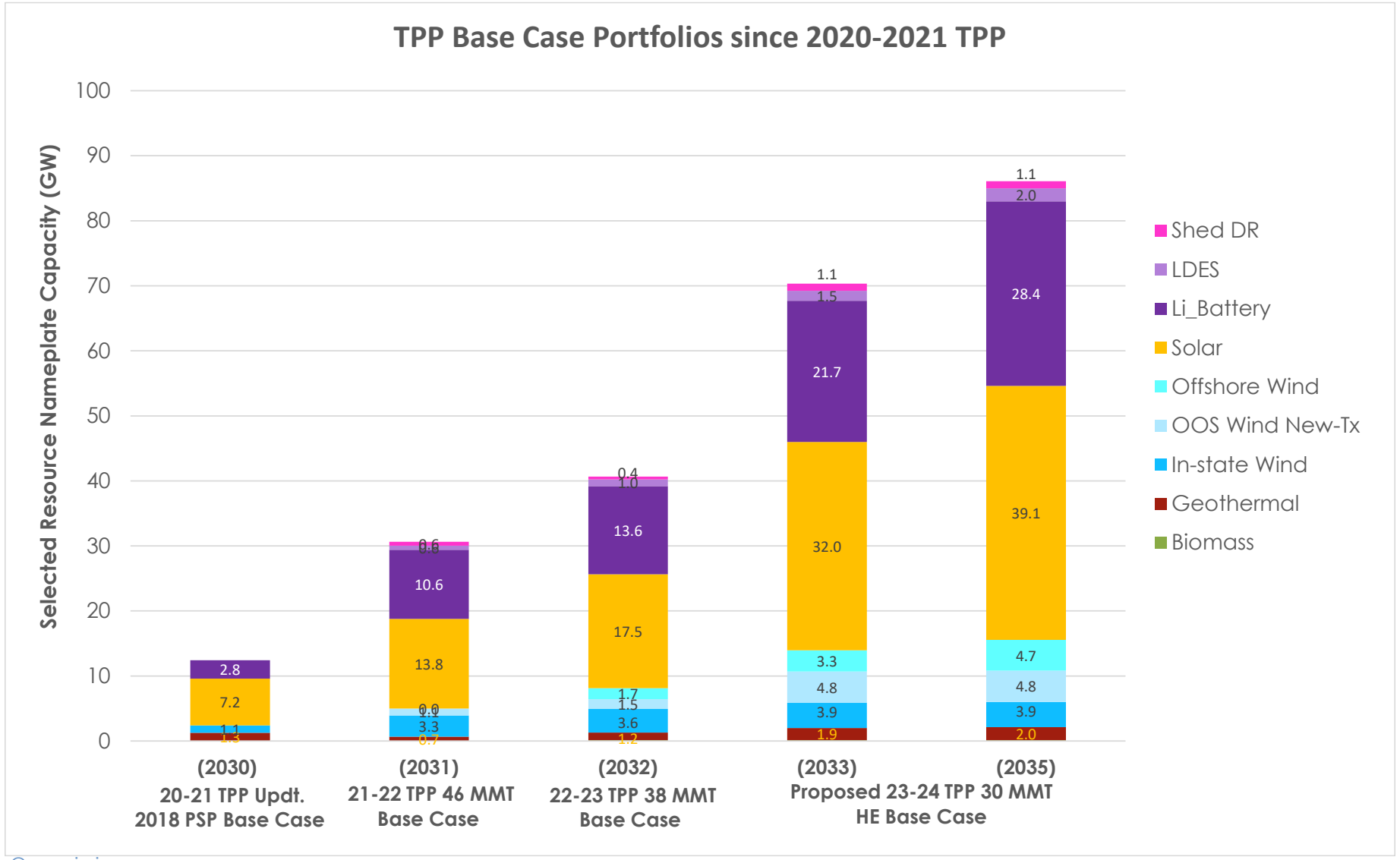
TPP and Busbar Mapping Overview

IRP Role in the CAISO's Transmission Planning Process

- The CAISO's TPP is an annual comprehensive evaluation of the CAISO's transmission grid to
  1. Address grid reliability requirements,
  2. Identify upgrades needed to successfully meet California's policy goals, and
  3. Explore projects that can bring economic benefits to consumers.
- Historically has focused on grid needs up to 10-years into the future
- In accordance with a May 2010 MOU between the CAISO and the CPUC, and in coordination with the CEC, the CPUC develops resource portfolios used by the CAISO in the TPP
- The CPUC typically transmits multiple distinct portfolios developed in the IRP process:
  - Reliability and Policy-Driven Base Case portfolio
  - Policy-Driven Sensitivity portfolio(s)

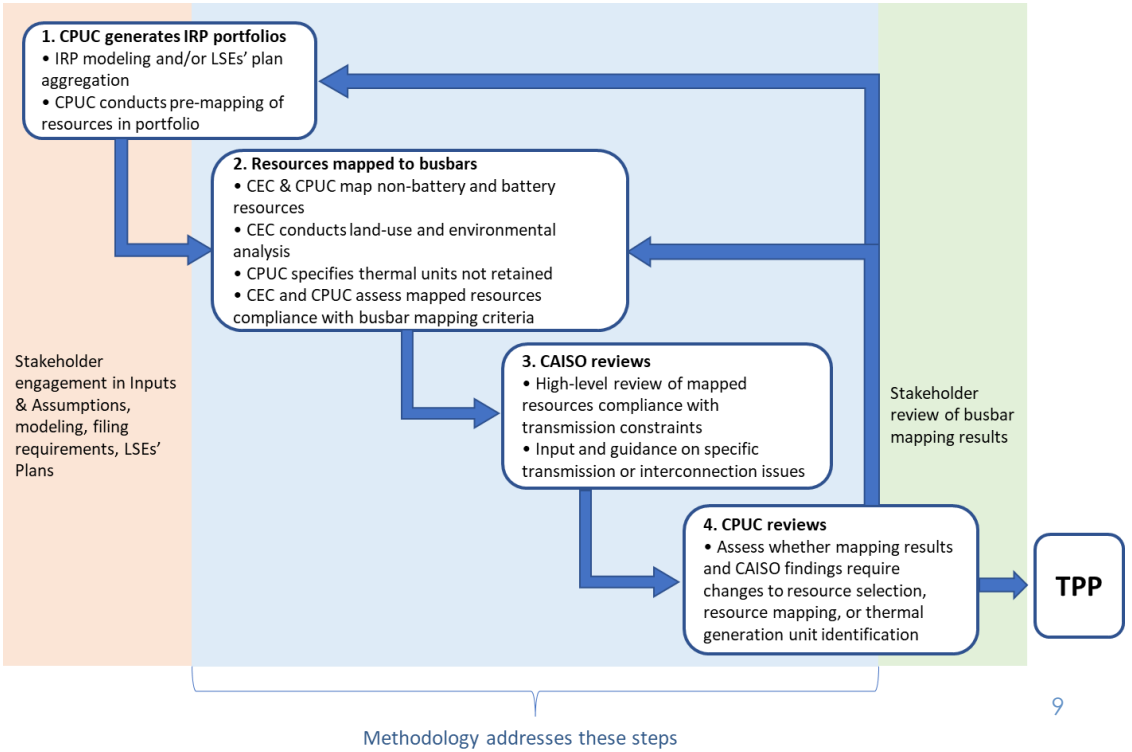


Base Case Portfolios since the 2020-2021 TPP



Role of Busbar Mapping in IRP and TPP

- **Resource to Busbar Mapping** ("busbar mapping"): The process of refining the geographically coarse portfolios developed through IRP to specific interconnection locations (i.e. substations) for analysis in the CAISO's annual Transmission Planning Process (TPP).
  - First conducted as "proof of concept" for the 2018-2019 TPP portfolio
  - Formalized into a joint effort by a working group comprised of CPUC, CEC, and CAISO staff.
  - Mapping is conducted based on stakeholder vetted methodology.
- **Busbar Mapping Scope:** Mapping focuses on utility-scale generation and storage resources that are not already in baseline.
- **Busbar Mapping Methodology:** Methodology document states guiding principles, establishes mapping criteria, and outlines the iterative inter-agency mapping process.
  - Current proposed Methodology makes only minor refinements to previous version used for the 22-23 TPP mapping efforts.



Overview of Proposed Portfolios

Proposed Base Case Portfolio – 30 MMT High Electrification Portfolio

- 2023-2024 TPP recommended reliability and policy-driven base case portfolio description:
  - 30 million metric tons (MMT) greenhouse gas (GHG) target in 2030
    - 25 MMT GHG target by 2035
  - CEC's 2021 IEPR Additional Transportation Electrification (ATE) grid planning scenario
    - Reflects higher loads that account for policy and market drivers towards higher levels of transportation electrification.
  - Model study years: 2033 and 2035
    - 2033 is the standard 10-year outlook needed for TPP
    - CPUC staff are proposing to transmit 2035 results as well, which aligns with the extension of CEC's IEPR scenarios out to 2035, to enable analysis of more long-term potential transmission needs
- Proposed base case portfolio will accelerate the State's move toward planning for a higher electrification future and identify incremental infrastructure needs for the increased renewable needs associated with existing and new policy drivers regarding high electrification

Proposed Sensitivity Portfolios

- CPUC staff recommend two sensitivity portfolios for the 2023-2024 TPP
- Both portfolios still optimize around the 30 MMT by 2030 GHG target and the CEC's 2021 IEPR ATE grid planning scenario and model out to 2035.

1. Offshore Wind Sensitivity Portfolio
   - **Purpose:** Refine and update transmission capability and upgrade assumptions relevant to offshore wind resources, including AB 525 planning goals and updated resource potential assumptions,
   - Force in the following offshore wind resources in 2035
     - Morro Bay: 5.4 GW
     - Humboldt: 3 GW
     - Cape Mendocino or Del Norte: 5 GW
2. Limited Offshore and Out-of-state Wind Sensitivity Portfolio
   - **Purpose:** Study transmission implications of a significantly different resource mix if key long lead-time resources are slow to develop; and aid in identifying "least regrets" transmission options that would be beneficial under a variety of resource mix futures.
   - Limit Offshore and Out-of-state wind on new transmission to 2 GW each through the 2035 build year.
   - Prohibited RESOLVE from selecting new gas through 2035

RESOLVE Modelling Results for Proposed Portfolios

Content

- Model Updates
- Sensitivity Definitions in RESOLVE
- Results for 30 MMT TPP 2023-2024 High Electrification (HE) Base Case
- Results for 30 MMT Additional Offshore Wind Sensitivity
- Results for 30 MMT Limited Offshore and Out-of-State Wind Sensitivity
- Comparison of 30MMT TPP 2023-2024 cases with 38MMT TPP 2022-2023 Base case

Major updates since the 2022-2023 TPP Base Portfolio

- Updated resource costs to the NREL 2021 ATB and Lazard LCOS v7.0
- Updated the load forecast to the CEC 2021 IEPR
  - The Base and Sensitivities all use the **2021 IEPR Additional Transportation Electrification** load forecast
- Refreshed the list of existing and planned resources (aligned with RDT)
- Updated NQC values based on latest NQC list and baseline resources
- Updated transmission deliverability-resource mappings, existing transmission deliverability capacity, and transmission upgrade costs using the CAISO 2021-2022 TPP draft results and the CAISO 20-year Study
- Updated storage secondary system need (SSN) transmission utilization values to be in line with latest CAISO recommendations
  - 50% transmission capacity utilization in SSN hours.

Definition of Sensitivities in RESOLVE

- Additional offshore wind sensitivity
  - 13.4 GW forced-in capacity for offshore wind by 2035
    - 5.4 GW to Morro Bay offshore wind
      - Assumes the combination of the $110 million transmission upgrade and the existing Diablo Canyon substation can accommodate all of the expanded capacity limit
    - 3 GW Humboldt offshore wind
      - Maintains the $2.3 billion cost for 1.6 GW of new transmission capacity but expanded the limit to meet the expanded capacity.
    - 5 GW to Cape Mendocino offshore wind
      - Assumes a $4 billion cost for 2 GW new transmission capacity, based on the CAISO 20-year study results

- Limited offshore and out-of-state wind sensitivity
  - New Mexico and Wyoming wind are limited to 1 GW each through 2035
  - The capacity limit for offshore wind is set to 2 GW through 2035
  - Northwest wind on existing transmission is limited through 2035
  - No new gas allowed through 2035

Long-Lead Time MTR Order, LSE plans and online or in-development resources – Annual Required Builds

		Long Lead-Time Resources Assumed as Part of Mid-Term Reliability Order								
Technology Class	**Unit**	**2023**	**2024**	**2025**	**2026**	**2028**	**2030**	**2032**	**2033**	**2035**
Geothermal	MW	-	-	-	-	1,053	-	-	-	-
Long Duration Storage	MW	-	-	-	-	1,000	-	-	-	-

		Online or In-Development	LSE Plans							
Technology Class	**Unit**	**Baseline**	**2023**	**2024**	**2025**	**2026**	**2028**	**2030**	**2032**	**2033**	**2035**
Battery Storage	MW	3,804	799	1,131	1,441	367	659	700	-	-	-
Pumped Storage	MW	-	-	-	-	196	40	72	-	-	-
Biomass	MW	-	65	18	12	12	27	-	-	-	-
Shed DR	MW	-	63	1	1	-	(1)	(0)	-	-	-
Geothermal	MW	61	53	-	-	70	36	71	-	-	-
Solar	MW	2,132	4,417	1,201	905	551	2,190	2,774	-	-	-
Wind	MW	581	1,138	330	709	321	341	1,612	-	-	-
Offshore Wind	MW	-	-	-	-	120	75	-	-	-	-
Wind OOS New Tx	MW	-	-	-	-	-	-	-	-	-	-

- These represent the minimum resource build requirements forced into the model.
  - The optimization can build more than these amounts if necessary.

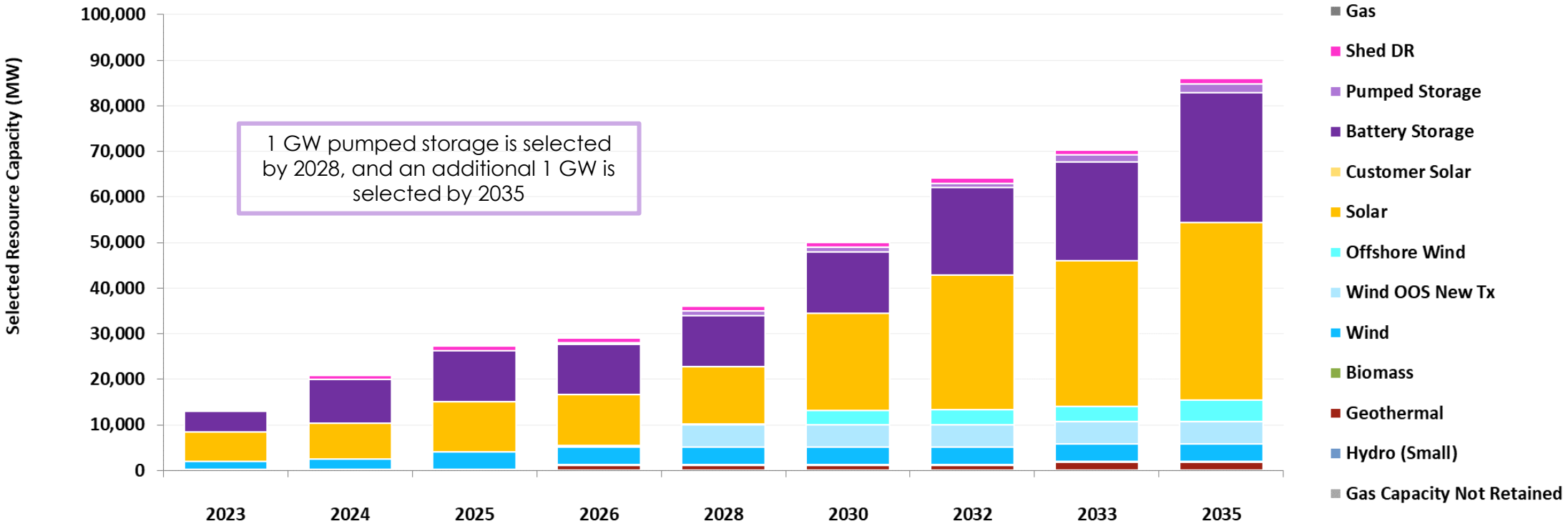
Scenario Results

Selected resources – 30 MMT 2023-2024 TPP HE Base Portfolio

28.4 GW battery storage built by 2035

4.8 GW of out-of-state wind is selected by 2028, 3.1 GW offshore wind is selected in 2030, and 1.6 GW additional selected by 2035

2.1 GW in-state wind added between 2023 and 2025



1 GW pumped storage is selected by 2028, and an additional 1 GW is selected by 2035

11 GW solar deployed by 2025 (hitting annual deployment limit), and an additional 28 GW is selected between 2025 and 2035

1 GW geothermal selected by 2026, and an additional 0.9 GW selected by 2035

0.1 GW additional biomass and 0.1 GW new gas by 2035

Total resource additions – 30 MMT 2023-2024 TPP Base Portfolio

	Unit		2023	2024	2025	2026	2028	2030	2032	2033	2035
Gas	MW		-	-	-	-	0	0	0	0	128
Biomass	MW		65	83	107	107	134	134	134	134	134
Geothermal	MW		114	114	114	1,095	1,151	1,151	1,151	1,863	1,863
Hydro (Small)	MW		-	-	-	-	-	-	-	-	-
Wind	MW		1,719	2,319	3,864	3,864	3,864	3,864	3,864	3,864	3,864
Wind OOS New Tx	MW		-	-	-	312	4,828	4,828	4,828	4,828	4,828
Offshore Wind	MW		-	-	-	120	195	3,100	3,261	3,261	4,707
Solar	MW		6,549	7,750	11,000	11,073	12,516	21,367	29,553	32,025	39,072
Customer Solar	MW		-	-	-	-	-	-	-	-	-
Battery Storage	MW		4,603	9,648	11,145	11,145	11,301	13,529	19,205	21,738	28,381
Pumped Storage	MW		-	-	-	196	1,000	1,000	1,000	1,524	2,000
Shed DR	MW		63	889	1,111	1,111	1,111	1,111	1,111	1,111	1,111
Gas Capacity Not Retained	MW		-	-	-	-	-	-	-	-	-
Storage + DR	MW		**4,666**	**10,537**	**12,257**	**12,453**	**13,413**	**15,640**	**21,316**	**24,373**	**31,492**
Total Resources (Renewables + Storage + DR)	MW		13,113	20,804	27,342	29,025	36,102	50,085	64,108	70,349	86,089

- GHG emissions constraint is binding starting in 2025
- PRM needs drive near-term builds in 2024-2025
- PRM is also binding beyond 2028
- CPUC staff chose to replace the 128 MW of new gas selected in 2035 with 174 MW of geothermal in the busbar mapping analysis

Difference in annual selected capacities relative to forced-in amounts – 30 MMT 2023-2024 TPP Base Portfolio

Technology Class	Unit	2023	2024	2025	2026	2028	2030	2032	2033	2035
Battery Storage	MW	0	3,913	56	(367)	(503)	1,528	5,676	2,533	6,643
Pumped Storage	MW	-	-	-	-	(236)	(72)	-	524	476
Biomass	MW	(0)	-	12	(12)	-	-	-	-	-
Shed DR	MW	-	825	221	-	1	0	-	-	0
Geothermal	MW	-	-	-	911	(1,033)	(71)	-	712	-
Solar	MW	0	(0)	2,344	(477)	(747)	6,077	8,186	2,472	7,047
Wind	MW	0	270	836	(321)	(341)	(1,612)	-	-	-
Offshore Wind	MW	-	-	-	-	-	2,905	161	-	1,446
Wind OOS New Tx	MW	-	-	-	312	4,516	-	-	-	-

Note 1: Negative values indicate resources have been selected in RESOLVE in an earlier year than the forced-in capacities from LSE plans and MTR order in that year

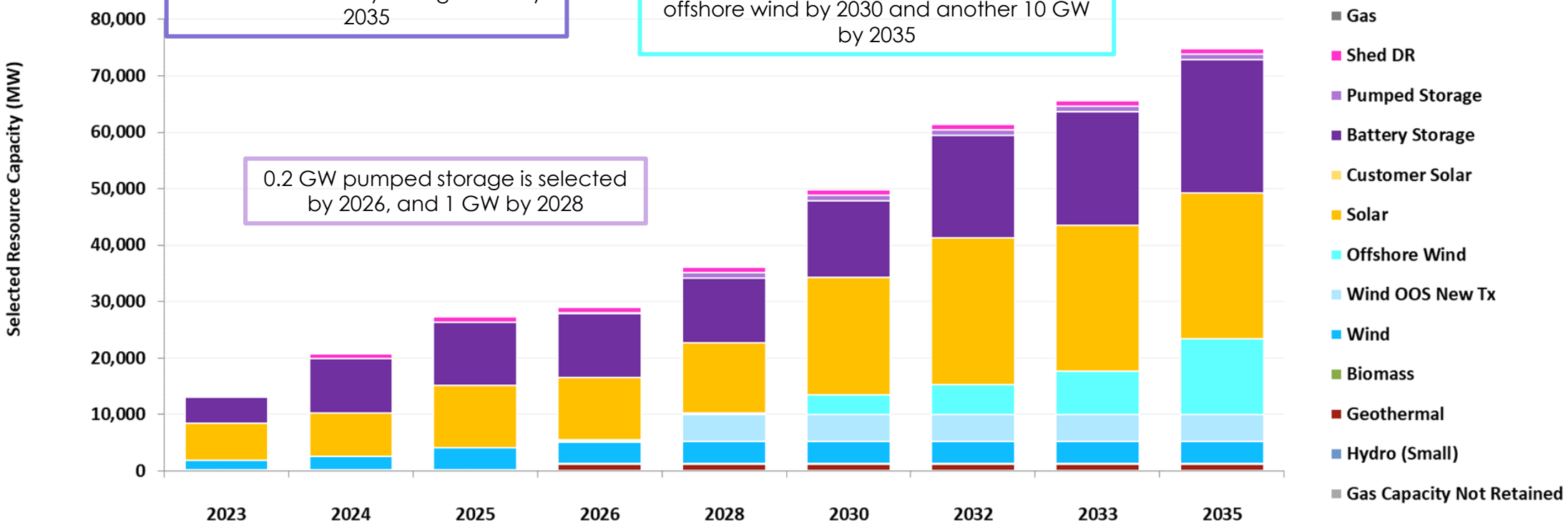
Note 2: The values exclude LSE plans, newly developed resources, and MTR-related 1 GW geothermal and 1 GW long-duration storage

Total resource additions – 30 MMT additional offshore wind sensitivity

2.1 GW in-state wind added between 2023 and 2025

23.5 GW of battery storage built by 2035

4.8 GW out-of-state wind by 2028; 3.4 GW offshore wind by 2030 and another 10 GW by 2035



0.2 GW pumped storage is selected by 2026, and 1 GW by 2028

11 GW solar deployed by 2025 (hitting annual deployment limit), and an additional 14.8 GW is selected between 2025 and 2035.

1 GW geothermal selected by 2026

0.1 GW new biomass and no new gas additions by 2035

Total resource additions – 30 MMT additional offshore wind sensitivity

	Unit		2023	2024	2025	2026	2028	2030	2032	2033	2035
Gas	MW		-	-	-	-	-	-	-	-	-
Biomass	MW		65	83	107	107	134	134	134	134	134
Geothermal	MW		114	114	114	1,117	1,149	1,149	1,149	1,149	1,149
Hydro (Small)	MW		-	-	-	-	-	-	-	-	-
Wind	MW		1,719	2,319	3,864	3,864	3,864	3,864	3,864	3,864	3,864
Wind OOS New Tx	MW		-	-	-	283	4,828	4,828	4,828	4,828	4,828
Offshore Wind	MW		-	-	-	120	195	3,449	5,355	7,656	13,400
Solar	MW		6,549	7,750	11,000	11,014	12,472	20,895	25,871	25,871	25,871
Customer Solar	MW		-	-	-	-	-	-	-	-	-
Battery Storage	MW		4,603	9,597	11,279	11,279	11,452	13,543	18,221	20,072	23,553
Pumped Storage	MW		-	-	-	196	1,000	1,000	1,000	1,000	1,000
Shed DR	MW		63	889	977	977	977	977	977	977	977
Gas Capacity Not Retained	MW		-	-	-	-	-	-	-	-	-
Storage + DR	MW		**4,666**	**10,486**	**12,256**	**12,452**	**13,429**	**15,520**	**20,199**	**22,049**	**25,530**
Total Resources (Renewables + Storage + DR)	MW		13,113	20,753	27,341	28,957	36,072	49,839	61,401	65,552	74,777

13.4 GW forced-in capacity

Compared to the 30 MMT TPP 2023-2024 case:

- By 2035, there is 8.7 GW incremental offshore wind resulting in 0.7 GW less geothermal, 13.2 GW less solar, 4.8 GW less battery storage, 1 GW less pumped storage

Difference in annual selected capacities relative to forced-in amounts – 30 MMT additional offshore wind sensitivity

Technology Class	Unit	2023	2024	2025	2026	2028	2030	2032	2033	2035
Battery Storage	MW	(0)	3,862	240	(367)	(485)	1,391	4,679	1,850	3,481
Pumped Storage	MW	-	-	-	-	(399)	(72)	-	0	-
Biomass	MW	(0)	-	12	(12)	-	-	-	-	-
Shed DR	MW	-	825	87	-	1	0	-	-	-
Geothermal	MW	-	-	-	933	(1,057)	(71)	-	-	-
Solar	MW	0	(0)	2,344	(537)	(732)	5,649	4,976	-	-
Wind	MW	(0)	270	837	(321)	(341)	(1,612)	-	-	-
Offshore Wind	MW	-	-	-	-	-	3,254	1,906	2,301	5,744
Wind OOS New Tx	MW	-	-	-	283	4,546	-	-	-	-

Reflects the 13.4 GW forced-in capacity

Note 1: Negative values indicate resources have been selected in RESOLVE in an earlier year than the forced-in capacities from LSE plans and MTR order in that year

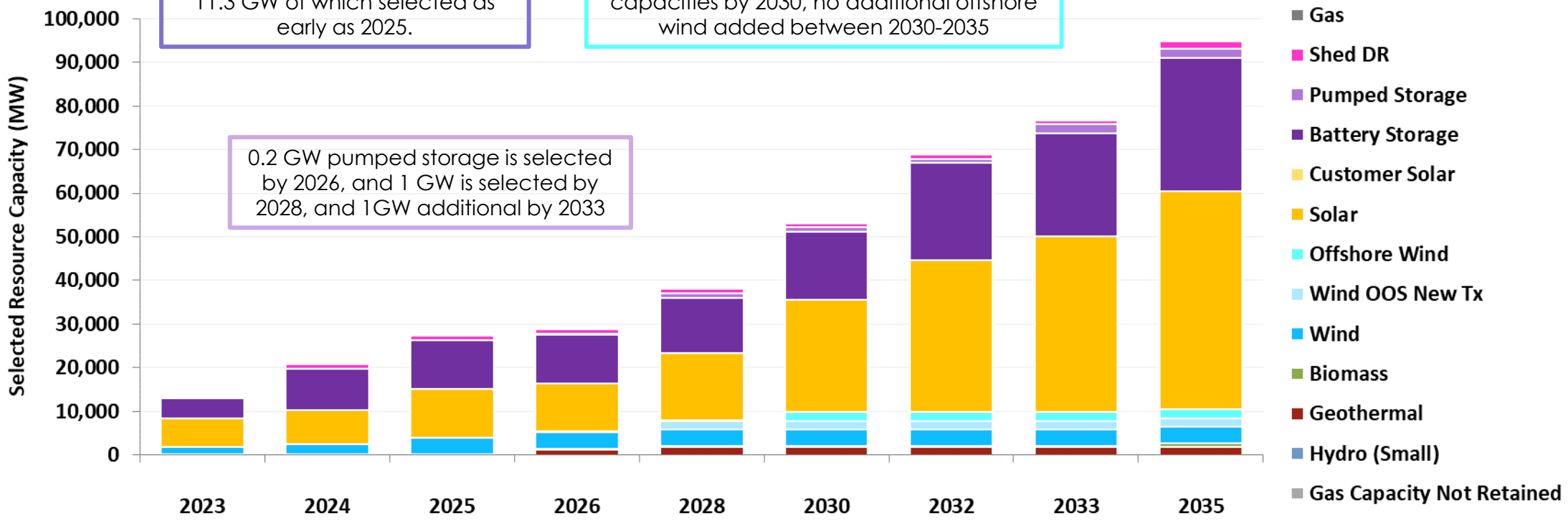
Note 2: The values exclude LSE plans, newly developed resources, and MTR-related 1 GW geothermal and 1 GW long-duration storage

Selected Resources – 30 MMT limited offshore and out-of-state wind sensitivity

23.7 GW storage built by 2033; 11.3 GW of which selected as early as 2025.

2 GW offshore wind, 2 GW out-of-state wind capacities by 2030, no additional offshore wind added between 2030-2035

2.1 GW in-state wind added between 2023 and 2025



0.2 GW pumped storage is selected by 2026, and 1 GW is selected by 2028, and 1GW additional by 2033

11 GW solar deployed by 2025 (hitting annual deployment limit), and an additional 39 GW is selected between 2025 and 2035

1.3 GW geothermal selected by 2026, and 1.9 GW selected by 2028

0.7 GW new biomass additions by 2035.

Selected Resources – 30 MMT limited offshore and out-of-state wind sensitivity

	Unit		2023	2024	2025	2026	2028	2030	2032	2033	2035
Gas	MW		-	-	-	-	-	-	-	-	-
Biomass	MW		65	83	107	107	134	134	134	134	699
Geothermal	MW		114	114	114	1,306	1,826	1,826	1,826	1,885	1,885
Hydro (Small)	MW		-	-	-	-	-	-	-	-	-
Wind	MW		1,719	2,319	3,797	3,797	3,797	3,797	3,797	3,797	3,797
Wind OOS New Tx	MW		-	-	-	-	2,000	2,000	2,000	2,000	2,000
Offshore Wind	MW		-	-	-	120	195	2,000	2,000	2,000	2,000
Solar	MW		6,549	7,750	11,000	11,009	15,448	25,905	34,966	40,193	49,961
Customer Solar	MW		-	-	-	-	-	-	-	-	-
Battery Storage	MW		4,603	9,571	11,252	11,252	12,629	15,504	22,173	23,741	30,713
Pumped Storage	MW		-	-	-	196	1,000	1,000	1,000	2,000	2,000
Shed DR	MW		63	889	977	977	977	977	977	977	1,716
Gas Capacity Not Retained	MW		-	-	-	-	-	-	-	-	-
Storage + DR	MW		**4,666**	**10,460**	**12,229**	**12,425**	**14,606**	**17,481**	**24,150**	**26,718**	**34,429**
Total Resources (Renewables + Storage + DR)	MW		13,113	20,727	27,248	28,765	38,007	53,143	68,874	76,728	94,771

Compared to the 30 MMT TPP 2023-2024 case:

- By 2035, 2.8 GW less out-of-state wind, 2.7 GW less offshore wind, 10.9 GW more solar, 2.3 GW more battery storage, 0.6 GW more biomass, and 0.6 GW more DR

RESOLVE optimized annual incremental selected capacities – 30 MMT limited offshore and out-of-state wind sensitivity

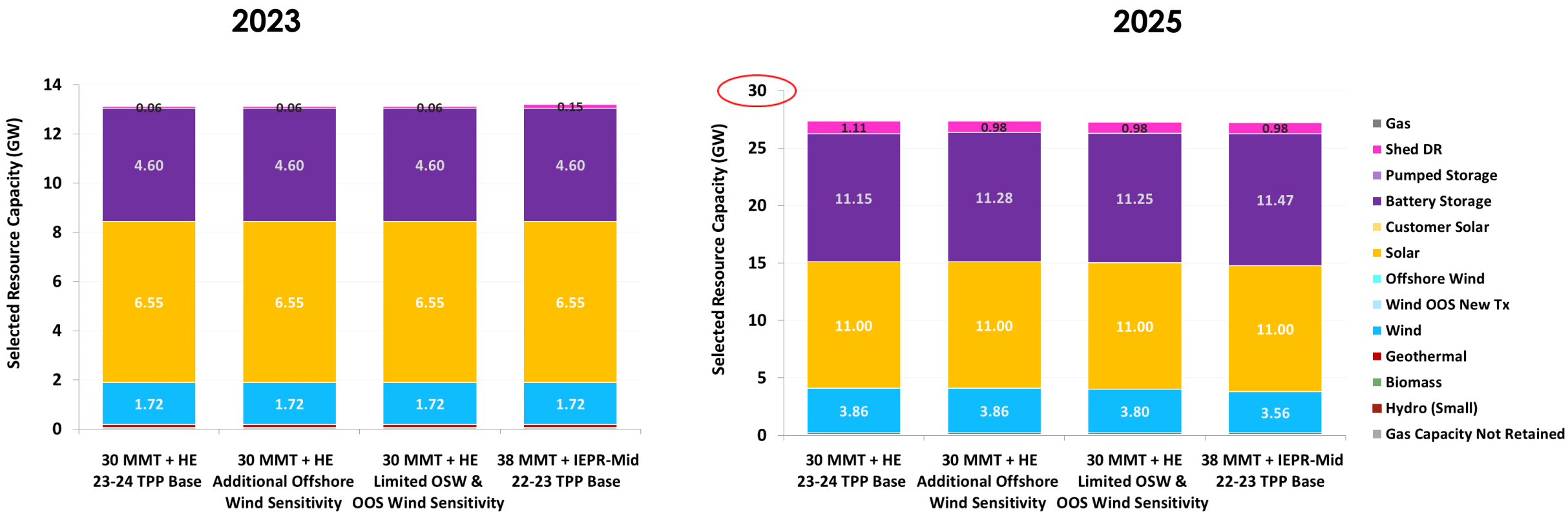
Technology Class	Unit	2023	2024	2025	2026	2028	2030	2032	2033	2035
Battery Storage	MW	0	3,836	240	(367)	718	2,175	6,670	1,568	6,972
Pumped Storage	MW	-	-	-	-	(399)	(72)	-	1,000	-
Biomass	MW	(0)	-	12	(12)	-	-	-	-	565
Shed DR	MW	-	825	87	-	1	0	-	-	739
Geothermal	MW	-	-	-	1,122	(569)	(71)	-	60	-
Solar	MW	0	0	2,344	(542)	2,249	7,682	9,062	5,226	9,769
Wind	MW	(0)	270	769	(321)	(341)	(1,612)	-	-	-
Offshore Wind	MW	-	-	-	-	-	1,805	-	-	-
Wind OOS New Tx	MW	-	-	-	-	2,000	-	-	-	-

Note 1: Negative values indicate resources have been selected in RESOLVE in an earlier year than the forced-in capacities from LSE plans and MTR order in that year

Note 2: The values exclude LSE plans, newly developed resources, and MTR-related 1 GW geothermal and 1 GW long-duration storage

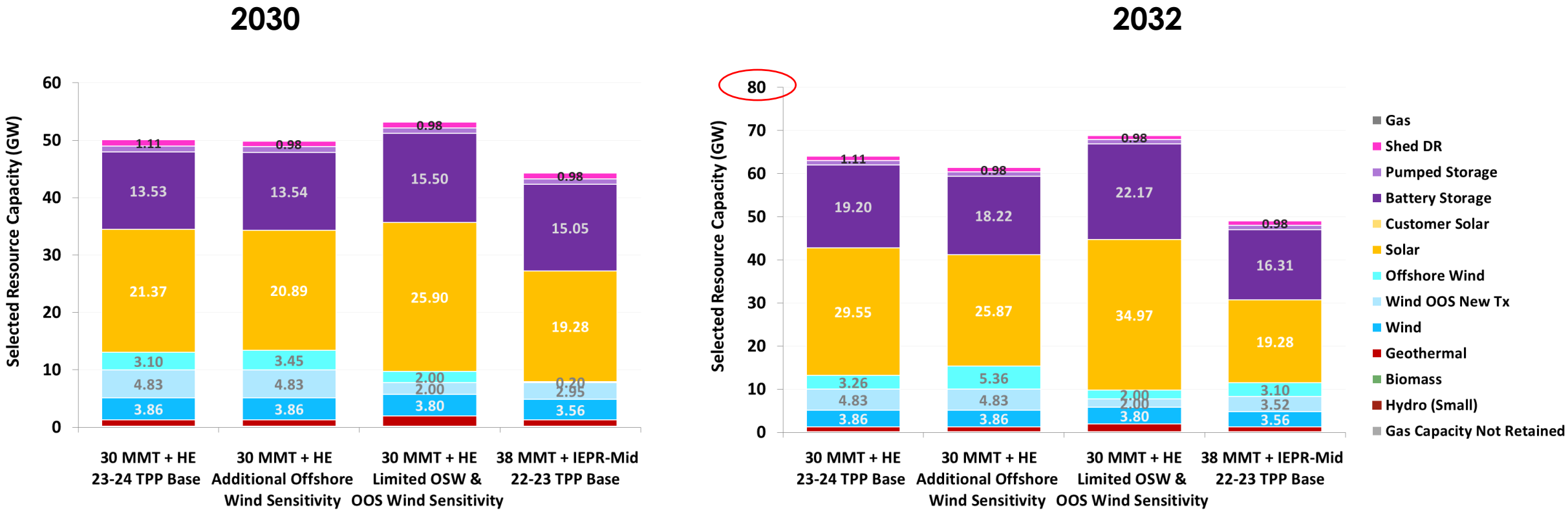
Comparison of 30 MMT TPP 2023-2024 Base Case, Sensitivities and the 2022-2023 TPP Base Portfolio

Selected resources comparison



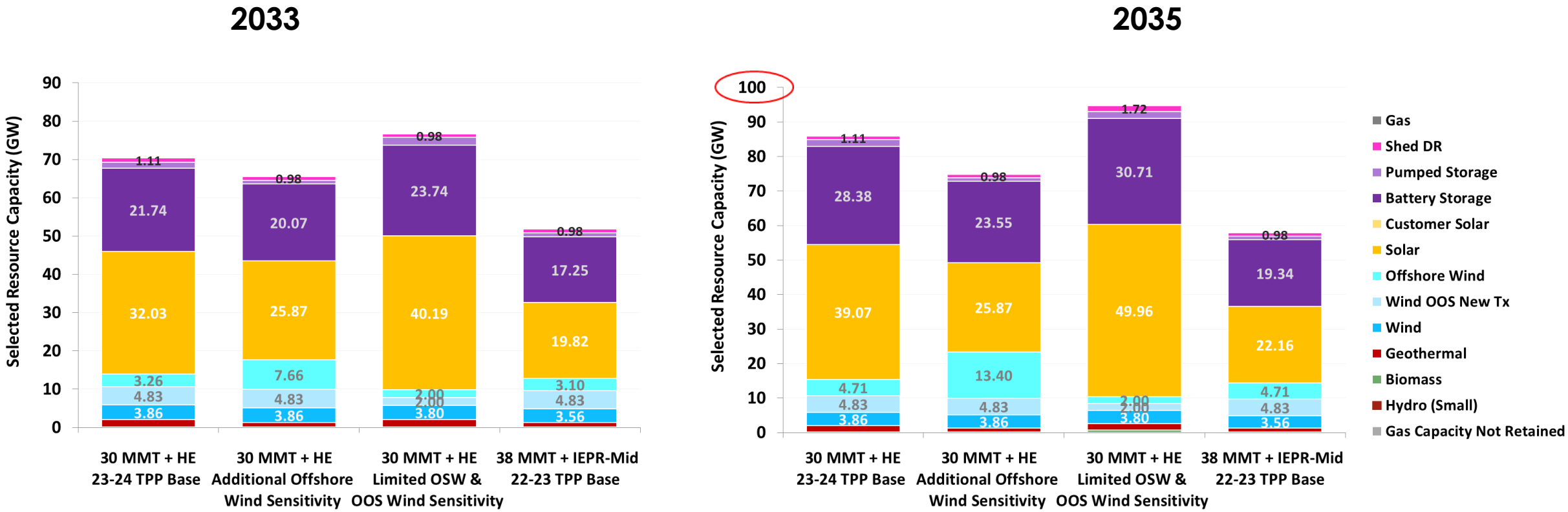
- In 2025, selected resources are similar in all cases except for small differences in DR.

Selected resources comparison



- In 2030, the sensitivity with limited wind has 4.5 GW more solar, 2 GW more battery storage and 0.7 GW more geothermal compared to the base case
- By 2030, there is small differences in offshore wind, solar and DR capacities in the forced-in OSW sensitivity compared to the base case
- In 2032, in the forced-in offshore wind sensitivity, 2 GW higher offshore wind reduces solar and battery storage by 4 and 1 GW, compared to the base case, respectively. The constrained wind sensitivity, however, results in 5 GW more solar and 3 GW more battery storage capacity compared to the base case.

Selected resources comparison



- In 2033, the forced-in offshore wind sensitivity reduces selected battery storage capacity only by 1 GW and solar capacity by 6 GW compared to the base case. 8 GW more solar and 2 GW more battery storage is selected instead of reduced 1 GW and 2.8 GW offshore and out-of-state wind in the wind capacity constrained sensitivity (no new gas) compared to the base case
- In 2035, the 13.4 GW offshore wind capacity further reduces solar, and wind buildout compared to the base case.
- In 2035, since no new gas is allowed in the sensitivity with constrained wind, additional capacity needs are sourced from additional solar (10 GW more) and storage (2 GW more), and DR (0.7 GW more compared to the base case

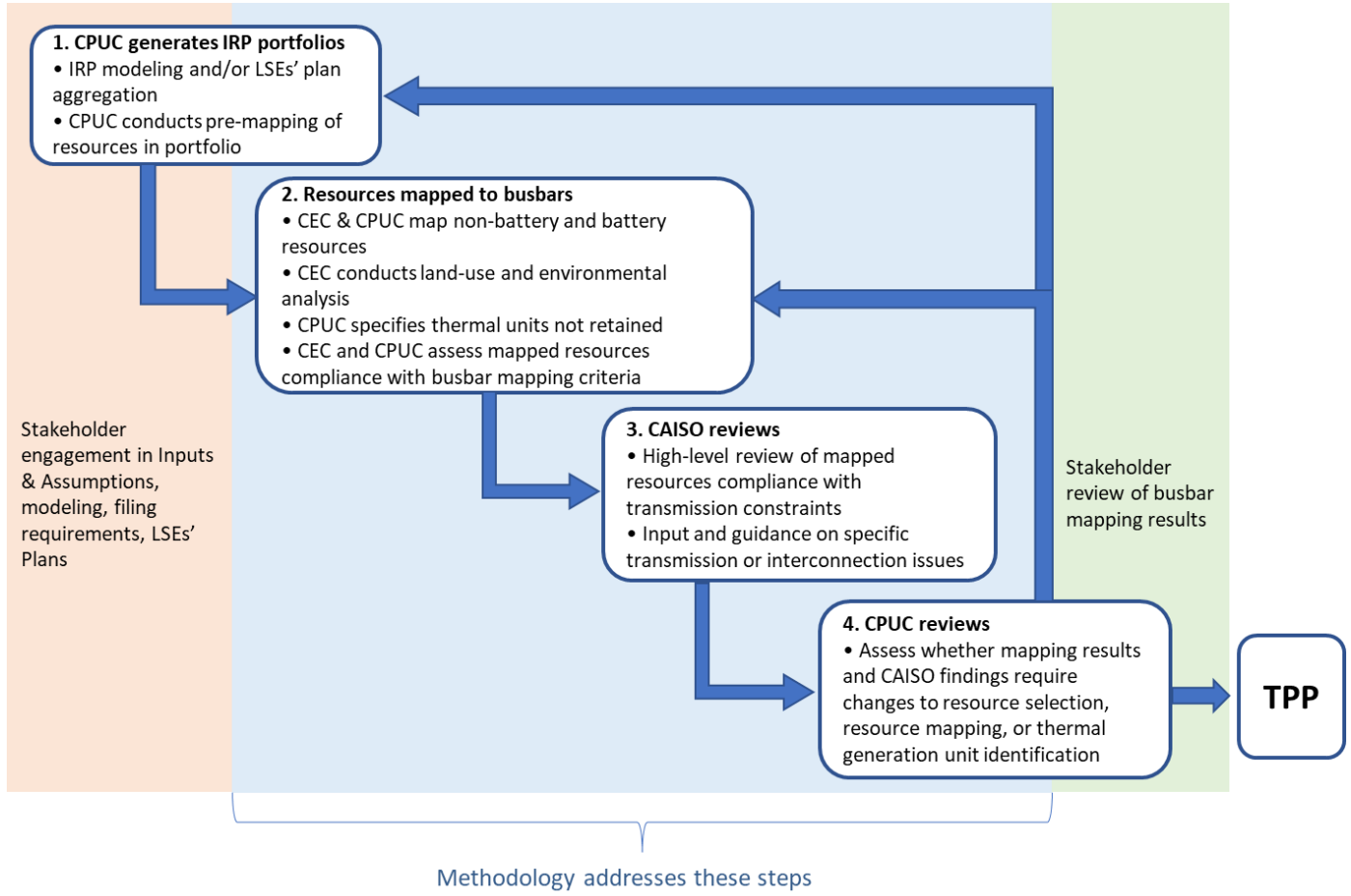
Takeaways

- By 2025, 30 MMT cases have similar build out as the 22-23 TPP Base portfolio.
- By 2030, total selected resources are similar across all three 30 MMT cases, but 6-10 GW more compared to the 22-23 TPP Base portfolio.
- Constraining wind triggers geothermal and biomass selection in 2030 and 2035, respectively.
- Limited wind availability results in much greater solar and storage capacity, especially in later years.
- In the 30 MMT TPP 23-24, offshore wind is first selected in 2030, earlier than in 2032 in the 22-23 TPP Base portfolio.

Busbar Mapping Methodology

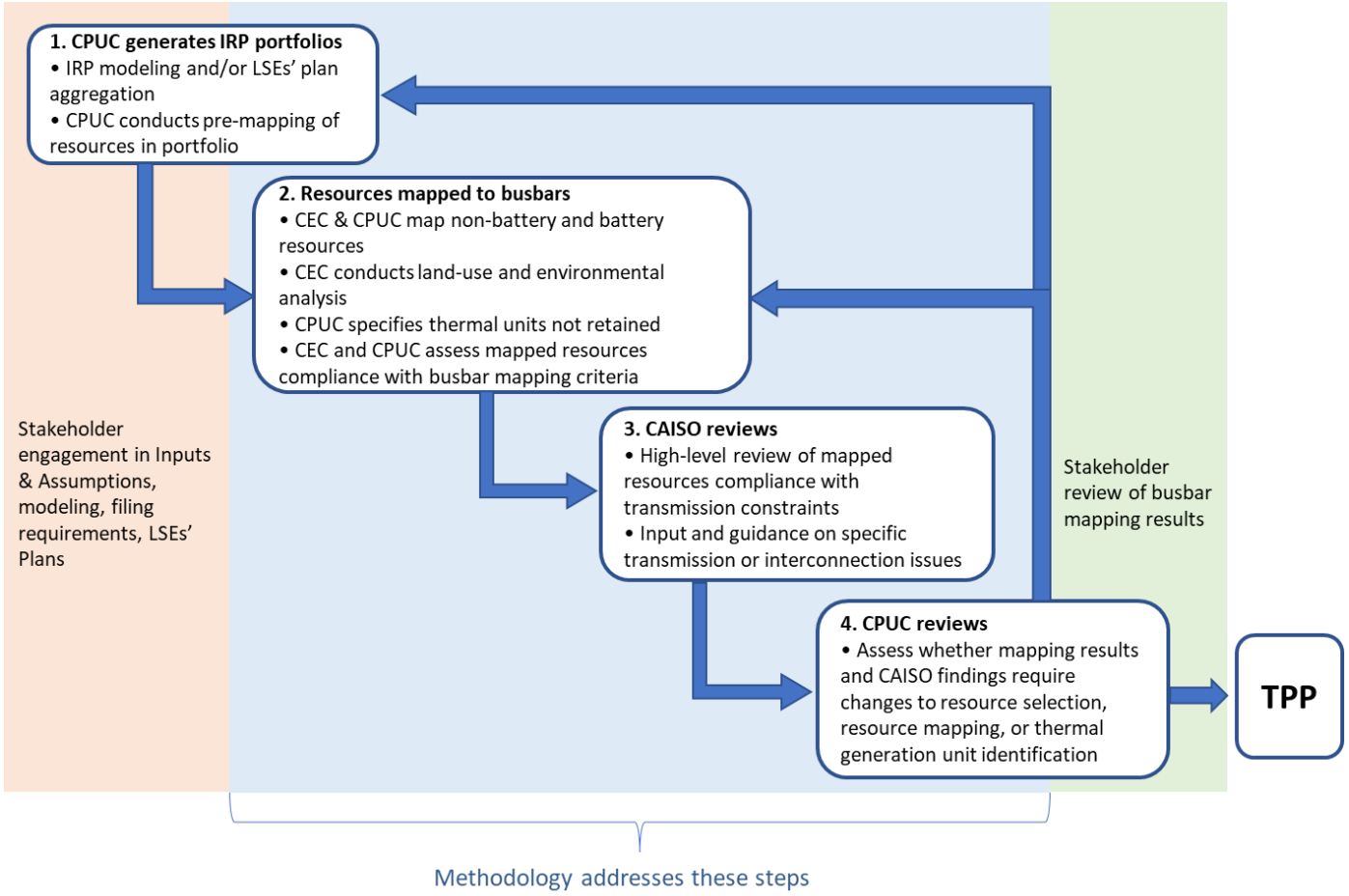
Busbar Mapping Methodology – Mapping Steps

- Busbar Mapping can be viewed as a sequence of steps between CPUC, CEC, and CAISO after the portfolios are developed:
  1. CPUC staff prepare and share portfolios with CEC
     - Pre-mapping effort to identify substations and MW amounts for CEC to consider when conducting land-use analysis
  2. Mapping and busbar criteria analysis preformed by CEC & CPUC
  3. CAISO reviews transmission implications of mapping results
  4. CPUC incorporates CAISO's findings and review criteria alignment to assess if a further round of mapping is needed.
- For further rounds, resources may be reallocated to different regions manually or using RESOLVE



Busbar Mapping Methodology – Mapping Criteria

- Goal of mapping process is to identify plausible locations for portfolio resources that do not violate established busbar mapping criteria.
- Criteria are organized into five categories:
  1. Distance to transmission of appropriate voltage
  2. Transmission capability limits
  3. Land-use and environmental constraints
  4. Commercial interest
  5. Consistency with prior year mapping
- Difference in criteria specifically for battery mapping
  - Criteria 1 and 3 are not incorporated
  - Additional criteria are implemented for battery mapping



Battery Mapping Methodology & Criteria

- Battery mapping partially differs from non-battery resource mapping
  - Land-use and environmental implication differ from other resources
  - Battery storage provides opportunity to consider additional local values
- Additional issues that can be addressed with battery siting:
  - Minimizing Ratepayer costs
    - Co-location with renewable resources
    - Reducing congestion and curtailment
    - Reducing market power in Local Capacity Requirement (LCRs) areas
  - Minimizing Criteria Pollutants
    - Prioritizing transmission-constrained LCR areas, areas with high air quality impacts, and disadvantaged communities (DACs) to potentially reduce use of local power plant emission sources.
- Substations are ranked based on the number of points received for aligning with the following attributes; rank is incorporated with general mapping criteria for prioritization of mapping batteries
  - Is in LCR
  - Is in DAC
  - Is in ozone non-attainment area
  - Is in NOx non-attainment area
  - Is in high renewable curtailment zone
  - Is near a identified fossil-fuel plant mapped as retiring

Criteria 1 – Distance to Transmission of Appropriate Voltage

- Mapped resources should fall within an economically viable distance to transmission
- Utilizes standard distances in assessment but exceedance of the standard distance does not necessarily mean the allocation is not plausible or economic.
- Busbar voltage is also considered broadly to assess if the interconnection costs are generally economical given resource type and MW amount mapped.
  - Limit mapping large amounts of resources to lower voltage 115 kV or 60 kV buses, and limit mapping small amounts of resources to 500 kV substations.
- Criteria Compliance Flags:
  - Level-2 flag: >10 mi from substation,
  - Level-2 flag: Substation voltage misalignment,
  - Level-3 flag: >20 mi from substation.
- Flags do not exclude resources from being mapped to specific areas just highlight potential issues for further assessment.
- Utilize CAISO participating transmission owner per unit cost estimates for more detailed analysis.

Criteria 2 – Transmission Capability

- Mapping should abide by existing transmission constraints and trigger only potential upgrades which are likely to be cost-effective or necessary to meet policy goals and reliability requirements
- Utilize transmission constraint and upgrade information identified in the most recent CAISO's White Paper – 2021 Transmission Capability Estimates (Link to 10/28/2021 Revised White Paper)
  - Updated with upgrade and capacity information from the Final 21-22 TPP Report
- Account for 44 transmission constraints with on-peak and off-peak limits and identified upgrades
  - Actual limits: binding amounts identified in CAISO studies,
  - Default constraints are non-binding limits, which represent the largest amount CAISO has studied.
- Criteria Compliance Flag: Level-3 for exceedance in actual constraint; Level-2 for default exceedance.

Transmission Constraint	Affected Zones	Condition under which Constraint is Binding	Estimated FCDS		ADNU & Cost Estimate ($million)		Estimated EODS		AOPNU & Cost Estimate ($million)		Wind/ Solar Area	FCDS Limit (Actual/ Default)	OPDS Limit (Actual/ Default)
			Existing System (MW)	Incremental due to ADNU	ADNU (Time to Construct)	Cost (Escalated to COD)	Existing System (MW)	Incremental due to AOPNU	AOPNU (Time to Construct)	Cost (Escalated to COD)			
SCE North of Lugo (NOL) Study Area Constraints													
Lugo 500/230 kV Transformer Constraint	Inyokern North Kramer, Victor, Pisgah	On-peak	1,576	980	New Lugo 500/230kV No. 3 transformer (42 months)	$70	1,619	N/A	N/A	N/A	Solar	Actual	Default
Victor-Lugo Constraint	Inyokern North Kramer, Victor	On-peak	1,156	430	Reconductor Lugo - Victor 230kV lines (27 Months)	$226	1,311	N/A	N/A	N/A	Solar	Actual	Default
Kramer- Victor/Roadway - Victor Constraint	Inyokern North Kramer	On-peak, Off-peak	826	430	Loop in Kramer - Victor 115kV line into Roadway and reconductor Kramer to Lugo 230kV lines (81 months)	$108	1,237	480	Loop in Kramer - Victor 115kV line into Roadway and reconductor Kramer to Lugo 230kV lines (81 months)	$108	Solar	Actual	Actual

Table: White paper information on transmission constraints in the Greater Kramer area

Criteria 2 – Transmission Capability: Deliverability Status

- Mapped resources are considered either Fully Deliverability (FCDS) or Energy Only (EODS)
  - FCDS resources require on-peak capacity at both CAISO's HSN and SSN scenarios and off-peak capacity
  - EODS resources require only off-peak capacity
- CAISO's White Paper includes resource specific output factors that represent a resource's utilization of transmission capacity.
  - Different values for On-peak (HSN and SSN) and Off-peak
  - Different values based on geographic area and dominate resource type
- Batteries in off-peak viewed as charging and thus enabling additional off-peak transmission capacity

On-Peak FCDS Output Factors

Resource type	HSN			SSN		
	SDG&E	SCE	PG&E	SDG&E	SCE	PG&E
Solar	3.00%	10.60%	10.00%	40.20%	42.70%	55.60%
Wind	33.70%	55.70%	66.50%	11.20%	20.80%	16.30%
Non-Intermittent resources	100%					
Energy storage	100%			50%		
	if duration is ≥ 4-hour or MW*(duration/4) if duration is < 4-hour					

Off-Peak EODS Output Factors

Resource type	Wind Area			Solar Area		
	SDG&E	SCE	PG&E	SDG&E	SCE	PG&E
Solar	68%			79%	77%	79%
Wind	69%	64%	63%	44%		
Hydro	30%					
Thermal	0%					
Energy storage	-100% in charging mode if duration is ≥ 4-hour or 4-hour equivalent if < 4-hour					

Criteria 2 – Transmission Capability: Calculating Tx Utilization (1/3)

- Multi-step process to calculate transmission utilization within a constraint
  - Aggregate all resources within constraint
    - Includes recently online resources in addition to in-development and generic resources
    - Need to account for all resources within constraint that have come online since the White Paper information was developed.

Table:2035 Resources in Greater Kramer Area

Total Resources (MW) by Substation		Geothermal	Biomass	Distributed Solar	Solar	Solar	Li_Battery
Substation	Voltage	FCDS	FCDS	FCDS	FCDS	EODS	FCDS
Calcite	230	-	-	-	200	230	185
Control	115	53	-	-	-	-	-
Coolwater	115	-	-	-	150	204	104
Kramer	230	-	-	-	620	741	700
Kramer	115	-	-	2	90	-	75
Pisgah	230	-	-	-	100	-	-
Roadway	115	-	-	3	111	120	150
Victor	230	-	3	2	100	-	50
Victor	115	-	22	-	-	-	-

	Kramer-Victor/Roadway - Victor Constraint		Kramer-Victor/Roadway - Victor Constraint		Lugo 500/230 kV Transformer Constraint	
	FCDS	EODS	FCDS	EODS	FCDS	EODS
Wind	-	-	-	-	-	-
Solar	971	1,065	1,071	1,065	1,371	1,295
Geothermal	53	-	53	-	53	-
Biomass	-	-	25	-	25	-
Li_Battery	1,029	-	1,079	-	1,264	-

Table: 2035 Resources aggregated by transmission constraint

Criteria 2 – Transmission Capability: Calculating Tx Utilization (2/3)

- Multi-step process to calculate transmission utilization within a constraint
  1. Aggregate all resources within constraint
     - Includes recently online resources in addition to in-development and generic resources
     - Need to account for all resources within constraint that have come online since the White Paper information was developed.
  2. Calculate transmission utilization of each resource type for each transmission use scenario.
  3. Sum across all resources for each constraint and comparing to existing transmission capacity

	Kramer-Victor/Roadway - Victor Constraint		Kramer-Victor/Roadway - Victor Constraint		Lugo 500/230 kV Transformer Constraint	
	FCDS	EODS	FCDS	EODS	FCDS	EODS
Wind	-	-	-	-	-	-
Solar	971	1,065	1,071	1,065	1,371	1,295
Geothermal	53	-	53	-	53	-
Biomass	-	-	25	-	25	-
Li_Battery	1,029	-	1,079	-	1,264	-

Tx Capacity Utilized by Mapped Resources (MW)	Kramer- Victor/Roadway - Victor Constraint			Kramer- Victor/Roadway - Victor Constraint			Lugo 500/230 kV Transformer Constraint		
	HSN	SSN	Off-Peak	HSN	SSN	Off-Peak	HSN	SSN	Off-Peak
Existing Capacity:	**826**	**826**	**1,237**	**1,156**	**1,156**	**1,311**	**1,576**	**1,576**	**1,619**
Wind	-	-	-	-	-	-	-	-	-
Solar	103	415	1,567	114	457	1,644	145	585	2,053
Geothermal	53	53	-	53	53	-	53	53	-
Biomass	-	-	-	25	25	-	25	25	-
Li_Battery	1,029	514	(1,029)	1,079	539	(1,079)	1,264	632	(1,264)
Total Utilized:	**1,185**	**982**	**539**	**1,270**	**1,075**	**566**	**1,487**	**1,295**	**789**
Remaining:	**(359)**	**(156)**	**698**	**(114)**	**81**	**745**	**89**	**281**	**830**
Tx Upgrade Amt:	**430**	**430**	**480**	**430**	**N/A**	**N/A**	**980**	**N/A**	**N/A**

Table: Transmission utilization in the three scenarios are calculated for each constraint

Criteria 2 – Transmission Capability: Calculating Tx Utilization (3/3)

- Multi-step process to calculate transmission utilization within a constraint
  1. Aggregate all resources within constraint
     - Includes recently online resources in addition to in-development and generic resources
     - Need to account for all resources within constraint that have come online since the White Paper information was developed.
  2. Calculate transmission utilization of each resource type for each transmission use scenario.
  3. Sum across all resources for each constraint and comparing to existing transmission capacity.
  4. Assess exceedances and if any CAISO identified upgrades could alleviate the exceedances.

Tx Capacity Utilized by Mapped Resources (MW)	Kramer- Victor/Roadway - Victor Constraint			Kramer- Victor/Roadway - Victor Constraint			Lugo 500/230 kV Transformer Constraint		
	HSN	SSN	Off-Peak	HSN	SSN	Off-Peak	HSN	SSN	Off-Peak
Existing Capacity:	**826**	**826**	**1,237**	**1,156**	**1,156**	**1,311**	**1,576**	**1,576**	**1,619**
Wind	-	-	-	-	-	-	-	-	-
Solar	103	415	1,567	114	457	1,644	145	585	2,053
Geothermal	53	53	-	53	53	-	53	53	-
Biomass	-	-	-	25	25	-	25	25	-
Li_Battery	1,029	514	(1,029)	1,079	539	(1,079)	1,264	632	(1,264)
Total Utilized:	**1,185**	**982**	**539**	**1,270**	**1,075**	**566**	**1,487**	**1,295**	**789**
Remaining:	**(359)**	**(156)**	**698**	**(114)**	**81**	**745**	**89**	**281**	**830**
Tx Upgrade Amt:	**430**	**430**	**480**	**430**	**N/A**	**N/A**	**980**	**N/A**	**N/A**

Flags without (left) and with (right) upgrades

Total Resources (MW) by Substation		Geothermal	Biomass	Distributed Solar	Solar	Solar	Li_Battery	Tx Criteria Flag	Tx Criteria Flag	Tx Criteria Flag	Tx Criteria Flag
Substation	**Voltage**	**FCDS**	**FCDS**	**FCDS**	**FCDS**	**EODS**	**FCDS**	**FCDS**	**EODS**	**FCDS**	**EODS**
Calcite	230	-	-	-	200	230	185	1	1	1	1
Control	115	53	-	-	-	-	-	3	1	1*	1
Coolwater	115	-	-	-	150	204	104	3	1	1*	1
Kramer	230	-	-	-	620	741	700	3	1	1*	1
Kramer	115	-	-	2	90	-	75	3	1	1*	1
Pisgah	230	-	-	-	100	-	-	1	1	1	1
Roadway	115	-	-	3	111	120	150	3	1	1*	1
Victor	230	-	3	2	100	-	50	3	1	1*	1
Victor	115	-	22	-	-	-	-	3	1	1*	1

Table: Criteria 2 non-compliance flags determined from transmission constraints utilization calculations

Criteria 3 – Land Use & Environmental Constraints

- Mapping should not exceed available land area to accommodate the resources.
- Mapping should seek to limit use of land with high environmental implications.
- In addition to relocating to other substations, possible solution is increasing gen-tie distance affecting criteria 1)
- Compliance criteria flags divided into two parts:
  - Criteria 3a) utilizes a CEC developed environmental implications layer
  - Criteria 3b) assess impacts from individual datasets
- Compliance criteria flag thresholds:
  - 3a) Level-2: > 50% of lower-implication potential area;
  - 3a) Level-3: > 75% of total potential area;
  - 3b) Level-2: 2 or more datasets with > 75% or 1 or more datasets with 95% or greater;
  - 3b) Level-3: 4 or more datasets with > 75% or 2 or more datasets with 95% or greater.

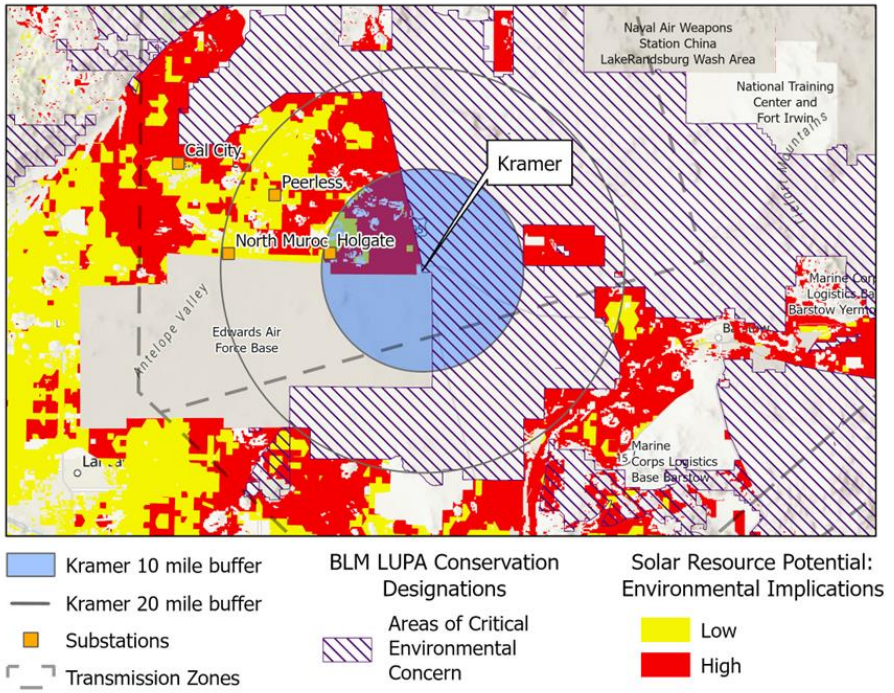
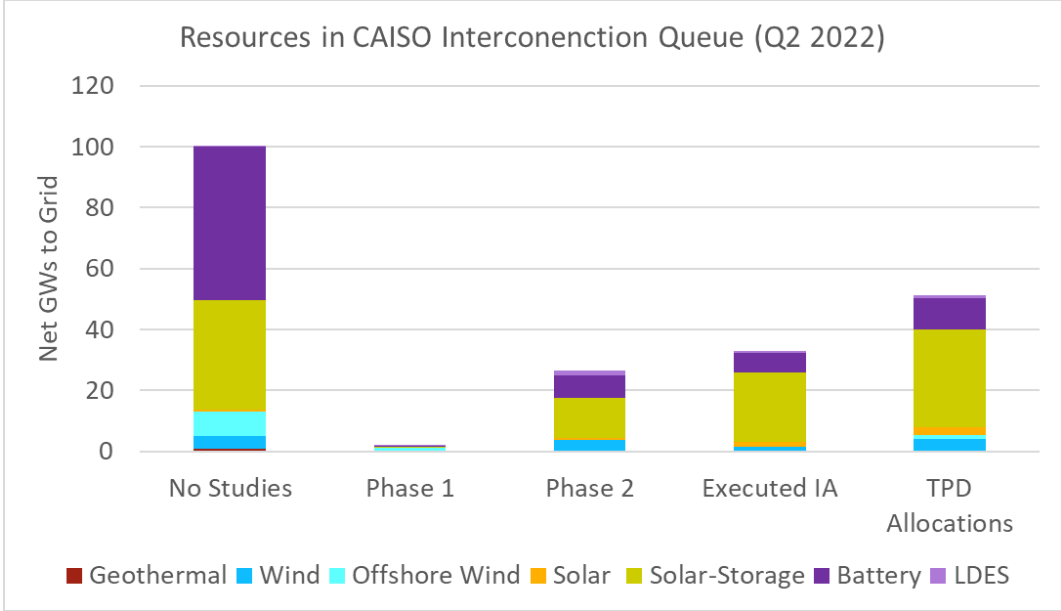


Figure: Criteria 3a and 1 analysis for the Kramer substation

Criteria 4 – Commercial Development Interest

- Mapping, to extent possible, should align with planned procurement by LSEs and the level of resources proposed in the CAISO interconnection queue and other relevant in queues.
- Prioritize "high-confidence" commercial interest:
  - In-development/identified resources in LSE plans
  - **Resources with CAISO TPD allocations**
  - Resource with executed IAs in CAISO or other queues
- Total commercial interest includes projects in queues still in initial study phases or not yet in an interconnection queue.
- Assess if mapping exceeds commercial interest or if it is significantly less than the commercial interest.



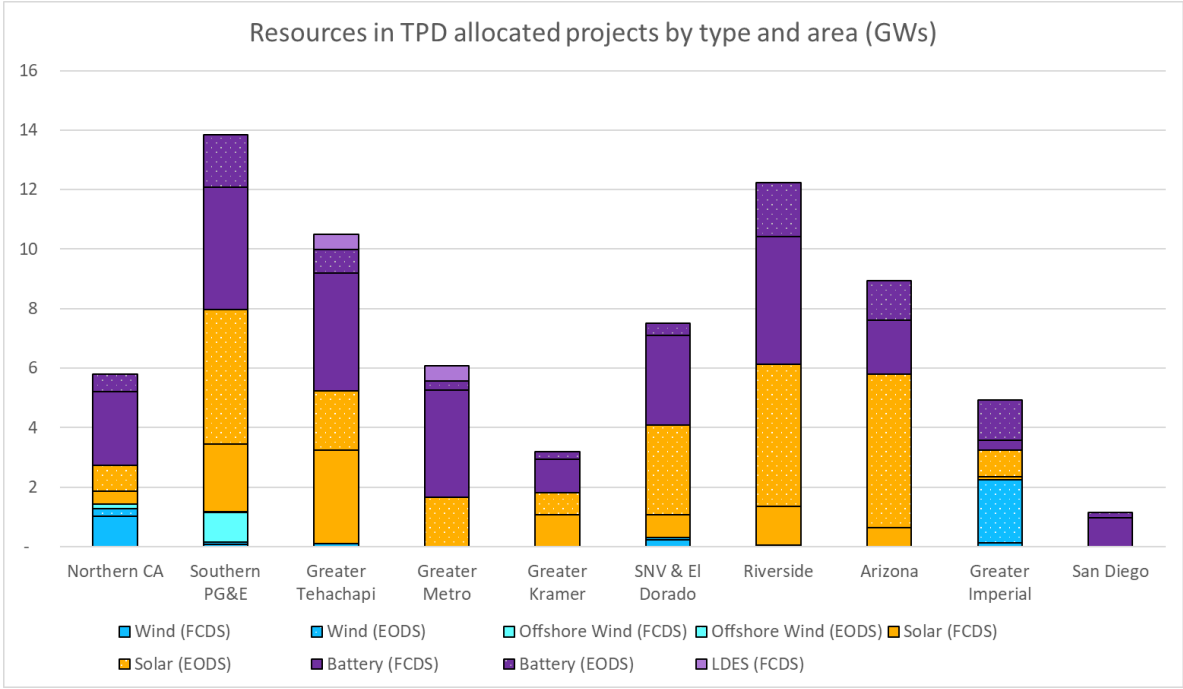
Interconnection Queues Utilized

- CAISO Interconnection Queue
- IID Interconnection Queue[1]
- NVEP Interconnection Queue[1]
- SCE WDAT Interconnection Queue[2]
- PG&E WDT Interconnection Queue[2]
- SDGE WDAT Interconnection Queue[2]

[1]Primarily for geothermal resources
[2]Biomass/gas and larger projects >5 MWs

Criteria 4 – Commercial Development Interest (cont'd)

- Criteria analysis is conducted on a busbar level (prior to 22-23 TPP, only RESOVLE area level)
  - Some resources at lower voltage buses included in nearest system level bus.
- Prioritize FCDS TPD alignment. **Note**: TPD from CAISO still confidential, so not included at substation level in Mapping Dashboards.
- Criteria Compliance Flags factors:
  - Alignment with high and total commercial interest
  - Amount mapped was more or less than commercial interest.
- Thresholds for level-2 and level-3 non-compliance variable depending on confidence-level
- Final flag utilizes a combined assessment



Substation	Mapped Amounts (MWs)			Executed IA Amounts (MWs)						All Projects Amounts (MWs)						Final Flags	
	Solar (FCDS)	Solar (EODS)	Battery	Solar (FCDS)	Flag	Solar (EODS)	Flag	Battery	Flag	Solar (FCDS)	Flag	Solar (EODS)	Flag	Battery	Flag	Solar	Battery
Sample	110.0	250.0	100.0	50.0	2	100.0	3	75.0	1	50.0	2	1,500.0	2+	1,475.0	2+	2	1+

Table: Analysis of commercial interest at a hypothetical substation

Criteria 5 – Alignment with prior TPP portfolios

- Mapping should be relatively consistent with prior years.
  - The Base Case compared to base cases of prior years
  - Sensitivity Portfolios compared to similar issue-focused portfolios of prior years
- Goal is to avoid significantly reducing transmission impacts of prior years' mapping without clear reasons which are explicitly justified.
- Criteria Following review by CAISO staff and woCompliance Flags focuses on reduction from prior years:
  - Level-2: Any reduction in resource compared to prior year
  - Level-3: Significant reduction in resources (500 MW or 50%)
- Following working group discussion, non-compliance can be reduced if changes are estimated to not significantly affect transmission implications.

CEC's Mapping Land-Use and Environmental Analysis

Land-Use Evaluation for Busbar Mapping

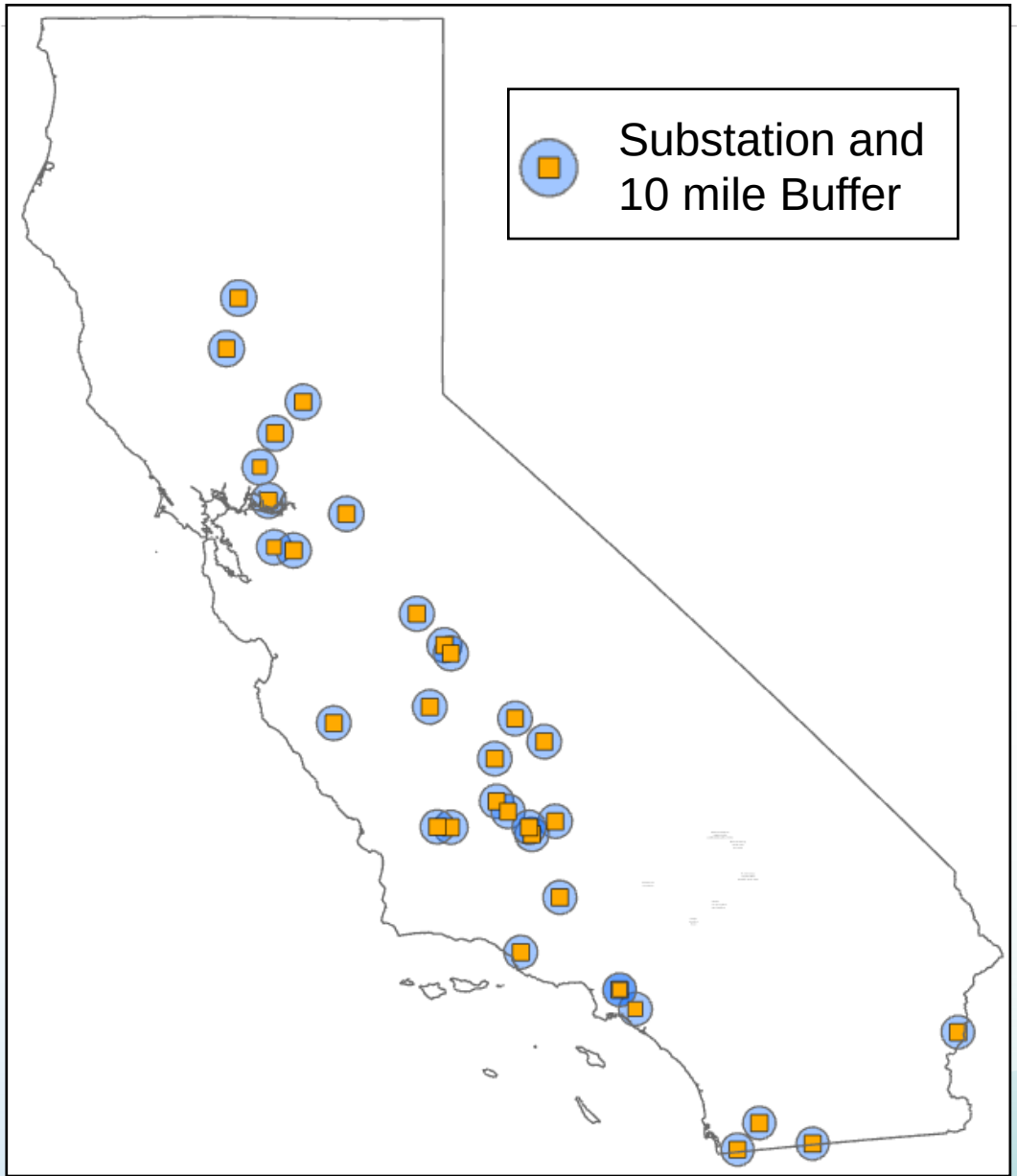
Presenter: Erica Brand
Siting, Transmission, and Environmental Protection Division

Date: October 20, 2022

Overview

- CPUC disaggregates geographically coarse zonal results from RESOLVE to specific substations for transmission analysis
- CEC Performs Land-Use Evaluation:
    - Resource Potential Area for each Technology
    - Environmental Implications Model
    - Calculate Metrics on Area Around Substation
- Report back to CPUC metrics on environmental and land use characteristics of proposed resource allocation to substations

Substations List



- CPUC provides list of substations intended for additional capacity for each technology
- Geolocate the substation from CEC and Homeland Infrastructure Foundation Level Data (HIFLD) databases of substations

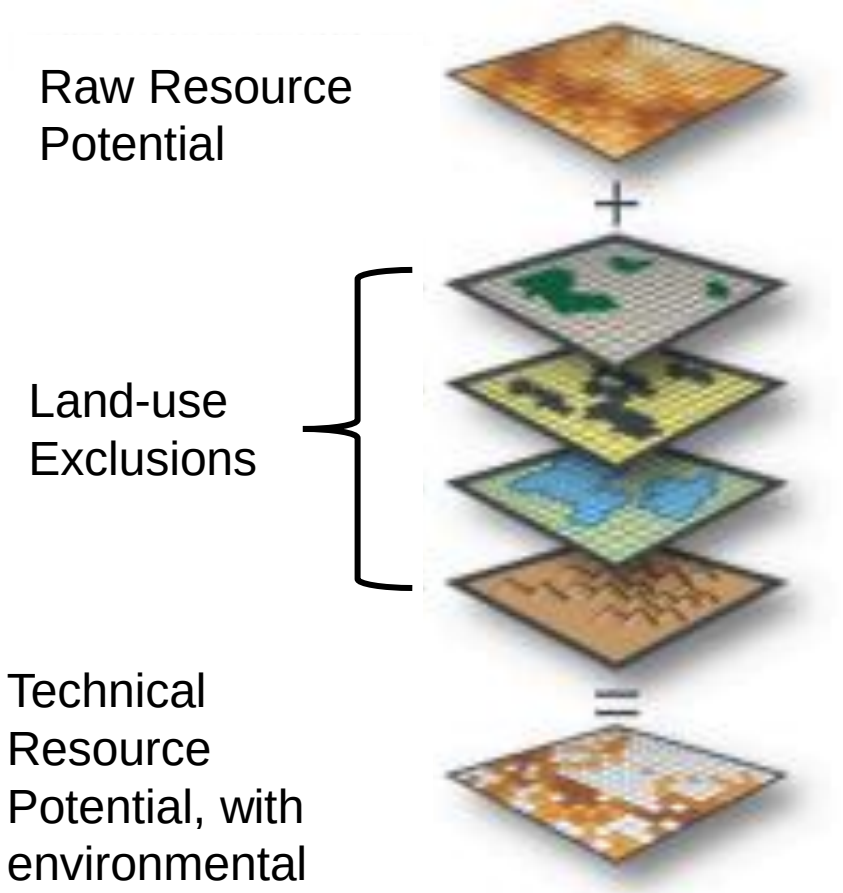
Summary of Analysis

- Buffer substations by chosen radius (10 or 15 miles)
- Intersect with resource potential map for each technology
- Analyze land-use and environmental factors within this area
  - Main Ecological and Biodiversity factors – bundled into model, single measure
    - Biodiversity
    - Connectivity
    - Landscape Intactness

    - Individual components to understand driving force behind model score:
      - Natural Landscape Blocks
      - Native Species Richness
      - Rarity of Species
      - Irreplaceability
  - Stand-alone Factors:
    - Important Bird Areas
    - Fire-Threat Tier
- Metrics reported back to CPUC to help inform decisions

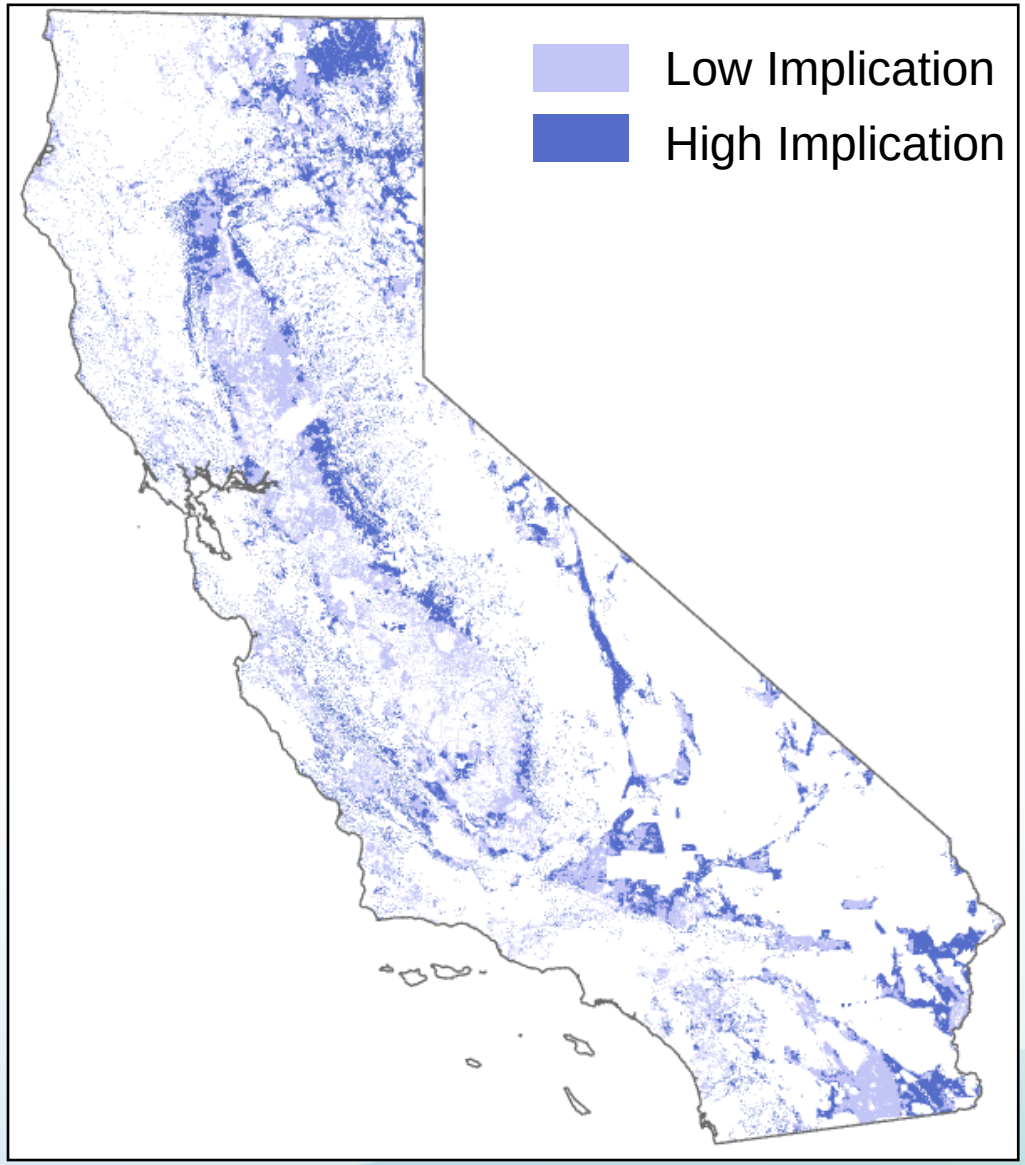
Environmental Implications Model

- Exclude lands that are unfeasible to build on
  - Military, urban areas, slope, protected areas (RETI Category 1 and 2 Lands)
- Multi-criteria evaluation method on remaining land
  - Composite score of three data sets:
    - Terrestrial Biodiversity[1]
    - Terrestrial Connectivity[1]
    - Landscape Intactness[2]
- Classify model results into high and low categories to identify potential implications

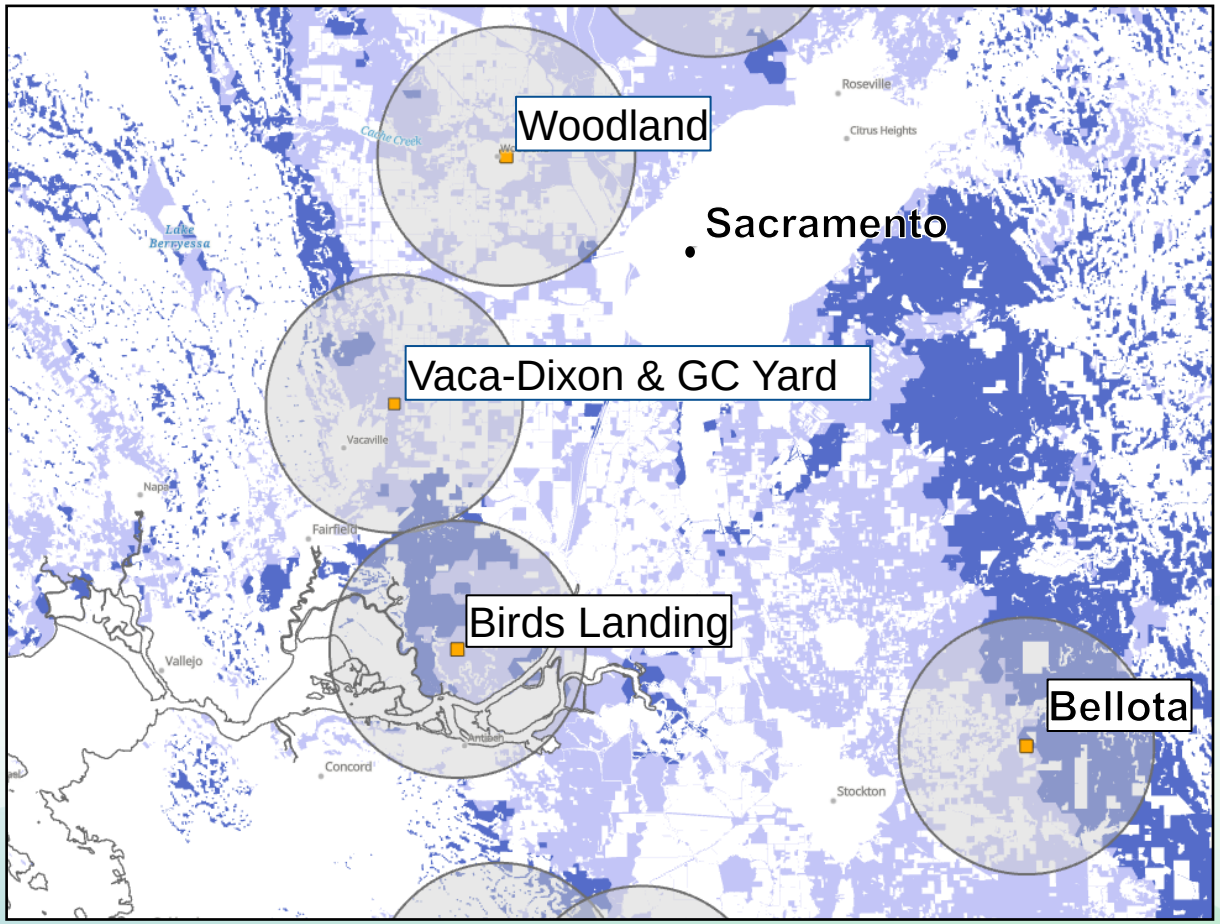


Modified from Maclaurin et al. 2019

Binary Classification of Environmental Model



- Overlayed on Solar Resource Area
- Buffered areas around substations for high-level analysis - metrics



Individual Components of Environmental Implications

Low Implication

High Implication

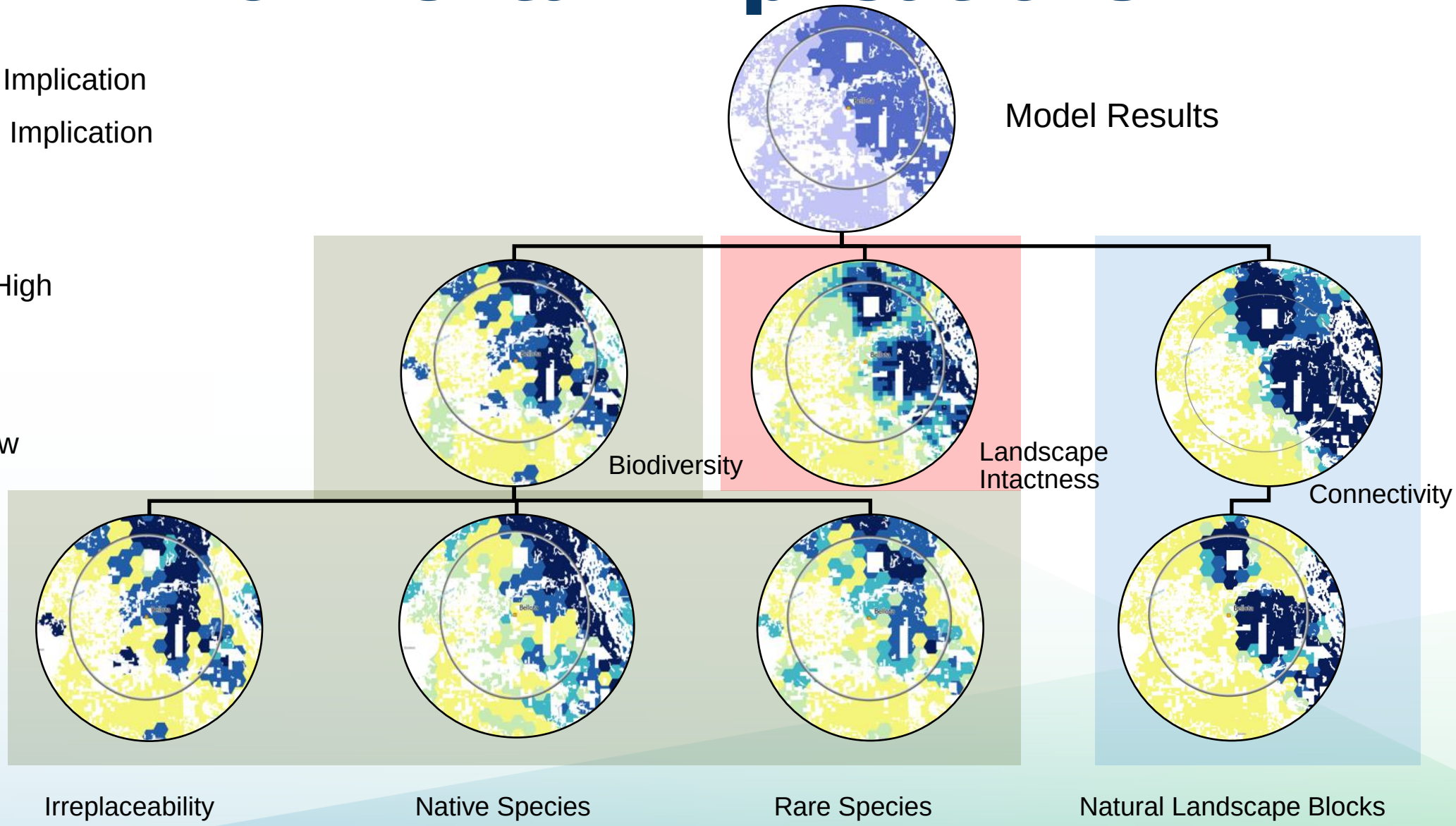
≥ 5 - High

4

3

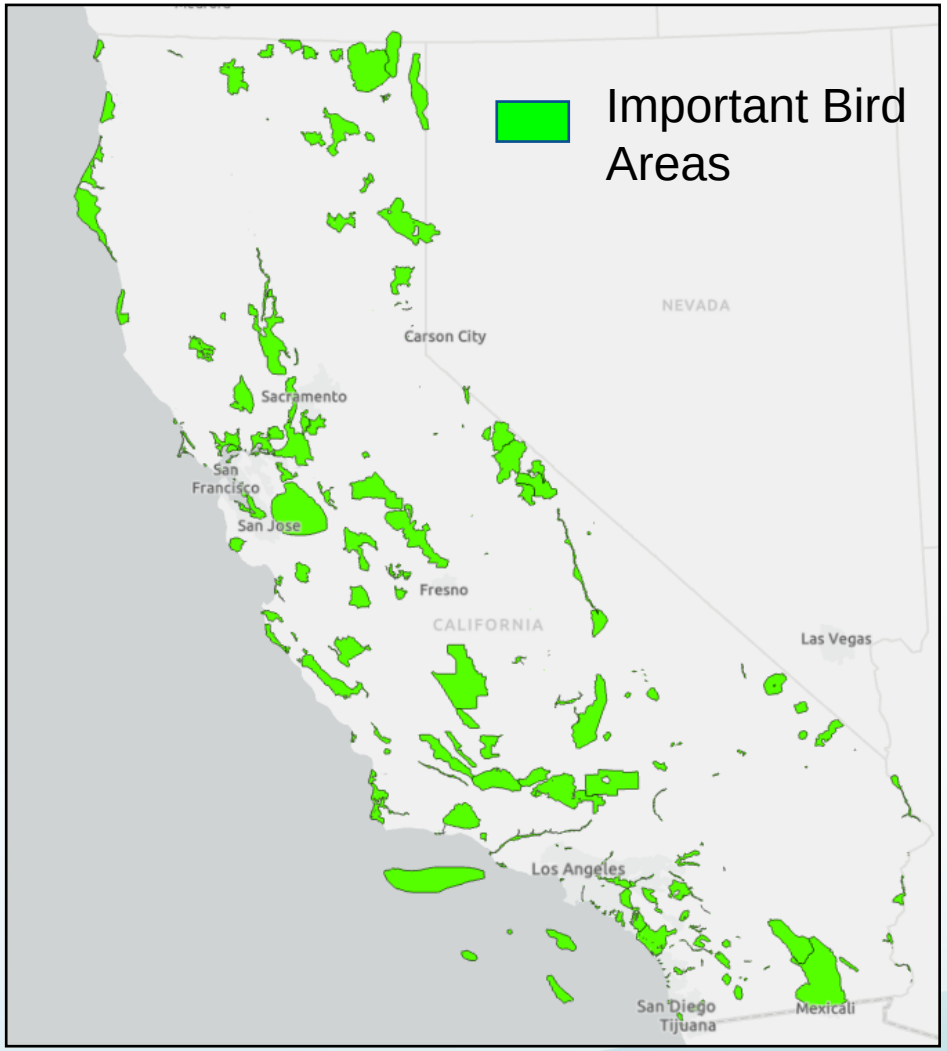
2

1 - Low

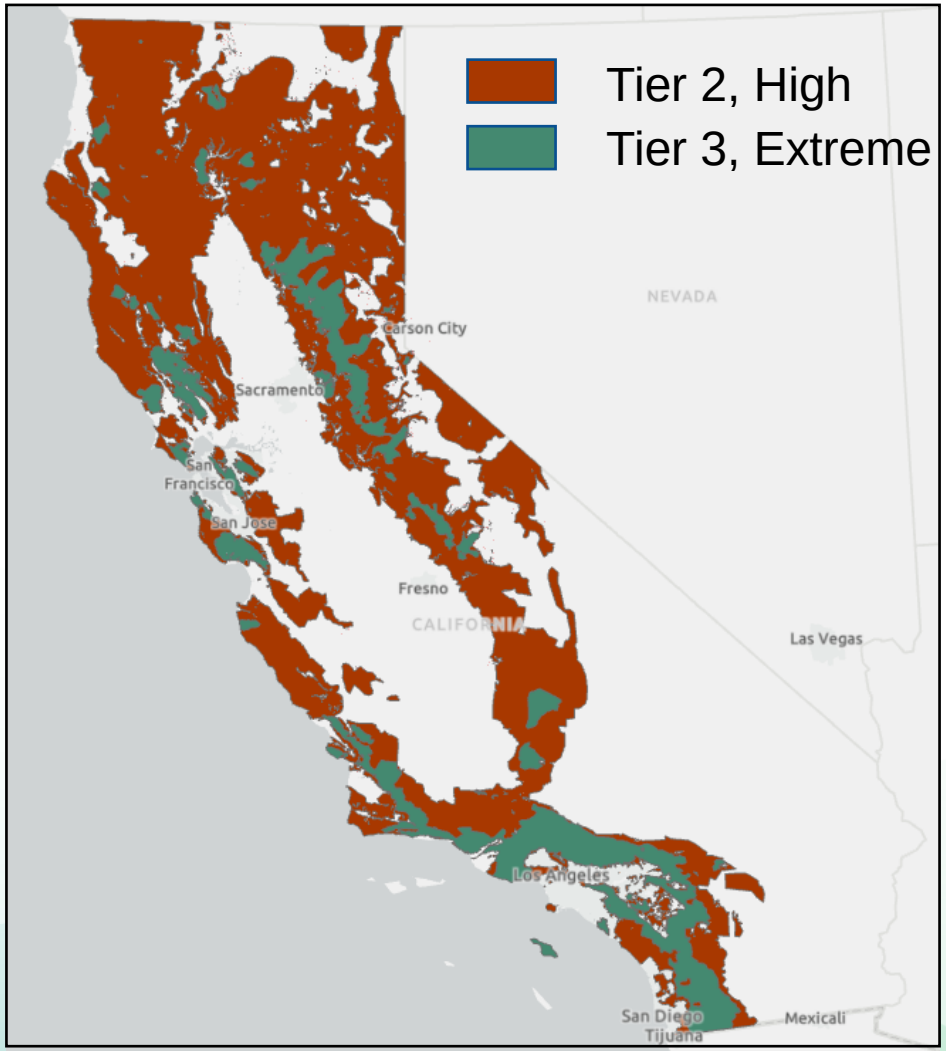


Stand-Alone Data Sets:

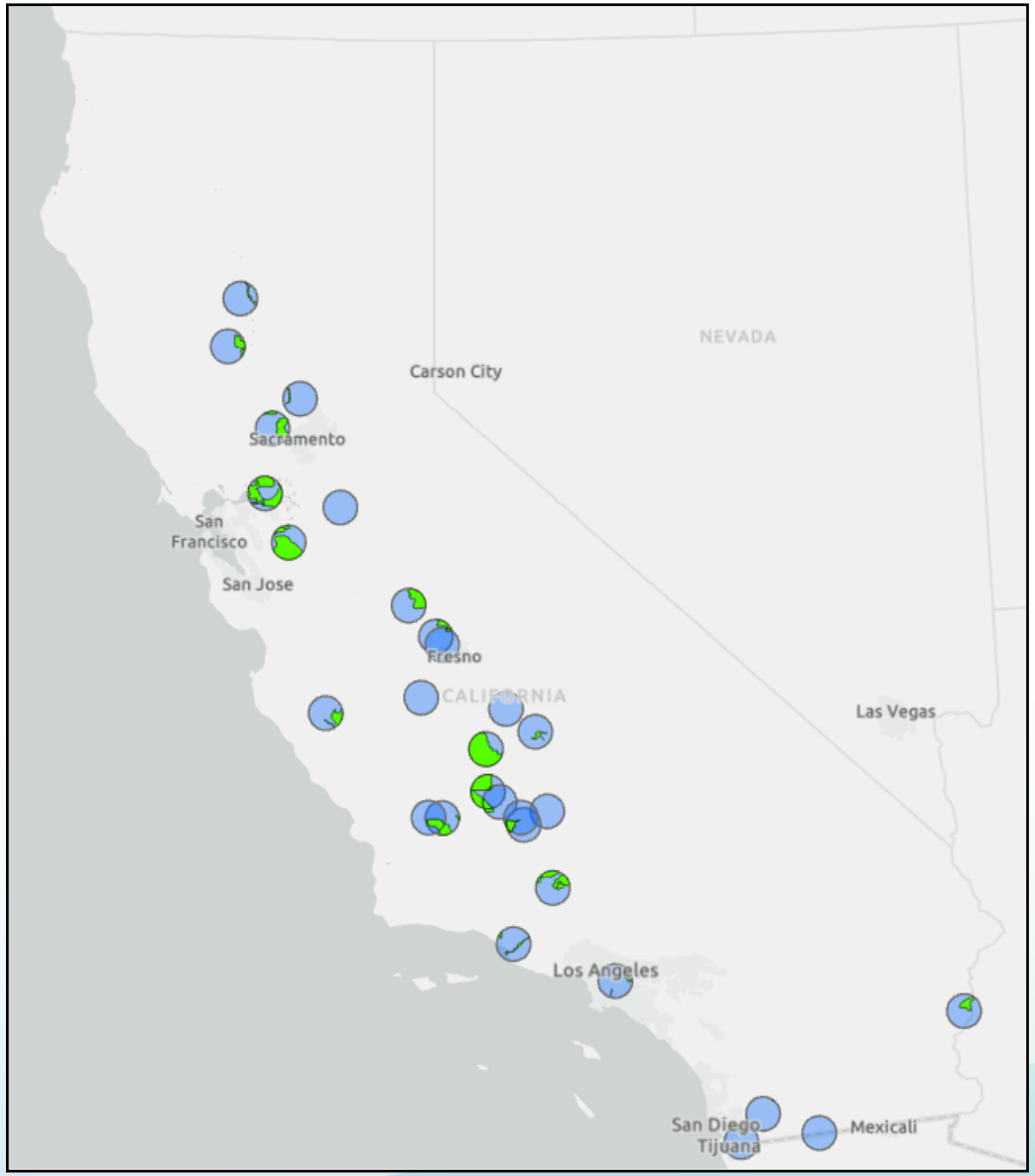
Audubon Important Bird Areas[3]

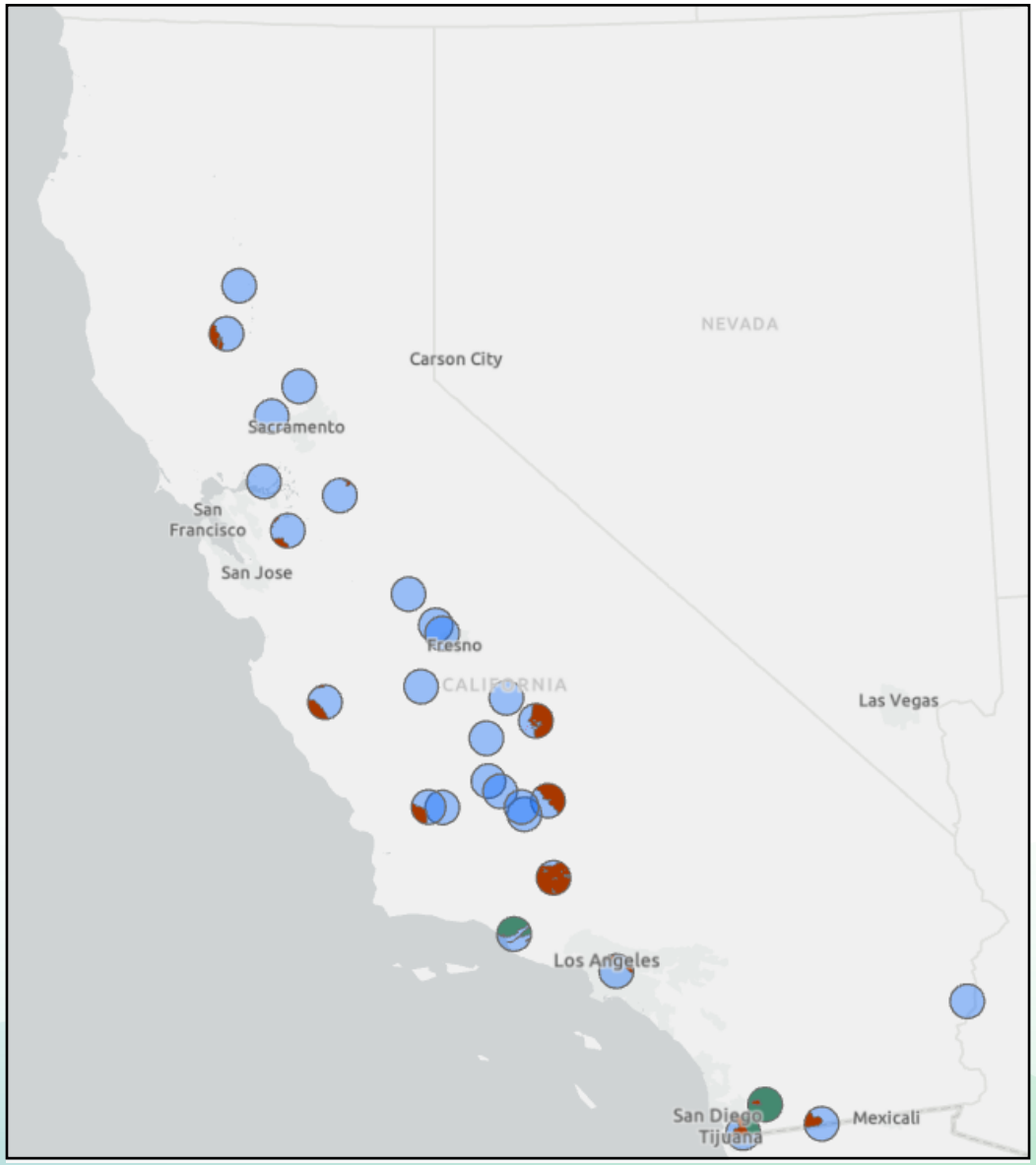


CPUC High Fire Threat Districts[4]



Intersect with Substation Buffers





Solar Resource Metrics Analysis I

- **Main Model Results: Of the low implication land available in the solar resource potential map, how much land area will the allocated MW require?**

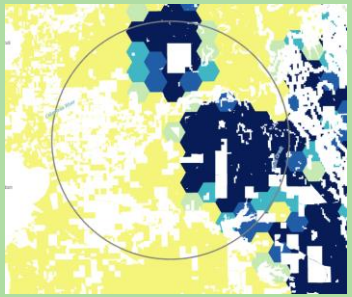
Percent Low Implication Build

- Total Acreage of Allocated Resource
  - 1,430 MW Allocated Resource → 7 Acres/MW → 10,010 Acres
- Total Acreage of Low Implication Land

Substation	
	Percent Low Implication Build
Bellota	19

Solar Resource Metrics Analysis II

- **Individual Components: Of the total resource potential land available, what percentage of it is occupied by highly ranked scores of the individual data variables that make up the environmental implication model?**



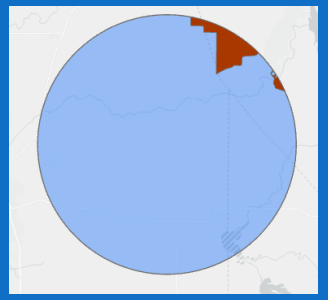
Percentage of High Characteristic

- Total Acreage of Highly-Ranked Biodiversity, Connectivity, Intactness, Natural Landscape Blocks, Native Species Richness, Rarity, Irreplaceability
- Total Acreage of Resource Potential

Substation	Percent of Highest Two Ranks in the Solar Resource Potential 10-mile Buffers						
	Biodiversity	Connectivity	Intactness	Natural Landscape Blocks	Native Species	Rarity	Irreplacability
Bellota	55	41	42	40	34	28	51

Solar Resource Metrics Analysis III

- **Stand-Alone Data Sets: Of the total buffer area around the substation, how much of the area intersects with an Important Bird Area or High Fire Threat District?**



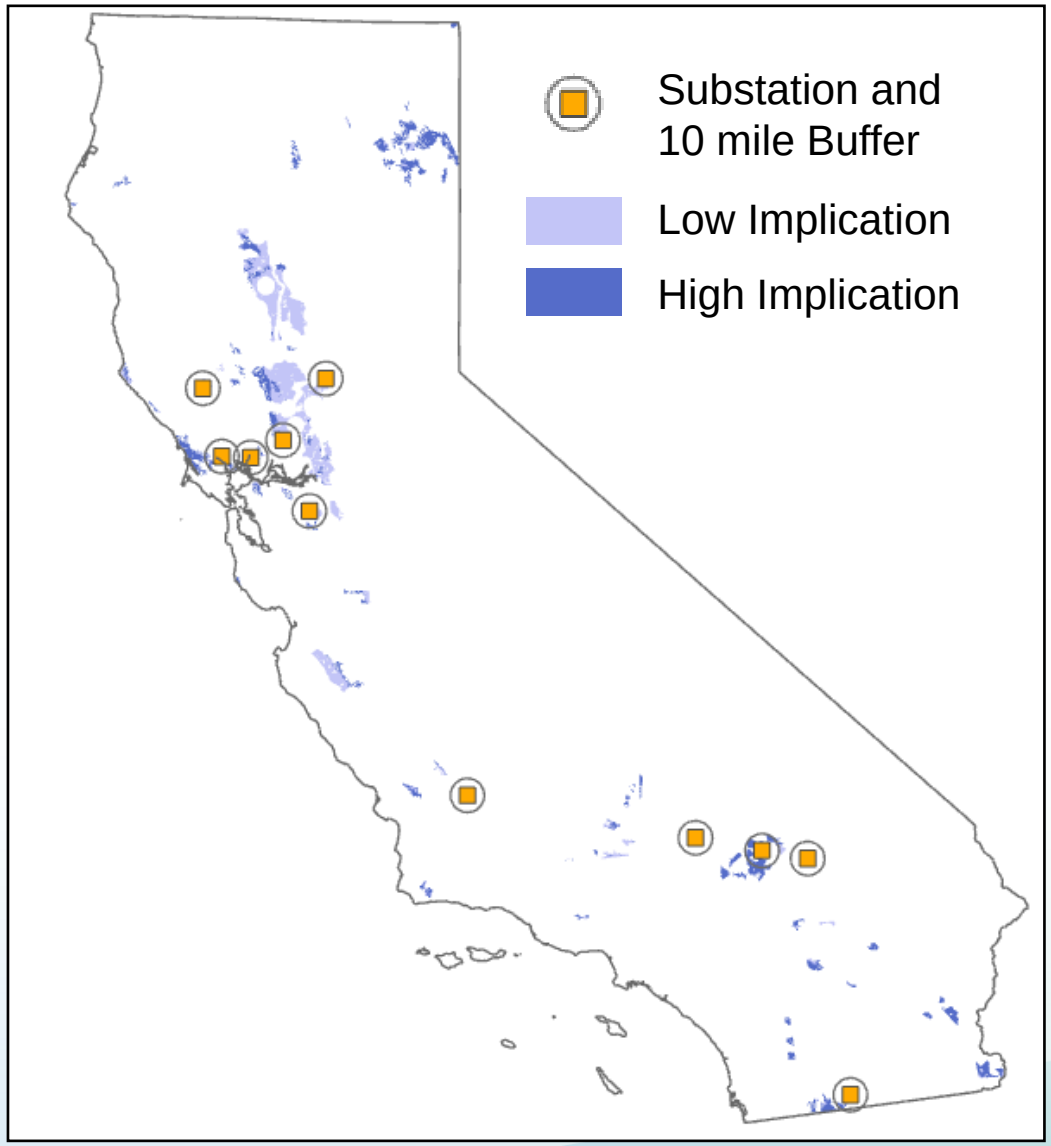
High Fire Threat Tiers 2 and 3

Percentage of High Fire Threat Areas

- Total Acreage of High Fire Threat Tier 2 and Tier 3
- Total Acreage of Buffer

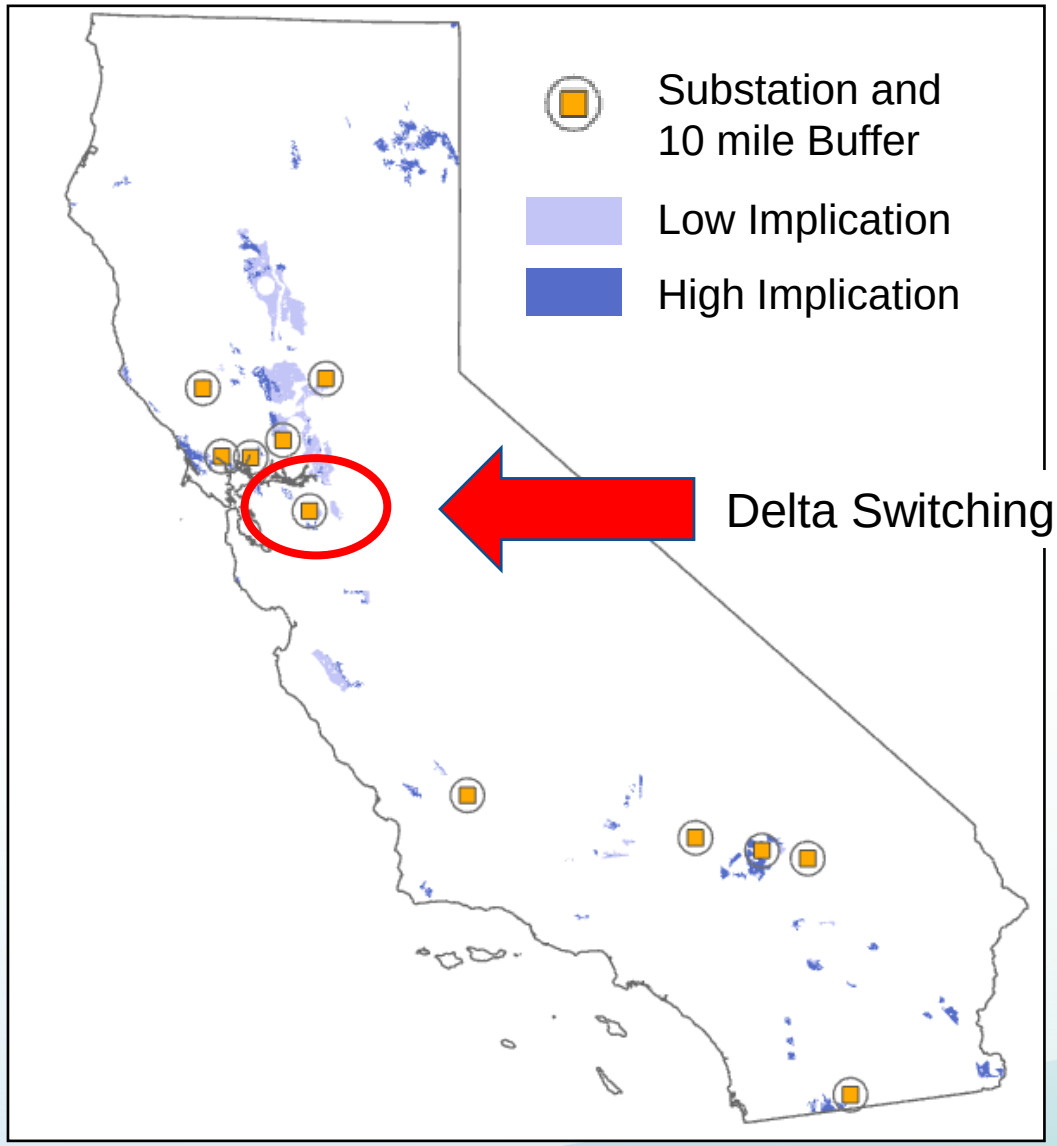
Substation	Percent of Buffer	
	Sum of Tiers 2 and 3 Fire Threat	Important Bird Areas
Bellota	3	0

Terrestrial Wind Resource Potential



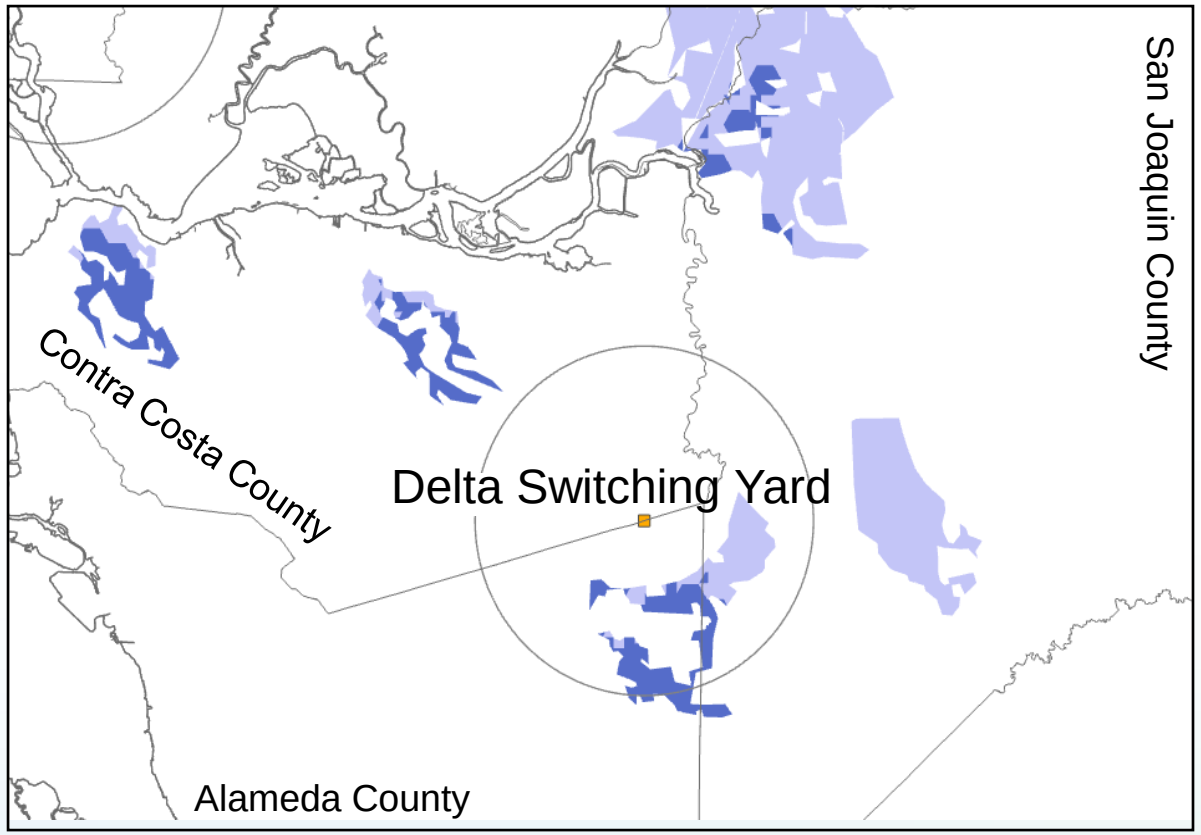
- Limited spatial extent of resource potential
- Environmental Implications Model overlayed on resource potential
- Already divided into Wind Resource Polygon Areas, minimum sized project areas

High Resolution Evaluation



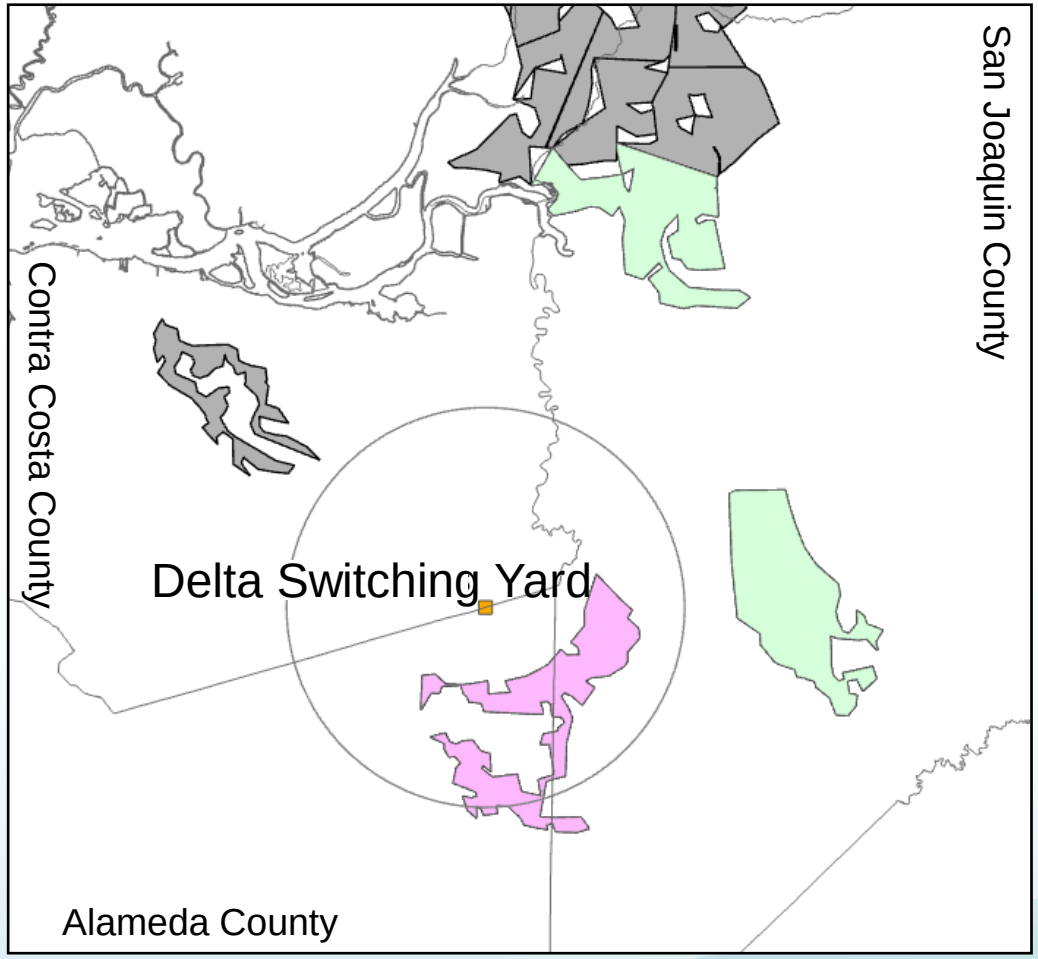
- Limited spatial extent of resource potential
- Environmental Implications Model overlayed on resource potential
- Already divided into Wind Resource Polygon Areas, minimum sized project areas

Adjusted Method



- Start with an intersection of wind resource areas to substation buffer
- Manually match wind resource polygons to substation even if outside of buffer radius
  - Proximity and within same transmission zone/grouping
- Calculate Land-Use Environmental Metrics on those areas

Example: Manual Assignment of Wind Resource Polygons to Substation



- Can add as many as are needed to fulfill the desired resource allocation

Wind Resource Polygons Intersected by Substation

Wind Resource Polygons Manually Chosen for Substation

Other Wind Resource Polygons under Consideration

Metrics Report for Wind:

Percent Low Implication Build

- Low implication area
- Allocated Resource Conversion:
  - 40 Acres/MW

	Percent Low Implication Build
Delta Switching Yard	24

Percentage of High Characteristic in Environmental Implications Model

Area of highest two ranks divided by area of total resource potential (sum of all wind resource polygons associated with substation)

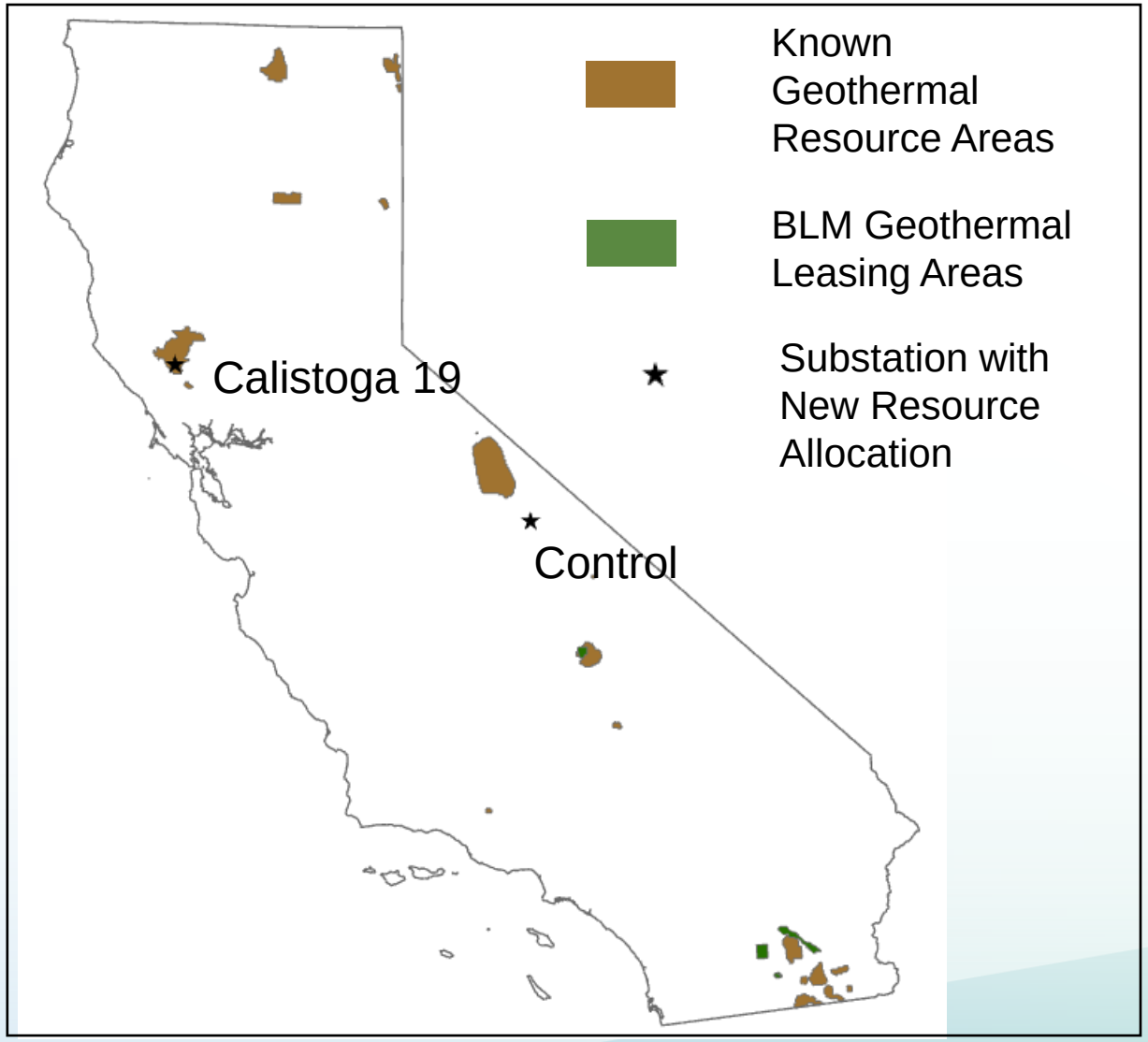
	Percent of Highest Two Ranks in the Wind Resource Area						
	Biodiversity	Connectivity	Intactness	Natural Landscape Blocks	Native Species	Rarity	Irreplaceability
Delta Switching Yard	68	12	13	14	41	90	57

Percent of Buffer

- Area of IBA and HFTD within buffer
- Divided by the area of the buffer

	Percent of Area	
	Fire Threat	Important Bird Areas
Delta Switching Yard	0	53

Geothermal



- Even more spatially constrained
- Apply Environmental Implications Model results to nearest geothermal resource potential field
- Calculate metrics to report back to the CPUC
- 5 acres/MW conversion factor
- Calculate IBA and Fire Threat percentages in field, no buffers

Metrics Report for Geothermal

Geothermal Resource Build: Low Implication Land

	ACRES_LOW IMPLICATION	TOTAL ACRES	GEOTHERMAL MW Assigned	GEOTHERMAL Resource Acres	Percent Low Implication Build
SUBSTATION	Resource	Resource		5 ACRES/MW	
Calistoga 19 (Geysers)	117,594	311,534	99	495	0.42%
Control	76,699	425,639	40	200	0.26%

Ecological Summary: High Characteristic Percentage of Total Resource Potential

Terrestrial Connectivity	6	7	Total Area	Percent Total Resource Area
Geysers	381	1,337	311,534	1%
Long Valley	-	-	425,639	0%

Stand-Alone Data Sets: Percent of IBA or Fire Threat in Geothermal Field Associated with Substation

	IBA ACRES	PERCENT RESOURCE
RESOURCE		
Geysers	70,458	23%
Long Valley	219,199	55%

Summary

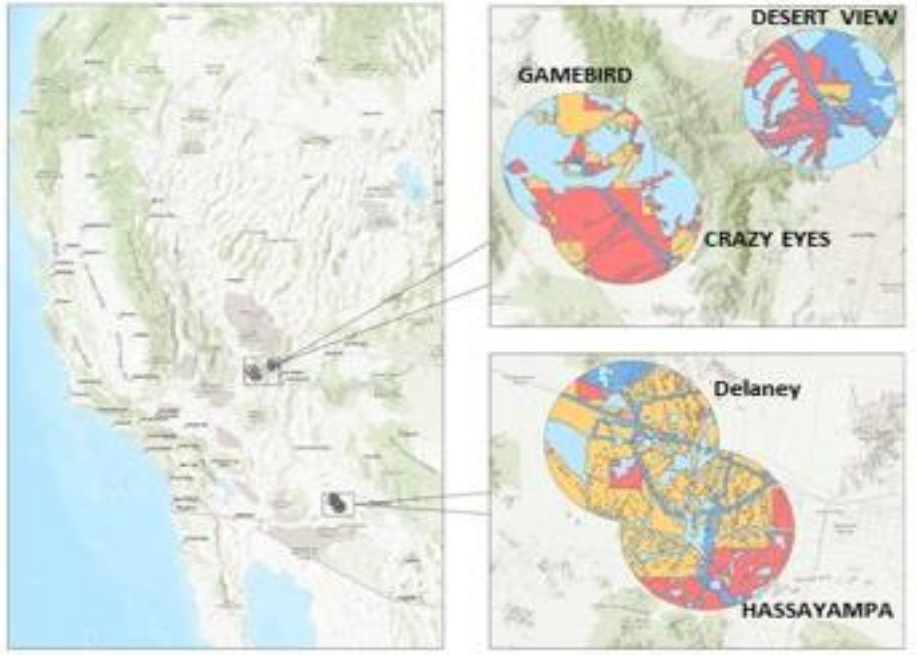
- CPUC provides a list of substations and their proposed resource allocation
- CEC uses resource potential maps to spatially define areas that are available for solar, wind or geothermal energy build
- CEC further evaluates the buffered area around each substation in terms of environmental implications and risk factors throughout the buffer.
- CEC returns metrics to CPUC to elucidate any issues with resource allocation or to flag potential non-compliance with Criteria 3a or 3b.

References

1. Areas of Conservation Emphasis. California Department of Fish and Wildlife. 2018. Accessed 2018 https://wildlife.ca.gov/Data/Analysis/Ace
2. Degagne, R., J. Brice, M. Gough, T. Sheehan, and J. Strittholt. Terrestrial Landscape Intactness 1 km, California. Conservation Biology Institute, December 2016. From DataBasin.org: https://databasin.org/datasets/e3ee00e8d94a4de58082fdbc91248a65
3. California Important Bird Areas. Audubon. 2016. https://ca.audubon.org/conservation/california-important-bird-areas-gis-data-and-methods
4. CPUC Fire-Threat Map. State of California – Public Utilities Commission. 2021. https://files.cpuc.ca.gov/safety/fire-threat_map/2018/PrintablePDFs/8.5X11inch_PDF/CPUC_Fire-Threat_Map_final.pdf

Out-of-State Land-use Evaluation

- For out-of-state resource still within the CAISO BAA, CPUC staff utilize alternative land-use data sets available for areas outside of California.
- Data source: WECC Environmental Data Viewer
  - Risk class 1: Least Risk of Environmental or Cultural Resource Sensitivities and Constraints
  - Risk class 2: Low to Moderate Risk of Environmental or Cultural Resource Sensitivities and Constraints
  - Risk class 3: High Risk of Environmental or Cultural Resource Sensitivities and Constraints
  - Risk class 4:Areas Presently Precluded by Law or Regulation
- Class 4 land is excluded from resource potential
- Class 2 land is correlated to low environmental implications; Class 3 land is correlated to high implications

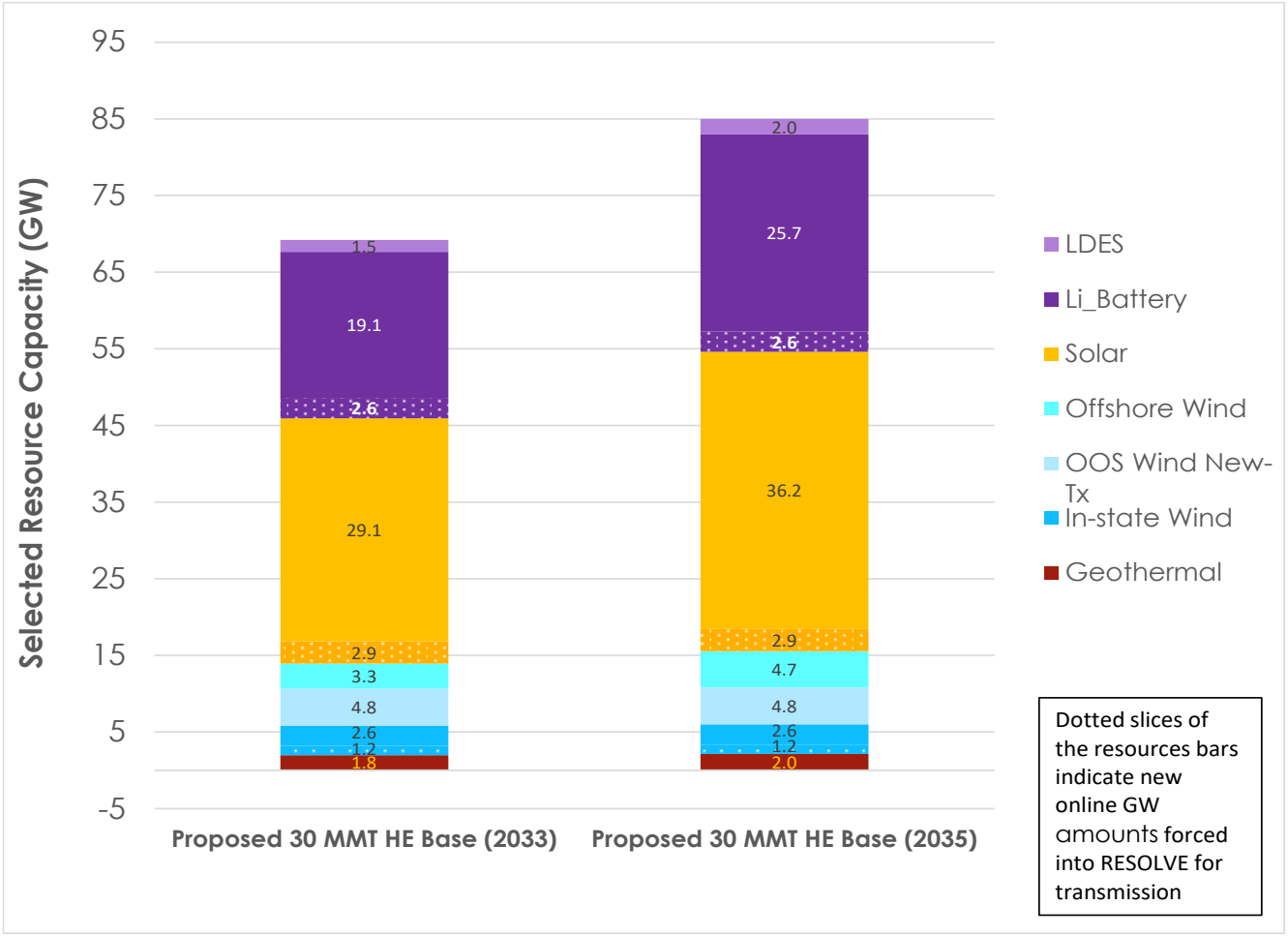


Substation	Percent of solar resource that occurs on RC3 land	Percent of solar resource that occurs on RC2 land
DELANEY	8.5%	75.7%
GAMEBIRD	54.7%	39.7%
HASSAYAMPA	31.2%	57.7%
CRAZY EYES	40.8%	20.5%
DESERT VIEW	54.3%	4.1%

Preliminary Mapping Results – Proposed 30 MMT High Electrification Base Case

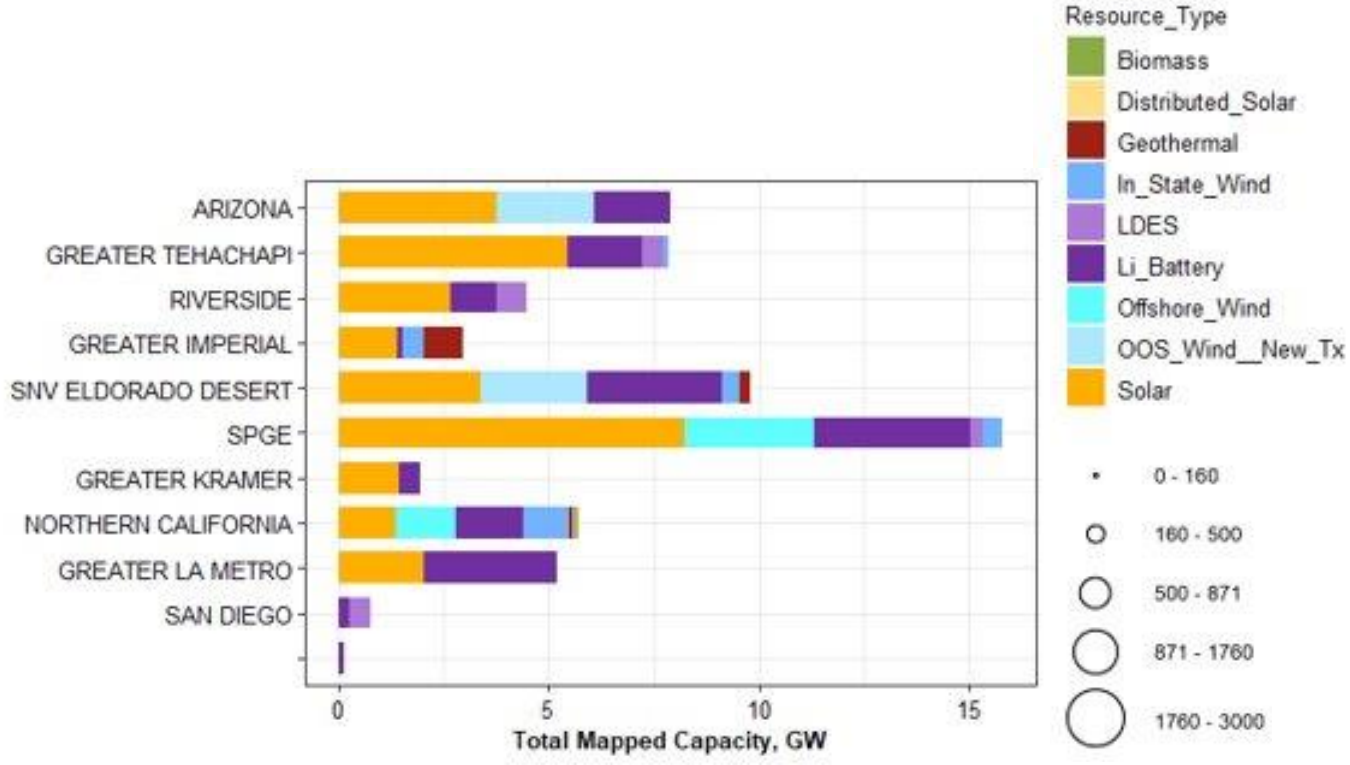
Preliminary Mapping Results – Overview

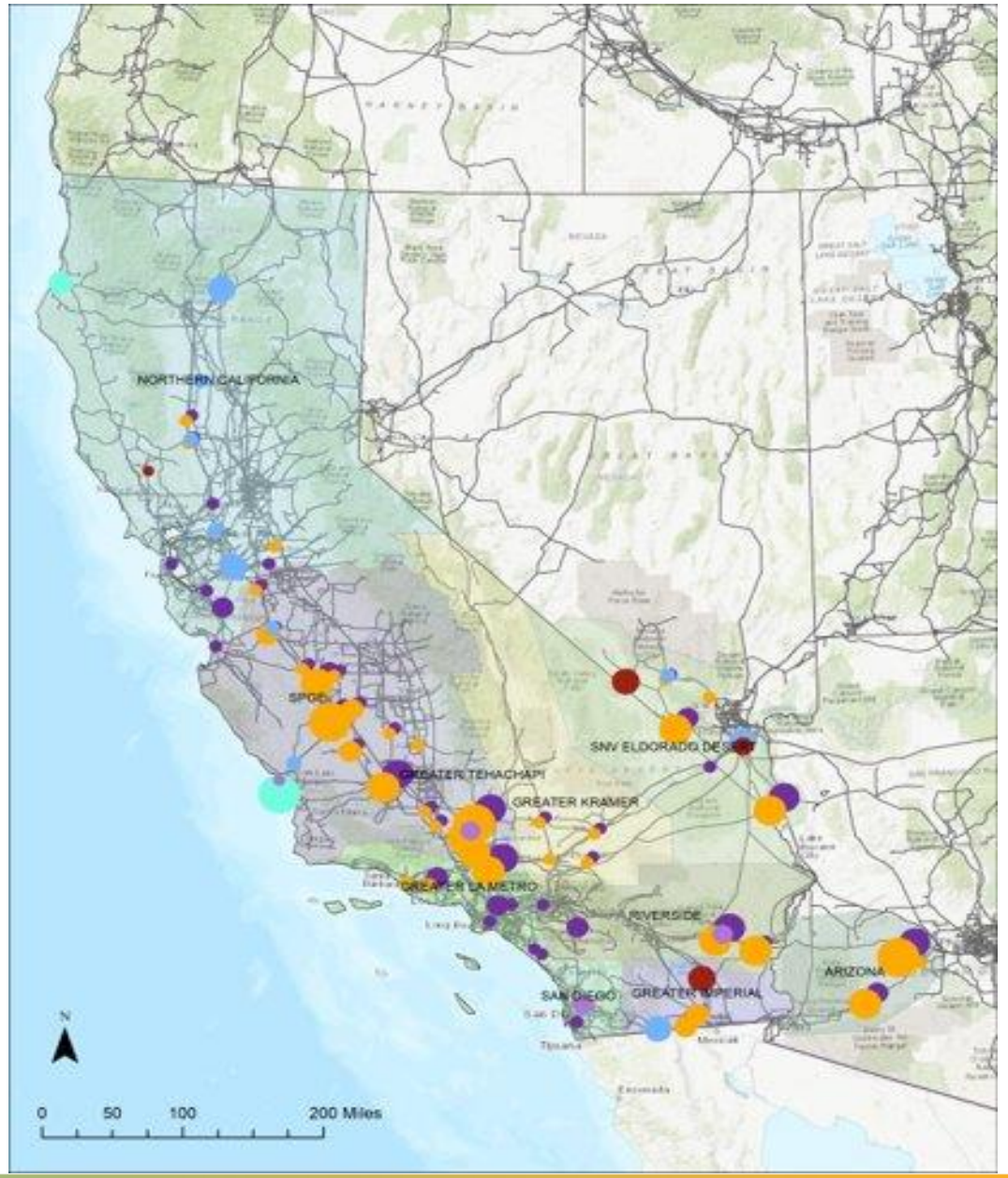
- Working Group staff conducted an initial round of mapping for the proposed base case.
- Mapped resources and completed busbar mapping criteria analysis for both 2033 and 2035 years:
  - 2033 Mapping Results: Dashboard Link
  - 2035 Mapping Results: Dashboard Link
- Preliminary results are a snapshot from the middle of the mapping process, before additional rounds of mapping with reallocation and relocation of resources to better optimize criteria alignment.



Preliminary Mapping Results – Mapping Summary

- Geographic distribution of generic resources in the 2035 portfolio, by resource area (below) and by substation location (right)
- Out of state wind and geothermal (imported at CAISO interties) are not plotted in map

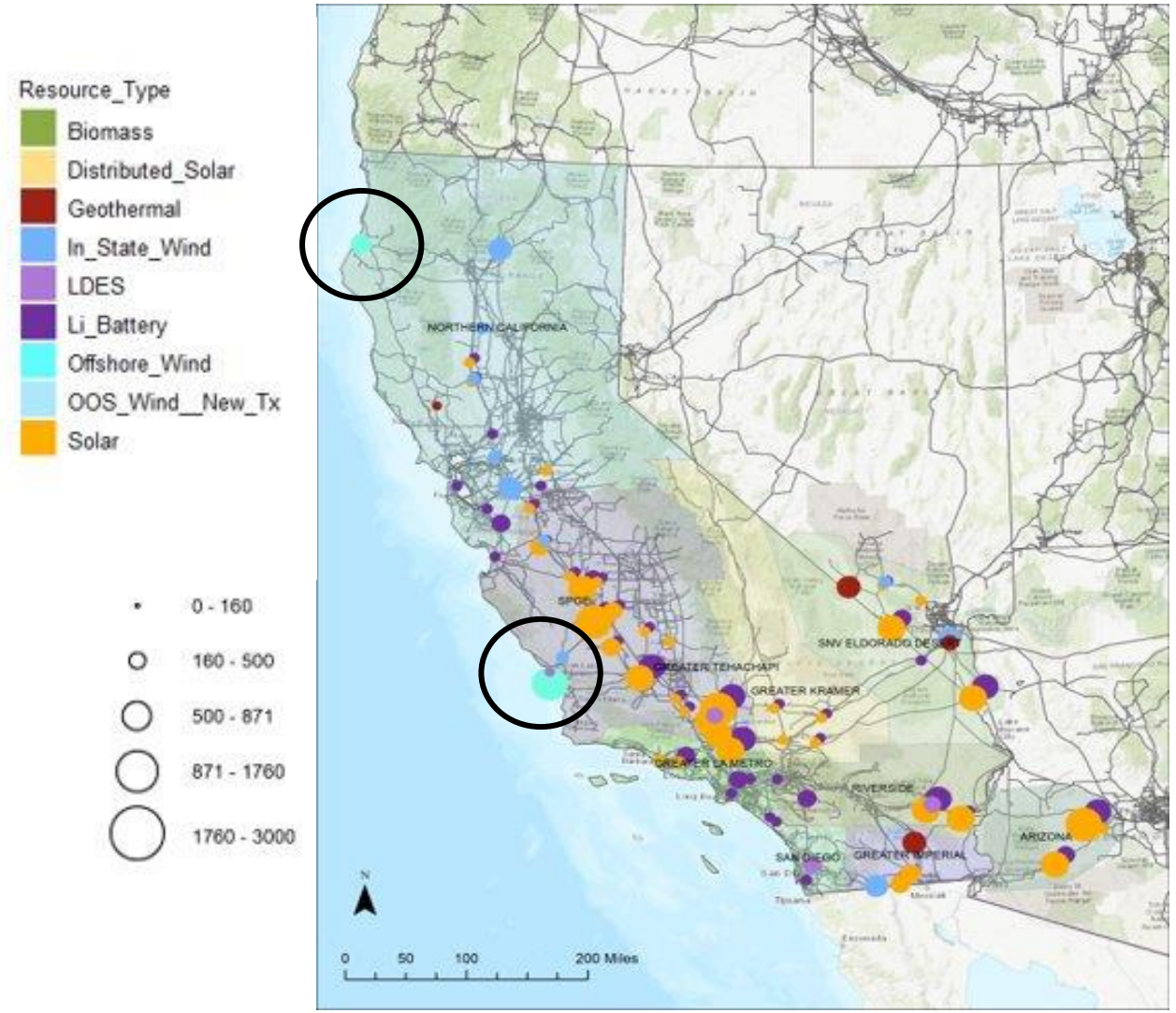




*Map visualizations do not full capture all mapped resources, some inconsistencies with complete workbook results

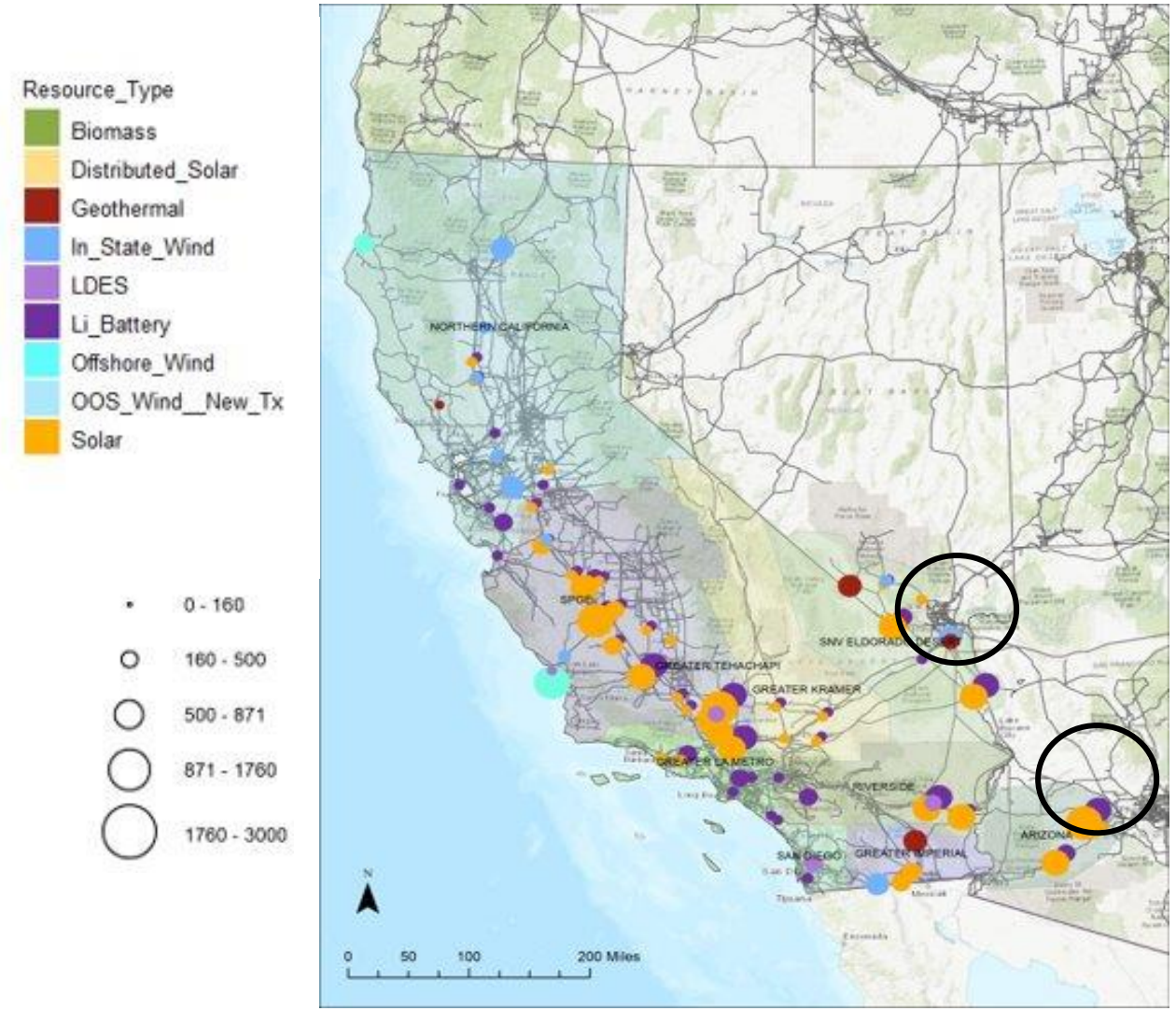
Preliminary Mapping Results – Key Resource: OSW

- Offshore Wind Mapping
  - 2033: 3,261 MW (3,100 MW at Morro Bay, 161 MW at Humboldt)
  - 2035: 4,707 MW (3,100 MW at Morro Bay, 1,607 MW at Humboldt
- Mapping aligns with RESOLVE selection and utilizes RESOLVE resource density assumptions
- Transmission implications by 2035:
  - Central Coast: Morro Bay wind can either tie into Diablo Canyon substation or a new 500 kV Morro Bay sub (a small transmission upgrade)
  - North Coast: Initial few hundred MWs can be energy only (as mapped in 2033), but full Humboldt wind requires major transmission upgrade to interconnect. Potential options identified in 21-22 TPP offshore wind sensitivity study.



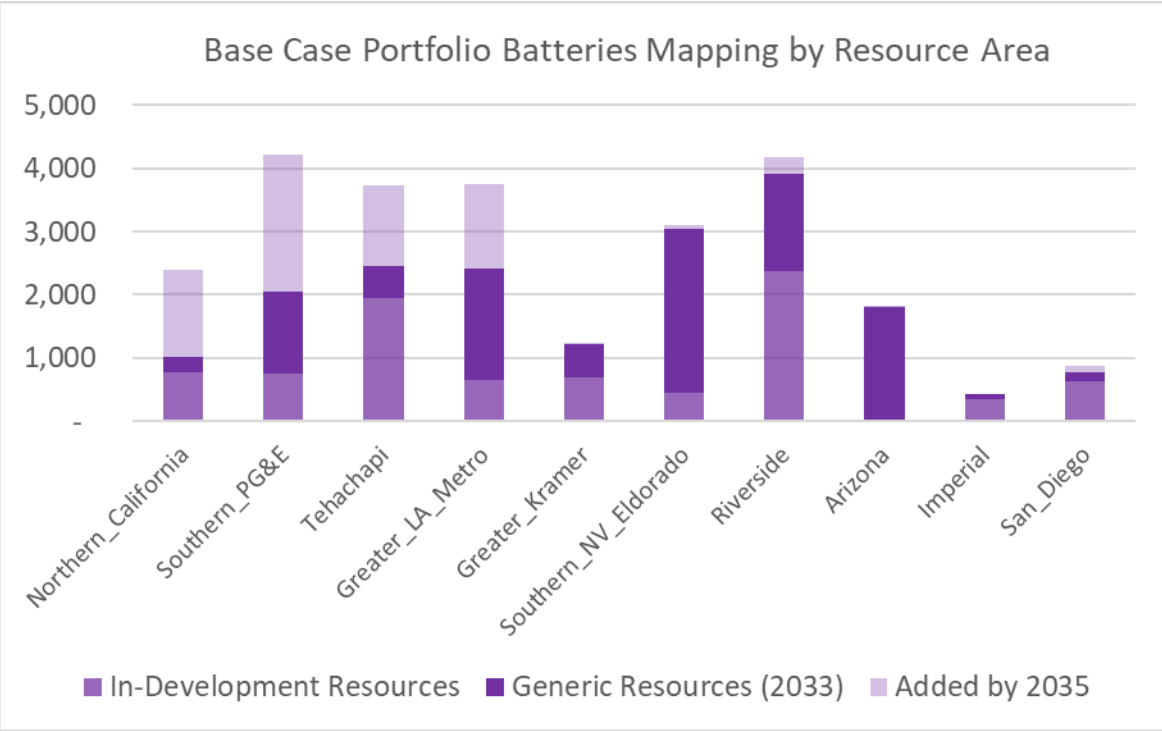
Preliminary Mapping Results – Key Resources: OOS

- Out-of-State Wind on new transmission
  - Complete build-out of RESOLVE available resources before 2033.
  - Mapped locations (same for 2033 & 2035)
    - 2,328 MW of New Mexico Wind interconnecting at Palo Verde
    - 1,500 MW of Wyoming wind interconnecting at Harry Allen or El Dorado
    - 1,000 MW of Idaho Wind interconnecting at Harry Allen
- Mapping shifted RESOLVE selected resources around to better align with potential transmission upgrades



Preliminary Mapping Results – Battery Results

- Mapped in-development and generic batteries alignment with batter mapping criteria for both 2033 and 2035 (right)
- Mapped batteries by resource area (below)



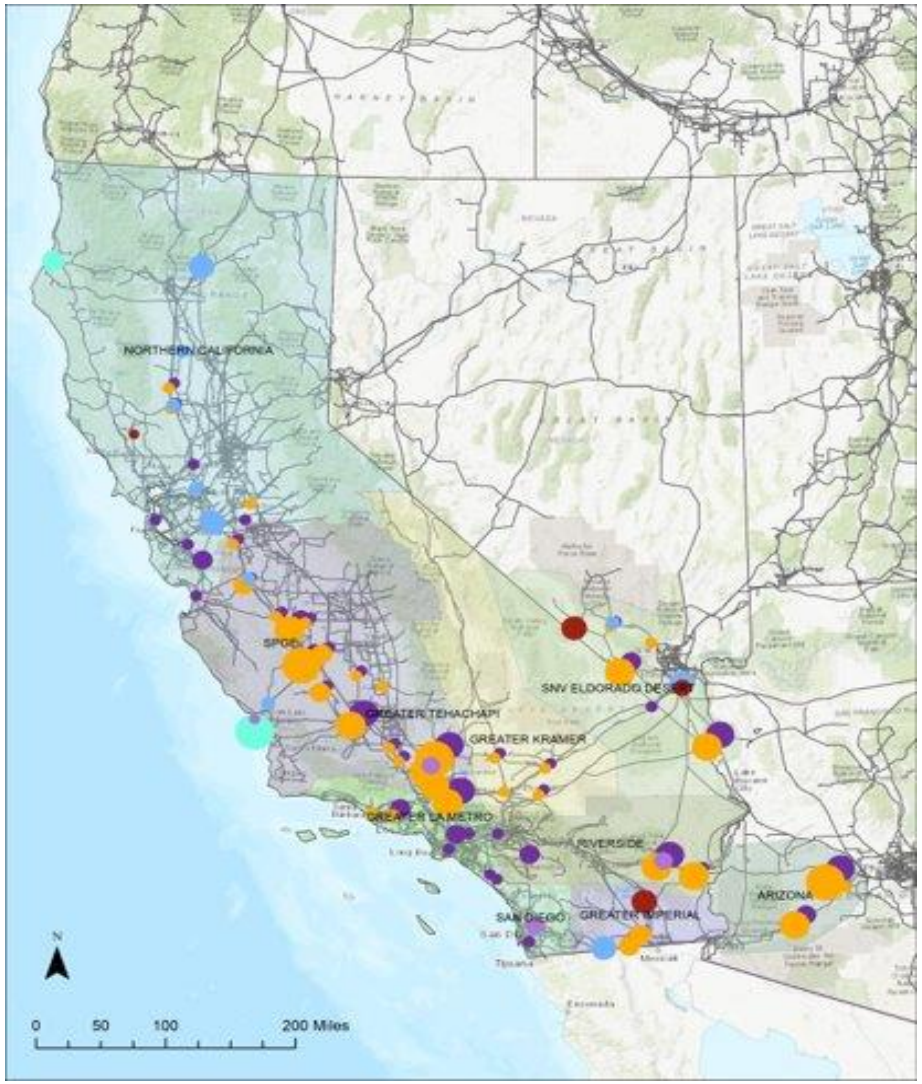
Battery Criteria Summary		
Battery Category	**2033 (MW)**	**2035 (MW)**
Co-Located	14,587	19,448
Stand-Alone	4,495	6,277
Total in LCR Areas	**19,082**	**25,725**
Co-Located in LCR Areas	2,275	2,560
Stand-Alone in LCR Areas	2,802	3,719
Total in LCR Areas	**5,077**	**6,279**
Co-Located in DACs	2,144	3,146
Stand-Alone in DACs	1,542	1,984
Total in DACs	**3,686**	**5,130**
Co-Located in Non-Attainment Zones	8,452	12,735
Stand-Alone in Non-Attainment Zones	3,079	4,714
Total in Non-Attainment Zones	**11,531**	**17,449**
Co-Located in High-Curtailment Zones	9,893	12,962
Stand-Alone in High-Curtailment Zones	350	475
Total in High-Curtailment Zones	**10,243**	**13,437**

Preliminary Mapping Results – Transmission Implications

- Preliminary mapping impacts on transmission constraints by region and ability of CAISO identified upgrades to alleviate them.
- Working group has not assessed cost effectiveness of all identified upgrades, only ability to accommodate the resources.

2033 Tx Constraint Exceedances	Actual Constraints Exceeded		Potentially Alleviated by Upgrade		Default Constraints Exceeded	
	FCDS	EODS	FCDS	EODS	FCDS	EODS
Northern CA	3	0	3	0	0	1
Southern PG&E	3	5	2	5	6	3
Tehacahpi and Greater LA Metro	0	0	0	0	0	0
Greater Kramer	2	0	2	0	0	0
Southern NV & Eldorado	0	0	0	0	2	0
Riverside & Arizona	2	0	1	0	0	0
San Diego & Greater Imperial	4	1	3	0	0	0

2035 Tx Constraint Exceedances	Actual Constraints Exceeded		Potentially Alleviated by Upgrade		Default Constraints Exceeded	
	FCDS	EODS	FCDS	EODS	FCDS	EODS
Northern CA	4	0	3	0	0	1
Southern PG&E	5	4	2	4	6	2
Tehacahpi and Greater LA Metro	1	0	1	0	0	0
Greater Kramer	2	0	2	0	0	0
Southern NV & Eldorado	0	0	0	0	2	0
Riverside & Arizona	2	0	1	0	0	0
San Diego & Greater Imperial	4	1	3	0	0	0



Preliminary Mapping Results – Imports

- Working group staff worked to better identify out of CAISO resources, their interconnection points, and MIC expansion implications.
- Dashboard includes tab providing mapping details for out of CAISO resources.

								23-24 TPP 30 MMT High Electrification Base Portfolio In-Dev and Generic Resources			CPUC and PTO Identified In-Development Resources			Incremental Generic Resources		
Transmission Area	CAISO Substation	Voltage	Out-of-CAISO substation	Resource Type/Location	Out-of-CAISO Transmission Utilized	CAISO MIC need	Notes on CAISO interites	FCDS (MW)	EODS (MW)	Total (MW)	FCDS (MW)	EODS (MW)	Total (MW)	FCDS (MW)	EODS (MW)	Total (MW)
East of Pisgah Study Area	Eldorado	230	NVEP substations	Geothermal, Northern NV	Existing Tx	Expanding MIC	Merchant_BG	40	-	40	40.0	-	40.0	-	-	-
East of Pisgah Study Area	Eldorado	500	Aeolus 500 kV (proposed, WY)	OOS Wind, Wyoming Wind	New Tx	Expanding MIC	Can consider Harry Allen interite	1,500	-	1,500	-	-	-	1,500	-	1,500
East of Pisgah Study Area	Gondor	345	NVEP substations	Geothermal, Northern NV	Existing Tx	Expanding MIC	GONDIPPDC_ITC intertie	68	-	68	36.0	-	36.0	32	-	32
East of Pisgah Study Area	Harry Allen	500	Eagle 120 kV (NVEP), Falcon 120 kV (NVEP), Millers 120 kV (NVEP)	Geothermal, Northern NV	Existing Tx	Expanding MIC	CPUC assuming resource is wheeled down ON-line; Can consider other NVEP interties	247	-	247	-	-	-	247	-	247
East of Pisgah Study Area	Harry Allen	500	Midpoint 345 kV (ID)	OOS Wind, Idaho Wind	New Tx	Expanding MIC		1,000	-	1,000	-	-	-	1,000	-	1,000
SDG&E Study Area	Imperial Vall	230	IID System	Geothermal, Imperial	Existing Tx	Expanding MIC	IID-SDGE intertie	50	-	50	50.0	-	50.0	-	-	-
SCE Eastern Study Area	Mirage	230	Bannister 230 kV (IID), Midway 230 kv (IID), Proposed New Facilities	Geothermal, Imperial	Existing Tx and New Tx	Expanding MIC	CPUC presumed IID-SCE intertie	924	-	924	-	-	-	924	-	924
SCE Eastern Study Area	Mirage	230	IID 92 kV System	Geothermal, Imperial	Existing Tx	Expanding MIC	IID-SCE intertie	26	-	26	26.0	-	-	-	-	-
SCE Eastern Study Area	Palo Verde	500	Proposed Substation, Lincoln County, NM	OOS Wind, New Mexico Wind	New Tx	Expanding MIC		2,328	-	2,328	-	-	-	2,328	-	2,328
SCE North of Lugo (NOL) Stud	Silver Peak	55	NVEP substations	Geothermal, Northern NV	Existing Tx	Expanding MIC	Can also consider other NVEP interties if lacking technical line capacity	13	-	13	13.0	-	13.0	-	-	-
PG&E North of Greater Bay St	Summit	115	NVEP substations	Geothermal, Northern NV	Existing Tx	Existing & Expan	Can also consider other NVEP interties if lacking technical line capacity	40	-	40	40.0	-	40.0	-	-	-

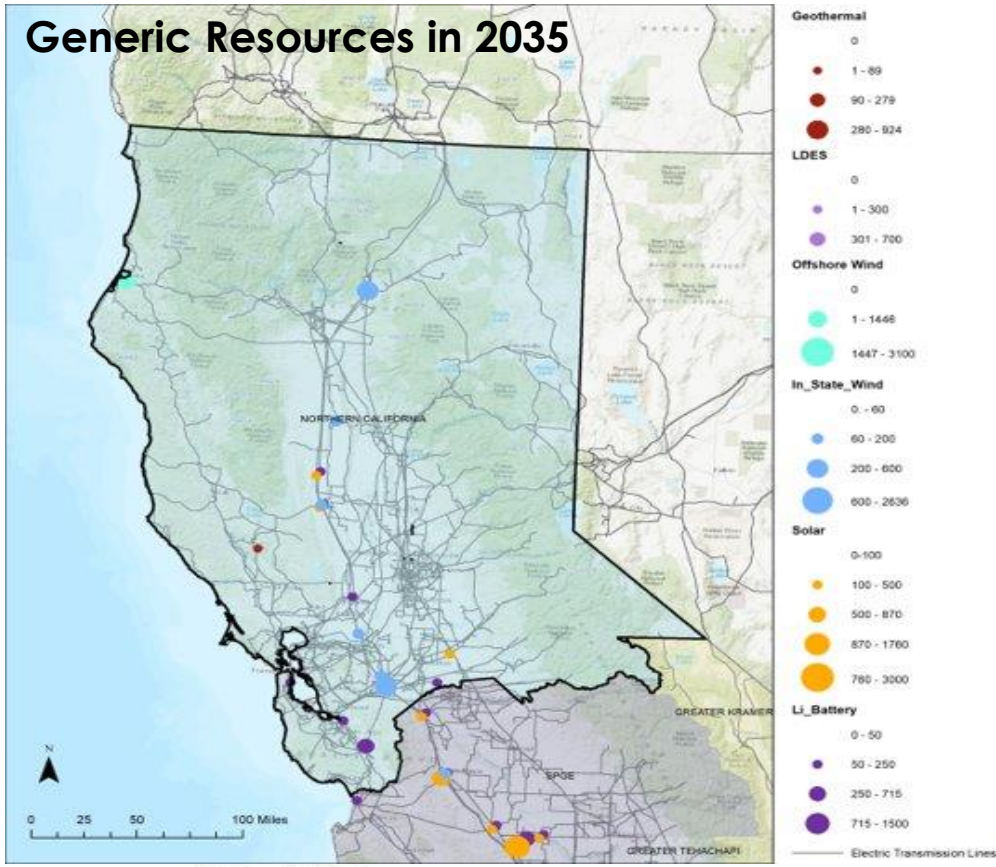
Preliminary Mapping Results – Summaries by Area

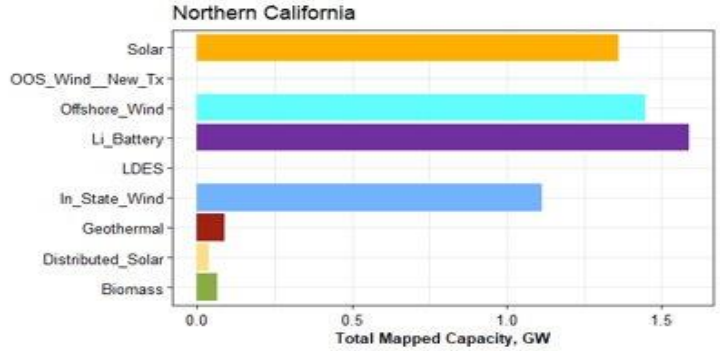
Northern California Area – Mapping Summary

- Greater Bay area, North Coast, and Central Valley north of Modesto

Northern California	In-Development Resources			Generic Resources (2033)			Additional MWs in 2035		
	FCDS	EODS	Total	FCDS	EODS	Total	FCDS	EODS	Total
Geothermal	-	-	-	89	-	89	-	-	-
Solar	120	-	120	505	10	515	50	782	832
Wind	-	-	-	911	292	1,203	-	-	-
Humboldt Offshore	-	-	-	41	120	161	1,446	-	1,446
Battery	782	-	782	236	-	236	1,383	-	1,383

- Key Preliminary 2035 Criteria Implications:
  2) Largest constraints significantly exceeded but could be alleviated by CAISO identified upgrades; smaller Humboldt constraint still exceeded even with identified upgrade; Humboldt offshore wind requires major transmission build.
  3) A few substations, particularly for wind, have high values for specific environmental datasets.
  4) Several substations exceed commercial interest.
  5) Reductions in battery and wind resources mapped at several substations, shifted to better align with commercial interest.





Northern California Area – 2035 Criteria Alignment by Substation (1/2)

2035 Mapping Amount of In-Development and Generic Resources						Busbar Mapping Criteria Compliance					
Substation	Voltage	Resource Type	FCDS (MW)	EODS (MW)	Total (MW)	1. Distance to Trans. of Appropriate Voltage	2. Transmission Capability Limit	3a. Available Land Area	3b. Environmental Impacts	4. Commercial Interest	5. Prior Base Case
Birds Landing	230	In-State Wind	90	10	100	2	1*	1	1	1	2
Cortina	115	In-State Wind	65	33	98	1	3	1	1	1*	1
Delta Switching Yard	230	In-State Wind	80	-	80	1	1*	1	1	1	1
Glenn	230	In-State Wind	30	98	128	1	1*	1	1	3	2*
Kelso	230	In-State Wind	36	25	61	1	1*	1	1	2+	1*
Round Mountain	230	In-State Wind	200	11	211	1	1*	2	3	1	2
Tesla	230	In-State Wind	80	25	105	1	1*	1	1	2+	2
Tesla	500	In-State Wind	330	-	330	1*	1*	1	1	2+	1
Thermalito	230	In-State Wind	-	-	-	1	1*	1	1	1	3
Delevan	230	In-State Wind	-	-	-	1	1*	1	1	1	3
Geysers	230	Geothermal	89	-	89	1	1*	1	2	2	1
Summit	115	Geothermal	40	-	40	Not Availabe	1*	Not Availabe	Not Availabe	1	1
Humboldt (Proposed)	500	Offshore Wind	1,487	-	1,487	Not Availabe	1*	Not Availabe	Not Availabe	3	1
Humboldt	115	Offshore Wind	-	120	120	Not Availabe	3	Not Availabe	Not Availabe	1	1

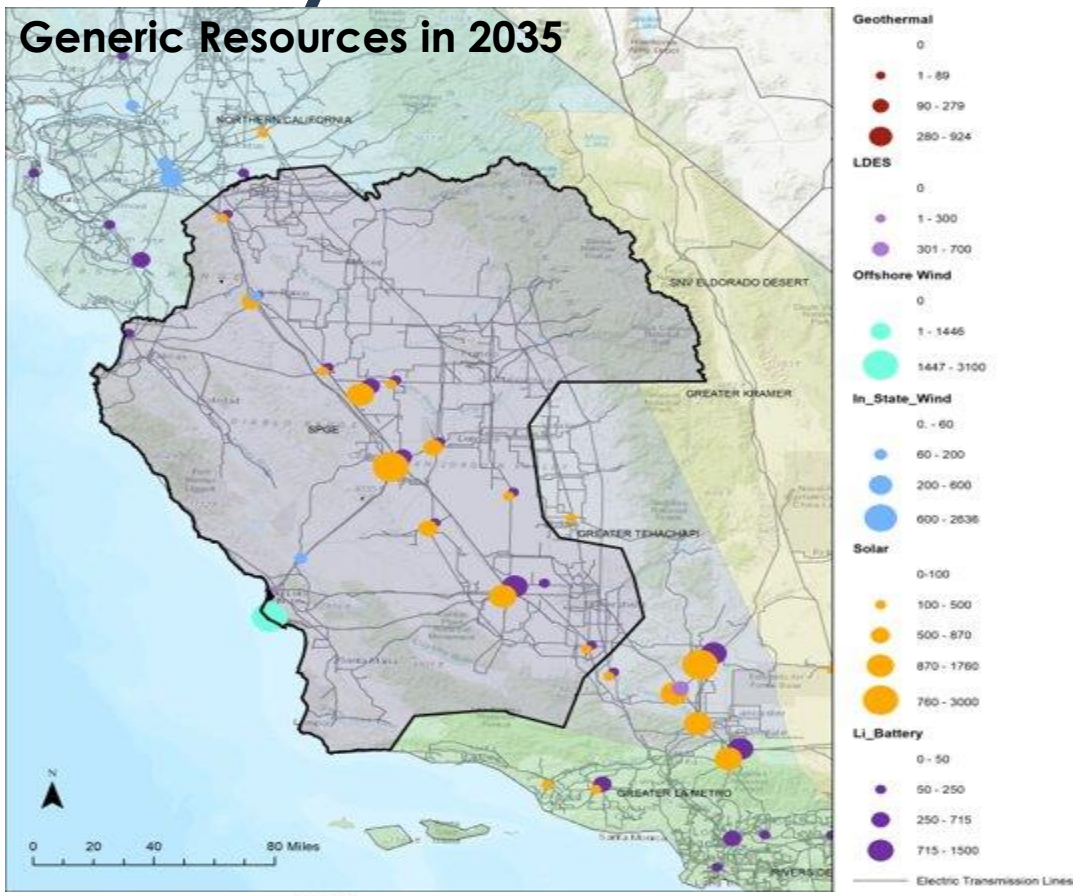
Full Criteria Alignment tables for Northern California and all other areas include in Appendix A at end of slides

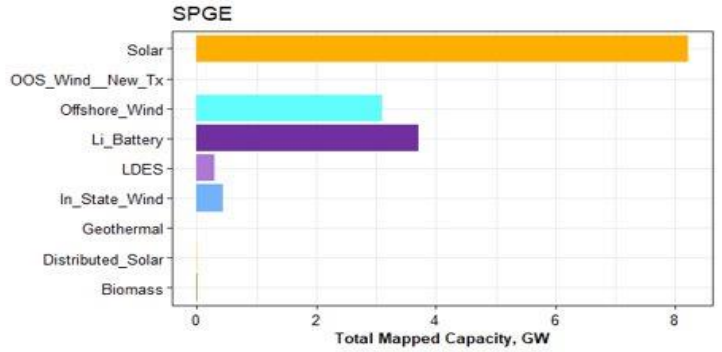
Southern PG&E Area – Mapping Summary

- San Joaquin Valley, Carrizo, and Central Coast

Southern PG&E	In-Development Resources			Generic Resources (2033)			Additional MWs in 2035		
	FCDS	EODS	Total	FCDS	EODS	Total	FCDS	EODS	Total
Solar	862	198	1,060	1,878	3,901	5,779	265	1,453	1,718
Wind	167	-	167	337	-	337	-	-	-
Morro Bay Offshore	-	-	-	3,100	-	3,100	-	-	-
Battery	749	-	749	1,304	-	1,304	2,175	-	2,175
LDES	-	-	-	-	-	-	300	-	300

- Key Preliminary 2035 Criteria Implications:
  2) Numerous constraint exceedances (9 in 2033, 11 in 2035). Some could be alleviated by CAISO identified upgrades, others have no identified upgrade.
  3) Three substations, have high values for specific env. datasets.
  4) Numerous substations exceed high-confidence commercial interest but not total commercial interest.
  5) Solar+storage resources shifted from several substations to better align with commercial interest.



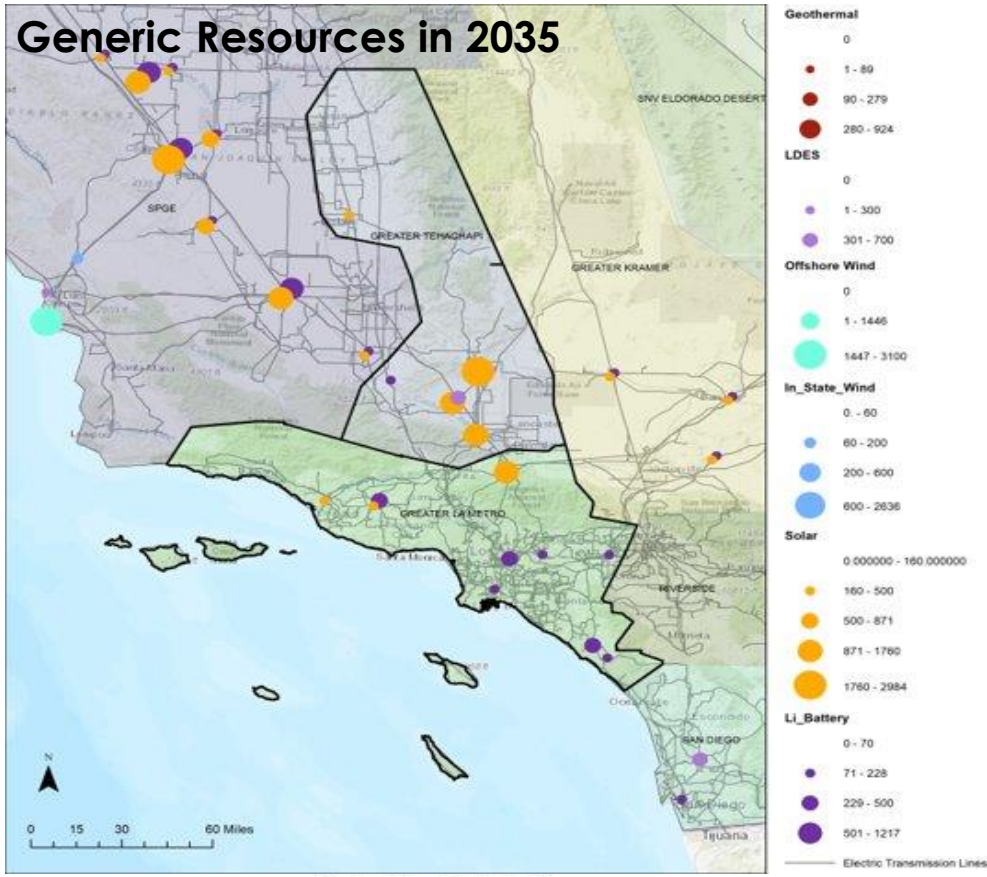


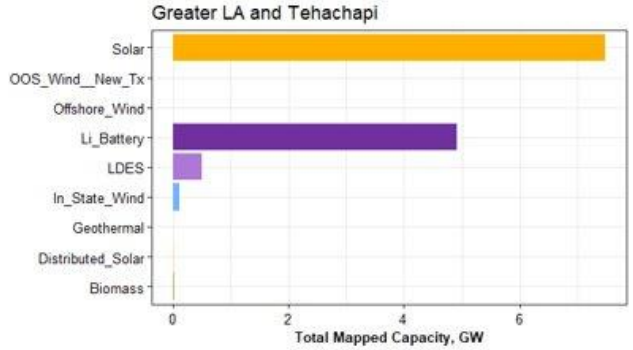
Greater Tehachapi Area – Mapping Summary

- Tehachapi and SCE system north of Tehachapi area

Greater Tehachapi	In-Development Resources			Generic Resources (2033)			Additional MWs in 2035		
	FCDS	EODS	Total	FCDS	EODS	Total	FCDS	EODS	Total
Solar	1,031	600	1,631	1,883	2,103	3,986	300	1,150	1,450
Wind	3	-	3	112	-	112	-	-	-
Battery	1,939	-	1,939	507	-	507	1,280	-	1,280
LDES	-	-	-	500	-	500	-	-	-

- Key Preliminary 2035 Criteria Implications:
  1) Small amounts of wind resources mapped to two wind resources some distance from substations.
  2) One constraint exceeded but can be alleviated by CAISO identified upgrade.
  3) A few substations with high values for specific env. datasets.
  4) Several substations exceed high-confidence commercial interest amounts but not total amount. Windhub 230 kV bus has less batteries mapped than high-confidence commercial interest.
  5) Some reductions in battery resources mapped to three substations, shifted to nearby buses.



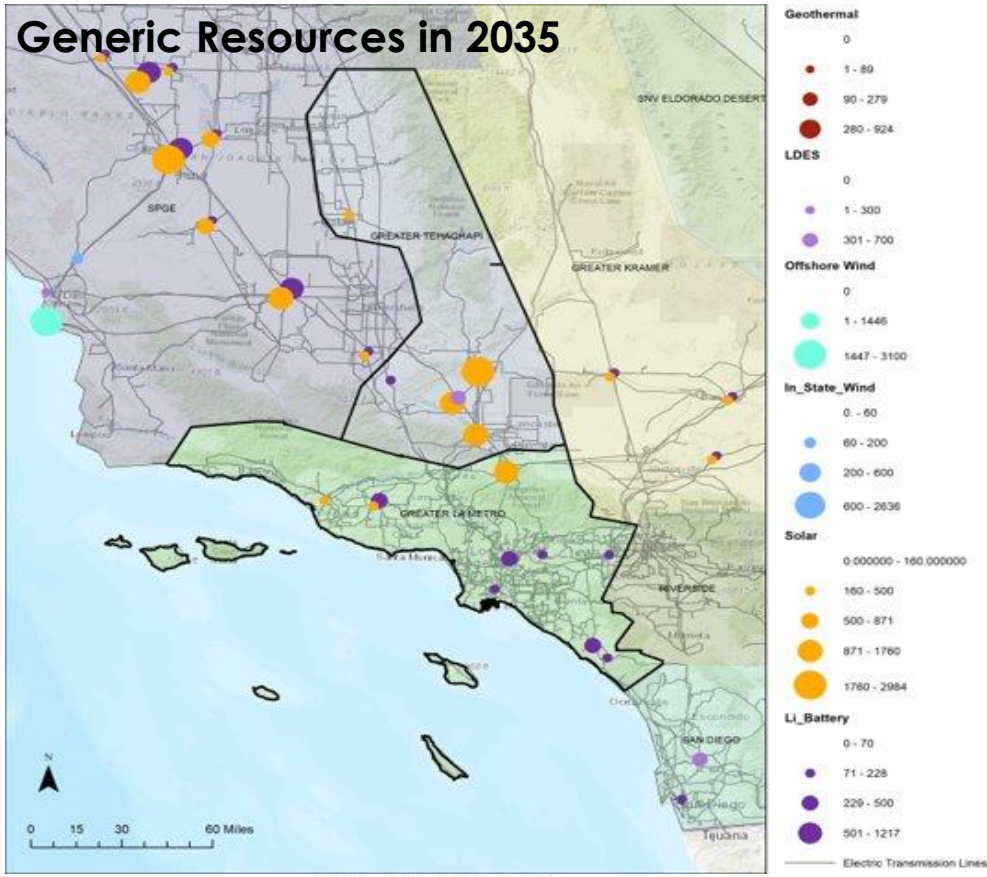


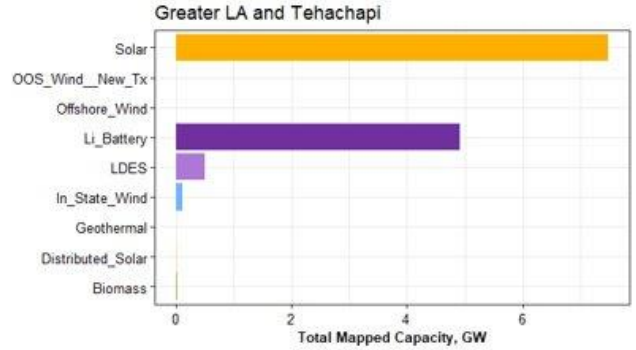
Greater LA Metro Area – Mapping Summary

- LA Metro, Orange County, and San Fernando and Simi valleys areas

Greater LA Metro	In-Development Resources			Generic Resources (2033)			Additional MWs in 2035		
	FCDS	EODS	Total	FCDS	EODS	Total	FCDS	EODS	Total
Solar	-	1	1	-	1,602	1,602	125	325	450
Battery	646	-	646	1,762	-	1,762	1,349	-	1,349

- Key Preliminary 2035 Criteria Implications:
  1) No identified non-compliance.
  2) No exceedances.
  3) No identified non-compliance.
  4) Two substations have more solar mapped than commercial interest, and two substations have fewer batteries mapped than high confidence commercial interest.
  5) Two buses have small reductions in batteries mapped.



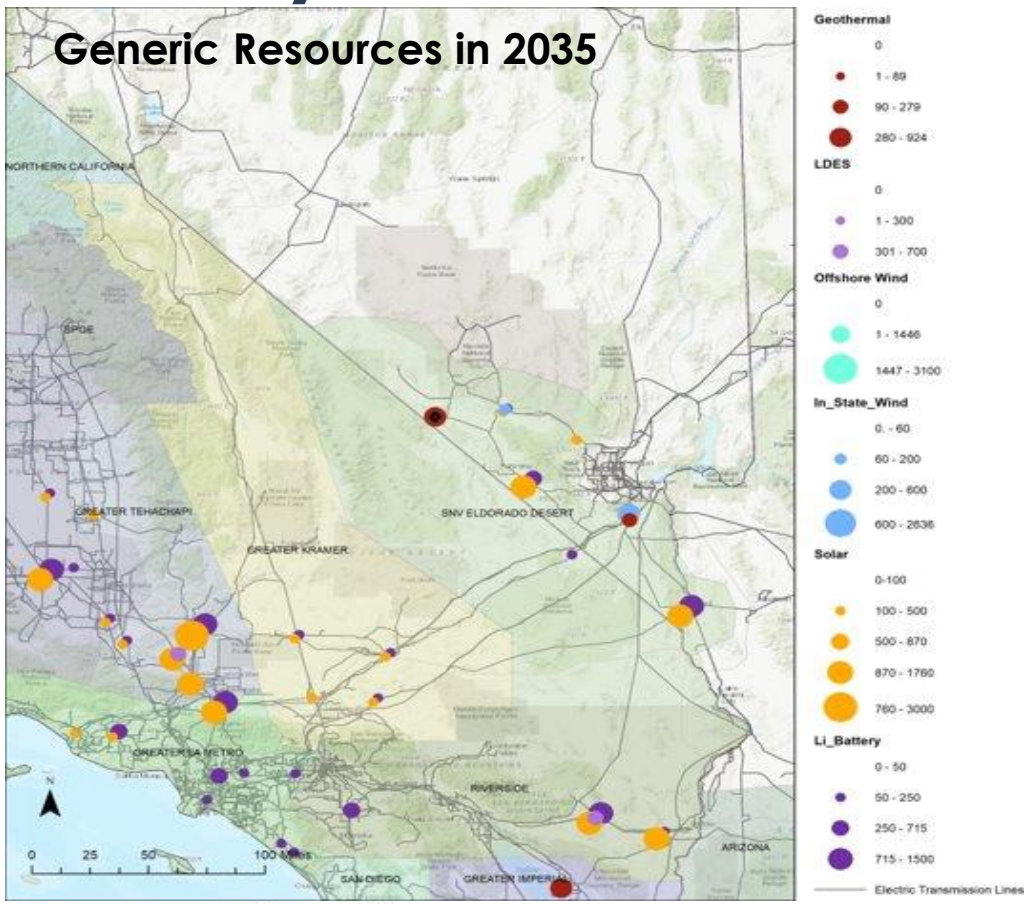


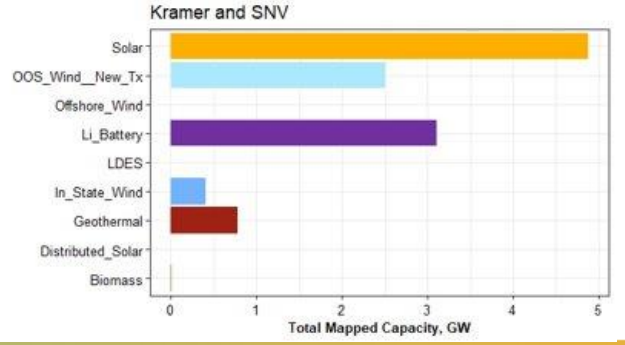
Greater Kramer Area – Mapping Summary

- Kramer area plus areas east to Pisgah and north up to Control

Greater Kramer	In-Development Resources			Generic Resources (2033)			Additional MWs in 2035		
	FCDS	EODS	Total	FCDS	EODS	Total	FCDS	EODS	Total
Nevada Geo. Import	13	-	13	-	-	-	-	-	-
Solar	620	510	1,130	651	785	1,436	-	-	-
Battery	700	-	700	514	-	514	4	-	4

- Key Preliminary 2035 Criteria Implications
  1) Kramer bus resources may require longer gen-ties to limit land-use implications
  2) Two constraints exceeded, but can be alleviated by CAISO upgrades
  3) A few substations with high values for specific env. datasets.
  4) A few substations exceed high-confidence commercial interest amounts but not total amount
  5) Small reductions in solar & battery resources mapped to three substations, shifted to nearby buses.



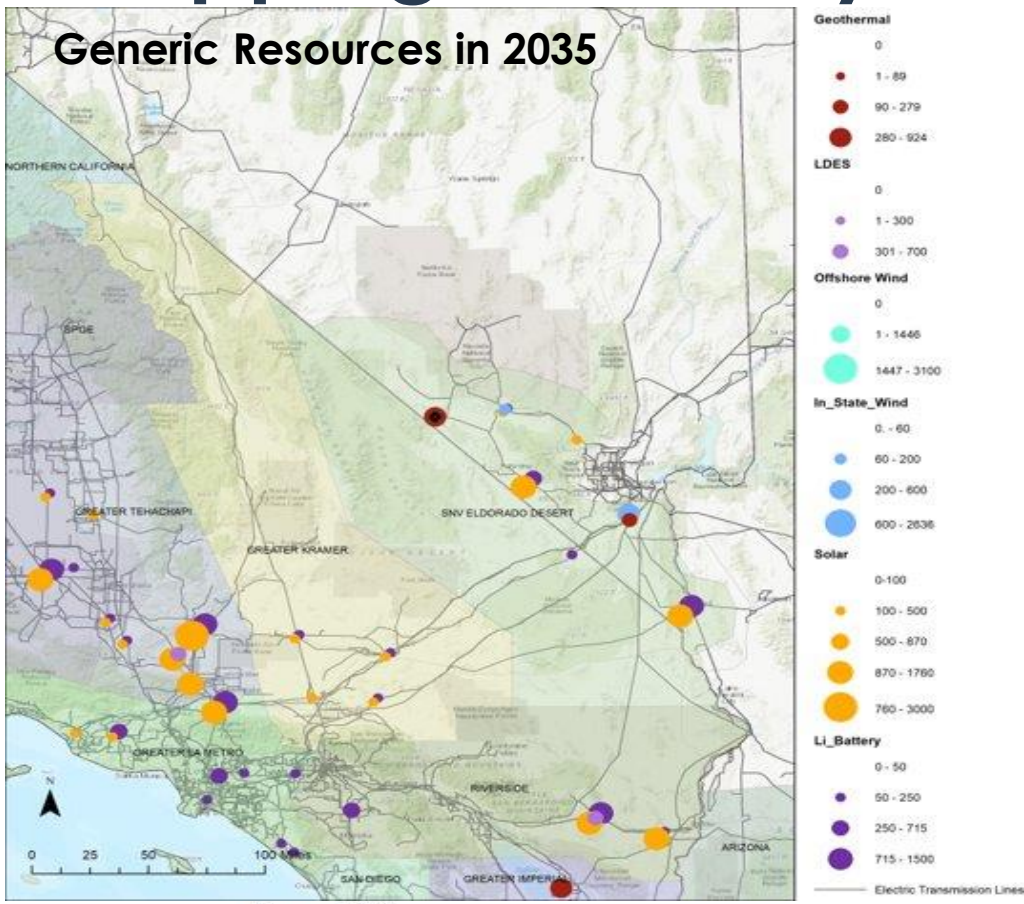


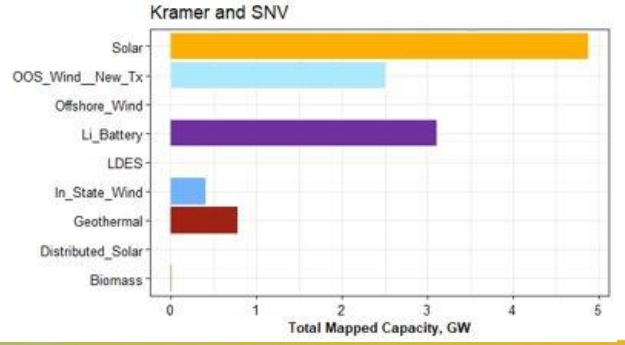
Southern Nevada/El Dorado Area – Mapping Summary

- Southern Nevada, Arizona, and California border area
- Includes key CAISO intertie points, e.g. El Dorado substations

Southern Nevada & El Dorado	In-Development Resources			Generic Resources (2033)			Additional MWs in 2035		
	FCDS	EODS	Total	FCDS	EODS	Total	FCDS	EODS	Total
Geothermal	-	-	-	500	-	500	-	-	-
Nevada Geo. Import	116	-	116	105	-	105	174	-	174
Solar	260	249	509	1,172	2,172	3,344		565	565
Wind	-	-	-	312	82	394	-	-	-
Battery	440	-	440	2,594	-	2,594	79	-	79
Wyoming Wind Import	-	-	-	1,500	-	1,500			-
Idaho Wind Import	-	-	-	1,000	-	1,000			-

- Key Preliminary 2035 Criteria Implications
  1) Few substations may require longer gen-ties
  2) Two constraints exceeded, no identified CAISO upgrades
  3) Several substations have limited low potential impact area
  4) Several substations exceed high-confidence commercial interest amounts but not total amount
  5) Minor reduction in wind resources mapped



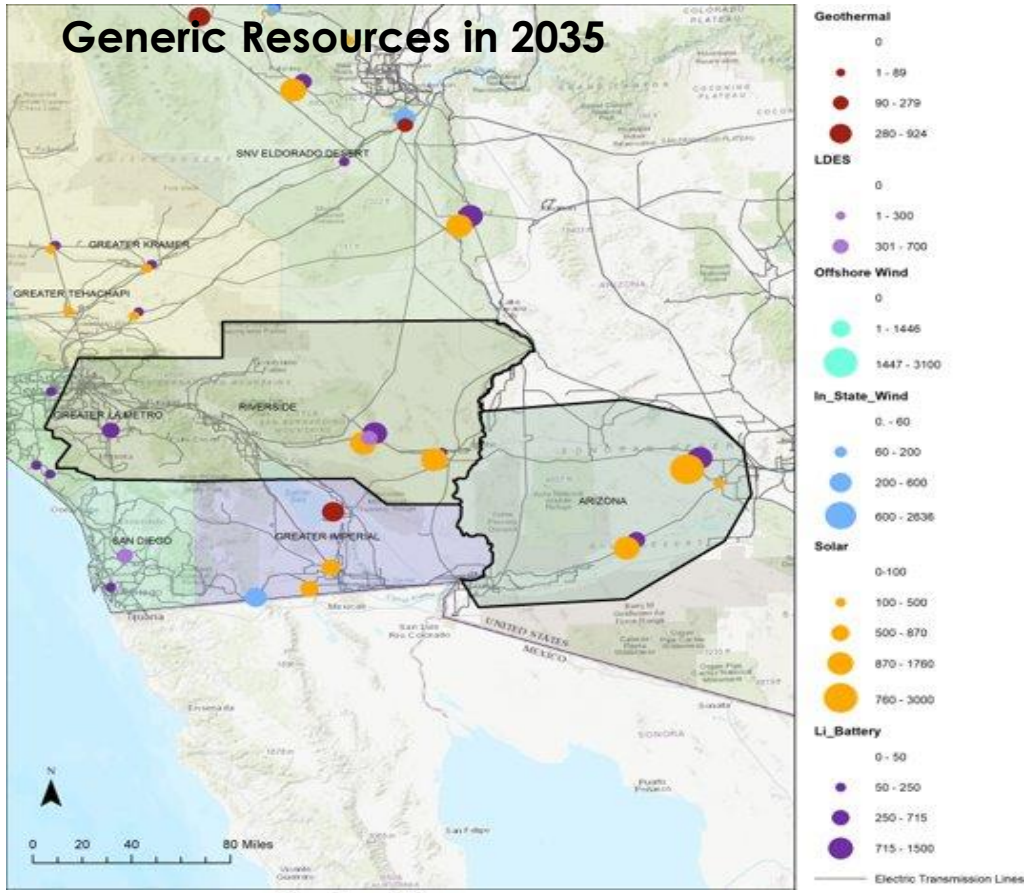


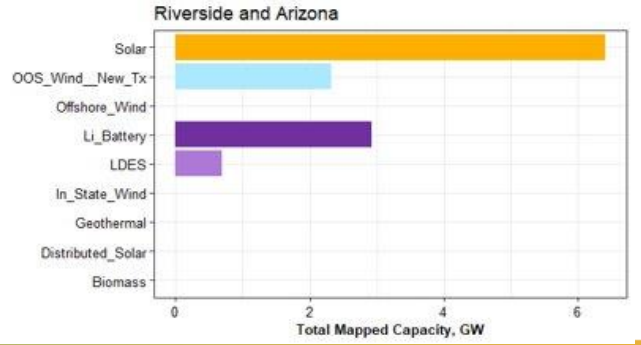
Riverside & Arizona Areas – Mapping Summary

- Riverside County and portions of western Arizona

Riverside & Arizona	In-Development Resources			Generic Resources (2033)			Additional MWs in 2035		
	FCDS	EODS	Total	FCDS	EODS	Total	FCDS	EODS	Total
Riverside Solar	912	1,359	2,271	21	1,956	1,977	15	670	685
Arizona Solar	350	-	350	550	2,597	3,147	-	600	600
Wind	9	-	9	1	-	1	-	-	-
Riverside Battery	2,382	-	2,382	1,530	-	1,530	258	-	258
Arizona Battery	-	-	-	1,805	-	1,805	-	-	-
New Mexico Wind	-	-	-	2,328	-	2,328	-	-	-
Riverside LDES	-	-	-	700	-	700	176	-	176

- Key Preliminary 2035 Criteria Implications
  1) A few substations may require longer gen-ties to limit land-use implications
  2) Riverside and SCE system mapped resources exceed two constraints, one can be alleviated by CAISO upgrade, other constraint upgrade is still exceeded. Remaining Arizona buses impacted by Greater Imperial area constraint exceedance.
  4) A few substations have more high-confidence commercial interest than mapped
  5) Shift in resources from Hassayampa to Hoodoo Wash.

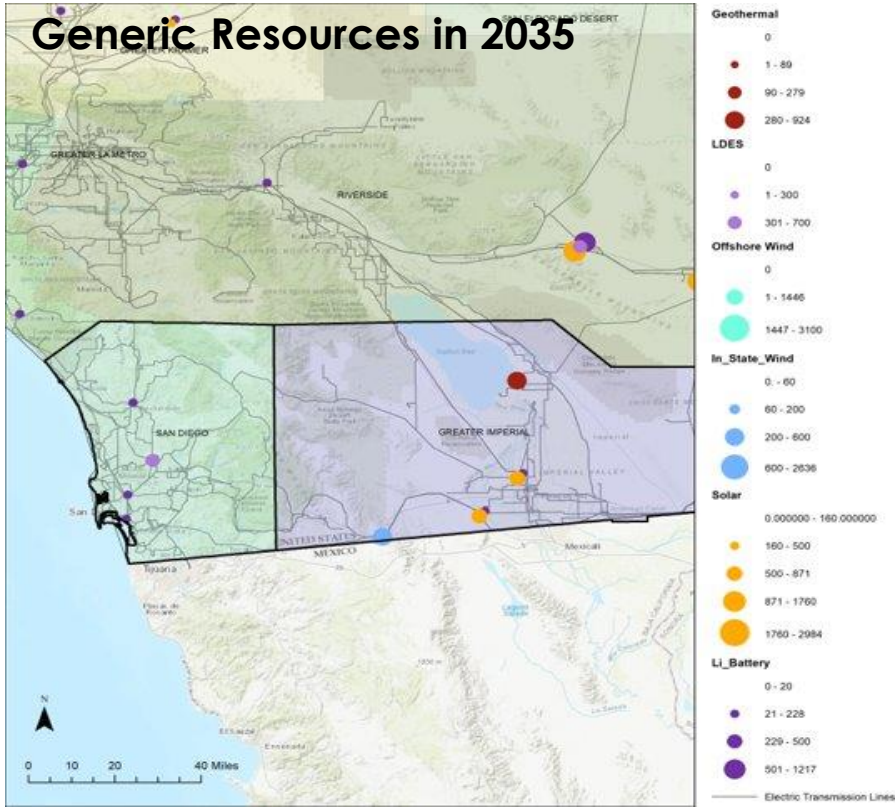




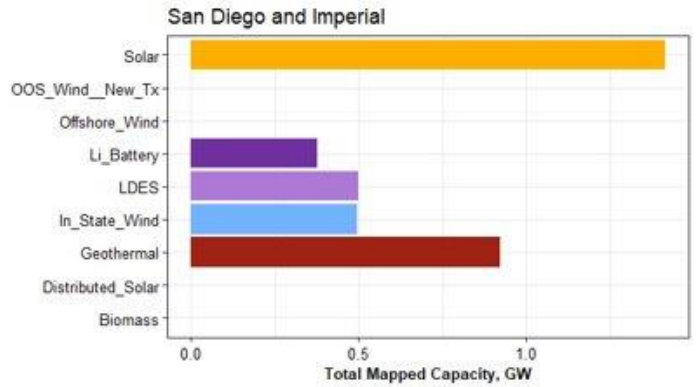
San Diego & Greater Imperial Areas – Mapping Summary

- San Diego and Imperial areas
- Note: Resources mapped to IID's area grouped as either IID-161 kV -> Connects through to SDGE intertie or IID-230 kV -> connects through SCE intertie

San Diego & Greater Imperial	In-Development Resources			Generic Resources (2033)			Additional MWs in 2035		
	FCDS	EODS	Total	FCDS	EODS	Total	FCDS	EODS	Total
Imp. Geothermal	76	-	76	924	-	924	-	-	-
Imperial Solar	20	-	20	100	440	540	-	213	213
Wind	-	-	-	135	360	495	-	-	-
San Diego Battery	351	-	351	82	-	82	-	-	-
Imperial Battery	630	-	630	135	-	135	115	-	115
San Diego LDES	-	-	-	500	-	500	-	-	-



- Key Preliminary 2035 Criteria Implications
  2) San Diego area resources cause three exceedances which can be mitigated by CAISO upgrades. Imperial area resource cause one constraint exceedance.
  3) A few substations have limited low potential impact area.
  4) Wind amount mapped to Imperial area substations significantly lower than commercial interests.
  5) A few key shifts in battery and wind resources.



Next Steps

Next Steps

- Stakeholders are encouraged to submit their comments to the Ruling on the proposed 2023-2024 TPP portfolios and preliminary mapping
  - **Comment Deadline: October 31, 2022**
  - **Reply Comment Deadline: November 10, 2022**
- Staff will review and incorporate input into the proposed portfolios and busbar mapping effort
- Staff expect the CPUC will finalize and transmit mapped portfolios to the CAISO in Q1 2023 in time for use in the CAISO's 2023-2024 TPP Study Plan

Appendix A – Criteria Alignment by Substation

Northern California Area – 2035 Criteria Alignment by Substation (1/2)

2035 Mapping Amount of In-Development and Generic Resources						Busbar Mapping Criteria Compliance					
Substation	Voltage	Resource Type	FCDS (MW)	EODS (MW)	Total (MW)	1. Distance to Trans. of Appropriate Voltage	2. Transmission Capability Limit	3a. Available Land Area	3b. Environmental Impacts	4. Commercial Interest	5. Prior Base Case
Birds Landing	230	In-State Wind	90	10	100	2	1*	1	1	1	2
Cortina	115	In-State Wind	65	33	98	1	3	1	1	1*	1
Delta Switching Yard	230	In-State Wind	80	-	80	1	1*	1	1	1	1
Glenn	230	In-State Wind	30	98	128	1	1*	1	1	3	2*
Kelso	230	In-State Wind	36	25	61	1	1*	1	1	2+	1*
Round Mountain	230	In-State Wind	200	11	211	1	1*	2	3	1	2
Tesla	230	In-State Wind	80	25	105	1	1*	1	1	2+	2
Tesla	500	In-State Wind	330	-	330	1*	1*	1	1	2+	1
Thermalito	230	In-State Wind	-	-	-	1	1*	1	1	1	3
Delevan	230	In-State Wind	-	-	-	1	1*	1	1	1	3
Geysers	230	Geothermal	89	-	89	1	1*	1	2	2	1
Summit	115	Geothermal	40	-	40	Not Available	1*	Not Available	Not Available	1	1
Humboldt (Proposed)	500	Offshore Wind	1,487	-	1,487	Not Available	1*	Not Available	Not Available	3	1
Humboldt	115	Offshore Wind	-	120	120	Not Available	3	Not Available	Not Available	1	1

Northern CA Area – 2035 Criteria Alignment by Sub (2/2)

Substation	Voltage	Resource Type	FCDS (MW)	EODS (MW)	Total (MW)	1. Distance to Trans. of Appropriate Voltage	2. Transmission Capability Limit	3a. Available Land Area	3b. Environmental Impacts	4. Commercial Interest	5. Prior Base Case	LCR	DAC	O3 non-attainment zone	PM2.5 non-attainment zone	High curtailment zone
Bellota	115	Li_Battery	194	-	194	Not Applicable	1*	Not Applicable	Not Applicable	1	1	No	No	Yes	Yes	No
Bellota	230	Solar	100	-	100	1	1*	1	1	2	1					
Bellota	115	Solar	-	255	255	1	1	1	1	2	1					
Cayetano	230	Li_Battery	100	-	100	Not Applicable	1*	Not Applicable	Not Applicable	1	1	Yes	No	Yes	No	No
Cayetano	230	Solar	100	-	100	1	1*	1	2	1	1					
Cortina	115	Li_Battery	160	-	160	Not Applicable	3	Not Applicable	Not Applicable	1	1	No	No	No	No	No
Cortina	115	Solar	-	230	230	1	3	1	1	1	1					
Curtis	115	Li_Battery	10	-	10	Not Applicable	1*	Not Applicable	Not Applicable	1	1	No	No	Yes	No	No
Delevan	230	Li_Battery	80	-	80	Not Applicable	1*	Not Applicable	Not Applicable	1+	1	No	No	No	No	No
Delevan	230	Solar	50	285	335	1	1*	1	1	1+	1					
Fulton	230	Li_Battery	25	-	25	Not Applicable	1*	Not Applicable	Not Applicable	1	1	Yes	No	Yes	No	No
Geysers	230	Li_Battery	13	-	13	Not Applicable	1*	Not Applicable	Not Applicable	1	1	No	No	No	No	No
Gold Hill	115	Li_Battery	50	-	50	Not Applicable	1*	Not Applicable	Not Applicable	1	1	Yes	No	Yes	No	No
Humboldt	115	Li_Battery	5	-	5	Not Applicable	3	Not Applicable	Not Applicable	3	3	No	No	No	No	No
Lakeville	230	Li_Battery	33	-	33	Not Applicable	1*	Not Applicable	Not Applicable	1	1	No	No	Yes	No	No
Los Esteros	115	Li_Battery	203	-	203	Not Applicable	1*	Not Applicable	Not Applicable	1+	1	Yes	Yes	Yes	No	No
Martin (San	115	Li_Battery	250	-	250	Not Applicable	1*	Not Applicable	Not Applicable	1	1	Yes	No	Yes	No	No
Martinez	115	Li_Battery	20	-	20	Not Applicable	1*	Not Applicable	Not Applicable	1	1	No	Yes	Yes	No	No
Mendocino	115	Li_Battery	-	-	-	Not Applicable	3	Not Applicable	Not Applicable	1	3	No	No	No	No	No
Metcalf	230	Li_Battery	425	-	425	Not Applicable	1*	Not Applicable	Not Applicable	1	1	No	No	Yes	No	No
Pittsburg	230	Li_Battery	-	-	-	Not Applicable	1*	Not Applicable	Not Applicable	2+	1	No	Yes	Yes	No	No
Ripon	115	Li_Battery	100	-	100	Not Applicable	1*	Not Applicable	Not Applicable	1	1	Yes	No	Yes	Yes	No
Tesla	230	Li_Battery	420	-	420	Not Applicable	1*	Not Applicable	Not Applicable	1+	1	No	No	Yes	No	No
Tesla	500	Solar	400	10	410	2	1*	1	1	1	1					
Vaca Dixon	115	Li_Battery	300	-	300	Not Applicable	1*	Not Applicable	Not Applicable	1	1	No	No	Yes	No	No
Vaca Dixon	115	Solar	25	-	25	1	1*	1	1	1	1					
Woodland	115	Li_Battery	12	-	12	Not Applicable	1*	Not Applicable	Not Applicable	1	1	Yes	No	Yes	No	No
Woodland	115	Solar	-	12	12	1	1	1	1	1	1					

Southern PG&E Area – 2035 Criteria Alignment by Sub (1/2)

Substation	Voltage	Resource Type	FCDS (MW)	EODS (MW)	Total (MW)	1. Distance to Trans. of Appropriate Voltage	2. Transmission Capability Limit	3a. Available Land Area	3b. Environmental Impacts	4. Commercial Interest – Storage	5. Prior Base Case – Storage	LCR	DAC	O3 non-attainment zone	PM2.5 non-attainment zone	High curtailment zone
Alpaugh	115	Li_Battery	70	-	70	Not Applicable	2	Not Applicable	Not Applicable	2	1	No	Yes	Yes	Yes	No
Alpaugh	115	Solar	20	125	145	1	2	1	1	2	1					
Arco	230	Li_Battery	201	-	201	Not Applicable	3	Not Applicable	Not Applicable	2	1	No	Yes	Yes	Yes	Yes
Arco	230	Solar	130	521	651	1	3	1	1	2	1					
Cabrillo	115	In-State Wi	99	-	99	1	2	1	2	1	1					
Caliente	230	Li_Battery	50	-	50	Not Applicable	3	Not Applicable	Not Applicable	2	1	No	No	Yes	No	No
Caliente	230	Solar	100	-	100	1	3	1	1	2	1					
Cholame	70	In-State Wi	60	-	60	1	3	1	1	3	1					
Coburn	230	Li_Battery	10	-	10	Not Applicable	2	Not Applicable	Not Applicable	1	1	No	No	No	No	No
Diablo	500	Offshore W	3,100	-	3,100	Not Availabe	1	Not Availabe	Not Availabe	2	1					
Gates	500	Li_Battery	300	-	300	Not Applicable	3	Not Applicable	Not Applicable	1	1	No	No	Yes	No	No
Gates	230	Li_Battery	253	-	253	Not Applicable	3	Not Applicable	Not Applicable	2	1	No	No	Yes	No	No
Gates	230	Solar	1,060	887	1,947	1	3	1	1	1+	1					
GWF Hanford Sw Sta	115	Solar	14	-	14		3			1	1					
Helm	230	Li_Battery	109	-	109	Not Applicable	2	Not Applicable	Not Applicable	2	1	No	Yes	Yes	Yes	No
Helm	230	Solar	165	200	365	1	2	1	1	2	1					
Henrietta	115	Li_Battery	54	-	54	Not Applicable	2	Not Applicable	Not Applicable	2	1	Yes	Yes	Yes	Yes	No
Henrietta	115	Solar	25	88	113	1	2	1	1	2	1					
Kettleman	70	Li_Battery	10	-	10	Not Applicable	3	Not Applicable	Not Applicable	1	1	No	No	Yes	No	No
Lamont	115	Li_Battery	-	-	-	Not Applicable	3	Not Applicable	Not Applicable	1	3	No	Yes	Yes	Yes	No
Lamont	115	Solar	90	-	90	1	3	1	1	1	2					
Los Banos	230	Li_Battery	100	-	100	Not Applicable	3	Not Applicable	Not Applicable	1	1	No	Yes	Yes	Yes	No
Los Banos	500	Li_Battery	-	-	-	Not Applicable	1	Not Applicable	Not Applicable	1+	1	No	Yes	Yes	Yes	No
Los Banos	230	Solar	300	230	530	1	3	1	1	2	1					
Los Banos	230	In-State Wi	186	-	186	1	3	1	1	2	1					
McCall	230	Li_Battery	-	-	-	Not Applicable	2*	Not Applicable	Not Applicable	1	3	No	Yes	Yes	Yes	No
McCall	230	Solar	-	-	-	1	2*	1	1	1	3					
Mesa	230	Li_Battery	100	-	100	Not Applicable	3	Not Applicable	Not Applicable	1	1	No	No	No	No	No
Mesa	115	Li_Battery	-	-	-	Not Applicable	3	Not Applicable	Not Applicable	1	3	No	No	No	No	No

Southern PG&E Area – 2035 Criteria Alignment by Sub (2/2)

Substation	Voltage	Resource Type	FCDS (MW)	EODS (MW)	Total (MW)	1. Distance to Trans. of Appropriate Voltage	2. Transmission Capability Limit	3a. Available Land Area	3b. Environmental Impacts	4. Commercial Interest – Storage	5. Prior Base Case – Storage	LCR	DAC	O3 non-attainment zone	PM2.5 non-attainment zone	High curtailment zone
Midway	230	Li_Battery	110	-	110	Not Applicable	3	Not Applicable	Not Applicable	1	1	No	No	Yes	No	Yes
Midway	500	Li_Battery	800	-	800	Not Applicable	2*	Not Applicable	Not Applicable	1	1	No	No	Yes	No	Yes
Midway	115	Li_Battery	-	-	-	Not Applicable	3	Not Applicable	Not Applicable	2+	3	No	No	Yes	No	Yes
Midway	230	Solar	8	425	433	1	3	1	2	2	1					
Midway	500	Solar	-	815	815	1*	1*	1	2	1	1					
Midway	115	Solar	-	-	-	1	3	1	2	2+	3					
Morro Bay	230	LDES	300	-	300	Not Applicable	3	Not Applicable	Not Applicable	2	1					
Morro Bay (Proposed	500	Offshore W	-	-	-	Not Availabe	1	Not Availabe	Not Availabe	2+	1*					
Moss Landing	500	Li_Battery	475	-	475	Not Applicable	1	Not Applicable	Not Applicable	3+	1	Yes	No	No	No	Yes
Mustang	230	Li_Battery	170	-	170	Not Applicable	3	Not Applicable	Not Applicable	1	1	Yes	Yes	Yes	Yes	No
Mustang	230	Solar	27	650	677	1	3	1	1	2	1					
Olive	115	Li_Battery	30	-	30	Not Applicable	3	Not Applicable	Not Applicable	1	1	No	Yes	Yes	Yes	No
Olive	115	Solar	40	-	40	1	3	1	1	1	1*					
Panoche	230	Li_Battery	170	-	170	Not Applicable	3	Not Applicable	Not Applicable	2	1	Yes	Yes	Yes	Yes	No
Panoche	230	Solar	50	317	367	1	3	1	1	2	1					
Rio Bravo	115	Li_Battery	55	-	55	Not Applicable	3	Not Applicable	Not Applicable	2	1	No	Yes	Yes	Yes	No
Rio Bravo	115	Solar	-	56	56	1	3	1	1	1	1					
Sisquoc	115	Li_Battery	10	-	10	Not Applicable	3	Not Applicable	Not Applicable	1	1	No	No	No	No	No
Templeton	230	In-State Wi	159	-	159	2	3	2	2	3	2					
Tranquility	230	Li_Battery	755	-	755	Not Applicable	3	Not Applicable	Not Applicable	1	1	No	Yes	Yes	Yes	No
Tranquility	230	Solar	370	793	1,163	1	3	1	1	2	1					
Westley	230	Li_Battery	170	-	170	Not Applicable	3	Not Applicable	Not Applicable	1	1	No	Yes	Yes	Yes	No
Westley	230	Solar	226	69	295	1	3	1	1	2	1*					
Wheeler Ridge	115	Li_Battery	157	-	157	Not Applicable	2	Not Applicable	Not Applicable	1	1	No	Yes	Yes	Yes	Yes
Wheeler Ridge	230	Li_Battery	70	-	70	Not Applicable	3	Not Applicable	Not Applicable	2	1	No	Yes	Yes	Yes	Yes
Wheeler Ridge	115	Solar	170	5	175	1	2	1	1	1	1					
Wheeler Ridge	230	Solar	210	280	490	1	3	1	1	2	1					

Greater Tehachapi Area – 2035 Criteria Alignment by Substation

2035 Mapping Amount of In-Development and Generic						Busbar Mapping Criteria Compliance						Additional Battery Mapping Criteria				
Substation	Voltage	Resource Type	FCDS (MW)	EODS (MW)	Total (MW)	1. Distance to Trans. of Appropriate Voltage	2. Transmission Capability Limit	3a. Available Land Area	3b. Environmental Impacts	4. Commercial Interest	5. Prior Base Case	LCR	DAC	O3 non-attainment zone	PM2.5 non-attainment zone	High curtailment zone
Antelope	230	In-State Wi	3	-	3	2	1*	1	3	1	1					
Antelope	230	Li_Battery	424	-	424	Not Applicable	1*	Not Applicable	Not Applicable	1	2	Yes	Yes	Yes	Yes	Yes
Antelope	230	Solar	770	502	1,272	1	1*	1	1	2	1					
Pastoria	230	Li_Battery	80	-	80	Not Applicable	1*	Not Applicable	Not Applicable	1	1	No	No	Yes	Yes	No
Pastoria	230	Solar	40	67	107	1	1*	1	1	1	1*					
Rector	230	Solar	-	100	100	1	1	1	1	2	1					
Vestal	230	Li_Battery	358	-	358	Not Applicable	1*	Not Applicable	Not Applicable	1	1	Yes	Yes	Yes	Yes	No
Vestal	230	Solar	294	451	745	1	1*	1	1	2	1					
Whirlwind	230	In-State Wi	101	-	101	1	1*	1	2	1	1					
Whirlwind	230	LDES	500	-	500	Not Applicable	1*	Not Applicable	Not Applicable	1	1					
Whirlwind	230	Li_Battery	959	-	959	Not Applicable	1*	Not Applicable	Not Applicable	1	2	No	No	Yes	No	Yes
Whirlwind	230	Solar	761	1,279	2,040	1	1*	1	2	2	1					
Windhub	230	In-State Wi	11	-	11	2	1*	1	1	1	2					
Windhub	500	Li_Battery	672	-	672	Not Applicable	1*	Not Applicable	Not Applicable	1	1	No	No	Yes	No	Yes
Windhub	230	Li_Battery	1,233	-	1,233	Not Applicable	1*	Not Applicable	Not Applicable	3+	1	No	No	Yes	No	Yes
Windhub	500	Solar	780	370	1,150	1*	1*	1	1	2	1					
Windhub	230	Solar	569	1,084	1,653	1	1*	1	1	1	1*					

Greater LA Metro Area – 2035 Criteria Alignment by Substation

2035 Mapping Amount of In-Development and Generic						Busbar Mapping Criteria Compliance						Additional Battery Mapping Criteria				
Substation	Voltage	Resource Type	FCDS (MW)	EODS (MW)	Total (MW)	1. Distance to Trans. of Appropriate Voltage	2. Transmission Capability Limit	3a. Available Land Area	3b. Environmental Impacts	4. Commercial Interest	5. Prior Base Case	LCR	DAC	O3 non-attainment zone	PM2.5 non-attainment zone	High curtailment zone
Alamitos	230	Li_Battery	82	-	82	Not Applicable	1	Not Applicable	Not Applicable	1	1	No	No	Yes	Yes	No
Barre	230	Li_Battery	20	-	20	Not Applicable	1	Not Applicable	Not Applicable	1	1	No	Yes	Yes	Yes	No
Capistrano	138	Li_Battery	250	-	250	Not Applicable	1	Not Applicable	Not Applicable	1	1	Yes	No	Yes	Yes	No
Chino	230	Li_Battery	10	-	10	Not Applicable	1	Not Applicable	Not Applicable	1	1	Yes	No	Yes	Yes	No
Etiwanda	230	Li_Battery	101	-	101	Not Applicable	1	Not Applicable	Not Applicable	1+	1	Yes	Yes	Yes	Yes	No
Goleta	230	Li_Battery	70	-	70	Not Applicable	1	Not Applicable	Not Applicable	1	1	No	No	No	No	No
Hinson	230	Li_Battery	200	-	200	Not Applicable	1	Not Applicable	Not Applicable	1	1	Yes	Yes	Yes	Yes	No
Johanna	230	Li_Battery	40	-	40	Not Applicable	1	Not Applicable	Not Applicable	1	1	Yes	Yes	Yes	Yes	No
Laguna Bell	230	Li_Battery	450	-	450	Not Applicable	1	Not Applicable	Not Applicable	2+	2	Yes	Yes	Yes	Yes	No
Mira Loma	230	Li_Battery	150	-	150	Not Applicable	1	Not Applicable	Not Applicable	2+	1	No	Yes	Yes	Yes	No
Moorpark	230	Li_Battery	500	-	500	Not Applicable	1	Not Applicable	Not Applicable	1+	1	Yes	No	Yes	No	No
Moorpark	230	Solar	-	500	500	1	1	1	1	1	1					
Pardee	230	Li_Battery	95	-	95	Not Applicable	1	Not Applicable	Not Applicable	1	1	No	No	Yes	Yes	No
Santa Clara	230	Li_Battery	35	-	35	Not Applicable	1	Not Applicable	Not Applicable	1	1	No	No	Yes	No	No
Santa Clara	230	Solar	125	125	250	1	1	1	1	3	1					
Talega	230	Li_Battery	100	-	100	Not Applicable	1	Not Applicable	Not Applicable	1	1	No	No	Yes	No	No
Vincent	230	Li_Battery	1,454	-	1,454	Not Applicable	1	Not Applicable	Not Applicable	1+	1	No	No	Yes	No	Yes
Vincent	230	Solar	-	1,303	1,303	1	1	1	1	2	1					
Walnut	230	Li_Battery	200	-	200	Not Applicable	1	Not Applicable	Not Applicable	1	2	Yes	Yes	Yes	Yes	No

Greater Kramer Area – 2035 Criteria Alignment by Substation

2035 Mapping Amount of In-Development and Generic Resources							Busbar Mapping Criteria Compliance						Additional Battery Mapping Criteria				
Substation	Voltage	Out-of-CAISO	Resource Type	FCDS (MW)	EODS (MW)	Total (MW)	1. Distance to Trans. of Appropriate Voltage	2. Transmission Capability Limit	3a. Available Land Area	3b. Environmental Impacts	4. Commercial Interest	5. Prior Base Case	LCR	DAC	O3 non-attainment zone	PM2.5 non-attainment zone	High curtailment zone
Calcite	230		Li_Battery	185	-	185	Not Applicable	1	Not Applicable	Not Applicable	1	2	No	No	Yes	No	No
Calcite	230		Solar	200	230	430	1	1	1	1	1	1*					
Control	115	Yes	Geotherma	13	-	13	Not Availabe	1*	Not Availabe	Not Availabe	1	1					
Coolwater	115		Li_Battery	104	-	104	Not Applicable	1*	Not Applicable	Not Applicable	1	1	No	Yes	Yes	No	No
Coolwater	115		Solar	150	204	354	1	1*	1	2	2	1					
Kramer	230		Li_Battery	700	-	700	Not Applicable	1*	Not Applicable	Not Applicable	1	1	No	No	Yes	No	No
Kramer	115		Li_Battery	75	-	75	Not Applicable	1*	Not Applicable	Not Applicable	1	1	No	No	Yes	No	No
Kramer	230		Solar	620	741	1,361	2	1*	1	2	2	1					
Kramer	115		Solar	90	-	90	1	1*	1	2	1	1					
Pisgah	230		Li_Battery	-	-	-	Not Applicable	1	Not Applicable	Not Applicable	1	1	No	Yes	Yes	No	No
Pisgah	230		Solar	100	-	100	1	1	1	1	2	1					
Roadway	115		Li_Battery	150	-	150	Not Applicable	1*	Not Applicable	Not Applicable	1	2	No	Yes	Yes	No	No
Roadway	115		Solar	111	120	231	1	1*	1	2	1	1*					
Victor	230		Solar	-	-	-	1	1*	1	2	1+	3					

Southern Nevada/El Dorado Area – 2035 Criteria Alignment by Substation

Substation	Voltage	Out-of-CAISO	Resource Type	FCDS (MW)	EODS (MW)	Total (MW)	1. Distance to Trans. of Appropriate Voltage	2. Transmission Capability Limit	3a. Available Land Area	3b. Environmental Impacts	4. Commercial Interest	5. Prior Base Case	LCR	DAC	O3 non-attainment zone	PM2.5 non-attainment zone	High curtailment zone
Beatty	138		Geotherma	500	-	500	3	2	Not Availabe	Not Availabe	2	1					
Carpenter Cany	230		Li_Battery	80	-	80	Not Applicable	2	Not Applicable	Not Applicable	2	1	No	No	No	No	Yes
Carpenter Cany	230		Solar	250	215	465	1	2	1	Not Available	2	1					
Desert View	230		Li_Battery	40	-	40	Not Applicable	2	Not Applicable	Not Applicable	2	1	No	No	Yes	No	Yes
Desert View	230		Solar	100	50	150	1	2	1	Not Available	2	1					
Eldorado	230		Li_Battery	529	-	529	Not Applicable	1	Not Applicable	Not Applicable	1	1	No	No	No	No	Yes
Eldorado	230		Solar	-	300	300	2	1	1	Not Available	1	1					
Eldorado	500	Yes	Geotherma	315	-	315	Not Availabe	2	Not Availabe	Not Availabe	2	1					
Eldorado	230	Yes	Geotherma	40	-	40	Not Availabe	1	Not Availabe	Not Availabe	1	1					
Eldorado	500	Yes	OOS Wind,	2,500	-	2,500	Not Availabe	2	Not Availabe	Not Availabe	1	1					
Innovation	230		Li_Battery	150	-	150	Not Applicable	2	Not Applicable	Not Applicable	1	1	No	No	No	No	Yes
Innovation	230		Solar	237	65	302	1	2	1	Not Available	1	1					
Innovation	230		In-State Wi	93	-	93	2	2	1	Not Available	3	2					
Ivanpah	230		Li_Battery	200	-	200	Not Applicable	1	Not Applicable	Not Applicable	1	1	No	Yes	No	No	No
Mohave	500		Li_Battery	1,504	-	1,504	Not Applicable	2	Not Applicable	Not Applicable	2+	1	No	No	No	No	Yes
Mohave	500		Solar	150	1,370	1,520	1*	1	2	Not Available	1	1					
Sloan Canyon (f	230		In-State Wi	228	82	310	1	2	2	Not Available	1	1					
Trout Canyon (f	230		Li_Battery	570	-	570	Not Applicable	2	Not Applicable	Not Applicable	1+	1	No	No	No	No	Yes
Trout Canyon (f	230		Solar	525	1,106	1,631	2	2	1	Not Available	2	1					
Valley (VEA)	138		Li_Battery	40	-	40	Not Applicable	2	Not Applicable	Not Applicable	1	1	Yes	No	No	No	No
Valley (VEA)	138		Solar	50	-	50	1	2	1	Not Available	1	1*					

Riverside & Arizona Areas – 2035 Criteria Alignment by Substation

Substation	Voltage	Out-of-CAISO	Resource Type	FCDS (MW)	EODS (MW)	Total (MW)	1. Distance to Trans. of Appropriate Voltage	2. Transmission Capability Limit	3a. Available Land Area	3b. Environmental Impacts	4. Commercial Interest	5. Prior Base Case	LCR	DAC	O3 non-attainment zone	PM2.5 non-attainment zone	High curtailment zone
Colorado River	500		Li_Battery	58	-	58	Not Applicable	3	Not Applicable	Not Applicable	1+	1	No	No	No	No	Yes
Colorado River	230		Li_Battery	995	-	995	Not Applicable	3	Not Applicable	Not Applicable	1	1	No	No	No	No	Yes
Colorado River	500		Solar	46	426	473	2	3	1	1	1	1					
Colorado River	230		Solar	700	1,300	2,000	2	3	1	1	1+	1					
Devers	230		Li_Battery	450	-	450	Not Applicable	3	Not Applicable	Not Applicable	1+	1	Yes	No	Yes	No	No
Devers	230		Solar	-	80	80	1	1	1	2	1	1					
Devers	230		In-State Wi	10	-	10	2	3	1	1	2+	1					
El Casco	230		Li_Battery	100	-	100	Not Applicable	3	Not Applicable	Not Applicable	1	1	No	No	Yes	Yes	No
Lee Lake (Proposed)	500		LDES	-	-	-	Not Applicable	1	Not Applicable	Not Applicable	3+	1					
Redbluff	500		Li_Battery	500	-	500	Not Applicable	3	Not Applicable	Not Applicable	1+	1	No	No	No	No	Yes
Redbluff	230		Li_Battery	1,186	-	1,186	Not Applicable	3	Not Applicable	Not Applicable	2+	1	No	No	No	No	Yes
Redbluff	500		Solar	150	900	1,050	2	3	1	1	1	1					
Redbluff	230		Solar	52	1,279	1,331	2	3	1	1	1+	1					
Redbluff	500		LDES	700	-	700	Not Applicable	3	Not Applicable	Not Applicable	2	1					
Valley	500		Li_Battery	680	-	680	Not Applicable	3	Not Applicable	Not Applicable	1	1	Yes	No	No	No	No
Vista	230		Li_Battery	200	-	200	Not Applicable	3	Not Applicable	Not Applicable	1	1	No	Yes	Yes	Yes	No
Delaney	500		Li_Battery	1,240	-	1,240	Not Applicable	3	Not Applicable	Not Applicable	2+	1	No	No	Yes	No	Yes
Delaney	500		Solar	350	2,250	2,600	1*	3	1	Not Available	1+	1*					
Hassayampa	500		Li_Battery	30	-	30	Not Applicable	3	Not Applicable	Not Applicable	1	3	No	No	Yes	No	Yes
Hassayampa	500		Solar	300	171	471	2	3	1	Not Available	1+	2					
Hoodoo Wash	500		Li_Battery	535	-	535	Not Applicable	3	Not Applicable	Not Applicable	2+	1	No	No	No	No	No
Hoodoo Wash	500		Solar	250	776	1,026	1*	3	1	Not Available	1+	1					
Palo Verde	500	Yes	OOS Wind,	2,328	-	2,328	Not Availabe	3	Not Availabe	Not Availabe	1	1					

San Diego & Greater Imperial – 2035 Criteria Alignment by Substation

2035 Mapping Amount of In-Development and Generic Resources							Busbar Mapping Criteria Compliance						Additional Battery Mapping Criteria				
Substation	Voltage	Out-of-CAISO	Resource Type	FCDS (MW)	EODS (MW)	Total (MW)	1. Distance to Trans. of Appropriate Voltage	2. Transmission Capability Limit	3a. Available Land Area	3b. Environmental Impacts	4. Commercial Interest	5. Prior Base Case	LCR	DAC	O3 non-attainment zone	PM2.5 non-attainment zone	High curtailment zone
Escondido	230		Li_Battery	85	-	85	Not Applicable	1*	Not Applicable	Not Applicable	1	1	Yes	No	Yes	No	No
Mission	138		Li_Battery	50	-	50	Not Applicable	1*	Not Applicable	Not Applicable	1	1	No	No	Yes	No	No
Otay Mesa	230		Li_Battery	75	-	75	Not Applicable	1*	Not Applicable	Not Applicable	2+	1	No	No	Yes	No	No
San Luis Rey	230		Li_Battery	70	-	70	Not Applicable	1*	Not Applicable	Not Applicable	1	1	No	No	Yes	No	No
Silvergate	230		Li_Battery	200	-	200	Not Applicable	1*	Not Applicable	Not Applicable	1	1	Yes	Yes	Yes	No	No
Sycamore	138		Li_Battery	400	-	400	Not Applicable	1*	Not Applicable	Not Applicable	1	1	Yes	No	Yes	No	No
Encina	115		Li_Battery	-	-	-	Not Applicable	1*	Not Applicable	Not Applicable	1	3	No	No	Yes	No	No
Sycamore	230		LDES	500	-	500	Not Applicable	1*	Not Applicable	Not Applicable	2	1					
ECO	115		Li_Battery	108	-	108	Not Applicable	3	Not Applicable	Not Applicable	1	1	Yes	No	Yes	No	No
ECO	115		Solar	-	180	180	1	3	2	1	1	1					
ECO	230		In-State Wi	-	360	360	2	3	Not Available	Not Available	2+	2*					
ECO	115		In-State Wi	135	-	135	1	3	2	1	1*	1					
ECO	500		In-State Wi	-	-	-	2	3	Not Availabe	Not Availabe	2+	1					
IID System	230	Yes	Li_Battery	150	-	150	Not Applicable	3	Not Applicable	Not Applicable	1	1	#N/A	#N/A	#N/A	#N/A	#N/A
IID System	230	Yes	Solar	20	100	120	Not Available	3	Not Available	Not Available	1	1					
IID System	230	Yes	Geotherma	950	-	950	Not Availabe	3	1	2	2	1					
IID System	161	Yes	Geotherma	50	-	50	Not Availabe	3	1	2	1	1					
Imperial Val	230		Li_Battery	175	-	175	Not Applicable	3	Not Applicable	Not Applicable	1+	1	Yes	No	No	No	No
Imperial Val	230		Solar	100	563	663	1	3	1	1	1+	1					
Ocotillo	500		In-State Wi	-	-	-	2	3	2	1	2+	1					