Higher Levels of Electrification for Use in the 2022-23 TPP

CAISO Stakeholder Meeting

July 6, 2022

California Public Utilities Commission

Purpose

- To move toward planning for a higher electrification future and identifying any incremental infrastructure needs, given existing and potentially new policy drivers regarding high electrification:
  - Assessing the transmission system and identifying potential transmission investments needed;
  - Investigating local capacity issues that may be significant in a high electrification future, especially in constrained areas like the Los Angeles (LA) Basin; and
  - Assessing any potential land-use constraints associated with the high electrification resource/transmission buildout, particularly through the busbar mapping process.

State’s Electrification Goals

- Considering the proposed CARB electrification regulations, the expectation is the 2022 IEPR will have higher level of load compared to the original 2021 IEPR.
  - Proposed CARB electrification regulation: Advanced Clean Cars II (ACCII) and Advanced Clean Fleets (ACF).
- The combined lead time associated with CEC, CPUC, and CAISO planning processes and the building of the generation and transmission infrastructure mean that planning for the high electrification future will need to begin now.
- Through different IRP stakeholder processes, many parties requested to move towards a higher level of electrification.
- IOUs requested to use higher level of electrification for their Grid Needs Assessments filings.

Other Procedural Background

- The 2021 PSP utilized a managed mid-demand paired with high electric vehicle (EV) demand forecast from CEC's 2020 IEPR.
- The 2021 PSP Decision also delegated to Commission staff to explore with CEC and CAISO staff the development of a policy-driven sensitivity portfolio designed around a lower GHG emissions limit and the use of "high electrification" demand assumptions in the 2022-2023 TPP.
- As part of 2022 IRP Filing Requirements, LSEs are instructed to describe and provide qualitative and quantitative information on what additional resource planning and procurement they would do under the high electrification scenario.

IRP Stakeholders Requested to Have Higher Level of Electrification Assumptions in Planning

- 2021 PSP development process:
  - The majority of parties supported adjusting the load forecast assumptions to include higher load, particularly related to EV adoption and high electrification more broadly.
    - Many parties, including ACP-CA, CalCCA, and CEJA, supported including even higher load than the 2021 IEPR High EV forecast, referring to the 2035 zero-emissions vehicle (ZEV) goal, carbon neutrality goals, and numerous executive orders of the Governor and previous Governor.
    - PG&E stated that all of the IEPR scenarios materially underestimate the likely EV load by 2030, and UCS recommended including 7 million ZEVs by 2030.
    - SDG&E pointed out that this approach would be consistent with action in the distribution resource plans.

IRP Stakeholders Request to Have Higher Level of Electrification Assumptions in Planning (Cont.)

- In response to an April 20, 2022, Ruling that proposed to use CEC's 2021 IEPR mid case as the energy forecast for LSEs to plan for their 2022 IRPs, some parties asked to have LSEs to plan for higher load forecast.
  - ACP-CA commented that this IRP cycle should account for California's aggressive electrification goals.
  - PG&E recommended having the LSEs plan for the Inter-Agency High Electrification scenario.
  - SCE noted that there is not enough time to consider higher electrification assumptions in this IRP cycle, but pointed out that their own internal forecasts expect higher electrification load and therefore recommended that this assumption should be adjusted in future cycles.

IOUs' GNA and the Request for Higher Transportation Electrification Load Forecast

- It is important to use consistent load input in IRP and Distribution Planning Process(DPP), as appropriate.
- Each year the IOUs’ Grid Needs Assessments (GNAs) filings identify distribution grid investment needs based on the most recently adopted IEPR datasets (e.g., 2022 GNAs based on 2020 IEPR).
- IOUs have expressed concern that the original 2021 IEPR datasets are already outdated because they don’t reflect the most recent CARB projections.
  - IOUs jointly proposed to CPUC Energy Division to insert transportation electrification (TE) loads from Inter-Agency High Electrification scenario into the 2021 IEPR mid-case for later years (2030-2032) and insert TE loads from the 2021 IEPR high case for early years (2023-2029).

Higher Level of Electrification for the 2022-23 TPP Base Case

- In recognition of the state's aggressive electrification goals and the development of implementing programs and mandates, and the importance of assessing these effects as an input into infrastructure planning, CPUC requested to use higher level of electrification for the 2022-23 TPP base case analysis.
  - CPUC, CEC, and CAISO agreed to do so, concluding that reflecting higher levels of transportation electrification was prudent given recent policy and market drivers that are increasingly favorable towards electrification.
  - CEC, consequently, adopted both the Inter-Agency High Electrification scenario and the Additional Transportation Electrification scenario at the May 24, 2022, business meeting as part of the 2021 IEPR.

2022-2023 TPP High Electrification Policy-Driven Sensitivity Portfolio — RESOLVE Results and Busbar Mapping

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Energy Division Staff Presentation

California Public Utilities Commission

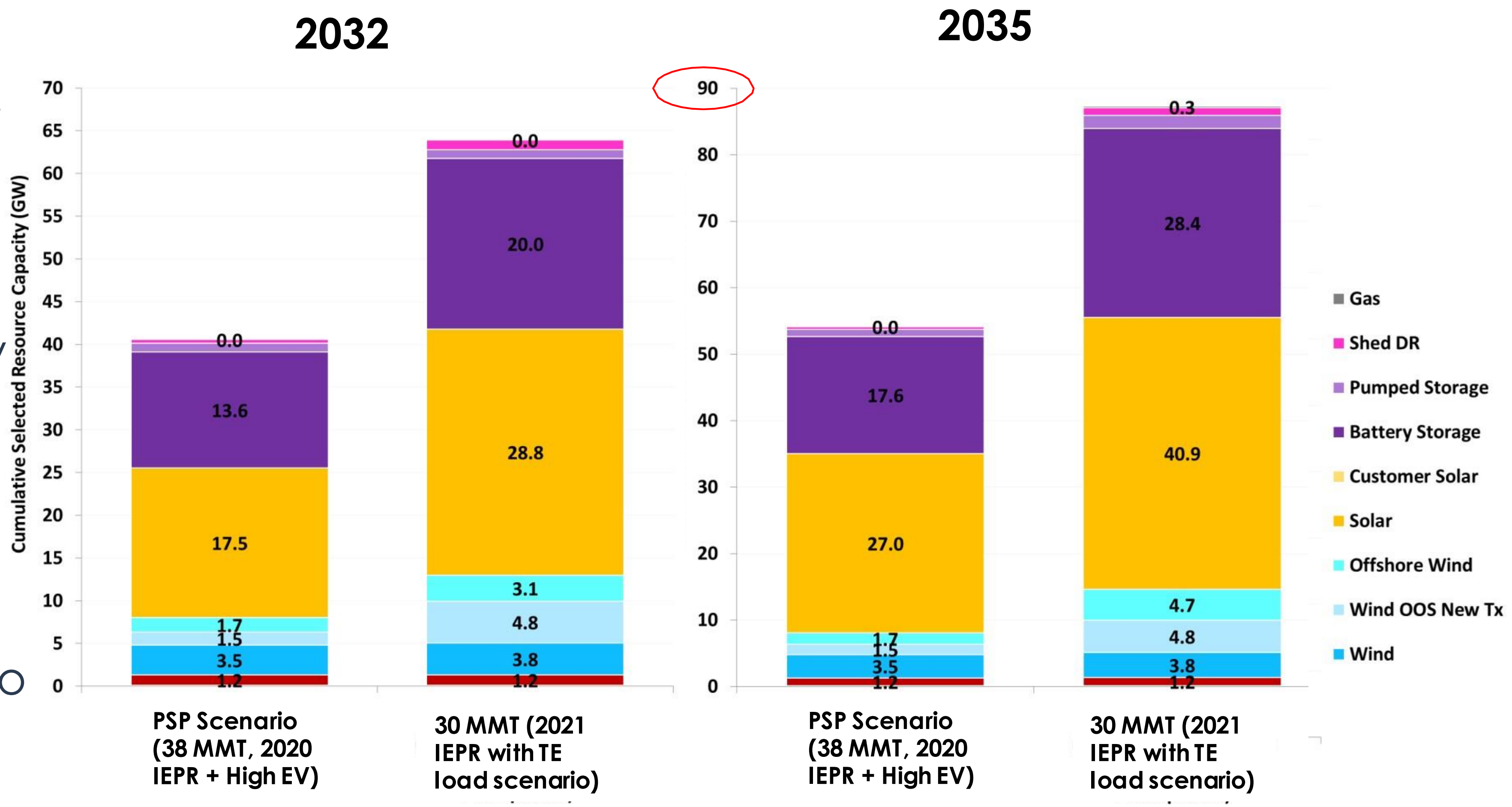
RESOLVE Updates for Sensitivity Portfolio

- RESOLVE is a capacity expansion model, which co-optimizes investment and dispatch over a multi-year horizon in order to identify least-cost portfolios for meeting specified GHG targets and other policy goals.
- Utilized in CPUC's IRP to develop optimal resource portfolio covering the CAISO balancing area.
- Staff implemented three key updates to RESOLVE from the version used for IRP's PSP base case portfolio, transmitted to the CAISO in February.

Update Category	Key Changes
Resource Costs and Potential	• Updated resource costs to NREL 2021 ATB and Lazard LCOS v7.0
Grid Planning Scenario	• Updated the load in RESOLVE to the CEC's 2021 IEPR with the additional Transportation Electrification scenario to capture a high electrification future
Transmission Deliverability	• Updates to transmission deliverability – resource mappings, existing transmission deliverability capacity, transmission upgrades using the updated 2021 CAISO transmission whitepaper and the results of the 2021-2022 TPP

RESOLVE Results – Comparison to 38 MMT PSP base case portfolio

- Sensitivity portfolio key attributes that increase resource build
  - Lower GHG target
    - 30 MMT by 2030 statewide (25 MMT by 2035)
  - Higher Load
    - 2021 IEPR with Additional Transportation Electrification scenario
  - Beyond 10-year focus
    - Study year is 2035



RESOLVE Results – Summary of selected resources

- Selected new resources in portfolio at key years:

Resource Type	2026 (MW)	2028 (MW)	2030 (MW)	2032 (MW)	2035 (MW)
Biomass	107	134	134	134	134
Geothermal	942	1,152	1,152	1,152	1,786
Wind	3,797	3,797	3,797	3,797	3,797
OOS Wind New Tx	0	4,828	4,828	4,828	4,828
Offshore Wind	120	195	200	3,100	4,707
Utility-Scale Solar	11,000	11,539	25,414	28,779	40,879
Battery Storage	11,771	11,539	15,613	22,437	28,402
Long-duration Storage	196	1,000	1,000	1,000	2,000
Shed Demand Response	1,115	1,115	1,115	1,115	1,115
Total	**29,049**	**35,633**	**53,254**	**63,898**	**87,650**

- Two manual adjustments to the portfolio built by RESOLVE
  - Removed the 256 MW of new gas
  - Added 600 MW of geothermal (amount is beyond what is needed to replace the gas)
- Purpose: to study in the TPP the more complex transmission challenges of interconnecting additional geothermal resources.

Busbar Mapping Overview

- **Resource to Busbar Mapping** ("busbar mapping"): The process for translating geographically coarse portfolios developed through IRP to individual substations for use in the CAISO's annual Transmission Planning Process (TPP).
  - The CPUC typically transmits multiple distinct portfolios developed in the IRP process:
    - Reliability and Policy-Driven Base Case portfolio -> the 38 MMT portfolio transmitted back in February
    - Policy-Driven Sensitivity portfolio(s) -> the 30 MMT high electrification sensitivity portfolio, presented here
  - Joint effort through a CPUC, CEC, and CAISO staff working group
  - Uses a stakeholder vetted methodology, described in detail in most recent [Methodology Document]

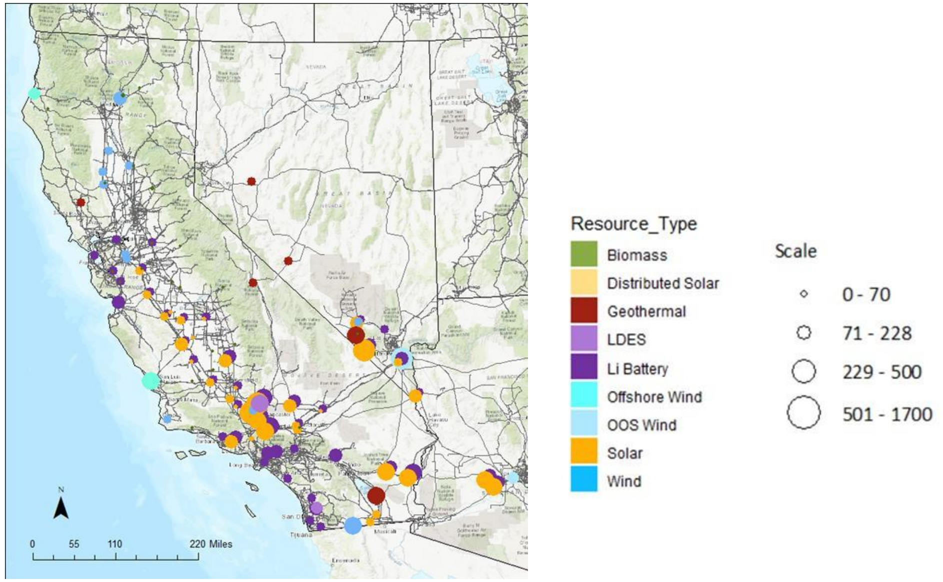
Inputs: Portfolio developed from RESOLVE results

Resource Type	MW by 2032
Biomass	134
Geothermal	1,160
Wind	3,531
Wind OOS New Tx	1,500
Offshore Wind	1,708
Utility-Scale Solar	17,506
Battery Storage	13,571
Long-duration Storage	1,000
Shed Demand Response	441
Total	40,551

RESOLVE Resource Name	2032 Total (MW)
Greater_LA_Solar	1
Northern_California_Solar	-
Southern_PGAE_Solar	1,238
Tehachapi_Solar	2,969
Greater_Kramer_Solar	3,166
Southern_NV_Eldorado_Solar	7,382
Riverside_Solar	4,001
Arizona_Solar	-
Imperial_Solar	-

Busbar Mapping Process

Output: Substation-level mapping



[Mapping Results of the portfolio for the 2022-23 TPP Base Case]

Busbar Mapping Overview

- Busbar Mapping's goal is to balance mapped resources alignment with the following criteria:
  - i. Distance to transmission of appropriate voltage
  - ii. Transmission capability limits, and cost-effective transmission upgrades
  - iii. Land use and environmental constraints
  - iv. Commercial development interest
  - v. Consistency with prior year's TPP base case mapping
- Additional criteria for battery storage (i.e., prioritizing DACs, Non-attainment areas, thermal retirements)
  - Also prioritize co-locating storage with solar (particularly EODS) to approximate transmission needs of hybrids
- CAISO staff produce transmission capability limits and upgrade cost estimates and provide feedback on transmission implications of mapping.
- CEC staff compile land-use and environmental data and implement the screens to assess mapping's potential environmental impact.

Table Right: Example of busbar mapping criteria analysis results for Northern CA wind

Area	Substation	Voltage	Wind Source	FCDS (MW)	EODS (MW)	Round 1 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
Northern PG&E	Bridgeville	115	In-State	-	34	**34**	1	1	2	2	3	1
Northern PG&E	Glenn	230	In-State	-	153	**153**	1	1	1	1	3	3
Northern PG&E	Kelso	230	In-State	-	50	**50**	1	1	1	1	1	1
Northern PG&E	Pit 1	230	In-State	-	200	**200**	3	1	3	2	3	1

Table Legend:	Level-3 Non-compliance	3	Level-2 Non-compliance	2	Level-1 Compliance	1

Criteria 2: Transmission Capability

- Criteria 2 analysis relies on information developed by the [CAISO in the 2021 Transmission Capability Estimates White Paper:]
  - Transmission constraint information:
    - Available transmission capacity
    - Known upgrades – estimated costs and transmission capacity
  - On-peak (for FCDS resources) and Off-peak (for FCDS and EODS resources) output factors that are resource and region specific
- Staff calculate the transmission utilization of mapped resources across all constraints.
- If mapping results exceeds transmission capability for constraints, staff determine:
  - Which white papers upgrades would alleviate exceedances,
  - The upgrades' cost-effectiveness given resources mapped, size of upgrade, and costs; and,
  - Alternative mapping locations with transmission availability which still align with the other criteria.

Transmission capability estimates for use in the CPUC's IRP process

Transmission Constraint	Affected Zones	Condition under which Constraint is Binding	Estimated FCDS Capability Based on On-peak Study Resource Output (MW)**		ADNU & Cost Estimate ($mln)		Estimated EODS Capability Based on Off-peak Study Resource Output (MW)**		AOPNU & Cost Estimate ($mln)		Wind/Solar Area Designation
			Existing System***	Incremental due to ADNU	ADNU (Time to Construct)	Cost (Escalated to COD)	Existing System***	Incremental due to AOPNU	AOPNU (Time to Construct)	Cost (Escalated to COD)	
SCE Northern Study Area Constraints											
South of Magunden Constraint	Non-CREZ – Big Creek	On-peak	670	840	Magunden 500kV upgrade (105 months)	$1,197	1,024	N/A	N/A	N/A	Solar
Antelope – Vincent Constraint	Tehachapi, Non-CREZ – Big Creek	On-peak	4,040	2,700	Antelope - Vincent 500kV line rating increase (18 months)	$15	5,171	N/A	N/A	N/A	Solar
Windhub 500/230kV Transformer Constraint	Tehachapi	On-peak, Off-peak	1,685	2,395	New 500/230kV substation connecting to Windhub 230kV and Vincent 500 kV (108 months)	$1,126	1685	1385	New 500/230kV substation connecting to Windhub 230kV and Vincent 500 kV (108 months)	$1,126	Solar
SCE Metro Study Area Constraints											
Laguna Bell – Mesa Constraint	Non-CREZ – Ventura	On-peak	3,178	N/A	N/A	-	2,708	N/A	N/A	N/A	Solar
SCE Metro Area	Non-CREZ – SCE Metro	None	4,083	N/A	N/A	-	4,083	N/A	N/A	N/A	Solar
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
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
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
SCE Eastern Study Area Constraints											
Serrano – Alberhill – Valley 500kV Constraint	Riverside_Palm_Springs, Arizona, Imperial	On-peak	5,700	3,648	Devers - Mira Loma - Mesa 500kV line (105 months)	$1,480	11,800	N/A	N/A	N/A	Solar
Devers – Red Bluff 500 kV Constraint	Riverside_Palm_Springs, Arizona	On-peak, Off-peak	5,400	3,100	New Devers - Red Bluff 500kV No. 3 line (105 months)	$1,022	5,820	1,876	New Devers - Red Bluff 500kV No. 3 line (105 months)	$1,022	Solar
Colorado River 500/230kV Transformer Constraint	Riverside_Palm_Springs: Colorado River Substation 230kV	On-peak	1,490	1,000	New Colorado River 500/230kV No. 3 transformer (42 months)	$74	1,739	1,000	New Colorado River 500/230kV No. 3 transformer (42 months)	$74	Solar
SCE/GLW East of Pisgah (EOP) Study Area Constraints											
Eldorado 500/230kV Transformer #5 Constraint	Southern_Nevada, Eldorado/Mountain Pass (230kV)	On-peak	3,360	400	New Eldorado 500/230 transformer (42 months)	$70	3,360	N/A	N/A	N/A	Solar
GLW-VEA Area Constraint	Southern_Nevada	On-peak, Off-peak	1,300	N/A	N/A	-	1379	N/A	N/A	N/A	Solar
Mohave/Eldorado 500kV	Southern_Nevada	On-peak	1,560	N/A	N/A	-	1,560	N/A	N/A	N/A	Solar
SDG&E Study Area Constraints											
East of Miguel Constraint	Arizona, Imperial, Baja, Riverside	On-peak, Off-peak	731	1,412	New Imperial Valley - Serrano 500 kV line (120 months)	$3,680	950	943	New Imperial Valley - Serrano 500 kV line (120 months)	$3,680	Solar
Encina-San Luis Rey Constraint	Arizona, Imperial, Baja, Non-CREZ within San Diego	On-peak	1,000	3,718	New Encina - San Luis Rey 230 kV line (120 months)	$102	3,035	N/A	N/A	N/A	Solar
Imperial Valley transformer Constraint	Imperial	On-peak	1,959	400	Install a new Imperial Valley 500/230kV Bank at new substation (105 months)	$214	1,959	N/A	N/A	N/A	Solar
San Luis Rey-San Onofre Constraint	Arizona, Imperial, Non-CREZ within San Diego	On-peak	1,500	4,269	New San Luis Rey - San Onofre 230 kV line (120 months)	$237	3,281	N/A	N/A	N/A	Solar
San Diego Internal Constraint	Imperial, Non-CREZ within San Diego	On-peak, Off-peak	968	2,067	Internal San Diego Area reconductoring (18 months)	$89	290	274	Internal San Diego Area reconductoring (18 months)	$89	Solar
Silvergate-Bay Boulevard Constraint	Imperial, Baja, Non-CREZ within San Diego	On-peak	1,202	2,119	Silvergate - Bay Blvd 230kV 3-ohm Series Reactor (72 months)	$31	2,163	N/A	N/A	N/A	Wind
San Diego Oceanside Constraint	Non-CREZ within San Diego	On-peak	280	301	Oceanside ADNU (60 months)	$133	280	N/A	N/A	N/A	Solar
Orange County Area	Non-CREZ within San Diego	None	450	N/A	N/A	-	450	N/A	N/A	N/A	Solar
PG&E North of Greater Bay Study Area Constraints											
Rio Oso-SPI-Lincoln 115 kV Line	Rio Oso area within Sacramento River	On-peak	96	N/A	N/A	-	124	N/A	N/A	N/A	Wind
Woodland-Davis 115kV Line	Davis Area within Sacramento River	On-peak	64	36	OSS3-Davis (60 months)	$11	64	N/A	N/A	N/A	Wind
Cortina-Vaca-Dixon 230kV Line	Sacramento River & Round Mountain	On-peak	454	2,838	Delevan 500kV (144 months)	$3,531	795	N/A	N/A	N/A	Wind
Humboldt-Trinity 115kV Line	Humboldt	On-peak	21	57	Humboldt (98 months)	$158	63	N/A	N/A	N/A	Wind
Humboldt Offshore Wind Line (Proposed)	Humboldt	None	0	1,607	New Offshore Transmission Line (120	2,300	0	1607	New Offshore Transmission Line (120 months)	2300	Wind
PG&E Greater Bay Study Area Constraints											
Vierra-Tracy-Kasson 115kV Line	Kasson Area within Sacramento River	On-peak	149	125	Vierra-Tracy-Kasson 230kV (62 months)	$15	247	N/A	N/A	N/A	Wind
Melones-Tulloch 115 kV Line	Melones area within Sacramento River	On-peak	126	46	Melones-Tulloch 230kV (64 months)	$18	239	N/A	N/A	N/A	Wind
Contra Costa-Delta Switchyard 230kV Line	Solano & Round Mountain	On-peak	1,523	1,476	Bay Area (CC) (86 months)	$505	1,523	N/A	N/A	N/A	Wind
PG&E South 500kV Study Area Constraints											
Gates-Panoche #1 and #2 230kV Lines	Westlands and Carrizo	On-peak, Off-peak	10,830	378	Gates-Panoche #1 and #2 230kV lines (50	$259	10,830	N/A	Gates-Panoche #1 and #2 230kV lines (50	$259	Solar
PG&E East Kern Study Area Constraints											
Midway – Gates 230kV Line	Kern and Greater Carrizo	On-peak, Off-peak	1,431	3,137	Gates - Arco - Midway 230 kV - Redraw boundary (98 months)	$142	2,568	N/A	Gates - Arco - Midway 230 kV - Redraw boundary (98 months)	$142	Solar
Kern–Lamont-Stockdale 115kV Line	Carrizo	Off-Peak	100	N/A	N/A	N/A	125	30	Lamont-Stockdale 115kV (74 months)	$84	Solar
PG&E West Kern Study Area Constraints											
Morro Bay-Templeton 230kV Line	Westlands, Kern and Carrizo	On-peak, Off-peak	1,708	739	Morro Bay 230 kV (98 months)	$1,248	1,903	N/A	Morro Bay 230 kV (98 months)	$1,248	Solar
Morro Bay Offshore Wind	Westlands, Kern and Carrizo	None	0	3,100	New 500 kV Morro Bay substation (96 months)	110	0	3100	New 500kV Morro Bay substation (96 months)	110	Solar
PG&E Fresno Study Area Constraints											
Gates 500/230kV Bank #13 Constraint	Westlands, Carrizo and Kern	On-peak, Off-peak	3,151	4,453	Gates TB# 13 ADNU (48 months)	$40	3,279	964	Gates TB# 13 ADNU (48 months)	$40	Solar
Wilson-Storey-Borden #1 & #2 230 kV Lines	Within Westlands	On-peak	113	96	Wilson-Storey-Borden #1 and #2 230kV lines (50 months)	$232	816	N/A	N/A	N/A	Solar
Los Banos 500/230kV TB	Westlands	On-peak	1,573	N/A	N/A	N/A	2,534	N/A	N/A	N/A	Solar
Tesla-Westley 230kV Line	Los Banos and Central Valley	On-peak	1,098	114	Reconductor Tesla-Westley 230kV Line (50 months)	$90	1,098	N/A	N/A	N/A	Solar
Moss Landing 500kV	Unconstrained zone	On-peak	1,500	N/A	None	N/A	1,500	N/A	N/A	N/A	Solar
Warnerville-Wilson 230kV	Westlands	Off-Peak	272	N/A	N/A	N/A	737	364	Warnerville-Wilson 230kV (86 months)	$36	Solar
Moss Landing-Las Aguilas 230kV	Los Banos and Central Valley	Off-Peak	316	N/A	N/A	N/A	0	1,308	Moss Landing-Las Aguilas 230kV (98 months)	$48	Solar
Las Aguilas-Panoche #1 and #2 230kV	Los Banos and Central Valley	Off-Peak	334	N/A	N/A	N/A	516	939	Las Aguilas sw sta-Panoche #1 and #2 230kV (	$317	Solar
Moss Landing-Los Banos 230kV	Los Banos and Central Valley	Off-Peak	1,611	N/A	N/A	N/A	3,102	1,822	Moss Landing-Los Banos 230kV (98 months)	$68	Solar
Los Banos-Gates #1 500kV line	Westlands/Los Banos	Off-Peak	1,265	N/A	N/A	N/A	2,595	2,076	Los Banos-Gates #1 500kV line (98 months)	$640	Solar

Table of constraint information (above) and FCDS output factors (below) are inputs for mapping taken from the CAISO White Paper

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% if duration is ≥ 4-hour or ISC*(duration/4) if duration					
Hybrid	The lesser of 100% of combined ISC or (100% of 4-hour storage capacity plus study amount of paired resource)/ISC					

Criteria 3: Land-use and Environmental Screens

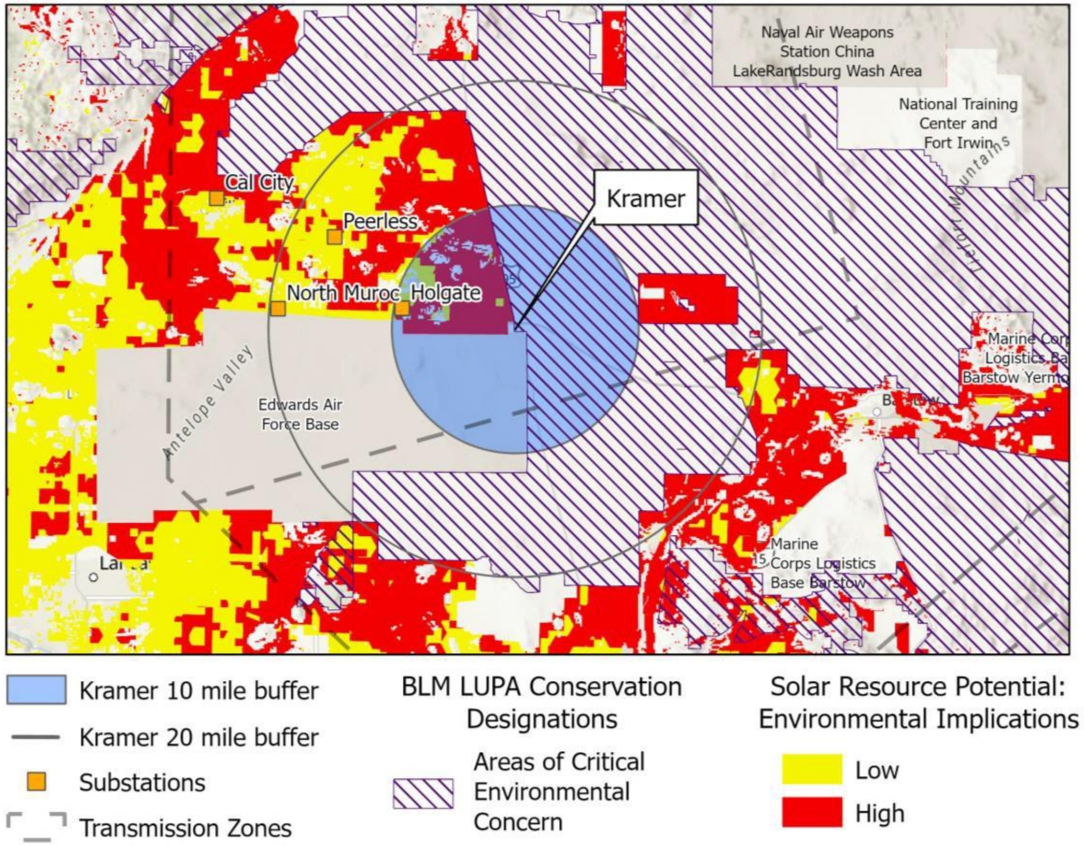
- Criteria 3 analysis, led by CEC staff, uses an array of land-use and environmental data sets, shown in table below
  - Utilizes geographic maps of resource potentials filtered to economical distances from existing and proposed substation.
  - Overlay environmental and land use information to identify potential implications.
- Criteria 3 screening is split into two analyses:
  - Criteria 3a: focuses on available land area and overall (high/low) potential environmental/land-use implications.
  - Criteria 3b: assesses the implications of individual environmental data sets.

Environmental and Land Use Data Sets Utilized in Busbar Mapping

- Terrestrial Landscape Intactness (California Energy Commission and Conservation Biology Institute, 2016)
- Areas of Conservation Emphasis, version 3.0 (ACE III) (California Department of Fish and Wildlife, 2018)
  - i. Terrestrial Connectivity
  - ii. Biodiversity
  - iii. Rarity
  - iv. Native species
  - v. Irreplaceability
- California Agricultural Value (California Energy Commission and Conservation Biology Institute, 2018)
- Natural Landscape Blocks
- Wildfire Threat
- Western Electricity Coordinating Council (WECC) Environmental Risk Dataset (utilized for resources mapped outside of California)

Criteria 3: Land-use and Environmental Screens

- Criteria 3a Implementation (example right)
  - Uses CEC staff developed screen – weighs multiple datasets to identify whether resource areas have higher or lower potential land-use/environmental implications.
  - CEC assesses available low and high areas within fixed radii of substations. Larger radii affects Criteria 1.
- Criteria 3b implementation (example below)
  - CEC staff overlay each of the environmental data sets individual
  - Assesses what percentage of resource potential area is in each data set's high impacts
- Analysis is tailored per resource type
  - With fixed resource locations, analysis is focused on resources potential areas



(Above) Criteria 3a analysis: Kramer substation with 10- and 20-mile radii

(Below) Criteria 3b analysis: Kramer – 10-mile radius

Intactness	Biodiversity	Connectivity	Rarity	Native Species	Important Bird Areas (IBA)	Important habitat	Wildfire threat	Irreplaceability
39%	85%	13%	92%	68%	27%	20%	0%	0%

Criteria 4: Commercial Development Interest

- Criteria 4 analysis utilizes summaries of potential resource development at individual substations.
- Relies predominately on CAISO's Public Interconnection Queue
- Also includes data from multiple other sources
  - Larger projects identified in the PGE, SCE, and SDGE WDT(WDAT) queues
  - Queues for other BAAs outside the CAISO – specifically the IID and NVEP for geothermal projects.
  - Known projects in planning/development currently not in queue (OOS Wind and LDES in particular)
- Prioritizing mapping at substations with projects further along in the interconnection process – rough approximation for higher confidence in potential development.

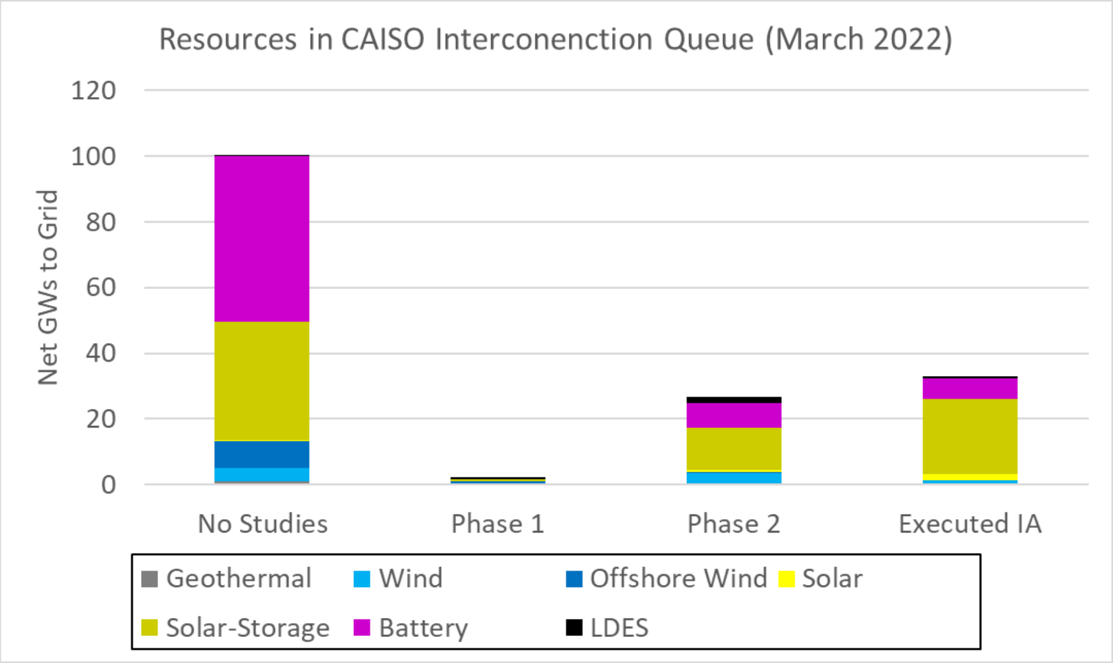


Chart summarizing resources in the CAISO interconnection queue by resource type and study status completed.

Busbar Mapping Results

- Summary table (right) of the completed busbar mapping for the 30 MMT high electrification sensitivity portfolio in 2035
- Full results can be found on the CPUC Website
  - Includes Dashboard workbook which:
    - Has all mapped resources by substation
    - Shows the detailed analysis for each criteria
- Key takeaways
  - Unprecedented number of resources mapped
    - ~87 GW in this sensitivity **vs** ~40 GW in base case **vs** ~28 GW in 21-22 TPP base case
  - Co-location of solar and battery storage
    - Stand-alone batteries: 6.4 GW, predominately in LA basin, San Diego, and Bay Area
    - Co-located: 22 GW batteries co-located at substations with 40.3 GW of solar (11.7 GW assigned FCDS, 28.6 GW assigned off-peak deliverability only)

RESOLVE Resource Name	Resource Type	FCDS	EODS	TOTAL
Solano_Geothermal	Geothermal	79		**79**
Inyokern_North_Kramer_Geothermal	Geothermal	48		**48**
Southern_Nevada_Geothermal	Geothermal	440		**440**
Northern_Nevada_Geothermal	Geothermal	327		**327**
Greater_Imperial_Geothermal	Geothermal	900		**900**
Greater_LA_Solar	Solar	75	2,128	**2,203**
Northern_California_Solar	Solar	344	1,512	**1,856**
Southern_PGAE_Solar	Solar	3,535	7,439	**10,974**
Tehachapi_Solar	Solar	3,031	4,952	**7,983**
Greater_Kramer_Solar	Solar	770	2,411	**3,181**
Southern_NV_Eldorado_Solar	Solar	1,320	4,196	**5,516**
Riverside_Solar	Solar	2,067	3,690	**5,757**
Arizona_Solar	Solar	800	1,831	**2,631**
Imperial_Solar	Solar	125	528	**653**
Northern_California_Wind	Wind	305	351	**656**
Solano_Wind	Wind	321	196	**517**
Kern_Greater_Carrizo_Wind	Wind	60	-	**60**
Carrizo_Wind	Wind	287	-	**287**
Central_Valley_North_Los_Banos_Wind	Wind	186	-	**186**
North_Victor_Wind	Wind	100	-	**100**
Tehachapi_Wind	Wind	281	-	**281**
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Riverside_Palm_Springs_Wind	Wind	116	-	**116**
Baja_California_Wind	Wind	600	-	**600**
Wyoming_Wind	OOS Wind	1,500	-	**1,500**
Idaho_Wind	OOS Wind	1,000	-	**1,000**
New_Mexico_Wind	OOS Wind	2,328	-	**2,328**
SW_Ext_Tx_Wind	OOS Wind	610	-	**610**
Humboldt_Bay_Offshore_Wind	Offshore Wind	1,487	120	**1,607**
Morro_Bay_Offshore_Wind	Offshore Wind	3,100	-	**3,100**
Renewable Resource Total		**26,842**	**29,353**	**56,196**
Greater_LA_Li_Battery	Li_Battery	5,139	-	**5,139**
Northern_California_Li_Battery	Li_Battery	2,198	-	**2,198**
Southern_PGAE_Li_Battery	Li_Battery	6,074	-	**6,074**
Tehachapi_Li_Battery	Li_Battery	3,884	-	**3,884**
Greater_Kramer_Li_Battery	Li_Battery	2,224	-	**2,224**
Southern_NV_Eldorado_Li_Battery	Li_Battery	2,711	-	**2,711**
Riverside_Li_Battery	Li_Battery	3,305	-	**3,305**
Arizona_Li_Battery	Li_Battery	1,229	-	**1,229**
Imperial_Li_Battery	Li_Battery	250	-	**250**
San_Diego_Li_Battery	Li_Battery	1,389	-	**1,389**
LI_Battery Total		**28,402**		**28,402**
SPGE_LDES	LDES	300	-	**300**
Tehachapi_LDES	LDES	500	-	**500**
Riverside_East_Pumped_Storage	LDES	700	-	**700**
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Total Storage+Resources		**57,244**	**29,353**	**86,598**

Table of mapped results summarized by resource area

Busbar Mapping Results

- Key takeaways (cont'd)
  - Transmission analysis points to need for significant number of transmission upgrades
    - Exceedances in ~28 of the white paper transmission constraints
    - In several constraints, transmission capability needs exceed even the capacity of the identified upgrade
  - Environmental/land use analysis show limitations to buildout
    - In several areas (e.g., Kramer, Colorado River), the number of resources mapped exceeded the low potential impacts land areas
    - Implies resources will need to be sited further out from the substation to avoid areas of higher potential environmental impacts
  - Able to map in close alignment with commercial interest
    - With Cluster 14, the CAISO queue has large amount of commercial interest
    - Magnitude of resources mapped resulted in significant mapping to locations with commercial interest, whose interconnection has not yet been studied.
    - Limited commercial interest for some long-lead time resources; reliant on areas outside the CAISO for particularly geothermal resources.

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Busbar Mapping Results – Supplemental

- Larger view of 2035 summary table of mapped resources by area.
- Full Mapping results on CPUC Website

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For more information:

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