

Busbar Mapping Results for the Proposed 24-25 TPP Portfolios

IRP Staff Webinar

December 8, 2023



California Public
Utilities Commission

Introduction

Scope

- Proposed 2023 PSP and 24-25 TPP Portfolios Ruling comments were received by Nov. 13, and reply comments were received by Dec 1.
 - IRP staff are still in process of reviewing, analysing, and incorporating stakeholder feedback.
- Webinar focuses on more detailed walkthrough and discussion of mapping results, noting that the mapping process is still ongoing and further updates are likely.
- The objectives of this webinar are to:
 - Provide a more detailed summary of busbar mapping results for the proposed base case portfolio and a discussion of the busbar mapping analysis.
 - CEC staff presentation detailing environmental and land-use analysis implemented in busbar mapping.
 - Overview of identified mapping issues and remapping goals.
 - Overview of gas retirement not retained mapping criteria and initial mapping results.
 - Familiarize stakeholder with busbar mapping results and analysis in preparation for release of full mapping results and material.

Logistics

- Webinar slides, updated busbar mapping dashboard, and supporting material will be available on the IRP webpage: [Assumptions for the 2024-2025 TPP](#).

Questions: We invite clarifying questions using the "Q&A" feature of this Webex.

- We also invite verbal questions at specific 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"
- This webinar is an informational webinar and staff will not be taking written comments following this webinar.

Agenda

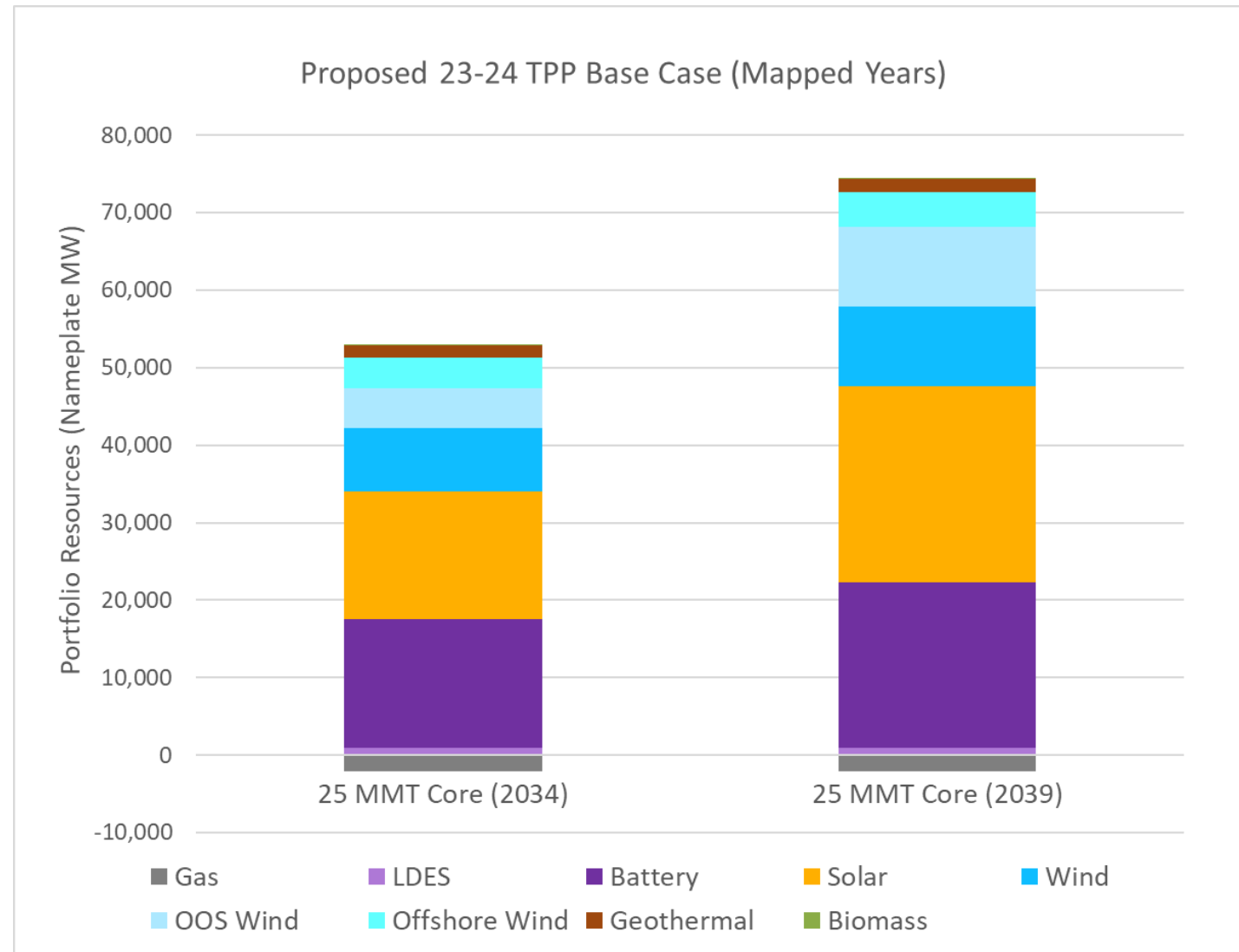
Topic	Presenter
Introduction	Nathan Barcic
Base case and sensitivity portfolios overview	Jared Ferguson
Base case mapping results	Jared Ferguson
CEC: Land-use and environmental analysis in busbar mapping	Saffia Hossainzadeh
Questions Break	-
Mapping Criteria Alignment, potential adjustments	Jared Ferguson
Gas capacity not retained mapping criteria	Nathan Barcic Jared Ferguson
Questions & Wrap Up	-

Proposed Portfolios Summary

Proposed 2024-2025 TPP Base Case Portfolio

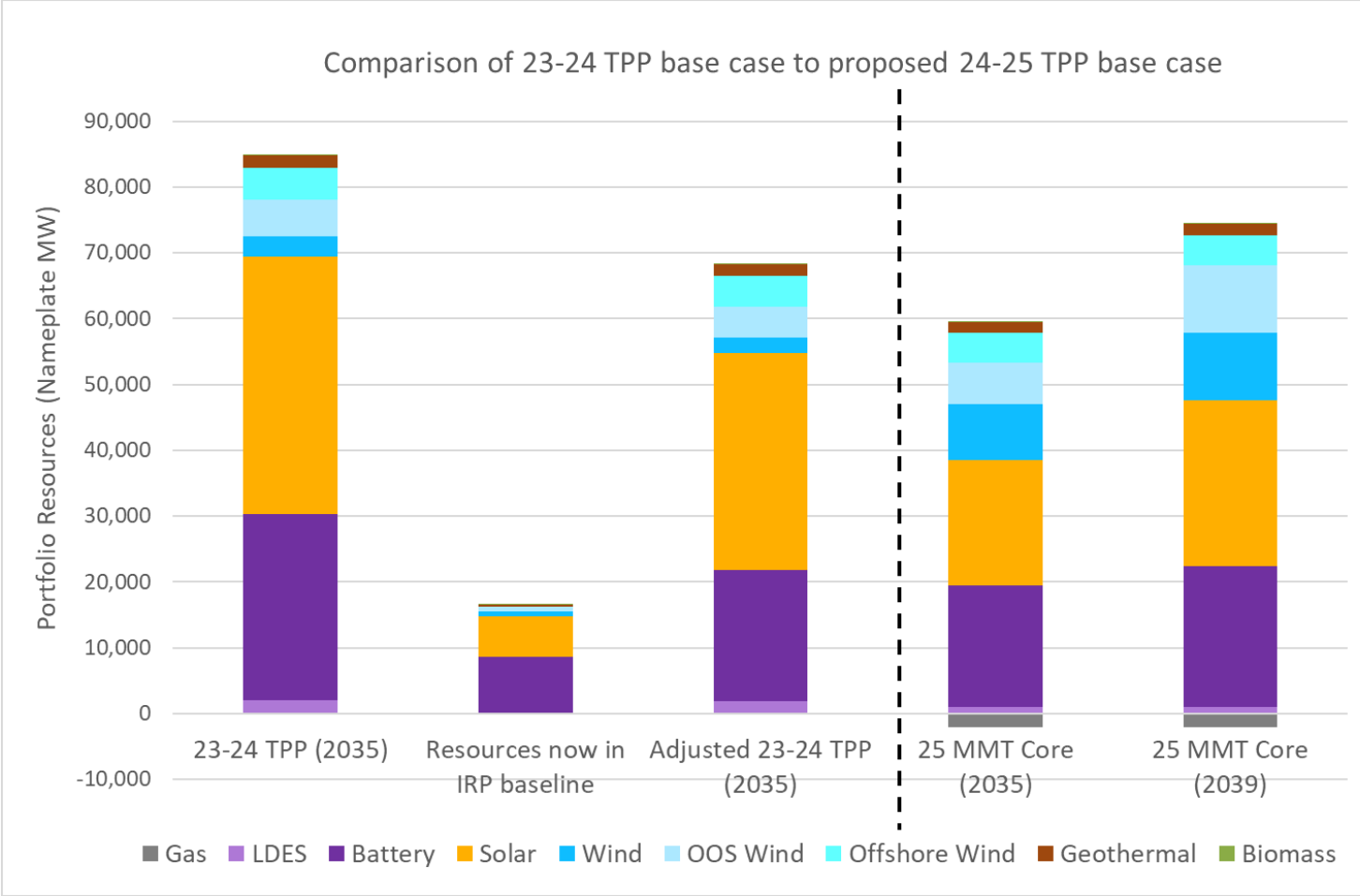
- The Proposed PSP Portfolio – the 25 MMT by 2035 Core Portfolio – is also the proposed 24-25 TPP Base Case.
- Will be transmitting model years 2034 (10-year projection) and 2039 (15-year projection) to the CAISO.

RESOLVE Resource Type	2034 – Selected MWs	2039 – Selected MWs
LDES	935	985
Li_Battery	16,671	21,364
Solar	16,395	25,200
Wind	8,129	10,362
OOS Wind	5,268	10,204
Offshore Wind	3,855	4,531
Geothermal	1,613	1,731
Biomass	171	171
Total New Res:	53,037	74,548
<i>Gas</i>	<i>(2,128)</i>	<i>(2,128)</i>



Baseline differences with previous 23-24 TPP

- Previous 23-24 TPP base case used older resource baseline to align with previous Transmission White Paper.
- Staff identified ~16.6 GW of resources mapped in the 23-24 TPP that are now included in the RESOLVE baseline.
 - Accounting for these resources reduces nameplate difference to ~9 GW in 2035.
- Remaining difference can be attributed:
 1. Different resource mix selected by RESOLVE (More wind selected, which has higher capacity value and thus leads to less nameplate MWs)
 2. Updated ELCC surfaces, particularly changes to solar-storage curve (Less solar and storage needed)
 3. Reduced load projections in 2022 IEPR scenario compared to 2021 IEPR ATE scenario used for the 23-24 TPP portfolios.



Proposed 2024-2025 TPP Base Case Portfolio: RESOLVE output portfolio

- Summary of RESOLVE portfolio solar and lithium battery storage resources for the 2034 and 2039 model years.
- Adjusted total resources for the 23-24 TPP base case in 2035 were:
 - Solar -> 32.9 GW
 - Li_Battery -> 19.8 GW

	2034			2039		
	Solar	4hr_Li_Battery	8hr_Li_Battery	Solar	4hr_Li_Battery	8hr_Li_Battery
Arizona	3,243.3	972.4	189.9	3,243.3	972.4	189.9
Greater_Imperial	39.0	-	-	39.0	-	-
Greater_Kramer	1,012.3	445.3	164.9	4,065.8	445.3	164.9
Greater_LA	-	3,471.0	587.2	-	4,020.4	587.2
Northern_California	126.0	875.4	-	126.0	875.4	2,697.0
Riverside	659.0	707.8	-	659.0	707.8	-
Southern_NV_Eldorado	4,665.3	1,145.5	439.4	4,665.3	1,145.5	439.4
Southern_PGAE	1,586.3	5,637.7	331.5	1,586.3	5,837.3	815.3
Tehachapi	5,063.7	1,702.9	-	10,796.1	1,702.9	762.8
Total:	16,395.0	14,958.0	1,713.0	25,180.9	15,707.0	5,656.5

Proposed 2024-2025 TPP Base Case Portfolio: RESOLVE output portfolio

- Summary of RESOLVE portfolio wind resources in the 2034 and 2039 model years.
- Adjusted total resources for the 23-24 TPP base case in 2035 were:
 - On-Shore, in-CAISO wind -> 2.2 GW
 - OOS, new-Tx, Wind -> 4.8 GW
 - Offshore Wind -> 4.7 GW

	2034 (MWs)	2039 (MWs)
Baja_California_Wind	1,572.8	2,472.8
Central_Valley_North_Los_Banos_Wind	32.0	32.0
Greater_Imperial_Wind	133.2	133.2
Greater_Kramer_Wind		
Humboldt_Wind		
Kern_Greater_Carrizo_Wind		
Northern_California_Wind	849.0	849.0
Riverside_Palm_Springs_Wind		
Solano_Wind	375.0	375.0
Southern_NV_Eldorado_Wind	5,011.2	5,011.2
Tehachapi_Wind	156.0	1,488.8
Onshore, in-state total:	8,129.2	10,362.0
Idaho_Wind	300.0	300.0
New_Mexico_Wind	1,968.0	1,968.0
Utah_Wind	-	-
Wyoming_Wind	3,000.0	7,936.1
OOS total:	5,268.0	10,204.1
Cape_Mendocino_Offshore_Wind	-	-
Del_Norte_Offshore_Wind	-	-
Diablo_Canyon_Offshore_Wind	-	-
Humboldt_Bay_Offshore_Wind	-	-
Morro_Bay_Offshore_Wind	3,855.0	4,531.0

Proposed 2024-2025 TPP Base Case Portfolio: RESOLVE output portfolio

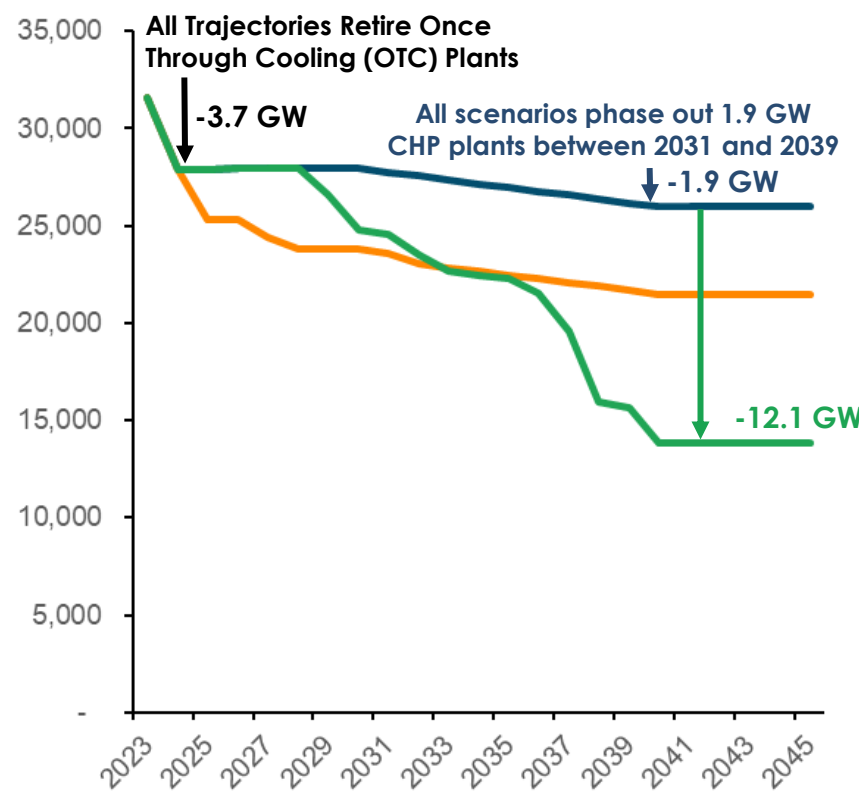
- Summary of RESOLVE portfolio geothermal, biomass, and LDES resources in the 2034 and 2039 model years.
- Adjusted total resources for the 23-24 TPP base case in 2035 were:
 - Geothermal -> 1.74 GW
 - Biomass -> 127 MW
 - LDES -> 2 GW

	2034 (MWs)	2039 (MWs)
In State Biomass	171.0	171.0
Central_Nevada_Geothermal	40.0	40.0
Greater_Imperial_Geothermal	1,238.6	1,356.1
Inyokern_North_Kramer_Geothermal	7.1	7.1
Northern_California_Geothermal	314.3	314.3
Northern_Nevada_Geothermal	-	-
Pacific_Northwest_Geothermal	13.0	13.0
Utah_Geothermal	-	-
Geothermal Total	1,613.0	1,730.5
Northern_California_Pumped_Storage	-	-
Riverside_East_Pumped_Storage	298.6	298.6
Riverside_West_Pumped_Storage	-	-
San_Diego_Pumped_Storage	-	-
Tehachapi_Pumped_Storage	178.4	178.4
Southern_PGAE_Adiabatic_CAES	-	-
Tehachapi_Adiabatic_CAES	200.0	200.0
Arizona_Flow_Battery	-	-
Greater_Imperial_Flow_Battery	29.4	29.4
Greater_Kramer_Flow_Battery	-	-
Greater_LA_Flow_Battery	50.0	50.0
Northern_California_Flow_Battery	70.6	70.6
Riverside_Flow_Battery	-	-
Southern_NV_Eldorado_Flow_Battery	-	-
Southern_PGAE_Flow_Battery	108.0	158.0
Tehachapi_Flow_Battery	-	-
LDES Total:	935.0	985.0

Proposed Gas Retirement Rate for Sensitivity Portfolio

CAISO Gas Capacity

(Installed Capacity MW)



Base

No gas forced to retire after OTC retirements, except for CHP phase out in the 2030s

High Gas Retirement

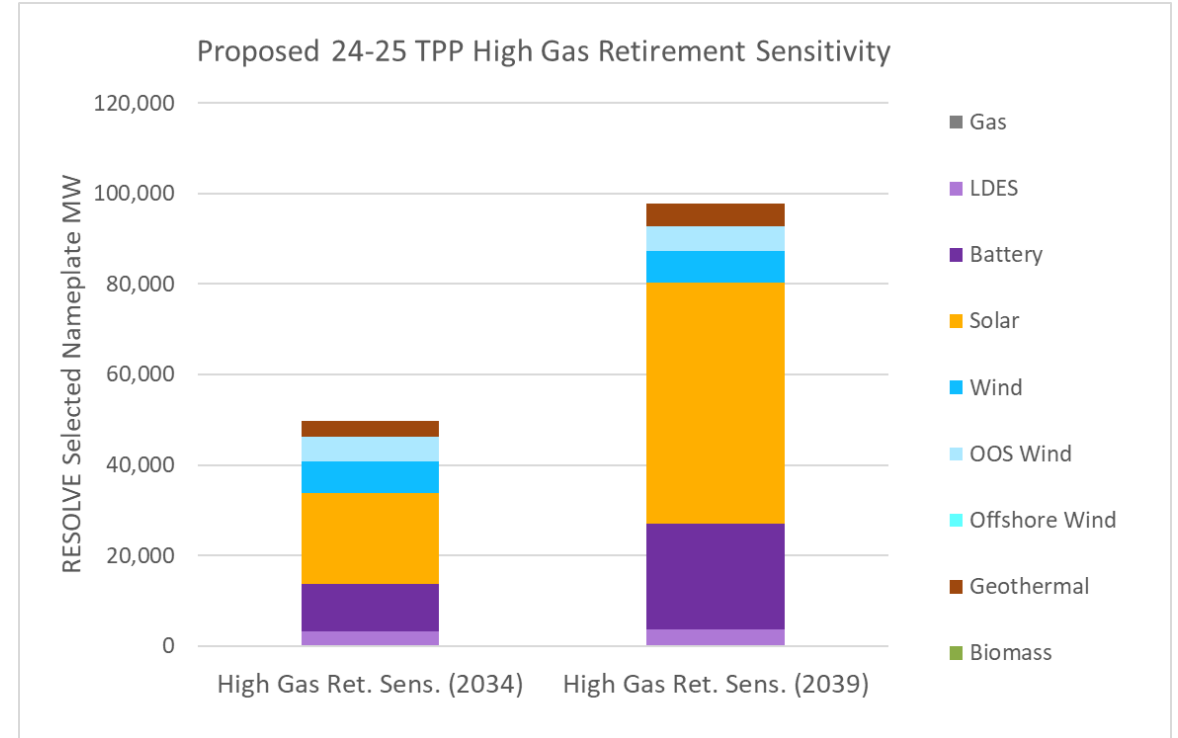
Delays retirements in near-term but ramps to meet LSEs un-contracted CC and CT gas capacity by 2035; continues to reduce gas capacity through 2040 using a 35-year age-based criteria

Proposed 24-25 TPP Sensitivity – High Gas Retirement Portfolio

- Total gas not retained forced into RESOLVE in the 2034 and 2039 model year.

Res Type	GWs retired (2034)	GWs retired (2039)
OTC	(3.7)	(3.7)
CHP	(0.76)	(1.73)
Additional Gas	(4.67)	(10.5)

- Sensitivity Portfolio does not include LSE planned resources as the base case did.
 - Instead, RESOLVE can fully optimize for least-cost.
- Portfolio and RESOLVE do not identify specific units or locations and only reflects system-wide impacts.



RESOLVE Resource Type	2034 – Selected MWs	2039 – Selected MWs
LDES	3,300	3,700
Li_Battery	10,500	23,400
Solar	20,000	53,300
Wind	7,000	7,000
OOS Wind	5,400	5,400
Offshore Wind	-	-
Geothermal	3,500	5,000
Biomass	-	-
Total New Res:	53,037	74,548

Proposed Sensitivity Portfolio: RESOLVE output portfolio

- Summary of RESOLVE portfolio solar and lithium battery storage resources for the 2039 model year compared with base case.

	Gas Retirement Sens. (2039)			Base Case (2039)		
	Solar	4hr_Li_Battery	8hr_Li_Battery	Solar	4hr_Li_Battery	8hr_Li_Battery
Arizona	11,242.6	500.8	1,348.2	3,243.3	972.4	189.9
Greater_Imperial	5,099.3	-	769.1	39.0	-	-
Greater_Kramer	4,438.0	231.5	665.3	4,065.8	445.3	164.9
Greater_LA	375.0	1,001.6	8,178.4	-	4,020.4	587.2
Northern_California	-	-	1,314.2	126.0	875.4	2,697.0
Riverside	8,688.0	-	-	659.0	707.8	-
Southern_NV_Eldorado	8,254.0	2,237.9	441.4	4,665.3	1,145.5	439.4
Southern_PGAE	4,773.6	861.9	3,307.9	1,586.3	5,837.3	815.3
Tehachapi	10,443.0	235.7	2,230.0	10,796.1	1,702.9	762.8
Total (MWs):	53,313.6	5,069.4	18,254.6	25,180.9	15,707.0	5,656.5

Proposed Sensitivity Portfolio: RESOLVE output portfolio

- Summary of RESOLVE portfolio wind resources for the 2039 model year compared with base case.

	Sens.	Base
	2039 (MWs)	2039 (MWs)
Baja_California_Wind	114.3	2,472.8
Central_Valley_North_Los_Banos_Wind	-	32.0
Greater_Imperial_Wind	133.2	133.2
Greater_Kramer_Wind	-	
Humboldt_Wind	-	
Kern_Greater_Carrizo_Wind	-	
Northern_California_Wind	-	849.0
Riverside_Palm_Springs_Wind	-	
Solano_Wind	-	375.0
Southern_NV_Eldorado_Wind	5,011.2	5,011.2
Tehachapi_Wind	1,731.7	1,488.8
Onshore, in-state total:	6,990.4	10,362.0
Idaho_Wind	-	300.0
New_Mexico_Wind	2,382.2	1,968.0
Utah_Wind	-	-
Wyoming_Wind	3,000.0	7,936.1
OOS total:	5,382.2	10,204.1
Cape_Mendocino_Offshore_Wind	-	-
Del_Norte_Offshore_Wind	-	-
Diablo_Canyon_Offshore_Wind	-	-
Humboldt_Bay_Offshore_Wind	-	-
Morro_Bay_Offshore_Wind	-	4,531.0

Proposed Sensitivity Portfolio: RESOLVE output portfolio

- Summary of RESOLVE portfolio geothermal, biomass resources for the 2039 model year compared with base case.

	Sens. 2039 (MWs)	Base 2039 (MWs)
InState Biomass	171.0	171.0
Central_Nevada_Geothermal	584.0	40.0
Greater_Imperial_Geothermal	2,467.7	1,356.1
Inyokern_North_Kramer_Geothermal	7.1	7.1
Northern_California_Geothermal	848.3	314.3
Northern_Nevada_Geothermal	637.0	-
Pacific_Northwest_Geothermal	436.5	13.0
Utah_Geothermal	-	-
Geothermal Total	4,980.6	1,730.5
Northern_California_Pumped_Storage	-	-
Riverside_East_Pumped_Storage	1,300.0	298.6
Riverside_West_Pumped_Storage	500.0	-
San_Diego_Pumped_Storage	500.0	-
Tehachapi_Pumped_Storage	480.0	178.4
Southern_PGAE_Adiabatic_CAES	400.0	-
Tehachapi_Adiabatic_CAES	500.0	200.0
Arizona_Flow_Battery	-	-
Greater_Imperial_Flow_Battery	-	29.4
Greater_Kramer_Flow_Battery	-	-
Greater_LA_Flow_Battery	-	50.0
Northern_California_Flow_Battery	-	70.6
Riverside_Flow_Battery	-	-
Southern_NV_Eldorado_Flow_Battery	-	-
Southern_PGAE_Flow_Battery	-	158.0
Tehachapi_Flow_Battery	-	-
LDES Total:	3,680.0	985.0

Mapping Overview

Key terms and concepts

- **In-development vs generic resources:** Resources in the portfolio are summarized and shown in the dashboard as either in-development or generic resources.
 - In-development resources are resource that working group staff have very high confidence that they will be developed and come online.
 - Includes recently online or contracted resources not in the modeling baseline as well as resources that the PTOs or CAISO have identified as the interconnection is under-construction/proceeding
 - Generic resources are the remaining resources in the portfolio.
- **In-state vs OOS wind:** The two classes of onshore wind in IRP modeling
 - In-state wind represents wind not just in-state but also areas in the existing CAISO transmission system
 - OOS wind represents wind not just out-of-state but is also modeled as requiring major new transmission beyond the current footprint of the CAISO. Generally, have distinctly higher capacity factor assumptions than in-state wind. In current IRP modeling and busbar mapping OOS wind is NM, WY, ID, and UT wind).
- **Mapping of out-of-CAISO resources**
 - Out-of-CAISO resources are mapped to the existing CAISO boundary intertie that staff view as the most probable/feasible interconnection point.
 - Mapping to the intertie point is necessary capture the in-CAISO transmission needs of the resources and to model the resources as MIC expanding.
 - Staff where possible also attempt to note the out-of-CAISO locations and interconnection substation.

Updates incorporated into mapping analysis

Recent mapping updates do not include a significant remapping of resources.

- Implementation of that is pending complete review of Ruling comments and replies.

This mapping analysis does incorporate several changes/fixes to the mapping analysis.

- Completion of additional mapping analysis and incorporation of data into dashboard.
 - Distance to transmission analysis.
 - In-state geothermal land-use and environmental analysis.
 - Commercial interests in other BAA interconnection queues and Cluster 15 application queue.
- Reviewing and updating transmission constraint and substation information.
 - Incorporating additional upgrades that were approved previous TPPs.
 - Updating capability limits and upgrade capacity estimates for several transmission constraints.
 - Updating which constraints certain substations belong to.
 - Inclusion of several proposed substations as identified by interconnection queues.
- Correcting issues in the mapping data calculations and dashboard.
 - Fixing wind resource land-use and environmental analysis to use same base resource potential.
 - Fixing Excel formula errors and mislabeled substations/constraints.

Proposed Base Case: Initial Mapping Summary

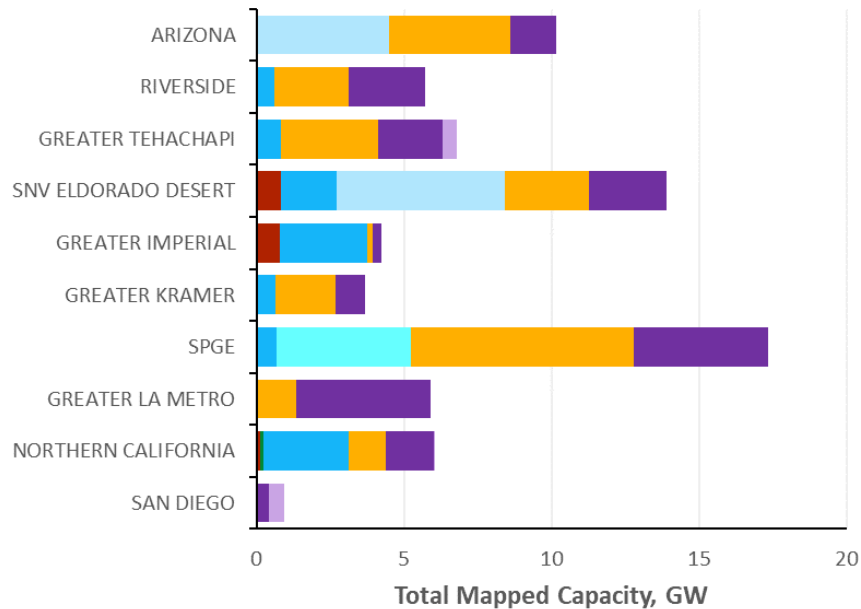
- Summary of initial mapping results that were released following the Oct. 20th workshop, again summarized by CAISO interconnection study area.

2034 Mapping Summary									
CAISO Interconnection Area	Geothermal (MW)	Biomass (MW)	Onshore Wind (MW)	OOS Wind (MW)	Offshore Wind (MW)	Solar (MW)	Li_Battery (MW)	LDES (MW)	Total (MW)
PG&E North of Greater Bay	107.0	98.1	971	-	-	331	332	5	1,844
PG&E Greater Bay	-	29.2	875	-	-	138	1,090	0	2,133
PG&E Fresno	-	16.0	265	-	-	2,692	1,849	0	4,822
PG&E Kern	-	17.0	285	-	3,855	1,660	919	0	6,735
SCE Northern Area	-	1.0	614	-	-	3,084	3,409	481	7,589
SCE Metro	-	5.6	-	-	-	27	1,962	0	1,994
SCE North of Lugo	-	1.5	650	-	-	1,585	806	0	3,043
East of Pisgah	716.0	-	1,810	3,268	-	2,440	1,864	0	10,098
SCE Eastern	740.0	2.6	599	2,000	-	3,059	2,950	0	9,350
SDG&E	50.0	-	2,060	-	-	1,383	1,490	449	5,432
Total:	1,613.0	171.0	8,129	5,268	3,855	16,398	16,671	935	53,040

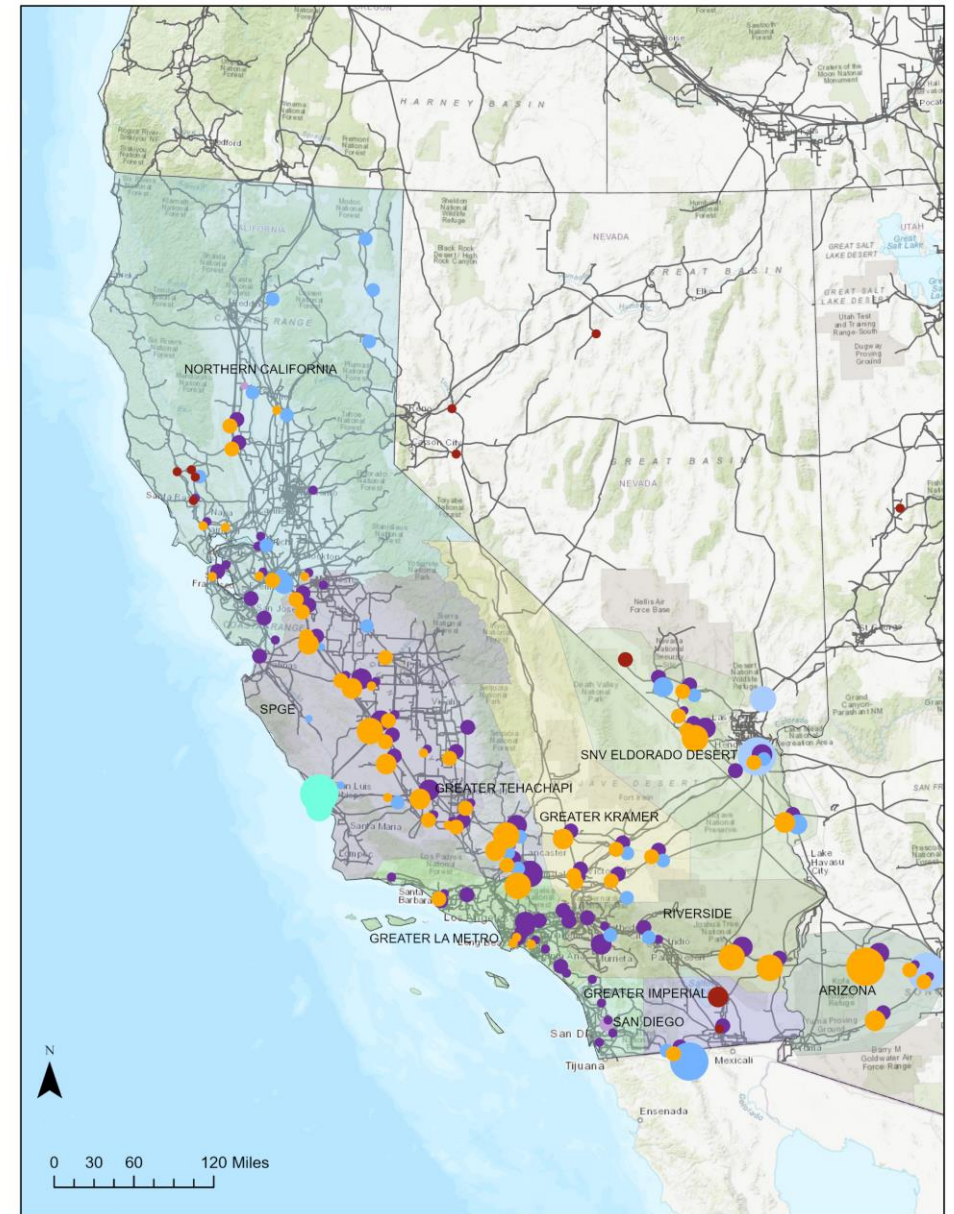
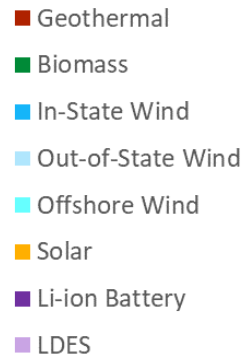
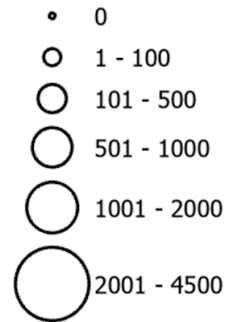
2039 Mapping Summary									
CAISO Interconnection Area	Geothermal (MW)	Biomass (MW)	Onshore Wind (MW)	OOS Wind (MW)	Offshore Wind (MW)	Solar (MW)	Li_Battery (MW)	LDES (MW)	Total (MW)
PG&E North of Greater Bay	124.0	98.1	2,104	-	-	731	502	5	3,564
PG&E Greater Bay	-	29.2	875	-	-	538	1,440	0	2,883
PG&E Fresno	-	16.0	265	-	-	4,816	2,830	0	7,927
PG&E Kern	-	17.0	285	-	4,531	2,760	1,369	0	8,961
SCE Northern Area	-	1.0	814	-	-	4,634	3,974	481	9,904
SCE Metro	-	5.6	-	-	-	34	2,292	0	2,331
SCE North of Lugo	-	1.5	650	-	-	2,037	1,011	0	3,700
East of Pisgah	816.0	-	1,910	5,704	-	2,840	2,614	0	13,884
SCE Eastern	740.0	2.6	599	4,500	-	5,409	3,750	0	15,000
SDG&E	50.0	-	2,860	-	-	1,383	1,582	449	6,324
Total:	1,730.0	171.0	10,362	10,204	4,531	25,181	21,364	935	74,478

Proposed Base Case Initial Mapping Summary

- Summary of initial mapping by RESOLVE resource region (below) and mapped locations.
- OOS wind resources (Wyoming, New Mexico, and Idaho Wind) are shown at there point of CAISO interconnection.

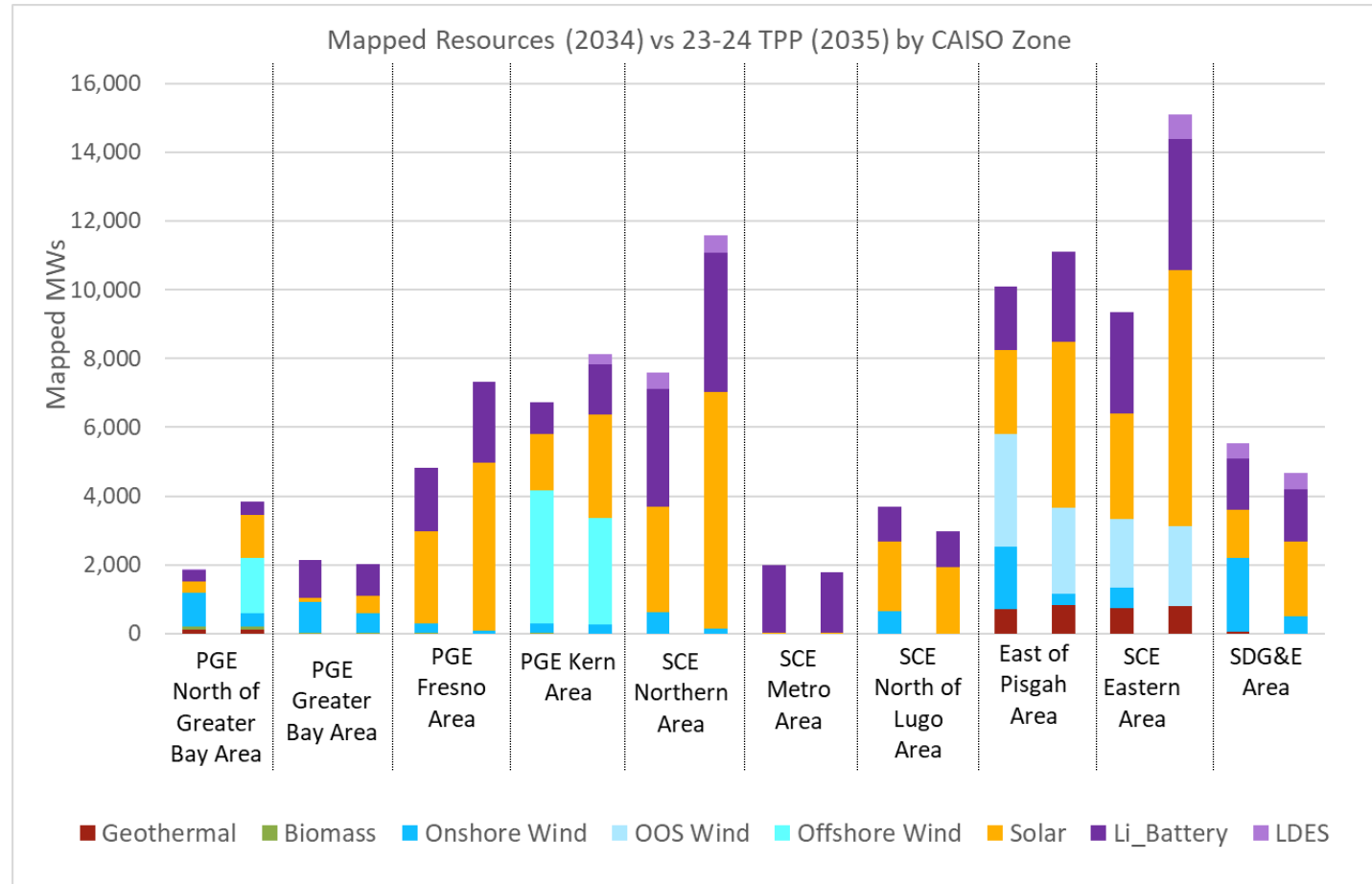


Scale (MW)



Remapping Focus: Consistency with previous TPP

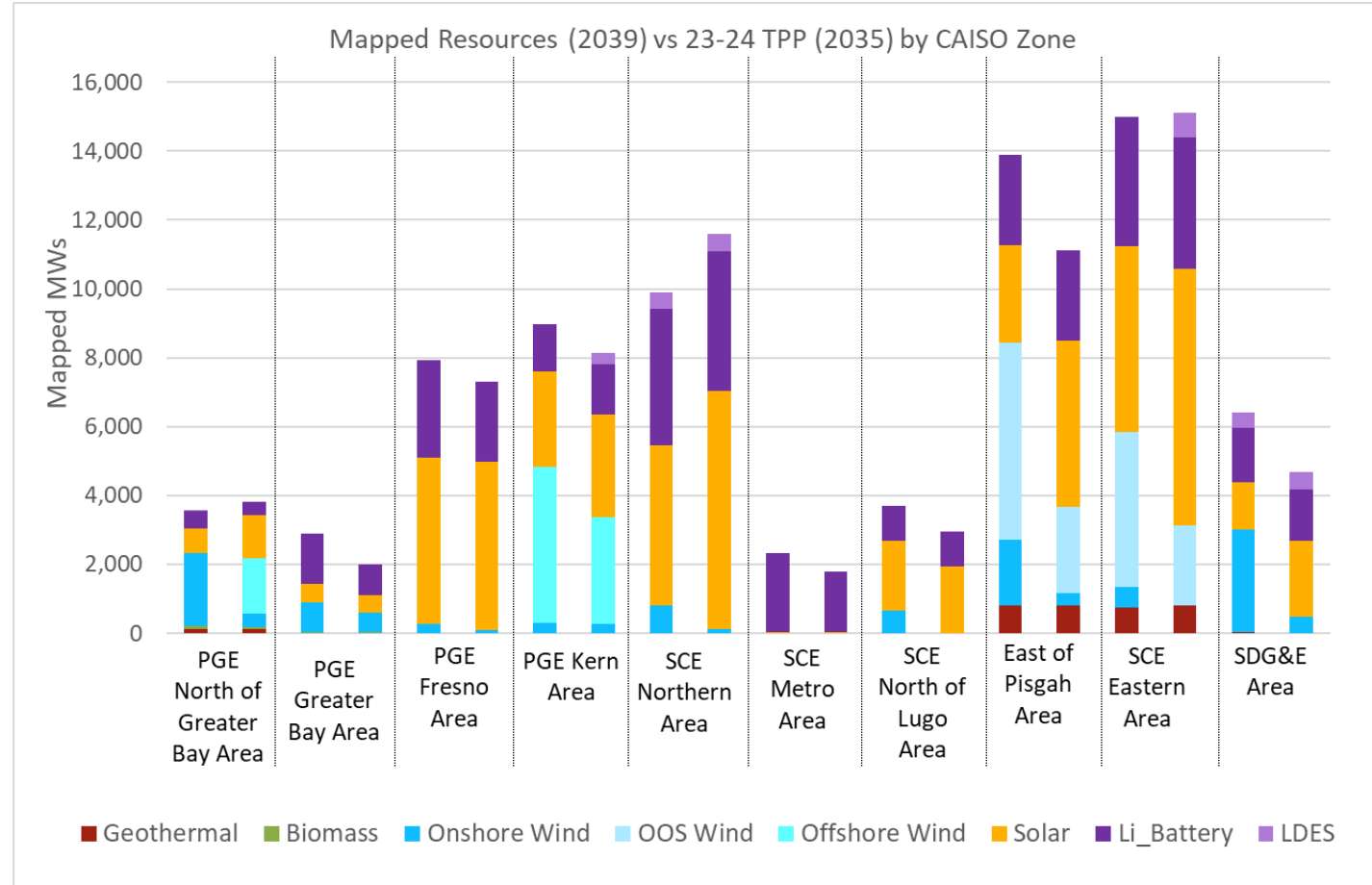
- Consistency with previous comparable TPP portfolios is one of the busbar mapping criteria.
 - Large changes in resource locations can have significant transmission implications.
 - When large changes occur, these changes should be clear and explicitly justified.
- Changes from exogenous factors, such as demand or resource cost shifts on the modeling side or new conservation requirements on mapping side are often necessary factors in the annual process.
- Changes arising from modeling or mapping analysis margins of error are often accounted for in the remapping efforts.



Left Column for each area is the Proposed 24-25 TPP (2034) amounts; Right Column is the 23-24 TPP (2035) amounts.

Remapping Focus: Consistency with previous TPP

- Even after the baseline reconciliation, the portfolio is still smaller overall than the 23-24 TPP base case.
 - Has a different resource technology composition with more onshore wind and less solar.
- By 2039, most CAISO interconnection zones have comparable amount of total MWs mapped, but often different resource mixes.
 - SCE eastern area still has ~2 GW less solar but 2 GW more OOS wind.
 - East of Pisgah area also has ~ 2GW less solar and 3 GW more wind.
 - PG&E North of the GBA has no offshore wind but ~1.7 GW more on-shore wind.
- Often results in similar but not always the same transmission needs.



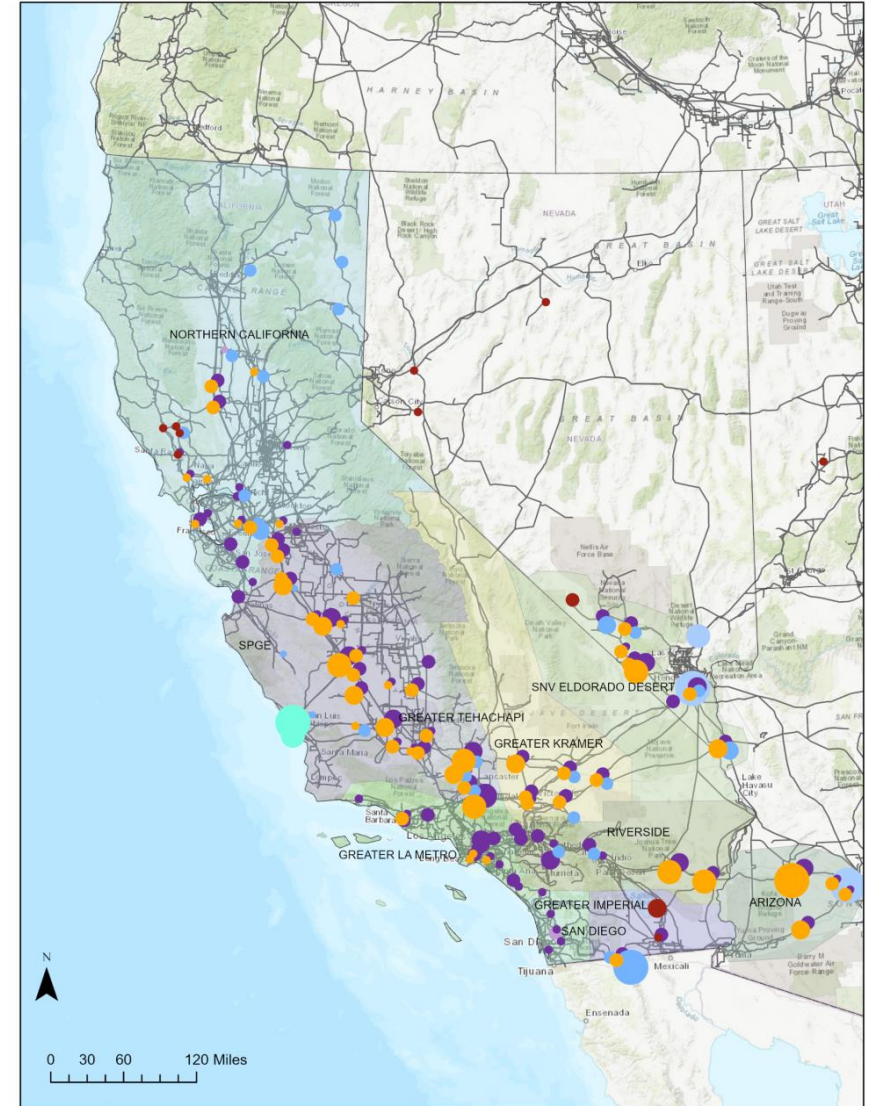
Left Column for each area is the Proposed 24-25 TPP (2039) amounts; Right Column is the 23-24 TPP (2035) amounts.

Remapping Focus: In-state wind resources

- Portfolio has, by 2039, roughly 3x more than previously mapped.
 - Analyzing mapping to areas not previously mapped to that have addition transmission considerations (e.g., Lassen and Modoc county areas east of the Sierras).
 - Reviewing feedback that IRP assumptions overestimate wind potentials in certain areas that RESOLVE selects.

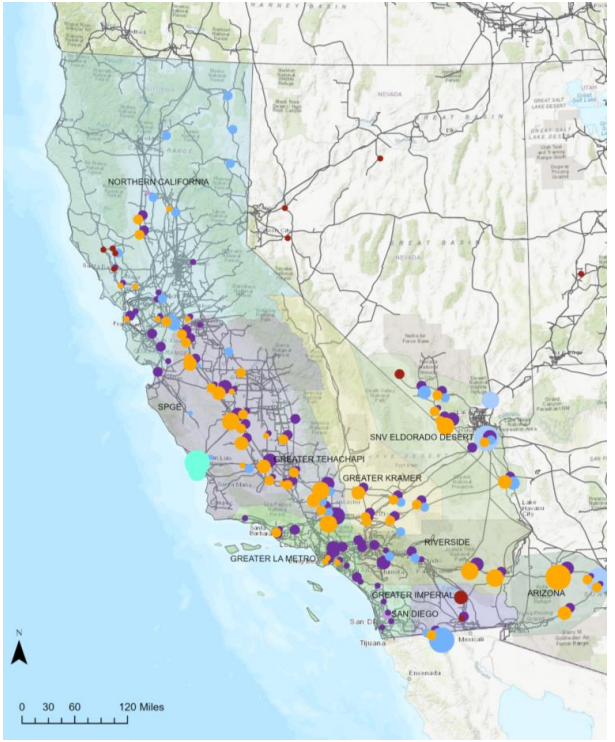
	23-24 TPP (2035)	23-24 TPP online/in baseline	Net 23-24 TPP	Proposed Base (2034)	Proposed Base (2039)
In-state Wind (MWs)	3,074	885	2,189	8,129	10,362

- Misalignment between identified commercial interest and identified resource potential.
 - Some areas with commercial interest have little to no base resource potential.
 - Staff note that wind potential data sources do have resolution limitations.
 - Staff are considering conducting analysis with lower capacity factor threshold (current cutoff is 28%). Staff are not relaxing environmental and land-use thresholds.



Remapping Focus: Out-of-CAISO resources

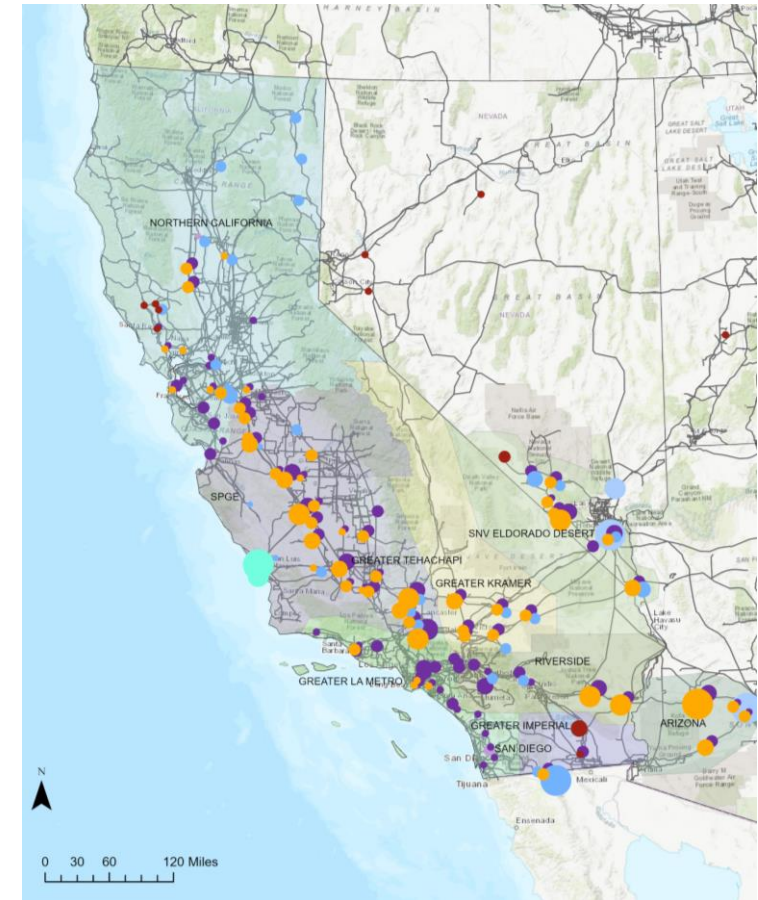
- Geothermal:** Identifying intertie points for out-of-CAISO Nevada and Utah geothermal.
 - Closest in proximity interties have very limited import capacity.
 - Summit & Silver Peak on the Nevada border would require major upgrades while Gonder and Mona on the IPP system are not within CAISO's operational control.
 - Southern NV has more transmission capacity but requires either wheeling or further transmission expansion.
- OOS Wind:** Amount of OOS wind in 2039 comparable to amount studied in CAISO's first 20-year outlook.
 - Key issues are mapping location based on "lumpiness" of new transmission and, for 2039, the modeled interconnection location.
 - Currently have all OOS wind interconnecting to Southern CA interties.
 - Could consider mapping some OOS wind as interconnecting to Northern CA through new Tx line, as noted in CAISO's first 20-year outlook.
- In-state Wind:** Cost-effective delivery of wind mapped in 2039 to Northern California in NVEP Tx area to the CAISO system vs. alternative mapping solutions.
 - Requires analysis of cost of long gen-ties or new transmission and potential co-utilization of new OOS Tx into Northern CA for OOS wind.



	RESOLVE Portfolio		Mapped Results	
	2034 (MWs)	2039 (MWs)	2034 (MWs)	2039 (MWs)
Central_Nevada_Geothermal (in CAISO)	40	40	450	500
Greater_Imperial_Geothermal	1,239	1,356	790	790
Inyokern_North_Kramer_Geothermal	7	7	-	-
Northern_California_Geothermal (in CAISO)	314	314	107	124
Northern_Nevada_Geothermal	-	-	240	240
Pacific_Northwest_Geothermal	13	13	-	-
Utah_Geothermal	-	-	26	76
Idaho_Wind	300	300	1,000	1,204
New_Mexico_Wind	1,968	1,968	2,000	4,500
Wyoming_Wind	3,000	7,936	2,268	4,500

Remapping Focus: Transmission constraint exceedances

- Working group has been engaging with CAISO to better implement the new White Paper constraints.
 - Have made several constraint and upgrade capacity adjustments.
 - Ongoing work to better represent the constraint complexities in the PG&E territory.
- Mapping results in 16 constraint exceedances in 2034 and 27 exceedances in 2039.
 - Fewer than reported in October because of several of the updates.
- Several exceedances would trigger expensive upgrades for only a small number of mapped resources.
 - Assessing whether resources can readily be re-mapped or alternative upgrade is a potential solution.
 - Some exceedances are caused by in-development resources, working with CAISO staff to assess implications.
- Mapping results in some large exceedances of even the upgrade capacity amount.

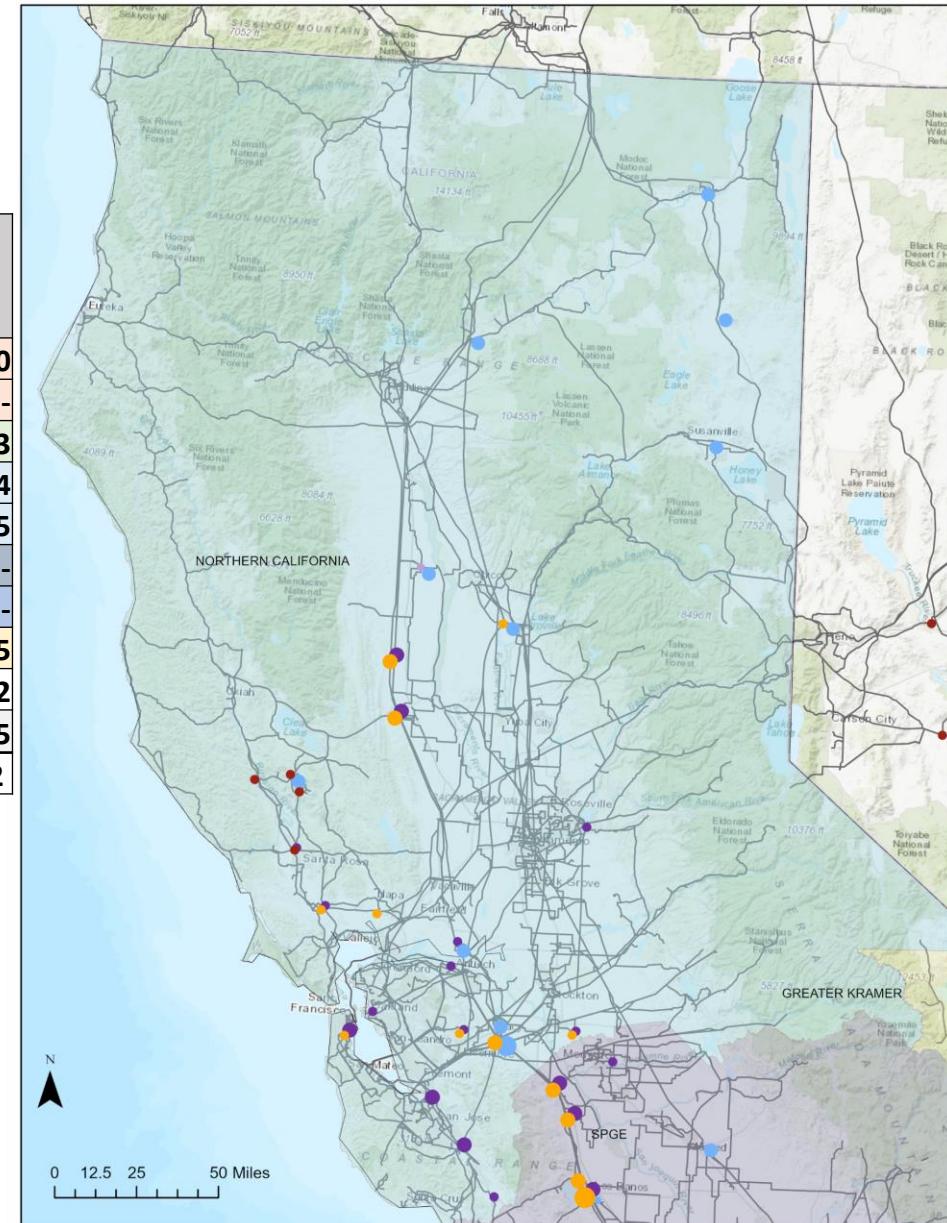


Base Case Mapping Summary by Region

Northern California Area – Summary

	RESOLVE Selected (2034)	RESOLVE Selected (2039)	In-Developm ent	Generic (2034)	Total by Res Type (2034)	Generic Addition (2039)	Total by Res Type (2039)
Northern California							
Northern CA Geothermal (MW)	314.3	314.3	32.0	75.0	107.0	17.0	124.0
Pacific NW Geothermal (MW)	13.0	13.0	-	-	-	-	-
InState Biomass (MW)	N/A	N/A	11.0	116.3	127.3	-	127.3
Northern CA Wind (MW)	849	849	-	761	761	1,133	1,894
Solano Wind (MW)	375	375	-	985	985	-	985
OOS Wind (MW)	-	-	-	-	-	-	-
North Coast Offshore Wind (MW)	-	-	-	-	-	-	-
Northern CA Solar (MW)	126	126	140	255	395	800	1,195
Northern CA Li Battery (MW)	875	3,572	264	1,158	1,422	520	1,942
Northern CA LDES (MW)	71	71	-	5	5	-	5
Total by Status (MW)	2,623	5,320	446	3,356	3,802	2,470	6,272

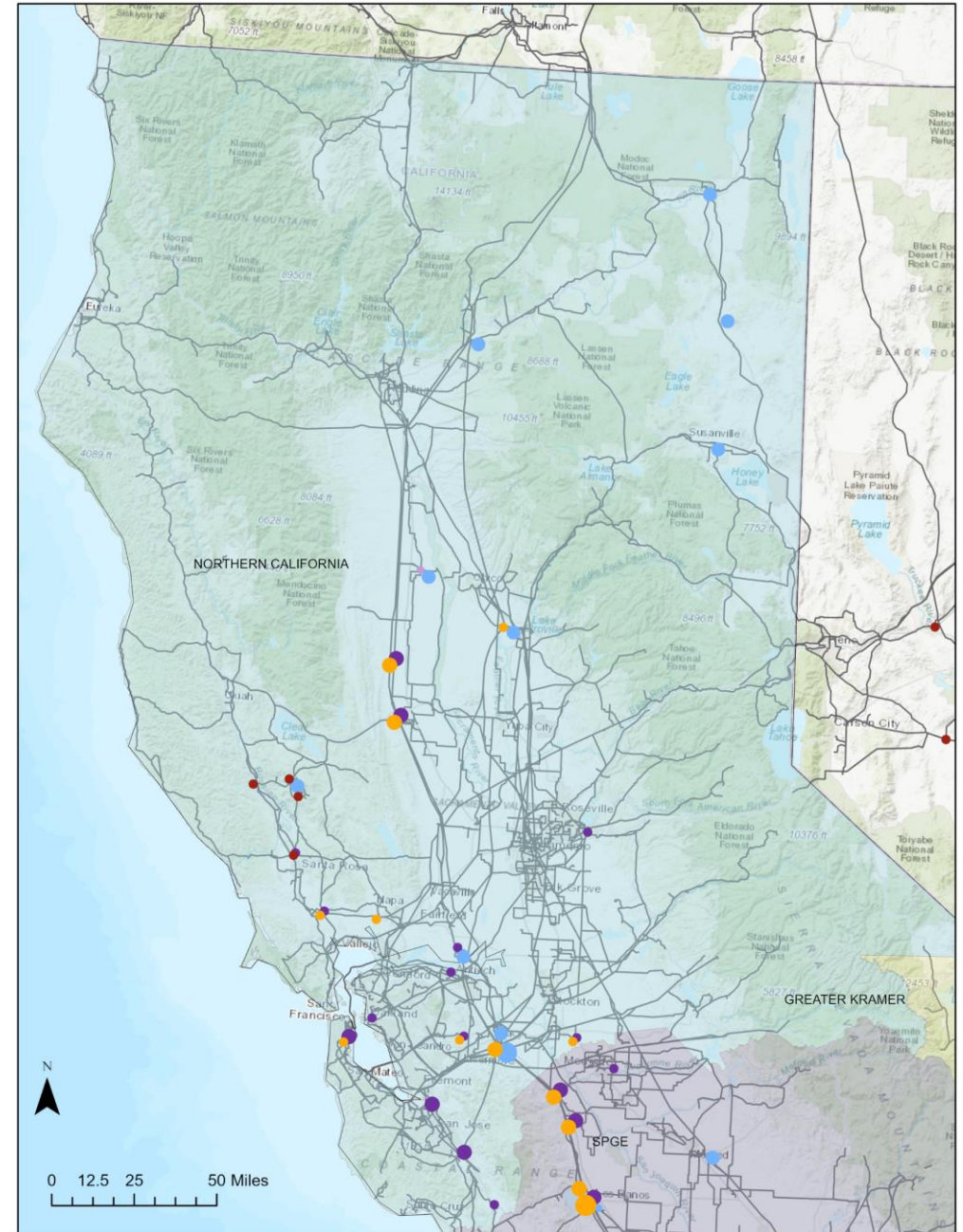
- Northern California area corresponds mostly to the following CAISO interconnection zones:
 - PG&E North of Greater Bay
 - PG&E Greater Bay



Northern California Area – Summary

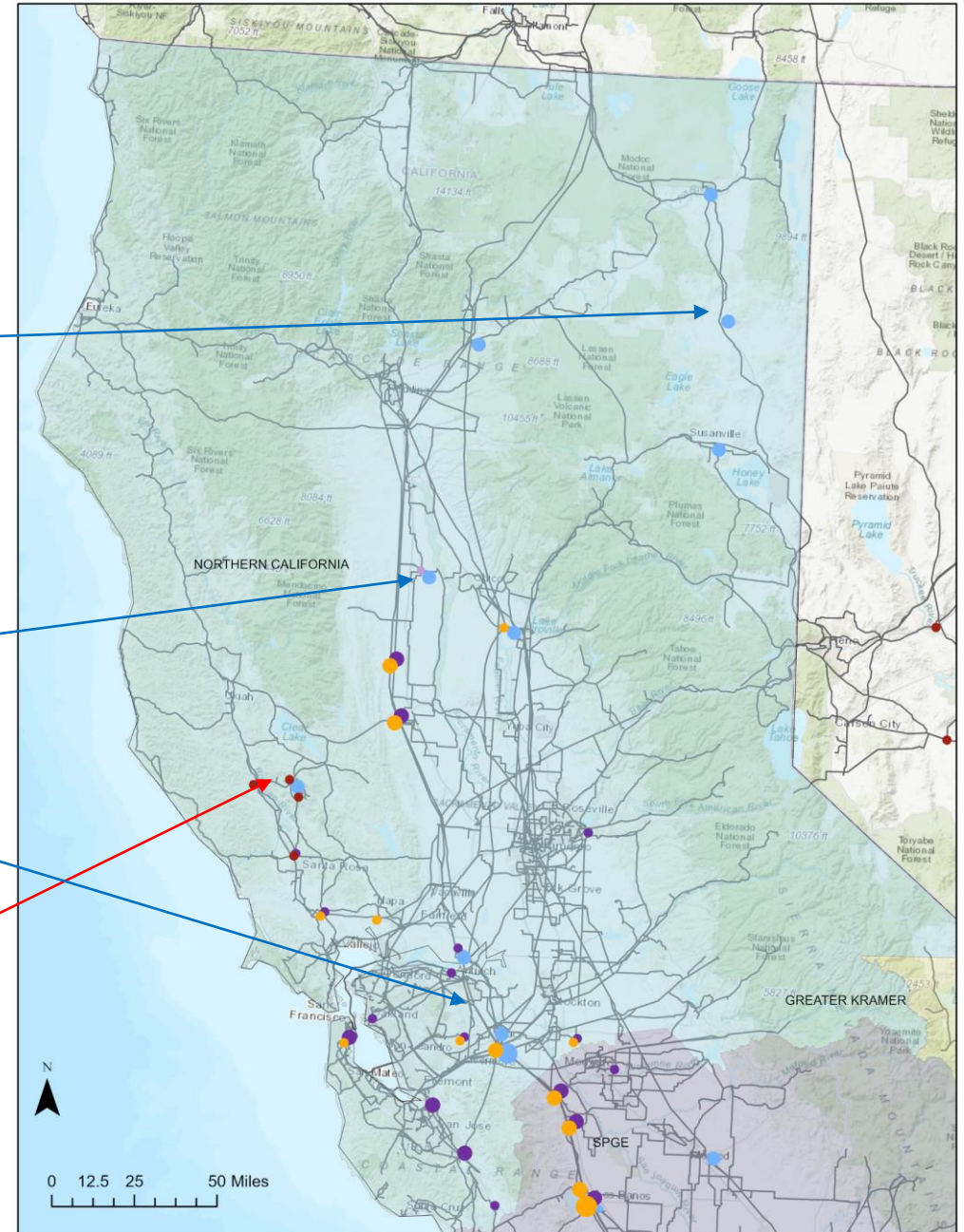
PG&E North of Greater Bay	In-Development	Generic (2034)	Total by Res Type (2034)	Generic Addition (2039)	Total by Res Type (2039)
Geothermal (MW)	32.0	75.0	107.0	17.0	124.0
Biomass (MW)	6.0	92.1	98.1	-	98.1
Onshore Wind (MW)	-	971.0	971.0	1,133.0	2,104.0
OOS Wind (MW)	-	-	-	-	-
Offshore Wind (MW)	-	-	-	-	-
Solar (MW)	52.2	279.0	331.2	400.0	731.2
Li_Battery (MW)	93.5	238.4	331.9	170.0	501.9
LDES (MW)	-	5.0	5.0	-	5.0
Total by Status (MW)	184	1,661	1,844	1,720	3,564

PG&E Greater Bay	In-Development	Generic (2034)	Total by Res Type (2034)	Generic Addition (2039)	Total by Res Type (2039)
Geothermal (MW)	-	-	-	-	-
Biomass (MW)	5.0	24.2	29.2	-	29.2
Onshore Wind (MW)	-	875.0	875.0	-	875.0
OOS Wind (MW)	-	-	-	-	-
Offshore Wind (MW)	-	-	-	-	-
Solar (MW)	114.4	23.9	138.3	400.0	538.3
Li_Battery (MW)	170.4	920.0	1,090.4	350.0	1,440.4
LDES (MW)	-	-	-	-	-
Total by Status (MW)	289.8	1,843.1	2,133	750.0	2,882.9



Northern California Area – Resources Mapped

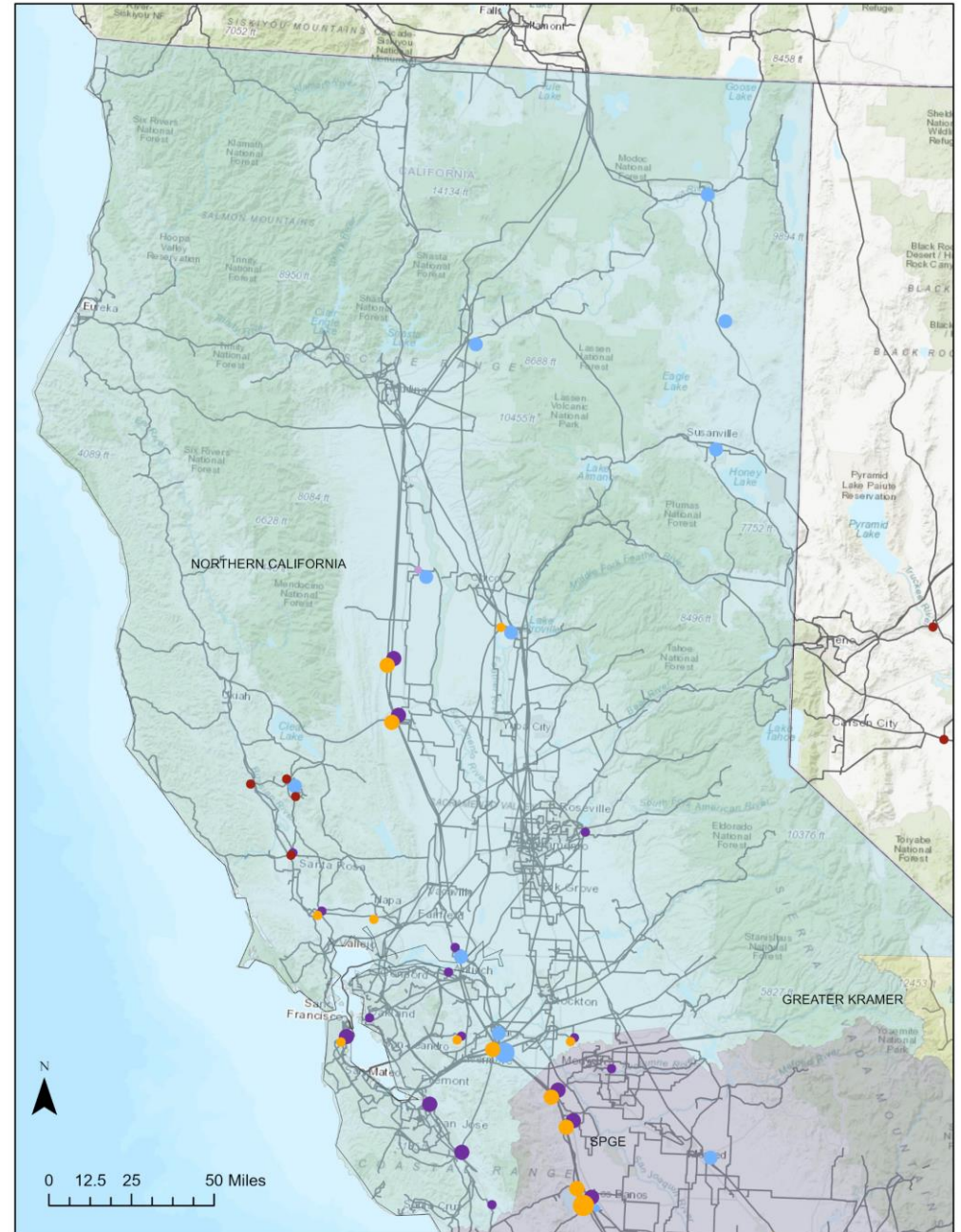
- The ~2.9 GW of in-state wind is mapped to several different areas.
 - ~1,000 MW are mapped to areas in Lassen in Modoc counties.
 - Region beyond the CAISO system and would require long interconnections or new transmission expansions.
 - Align with commercial interest in NVEP queue.
 - ~880 MW to substations in and around the Solano and Altamont area.
 - ~890 to substations in and around the Sacramento Valley.
- The 124 MW of geothermal resources are mapped in the Geysers geothermal area but are modeled as interconnecting to several different substations inline with identified commercial interest.



Northern California Area – Resources Mapped

- 630 MW of utility Scale solar is mapped to two substations in the Sacramento Valley (Cortina and Delevan) and 500 MW is mapped to two substations in the Altamont area (Cayetano and Telsa).
 - Smaller amounts and some distrusted-scale solar resources are mapped to several substations in the greater Bay area.
- Most batteries mapped to region are mapped as stand-alone in the Bay area.

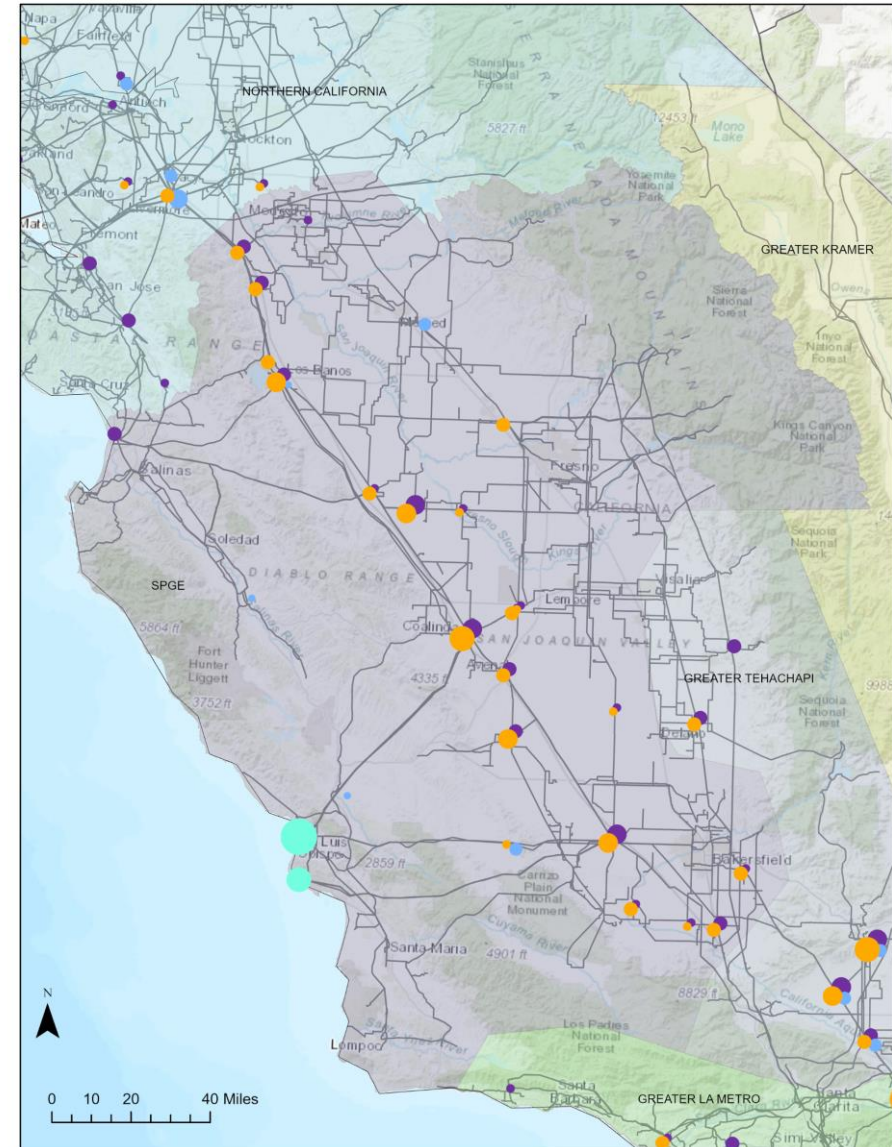
Li Batteries	In-Dev	Generic (2039)	Total (2039)	In DAC	Near Gas Plant
Stand-alone	150	1,358	1,508	764	1,078
Co-located	113	320	433	-	170



Southern PG&E Area – Summary

	RESOLVE Selected (2034)	RESOLVE Selected (2039)	In-Developm ent	Generic (2034)	Total by Res Type (2034)	Generic Addition (2039)	Total by Res Type (2039)
Southern PG&E							
InState Biomass (MW)	N/A	N/A	3.0	30.0	33.0	-	33.0
Central Valley & Los Banos Wind (MW)	32	32	-	365	365	-	365
Kern/Greater Carrizo Wind (MW)	-	-	-	285	285	-	285
Morro Bay Offshore Wind (MW)	3,855	4,531	-	3,855	3,855	676	4,531
Southern PG&E Solar (MW)	1,586	1,586	2,044	2,021	4,065	3,224	7,289
Southern PG&E Li Battery (MW)	5,969	6,653	1,641	1,127	2,768	1,431	4,199
Southern PG&E LDES (MW)	108	158	-	-	-	-	-
Total by Status (MW)	11,551	12,960	3,688	7,683	11,371	5,331	16,702

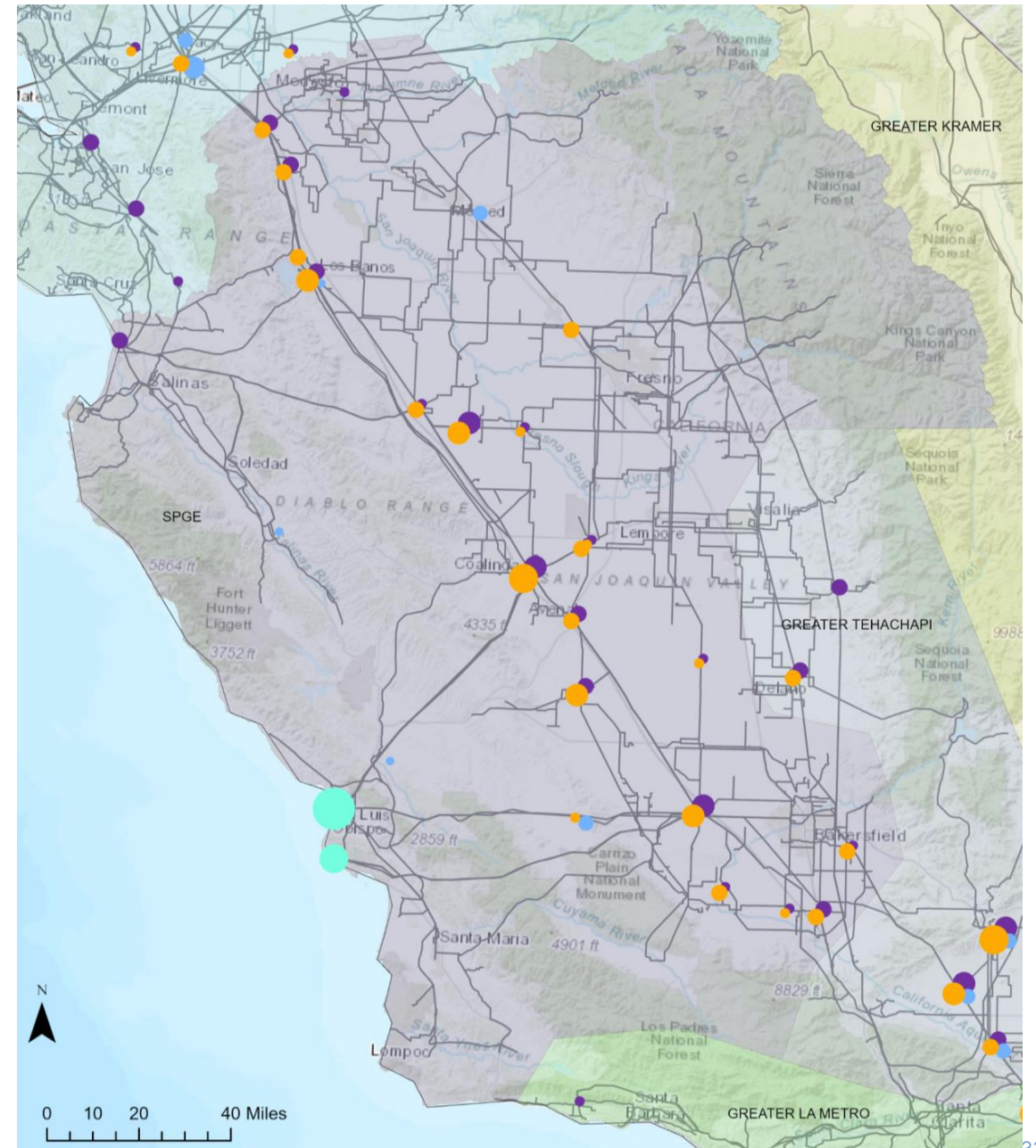
- Southern PG&E area corresponds mostly to the following CAISO interconnection zones:
 - PG&E Fresno
 - PG&E Kern



Southern PG&E Area— Summary

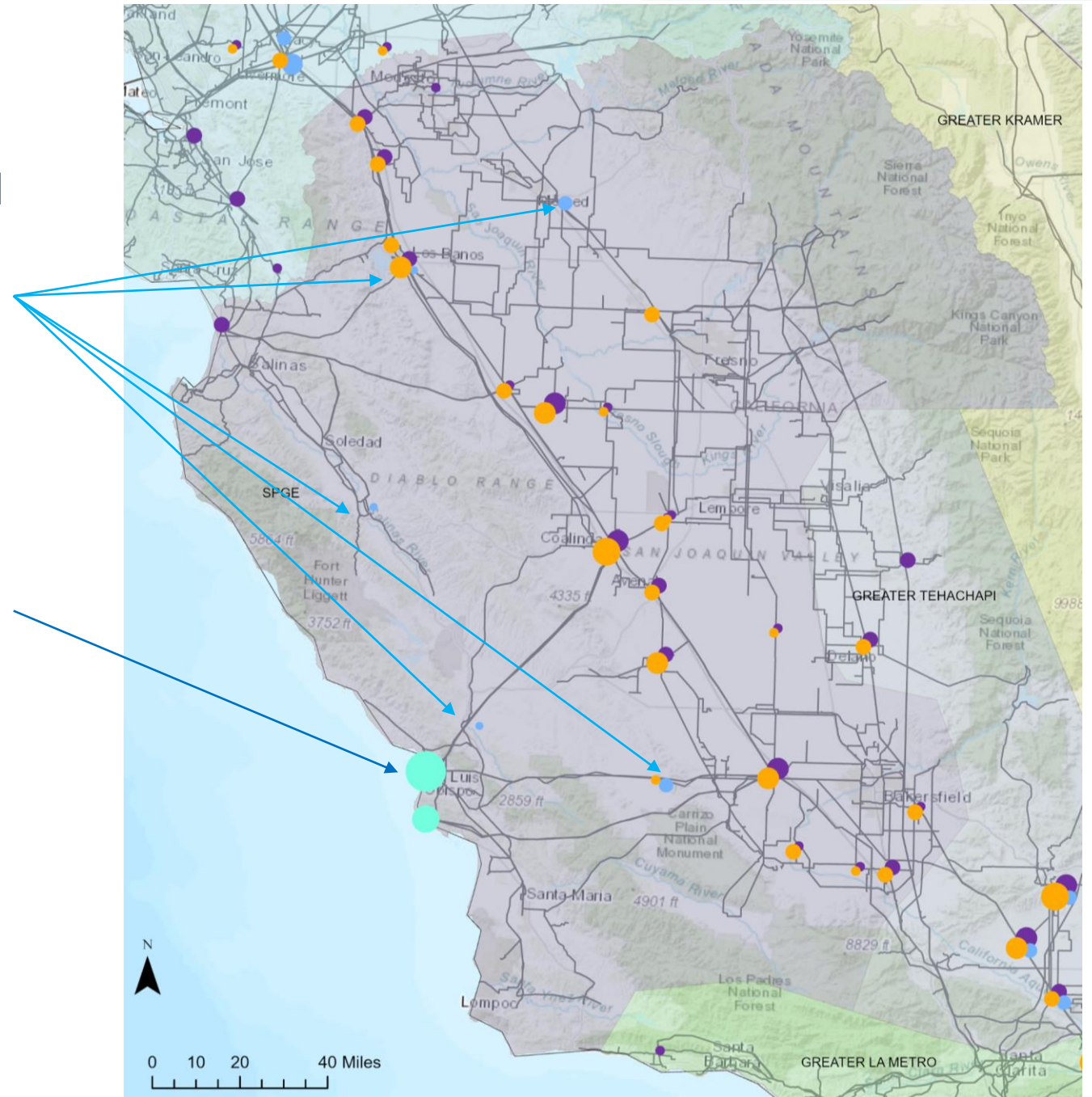
	In-Develop ment	Generic (2034)	Total by Res Type (2034)	Generic Addition (2039)	Total by Res Type (2039)
PG&E Fresno					
Geothermal (MW)	-	-	-	-	-
Biomass (MW)	3.0	13.0	16.0	-	16.0
Onshore Wind (MW)	-	265.0	265.0	-	265.0
OOS Wind (MW)	-	-	-	-	-
Offshore Wind (MW)	-	-	-	-	-
Solar (MW)	1,597.6	1,094.0	2,691.6	2,124.0	4,815.6
Li_Battery (MW)	1,454.6	394.6	1,849.2	981.1	2,830.3
LDES (MW)	-	-	-	-	-
Total by Status (MW)	3,055.2	1,766.6	4,822	3,105.1	7,926.9

	In-Develop ment	Generic (2034)	Total by Res Type (2034)	Generic Addition (2039)	Total by Res Type (2039)
PG&E Kern					
Geothermal (MW)	-	-	-	-	-
Biomass (MW)	-	17.0	17.0	-	17.0
Onshore Wind (MW)	-	285.0	285.0	-	285.0
OOS Wind (MW)	-	-	-	-	-
Offshore Wind (MW)	-	3,855.0	3,855.0	676.0	4,531.0
Solar (MW)	503.6	1,156.0	1,659.6	1,100.0	2,759.6
Li_Battery (MW)	186.4	732.4	918.8	450.0	1,368.8
LDES (MW)	-	-	-	-	-
Total by Status (MW)	690.0	6,045.4	6,735	2,226.0	8,961.4



Southern PG&E Area— Resources Mapped

- The 650 MW of in-state on-shore wind is mapped to five different substations: Caliente, Los Baños, Templeton, Wilson and Coburn. *(note Coburn is included in PG&E Bay interconnection area)
- The 4.5 GW of Morro Bay offshore wind is mapped with portions interconnecting to a proposed new 500 kV Morro Bay substation and the Diablo Canyon 500 kV substation.
- Solar and storage is mostly mapped along the western side of the San Joaquin Valley.



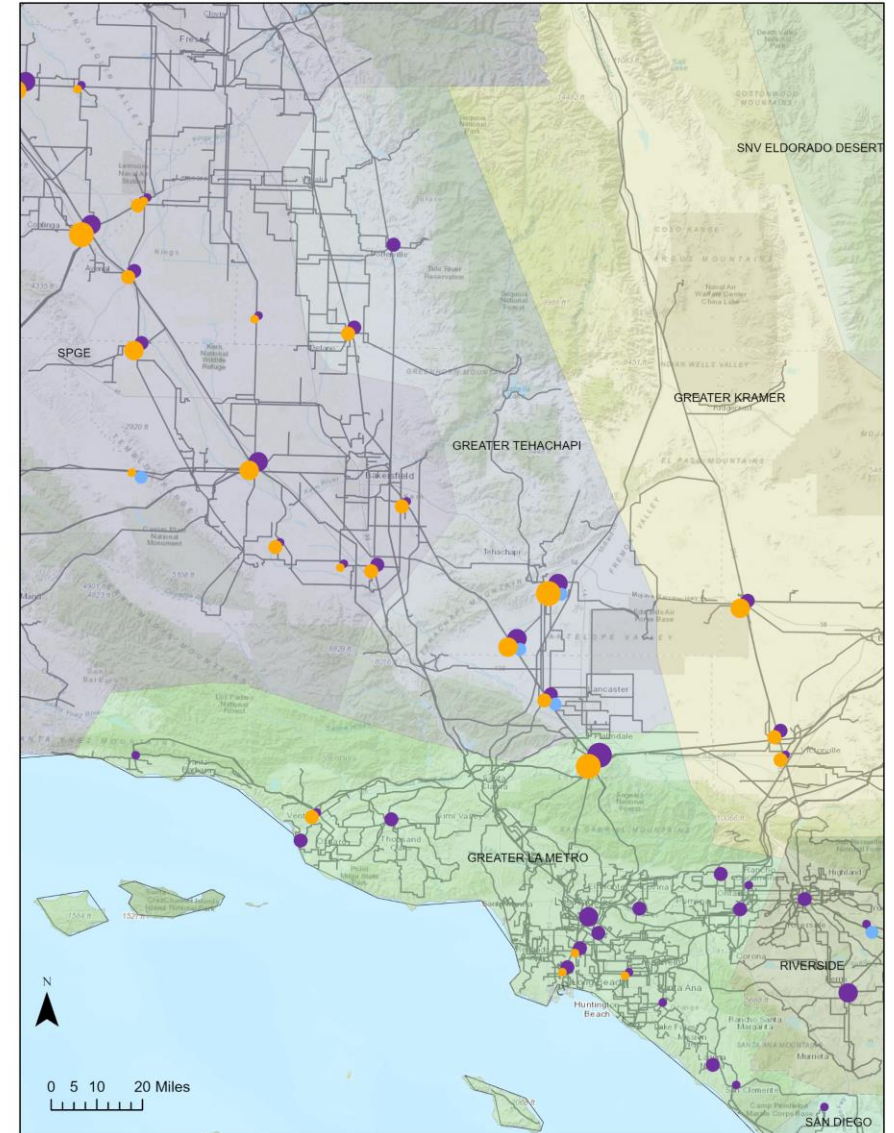
Greater Tehachapi & LA Metro Area – Summary

	RESOLVE Selected (2034)	RESOLVE Selected (2039)	In-Developm ent	Generic (2034)	Total by Res Type (2034)	Generic Addition (2039)	Total by Res Type (2039)
Greater Tehachapi							
InState Biomass (MW)	N/A	N/A	-	-	-	-	-
Tehachapi Wind (MW)	156	1,489	-	614	614	200	814
Tehachapi Solar (MW)	5,064	10,796	1,031	2,048	3,079	1,300	4,379
Tehachapi Li Battery (MW)	1,703	2,466	2,005	670	2,675	515	3,189
Tehachapi LDES (MW)	378	378	200	281	481	-	481
Total by Status (MW)	7,301	15,129	3,236	3,613	6,849	2,015	8,863

	RESOLVE Selected (2034)	RESOLVE Selected (2039)	In-Developm ent	Generic (2034)	Total by Res Type (2034)	Generic Addition (2039)	Total by Res Type (2039)
Greater LA Metro Area							
InState Biomass (MW)	N/A	N/A	5.6	1.0	6.6	-	6.6
Greater LA (MW)	-	-	-	-	-	-	-
Greater LA Solar (MW)	-	-	23	-	23	250	273
Greater LA Li Battery (MW)*	4,058	4,608	1,130	1,566	2,696	380	3,076
Greater LA LDES (MW)	50	50	-	-	-	-	-
Total by Status (MW)	4,108	4,658	1,159	1,401	2,560	630	3,190

*In RESOLVE San Diego batteries were included within the LA metro battery totals

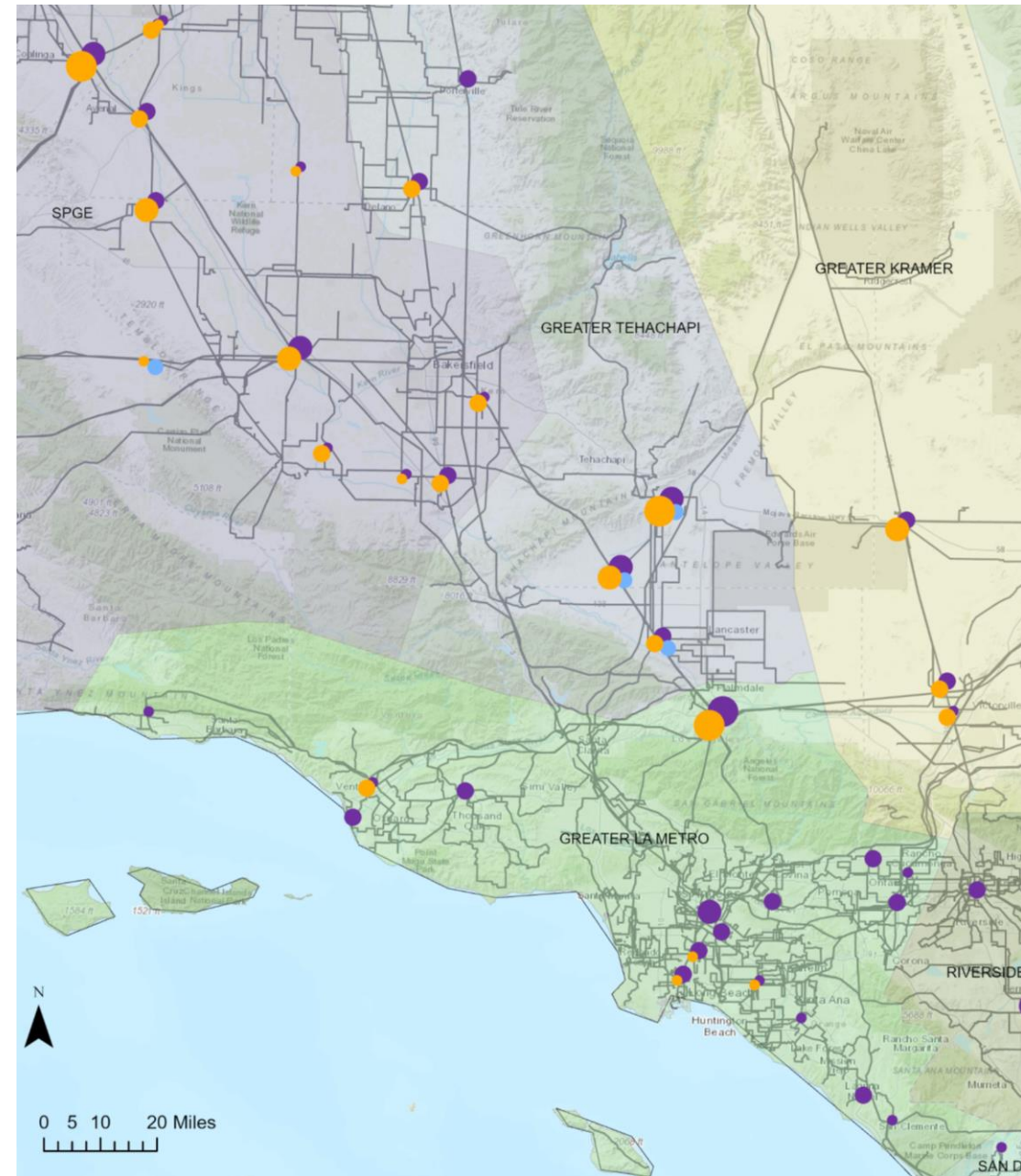
- The Greater Tehachapi area corresponds to the portion of the SCE Northern Area north of and including the Vincent substation.
- The Greater LA Metro area corresponds to the SCE Metro area and the portion of SCE Northern area south and east of Vincent.



Greater Tehachapi & LA Metro Area – Summary

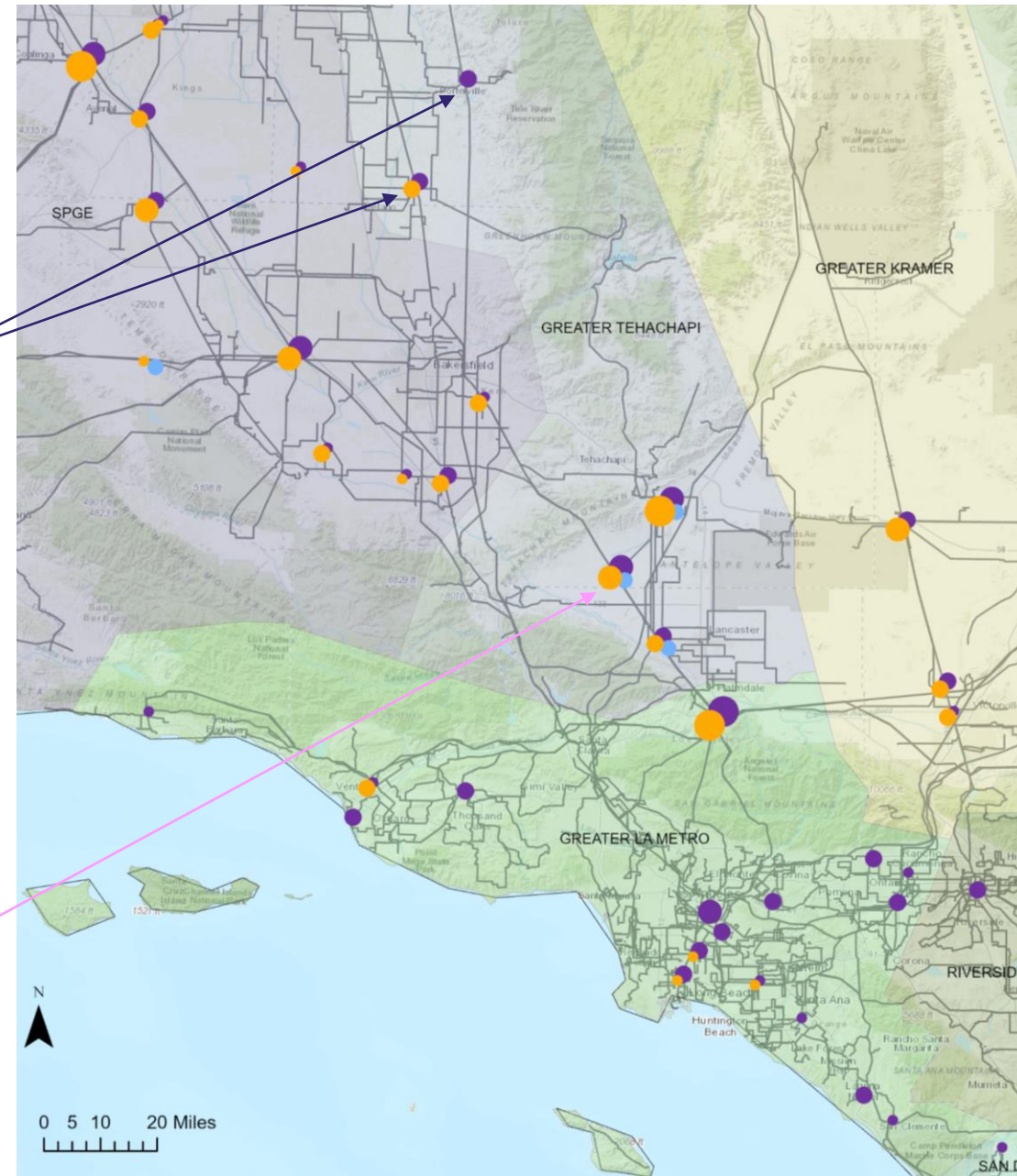
	In-Develop ment	Generic (2034)	Total by Res Type (2034)	Generic Addition (2039)	Total by Res Type (2039)
SCE Northern Area					
Geothermal (MW)	-	-	-	-	-
Biomass (MW)	-	1.0	1.0	-	1.0
Onshore Wind (MW)	-	614.0	614.0	200.0	814.0
OOS Wind (MW)	-	-	-	-	-
Offshore Wind (MW)	-	-	-	-	-
Solar (MW)	1,036.0	2,048.0	3,084.0	1,550.0	4,634.0
Li_Battery (MW)	2,239.9	1,169.5	3,409.4	564.5	3,973.9
LDES (MW)	200.0	281.0	481.0	-	481.0
Total by Status (MW)	3,475.9	4,113.5	7,589	2,314.5	9,903.9

	In-Develop ment	Generic (2034)	Total by Res Type (2034)	Generic Addition (2039)	Total by Res Type (2039)
SCE Metro					
Geothermal (MW)	-	-	-	-	-
Biomass (MW)	5.6	-	5.6	-	5.6
Onshore Wind (MW)	-	-	-	-	-
OOS Wind (MW)	-	-	-	-	-
Offshore Wind (MW)	-	-	-	-	-
Solar (MW)	27.0	-	27.0	7.0	34.0
Li_Battery (MW)	895.0	1,066.5	1,961.5	330.0	2,291.5
LDES (MW)	-	-	-	-	-
Total by Status (MW)	927.6	1,066.5	1,994	337.0	2,331.1



Greater Tehachapi & LA Metro Area – Resources Mapped

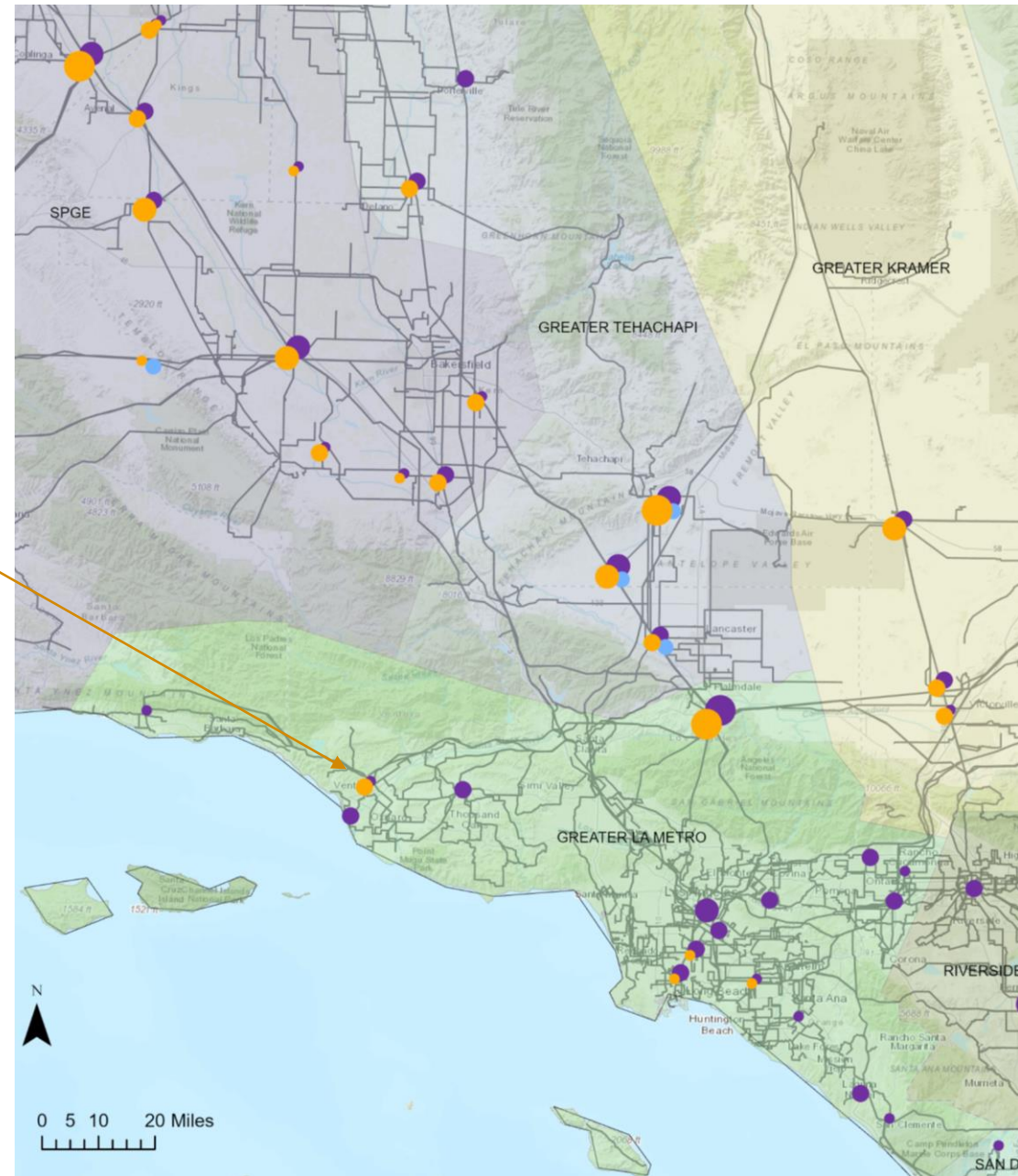
- Tehachapi area resources include resources in the Central Valley interconnecting to the SCE Pastoria substation and north of the Magunden system.
 - Solar and storage mapped to Springville and Vestal substations.
- Significant amounts of solar and co-located storage are mapped Windhub, Whirlwind, Antelope, and Vincent substations.
- ~800 MW of in-state wind is mapped to Whirlwind (~500 MW), Windhub (~100 MW), and Antelope (~200 MW).
- 480 MW of LDES is mapped to Whirlwind and is treated as A-CAES in line with resources identified in the commercial development criteria.



Greater Tehachapi & LA Metro Area – Resources Mapped

- The RESOLVE LA metro region includes the portion of SCE Northern that covers out to the Goleta substation.
- Regions includes a small amount of utility scale solar mapped to Santa Clara substation and some distributed solar.
- Nearly all the 2.9 GW of battery storage is mapped as stand-alone.

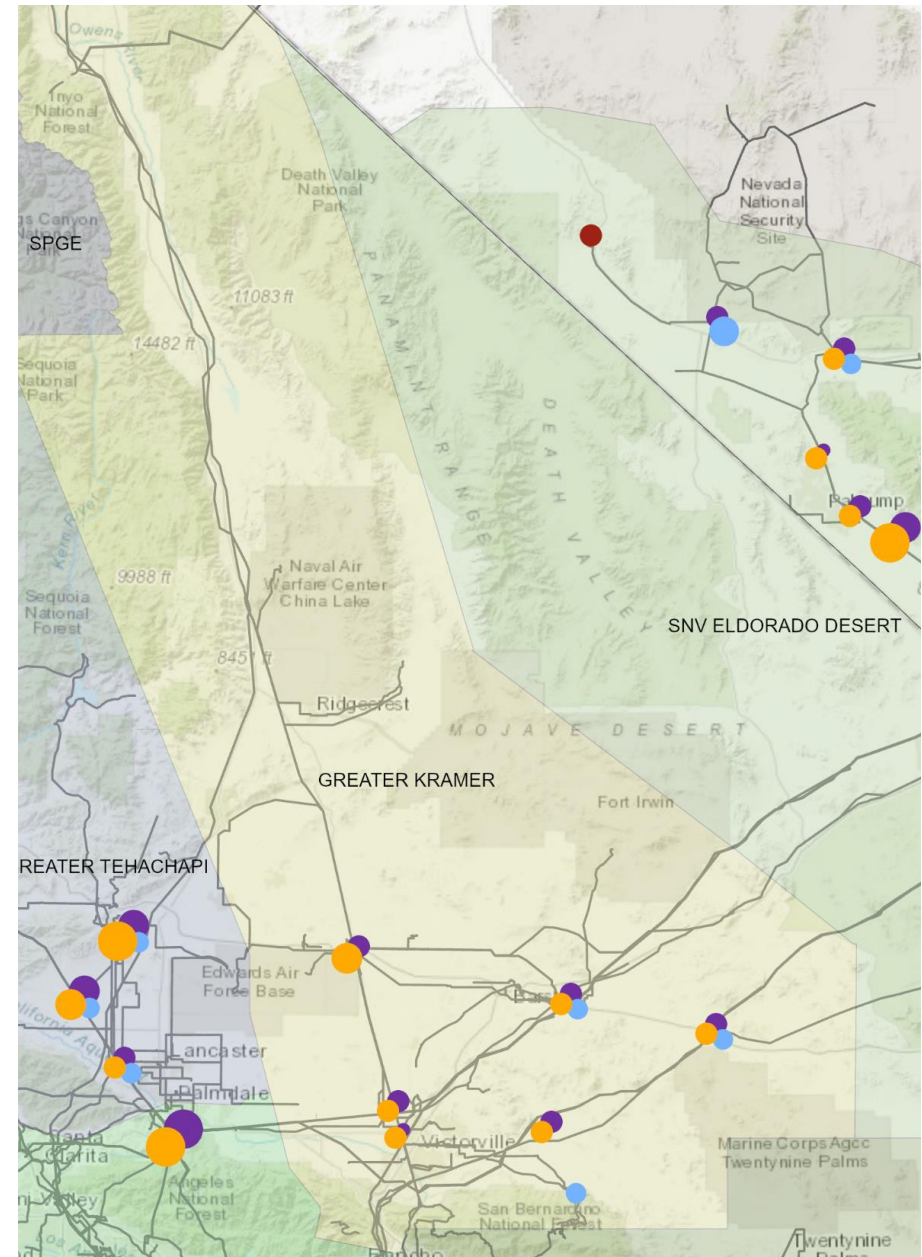
Li Batteries	In-Dev	Generic (2039)	Total (2039)	In DAC	Near Gas Plant
Stand-alone	1,130	1,897	3,027	1,149	2,150
Co-located	-	50	50	-	50



Greater Kramer Area – Summary & Resources Mapped

	In-Develop ment	Generic (2034)	Total by Res Type (2034)	Generic Addition (2039)	Total by Res Type (2039)
SCE North of Lugo					
Geothermal (MW)	-	-	-	-	-
Biomass (MW)	-	1.5	1.5	-	1.5
Onshore Wind (MW)	-	650.0	650.0	-	650.0
OOS Wind (MW)	-	-	-	-	-
Offshore Wind (MW)	-	-	-	-	-
Solar (MW)	535.0	1,050.0	1,585.0	452.0	2,037.0
Li_Battery (MW)	361.0	445.0	806.0	205.0	1,011.0
LDES (MW)	-	-	-	-	-
Total by Status (MW)	896.0	2,146.5	3,043	657.0	3,699.5

- The 650 MW of in-state wind is mapped to three substations: Coolwater, Pisgah, and a proposed new substation.
- Solar and storage are mapped co-located to six substations in the great Kramer area.
- Previous TPP had identified some OOS geothermal interconnecting through the Silver Peak intertie.
 - This resource is currently modeled in the updated baseline

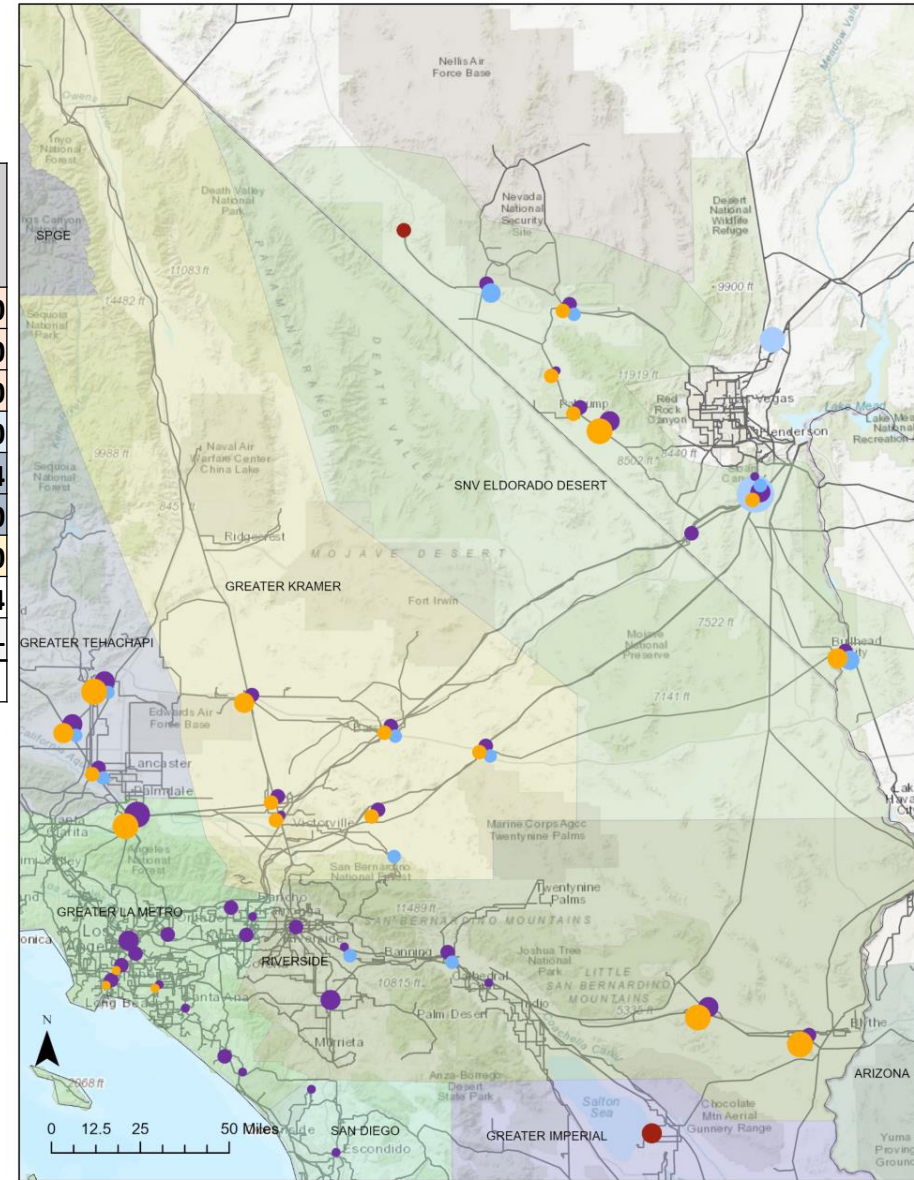


Southern NV & El Dorado Area – Summary

	RESOLVE Selected (2034)	RESOLVE Selected (2039)	In-Development	Generic (2034)	Total by Res Type (2034)	Generic Addition (2039)	Total by Res Type (2039)
Southern Nevada							
Central Nevada Geothermal (MW)	40.0	40.0	-	450.0	450.0	50.0	500.0
Northern NV Geothermal* (MW)	314.3	314.3	-	240.0	240.0	-	240.0
Utah Geothermal* (MW)	-	-	26.0	-	26.0	50.0	76.0
Southern NV & Eldorado Wind (MW)	5,011	5,011	-	1,810	1,810	100	1,910
Idaho Wind* (MW)	300	300	-	1,000	1,000	204	1,204
Wyoming Wind* (MW)	3,000	7,936	-	2,268	2,268	2,232	4,500
Southern NV & Eldorado Solar (MW)	4,665	4,665	460	1,980	2,440	400	2,840
Southern NV & Eldorado Li Battery (MW)	1,585	1,585	624	1,240	1,864	750	2,614
Southern NV & Eldorado LDES (MW)	-	-	-	-	-	-	-
Total by Status (MW)	14,916	19,852	1,110	8,988	10,098	3,786	13,884

*Out-of-CAISO Resources mapped to current CAISO intertie points

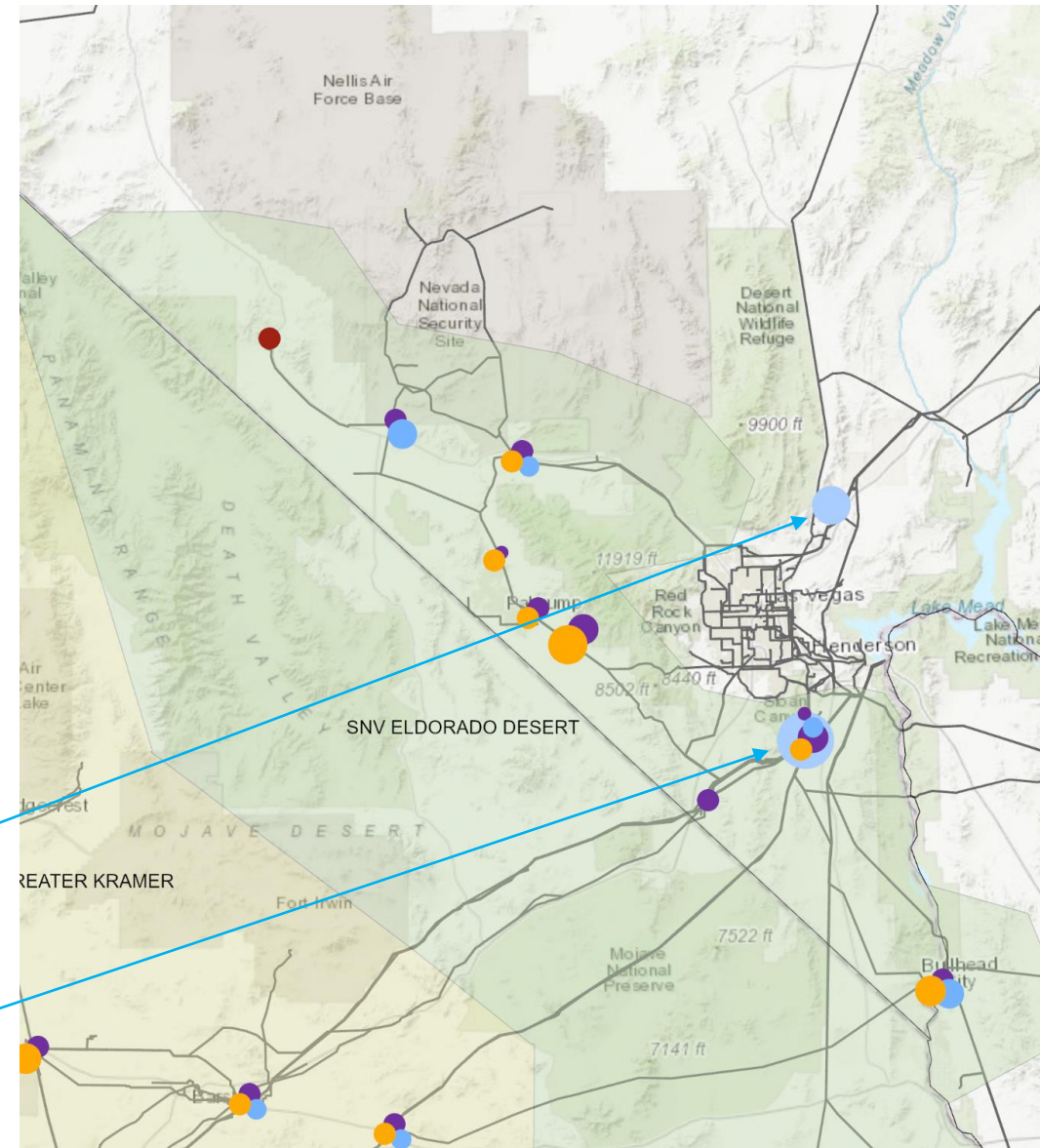
- The Southern Nevada & El Dorado area corresponds to the following CAISO interconnection zone:
 - East of Pisgah
- Region includes potential out-of-CAISO resources, which are mapped to several substations in the area representing their likely interties to the existing CAISO grid:
 - Subs include Harry Allen, El Dorado, and Mead



Southern NV & El Dorado Area – Summary & Resources Mapped

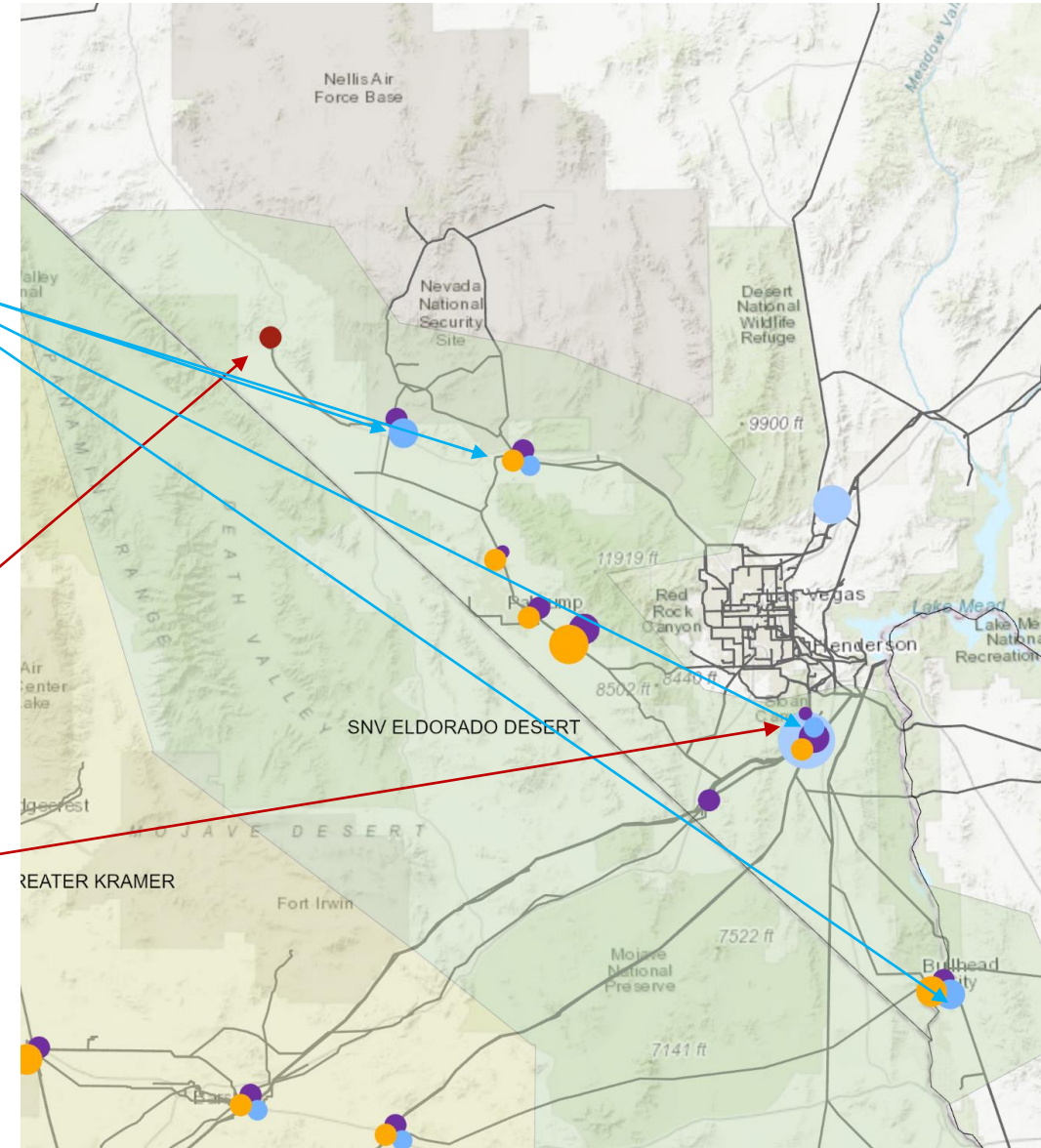
East of Pisgah	In-Development	Generic (2034)	Total by Res Type (2034)	Generic Addition (2039)	Total by Res Type (2039)
Geothermal (MW)	26.0	690.0	716.0	100.0	816.0
Biomass (MW)	-	-	-	-	-
Onshore Wind (MW)	-	1,810.0	1,810.0	100.0	1,910.0
OOS Wind (MW)	-	3,268.4	3,268.4	2,435.7	5,704.1
Offshore Wind (MW)	-	-	-	-	-
Solar (MW)	460.0	1,980.0	2,440.0	400.0	2,840.0
Li_Battery (MW)	624.0	1,240.0	1,864.0	750.0	2,614.0
LDES (MW)	-	-	-	-	-
Total by Status (MW)	1,110.0	8,988.4	10,098	3,785.7	13,884.1

- OOS Wind resources for transmission constraint calculations:
 - Wyoming wind, 2.2 GW in 2034 (4.5 GW in 2039) is represented as mapped to the El Dorado 500 kV substation.
 - Idaho wind, 1 GW in 2034 (1.2 GW in 2039) is mapped to the Harry Allen 500 kV substation.



Southern NV & El Dorado Area – Resources Mapped

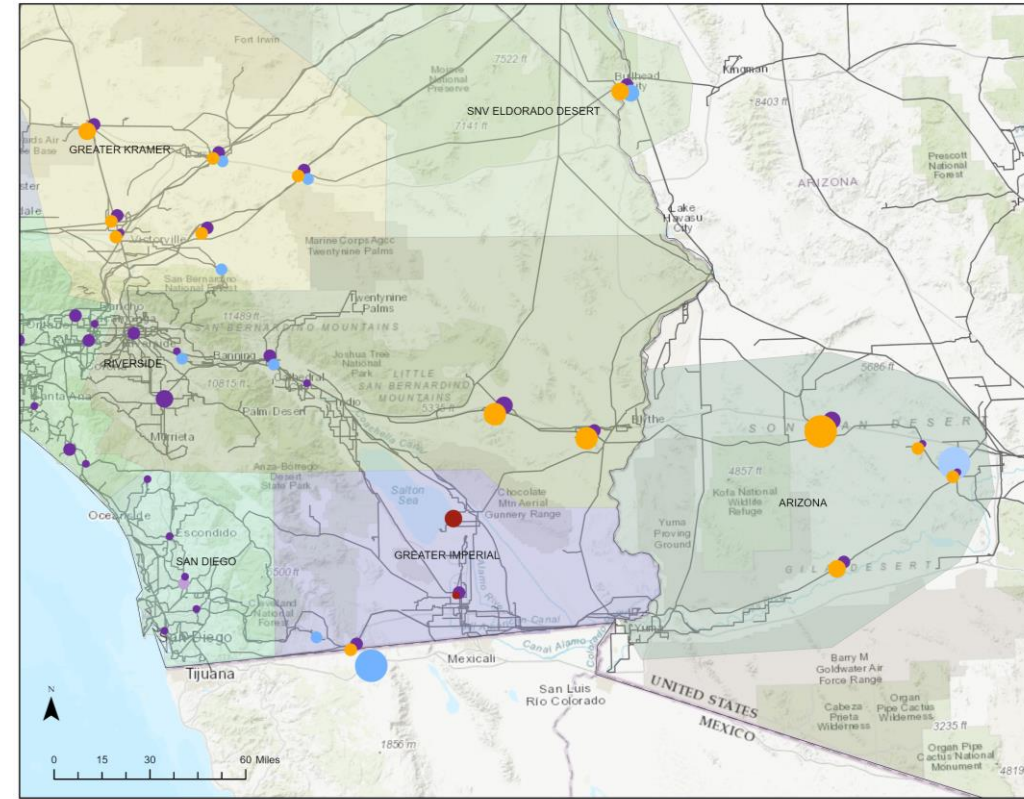
- The 1.9 GW of In-state wind mapped to Southern Nevada is at four substations: Lathrop, Innovation, Sloan Canyon and Mohave.
 - Incorporated projects in NVEP queue and in the Cluster 15 application list to identify development interest at Lathrop and Mohave, respectively.
- 500 MW of Central Nevada geothermal is mapped as interconnecting at the Beatty substation, though does require a significant gen-tie.
- 240 MW of Northern NV geothermal and 76 MW of Utah geothermal are mapped as imported interconnecting at the CAISO's El Dorado interties.
- Solar has been mapped to four substations in the GLW-VEA system as well as El Dorado and Mohave substations. And, nearly all storage is mapped as co-located with solar resources.



Riverside & Arizona Areas – Summary

	RESOLVE Selected (2034)	RESOLVE Selected (2039)	In-Develop ment	Generic (2034)	Total by Res Type (2034)	Generic Addition (2039)	Total by Res Type (2039)
Riverside & Arizona							
Greater Imperial Geothermal* (MW)	1,238.6	1,356.1	-	790.0	790.0	-	790.0
InState Biomass (MW)	N/A	N/A	2.6	-	2.6	-	2.6
Riverside & Palm Springs Wind (MW)	-	-	-	599	599	-	599
New Mexico Wind* (MW)	1,968	1,968	-	2,000	2,000	2,500	4,500
Riverside Solar (MW)	659	659	850	2,000	2,850	1,100	3,950
Arizona Solar (MW)	3,243	324	1,409	-	1,409	1,250	2,659
Riverside Li Battery (MW)	708	708	2,205	45	2,250	400	2,650
Arizona Li Battery (MW)	1,162	1,162	250	910	1,160	400	1,560
Riverside LDES (MW)	299	299	-	-	-	-	-
Arizona LDES (MW)	-	-	-	-	-	-	-
Total by Status (MW)	9,278	6,476	4,716	6,344	11,060	5,650	16,710

*Out-of-CAISO Resources modeled at current CAISO intertie points

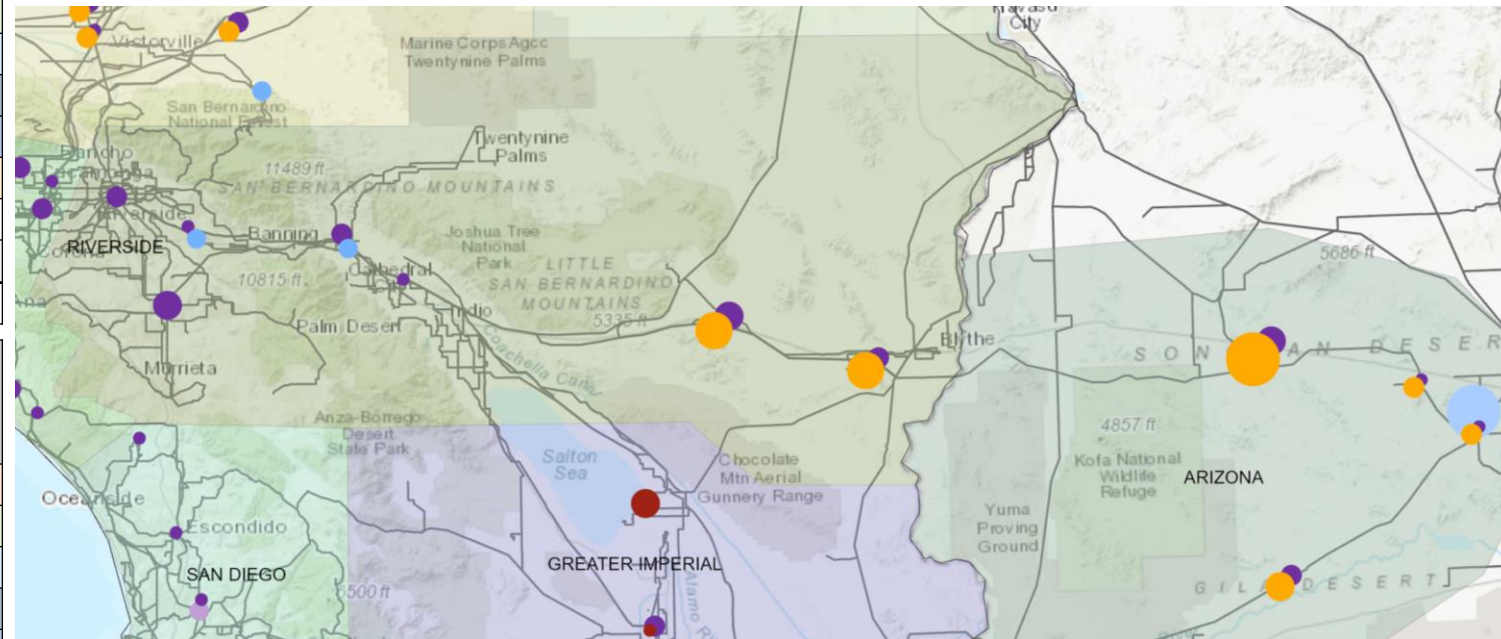


- The two areas combined corresponds to the following CAISO interconnection zones:
 - SCE Eastern area
 - Several substations in AZ are in the SDG&E study area
- Region includes potential out-of-CAISO resources, which are mapped to substations in the area representing their likely interties to the existing CAISO grid:
 - Intertie substations include Palo Verde and Mirage

Riverside & Arizona Areas – Summary

	In-Develop ment	Generic (2034)	Total by Res Type (2034)	Generic Addition (2039)	Total by Res Type (2039)
SCE Eastern					
Geothermal (MW)	-	740.0	740.0	-	740.0
Biomass (MW)	2.6	-	2.6	-	2.6
Onshore Wind (MW)	-	599.0	599.0	-	599.0
OOS Wind (MW)	-	2,000.0	2,000.0	2,500.0	4,500.0
Offshore Wind (MW)	-	-	-	-	-
Solar (MW)	1,758.5	1,300.0	3,058.5	2,350.0	5,408.5
Li_Battery (MW)	2,255.0	695.0	2,950.0	800.0	3,750.0
LDES (MW)	-	-	-	-	-
Total by Status (MW)	4,016.1	5,334.0	9,350	5,650.0	15,000.1

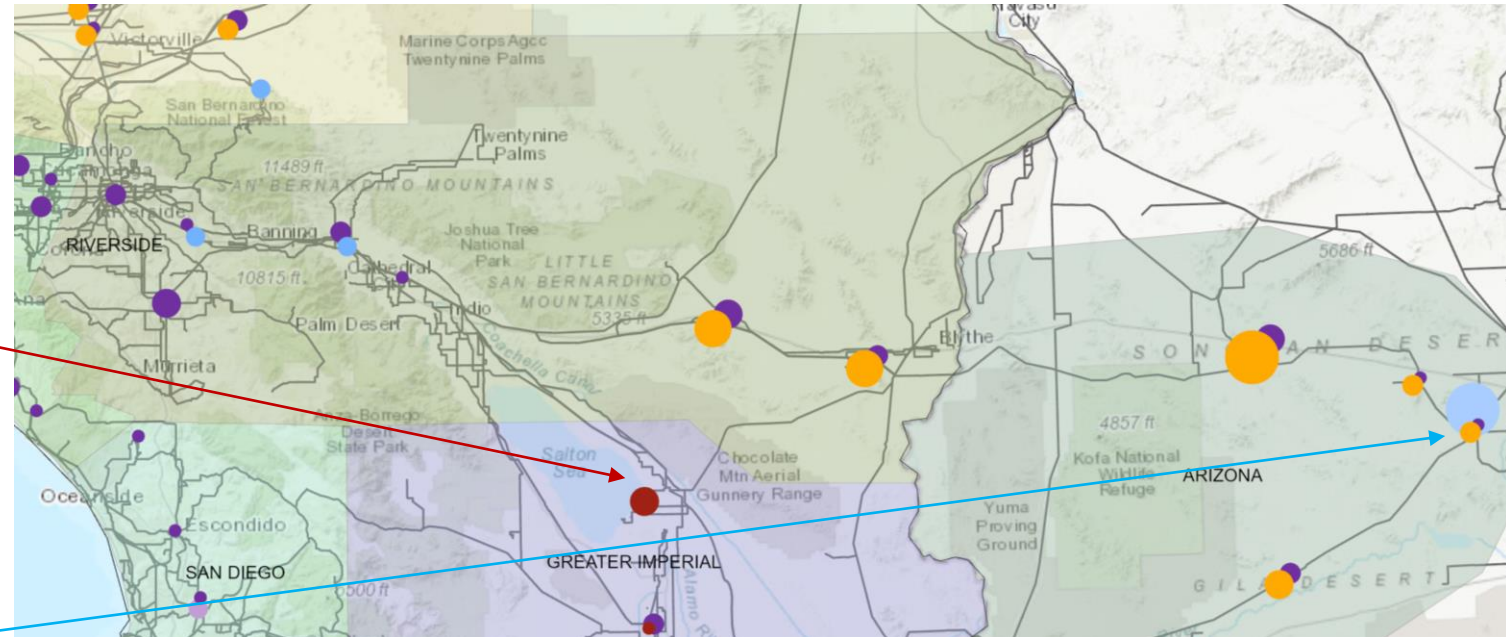
	In-Develop ment	Generic (2034)	Total by Res Type (2034)	Generic Addition (2039)	Total by Res Type (2039)
SDG&E					
Geothermal (MW)	-	50.0	50.0	-	50.0
Biomass (MW)	-	-	-	-	-
Onshore Wind (MW)	-	2,060.0	2,060.0	900.0	2,860.0
OOS Wind (MW)	-	-	-	-	-
Offshore Wind (MW)	-	-	-	-	-
Solar (MW)	610.8	772.0	1,382.8	-	1,382.8
Li_Battery (MW)	1,100.1	389.6	1,489.7	92.0	1,581.7
LDES (MW)	-	449.0	449.0	-	449.0
Total by Status (MW)	1,711.0	3,720.6	5,432	992.0	6,423.6



- Most of the SDG&E area solar and some battery are mapped to Arizona area substations (1,201 MW of solar and 510 MW of Li_battery)

Riverside & Arizona Areas – Resources Mapped

- Solar and co-located storage is mapped to Red bluff and Colorado River substations in Riverside and in Arizona to Hoodoo Wash, Hassayampa, Delaney, and a proposed substation along the new DCRT line.
- 740 MW of geothermal mapped to the IID area is modeled as interconnect to CAISO at the Mirage/Devers intertie in the SCE Eastern area.
- All 2 GW (2034) and 4.5 GW (2039) of New Mexico Wind mapped are shown as interconnecting at the Palo Verde substation.
- Stand-alone storage is mapped to substations in the urban areas of Riverside County.



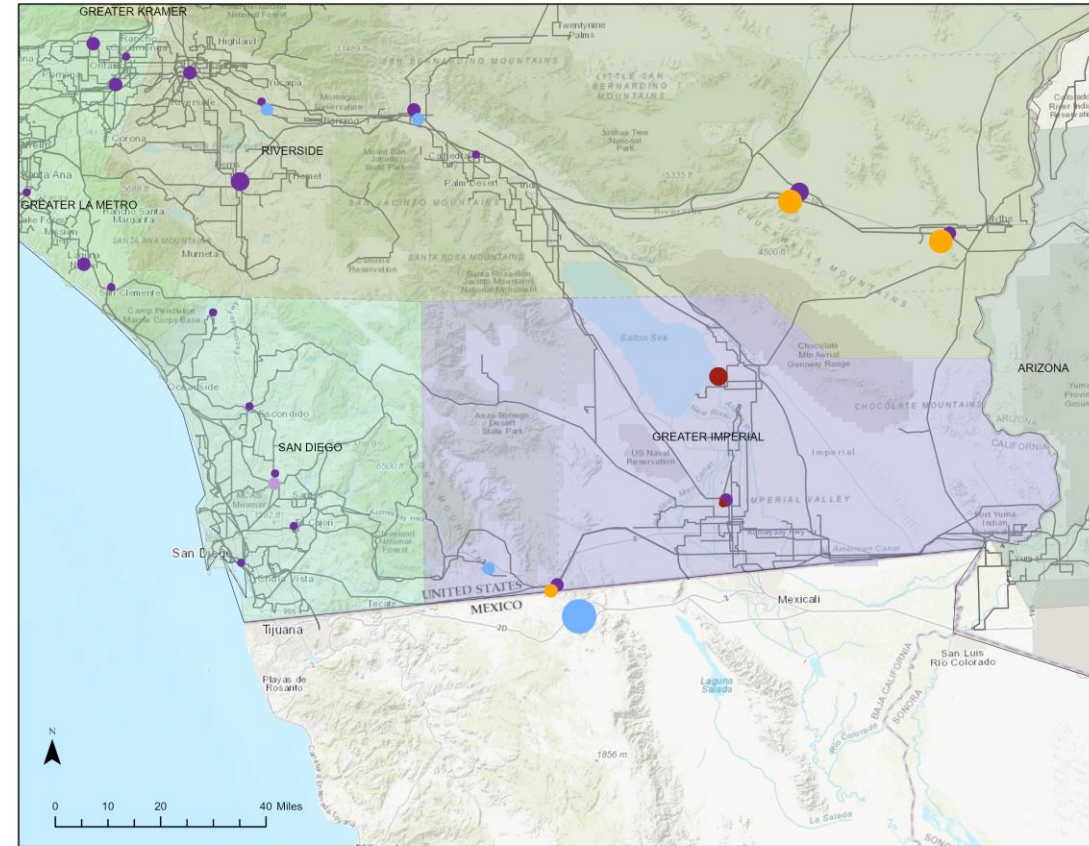
	Li Batteries	In-Dev	Generic (2039)	Total (2039)	In DAC	Near Gas Plant
Stand-alone		1,135	45	1,180	200	990
Co-located		1,245	1,710	2,955	-	-

Greater Imperial and San Diego Areas – Summary

Greater Imperial & San Deigo	RESOLVE Selected (2034)	RESOLVE Selected (2039)	In-Develop ment	Generic (2034)	Total by Res Type (2034)	Generic Addition (2039)	Total by Res Type (2039)
Greater Imperial Wind (MW)	133	133	-	560	560	-	560
Baja California Wind (MW)	1,573	2,473	-	1,500	1,500	800	2,300
Imperial Solar (MW)	39	39	110	72	182	-	182
Imperial Li Battery (MW)	-	-	341	-	291	-	341
San Diego Li Battery (MW)*	-	-	559	130	689	92	781
San Diego LDES (MW)	-	-	-	449	449	50	499
Imperial LDES (MW)	29	29	-	-	-	-	-
Total by Status (MW)	1,774	2,674	960	2,711	3,671	942	4,663

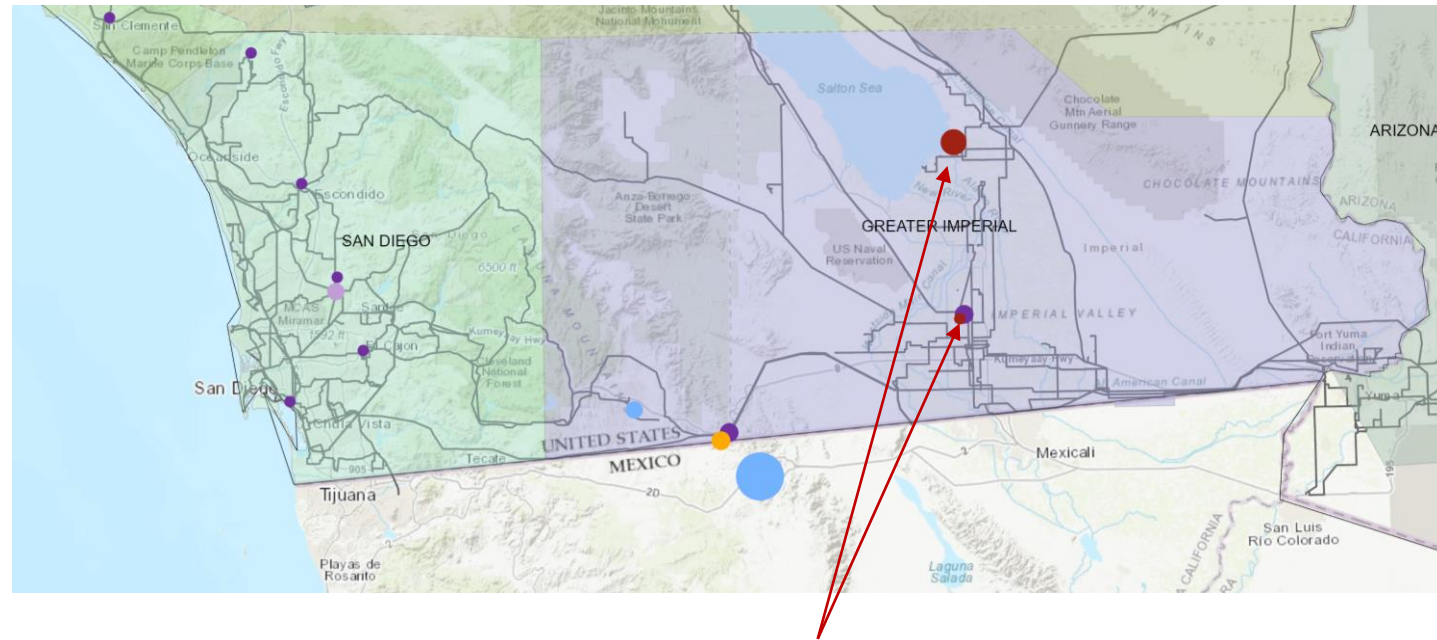
*In RESOLVE San Diego batteries were included within the LA metro battery totals

- The two areas combined corresponds to most of the following CAISO interconnection zones:
 - SDG&E study area
- Region includes potential out-of-CAISO resources, which are mapped to substations in the area representing likely interties to the existing CAISO grid:
 - Intertie substations include Imperial Valley.



Greater Imperial and San Diego Areas – Summary & Resources Mapped

SDG&E	In-Development	Generic (2034)	Total by Res Type (2034)	Generic Addition (2039)	Total by Res Type (2039)
Geothermal (MW)	-	50.0	50.0	-	50.0
Biomass (MW)	-	-	-	-	-
Onshore Wind (MW)	-	2,060.0	2,060.0	900.0	2,860.0
OOS Wind (MW)	-	-	-	-	-
Offshore Wind (MW)	-	-	-	-	-
Solar (MW)	610.8	772.0	1,382.8	-	1,382.8
Li_Battery (MW)	1,100.1	389.6	1,489.7	92.0	1,581.7
LDES (MW)	-	449.0	449.0	-	449.0
Total by Status (MW)	1,711.0	3,720.6	5,432	992.0	6,423.6

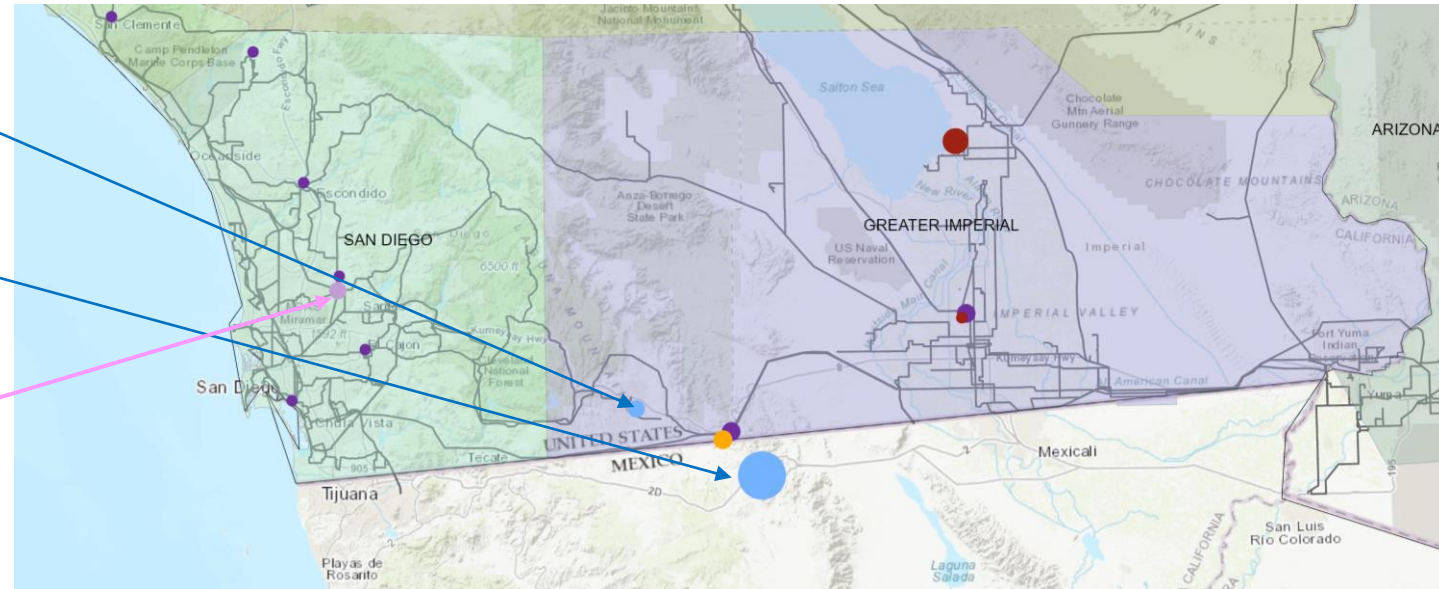


- Most of the SDG&E area solar and a portion of the Li_battery are mapped to Arizona area substations (1,201 MW of solar and 510 MW of Li_battery)

- 790 MW of geothermal are mapped to IID area
 - 740 MW are mapped to the Salton Sea geothermal area and mapped as interconnecting north to SCE system
 - 50 MW are mapped to other KGAs and mapped as interconnecting to the CAISO system at Imperial Valley.

Greater Imperial and San Diego Areas– Resources Mapped

- 2,860 MW of onshore wind are mapped by 2039 reflecting commercial development interest in the area:
 - 560 MW to the Greater Imperial area interconnecting on the Suncrest-Ocotillo line or at East County.
 - 2.3 GW to the Baja California, MX, area interconnecting directly to CAISO at East County
- 500 MW of LDES, modeled as pumped storage, is mapped to the Sycamore Canyon substation in alignment with identified development interest.
- 850 MW of Li Battery storage (mostly in-development, 730 MW) mapped to several San Diego area subs.
- 180 MW solar co-located with 110 MW of storage mapped to East County.



Li_Batteries	In-Dev	Generic	Total (2039)	In DAC	Near Gas Plant
Stand-alone	733	222	1,180	174	192
Co-located	117	-	2,955	-	-

CEC Presentation on Land-use and Environmental Analysis in Busbar Mapping

See Separate Slide Deck

Questions Break