Power of Place

Land Conservation and Clean Energy Pathways for California

The Nature Conservancy

Executive Summary

This Executive Summary was prepared by The Nature Conservancy as a summary of a detailed technical report *Power of Place: Land Conservation and Clean Energy Pathways for California*.[i] The views expressed in the summary are those of The Nature Conservancy.

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Introduction

Clean energy policies are commanding a central position in the national conversation on how to address climate change. These policies are ambitious and urgent, with bold new goals proposed at city, utility, corporate, and state levels. Achieving these clean energy goals will require the development of tremendous amounts of new renewable energy generation at local and grid scales and a transmission system that can efficiently and cost-effectively deliver clean power where it is needed. As states strategically plan the clean, affordable, and reliable electricity systems of the future, there is an opportunity to maximize benefits and minimize environmental impacts. To do this, conservation data must be applied to energy resource planning decisions.

California has passed some of the most ambitious policies to reduce greenhouse gas (GHG) emissions across its economy: a state goal of 80 percent reduction below 1990 levels by 2050 (Schwarzenegger, EO S-3-05, 2005) and a policy of 100 percent zero-carbon electricity by 2045 (100 Percent Clean Energy Act, Cal. SB 100, Cal. Stat 2018). The need to design a new low-carbon electricity system to power the fifth largest economy in the world provides an opportunity for California to engage in proactive efforts to minimize conflicts between renewable energy development and other land uses.

The *Power of Place* study analyzes pathways to meet California's 2050 clean energy demand in alignment with economy-wide decarbonization goals while integrating ecological considerations. The demand forecast used in this study includes demand growth associated with significant electrification of heating and transportation. The scenarios in the study deliver 102–110 percent of retail sales of zero-carbon electricity, which we interpret to be consistent with the retail-sale requirements of SB 100 in 2050.

The study shows that many land areas across the West have both high renewable resource potential and high conservation values, creating the potential for conflict between renewable energy development and land conservation goals. Poor siting can unnecessarily degrade the habitat, biodiversity, and other values of natural landscapes. Siting conflicts can also seriously impede renewable energy development; projects have been subject to multi-year delays, major cost increases, and, in some cases, abandonment.

The study reveals that California can significantly ramp up renewable energy generation required to achieve economy-wide greenhouse gas reduction goals while reducing the impact of new onshore wind, solar, geothermal energy and transmission infrastructure on natural lands across the West. These findings suggest that the best pathways to reach climate goals are those that recognize the *power of place*—a strategic approach to planning for clean energy and land conservation to reach our climate goals.

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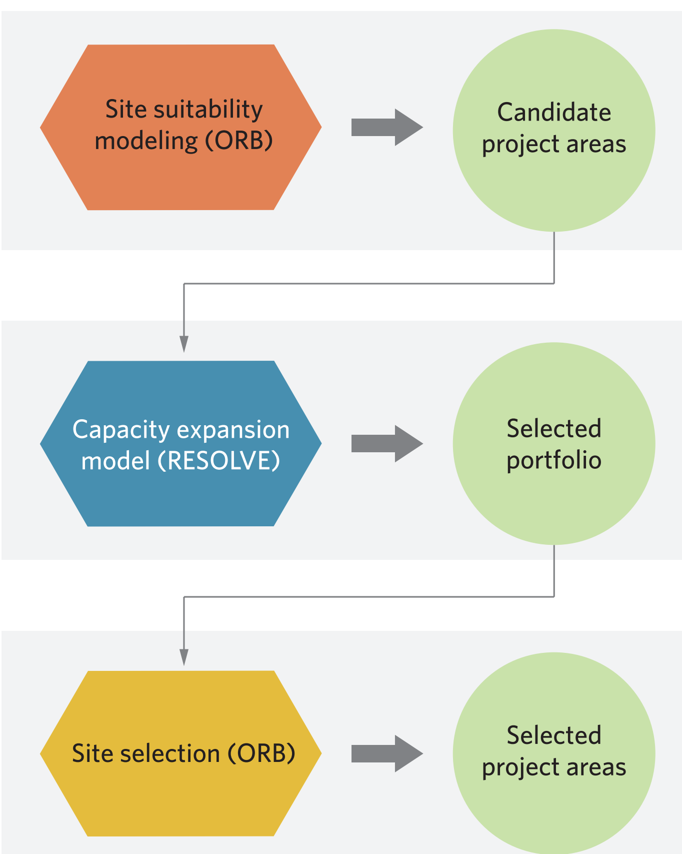
Methods

The study used two models: the Optimal Renewable Energy Buildout (ORB)[ii] model and the RESOLVE[iii] model (Figure 1). This study used the California-wide RESOLVE model developed for the 2018 California Energy Commission *Deep Decarbonization in a High Renewables Future* report.[iv] Together the ORB and RESOLVE models were used to create optimal resource development pathways that achieve a decarbonized electricity sector while factoring in natural and agricultural land[v] constraints and impacts.

Process

The ORB model provided candidate renewable resource assumptions informed by spatial environmental data. With this input, RESOLVE selected portfolios of future generation and transmission investments that minimize cost, subject to reliability and technical and policy constraints. The ORB model then took the RESOLVE portfolios and assigned project locations and interconnection transmission paths to assess overall environmental implications.

Figure 1: How the ORB model interacts with the RESOLVE model



Site Suitability Inputs

Suitable candidate renewable resources were mapped using four siting categories of increasingly protective environmental exclusions (see Tables 1 and 2 on page 3). The land categorizations and datasets drew primarily on previous renewable energy planning studies,[vi] as detailed in the technical report, along with important additional data inputs from chapters of The Nature Conservancy across eleven Western states. Across all categories, the modeling excluded lands that are not suitable for utility-scale renewable energy development for physical, technical, or socioeconomic reasons. The footprints of existing commercial wind and solar power plants were removed from candidate resource area maps to ensure only undeveloped areas could be selected for future development. Lands outside of areas covered by Environmental Exclusion Categories 1, 2, 3, or 4 and the physical, technical, or socioeconomic exclusions were considered candidates for renewable energy development (Figure 2).

The full list of data sources and exclusions are included in the technical report.

Table 1: Environmental Exclusion Categories Used in the Site Suitability Analysis

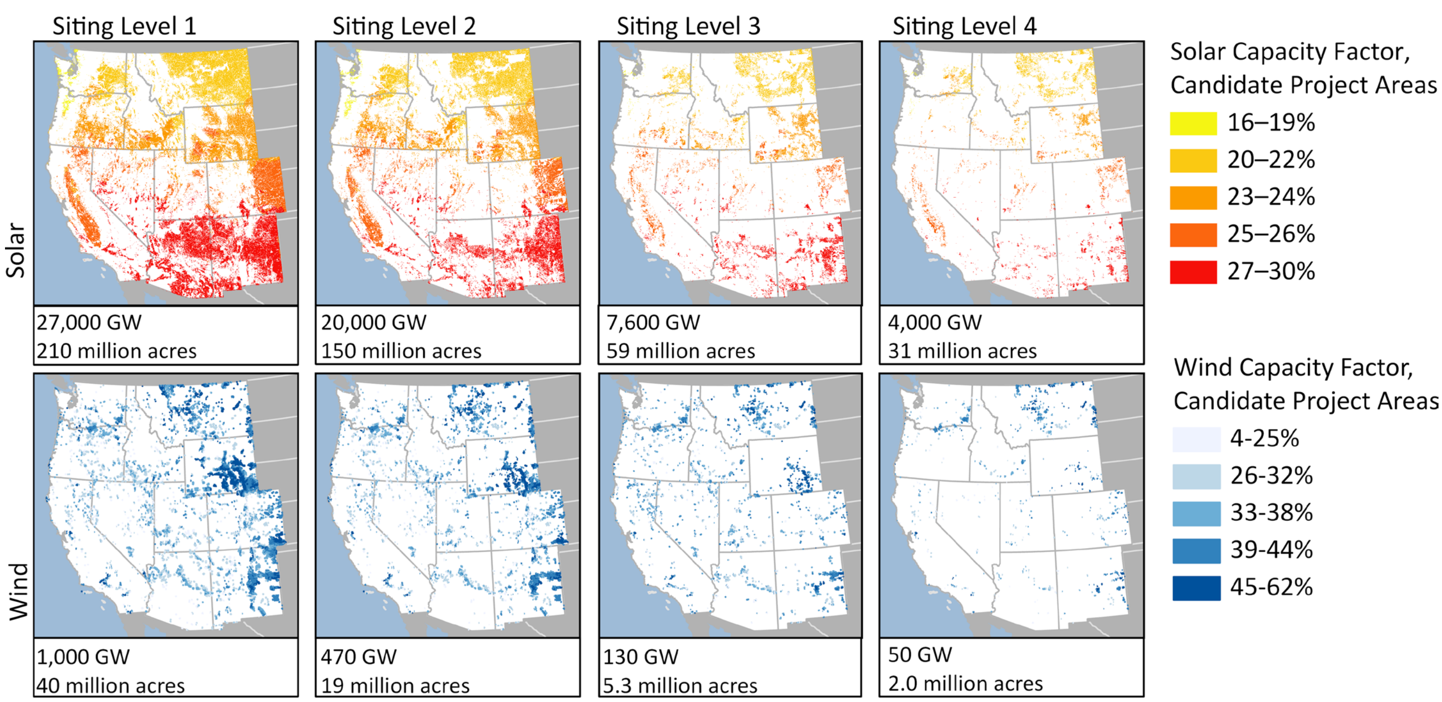
Category	Definition	Examples
1 Legally Protected	Areas with existing legal restrictions against energy development.	National wildlife refuges, National parks
2 Administratively Protected	Areas where the siting of energy requires consultation or triggers a review process to primarily protect ecological values, cultural values, or natural characteristics. This category includes areas with administrative and legal designations by federal or state public agencies where state or federal law requires consultation or review. This category includes tribal lands, as these areas are subject to the authority of tribes, or nations, to determine if utility-scale renewable energy development is an appropriate or allowable use. Lands owned by nongovernmental organizations (NGOs) that have conservation obligations are also included in this category.	Critical habitat for threatened or endangered species, sage grouse priority habitat management areas, vernal pools and wetlands, tribal lands
3 High Conservation Value	Areas with high conservation value as determined through multistate or ecoregional analysis (e.g., by a state, federal, academic, or nongovernmental organization entity) primarily characterizing the ecological characteristics of a location. This category may also include lands that have social, economic, or cultural value.	Prime farmland, important bird areas, big game priority habitat, The Nature Conservancy ecologically core areas
4 Landscape Intactness	Lands with potential conservation value based on their contribution to intact landscape structure. This category includes lands that maintain habitat connectivity or have high landscape intactness (low fragmentation).	Landscape intactness, wildlife corridors

Table 2: Environmental Siting Levels

Siting Level Cases	Siting Level **1**	Siting Level **2**	Siting Level **3**	Siting Level **4**
Lands Excluded	Category **1**	Categories **1** and **2**	Categories **1**, **2**, and **3**	Categories **1**, **2**, **3**, and **4**

Figure 2: Site Suitability Results

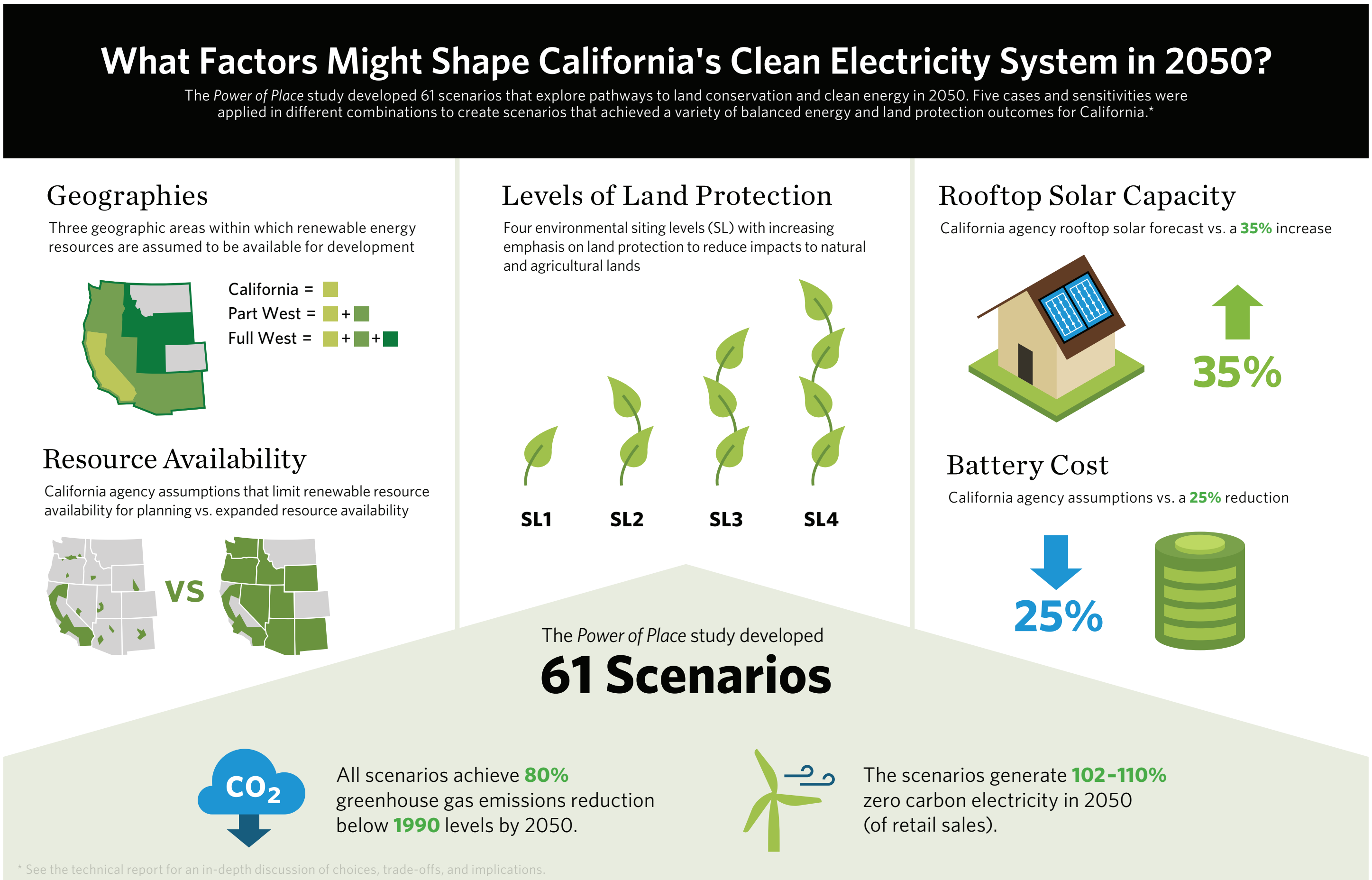
These maps show the remaining candidate lands available for wind and solar selection across all Western states after environmental and technical exclusions are applied for each siting level. The total acreage and estimated potential energy capacity for these maps are shown at the bottom of each map.



Cases and Sensitivities

The cases and sensitivities explored the implications of environmental siting, geographic availability of renewable resources, current California energy resource planning assumptions, rate of deployment of rooftop solar, and future cost of battery storage (Figure 3). The modeled scenarios were presented as a plausible range of future high-electrification pathways for renewable energy development in California and the West, but they did not account for the technological breakthroughs that will also influence the clean energy transition.

Figure 3: Cases and sensitivities explored

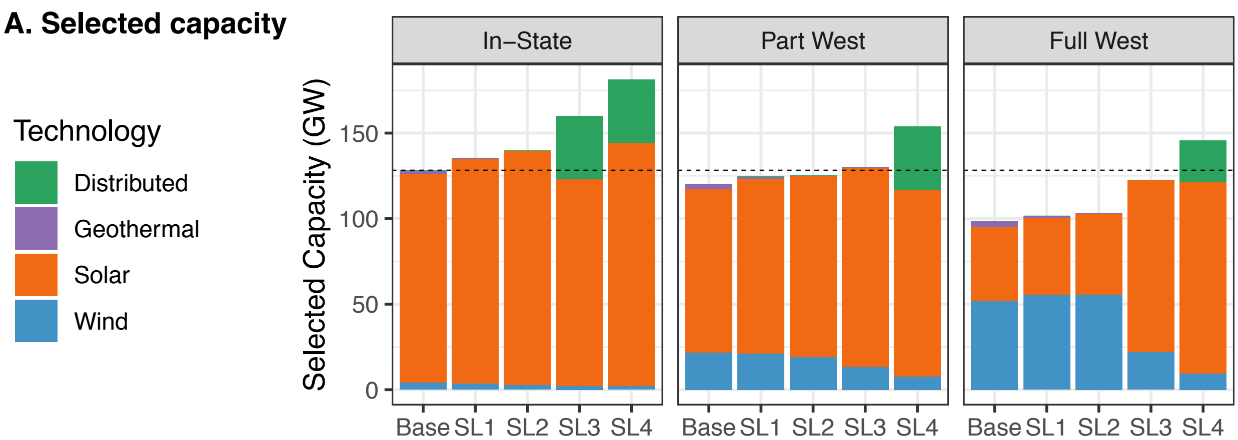


A detailed description of the cases and sensitivities can be found in the technical report.

Strategic Environmental Assessment

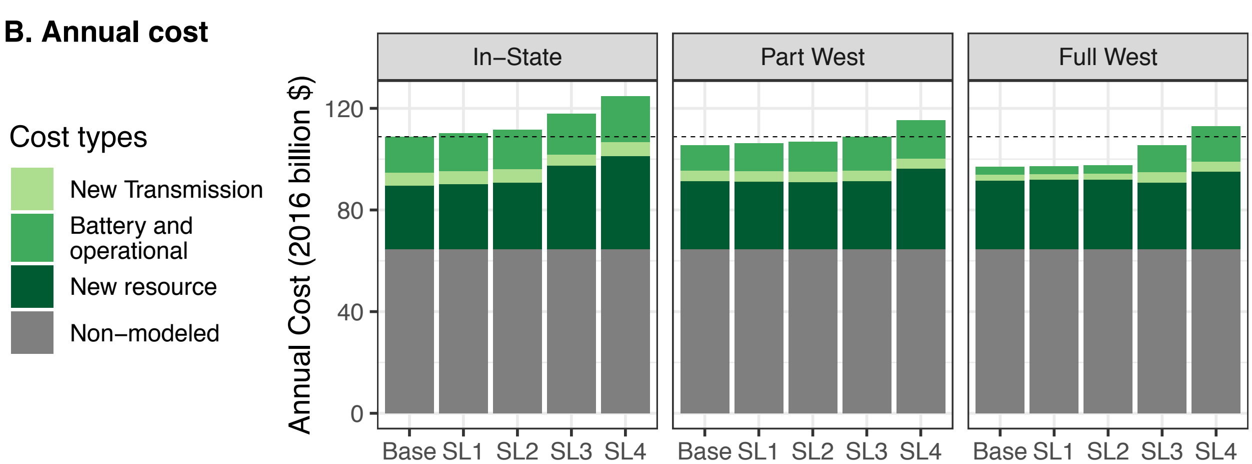
The environmental implications of each scenario were assessed using the modeled footprint of generation, interconnection, and planned bulk transmission. Scenarios were assessed using natural and agricultural land, landscape intactness, and wildlife habitat metrics. The purpose of this assessment was to allow for comparative analysis of natural resource implications and trade-offs across scenarios.

Figure 4a: Selected capacity of renewable technologies by geography and siting level



The y axis (vertical) shows the selected installed capacity of distributed wind and solar resources, geothermal, solar PV, and onshore wind by 2050. The x axis (horizontal) shows each environmental siting level. Results are grouped into boxes by geographic case—California (In-State), Part West, and Full West. The dotted horizontal line across all three geography panel plots shows the value of the California (In-State) base case for reference. The base case is the unmodified RESOLVE, which does not incorporate the siting levels developed in this present study. This chart shows that geographic availability of renewable resources and siting level constraints affect the generation mix as well as the total generation capacity. As wind generation declines with increasing siting restrictions and reduced geographic availability, more solar or distributed generation is needed to fill the gap.

Figure 4b: Total annual resource cost in 2050 by geography and siting level



The y axis (vertical) shows the total annual cost of the electricity sector (revenue requirements) for each portfolio in 2050—all costs are reported in 2016 U.S. dollars. The x axis (horizontal) shows each siting level. Results are grouped into boxes by geographic case—California (In-State), Part West, and Full West. The dotted horizontal line across all three geography panel plots shows the cost of the California (In-State) base case for reference. The base case is the unmodified RESOLVE, which does not incorporate the siting levels developed in this present study. The results suggest that avoiding impacts to natural and agricultural lands does affect annual electric sector costs, but more protective scenarios can actually be cost-effective in the regional geographic cases.

Key Results

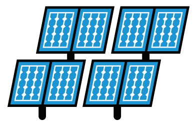
Renewable Energy 2050 | By the Numbers

Total acres of **wind** across the scenarios:

Approximately
480,000 to
2.6 million
acres

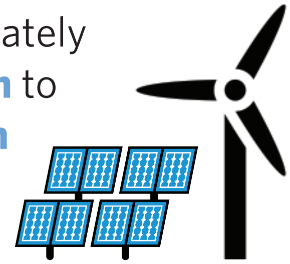
Total acres of utility-scale **solar** across the scenarios:

Approximately
430,000 to
1.6 million
acres



Total acres of **wind** and **solar** across the scenarios:

Approximately
1.6 million to
3.1 million
acres



- **With planning, California can significantly ramp up renewables and limit land impacts.** Through proactive planning that incorporates conservation data, California can achieve deep decarbonization by 2050 under a high-electrification scenario while protecting important lands.

- **In the absence of a plan to limit land impacts and scale up renewables, impacts to natural and agricultural lands could be high.** The study reveals that a large percentage of areas in the West with renewable resource potential have environmental or agricultural value. If siting protections are not applied, many of these lands could be selected for energy development.

- **Future solar development is likely to impact agricultural lands.** The impacts of future solar development on agricultural lands are likely to be significant. Across all scenarios, one-third to one-half of all selected solar projects were sited on agricultural land, and one-half of all selected solar projects were sited on rangelands.

- **Access to Western wind resources reduces generation costs.** Access to Western renewable resources is more cost-effective than limiting new renewable resource development to California due to the availability of high-value Western wind resources. While the California (In-State) cases require the least new interconnection and bulk transmission investment in comparison to regional scenarios, the In-State transmission cost savings are offset by generation cost savings in the Full West scenarios.

- **Achieving the best conservation outcome is more cost-effective at a regional scale.** Costs of increased environmental siting protections are highest when resources available for development are limited to California. In the regional scenario (Full West), the portfolio that protects high-conservation-value lands (Siting Level 3) is approximately 10 percent less expensive than the same level of protection in the California (In-State) scenario.

- **In-State and regional portfolios differ in their technology mixes.** In the California (In-State) scenarios, the vast majority of selected generation capacity is solar photovoltaic (PV) due to the scarcity of In-State wind potential. Thus, these In-State portfolios rely heavily on battery storage to make solar generation available at night and during winter storms. In the regional scenarios, economically competitive wind resources with generation profiles that complement those of solar PV can avoid heavy reliance on battery storage.

- **Distributed energy resources (DER) can play an important role in decarbonization.** Total residential and commercial DER accounted for 11–31 percent of electricity demand in 2050 scenarios. High-rooftop solar scenarios (an additional ~9 GW compared to baseline 2050 forecast, or a 35 percent increase) reduced the amount of land needed for utility-scale generation by 49,000–110,000 acres.

Policy Recommendations

The study shows that a deeply decarbonized electric sector in California is not only possible, but that with appropriate planning and policy frameworks the transition can be accomplished while reducing impacts to natural lands across the West and minimizing system costs. Conservation of these natural and agricultural lands across the West can protect wildlife habitat, improve air and water quality, store carbon, and provide other economic and societal benefits.

The following recommendations for policy makers identify actions to achieve multiple goals:

- **Incorporate conservation data into long-term energy planning.** Establish the protection of natural lands and conservation values as an objective in long-term energy planning to improve planning forecasts, limit future development conflict, and avoid loss of habitat and ecosystem services.

- **Invest in new West-wide planning to improve outcomes.** A science-based vision for balancing renewable energy and land conservation in the Western Interconnection is needed. The land use data that inform state and local energy planning can be improved if there is a common set of assumptions across the West. These data could be used to minimize conflict and bring certainty to state or regional efforts to build renewables to meet clean energy targets.

- **Prioritize conservation in regional resource-sharing discussions.** The lower-cost, lower-impact pathway to decarbonization includes increased access to regional renewable energy with the appropriate planning and policy framework to protect natural and agricultural lands. As Western states consider the merits and trade-offs of a future regional energy market, the protection of natural and agricultural lands should be a policy priority.

- **Promote interstate and interagency coordination.** Expand collaboration between states and state energy and natural resource agencies in energy planning. Cooperation will be essential to achieve the goals of building renewable energy infrastructure at scale and protecting natural resources.

- **Promote siting of clean energy technologies on already disturbed or degraded land, including brownfields.** Given the large scale of solar deployment and its land use requirements, invest in new strategies to remove barriers and incentivize deployment of utility-scale solar in already disturbed or degraded lands, especially areas where solar is an economically beneficial alternative land use (e.g., former mine lands, brownfields, impaired former agricultural lands).

- **Strengthen links between resource planning and procurement.** Resource planning should inform generation procurement and transmission expansion to ensure that the cumulative procured mix of low-carbon resources optimally achieves multiple benefits and services, such as affordability, low emissions, grid reliability, and protection of conservation values. This is to ensure individual procurement decisions add up to an electricity system that achieves decarbonization and other important policy goals.

- **Model electricity demand of multiple states.** Multiple states are moving toward low-carbon economies; therefore, it is important to model multi-state electricity demand to understand the cumulative implications, interactive effects, magnitude of trade-offs, and benefits of different pathways to decarbonization.

- **Account for indirect effects and supply-chain impacts of storage.** Across all scenarios, battery storage is the primary resource selected to allow solar to be shifted to different hours of the day. The deployment of batteries at scale will increase pressure for lithium exploration and mining. We recommend a landscape-scale assessment of lithium-mining potential to explore opportunities and solutions to limit impacts to natural and agricultural lands.

- **Pursue low-impact wind siting and operations.** As Western states move toward decarbonization of the electric sector, we note the increasing importance of wind energy siting, design, and operational practices to minimize impacts to wildlife and habitat. After all efforts have been made to avoid impacts, remaining unavoidable impacts should be minimized. Wind developers should utilize the U.S. Fish and Wildlife Service Land-Based Wind Energy Guidelines and best available science to identify appropriate measures to reduce impacts of development and operation.

- **Pursue policies and programs to increase energy efficiency, demand response, and distributed energy resources.** To reduce the amounts of natural and agricultural lands needed to achieve clean energy policies, we recommend increasing incentives and investments in energy efficiency, demand response, and DERs.

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Endnotes

i. Wu, G.; Leslie, E.; Allen, D.; Sawyerr, O.; Cameron, D.; Brand, E.; Cohen, B.; Ochoa, M.; Olson, A. *Power of Place: Land Conservation and Clean Energy Pathways for California,* 2019.

ii. The Optimal Renewable Energy Buildout (ORB) modeling framework is a suite of spatial modeling tools that perform site-suitability and site-selection analyses for planning the spatial buildout for new wind, solar, and geothermal technologies. It was developed by Dr. Grace Wu, with guidance from Energy and Environmental Economics, Inc. (E3) and Lawrence Berkeley National Laboratory (LBNL), and was published in a peer-reviewed scientific journal (Wu, G. C.; Torn, M. S.; Williams, J. S. Incorporating Land-Use Requirements and Environmental Constraints in Low-Carbon Electricity Planning for California. *Environmental Science and Technology* **2015,** 2013–2021). With The Nature Conservancy's support, ORB was modified and extended to examine renewable energy buildout scenarios associated with California's Renewable Portfolio Standard (RPS) Calculator (2015) and renewable energy solutions model (RESOLVE).

iii. RESOLVE is a resource-investment model developed by Energy and Environmental Economics, Inc. (E3) to identify optimal long-term generation and transmission investments in an electric system. Designed specifically to address the capacity-expansion questions for systems seeking to integrate large quantities of variable renewable resources, RESOLVE layers capacity-expansion logic on top of a production-cost model to determine the lowest-cost investment plan, accounting for both the up-front capital costs of new resources and the variable costs to operate the grid reliably over time.

iv. Mahone, Amber; Subin, Zachary; Kahn-Lang, Jenya; Allen, Douglas; Li, Vivian; De Moor, Gerrit; Ryan, Nancy; Price, Snuller. *Deep Decarbonization in a High Renewables Future: Updated Results from the California PATHWAYS Model;* CEC-500-2018-012; California Energy Commission: 2018.

v. Natural and agricultural lands include forests, woodlands, wetlands, grasslands, shrublands, deserts, riparian areas, rangelands, and farmlands.

vi. Western Electricity Coordinating Council Environmental Data Working Group. *Western Renewable Energy Zones—Phase 1 Report.* DOE-1000-2009-011; Renewable Energy Transmission Initiative (RETI). *RETI Phase 1B Final Report;* and The Nature Conservancy. *Integrating Land Conservation and Renewable Energy Goals in California: A Study of Costs and Impacts Using the Optimal Renewable Energy Build-Out (ORB) Model.*

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