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STAFF PAPER

2045 Scenario for the Update of the 20-Year Transmission Outlook

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ABSTRACT

The *2045 Scenario for the Update of the 20-Year Transmission Outlook* staff paper describes a 2045 demand and resource scenario for use by the California Independent System Operator in the update of the 20-Year Transmission Outlook. The staff paper outlines the demand and resource assumptions within the scenario. The staff paper details the method for resource mapping the new renewable resource and energy storage capacity within the scenario.

Keywords: Demand scenario, clean energy resources, offshore wind, land use, transmission planning

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EXECUTIVE SUMMARY

California's energy transition is underway, but the next two decades will require an unprecedented amount of generation and transmission to supply clean, reliable power. The need for record-setting buildout of new utility-scale clean energy resources and energy storage is being driven by increased customer demand for clean energy, the continuing electrification of transportation and other industries to achieve the state policy of economy-wide carbon neutrality by 2045, and the state's target of 100 percent clean electricity. The 100 Percent Clean Energy Act of 2018 (Senate Bill 100, De León, Chapter 312, Statutes of 2018) sets a 2045 target of supplying all retail electricity sold in California and state agency electricity needs with renewable and zero-carbon energy resources.

Senate Bill (SB) 100 also increases the state's Renewables Portfolio Standard (RPS) procurement target to 60 percent of retail sales by December 31, 2030, and requires all state agencies to incorporate the 2030 and 2045 targets into their relevant planning. SB 100 requires the California Energy Commission (CEC), California Public Utilities Commission (CPUC), and California Air Resources Board (CARB) to use programs under existing laws to achieve 100 percent clean energy and issue a joint policy report on SB 100 by 2021 and every four years thereafter.

The first 2021 Joint Agency SB 100 Report was released in March 2021 and assessed various pathways to achieve the SB 100 targets and included an initial assessment of costs and benefits. One key finding from the report was that sustained record-setting renewable generation and energy storage capacity build rates will be required to meet the target in a high electrification future, citing growing electricity demand as a significant driver. Effectively integrating 100 percent renewable and zero-carbon technologies in California by 2045 will require rigorous analysis of implementation considerations and coordinated planning across different levels of government and with grid operators throughout the state. One such track of analysis, which emerged following the 2021 Joint Agency SB 100 Report, is the California Independent System Operator's (California ISO's) 20-Year Transmission Outlook (20-year outlook).

The California ISO's 20-year outlook explores longer term grid requirements and options for meeting the state's greenhouse gas reduction and renewable energy targets reliably. The CEC, CPUC, and California ISO collaborated on an approach to translate the analysis conducted for the 2021 SB 100 Joint Agency Report into a 2040 Starting Point Scenario for use by the California ISO in the first 20-year outlook, which was released in May 2022.

Following the release of the first SB 100 Joint Agency Report, the CEC, CPUC, and California ISO, began to focus on the resource build requirements to achieve SB 100 (Docket 21-SIT-01). This collaboration includes a public stakeholder process, with several workshops held in 2021 and 2022, and is ongoing. In December 2022, the CEC, CPUC, and California ISO signed a "Memorandum of Understanding (MOU) Regarding Transmission and Resource Planning and Implementation," reinforcing cooperation and collaboration of the three parties in the timely development of resources needed to achieve the state's clean energy goals reliably and economically.

A near-term priority for collaborative efforts is providing an updated 2045 Scenario for California ISO to use in the next 20-Year Transmission Outlook, which is anticipated in 2024. The next 20-year transmission outlook will inform the 2025 SB 100 Joint Agency Report.

The *2045 Scenario for the Update of the 20-Year Transmission Outlook* staff paper describes a 2045 demand and resource scenario for use by the California ISO in the update of the 20-Year Transmission Outlook. The staff paper describes the load and resource assumptions within the scenario, which assumes 100 percent of retail sales is supplied by renewable and zero-carbon electricity resources by 2045. The staff paper details the method for resource mapping the new renewable resource and energy storage capacity within the scenario. Consistent with the scenarios from the 2021 SB 100 Joint Agency report, the 2045 Scenario for the 20-Year Outlook includes significant capacity additions by 2045.

CHAPTER 1: Background

Senate Bill 100 Targets

The 100 Percent Clean Energy Act of 2018 (Senate Bill 100, De León, Chapter 312, Statutes of 2018) sets a 2045 target of supplying all retail electricity sold in California and state agency electricity needs with renewable and zero-carbon resources.[1] SB 100 also increases the state's Renewables Portfolio Standard (RPS) procurement target to 60 percent of retail sales by December 31, 2030, and requires all state agencies to incorporate the 2030 and 2045 targets into their relevant planning. SB 100 requires the California Energy Commission (CEC), California Public Utilities Commission (CPUC), and California Air Resources Board (CARB) to use programs under existing laws to achieve 100 percent clean energy and issue a joint policy report on SB 100 by 2021 and every four years thereafter.

The Clean Energy, Jobs, and Affordability Act of 2022 (Senate Bill 1020, Laird, Chapter 361, Statutes of 2022) revises SB 100 targets to instead provide that eligible renewable energy resources and zero-carbon resources supply:

- 90 percent of all retail sales of electricity to California end-use customers by December 31, 2035.
- 95 percent of all retail sales of electricity to California end-customers by December 31, 2040.
- 100 percent of all retail sales of electricity to California end-use customers by December 31, 2045.
- 100 percent of electricity procured to serve all states agencies by December 31, 2035.

2021 Joint Agency SB 100 Report

The 2021 Joint Agency SB 100 Report assessed various pathways to achieve the SB 100 targets and an initial assessment of costs and benefits. One key finding from the report was that sustained record-setting renewable generation and energy storage capacity build rates will be required to meet the target in a high electrification future, citing growing electricity demand as a significant driver.[2] Effectively integrating 100 percent renewable and zero-carbon technologies in California by 2045 will require rigorous analysis of implementation considerations and coordinated planning across different levels of government and with grid operators throughout the state. One such track of analysis, which emerged following the 2021

1 Senate Bill 100 (De León, Chapter 312, Statutes of 2018). https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180SB100.

2 CEC, CPUC, and CARB. 2021. *2021 SB 100 Joint Agency Report Achieving 100 Percent Clean Electricity in California: An Initial Assessment.* Publication Number: CEC-200-2021. https://efiling.energy.ca.gov/EFiling/GetFile.aspx?tn=237167&DocumentContentId=70349.

Joint Agency SB 100 Report, is the California Independent System Operator's (California ISO's) *20-Year Transmission Outlook*[3] (20-year outlook).

20-Year Transmission Outlook

The California ISO's 20-year outlook explores longer-term grid requirements and options for meeting the state's greenhouse gas reduction and renewable energy targets reliably. The California ISO initiated the 20-year outlook to have a longer-term outlook and stakeholder process outside the formal tariff-based Transmission Planning Process (TPP), which focuses on transmission project needs and transmission project approvals over a 10-year planning horizon. The California ISO will conduct the update of the 20-year outlook in parallel with its current 2023–2024 TPP. The 20-year outlook is intended to support state electric sector planning by providing long-term context and framing of key transmission-related issues.

The CEC, CPUC, and California ISO collaborated on an approach to translate the analysis conducted for the 2021 SB 100 Joint Agency Report into a 2040 Starting Point Scenario for use by the California ISO in the first 20-year outlook, which was released in May 2022. The first 20-year outlook identified the need for significant 500 kilovolt (kV) alternating current (AC) and high-voltage direct current (HVDC) transmission development to access offshore wind (OSW) and out-of-state wind and reinforce the transmission system within the existing California ISO footprint. Figure 1 diagrams the transmission development required to integrate the resources of the SB 100 Starting Point Scenario and high electrification load projection by 2040.

3 California Independent System Operator. May 2022. 20-Year Transmission Outlook. http://www.caiso.com/InitiativeDocuments/Draft20-YearTransmissionOutlook.pdf. Page 20.

Figure 1: Diagram of Transmission Development in the 20-Year Outlook (2022)

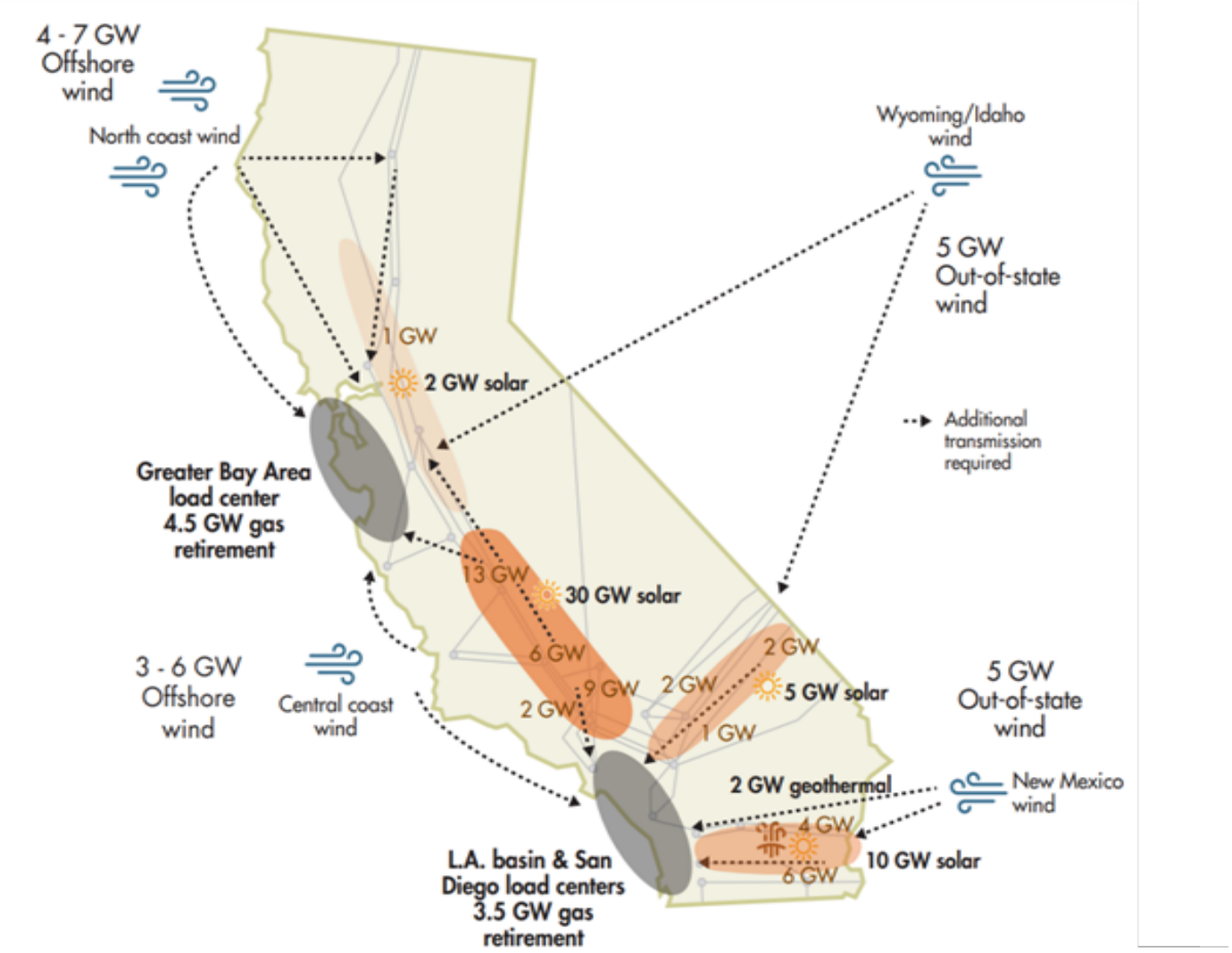

Diagram of transmission development identified in the California ISO 20-Year Outlook (May 2022).

Source: California ISO

Following the release of the first SB 100 Joint Agency Report, the CEC, CPUC, and California ISO focused on the resource build requirements to achieve SB 100 (Docket 21-SIT-01). This collaboration includes a public stakeholder process, with several workshops held in 2021 and 2022, and is ongoing. In December 2022, the CEC, CPUC, and California ISO signed the "Memorandum of Understanding (MOU) Regarding Transmission and Resource Planning and Implementation," reinforcing cooperation and collaboration of the three parties in the timely development of resources needed to achieve the state's clean energy goals reliably and economically.

A near-term priority for collaboration is providing a 2045 Scenario for California ISO to use in the next 20-Year Transmission Outlook, which is anticipated in 2024. The next 20-Year Transmission Outlook will inform the 2025 SB 100 Joint Agency Report.

The 2045 Scenario is informed by several recent long-term resource planning scenarios (Table 1). Given the 20-plus-year planning horizon, the resource and storage mix presented in this scenario does not account for the full suite of development uncertainties, such as cost, commercial readiness, technical challenges, supply chain, and permitting. Therefore, the use of the 2045 Scenario is not a commitment to the resource and storage mix included in the scenario. Instead, the 2045 Scenario is designed to provide information for a wide range of potential transmission needs driven by a combination of potential renewable and zero-carbon resource and storage opportunities. The 2045 Scenario is informational only and should not be used, on its own, to support approval of near-term infrastructure investments.

Table 1: Summary of Long-Term Planning Scenarios that Inform the 2045 Scenario

Study Name	Scenario Description	Year Studied	Links to Report
SB 100 Core Scenario	The core scenario from the 2021 Joint Agency SB 100 Report. This scenario includes retail sales and state loads, high electrification demand, and all candidate resources available. This scenario includes 145 GW of new resources by 2045.	2045	2021 SB 100 Joint Agency Report Achieving 100 Percent Clean Electricity in California: An Initial Assessment. (https://efiling.energy.ca.gov/EFiling/GetFile.aspx?tn=237167&DocumentContentId=70349)
2040 Starting Point Scenario	The 2040 Starting Point Scenario (2021) was developed by the CEC and CPUC for use by the California ISO in the 20-year transmission outlook (2022). This scenario includes 120 GW of new resources by 2040. This scenario also includes 15,000 of assumed natural gas retirements.	2040	SB 100 Starting Point Scenario for the CAISO 20-year Transmission Outlook. (https://efiling.energy.ca.gov/GetDocument.aspx?tn=239685&DocumentContentId=73101)
2023-2024 TPP Base Case	A base case portfolio for both reliability and policy-driven purposes produced by the CPUC and evaluated by the California ISO to determine transmission investments needed. The portfolio expects 85 GW of new resources by 2035 to be built to meet a 30 million metric ton greenhouse gas emissions target in 2030 and uses the CEC's 2021 Integrated Energy Policy Report "Additional Transportation Electrification" load scenario.	2035	Decision Ordering Supplemental Mid-Term Reliability Procurement (2026-2027) and Transmission Electric Resource Portfolios to California Independent System Operator for 2023-2024 Transmission Planning Process. (https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M502/K956/502956567.PDF)

Table 1 describes long-term resource planning scenarios which inform the 2045 Scenario for the 20-Year Transmission Outlook.

Source: CEC staff

CHAPTER 2:
Demand Assumptions

The 2021 SB 100 Starting Point Scenario, which informed the 2022 California ISO 20-year outlook, used the PATHWAYS High Electrification demand scenario that was used in the SB 100 Core Scenario. The peak load in 2040, before accounting for behind-the-meter (BTM) solar photovoltaic (PV), was projected to be 73,900 megawatts (MW) for the California ISO region. For the 2024 California ISO 20-year outlook, a more recent demand scenario produced by the CEC is used that projects a peak load of 68,800 MW in 2040 before accounting for BTM PV.

Demand Scenario for the 2045 Scenario

The 2045 Scenario will use the CEC's 2021 Mid-Mid Case extrapolated to 2045, with the transportation load swapped for the 2022 Integrated Energy Policy Report (IEPR) Update Forecast results. The Mid-Mid Case was chosen for the 20-year transmission outlook because this is a longer-term system-wide study, in contrast to the TPP which is a localized study and relies on higher demand assumptions due to the increased uncertainty when disaggregating to the load bus level. [4] The projected peak load for this scenario in 2045 is 61,900 MW, and annual energy demand is 313,000 GWh for the California ISO region which includes generation from BTM PV.

CEC's California Energy Demand Forecast is a cornerstone component of the state's energy planning process. The forecast includes several products that are used across several energy planning proceedings such as Resource Adequacy and Integrated Resource Planning. CEC's 2021 Mid-Mid Case[5] is the main product that informs these proceedings. Each year, forecasts are updated to account for changes in key energy demand drivers and historical datasets. The 2021 Mid-Mid Case is based on economic and demographic forecast drivers, historical energy consumption data, electricity and natural gas rates projections, adoption forecasts for BTM PV and battery storage, energy efficiency, fuel substitution, and electric vehicles. Moreover, adjustments were made to the forecast to account for changes in demand due to climate

[4] For comparison, the Additional Transportation Electrification scenario adopted in May 2022 which will be used for the 2023-24 TPP projected a peak load of 55,500 MW and 281,000 annual GWh in 2035 for the California ISO region, compared to the scenario used for the 20-year outlook which projects a peak load of 54,900 MW and 265,000 annual GWh in 2035.

[5] Javanbakht, Heidi, Cary Garcia, Ingrid Neumann, Anitha Rednam, Stephanie Bailey, and Quentin Gee. 2022. Final 2021 Integrated Energy Policy Report, Volume IV: California Energy Demand Forecast. California Energy Commission. Publication Number: CEC-100- 2021-001-V4.

change. As mentioned above, the 2045 Scenario swaps the 2021 Mid-Case transportation load for the *2022 IEPR Update* transportation forecast.[6]

The *2022 IEPR Update* transportation forecast provides a key update to incorporate the recently adopted vehicle regulations established by the California Air Resources Board (CARB). The Advanced Clean Cars II regulation and the Advanced Clean Fleets regulation require a much larger growth in zero-emission vehicles than forecasted in the *2021 IEPR*. Current market conditions strongly indicate that battery-electric vehicles will represent the vast majority of zero-emission vehicles. A new forecast framework was developed to account for these additional vehicles, called Additional Achievable Transportation Electrification. The adoption of these regulations results in a significant growth in electric vehicle load compared to the original 2021 Mid-Mid Case.

CEC mapped the Additional Achievable Transportation Electrification, Additional Achievable Energy Efficiency, and Additional Achievable Fuel Substitution components of the forecast to the busbar level through 2035. For 2036 through 2045, the California ISO will disaggregate the load from the transmission access charge area to busbar using a weighting approach.

Behind-the-Meter Resource Assumptions

BTM resource adoption and its associated impacts on electricity demand are imbedded in the 2021 Mid-Mid Case. The demand scenario includes approximately 42 GW of BTM PV capacity in 2045. Forecasted BTM PV adoption is based on system payback periods calculated from projections for technology costs, economic conditions, hourly BTM system performance, electricity rates, and incentives. It's important to note that cost calculations incorporate CPUC's Net Energy Metering (NEM) 2.0 tariff and the federal government's Investment Tax Credit (ITC).[7] BTM energy storage adoption was predicted from historic adoption trends for both BTM storage and solar PV. Thus, any impacts on storage adoption influenced by NEM 2.0 or ITC are assumed to be embedded in the projections. Forecasted BTM solar PV and storage adoption forecasts were adjusted to account for growth in these resources based on Title 24 standards for new buildings. Finally, annual as well as hourly demand impacts resulting from cumulative BTM resource adoption were forecasted using hourly BTM system performance data.

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[6] Bailey, Stephanie, Jane Berner, David Erne, Noemí Gallardo, Quentin Gee, Akruti Gupta, Heidi Javanbakht, Hilary Poore, John Reid, and Kristen Widdifield. 2023. Final 2022 Integrated Energy Policy Report. California Energy Commission. Publication Number: CEC-100-2022001-CMF.

7 Note that CPUC adopted NEM 3.0 in 2023 which is not reflected in the 2021 IEPR forecast. Additionally, the 2021 IEPR forecast does not reflect the extension of the ITC which was slated to end in 2023. These updates will be reflected in the 2023 IEPR forecast.

CHAPTER 3:
Resource Assumptions

The 2021 SB 100 Starting Point Scenario, which informed the 2022 California ISO 20-year outlook, was developed by taking the 2040 SB 100 Core Scenario and increasing assumed natural gas power plant retirements to 15,000 MW. This increase allowed for an evaluation of the impact of more gas power plant retirements on the transmission system than was identified in the SB 100 Core scenario, in conjunction with bringing new energy storage and renewable energy resources online. In addition, to generally offset the additional assumed natural gas power plant retirements, geothermal, offshore wind (OSW), out-of-state wind, and battery-energy storage systems capacity was added to levels that are generally reflective of other 2021 SB 100 Report scenarios. The scenarios in the 2021 SB 100 Report were developed through a comprehensive interagency stakeholder process to meet a statewide 2045 policy, which includes balancing area authorities (BAA) outside the California ISO.

Table 2: Resource Assumptions in the 2040 SB 100 Starting Point Scenario

Resource Type	2040 Starting Point Scenario (MW)
Natural gas-fired power plants	(-15,000)
Utility-scale solar	53,212
In-state wind	2,837
Offshore wind	10,000
Out-of-state wind	12,000
Geothermal	2,332
Battery-energy storage	37,000
Long-duration energy storage	4,000

Table 1 details the resource assumptions in the 2040 Starting Point Scenario which the California ISO used in the 20-year transmission outlook (2022).

Source: CEC staff

Resource Assumptions for the 2045 Scenario

The 2045 Scenario was developed by taking the resource portfolio from the 2040 Starting Point Scenario with the following adjustments:

- Retain 15 gigawatts (GW) natural gas retirement assumptions.
- Increase offshore wind to 20 GW to reflect updated state policy and executive actions.
- Add resources to help offset additional natural gas retirements in-line with resources included in the previous Starting Point Scenario for the 20-year transmission outlook.

- Add 5 GW of generic clean firm resources/long-duration energy storage.
- Add resources and update resource mapping assumptions to align with resource locations in the latest IRP portfolios for the TPP.[8]

Table 2 provides an overview of the resource assumptions in the 2045 Scenario.

Table 3: New Resource Assumptions in the 2045 Scenario

Resource Type	2045 Scenario (MW)
Natural gas fired power plants	(-15,000)
Utility-scale solar	69,640
Distributed Solar	125
In-state wind	3,074
Offshore wind	20,000
Out-of-state wind	12,000
Geothermal	2,332
Biomass	134
Battery-energy storage	48,813
Long-duration energy storage	4,000
Generic clean firm/long-duration energy storage	5,000

Table 2 details the resource assumptions in the 2045 Scenario which the California ISO will use in the 20-year transmission outlook (anticipated 2024).

Source: CEC and CPUC staff

To further illustrate the 2045 Scenario, Table 3 below compares the SB 100 Core Scenario (2045), the 2040 Starting Point Scenario, and the 2023–2024 TPP base portfolio and OSW Sensitivity (2035) with the 2045 Scenario.

8 CPUC. February 2023. Modeling Assumptions for the 2023-2024 Transmission Planning Process. Staff Report. https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/2023-irp-cycle-events-and-materials/modeling_assumptions_2023-24tpp_v02-23-23.pdf.

Table 4: Comparison of SB 100 Core, 2040 Starting Point Scenario, CPUC IRP TPP Base and Sensitivity Portfolios, and 2045 Scenario

Resource Type (MW)	SB 100 Core (2045)	Starting Point Scenario (2040)	2023–2024 TPP Base Portfolio (2035)	2023–2024 TPP OSW Sensitivity (2035)	2045 Scenario (2045)
Natural Gas Fired Power Plants	(-4,722)	(-15,000)	-	-	(-15,000)
Utility-Scale Solar	69,640	53,212	38,947	25,746	69,640
Distributed Solar	-	-	125	125	125
In-state wind	2,837	2,837	3,074	3,074	3,074
Offshore wind	10,000	10,000	5,497	13,400	20,000
Out-of-state wind	2,837	12,000	5,618	5,618	12,000
Geothermal	135	2,332	2,037	1,149	2,332
Biomass	-	-	134	134	134
Battery-energy storage	48,813	37,000	28,373	23,545	48,813
Long-duration energy storage	4,000	4,000	2,000	1,000	4,000
Generic clean firm/long-duration energy storage	-	-	-	-	5,000

Table 3 compares resource assumptions across recent state resource and transmission planning studies.

Source: CEC and CPUC staff

Offshore Wind

The 2021 Starting Point Scenario included 10,000 MW of offshore wind in 2040. The 2045 Scenario includes 20,000 MW of offshore wind to reflect updated state policy and executive actions.

Following the publication of the 2021 Starting Point Scenario, on September 23, 2021, Governor Gavin Newsom signed into law Assembly Bill 525 (AB 525, Chiu, Chapter 231, Statutes of 2021), which took effect January 1, 2022. AB 525 requires the CEC, in coordination

with federal, state, and local agencies and a wide variety of stakeholders, to develop a strategic plan for offshore wind energy deployment off the California coast in federal waters.

In a July 22, 2022, letter to the chair of the California Air Resources Board, Governor Newsom asked the CEC to establish an offshore wind planning goal of at least 20 GW by 2045, among other requested actions.[9] In August 2022, the CEC published the *Offshore Wind Energy Development off the California Coast*[10] report, which established a potentially achievable but aspirational planning goal of 25,000 MW for 2045. The CEC report also established 21.8 GW as a reference point for technically feasible capacity that the CEC will continue to evaluate in developing the AB 525 strategic plan.

The 20 GW of OSW resources assumed in the 2045 Scenario is within the range of California OSW technically feasible capacity evaluated in the 2022 CEC report.

Generic Clean Firm Resources/Long-Duration Energy Storage

The assumed retirement of 15,000 MW of gas resources creates the presumptive need for additional capacity to meet peak demand needs. After adding the additional offshore wind capacity and additional renewable resources in line with the previous 20-year transmission outlook and the 23-24 TPP base case portfolio, the CPUC and CEC staff estimate that an additional 5,000 MW of generic clean firm resources or long-duration energy storage capacity is needed. SB 423 (Stern, Chapter 243, Statues of 2021) defines "firm zero-carbon resources" as electrical resources that can individually, or in combination, deliver zero-carbon electricity with high availability for the expected duration of multiday extreme or atypical weather events, including periods of low renewable energy generation, and facilitate integration of eligible renewable energy resources into the electrical grid and the transition to a zero-carbon electrical grid.[11] Examples of zero-carbon firm resources include geothermal, biomass and resources that generate electricity from zero-carbon hydrogen. The option for long-duration energy storage resources likewise represent an array of existing and emerging long-duration storage types including pumped storage, compressed air, iron-air batteries, and other battery storage technologies. The key requirement is to be able to serve additional capacity to meet peak demand needs on the eight-hour to multi-day time frame.

Distributed Solar

The 2045 Scenario includes considerations for BTM solar and distributed solar. BTM solar is included through the load assumptions, as described in Chapter 2. In addition to BTM solar, the 2045 Scenario includes 125 MW of distributed solar. Distributed solar is separate from BTM

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9 Governor Gavin Newsom, letter to chair of the California Air Resources Board. July 22, 2022. https://www.gov.ca.gov/wp-content/uploads/2022/07/07.22.2022-Governors-Letter-to-CARB.pdf?emrc=1054d6.

10 Flint, Scott, Rhetta DeMesa, Pamela Doughman, and Elizabeth Huber. 2022. *Offshore Wind Development off the California Coast: Maximum Feasible Capacity and Megawatt Planning Goals for 2030 and 2045.* California Energy Commission. Publication Number: CEC-800-2022-001-REV. https://www.energy.ca.gov/publications/2022/offshore-wind-energy-development-california-coast-maximum-feasible-capacity-and

11 Senate Bill 423. (Stern, Chapter 243, Statues of 2021). Public Resources Code 25216.7(d)(2). https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=202120220SB423.

solar PV and represents in-front of the meter large-scale commercial rooftop to community scale solar.

CHAPTER 4:
Geographic Allocation of Resources

The 20-year outlook requires geographically mapping resources to specific locations, to the extent feasible. This section describes, for each resource in the 2045 Scenario, criteria for the California ISO to use in the 20-year outlook. Wherever possible, the mapping criteria aligns with the current CPUC integrated resource plan (IRP) portfolios being studied within the 2023-2024 TPP. In Appendix B, a table with the geographic allocations for the 20-year transmission outlook for each resource is included, as applicable. All MW values discussed below are assumed to occur by 2045.

Natural Gas Power Plant Retirements

The 2045 Scenario retains the assumption from the 2021 Starting Point Scenario that 15,000 MW of natural gas power plant capacity would be retired by 2040, which is about 50 percent of natural gas power plant capacity assumed in the 2021 SB 100 Report scenarios. This assumption is made only to support the objective of California ISO's informational study and has not been analyzed or modeled through any other process. To identify the locations of assumed retirements for this 20-year transmission outlook, the California ISO should follow the criteria established in the 2021 Starting Point Scenario and first 20-year transmission outlook. These criteria are the following:

- The oldest natural gas power plants retire first, with a priority for those that are in and adjacent to disadvantaged communities.[12]
- At least 3,000 MW of the 15,000 MW of retirements are assigned to natural gas power plants that rely on the Aliso Canyon storage facility as provided by the agencies, with a priority on the oldest power plants and those that are in and adjacent to disadvantaged communities.

Table 3.1-4 in the first 20-year outlook provides an overview of the assumed natural gas-fired generation retired by local capacity area.[13]

New Energy Generation and Storage Capacity

Lithium ion-battery (Li-battery) energy storage: The 2045 Scenario includes 48,813 MW of battery energy storage. The approach used for assigning battery energy storage to transmission zones for the 20-year outlook draws on the approach applied to battery energy

12 Disadvantaged communities are defined and identified by the California Office of Environmental Health Hazard Assessment and are available in the CalEnviroScreen 3.0 webtool at https://oehha.ca.gov/calenviroscreen/report/calenviroscreen-30. For this 2045 Scenario, a natural gas power plant "adjacent to" a disadvantaged community is defined as within a 2.5-mile radius.

13 California Independent System Operator. May 2022. 20-Year Transmission Outlook. http://www.caiso.com/InitiativeDocuments/Draft20-YearTransmissionOutlook.pdf. Page 20.

storage in the CPUC's IRP process for the California ISO's TPP. As shown in Appendix B, the 48,813 MW of battery energy storage is allocated as follows:

- The 28,373 MW of battery energy storage already mapped in the IRP resource portfolio for the 2023–2024 TPP base case is carried over without any changes.
- The remaining 20,440 MW of battery energy storage will be allocated by expanding upon the approach from the 2023-2024 TPP base case:
    - Co-locate at substations where utility-scale solar resources are mapped.
    - Stand-alone in local capacity areas to displace gas resources.

Long-duration energy storage: Long-duration energy storage (LDES) was modeled in the 2021 SB 100 Joint Agency Report as pumped hydroelectric energy storage.[14] However, any long-duration storage technology with eight hours or longer of energy generation at maximum output would represent similar attributes. Thus, for the 2045 Scenario, any long duration energy storage technology is considered and not just limited to potential pumped storage resources. The 4,000 MW of LDES in the 2045 Scenario is allocated by building off the current 2023–2024 TPP base case, as well as current commercial interest.

The 4,000 MW of LDES is allocated by:

- 2,000 MW of LDES already mapped in the IRP resource portfolio for the 2023–2024 TPP base case.
- 2,000 MW of LDES aligned with LDES identified in the current California ISO interconnection queue.

Generic clean firm/LDES: Given the current commercial interests and development uncertainty of various emerging technologies, the 5,000 MW of generic clean firm resources and long duration energy storage resources are mapped specifically outside of local areas, near renewable generation. Mapping of these resources outside of the local reliability areas enables study of greater transmission needs into local areas.

Utility-scale solar: The 2045 Scenario includes 69,640 MW of utility-scale solar, which is consistent with the SB 100 Core Scenario from the 2021 SB 100 Joint Agency report. The approach used for allocating utility-scale solar for the 20-year outlook draws on the approach applied to mapping utility-scale solar in the CPUC's IRP process for the California ISO's TPP. As shown in Appendix B, the 69,640 MW of utility-scale solar is allocated as follows:

- 38,947 MW of utility-scale solar energy is already mapped in the IRP resource portfolio for the 2023–2024 TPP base case and is carried over without any changes.
- The allocation of the remaining 30,693 MW of utility-scale solar will be guided by these criteria, which are informed by criteria applied in busbar mapping of the IRP resource portfolios for the TPP:

14 An energy storage technology consisting of two water reservoirs separated vertically; during off-peak hours, water is pumped from the lower reservoir to the upper reservoir, allowing the off-peak electrical energy to be stored indefinitely as gravitational energy in the upper reservoir. During peak hours, water from the upper reservoir is released and passed through hydraulic turbines to generate electricity, as needed.

- *Commercial interest*: Commercial interest, as used in this 2045 Scenario, is determined by using the California ISO's publicly available interconnection queue information.[15] This information includes projects in the queue through the Cluster 14 study window.
- *Environmental and land-use evaluation*: The CEC used the core land-use screen[16] to assess whether substations that were mapped in the 2023–2024 IRP portfolios had sufficient availability of "lower implication"[17] land to map additional utility-scale solar capacity. Other substations that are on the 500 or 230/220 kV system were considered for possible distribution of new resources. Staff performed a geospatial analysis by intersecting 15-mile buffers around each substation with the area remaining outside the core land-use screen. This "lower implication" land with technical resource potential is aggregated within these buffered circles. Land with existing solar facilities were removed from this sum. A limit of 50 percent of the technical resource potential area was chosen for how much new resource could be mapped to a given substation before it was considered "full". See Appendix C for additional information on the core land-use screen.

In-state wind: The 2045 Scenario includes 3,074 MW of in-state wind resources. The 3,074 MW of in-state wind resources already mapped in the IRP resource portfolio for the 2023–2024 TPP base case is carried over without any changes. The allocation of in-state wind resources is shown in Appendix B.

Out-of-state (OOS) wind: The 2045 Scenario includes 12,000 MW of wind energy resources generated outside of the existing California ISO system. As shown in Appendix B, the 12,000 MW of out-of-state wind is allocated as follows:

- 790 MW from Arizona and New Mexico on existing out-of-state (OOS) transmission
- 1,000 MW from Idaho on new OOS transmission
- 5,000 MW from Wyoming on new OOS transmission
- 5,210 MW from New Mexico on new OOS transmission

Offshore wind: The 2045 Scenario includes 20,000 MW of offshore wind (OSW) resources. To identify the regions for mapping the 20,000 MW of OSW resources, the staff started with the 13,400 MW of OSW resources already mapped in the high OSW sensitivity from the IRP resource portfolio for the 2023-2024 TPP. The resources in the CPUC's high OSW sensitivity were mapped to the following locations: Morro Bay Wind Energy Area (5,400 MW), Humboldt Wind Energy Area (2,600 MW), Del Norte Interest Area (3,400 MW), and Cape Mendocino

15 http://www.caiso.com/planning/Pages/GeneratorInterconnection/Default.aspx

16 Hossainzadeh, Saffia, Erica Brand, Travis David, and Gabriel Blossom. 2023. *Land-Use Screens for Electric System Planning: Using Geographic Information Systems to Model Opportunities and Constraints for Renewable Resource Technical Potential in California.* California Energy Commission. Forthcoming publication.

17 In the CEC staff statewide land-use screening for electric system planning, *implication* is defined as a possible significance or a likely consequence of an action, for example, planning for energy infrastructure development in an area of higher biodiversity has *implications* for other land-use priorities.

Interest Area (2,000 MW). To inform mapping the remaining 6,600 MW of OSW resources, the staff consulted two in-progress analyses to understand a range of generation potentials and possible constraints:

- The OSW Development Scenarios under development and evaluation by the Schatz Energy Research Center for the *Northern California and Southern Oregon Offshore Wind Transmission Study*.[18] The analysis considers three scales of OSW development in Northern California, including:
    - Low Development Scenario: 4,100 MW of OSW capacity.
    - Mid-Range Development Scenario: 9,300 MW of OSW capacity.
    - High Development Scenario: 16,000 MW of OSW capacity.
- The in-development AB 525 sea space area identification. During a June 1, 2023, workshop, CEC staff presented a draft range of estimated generation potential from within lease areas and AB 525 sea space areas.[19] The additional AB 525 sea space areas identified are based on wind resource and technical characteristics, such as ocean bottom depth, ocean bottom slope, and distance to shore. These areas will likely reduce in size once screened for conflicts such as existing ocean uses and cultural and biological resources. The draft ranges are:
    - Humboldt Leases: 1,600–3,000 MW
    - North Coast AB 525 sea space: 27,000–45,000 MW
    - Morro Bay Leases: 3,000–6,000 MW
    - South Central Coast AB 525 sea space: 3,500–6,000 MW

After consulting the two in-progress analyses, staff allocated the remaining 6,600 MW of OSW to the Humboldt Wind Energy Area (100MW), the Del Norte Interest Area (3,600 MW), and the Cape Mendocino Interest Area (2,900 MW).

As shown in Appendix B, the CEC and CPUC staff allocated the full 20,000 MW of OSW as follows:

- 7,000 MW potential from Del Norte Interest Area
- 2,700 MW from Humboldt Wind Energy Area
- 4,900 MW potential from Cape Mendocino Interest Area
- 5,400 MW from Morro Bay Wind Energy Area

The geographic allocation of the OSW resources fits within the generation potential ranges under evaluation in the Schatz Energy Research Center *Northern California and Southern Oregon Offshore Wind Transmission Study* and the CEC AB 525 sea space identification.

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18 CEC AB 525 Workshop. May 25, 2023. Presentation slides available online at https://efiling.energy.ca.gov/GetDocument.aspx?tn=250371&DocumentContentId=85115. Starts at slide 41.

19 CEC AB 525 Workshop. June 1, 2023. Presentation slides available online at https://efiling.energy.ca.gov/GetDocument.aspx?tn=250471. Slide 59.

Geothermal: The 2045 Scenario includes 2,332 MW of geothermal resources. As shown in Appendix B, the 2,332 MW of geothermal resources is allocated as follows:

- The 2,037 MW of geothermal resources already mapped in the IRP resource portfolio for the 2023–2024 TPP base case is carried over without any changes.
- The remaining 295 MW are mapped to the Imperial region bringing the total geothermal mapped to the Imperial area to 1,195 MW. The Salton Sea area has significant geothermal resource potential beyond what was mapped to in the 23-24 TPP base portfolio and the previous 20-year outlook mapped a significant portion of the geothermal resources to the Salton Sea area.

Biomass: The 2045 Scenario includes 134 MW of biomass resources. The 134 MW of biomass resources already mapped in the IRP resource portfolio for the 2023–2024 TPP base case is carried over without any changes.

APPENDIX A
Glossary

Term	Definition
2021 SB 100 Starting Point Scenario	A scenario is a plausible description of how the future may develop based on a coherent and internally consistent set of assumptions about key driving forces (for example, rate of technological change, prices) and relationships. Note that scenarios are neither predictions nor forecasts but are used to provide a view of the implications of developments and actions. The 2021 SB 100 Starting Point Scenario was developed for use by the California ISO in the 20-year transmission outlook.
Additional Achievable Transportation Electrification	A CEC transportation energy demand forecasting framework that allows for standard forecasting model modifications to account for transportation policy changes that are reasonably expected to occur. These modifications can be made even if standard economic forecasting tools do not have the ability to capture such policies. For example, standard demand forecasting can capture policies that influence the demand for electric vehicles, but supply-side policies that influence vehicle manufacturers may not be captured under standard demand forecasting techniques.
Advanced Clean Cars II regulation	Two-pronged regulation from California Air Resources Board (CARB). First, it amends the Zero-emission Vehicle Regulation to require an increasing number of zero-emission vehicles, and relies on currently available advanced vehicle technologies, including battery-electric, hydrogen fuel cell electric and plug-in hybrid electric-vehicles, to meet air quality and climate change emissions standards. These amendments support Governor Newsom's 2020 Executive Order N-79-20 that requires all new passenger

	vehicles sold in California to be zero emissions by 2035. Second, the Low-emission Vehicle Regulations were amended to include increasingly stringent standards for gasoline cars and heavier passenger trucks to continue to reduce smog-forming emissions. For more information see, Advanced Clean Cars II Regulations.
Advanced Clean Fleets regulation (ACF)	The Advanced Clean Fleets regulation is part of the California Air Resources Board's (CARB or Board) overall approach to accelerate a large-scale transition to zero-emission medium- and heavy-duty vehicles. This regulation works in conjunction with the Advanced Clean Trucks (ACT) regulation, approved March 2021, which helps ensure that zero-emission vehicles (ZEV) are brought to market. For more information see, Advanced Clean Fleets Regulation.
Aliso Canyon storage facility	Aliso Canyon is a depleted oil field that has been used to store natural gas for the Los Angeles region since 1972. SoCalGas has historically used Aliso Canyon to help balance supply and demand in the summer and to help meet peak demand in the winter. On October 23, 2015, a massive leak at the Aliso Canyon natural gas storage facility was discovered and continued until it was sealed on February 18, 2016. In response to the leak at the Aliso Canyon, the state limited its use.
Alternating current (AC)	Flow of electricity that constantly changes (alternates) direction between positive and negative sides in a sine curve. Almost all power produced by electric utilities in the United States moves in current that shifts direction at a rate of 60 times per second.
Balancing authority	A balancing authority is the responsible entity that integrates resource plans ahead of time, maintains load-interchange-generation balance within a balancing authority area, and supports interconnection frequency in real time. Balancing authorities in California include the Balancing Authority

	of Northern California (BANC), California ISO, Imperial Irrigation District (IID), Turlock Irrigation District (TID) and Los Angeles Department of Water and Power (LADWP). The California ISO is the largest of about 38 balancing authorities in the Western Interconnection, handling an estimated 35 percent of the electric load in the West and 80 percent of the electric load in California. For more information, see the WECC Overview of System Operations: Balancing Authority and Regulation Overview Web page.
California Energy Demand Forecast (CED)	CED is a set of several forecasting products that are used in various energy planning proceedings, including the California Public Utilities Commission's (CPUC's) oversight of energy procurement and the California Independent System Operator's (California ISO's) transmission planning. The demand forecast generally includes: Ten-year annual end-use consumption forecasts for electricity and natural gas by customer sector, eight planning areas, and 20 forecast zones. Annual peak electric system load with different weather variants for eight planning areas. Annual projections of load modifier impacts including adoption of photovoltaic and other self-generation technologies, energy efficiency standards, and program impacts. For more information, see the Final 2021 Integrated Energy Policy Report Volume IV: California Energy Demand Forecast.
California ISO's 20-Year Transmission Outlook	A report published by the California ISO to provide a long-term conceptual plan of the transmission grid in 20 years, meeting the resource and electric load needs aligned with state agency input on integrated load forecasting and resource planning. The report is developed in collaboration with the California Public Utilities Commission and the California Energy Commission. For more

	information, see the 20 Year Transmission Outlook report.
Direct current (DC)	Electricity that flows continuously in the same direction rather than alternating (see above).
CPUC Integrated Resource Planning (IRP)	A planning proceeding to consider all the CPUC's electric procurement policies and programs and ensure California has a safe, reliable, and cost-effective electricity supply. The integrated resource planning process ensures that load-serving entities (LSEs) detail the procured and planned resources in their portfolios that allow the electricity sector to meet electricity demand while also contributing to meeting California's economywide greenhouse gas emissions reductions goals.
Kilovolt (kV)	One-thousand volts (1,000). Distribution lines in residential areas usually are 12 kV (12,000 volts).
PATHWAYS High Electrification Demand Scenario	The PATHWAYS model, developed by Energy and Environmental Economics, Inc (E3), is an economy-wide scenario tool used to identify pathways to achieve economy-wide decarbonization. For more information, see PATHWAYS Model.
Renewables Portfolio Standard (RPS)	The Renewables Portfolio Standard, also referred to as RPS, is a program that sets continuously escalating renewable energy procurement requirements for California's load-serving entities. The generation must be procured from RPS-certified facilities (which include solar, wind, geothermal, biomass, biomethane derived from landfill and/or digester, small hydroelectric, and fuel cells using renewable fuel and/or qualifying hydrogen gas). More information can be found at the CEC Renewables Portfolio Standard web page and the CPUC RPS Web page.
SB 100 Core Scenario	A scenario is a plausible description of how the future may develop based on a coherent and internally consistent set of assumptions

	about key driving forces (for example, rate of technological change, prices) and relationships. Note that scenarios are neither predictions nor forecasts, but are used to provide a view of the implications of developments and actions. The SB 100 Core Scenario from 2021 SB 100 Joint Agency Report is based on retail sales and in-state demand.

APPENDIX B
Resource Allocations for the 2045 Scenario for the 20-Year Outlook

Table B-1 provides an overview of the resource allocations by RESOLVE resource area[20] for the 2045 Scenario for the 20-year outlook. A full breakdown of the resources, including the mapping by substation and mapping analysis, can be found in the 2045 Scenario Portfolio Dashboard in CEC Docket 21-SIT-01.

Table B-1: Resource Allocations for the 2045 Scenario for the 20-Year Transmission Outlook

		2040 SB 100 Starting Point Scenario	23-24 TPP Base Case	2045 Scenario
		2040	2035	2045
InState Biomass	Biomass/Biogas	-	134	134
Solano_Geothermal	Geothermal	-	139	139
Northern_California_Geothermal	Geothermal	-	-	-
Inyokern_North_Kramer_Geothermal	Geothermal	-	53	53
Southern_Nevada_Geothermal	Geothermal	320	500	500
Northern_Nevada_Geothermal	Geothermal	-	445	445
Riverside_Palm_Springs_Geothermal	Geothermal	-	-	-
Greater_Imperial_Geothermal	Geothermal	2,012	900	1,195
Distributed Solar	Solar	-	125	125
Northern_CA	Solar	1,167	898	2,847
Greater_Bay	Solar	-	510	510
Central_Valley_LosBanos	Solar	809	1,208	3,391

20 CPUC. June 2023. Draft Inputs and Assumptions. 2022-2023 Integrated Resource Planning (IRP). https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/2023-irp-cycle-events-and-materials/draft_2023_i_and_a.pdf

SPGE_Westlands_Fresno	Solar	12,925	4,805	14,065
SPGE_Greater_Carrizo	Solar	-	230	1,630
SPGE_Kern	Solar	6,154	2,957	6,396
Big_Creek-Magunden	Solar	-	1,205	2,600
Greater_Tehachapi	Solar	9,544	6,829	8,978
Ventura_Area	Solar	2,066	750	1,800
Greater_LA	Solar	-	-	-
Greater_Kramer	Solar	3,510	2,660	3,460
SouthernNV_Desert	Solar	2,272	4,943	6,326
Riverside	Solar	4,922	6,493	6,793
Arizona	Solar	3,952	4,497	6,000
Greater_Imperial	Solar	4,807	963	4,345
San_Diego	Solar	995	-	500
Northern_California_Wind	Wind	866	339	339
Solano_Wind	Wind	542	757	757
Humboldt_Wind	Wind	34	-	-
Kern_Greater_Carrizo_Wind	Wind	60	180	180
Carrizo_Wind	Wind	287	174	174
Central_Valley_North_Los_Banos_Wind	Wind	173	150	150
North_Victor_Wind	Wind	-	-	-
Tehachapi_Wind	Wind	275	345	345
Southern_Nevada_Wind	Wind	-	403	403
Riverside_Palm_Springs_Wind	Wind	-	127	127
Baja_California_Wind	Wind	600	600	600
Wyoming_Wind	OOS Wind	4,685	1,500	5,000
Idaho_Wind	OOS Wind	-	1,000	1,000

New_Mexico_Wind	OOS Wind	5,215	2,328	5,210
SW_Ext_Tx_Wind	OOS Wind	-	790	790
NW_Ext_Tx_Wind	OOS Wind	1,500	-	-
North_Coast_Offshore_Wind	Offshore Wind	4,000	n/a	n/a
Humboldt_Bay_Offshore_Wind	Offshore Wind	n/a	1,607	2,700
Cape_Mendocino_Offshore_Wind	Offshore Wind	n/a	-	4,900
Del_Norte_Offshore_Wind	Offshore Wind	n/a	-	7,000
Central_Coast_Offshore_Wind	Offshore Wind	6,000	n/a	n/a
Morro_Bay_Offshore_Wind	Offshore Wind	n/a	3,100	5,400
Diablo_Canyon_Offshore_Wind	Offshore Wind	n/a	-	-
Renewable Resource Total		**79,692**	**54,642**	**107,305**
Northern_CA	Li_Battery	64	674	1,843
Greater_Bay	Li_Battery	250	2,479	3,079
Central_Valley_LosBanos	Li_Battery	-	537	1,846
SPGE_Westlands_Fresno	Li_Battery	431	2,341	7,899
SPGE_Greater_Carrizo	Li_Battery	50	210	1,050
SPGE_Kern	Li_Battery	95	1,441	3,603
Big_Creek-Magunden	Li_Battery	-	575	1,411
Greater_Tehachapi	Li_Battery	4,036	4,471	6,339
Ventura_Area	Li_Battery	500	668	1,298
Greater_LA	Li_Battery	1,651	2,527	2,527
Greater_Kramer	Li_Battery	176	1,404	1,884
SouthernNV_Desert	Li_Battery	700	2,689	3,517
Riverside	Li_Battery	-	4,900	5,380
Arizona	Li_Battery	695	1,567	2,918

Greater_Imperial	Li_Battery	-	603	2,632
San_Diego	Li_Battery	720	1,289	1,589
Unspecified_Locations	Li_Battery	27,632	-	-
Li_Battery_Total		**37,000**	**28,374**	**48,814**
SPGE_Greater_Carrizo	LDES	-	300	500
SPGE_Westlands_Fresno	LDES	-	-	100
Greater_Tehachapi	LDES	-	500	1,000
Riverside	LDES	1,900	700	1,500
San_Diego	LDES	500	500	500
Northern_CA_LDES	LDES	-	-	400
Unspecified_Locations	LDES	1,600	-	-
LDES Total		**4,000**	**2,000**	**4,000**
Storage Total		**41,000**	**30,374**	**52,814**
Generic Clean-Firm or LDES	Unspecified	-	-	5,000
Total New Resources		**120,692**	**85,015**	**165,118**

APPENDIX C
Core Land-Use Screen

The core land-use screen is the primary screen established by the geospatial analysis in the CEC Land-Use Screens Report.[21] The core land-use screen identifies:

(1) areas of the state that should be excluded from resource potential consideration because of technical and economic criteria commonly applied in energy infrastructure development,[22] and

(2) areas where utility-scale renewable energy or transmission development is precluded by state or federal law, policy or regulation.[23]

The geospatial datasets consisting of these categories of data are identified and compiled into a single map at statewide scale. They are referred to as the technoeconomic exclusion layer and the protected area layer and form the base exclusions of the core land-use screen.

The other components of the core land-use screen address several state policy priorities, including sustaining agriculture, protecting natural lands that support biodiversity,[24] and conserving intact landscapes. These additional land-use planning considerations fall into three categories used in the core screen:

(1) Biological Planning Priorities: Combines mapped delineations of U.S. Fish and Wildlife Service critical habitat (including the proposed bistate sage grouse), high ranks of California Department of Fish and Wildlife's Areas of Conservation Emphasis Terrestrial Connectivity, Biodiversity and Irreplaceability, and lands classified as wetlands.

(2) Terrestrial Landscape Intactness: A multicriteria evaluation model[25] result representing landscape condition based on the extent to which human impacts such as agriculture,

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21 Hossainzadeh, Saffia, Erica Brand, Travis David, and Gabriel Blossom. 2023. *Land-Use Screens for Electric System Planning: Using Geographic Information Systems to Model Opportunities and Constraints for Renewable Resource Technical Potential in California.* California Energy Commission. Forthcoming publication.

22 Spatial datasets that capture technical (for example, competitive wind resource locations), physical (for example, slope, water bodies) and socioeconomic or hazardous (for example, densely populated areas, railways, airports, highways, mines) criteria. This category also includes military lands. This layer was developed by CPUC staff.

23 Example designations of lands that fall under the protected area layer are National Parks, GAP Status 1 and 2, Open Spaces, Wilderness Areas, National Conservation Lands, Scenic Areas, easements, and Recreation Areas. For a full description and list of categories see Table D-1 and Table D-2 of the California Energy Commission, *Land-Use Screens for Electric System Planning: Using Geographic Information Systems to Model Opportunities and Constraints for Renewable Resource Technical Potential in California.* Staff report. Forthcoming publication.

24 Executive Order N-82-20, available at https://www.gov.ca.gov/wp-content/uploads/2020/10/10.07.2020-EO-N-82-20-.pdf.

25 A multicriteria evaluation is common in geospatial analyses when multiple inputs affect an overall value decision for an area. This method allows each input data layer to be transformed onto a common scale and weights each dataset according to relative importance. The result is a summation of the input data layers into a single-gridded map.

urban development, natural resource extraction, and invasive species have disrupted the landscape across California.[26]

(3) CEC Cropland Index Model: For lands used to produce crops, CEC developed a multicriteria evaluation model that uses information on soil quality, farmland designation, and existence of crops to create a numerically weighted index for the relative suitability of an area for crop production.

The CEC Cropland Index Model and the CBI Landscape Intactness modeled results are evaluated, then partitioned at the mean to produce areas of higher and lower implication, with higher implication areas recommended for resource potential exclusion. These are then combined with the base exclusions and the biological planning priorities to produce the core land-use screen. The areas remaining outside the screen are considered as lower implication areas and can be quantified, typically in units of acres and capacity (megawatt or gigawatt), to estimate renewable resource technical potential for electric system modeling and energy resource planning.

26 Degagne, R., J. Brice, M. Gough, T. Sheehan, and J. Strittholt. 2016. "Landscape Intactness (1 km), California." Conservation Biology Institute. From DataBasin.org: https://databasin.org/datasets/e3ee00e8d94a4de58082fdbc91248a65.