TRANSMISSION IN 2024

CEERT'S REVIEW OF THE CHALLENGES AHEAD

GridLAB CEERT

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1 INTRODUCTION

The Center for Energy Efficiency and Renewable Technologies (CEERT) continues to prioritize its engagement in California's transmission planning, interconnection, and permitting processes. Last year we released three reports focused on the need for substantial expansion of the high voltage transmission system and on the need for major reforms to transmission permitting at the California Public Utilities Commission (CPUC). This report focuses on more recent California Independent System Operator (CAISO) planning activities, including the issuance of a draft 2023-2024 Transmission Plan, the finalization of the interconnection process enhancement initiative, and the preparation for studies in the upcoming 2024-2025 Transmission Plan.

This report also evaluates ongoing efforts of the Legislature and the CPUC to address transmission permitting reform following up on last year's activities.[1] The backlog of policy-driven and reliability-driven transmission projects that need to commence construction is continuing to grow with the expected addition of 26 new projects in the 2023-2024 Transmission Plan, which will bring the total number of transmission projects that have been approved over the past three transmission plans to 94. Delays in transmission development will jeopardize California's necessary transition to a zero-carbon economy. In particular, permitting reform is urgently needed in order to expand and modernize California's electric system and strengthen linkages to the rest of the Western grid.

In 2023, the CAISO adopted a new framework to coordinate transmission planning with the interconnection of new generation and storage projects and with the procurement of clean energy by load serving entities.[2] This zonal focus prioritizes transmission expansion to resource-rich areas that are needed to accelerate the transition to a zero-carbon grid and economy.

This year's Transmission Plan is based on a resource portfolio developed by the CPUC in its integrated resource planning process. This portfolio envisions the addition of more than 85 gigawatts (GW) of clean energy capacity by 2034.[3] It also reflects the state's greenhouse gas reduction goals and load growth, including that resulting from the electrification of transportation, the heating of buildings, and other sectors of the economy. The 85 GWs of new capacity is a significant increase from the amount included in the 2022-2023 Transmission Plan. The new resource portfolio is expected to keep the state on a sustainable trajectory to reach the state's goals of decarbonizing the economy by 2045.

This transmission report reviews and comments on the following documents and issue areas: 1) the draft 2023-2024 CAISO Transmission Plan; 2) transmission expansion needed in the San Joaquin Valley for large-scale solar development; 3) transmission required to reduce the need for gas-fired generation in the Los Angeles Basin; 4) transmission permitting reform; 5) the CAISO's proposed interconnection reform and their impact on Cluster 15 interconnection requests; and 6) an overview of advanced transmission technologies and solutions to improve the capabilities of the transmission system. Finally, this report provides findings and recommendations to guide 2024 advocacy that will advance transmission planning and permitting reform.

2 Load serving entities include investor owned utilities, publicly owned utilities, rural electric cooperatives, community choice aggregators, and electric service providers.

3 As of April 2024 the CAISO system has 30.7 GW of nameplate renewable capacity. The operating portfolio consists of 19.0 GW solar, 8.1 GW wind, 1.6 GW geothermal, 1.2 GW small hydro, and 0.8 GW of biofuels.

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REVIEW OF THE DRAFT 2023-2024 CAISO TRANSMISSION PLAN

Recently, the CAISO released its draft 2023-2024 Transmission Plan (TP). The CAISO Board of Governors is scheduled to adopt the TP at its May meeting. The transmission planning process is guided by the joint Memorandum of Understanding (MOU) adopted by the CPUC, the CEC, and the CAISO in December 2022.

The draft TP identifies transmission that is needed to maintain electric system reliability, meet the state's clean energy goals, and provide economic benefits to consumers. Under the MOU, the CPUC is responsible for providing guidance to load-serving entities across the state to procure clean energy resources located in zones where new transmission is being developed or enhanced.

RELIABILITY PROJECTS THAT BENEFIT DISADVANTAGE COMMUNITIES

In October 2023, CEERT commented to the CAISO that parts of the San Joaquin Valley, the Salinas Valley, and the Stockton area would benefit from upgrades to the lower-voltage local transmission networks that serve many rural communities. Transmission system upgrades can improve electric service reliability by avoiding power outages and create opportunities for clean energy resources to be developed in these areas.

CEERT is pleased to see that the CAISO has recommended moving forward on multiple reliability projects located in disadvantaged regions of the state. The table below lists some of the reliability-driven projects located in underserved areas. Reinforcement projects typically include multiple transmission elements to improve capacity, reliability, or resiliency. For example, the Camden project in the Greater Fresno area includes the reconductoring of a 70 kV transmission line and the addition of voltage support at the Camden substation to assure that the reinforced line can operate at 800 amps.

TABLE 1.

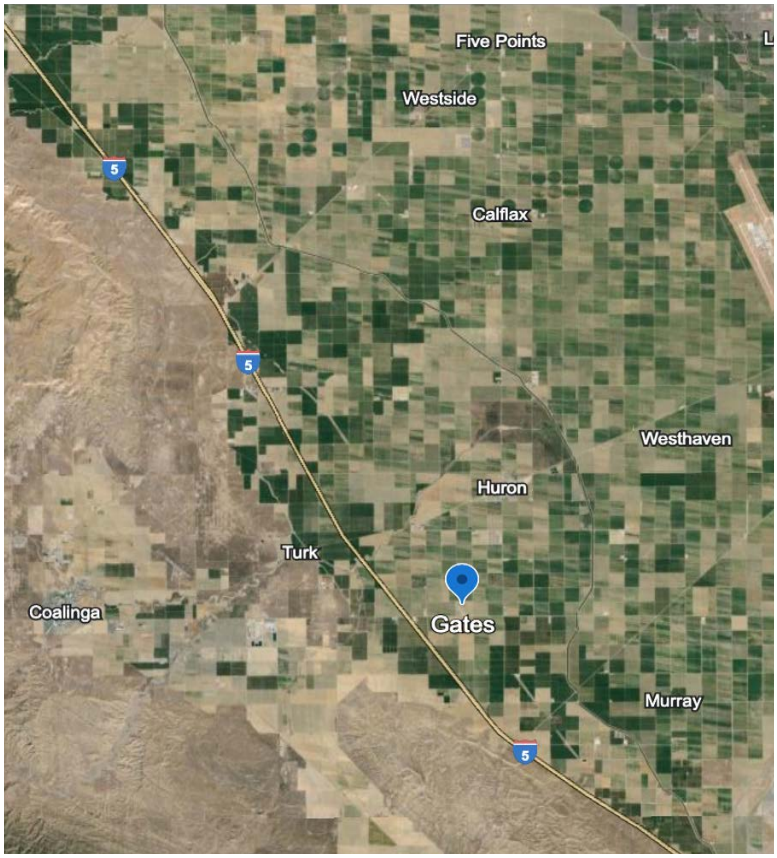
Recommended Reliability Projects in Disadvantaged Regions

PROJECT NAME	TRANSMISSION PLANNING AREA	ESTIMATED COST (MILLIONS)
Camden 70 kV Reinforcement	Greater Fresno	$100
Gates 230/70 kV Transformer Addition	Greater Fresno	$72
Reedley 70 kV Capacity Increase	Greater Fresno	$98
Salinas – Soledad #1 & #2 115 kV line reconductoring	Central Coast (Salinas)	$108
Salinas Area Reinforcement	Central Coast (Salinas)	$452.3
French Camp Reinforcement	Central Valley (Stockton)	$84.2

An example of a reliability project that will benefit rural communities is one that is proposed for the Gates area of Fresno County, which includes the towns of Coalinga, Huron, Five Points, and Kettleman City. The map below shows the general area served by the 70 kV network emanating from the Gates substation.

MAP 1.

Southwestern Fresno County



The main source of power feeding the power lines serving the identified rural communities in Southwestern Fresno County comes from a single 230/70 kV transformer located at the Gates substation, with an additional source of power from a 115/70 kV transformer located further north at the Schindler substation. An outage of the Gates transformer would result in overloads of other portions of the transmission system, jeopardizing the reliability of electric service in this area. The CAISO has found that this situation will violate national reliability standards.[4]

In addition, the area will experience widespread low voltages in the future without the new transformer. The proposed mitigation is to add a new transformer at the Gates substation that will provide a second source of power from the Gates substation and eliminate the violations. The project has an expected in-service date of May 2030 or earlier.

There is a need to improve reliability in many other rural areas of California. Reinforcing the lower voltage grid will also create opportunities for economic development in these areas. The policy goal of increasing economic opportunities through better electric service needs to become more deeply ingrained into integrated resource planning and transmission planning in California.

OFFSHORE WIND POLICY-DRIVEN TRANSMISSION PROJECTS

The policy-driven transmission projects recommended in the 2023-2024 TP are strongly influenced by the state's goal of developing offshore wind projects at locations identified in the CPUC base case resource portfolio.[5] The base case portfolio is designed to keep the state on target to zero-out greenhouse gas (GHG) emissions from the electric system by 2045 and achieve an interim target of reducing GHG emissions to 30 million metric tons (MMT) by 2030.[6]

A second sensitivity portfolio was also used by the CAISO in its modeling. The sensitivity case has the same GHG emissions reduction target as in the base case and is intended to examine the additional transmission that would be needed for the development of 13.4 GW of offshore wind (OSW) by 2035. The sensitivity portfolio reduces the amount of other resources needed to meet the GHG emissions reduction goal. The value of studying the sensitivity case is to provide energy policymakers with a better understanding of the required transmission to rapidly expand the development of OSW beyond the initial goals contained in the base case portfolio.

In addition to offshore wind, the two CPUC resource portfolios include forecasted quantities of biomass/biogas, geothermal, solar, in-state and out-of-state wind resources, and battery and long duration energy storage that would be needed through 2035 to reduce GHG emissions.

4 NERC TPL-001-5 Category P1 and P3 violations.

5 CPUC Decision 23-02-040.

6 The portfolio was developed with updated assumptions from California Energy Commission's 2021 Integrated Energy Policy Report, including using the additional transportation electrification (ATE) scenario of the demand forecast.

Both portfolios assume that some resources will have full capacity deliverability status (FCDS) while others will have energy only deliverability status. Only FCDS resources are modeled by the CAISO in its on-peak deliverability assessment to determine eligibility for participation in the state's resource adequacy program. Resource adequacy needs are met largely through bilateral contracts between load serving entities and project developers. Resource adequacy payments represent a significant portion of the value of new clean energy projects.

The base case portfolio includes 85 GW of new clean energy resources to be built by 2035.[7] The sensitivity portfolio requires 74 GW of new clean energy resources with somewhat fewer solar and battery resources than in the base case. The table below shows the amount of new resources that would be expected to become operational by 2035. The table also includes a 2045 resource portfolio that is being used in the 20-Year Transmission Outlook update, which shows a need for 165 GW of new clean energy resources by 2045. It also assumes the retirement of 15 GW of natural gas power plants.

TABLE 2.

Comparison of Resource Portfolios

RESOURCE TYPE	2023-2024 BASE CASE FOR 2035 (MW)	2023-2024 SENSITIVITY FOR 2035 (MW)	20-YEAR TRANSMISSION OUTLOOK FOR 2045 (MW)
Natural gas power plants	-	-	(-15,000)
Utility scale solar	38,947	25,746	69,640
Distributed solar	125	125	125
In-state wind	3,074	3,074	3,074
Offshore wind	4,707	13,400	20,000
Out-of-state wind	4,828	4,828	12,000
Geothermal	2,037	1,149	2,332
Biomass	134	134	134
Battery storage	28,374	23,545	48,813
Long-duration storage	2,000	1,000	4,000
Generic clean firm energy	-	-	5,000
Total New Resources	**85,015**	**73,791**	**165,118**

7 The resource capacity is the nameplate capacity. Many of the battery resources will be co-located with other resources, primarily solar. The amount of transmission needed for the deliverability of these resources will be determined by the busbar mapping for the combined resources.

A key driver of the 2023-2024 TP is the proposed development of just over 4.7 GW of offshore wind, with 3.1 GW located along the Central Coast (the Morro Bay call area) and 1.6 GW in the North Coast area (the Humboldt call area). The inclusion of offshore wind resources as part of the 2023-2024 TP is part of a multi-year effort by the Legislature and State Energy Agencies to create a comprehensive course of action for the development of offshore wind in California. The level of effort and coordination across state agencies is reflected in the California Energy Commission's (CEC) Offshore Wind Strategic Plan.[8]

Developing wind generation in the deep waters off California's coast requires the installation of wind turbines on floating platforms that will be tethered to the seabed. This approach differs from development in shallower locations like the East Coast, where wind turbines have fixed bottom foundations. The CEC acknowledges that OSW development off the coast of California will require the construction of massive floating platforms as well as the vessels to tow them to the lease areas for installation.

Other technologies, such as dynamic high-voltage cables, also need further development for the West Coast deep water environment. The CEC is supporting the orderly development of necessary components for offshore wind commercialization in California through early state and federal investments in technology supply chains and port infrastructure. The CEC's roadmap recognizes the need for close coordination between port expansion, the development of transmission infrastructure, and the maturation of offshore wind supply chains so that projects can become operational by 2035.

There is currently no substation in the North Coast area that can serve as the landing point for offshore wind to be developed in the Humboldt lease areas. The CAISO is proposing the construction of a new 500 kV substation in Humboldt County, approximately six miles from the existing 115 KV Humboldt substation. Besides serving at the point where wind project gen-ties could interconnect to the CAISO system, the substation would include a 500/115 kV transformer that would allow a portion of the power from the offshore wind projects to be delivered to customers in Humboldt County.

The CAISO initially examined four alternative transmission solutions to enable FCDS for 1,446 megawatts (MW) of offshore wind capacity with energy-only deliverability for 161 MW. Two of the proposed solutions were subsea HVDC cables to two different locations in the Bay Area. These subsea alternatives were rejected at this time because of the challenging sea floor topography off the coast of Mendocino County as well as the higher capital costs.

The proposed land-based transmission alternatives included the following: 1) two 500 kV alternating current transmission lines (140 miles) from the new substation to the Fern Road substation (currently being built in Shasta County) and 2) a 2,000 MW bipole HVDC cable (260 miles) from the new Humboldt substation to the Collinsville substation being built in Solano County in the Bay Area. Both of these land-based alternatives were rejected

8 https://www.energy.ca.gov/programs-and-topics/topics/renewable-energy/offshore-renewable-energy. The CEC is continuing to take public comments on the draft plan.

because of capital costs and reliance on a single corridor, which can impact deliverability because of the potential outage of two circuits on a single set of towers.

In the 2023-2024 transmission planning process, the CAISO staff proposed an alternative solution that consists of one 500 kV AC line to the Fern Road substation in Shasta County and a second 500 kV AC line to the Collinsville substation in the Bay Area. An advantage of this approach is that it would create a new parallel transmission path to the existing 500 kV lines running down the Central Valley from the Fern Road substation to the Tesla substation. A new north-south transmission path would make it easier in the future to reconductor or upgrade the existing lines on the California-Oregon Intertie.

The CAISO observes that this proposed solution avoids the possibility that offshore wind transmission lines would not be economically useful if the offshore wind projects do not get developed as anticipated. However, it is unlikely that this parallel path would be a chosen alternative for a new north-south transmission path in the absence of the opportunity to develop the Humboldt area offshore wind resource.

The CAISO is recommending this fifth alternative as the preferred solution in the 2023-2024 TP. It also recommended that the Humboldt to Collinsville 500 kV line be built so it could be converted later to an HVDC line if the need for additional transmission capacity arises.

The CAISO's technical analyses identified three additional mitigation projects that were needed for offshore wind deliverability: 1) reconductoring the 230 kV line from North Dublin to Vineyard; 2) reconductoring the Tesla to Newark 230 kV Number 2 line; and 3) the addition of a 10-ohms series reactor at the Collinsville substation. These mitigation projects can be completed in 24 to 54 months.

The total costs for the transmission projects needed for the delivery of 1.6 GW of North Coast offshore wind energy are estimated to be from $3.1 billion to $4.5 billion. Details for the various components are shown in Table 3 below.

TABLE 3.

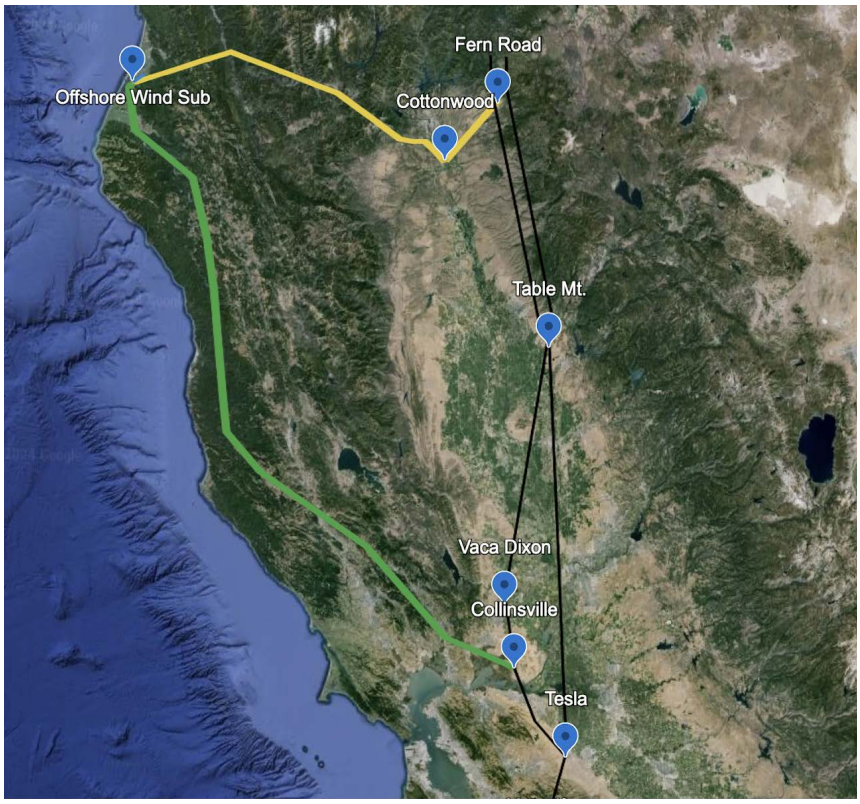
Transmission Projects Needed to Delivery North Coast Offshore Wind

PROJECT DESCRIPTION	ESTIMATED COSTS ($M)
New 500 kV substation and 260 mile 500 kV line to the new Collinsville substation (convertible to HVDC in the future)	$1,913 - $2,740
140 mile 500 kV line from the new Humboldt substation to the Fern Road substation (Shasta County)	$980 - $1,400
115 kV/115 KV phase shifting transformer and 6 mile 115 kV line to the existing Humboldt 115 kV substation (community benefit)	$40 - $57
North Dublin – Vineyard 230 kV reconductor	$116 - $233
Tesla – Newark 230 kV line No. 2 reconductor	$29 - $58
Collinsville 230 kV reactor (10 ohms)	$39 - $58

The new 500 kV Humboldt substation and the two new 500 kV transmission lines will be eligible for competitive solicitation by the CAISO. The other transmission projects will be managed by PG&E. It is expected that the CAISO will provide a schedule for the competitive solicitation in May 2024. Map 2 below shows the approximate locations of the proposed transmission lines. Existing 500 kV transmission lines are shown in black.

MAP 2.

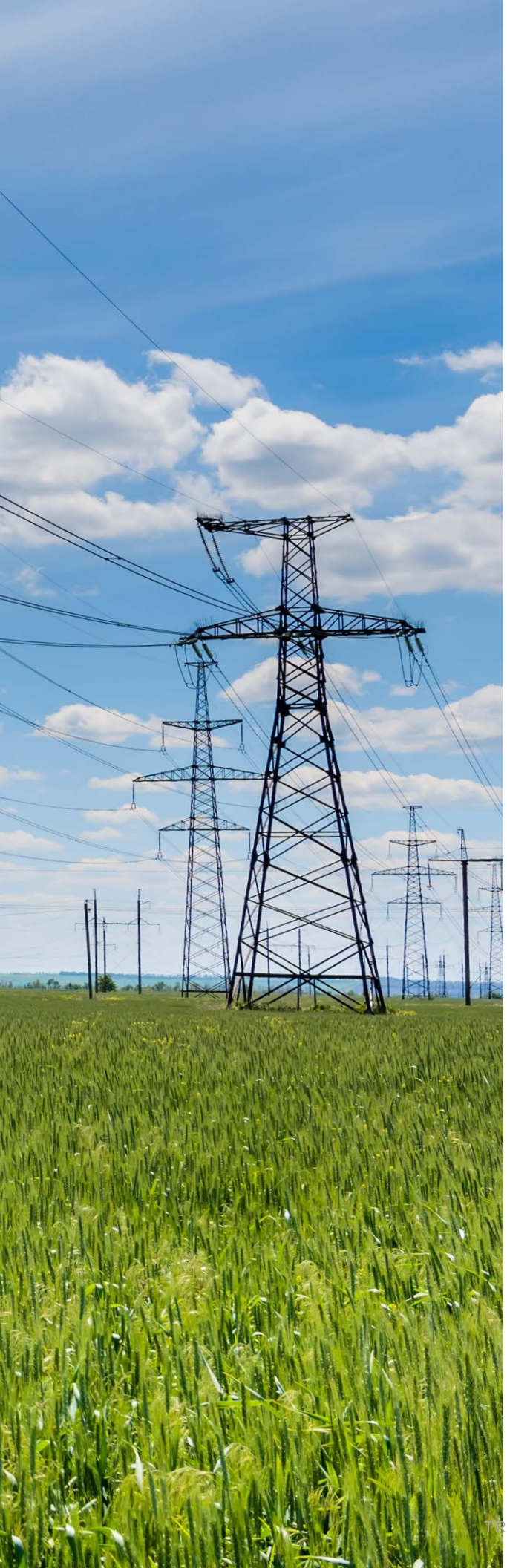
Approximate Locations of New 500 kV Transmission Projects



The proposed 500 kV transmission lines will need to go through very steep and fire-prone terrain in the Northern California Coastal Range. It will be the responsibility of the selected project developer(s) to define the specific routes for each transmission line as well as to acquire land rights and obtain development permits.

CEERT believes that it is important to start to make progress in developing transmission for potential North Coast offshore wind development. Therefore, CEERT supports the CAISO staff recommendations for the North Coast offshore wind projects. However, there is substantial uncertainty that the Humboldt offshore wind resource will be operational by 2035. The level of risk for these projects is greater than for other resources included in the base case portfolio.

The CAISO staff has argued that the new 500 kV substation and the two new 500 kV lines can still provide economic benefits to the grid in the event that the offshore wind resources are not built or are significantly delayed. However, they have not analyzed these benefits



in comparison with other alternatives that would increase transmission capacity from the California Oregon Intertie. In addition, there is an opportunity cost of proceeding with transmission projects that may not deliver additional renewable energy compared to transmission projects developed in other parts of the state that create more optionality.

For these reasons, CEERT believes it is prudent to proceed with the award of competitively solicited transmission development agreements for the new Humboldt 500 kV substation and the 260 mile HVDC cable, which will initially be operated as a 500 kV AC line to the Collinsville substation and the 140 mile 500 kV AC line from the Humboldt 500 kV substation to the Fern Road substation. The developers should be encouraged to obtain necessary permits with a guarantee of cost recovery of the permitting costs. However, a final decision to build the projects should await further information about the viability of the Humboldt offshore wind project and its timing.

ECONOMIC PLANNING STUDIES

As part of its transmission planning process, the CAISO conducts a production cost simulation to assess the economic benefits of transmission projects that mitigate congestion and curtailment on the transmission system. The CAISO conducts the economic analysis using a base case transmission model that includes transmission projects that have been identified through earlier reliability- and policy-driven studies. The purpose of the economic studies is to identify additional cost-effective transmission projects beyond those that are being recommended for reliability- or policy-driven needs.

The CAISO presents the results of the economic studies for major sections of the bulk power grid. The results provide an estimate of the number of hours that portions of the grid are congested and the costs to ratepayers resulting from the congestion. The CAISO also provides a high-level explanation of the causes of the congestion. The following table shows five congested portions of the CAISO system.

TABLE 4.

Base Case Production Cost Simulation Results

CONSTRAINED AREA	ANNUAL HOURS OF CONGESTION	ANNUAL CONGESTION COSTS (M$)	CAUSES OF CONGESTION
California – Oregon Intertie (Round Mountain to Tesla)	1903	$159.61	Congestion increases with the development of the Humboldt offshore wind project
Path 26 (Antelope Valley to Southern Central Valley)	3220	$61.06	Congestion occurs from large amount of renewable generation from Southern California with south to north power flows
Path 61 (Victorville to Lugo in the Mojave Desert)	1247	$54.64	Congestion occurs under N-1 contingencies of the El Dorado–Lugo line impacting Southern Nevada solar and Wyoming wind
Moss Landing to Las Aguilas 230 kV Line (Central Coast to Central Valley)	1115	$27.0	Congestion occurs from Fresno area solar generation and will be aggravated by increases in solar generation in the Fresno area
Path 15 (Midway to Los Banos)	1140	$21.7	Path 15 congestion is correlated with Path 26 congestion and is impacted by solar development in the Fresno/Kern areas and Central Coast offshore wind

Related to transmission congestion is the curtailment of wind and solar generation on the CAISO transmission system. Congestion on the transmission system acts as a bottleneck, forcing the grid operator to give instructions to generators that are behind the bottleneck to reduce their output. Increasing levels of curtailment of solar and wind generation indicate that there is a need to upgrade or expand grid infrastructure. When solar and wind resources are curtailed it often results in the increased dispatch of fossil fuel generation situated in other locations of the grid. The table below highlights the renewable energy zones within the CAISO system where curtailment is occurring at relatively high levels.

TABLE 5.

Wind and Solar Curtailment in the Base Case Resource Portfolio

RENEWABLE ZONE	CURTAILMENT (GWH)	CURTAILMENT RATIO	PORTION OF TOTAL CURTAILMENT
PG&E Greater Fresno	4,267	18.8%	22.5%
Valley Electric (Southern Nevada)	2,622	22.9%	13.8%
SCE Northern (Antelope Valley)	2,560	5.7%	13.5%
SCE North of Lugo (San Bernardino)	1,449	14.1%	7.6%
Arizona (Palo Verde)	1,355	12.1%	7.1%
Total	**18,972**	**8.8%**	

The CAISO did not recommend any transmission projects in the 2023-2024 TP based on its economic production cost modeling. However, the CAISO observed that congestion on the Path 15 Corridor and on the Moss Landing – Las Aguilas 230 kV line increased significantly since the last CAISO Transmission Plan. The map below shows the Path 15 and Path 26 Corridors as well as the location of the Moss Landing – Las Aguilas 230 kV line.

MAP 3.

Path 15, Path 26 and Moss Landing – Las Aguilas 230 kV Line

The CAISO evaluated eight alternative transmission proposals to mitigate congestion on Path 15 and the Moss Landing – Las Aguilas line. The CAISO found that two alternatives for reconductoring the Moss Landing – Las Aguilas 230 kV line offered net positive economic benefits for ratepayers by mitigating congestion. However, a larger, more comprehensive project consisting of the development of a new 500 kV line from Manning to Moss Landing, to replace the existing Moss Landing – Las Aguilas 230 kV line and the reconductoring of the Moss Landing – Metcalf 500 kV line, could provide greater benefits and will continue to be assessed in the next annual transmission planning process.

The reduction in congestion alone was found not to be sufficient to cover the cost of the more comprehensive Central Valley transmission project. However, the CAISO indicated that there may be additional benefits from this transmission alternative, such as reducing the need for gas-fired generation in the Greater Bay Area, that still need to be evaluated. The CAISO requested further guidance from the CPUC regarding planning for the future retirement of gas-fired generation. In response, the CPUC has proposed a high-level gas retirement sensitivity case to be included in the 2024-2025 Transmission Planning Process.

Similarly, the subsea HVDC cable between Diablo Canyon and the Los Angeles Basin proposed by California Western Grid Development was not found to be economically justified based solely on the reduction in congestion on Path 26. However, the impact of this project on the need for gas-fired generation in the Los Angeles Basin was not evaluated in the economic studies in the 2023-2024 TP.

3

TRANSMISSION IN THE SAN JOAQUIN VALLEY

The San Joaquin Valley of California is an excellent location for solar energy development. The Valley receives an average of 300 days of sunshine per year, and the land is relatively flat and open. Unfortunately, excessive drafting of groundwater is limiting agricultural uses in some areas of the San Joaquin Valley. However, there is a significant potential for economic development associated with the growth of solar and associated battery development here. The major limiting factor to solar development in the Valley has been congestion and curtailment on the transmission lines in the Path 15 Corridor.

The 2023-2024 TP analyzed several new alternative transmission projects along the Path 15 Corridor. The alternatives included a new 500 kV line linking the Midway, Gates, and Manning substations, and a new Manning to Los Banos to Tracy 500 kV line. These new transmission lines were evaluated as standalone projects as well as in combination with a Moss Landing to Manning 500 kV line and the reconductoring of the existing Moss Landing to Metcalf 500 kV line.[9]

None of the combinations of the Path 15 transmission projects were determined by the CAISO to be economically justified based on the value of reduced transmission congestion when using the 2035 base case portfolio. Map 4 below shows the transmission projects that were evaluated through production cost modeling in the draft 2023-2024 TP.

MAP 4.

Path 15 500 kV Transmission Expansion Projects Modeled for Economic Benefits

For the 2024-2025 Transmission Planning Process, the CAISO will model a new base case portfolio provided by the CPUC, which forecasts need through 2039. The CPUC has also mapped out a high gas retirement sensitivity portfolio that assumes 10.5 GW of gas-fired generators will be retired by 2039. While the details of the CPUC busbar mapping have not yet been posted, the majority of the gas retirements are assumed to be located in the Greater Bay Area and the Los Angeles Basin.

The 2024-2025 base case resource portfolio has made some major changes from the 2023-2024 base case portfolio. The new base case portfolio is assumed to achieve a GHG target for the electric system of 25 MMT by 2035. The 2024-2025 base portfolio includes significantly more in-state wind capacity and less solar and battery capacity.

The CPUC explained these major changes were triggered by new wind projects being added by the RESOLVE capacity expansion model. Busbar mapping of resources to specific substations has also changed due to the use of an updated set of transmission

constraints developed by the CAISO. The changes in busbar mapping result in fewer resources being mapped to the San Joaquin Valley. Table 6 below compares the resources included in the 2023-2024 base case portfolio in 2035 with the 2024-2025 base case portfolio for 2039. The two bases case portfolios are also compared to the 2045 resource portfolio provided by the California Energy Commission for use in the 20-Year Transmission Outlook update.

TABLE 6.

Nameplate Capacity (MW) of Various Resource Portfolios Modeled by the CAISO[10]

RESOURCE TYPE	2023-2024 BASE CASE (2035)	2024-2025 BASE CASE (2039)	20-YEAR OUTLOOK SCENARIO (2045)
Natural gas power plants	(-4,460)	(-5,430)	(-15,000)
Utility Scale Solar	38,947	25,200	69,640
Distributed Solar	125	125	125
In-state wind	3,074	10,362	3,074
Offshore wind	4,707	4,531	20,000
Out-of-state wind	4,828	10,204	12,000
Geothermal	2,037	1,731	2,332
Biomass	134	171	134
Battery storage	28,374	21,364	48,813
Long-duration storage	2,000	985	4,000
Generic clean firm energy	-	-	5,000
Total New Resources	**85,015**	**74,548**	**165,118**

The changes in the types of resources included in the 2024-2025 base case resource portfolio impact the amount of resources allocated to transmission zones across the state. A significant impact can be seen in the opportunity for solar and battery resource development in the San Joaquin Valley. Table 7 below compares the amount of solar and battery storage assumed to be developed in the PG&E Greater Fresno area[11] for the CPUC 2023-2024 base case portfolio, the 2024-2025 base case portfolio, and the 20-Year Outlook portfolio.

10 The 2023-2024 base case portfolio is from the CAISO draft 2023-2024 Transmission Plan, Page 63. The 2024-2025 base case portfolio is from the Busbar Mapping Results for the Proposed 2024-2025 TPP Portfolio, IRP staff, Dec. 8 2023, Page 7. The 2045 Outlook portfolio is from the CAISO 20-Year Transmission Outlook Update, Jan. 4, 2024, Page 11.

11 The mapped portfolio for the PG&E Greater Fresno Interconnection Area can be found at Page 78 of the draft 2023-2024 TP.

TABLE 7.

Nameplate Capacity (MW) for Portfolio Resources in the Greater Fresno Area

RESOURCES	2023-2024 BASE CASE PORTFOLIO (2035)	2024-2025 BASE CASE PORTFOLIO (2039)	20-YEAR TRANSMISSION OUTLOOK PORTFOLIO (2045)
Solar	5,819	4,816	14,065
Lithium Ion Batteries	3,814	2,830	7,895

The purpose of the 20-Year Transmission Outlook is to help state policymakers further refine resource planning by providing a longer term perspective regarding the need for transmission to meet the state's policy goals. The portfolio comparison suggests there is a need for better coordination between the 20-Year Transmission Outlook and the CPUC's Integrated Resource Planning Process in future resource portfolio development. The magnitude of change from the 2023-2024 and the 2024-2025 base case portfolios could make longer term procurement challenging.

There is robust commercial interest in developing solar paired with battery storage as well as standalone battery storage in the Greater Fresno area. In interconnection Cluster 15 there are 77 requests for solar paired with battery storage projects, 47 interconnection requests for standalone battery storage projects, four interconnection projects for hydrogen-powered combustion turbines combined with battery storage, one standalone wind project, and one standalone solar project. The interconnection capacity requested for solar hybrid projects totaled 47,366 MW while standalone batteries accounted for 16,540 MW. The following tables break out the interconnection requests for solar paired with battery storage projects and standalone projects by counties in the Greater Fresno Area.

TABLE 8.

Cluster 15 Interconnection Requests for Solar Paired with Battery Storage

COUNTY	NUMBER OF INTERCONNECTION REQUESTS	CAPACITY AT POINTS OF INTERCONNECTION (MW)
Fresno	42	24,480
Kern	10	7,450
Kings	10	7,900
Madera	1	400
Merced	10	2,290
Tulare	4	4,846
Total	**77**	**47,366**

The quantity of solar projects paired with battery storage in Cluster 15 of the CAISO interconnection queue vastly exceeds the amount of resources that the CPUC has included in its 2024-2025 base case portfolio. Unless additional transmission is developed, the vast majority of the interconnection requests cannot be accommodated in the foreseeable future. If energy policy makers are interested in promoting solar energy development in the San Joaquin Valley, there will be a need for the CPUC to revisit how it incorporates the large amount of commercial interest in the San Joaquin Valley in its Integrated Resource Planning process.

TABLE 9.

Cluster 15 Interconnection Requests for Standalone Battery Projects

COUNTY	NUMBER OF INTERCONNECTION REQUESTS	CAPACITY AT POINTS OF INTERCONNECTION (MW)
Fresno	23	9,450
Kern	2	1,000
Kings	2	300
Madera	3	575
Merced	16	5,215
Tulare	1	40
Total	**47**	**16,540**

It is unclear at this moment how the Cluster 15 interconnection requests for standalone battery storage projects will be prioritized in comparison with solar projects paired with battery storage in the PG&E Greater Fresno area. Many of the battery project developers have requested interconnection at the same substations as those requested by developers of solar projects paired with battery storage. The CAISO Interconnection Process Enhancement initiative, which will be discussed further below, intends to limit the total quantity of interconnection capacity that will be studied in each transmission zone and subzone.

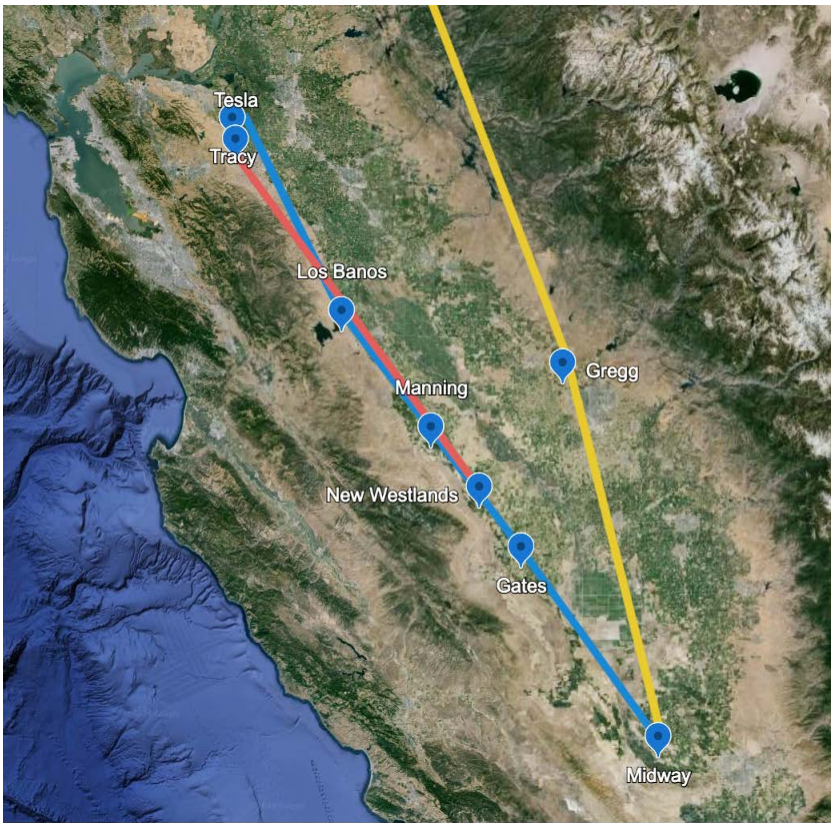
CEERT has supported prioritizing the San Joaquin Valley as a location for the development of solar and battery resources. The Valley is going through a transition as climate change impacts agricultural production. CEERT believes that, with careful attention to addressing community needs, the San Joaquin Valley can become an important hub of the emerging clean energy economy. However, the sustained growth of solar development in the San Joaquin Valley will require investment in additional transmission infrastructure.

Renewable project developers have requested that three new transmission lines located in the San Joaquin Valley be studied in the 2024-2025 transmission planning process. Those

projects include: 1) the Monarch 500 kV line from a new substation in the Westlands Water District to the Tracy substation; 2) a 500 kV line from the Midway substation to the Gregg substation located near Madera and extending up to the Round Mountain substation in Shasta County; and 3) a 500 kV line running from the Midway substation to the Tesla substation. The map below shows the approximate routes of the proposed new 500 kV transmission lines in the Central Valley.

MAP 5.

500 kV Transmission Lines Proposed for Study in the 2024-2025 Transmission Plan



4

REDUCING THE LA BASIN'S DEPENDENCE ON GAS-FIRED GENERATION

The Los Angeles Basin continues to be very dependent on local gas-fired generation to maintain local electric system reliability. Local plants are required to operate since the regional transmission system is insufficient to meet local requirements during most hours of the year. In addition to the local needs, thermal power plants along the South Coast have been needed to meet statewide reliability requirements. It was assumed that these coastal power plants with once-through-cooling, built in the 1950s, would be retired to eliminate their thermal pollution of the ocean and its impact on aquatic habitat.

While these older coastal power plants[12] were originally planned for closure in 2023, the California Energy Commission determined that they might still be needed through the summer of 2026 during extreme weather events. Based on this potential need, the State Water Resources Control Board extended their compliance date for water discharge permits until the end of 2026.[13] CEERT has requested that the CEC staff reassess their finding that there is a continued need for these power plants to operate through 2026 based on changed circumstances over the past year. In particular, CEERT has pointed out to the CEC the large quantity of battery storage projects added to the CAISO system in 2023.[14]

In 2022, the Accelerating Renewable Energy Delivery Act (SB 887, Becker) was enacted into law. The law provided additional direction to the CPUC regarding resource and transmission planning. It noted that there are multiple load pockets in California where there is insufficient transmission to import readily available renewable energy resources that could reduce the need for fossil fueled resources.

SB 887 directed the CPUC to provide by March 31, 2024 resource projections for 2035 that would enable the CAISO to determine what transmission expansion would be needed to reduce reliance on fossil fuel resources in load pockets such as the Los Angeles Basin.

12 The coastal power plants are Alamitos 3, 4, and 5 (1,141 MW), Huntington Beach Unit 2 (227 MW), and Ormond Beach Units 1 and 2 (1,491 MW).

13 The California Energy Commission voted on August 9, 2023 that there was a need to extend the life of the Ormond Beach Generating Station, the AES Alamitos, and the AES Huntington power plants through the summer of 2026.

14 As of 3/7/2024 the CAISO reports that there are 7,261MW of battery storage projects they can dispatch to meet reliability needs. At the beginning of 2023, the total amount of battery storage was 4,514 MW.

It is with this policy guidance that the CPUC decided to develop a high gas retirement sensitivity portfolio for use in the 2024-2025 transmission planning process. The CAISO requires detailed busbar mapping for the sensitivity portfolio from the CPUC. That information was not available at the time the CAISO posted its draft study design for the 2024-2025 transmission planning process.[15]

In December, the CPUC IRP staff held a workshop at which they outlined criteria for determining which gas-fired power plants should be modeled as offline for the purpose of transmission planning. In addition to the planned retirement of the coastal once-through-cooling power plants and older cogeneration power plants, they assumed that an additional 4,677 MW would not be retained in the resource mix by 2034, and 10,515 MW would be offline by 2039.

The IRP staff proposed criteria to be used to determine which power plants should be modeled as not operating included data about the power plants' locations, their emissions, and their performance. Factors used to prioritize resources as being offline include: 1) proximity to a disadvantaged community; 2) emissions of nitrogen oxide (NOx); 3) location in an ozone or PM 2.5 nonattainment zone; 4) power plant age; and 5) power plant heat rate and capacity factor.

While the detailed busbar mapping of the resource locations for the sensitivity portfolio are not yet available, the IRP staff provided an illustrative high-level breakdown of non-retained gas plants by local capacity areas (load pockets). Table 10 below presents the general locations of the gas-fired power plants that would not be retained by 2039. These non-retained plants represent approximately 39% of the gas-fired fleet capacity.

TABLE 10.

Locations of Offline Gas-fired Power Plants by Local Capacity Areas

LOAD POCKET (LCR AREA)	MW TO BE MODELED AS OFFLINE
LA Basin	3,622
Bay Area	1,260
Fresno	648
San Diego – Imperial Valley	625
Stockton	361
Ventura	349
Kern	304
Sierra	196
Not in LCR Area	3,622
Total	**10,469**

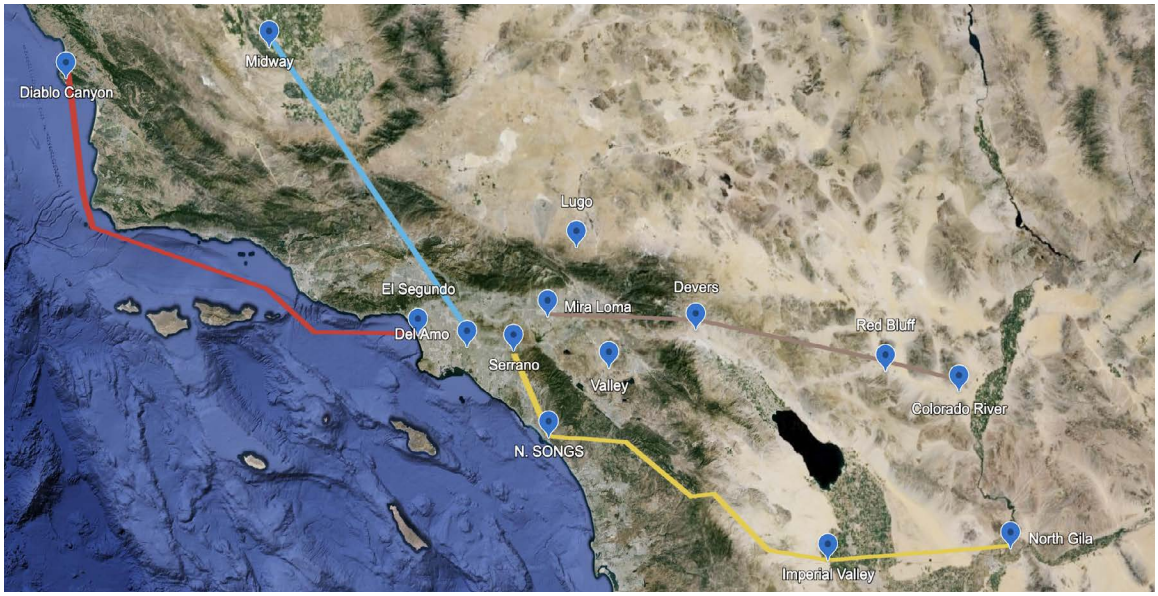
15 The final 2024-2025 Study Plan is expected to be posted by the CAISO sometime in Spring 2024.

CEERT will continue to participate in the 2024-2025 transmission planning process. One of CEERT's top objectives is to advance transmission solutions, which, when combined with clean energy projects, can significantly reduce the need for gas-fired generation in or near disadvantaged communities. According to the IRP staff, approximately 72% of the gas-fired power plant fleet in California is in or near a disadvantaged community.

The first CAISO 20-Year Transmission Outlook identified three possible HVDC lines into the Los Angeles Basin from surrounding resource-rich regions. These conceptual projects included a subsea HVDC cable from Diablo Canyon to El Segundo as well as two HVDC lines starting from the Lugo and Devers substations and terminating at substations in the LA Basin. More recently, project developers have proposed several transmission projects to be studied by the CAISO. These projects are shown on the map below.

MAP 6.

Transmission Projects Proposed to be Studied in the 2024-2025 Transmission Plan



The 20-Year Transmission Outlook evaluated the benefits of a new 500 kV AC line from the North Gila substation located in Arizona that tied into the Imperial Valley substation west of El Centro as well as several alternative routes from Imperial County into the Greater LA region.

The 2022-2023 Transmission Plan further studied the need for transmission expansion along this southern corridor. The CAISO approved three separate transmission projects in the 2022-2023 Transmission Plan that are being competitively procured. The 500 kV lines from North Gila, to Imperial Valley, continuing to a new North of SONGS substation, and terminating at the Serrano substation in Orange County, are shown in the map above in yellow.

The transmission lines highlighted in blue and red in the map above have been proposed by transmission project developers[16] for study by the CAISO in the 2024-2025 Transmission Plan. One project, a 2,000 MW subsea HVDC line from Diablo Canyon to El Segundo, has been previously evaluated by the CAISO.[17] However, the benefits of reducing dependence on LA Basin gas-fired generation was not included in that evaluation. The second project is also a 2,000 MW HVDC line that would use a decommissioned oil pipeline for much of the proposed route from Kern County to the LA Basin. The transmission line highlighted in brown on the map would follow an existing SCE transmission corridor from the Colorado River substation, through the Red Bluff substation, to the Devers substation, and then extended to the Mira Loma substation in San Bernardino County.

CEERT is looking forward to the CAISO studying the multiple economic benefits for both the base case portfolio and, in particular, the high gas generation retirement portfolio. CEERT expects that the CAISO will evaluate the projects both individually and in combination to determine how the retirement of gas generation can be effectuated by 2039.

16 California Western Grid Development LLC and Kern Southland Energy Link LLC.

17 The subsea HVDC cable would terminate at a converter station near the El Segundo power plant and would then extend to the El Nido and Redondo Beach substations via four 230 kV transmission lines.

5
TRANSMISSION PERMITTING REFORM

Transmission permitting reform continues to be a high priority need in California as the CAISO prepares to approve an additional 26 reliability-driven and policy-driven transmission projects. Including the last two transmission plans and the one in the current planning cycle, the CAISO will have recommended 94 transmission projects that will need to be built to assure that California's electric system remains reliable and meets the state's climate goals over the coming decades.

Last year's efforts at Legislature for the reform of transmission permitting by providing additional authority to the California Energy Commission were unsuccessful, with vetoes of SB 420 (Becker) and SB 619 (Padilla). The Governor's veto message indicated that transmission permitting reform would be a priority at the CPUC as it revises General Order (GO) 131-D, which sets forth the rules for permitting transmission projects.[18]

Currently, the CPUC reviews the need for transmission projects, their benefits to electric ratepayers, and environmental impacts through either its Certificate for Public Convenience and Necessity (CPCN) process or its Permit to Construct (PTC) process.

In our last transmission report, CEERT reviewed a Southern California Edison (SCE) study that found the average time for the review and approval of 28 transmission permit applications submitted between 2003 and 2018 was 836 days. SCE concluded that the time it took the CPUC to review and approve CPCN and PTC applications for transmission projects was unreasonable.

Awareness of the very lengthy transmission permitting process is not new. In 2022, SB 529 (Hertzberg) was enacted in order to reduce the amount of time it takes the CPUC to permit transmission projects. A Senate analysis at the time observed that the current CPUC process "hampers the ability of deploying necessary transmission projects in a timely fashion to support deployment of zero-carbon and renewable energy resources."

SB 529 required the CPUC to reform the permitting process used for applications for extensions, expansions, or upgrades of transmission projects. In December 2023, the

18 https://docs.cpuc.ca.gov/PUBLISHED/Graphics/589.PDF

CPUC adopted changes to GO 131-D to make the change mandated by SB 529.[19] However, as Assemblymember Eduardo Garcia and other members of the State Assembly recently observed, "the decision did not go far enough."[20]

CEERT believes that the most direct path forward at this time is for the CPUC to grant the motion for review of the Settlement Agreement submitted by 18 parties to CPUC in the SB 529 permitting reform proceeding.[21] The Settlement Agreement was filed on September 29, 2023 and has not been acted upon.

The reforms proposed in the Settlement Agreement are straightforward. The reforms include:

- Allowing project proponents to prepare CEQA documents
- Recognizing CAISO transmission planning decisions regarding project need
- Setting clear deadlines for CPUC CEQA processes
- Clarifying procedures for filing, processing and disposition of protests

Recognizing the broadly supported Settlement Agreement is an action the CPUC can take immediately to expedite the permitting of CAISO approved transmission projects.

There may be other transmission policy reforms that the CPUC should consider to improve the timely completion of needed transmission projects in a cost-effective manner. One idea that has been advanced by Cal Advocates is the sharing of utility transmission rights of way (ROW) between incumbent electric utilities and other regulated transmission operators. Cal Advocates argue that ROW sharing can reduce project costs and streamline project construction because it would enable other transmission developers to: 1) build on already-permitted land; 2) use already-constructed assets; and 3) locate construction on land parcels that have already undergone some form of environmental review.[22]

The CAISO already utilizes a competitive bidding process for certain transmission projects. The Cal Advocates proposal could expand the number of transmission projects subject to competitive bidding, which may help contain costs. CEERT believes that the Cal Advocates proposal deserves further consideration by the CPUC to determine under what circumstances ROW sharing might be appropriate and in the interest of ratepayers.

19 CPUC rulemaking R.23-05-018.

20 March 20, 2024 letter to CPUC President Alice Reynolds from Assemblymember Eduardo Garcia and others.

21 The Settling Parties are SCE, PG&E, SDG&E, San Diego Gas & Electric Company (SDG&E), Pacific Gas and Electric Company (PG&E), Southern California Edison Company (SCE), Bear Valley Electric Service, Inc., Liberty Utilities (CalPeco Electric) LLC, PacifiCorp, American Clean Power, Independent Energy Producers Association, Center for Energy Efficiency and Renewable Technologies, Environmental Defense Fund, LS Power Grid California LLC, REV Renewables, LLC, Large-Scale Solar Association, California Energy Storage Alliance (CESA), Horizon West Transmission, LLC, Trans Bay Cable LLC, and GridLiance West LLC.

22 Public Advocates Office Opening Comments on the ALJ Ruling Inviting Comment on Phase 2 Issue, Rulemaking 23-05-018, February 5, 2024.

6
INTERCONNECTION REFORM

The volume of clean energy interconnection requests has surged across the United States, overwhelming the processes used to study their impact on the electric grid. While the increase in number of interconnection requests is particularly notable in California and the rest of the West, there has been rising interest in other regions of the country as well. According to a report recently released by Lawrence Berkeley National Laboratory (LBNL) there are 995 active projects in the CAISO interconnection queue with a total estimated capacity of 523.3 GW—that amount of capacity is almost 10 times the current peak demand for electricity in the CAISO system.[23]

In response to this surge of interconnection activity, the Federal Energy Regulatory Commission (FERC), the CAISO, and others have begun implementing interconnection reform.

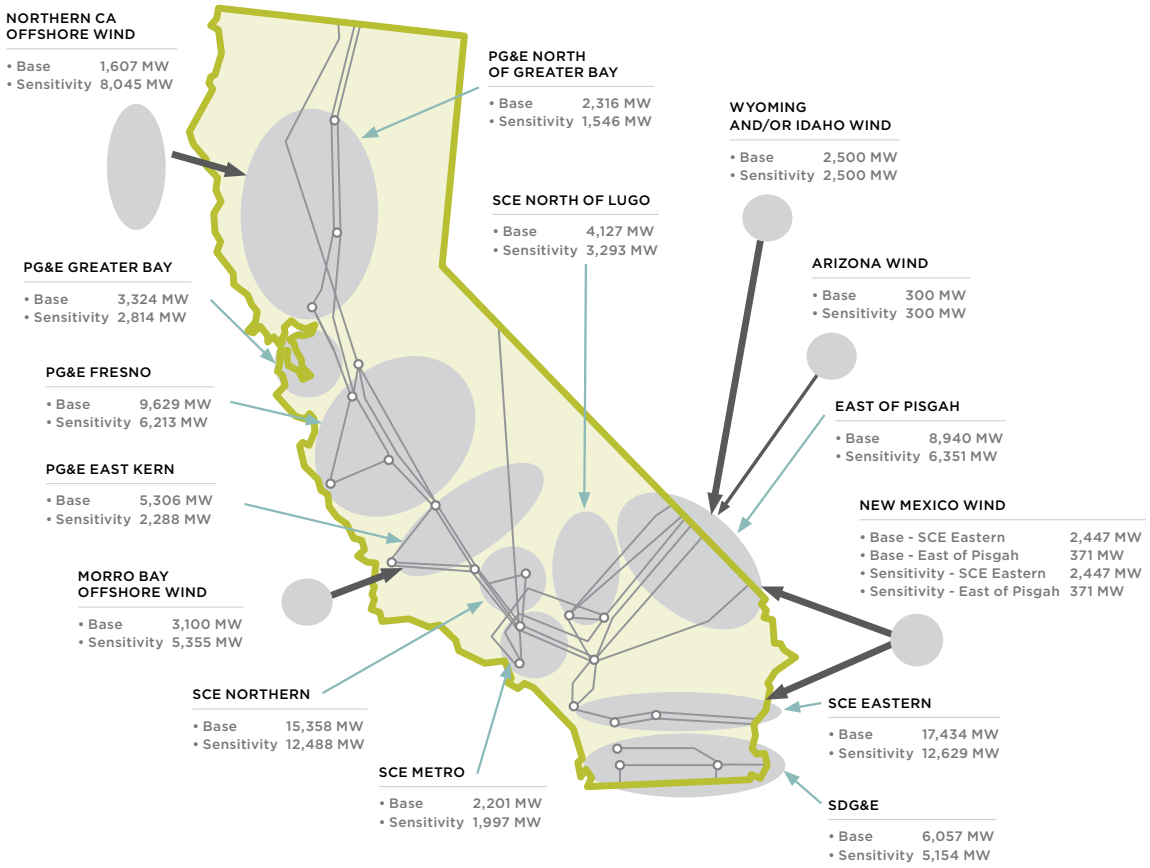
FERC Order 2023 was adopted in July 2023 with the intent of expediting the connection of new generation projects to the grid. Order 2023 introduced more transparency about grid capabilities for interconnection customers, standardized study processes including requirements for site control, entry fees and security deposits, and provided more clarity on cost allocation, while also promoting grid modernization technologies. Importantly, FERC recognized the need for "readiness requirements" for project developers, ensuring they are prepared to move forward with interconnection once approved.

23 Queued Up: 2024 Edition, Characteristics of Power Plants Seeking Transmission Interconnection as of the End of 2023. Joseph Rand, Nick Manderlink, Will Gorman, Ryan Wiser, Joachim Seel, Julie Mulvaney Kemp, Seongeun Jeong, Fritz Kahrl. April 2024 .

The CAISO's interconnection process enhancement has focused on adding necessary implementation details to the "readiness requirement" for interconnection customers to determine which projects to study. A key principle that has driven the CAISO interconnection reform process is the zonal approach to planning that was adopted to coordinate transmission planning and resource procurement. The map below shows the CAISO transmission planning zones and the planned resource capacity additions for each zone based on the 2023-2024 Transmission Plan.

FIGURE 1.

Transmission Planning Zones and Capacity



The CAISO is proposing a scoring system to rank each interconnection request beginning with Cluster 15. Interconnection requests for projects in each transmission zone will be ranked based on criteria related to commercial interest, project viability and system need.[24]

24 https://stakeholdercenter.caiso.com/StakeholderInitiatives/Interconnection-process-enhancements-2023

Interconnection requests in Cluster 15 and future clusters will be studied only for projects that are ranked, up until a threshold of 150% for each transmission constrained area.[25] The CAISO has proposed a tie-breaking process for equally ranked projects on the margin.

In addition to revising the project intake process, the CAISO is also proposing to regularly apply viability criteria for projects in the queue to ensure that they continue to make progress to commercial operation. If projects fail to make progress they will be removed based on specific limits on time-in-queue for each cluster.

The ISO will also require transmission owners to commence network upgrades upon receipt of a notice to proceed. Delays in completing network upgrades, particularly by PG&E, have significantly delayed the commencement of clean project construction over the past several years.

CLUSTER 15 INTERCONNECTION REQUESTS

The most immediate impact of the proposed CAISO interconnection reform will be on the study of requests submitted during the Cluster 15 intake period, which occurred in April 2023. The quantity of interconnection requests was so large that the CAISO requested permission from FERC to delay the initiation of interconnection studies. The delay was granted by FERC in August 2023.

According to the CAISO, there were 508 active interconnection requests in Cluster 15. The overwhelming majority of the Cluster 15 interconnection requests are for standalone battery projects and for solar projects paired with batteries. However, Cluster 15 also includes interconnection requests from offshore wind projects and out-of-state wind projects in Idaho, New Mexico, and Wyoming, as well as several pumped storage and hydrogen combustion turbine projects.

The CAISO has conducted a survey of projects in the queue and believes that approximately 200 projects will continue with the process and be scored based on the criteria for commercial interest, project viability, and system needs. The CAISO believes that limiting the projects to 150% of the transmission capacity in each zone and subzone will leave about 112 projects to be studied. The implementation of this funneling process will occur over the next year.

Interconnection customers will have until December 2024 to modify their request, taking into account their understanding of zonal limitations in transmission capacity. Each project developer will self-score the viability of their projects based on specific criteria and submit the information to the CAISO. Then, within 10 days, load serving entities will submit information about their commercial interest in procuring energy from specific projects.

25 Several participants in the CAISO stakeholder process on interconnection have suggested a pro rata reduction among the interconnection requests. Others have argued for a higher cap such as 200%.

The CAISO will have until May 2025 to validate the submitted information and rank the projects. Scoping meetings, presenting the results for each zone, will be held before the end of May, 2025. The Cluster 15 study will begin by June 2025. CEERT recognizes that the process for funneling down the queue is complicated. We understand that there are some details about deliverability allocation that still need to be worked on collaboratively. CEERT urges the CAISO to adopt the recommended reforms at its May meeting.

CEERT has taken a look at the Cluster 15 interconnection queue and has conducted a high-level review of completed applications to gain a better understanding of potential impacts using the 150% threshold for specific regions of the state. As noted above in this report, CEERT supports prioritizing the San Joaquin Valley for solar and associated battery development and developing transmission together with clean energy projects that will reduce dependence on gas-fired generation in the LA Basin.

Our analysis starts by observing that the Cluster 15 study process should assure that the portfolio of procured resources be diversified among technologies and geographical location. To promote diversity, the CPUC 2023-2024 base case portfolio includes offshore and out-of-state resources. The quantities for each resource are shown in the following table.

TABLE 11.

Quantities of Offshore and Out-of-State Wind Resource Included in the 2023-2024 Base Case Portfolio

RESOURCE AREA	WIND RESOURCE (MW)
Northern California Offshore Wind	1,607
Morro Bay Offshore Wind	3,100
Wyoming/Idaho Wind	2,500
New Mexico Wind	2,881

The Cluster 15 interconnection queue shows that there are interconnection requests for quantities far in excess of the amounts specified for each region in the resource plan. A summary of the interconnection requests for offshore and out-of-state wind projects is shown in the following table.

TABLE 12.

Interconnection Requests for Offshore and Out-of-State Wind Projects in the Cluster 15 Queue

RESOURCE AREA	NUMBER OF IRS	TOTAL REQUESTED CAPACITY
Northern California Offshore Wind	2	2,300
Morro Bay Offshore Wind	4	5,600
Wyoming/Idaho Wind	7	9,728
New Mexico Wind	1	3,000

The amount of interconnection capacity requested for the Morro Bay offshore wind projects at the Diablo Canyon 500 kV switchyard exceeds 150% of the need contained in the resource plan. However, since there are only four interconnection requests for offshore wind projects, eliminating one or more from the study process could limit procurement options for load serving entities.

However, in the case of Wyoming/Idaho wind resources, which would deliver power into the East of Pisgah transmission zone, it seems reasonable to reduce the number of requests to study the interconnection of 3,750 MW of capacity for the CAISO system. The East Pisgah transmission zone also serves as the transmission pathway for solar and geothermal power plants that could be developed in Southern Nevada.

The 2024-2025 base case portfolio calls for the development of 985 MW of long-duration storage by 2039. The Cluster 15 interconnection queue includes five pumped hydro storage projects, including a major upgrade to the existing Helms project and another in the Sierras near Fresno. The two large pumped hydro resources in Fresno County both are approximately 150% of the need for long-duration storage, as are the combined total for the other three projects, which are located in Calaveras, Colusa, and Kern Counties.

PG&E is the owner of the Helms pumped hydro project, the load-serving entity for a portion of Northern California and the owner of transmission in Fresno County. Under the CAISO scoring proposal, PG&E could indicate its preference to procure storage from the expanded Helms project for its customers. It is likely that the interconnection study for the 1,332 MW of additional energy flowing through the nearby Gregg substation would trigger the need for large-scale network upgrades. It is possible that this is the best solution for the procurement of long-duration storage, but the interconnection reform rules may preclude full consideration of other long-duration storage options in the Cluster 15 queue.

The Cluster 15 queue includes 13 hybrid battery/combustion turbine projects totaling 5,196 MW of capacity. Information in the queue indicates that the combustion turbines would use hydrogen as fuel. Three of the projects would be located in the Metro Los Angeles area, three in or near Fresno, and three in or near Stockton. Two of the projects would be interconnected at 500 kV to the Lugo and Antelope substations. Presumably, there is yet to be commercial interest in procuring power from the projects so they are unlikely to be ranked highly in areas where there are other more competitive projects. However, it may be important over the longer term to plan for the interconnection needs of "clean firm power."

As noted earlier, the overwhelming majority of projects in the Cluster 15 queue are either standalone batteries or batteries paired with solar generation. Besides the offshore wind projects, there are only 10 interconnection requests for wind generation and none for geothermal projects in Cluster 15. The following table shows the number of interconnection requests and the requested capacity by each of the transmission zones in the CAISO system.[26]

TABLE 13.

Cluster 15 Interconnection Requests by Transmission Zone

TRANSMISSION ZONE	TOTAL INTERCONNECTION REQUESTS	MW REQUESTED AT THE POINT OF INTERCONNECTION	INTERCONNECTION REQUESTS FOR STANDALONE BATTERY SYSTEMS
SCE Northern (Tehachapi and Ventura)	38	20,688	22
SCE Eastern (Riverside and Arizona)	34	19,312	16
East of Pisgah (San Bernardino and Nevada)	45	23,235	16
Greater Fresno Area[27]	117	51,751	44
Greater Bay Area	54	16,686	40
Kern (Excluding Tehachapi)	34	7,664	17
Los Angeles Metro	23	9,770	23
North Bay Area (Central Valley and Coast)	59	14,836	32
North of Lugo (San Bernardino and Inyo)	50	19,703	27
SDG&E/Imperial Valley	53	18,625	31

26 The table excludes interconnection requests for offshore wind, pumped hydro, and hydrogen combustion turbine projects that were described earlier.

27 Projects interconnected at 500 kV to Path 15 substations are included in the Greater Fresno Area. There are 16 projects with interconnection requests located on the 500 kV portions of the Gates, Midway, and Los Banos substations.

It can be seen from this table that the quantities of interconnection requests within each transmission zone are very robust. The process of ranking the projects by subzone within each transmission zone is clearly needed so that meaningful interconnection studies can be initiated for Cluster 15 in 2025.

However, there are two important observations worth highlighting about the Cluster 15 interconnection queue and the need to reduce the number of projects that will be studied.

First, all of the interconnection requests in the Los Angeles Metro area are for battery energy storage systems.[28] The proposed capacity of the battery systems in Cluster 15 exceeds the base case portfolio amount by more than four-fold, suggesting that many of the proposed battery projects will not be included in the Cluster 15 study. The 2023-2024 base case portfolio assumes a need for just 2,201 MW of new resources in the Los Angeles Metro Area by 2039. However, a total of 9,770 MW of standalone batteries located within the Los Angeles Metro Area have interconnection requests in Cluster 15. CEERT recommends that the CAISO be cognizant of likely future policy directed towards retiring gas-fired generation in the Los Angeles Basin as it makes decisions about the quantity and the locations of interconnection requests to study.

The second observation is that there is a very large number of interconnection requests for projects located in the Greater Fresno Area. In fact, the proposed project capacity at points of interconnection within the Greater Fresno Area exceeds by more than five-fold the resource capacity assigned to the area in the 2023-2024 base case portfolio. As noted earlier, there are 16 projects that are seeking to interconnect at 500 kV at major Path 15 substations. This should not be surprising since projects on the backbone 500 kV system should be deliverable to load located in both Northern and Southern California. In addition, there are another 101 projects seeking interconnection at lower voltage levels in the San Joaquin Valley.

While there are advantages to geographic diversity for solar generation that include projects located in Southern Nevada, Western Arizona, and the Imperial Valley, it should not be forgotten that there are economic and community benefits associated with a 10 to 20 year project development pipeline. CEERT continues to urge energy policymakers to prioritize development of solar, storage and new transmission in the San Joaquin Valley.

A core objective of interconnection process reform is to keep the State on track to meet its policy commitment to decarbonize the economy through increased electrification based on clean energy technologies. CEERT believes that the CAISO and stakeholders have made excellent progress through a collaborative process. CEERT recommends that the reforms put forward by the CAISO staff be adopted at the upcoming May CAISO Board meeting.

28 As noted above there are three hydrogen combustion turbine systems paired with equally sized batteries located in the Los Angeles Metro area.

7

ADVANCED TRANSMISSION TECHNOLOGIES AND SOLUTIONS

A modern suite of advanced transmission technologies (ATTs) has been piquing interest amongst energy experts and policymakers. Grid-enhancing technologies (GETs) refer to a collection of hardware and software solutions that dynamically monitor and improve the efficiency, reliability, and flexibility of transmission systems. While some consider other ATTs like advanced conductors and storage-as-transmission assets under the umbrella term of GETs, most experts prefer to keep the term reserved for technology that can easily be installed as an addition to an existing, stand-alone transmission system.

GETs can be used to increase the capacity of the grid, improve its operational efficiency, make it more resilient to disturbances, and speed up the time it takes to get renewables connected. Some of the most common GETs include:

- Dynamic line ratings (DLRs): DLRs use real-time data to monitor the ambient conditions around transmission lines and adjust power flows based on their carrying capacity. DLRs allow grid operators to safely schedule more power to flow over existing lines.
- Advanced power flow controllers (APFCs): APFCs can be used to redirect power flow around congested areas of the grid. APFCs can help to improve the efficiency of the grid and reduce the risk of outages.
- Topology optimization: Topology optimization is a software tool that can be used to quickly identify more efficient switching configurations for the grid. This software can help to reduce the cost of operating the grid and possibly defer upgrades.

GETs are used to varying degrees across the United States. Some utilities have been more willing to test and adopt the technologies than others. However, the use of GETs is increasing as utilities recognize the benefits they can offer.

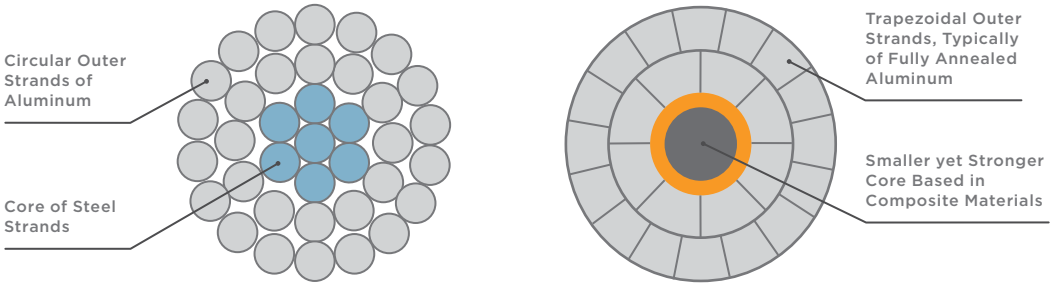
Most of the US high voltage electric system uses aluminum conductor steel reinforced (ACSR) wires. There are several reasons why most of the US power grid is wired with this century-old technology. ACSR is a durable electric conductor; it is made of a steel core surrounded by aluminum strands, which makes it resistant to corrosion and other forms of damage. Much of the U.S. power grid was built in the early 20th century, when ACSR

was the most common type of conductor available. As a result, there is a large existing supply chain supporting ACSR lines in the United States, despite falling far behind modern conductors. ACSR lines are not as conductive as more advanced conductors, meaning they need to be larger in diameter, and are more susceptible to sagging.

There is a growing interest in using new types of conductors for transmission lines. Modern advanced conductors swap out the conventional steel core for either a composite-based core or high-strength steel core to increase the amount of conductive aluminum on the wire while maintaining an equivalent diameter, reducing the weight of the line without jeopardizing strength. This results in reduced thermal expansion and thus reduced line sag while allowing for higher operating temperatures. Additional benefits include grid resiliency, reduced risk of wildfire caused by faulty lines or contact with vegetation, enhanced efficiency via lower line losses, increased ampacity to deliver up to twice as much electricity, and performance cost-savings through extended lifetime and reduced maintenance of the line.

FIGURE 2.

ACSR cross-section versus advanced conductor with composite core cross section



The higher strength composite core allows for a larger amount of aluminum to be added to the wire within the same diameter. This additional aluminum reduces the losses in the line and increases the transfer capacity. In addition, the higher-strength core allows the wire to operate at higher temperatures, increasing the power transfer capacity of the line.

Some examples of alternative conductors include the Aluminum Conductor Composite Reinforced (ACCR) by 3M, Aluminum Conductor Composite Core (ACCC) by CTC Global, and the Advanced Encapsulated Core Conductor (AECC) by TS Conductor. These new conductors are more expensive than ACSR, however, in many cases the cost of reconductoring a line with advanced conductors is far more cost-effective and can be completed in a fraction of the time than adding that same capacity through construction of new lines.

Advanced conductors create the potential to leverage existing towers and ROW to add transmission capacity. Advanced reconductoring replaces a transmission line's existing conductors with advanced conductors. Depending on the configuration of existing infrastructure, terminal upgrades (i.e., protection systems and transformers)

may be required. The Electric Power Research Institute (EPRI) estimates that advanced reconductoring may increase line capacity by 30-100%. Combined with voltage uprating, line capacity may even increase by 80-150%.[29]

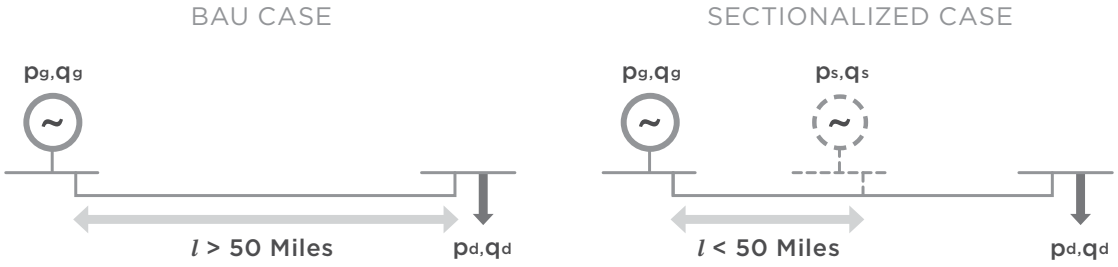
The state of Montana recently enacted a law that requires the state public utility commission to develop advanced conductor cost-effectiveness and allows advanced conductor rate basing.[30] The law defines advanced conductors as those of equal size that reduce electrical resistance by 10% or more. In addition to grid-efficiency benefits, wildfire risk mitigation benefits due to the lines' low-sag was another driving reason for enacting the law.

Energy researchers at the University of California Energy Institute at Haas looked at another opportunity to improve grid efficiency through sectionalizing, or temporarily isolating a section of the line. This method is helpful to grid planning, by assessing the impact of different scenarios on the reliability and performance of the grid.[31]

Sectionalizing is a powerful tool that can be used to study a wide range of scenarios in grid planning studies. By sectionalizing the grid and modeling different scenarios, grid planners can identify potential problems and develop solutions to improve the reliability, efficiency, and sustainability of the electric grid; for example, it can be used to study the impact of a new transmission line, the retirement of a power plant, or the integration of new renewable energy resources. Sectionalizing can also be used to mitigate reliability risks such as thermal overloads and voltage instability. This method can reduce congestion on the grid and the amount of renewable energy that may need to be curtailed by enabling multiple pathways for clean energy to flow to load centers.

FIGURE 3.

The concept of sectionalization



Long lines can be sectionalized into segments of 50 miles in length, to interconnect generation with grid-forming inverter technology. This enables greater transfer capacity across the entire line and the incorporation of new interconnection points for storage and renewable energy resources. p_g is generator active power, q_g is generator reactive power, l is line length, p_d is load active power, and q_d is load reactive power.

29 https://www.epri.com/research/products/000000003002023335

30 Montana House Bill 729

31 *Accelerating Transmission Expansion by Using Advanced Conductors in Existing Right-of-Way*, Emilia Chojkiewicz, Umed Paliwal, Nikit Abhyankar, Casey Baker, Ric O'Connell, Duncan Callaway, and Amol Phadke, Revised February 2024. https://haas.berkeley.edu/wp-content/uploads/WP343.pdf

In the 2023-2024 Draft Transmission Plan, the CAISO included a section on the consideration and application of several of these technologies in their planning cycles. The CAISO chooses to include advanced conductors in the umbrella term of GETs, along with the agreed-upon dynamic line ratings, power flow controllers, and topology optimizations. CAISO has thus far reserved these technologies as project alternatives in past planning cycles, typically in exchange for other capital expenditures.

Currently, California policy does not incentivize utilities to use these technologies to their full beneficial extent. This is often attributed to the regulated utility ratemaking structure, in which a utility can increase their rate base and make greater profits with larger capital investments. Because of this, utilities often overlook low-cost investments, despite the savings they could bring to ratepayers. However, increased pressure on the utilities and CPUC over climbing electricity rates, as well as increased awareness of the benefits of these technologies may alter the incentives.

Several bills introduced in the 2024 legislative session may push for a more aggressive deployment of these technologies in order to expand operating capacity on the existing grid while additional long-lead-time transmission infrastructure is built. Legislation includes:

- SB 1006 by Senator Padilla: requires transmission owners within the CAISO system to study opportunities for cost-effective deployment of GETs and advanced conductors as part of a jointly prepared strategic plan by the start of 2026. Additionally, the bill requires each transmission-owning utility to prepare and regularly update an implementation timeline for their transmission and distribution systems.
- AB 3246 by Assemblymember Garcia: offers a permitting incentive to investor-owned utilities to use advanced conductors on their existing system (a process known as "advanced reconductoring"). This incentive builds upon the existing "permit to construct" exemption for the placement of new or additional conductors set forth in General Order 131-D, allowing advanced reconductoring projects to go through a quicker permitting process via a Tier 2 advice letter (pursuant to General Order 96-B) at the CPUC.
- AB 2779 by Assemblymember Petrie-Norris: a spot bill, which in its current form would require the CAISO to report to the CPUC and legislature any new use of GETs deemed reasonable and cost-effective following the approval of each Transmission Plan.

In 2024 and the years beyond, CEERT will seek to encourage state energy officials, including legislators and regulators, to advance policies that will enable the more efficient use of existing transmission resources and rights of way. CEERT looks forward to discussing with the CAISO staff and transmission owners in California opportunities to more fully study sectionalizing opportunities, particularly where they would be beneficial for disadvantaged regions that experience high fault rates. CEERT is an active member in the ongoing advocacy for the deployment of GETs and advanced conductors, prioritizing affordability of electricity and grid reliability.

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SUMMARY OF FINDINGS AND RECOMMENDATIONS

FINDINGS

1. The need for additional clean energy generation continues to expand as California electrifies energy end-uses and decarbonizes the economy.
2. The need for more transmission capacity is also urgent, as can be seen with the recommendation of 26 new policy-driven and reliability-driven projects in the draft 2023-2024 Transmission Plan (TP).
3. The permitting, financing, and construction of recommended new transmission projects has not kept pace with the planned mid-term clean energy goals.
4. The 2023-2024 TP recommends several reliability projects to improve lower voltage transmission in the San Joaquin Valley, the Salinas Valley, and the Stockton areas.
5. The 2023-2024 TP provides focused attention on transmission projects that are required to integrate offshore wind from the North Coast, including two new 500 kV transmission lines that begin from a new 500 kV Humboldt County substation; one 500 kV line would reach the upper Central Valley and the other would extend to the Bay Area.
6. The 2023-2024 TP did not recommend policy-driven transmission projects in the Central Valley that would be needed to support the development of very large amounts of solar and storage projects that will be in the interconnection queue in this resource-rich region.
7. The 2023-2024 TP deferred making recommendations on transmission projects that could significantly reduce gas-fired generation in the Los Angeles Basin.
8. The CPUC transmission permitting process is failing to keep up with the challenge of advancing the large number of transmission projects that have been recommended for development by the CAISO.
9. The CAISO Interconnection Process Enhancement initiative has made substantial progress. Cluster 15 interconnection should be studied in the near future so that progress can be made on developing a more diversified set of resources needed to reduce GHG emissions.
10. Battery energy storage systems paired with solar constitute a substantial amount of new resource adequacy capacity in the interconnection queue, particularly in the San Joaquin Valley.

11. The CAISO has acknowledged the value of Grid Enhancing Technologies (GETs), including advanced conductors and flow control devices, along with a commitment to continue to explore opportunities for the use of GETs in future plans.

RECOMMENDATIONS

1. The CAISO should adopt the draft 2023-2024 Transmission Plan with the caveat that initiation of construction of the new Humboldt 500 kV substation and associated transmission projects should proceed beyond the permitting phase of development only when there is a higher degree of certainty that the Humboldt lease area offshore wind projects will be built.
2. The CPUC needs to accelerate the procurement of new clean generation resources based on the CAISO 2023-2024 Transmission Plan and the upcoming Cluster 15 study in order to meet the State's growing demand for electricity while reducing greenhouse gas emissions.
3. A longer term perspective is needed to inform procurement, including the need to advance long-lead-time technologies in the interconnection queue, including offshore wind, pumped hydroelectric and other longer duration storage, advanced geothermal, and other clean firm technologies.
4. Priority for transmission planning in the 2024-2025 Transmission Planning Process should be given to the following areas:
    1) The San Joaquin Valley, where significant quantities of solar and battery projects are expected to be developed.
    2) The Los Angeles Basin, where transmission expansion can reduce the region's dependence on natural gas generation.
5. State energy policy makers should further evaluate opportunities to use grid enhancing technologies and advanced conductors to expand transmission capacity on existing rights of way.
6. The CPUC should expeditiously review and adopt the permitting reforms put forward by CEERT and 17 other parties in the September 29, 2023 Settlement Agreement in the CPUC permitting reform proceeding for GO 131-D.
7. Cal Advocates' proposal for the sharing of incumbent utilities' rights of way on the transmission system merits further investigation by the CPUC and the Legislature as a way of controlling costs.
8. The CAISO should adopt the interconnection reforms coming out of the Interconnection Process Enhancement initiative. Further refinement of interconnection procedures will be needed in Phase 3 of the initiative.
9. Energy policymakers should investigate alternative approaches to reduce the costs of financing transmission development, such as those adopted in Colorado and New Mexico.