Green Light Study

Economic and Conservation Benefits of Low-Impact Solar Siting in California

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The Nature Conservancy

KOIN Center
222 SW Columbia Street
Suite 1600
Portland, OR 97201

201 Mission Street #4
San Francisco, CA 94105

Authorship

The primary authors of this report are:

Stephanie Dashiell, California Energy & Land Use Project Director, The Nature Conservancy
Dr. Mark Buckley, Partner/Senior Economist, ECONorthwest
Dr. Dustin Mulvaney, Associate Professor, Environmental Studies Department, San Jose State University

Additional contributions were provided by staff at The Nature Conservancy: Sarah Heard, Sophie Parker, Erica Brand, Laura Crane, Nels Johnson, Brian Cohen, Dick Cameron, Marcela Ochoa; and staff at ECONorthwest: Marcy Shrader-Lauinger and Virginia Wiltshire-Gordon.

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Disclaimer

ECONorthwest and The Nature Conservancy are responsible for the content of this report. The staff at ECONorthwest and The Nature Conservancy along with Dustin Mulvaney prepared this report based on their knowledge of conservation, economics, and economic development and on information derived from government agencies, private statistical services, the reports of others, interviews of individuals, or other sources believed to be reliable. ECONorthwest and The Nature Conservancy have not independently verified the accuracy of all such information and make no representation regarding its accuracy or completeness. Any statements nonfactual in nature constitute the authors' current opinions, which may change as more information becomes available.

Table of Contents

Key Concepts and Acronyms

Key Concepts

Ecological impacts—The suite of impacts to biodiversity and ecological systems that result from the development of solar energy projects.

Economic benefits and costs—The benefits and costs that accrue to developers (and, as a result, energy buyers) with budgetary implications. These benefits have direct implications for the financial bottom line.

Biodiversity value—The degree of diversity of plants and animals, and habitat for multiple species, provided at a specific location. Areas of high biodiversity value have been prioritized for conservation, based on analyses completed by The Nature Conservancy.

Low impact siting—The siting of renewable energy projects in areas that have been identified as having low biodiversity value based on analyses of the Mojave and Sonoran Deserts and the San Joaquin Valley by The Nature Conservancy and other environmental stakeholders.

Acronyms

ACEC	Area of Critical Environmental Concern
BLM	Bureau of Land Management
BO	Biological Opinion
CCA	Community Choice Aggregation
CDCA	California Desert Conservation Area
CDFW	California Department of Fish and Wildlife
CDOC	California Department of Conservation
CDOF	California Department of Forestry
CEC	California Energy Commission
CESA	California Endangered Species Act
CEQA	California Environmental Quality Act
DOI	Department of the Interior
DRECP	Desert Renewable Energy Conservation Plan

EA	Environmental Assessment
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
EO	Executive Order
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FEIS	Final Environmental Impact Statement
FERC	Federal Energy Regulatory Commission
FLPMA	Federal Land Policy and Management Act of 1976
FWS	U.S. Fish and Wildlife Service
GW	Gigawatt
IOUs	Investor Owned Utilities
kV	Kilovolt
LBNL	Lawrence Berkeley National Laboratory
MW	Megawatt
NEPA	National Environmental Policy Act of 1969
PEIS	Programmatic Environmental Impact Statement
PPA	Power Purchase Agreement
PV	Photovoltaic
ROD	Record of Decision
ROW	Right-of-Way
RPS	Renewable Portfolio Standards
USDA	U.S. Department of Agriculture
USSE	Utility-Scale Solar Energy
W	Watt
WECC	Western Electricity Coordination Council

1 Abstract

The *Green Light Study* evaluated publicly available information to explore if there is an economic benefit to low-impact siting of solar energy projects in California. In gathering this information, we documented the factors and conditions that may increase, decrease, or outweigh such benefit. This study included analysis of existing data and literature, interviews with key industry experts, and a case study analysis of 16 utility-scale solar projects in California which collectively represent more than 40 percent of total in-state solar capacity as of December 2018. For the project locations we assessed, the case study analysis indicated that average permitting timeframes, habitat mitigation requirements, and habitat mitigation costs differ across biodiversity value categories associated with project location. Specifically, utility-scale solar projects sited in areas of high biodiversity were associated with habitat mitigation costs that are greater than those for low biodiversity value siting. Collectively, the cost savings of siting projects in areas of low biodiversity value could be in the range of 7–14 percent of overall project costs. These habitat-related economic benefits of low-impact solar are one of many cost considerations that drive site selection decisions. Based on interviews with representatives associated with developing, permitting, or purchasing solar energy projects in California, some other considerations for solar energy facility site selection are:

- proximity and ability to interconnect to transmission;
- ability to secure a power purchase agreement;
- permitting factors, including certainty in securing land-use entitlements; environmental review; civil, environmental, and regulatory issues; and local jurisdiction requirements;
- land price; and
- predetermined zones for renewable energy development, where established, including federal, state, or county zoning and other preidentified least-conflict lands.

While threatened and endangered species habitat was identified as a factor in site selection, biodiversity value more broadly was not consistently identified by all interviewees. The synthesis of data and information in this study suggests that integrating information from biodiversity assessments into site selection decisions could yield both economic and conservation benefits and provide more certainty in accelerating renewable energy deployment.

2 Introduction

The transition from fossil fuels to renewable energy resources is necessary to address climate change but may contribute to social and environmental conflicts due to changing land-use patterns. Looking at solar energy in California, the California Energy Commission (CEC) has documented more than 700 solar power plants greater than 1 megawatt (MW) in size operating in California, with a total installed capacity near 12,000 MW.[1] This level of solar development comes with land-use conversion and associated ecological impacts. These impacts vary across landscapes, as the biodiversity value of project sites ranges from high quality habitat for endangered, threatened, and special status species to areas with less ecological function such as brownfields, abandoned mines, agricultural fields, and retired landfills. Some utility-scale solar energy (USSE) projects in California have been sited on lands with high biodiversity value. This has resulted in project delays and cancellations, costly compensatory mitigation requirements, resistance from environmental groups, and, in some cases, litigation.

State renewable portfolio standards (RPSs), new forms of electricity procurement such as community choice aggregation (CCA), and direct renewable energy purchases by organizations and corporations are driving new investments in renewable energy. California's ambitious plan to rely only on zero-carbon electric power by 2045 (100 Percent Clean Energy Act, Cal. SB 100, Cal. Stat 2018) will put more pressure on landscapes to carve out space for solar energy facilities to meet the state's policy goals. The Nature Conservancy's recent report, *Power of Place: Land Conservation and Clean Energy Pathways for California,* found that California can significantly ramp up renewable energy and limit ecological impacts by integrating conservation information up front.

While the ecological impacts of siting USSE projects in areas with high biodiversity value have been widely documented (Hernandez et al., *Solar energy development,* 2015; Lovich and Ennen, 2011), the private economic impacts associated with USSE projects sited in areas of high biodiversity value have not been evaluated comprehensively, as these costs are not easily accessible to the public. The *Green Light Study* is the first initiative to evaluate publicly available information to explore if there is an economic benefit to developers from low-impact siting of solar energy projects in California. The *Green Light Study* includes three components: (1) synthesis of existing background information, including quantitative and spatial data on ecosystems, land use, and land cover associated with USSE projects; (2) case study analysis of 16 USSE projects on lands with either high or low biodiversity value; and (3) interviews with developers, public natural resource agency representatives, and solar industry experts.

The trends documented in the *Green Light Study* indicate that building solar energy facilities in areas of low biodiversity value could help California maintain the pace and scale of renewable energy development needed to address the urgent challenge of climate change while also protecting the state's important lands and waters and minimizing costs.

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[1] See the California Energy Commission's database: https://ww2.energy.ca.gov/almanac/renewables_data/solar/index_cms.php.

3 Background Information

3.1 Geography of USSE in California

California leads the country on USSE installations and has for the last decade (SEIA, 2019). USSE has been growing rapidly in California due to high solar insolation, declining costs of photovoltaic panels, and policy drivers such as California's Renewable Portfolio Standard. Most of the development in California has occurred in the southern portion of the state, where there is the highest average daily solar resource (both direct normal irradiance and global horizontal irradiance).[2] The counties with the highest level of installed capacity—Kern, San Bernardino, Riverside, Imperial—are located in the southern portion of the San Joaquin Valley and the desert region of the state (Figure 2 and Figure 3 and Appendix A). USSE projects are generally located near major transmission corridors, particularly the larger projects.

By measures of both acreage and installed capacity, the majority of USSE projects in California are sited on private lands (Figure 1). Solar projects on private land are primarily in areas previously used for farming, both irrigated and non-irrigated agriculture, specifically in the San Joaquin Valley region. As California implements its Sustainable Groundwater Management Act, which will cut agricultural water use, some agricultural lands will likely continue to transition to solar due to water scarcity.

There was a peak in solar energy development on lands managed by the Bureau of Land Management (BLM) in the early 2010s, which was largely a result of funding provided by the American Recovery and Reinvestment Act of 2009 (White House Council of Economic Advisors, 2016). Land-ownership information is key to understanding the ecological impacts of project siting. This is because in the California desert publicly owned lands are generally of higher biodiversity value than privately owned lands (Randall et al., 2010).

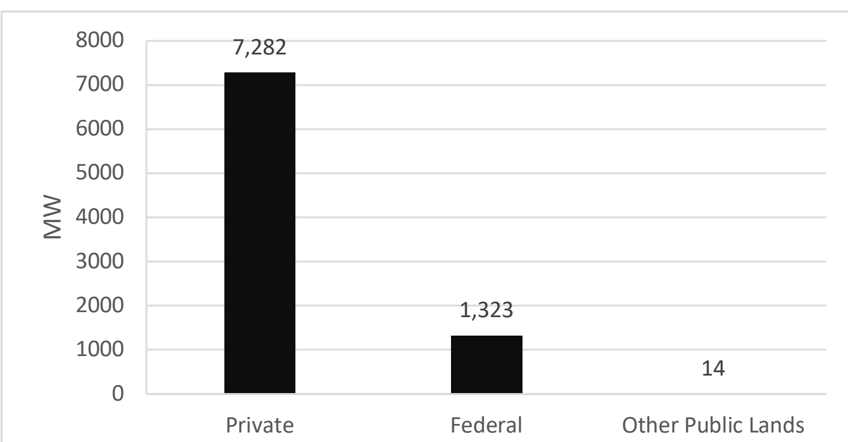

Figure 1. USSE Capacity Built by Land Ownership in California (MW)
Note: Federal generally refers to Bureau of Land Management (BLM) lands, and other public lands are state and local. As of 2016.
Source: California Energy Commission (CEC) (2016); California Department of Forestry (CDOF) (2018).

[2] National Renewable Energy Laboratory Geospatial Data Science: Solar Maps—https://www.nrel.gov/gis/solar.html.

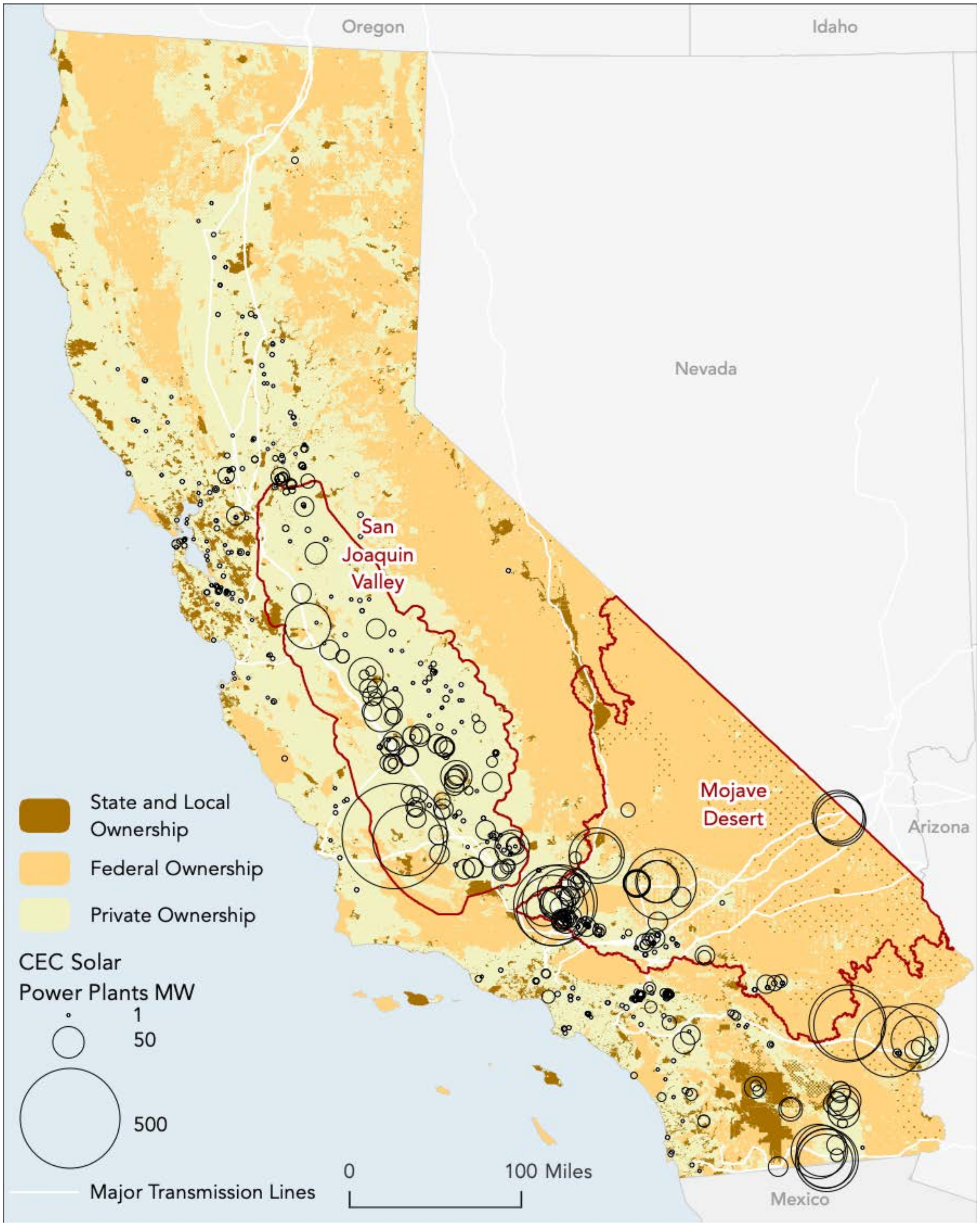

Figure 2. USSE Siting Geography

Source: CEC (2016); Public land ownership data from California Department of Forestry (CDOF) (2018).
Note: Private land includes land not owned by public agencies. Circles representing power plants are proportional in size to the MW produced by the power plant. Major transmission lines are defined as lines of 500 kilovolts (kV) or more.

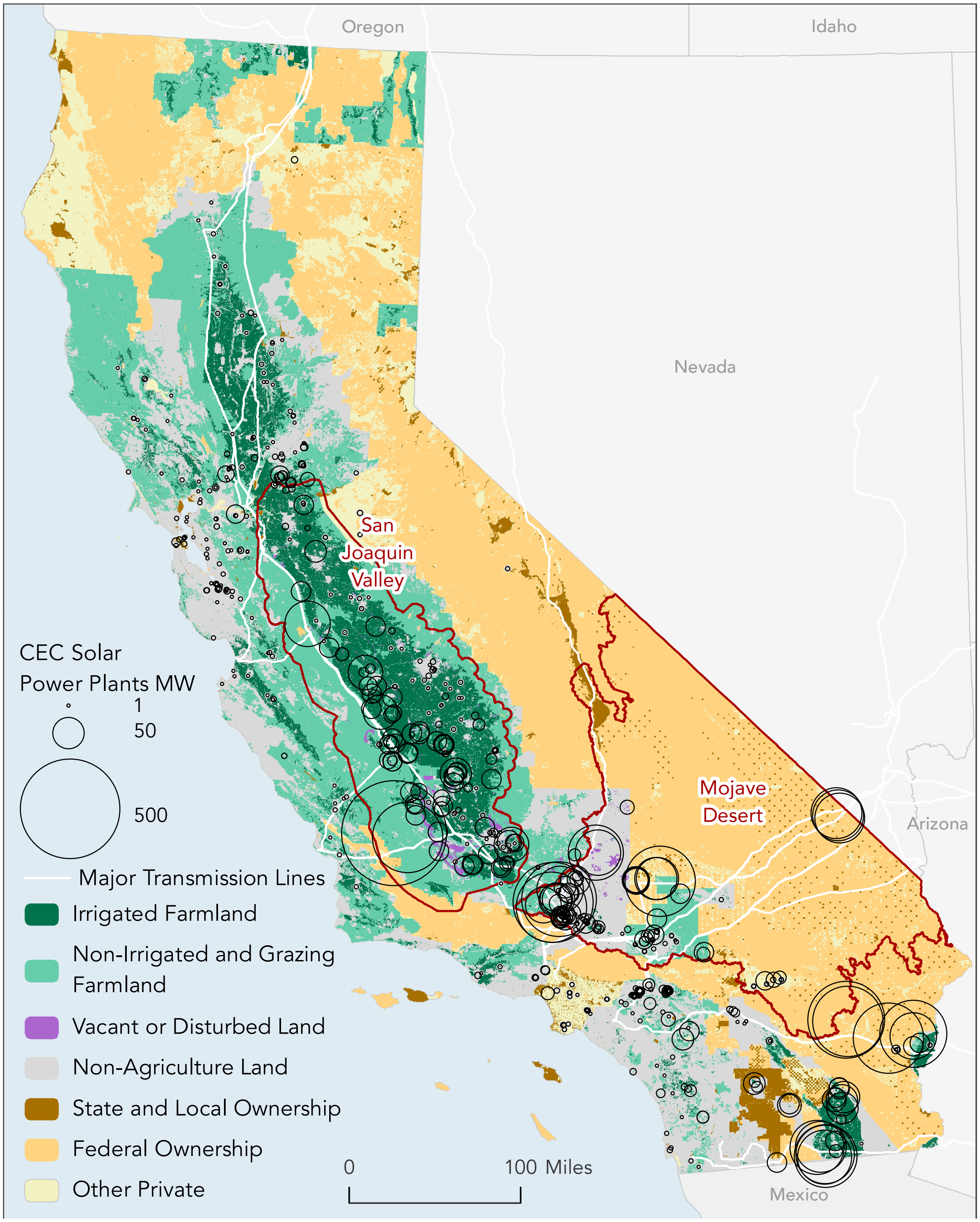

Figure 3. California USSE Map by Agricultural Land Use

Source: CEC (2016); CDOF (2018); California Department of Conservation (CDOC) (2016); Western Electricity Coordination Council (WECC) (2014).

Note: Public lands are only displayed where there is no Important Farmland. Other areas consist of private land that is not Important Farmland. Private land includes land not owned by public agencies. Circles representing power plants are proportional in size to the MW produced by the power plant. Major transmission lines are defined as lines with voltage of 500 kV or more. Vacant or Disturbed Land includes open field areas that do not qualify for an agricultural category, mineral and oil extraction areas, off-road vehicle areas, electrical substations, channelized canals, and rural freeway interchanges.

3.2 Impacts of USSE Projects

The largest USSE projects, some occupying several thousand acres of land, pose a variety of challenges for the long-term protection of biodiversity. For a discussion of the biodiversity values that may be threatened by the development of USSE projects in the Mojave Desert, please see Randall et al. (2010). For the Sonoran Desert, please see Conservation Biology Institute and The Nature Conservancy (2009). For the San Joaquin Valley, please see Butterfield et al. (2013).

Impacts to biodiversity associated with USSE development include, but are not limited to, habitat loss, habitat fragmentation, and loss of landscape connectivity. These impacts present significant challenges to biodiversity conservation as the climate changes and populations of species need to migrate in response. In at least two parts of the California desert—the western Mojave Desert and Ivanpah Valley—USSE and wind facilities have been responsible for the majority of land-use change and habitat degradation over the past decade (Parker et al., 2018). Additionally, there are numerous threatened, endangered, and special status species directly or indirectly impacted by USSE project development, several of which require special monitoring and management plans (see Table 1). Some projects require eviction or translocation of species, for which long-term monitoring of their survival is required.

On agricultural lands, biodiversity impacts vary by crop type and geography. In some areas, avian species, such as burrowing owl, mountain plover, or Swainson's hawk, use agricultural lands for foraging habitat that may be displaced by solar facilities.

Table 1. Species habitat mitigation and management requirements documented in the 16 case study USSE projects examined in this report.

	Compensatory mitigation requirement	Habitat monitoring and management plans
Species		
American badger	X	X
Bighorn sheep		X
Blunt-nosed leopard lizard	X	X
Burrowing owl		X
California condor		X
Couch's spadefoot toad		X
Desert tortoise	X	X
Flat-tailed horned lizard	X	X
Foxtail cactus	X	
Fringe-toed lizard	X	X
Golden eagle	X (foraging habitat)	X
Mohave ground squirrel	X	
Mountain plover		X
Nelson's antelope ground squirrel		X
Pronghorn antelope		X
San Joaquin kit fox	X	X
Special status bats	X (roosting habitat)	
Swainson's hawk	X (foraging habitat)	X
Tule elk		X

Other Natural Features		
Creosote bush scrub	X	
Desert dry wash woodland	X	
Ephemeral wash	X	
Upland scrubland	X	
Vernal pool		X

3.3 USSE Permitting Process

Many of the ecological impacts associated with USSE projects are documented in the permitting and environmental review documents associated with each proposed project. Permitting requirements for USSE facilities can vary across jurisdictions and land ownership. On private lands in California, USSE projects are subject to both environmental review under the California Environmental Quality Act (CEQA) and compliance with the California Endangered Species Act (CESA). For projects on BLM-managed public land, the BLM leases public lands to solar developers by granting right-of-way (ROW) permits under the Federal Land Policy and Management Act (FLPMA).[3] Federal leasing decisions trigger environmental review under the National Environmental Policy Act (NEPA). Projects on both public and private lands must comply with other relevant state and federal laws and policies (e.g., the Antiquities Act, the Endangered Species Act (ESA), the Migratory Bird Treaty Act, the Bald and Golden Eagle Protection Act, California's Lake and Streambed Alteration Program, and the National Historic Preservation Act, among others).

When impacts from a USSE project are unavoidable, the environmental impact review process requires that a USSE project mitigate those impacts by acquiring, restoring, and managing land for species habitat that is impacted by the development. In our case study, we found documentation for compensatory mitigation and habitat management requirements for several special status species listed in Table 1.

3.4 Landscape-scale Planning for USSE

Landscape-scale planning for renewable energy development is a process to identify appropriate locations for renewable energy facilities across a region, taking into account ecological, development, and other factors. Completing landscape-scale plans can help avoid land-use and ecological conflicts associated with solar energy development. Landscape-scale planning is informed by the concept of the "mitigation hierarchy" whereby project proponents first avoid impacts to areas with high biodiversity value. Where impacts are unavoidable, USSE developers minimize impacts through better project design, by enhancing compatibility of projects with wildlife habitat, forage, and connectivity, for example. This step of minimizing impacts also results in a reduced need for habitat mitigation. Finally, where impacts occur, developers compensate for impacts to species and habitats through direct conservation actions such as acquisition and/or restoration of lands with habitat for the affected species.

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[3] BLM, 2019. Right-of-Way (ROW) Authorizations. http://blmsolar.anl.gov/program/authorization-policies/row-authorizations/.

California has invested significantly in landscape-scale planning for USSE to limit impacts and reduce conflict in achieving clean energy and biodiversity goals (Appendix B). Even with these landscape-scale plans for renewable energy and other resources to guide low-impact solar energy development, USSE projects continue to be proposed in areas of high biodiversity value, and compensatory mitigation for impacts is relatively common for USSE projects that affect otherwise natural land. While the conservation benefits of landscape-scale planning for renewable energy are well-documented, the economic benefits to date have not been quantified. This is the first study of its kind to quantify these benefits using a case study approach.

3.5 The Policy and Market Drivers for USSE

California's climate goals, including a target of 100 percent zero-carbon energy by 2045,[4] will drive additional development of solar energy facilities in California. In a scenario where California's economy switches nearly all of its energy demand to electricity (vs. other sources such as gasoline), California could require a cumulative 8,000 km^2 for solar development to meet its 2045 renewable energy goals, and the rate of development of renewable energy facilities would need to increase sevenfold (Wu, G. C. et al., 2019).

Accompanying these increases in demand are fundamental changes in the energy marketplace. Only a decade ago, three utilities—Pacific Gas and Electric (PG&E), Southern California Edison (SCE), and San Diego Gas & Electric (SDG&E)—supplied 80 percent of California's electricity. Today's procurement landscape for renewable energy is changing with a proliferation of CCAs, a community-based and localized model for buying energy. As of October 2019, there are 19 operating CCAs serving more than 10 million customers in California. CCAs often set higher targets for renewable energy in their overall electricity mix, making them a driver for more clean energy, including solar energy. To date, CCAs have contracted for more than 2,000 MW of new clean-energy-generation capacity, the majority of which is from solar energy (1,360 MW). In addition, there is increased demand from corporations, which are increasingly purchasing renewable energy as part of their own sustainability initiatives. In 2019, the greatest amount of new USSE development resulted from corporate procurement of clean energy. As more corporations commit to 100 percent renewable power, they will be increasingly looking to procure clean energy from off-site renewable energy facilities driving the market for more than 20 percent of new solar energy capacity additions through 2024 (SEIA, 2019).

3.6 Solar Electricity Cost[5]

California leads the nation in solar electricity capacity and generation. By 2016, California had 42 percent of all solar energy capacity in the nation, leading in both the utility-scale and distributed sectors (Margolis et al., 2017). As of 2018, solar-electricity generation in California composed close to 14 percent of the state's total net electricity generation (California Energy Commission, 2019).

As solar energy has been expanding its share of electricity generation, the installed price of solar has been dropping. In a report by Bloomberg New Energy Finance (BNEF) and the Business Council for Sustainable Energy (BCSE) published in 2017, an important factor has been the price drop in

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[4] Senate Bill 100 (SB100).

[5] Note: Throughout the report, all projects costs are noted in $/watt DC, not AC.

photovoltaic (PV) modules. The report finds that PV module prices have fallen 26.5 percent for every doubling of cumulative installed capacity (Bloomberg, 2017).

In another report, the Lawrence Berkeley National Laboratory (LBNL) identified a downward trend in installed utility-scale and commercial PV prices since 2010, when the average installed price estimate was approximately $4.50/watt, compared with $1.56/watt in 2017. The report states that costs for some individual PV projects have fallen below $1/watt, with a range of $0.70 to $3.30 per watt. The variation in total installed costs are attributed to system design choices (fixed-tilt panels versus single-axis tracking panels), differences in project size (larger projects benefit from economies of scale), and geographic region. California had the highest installed price of utility-scale PV at $2.47/watt. The report cites the reasons for the geographic variation as system design choices, labor and land costs, soil conditions or snow load, balance of supply/demand, and competition with other electric generators (Lawrence Berkeley National Laboratory, 2018).

Compared with other installed cost estimates from National Renewable Energy Laboratory (NREL: Fu, Feldman and Margolis, 2018), BNEF (Grace, Bromely, and Morgan 2017), and Greentech Media (GTM Research and SEIA 2018), the LBNL estimates are, on average, higher (Figure 4). These publications take a different approach to modeling total installed prices via a bottom-up process rather than the LBNL empirical top-down price estimates gathered from sources such as corporate financial filings, Federal Energy Regulatory Commission (FERC) filings, the Energy Industry Association, and press releases. The bottom-up approach provides more granular information on component costs by aggregating modeled cost estimates for various project components to arrive at a total installed cost or price.

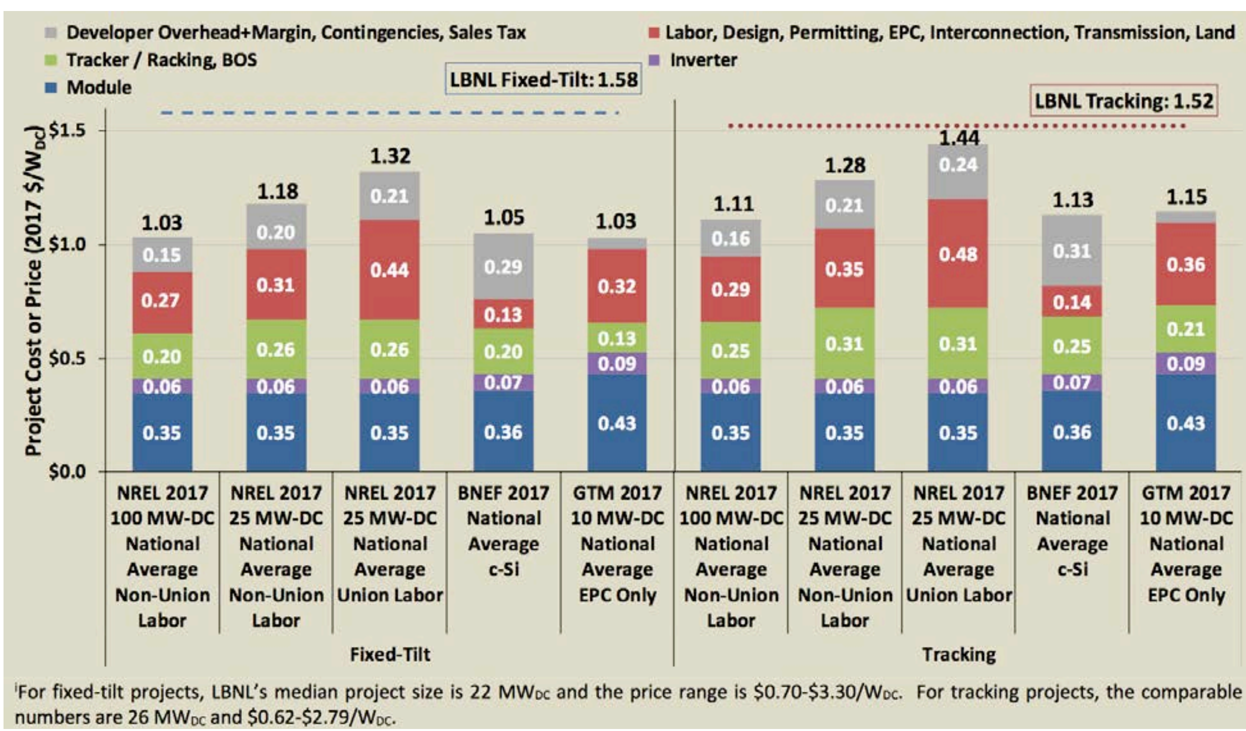

Figure 4. 2017 Solar Project Cost or Price (2017 $/Watt)

Source: Lawrence Berkeley National Laboratory, Bolinger and Seel. Utility-Scale Solar: Empirical Trends in Project Technology, Cost, Performance, and PPA Pricing in the United States—2018 Edition, 2018, p 20. https://emp.lbl.gov/sites/default/files/lbnl_utility_scale_solar_2018_edition_report.pdf.

3.7 Land Costs

Land costs are an important factor when developers select potential sites for USSE development. Developers can choose from public and private siting options. The land-cost information from this case study is included in Figure 5.

The BLM has an established solar-specific lease rate and schedule over a project's lifespan. Lease rates vary by designated geographic zones. BLM has stated that the lease rates are intended to be based on fair market value and sound business management principles, consistent with comparable commercial practices (BLM, 2017). The schedule per acre varies significantly by geography, with BLM providing county-specific annual lease rates. In addition to annual lease rates, the BLM has an annual per MW capacity fee that varies from $2,863/MW for standard solar PV up through $4,294/MW for concentrated PV with storage capacity. BLM also requires bonding for solar projects to cover potential costs of returning the site to original conditions.

Private land acquisition costs can vary considerably, generally based on market conditions. While proximity to transmission capacity and overall market access relate to geography, more local considerations of existing and potential land use, including past development, influence the ultimate cost of the land for the site. For example, the cost of productive farmland with structures and irrigation can be multiple times that of retired farmland or rangeland without valuable assets or water rights.

The U.S. Department of Agriculture (USDA) conducts annual surveys of land values and cash rents for farmland. The average value for farm real estate as of 2018 was $9,000 per acre in California, generally increasing annually relatively consistent with inflation rates. Cropland averaged $11,740 per acre for California in 2018, with nonirrigated cropland at $4,900 per acre and pastureland at $2,700 per acre (USDA 2018). Annual rental rates as of 2018 for farmland in California were $340 per acre for all cropland and $13 per acre for pastureland. Time trends show that farmland value has steadily increased over time, likely reflecting general increases in land value across all land uses, while farmland rents have not increased at the same rate, as they are more influenced by agriculture market prices.

To summarize the different land values of private land acquisition, private land leases, and public land leases, we compared per-acre estimated costs for private land purchase, private land lease, or BLM land lease over 20 years at a 5 percent discount rate for future payments (Figure 5). These cost estimates show that private land leasing based on current price estimates would be the lowest cost, followed by private land purchase; BLM leasing is the most expensive option.

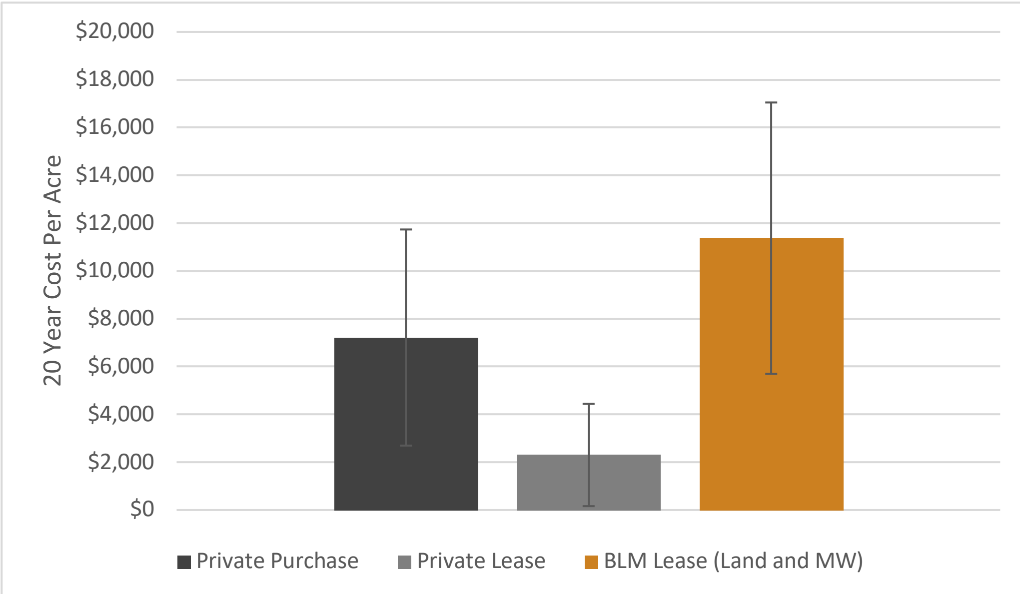

Figure 5. 20-Year Net Present Value Per Acre Land Cost Comparison

Source: USDA (2018). Bureau of Land Management Solar Lease Schedule (2016). 20-Year NPV with 5 percent discount rate. Private land ranges reflect cropland and pastureland values for California described in the text. BLM range represents the range of lease rates by zone within the Mojave region.

4 Utility-scale Solar Energy Case Study Analysis

We conducted a case study analysis to evaluate costs associated with developing USSE projects on lands with high vs. low biodiversity value. Solar siting costs in this analysis include financial costs that are generally directly borne by the developer but can also be passed on to utilities and ratepayers. Due to limitations in financial data availability and accessibility, the analysis focused on three metrics that we were able to obtain and estimate from USSE project documentation: permitting timeframes, compensatory mitigation ratios, and habitat mitigation costs. We averaged and compared these metrics based on biodiversity value categories (low and high) to identify any trends in economic benefits of low-impact solar energy.

4.1 Selecting USSE Project Case Studies

We selected 16 case studies for our analysis, which represent 41 percent of California's installed capacity as of June 2018. Project selection was made by considering a variety of factors and available information. To begin the selection process, we started with a database maintained by one of the coauthors (Mulvaney) of California's solar projects. A total of 622 projects were in the database at the time of selection, with a total installed capacity of ~10,900 MW.

All the projects we selected were either completed or in process at the time we started our analysis in June of 2018. All projects were located within one of three focal geographies of this analysis: the San Joaquin Valley, the Mojave Desert, or the Sonoran Desert of California. For the purposes of our analysis, the projects we selected as case studies had accessible environmental review documentation under CEQA (an Environmental Impact Report [EIR]) or NEPA (an Environmental Impact Statement [EIS] or Environmental Assessment [EA]). We also limited projects to those that were proposed and permitted for 100 MW of capacity or larger. Projects of small size do not always require the same level of permitting and documentation as larger projects and therefore may not have the mitigation requirements and documentation necessary to evaluate associated costs. To ensure representation across all focal geographies, we selected one project that is currently smaller than 100 MW in size—Westlands Solar Park. The environmental documents for Westlands Solar Park show 2,700 MW can be built, and Kings County permitted 1,170 MW; however, only 2 MW have been built. Locations and statistics about the 16 USSE case studies are included in Figure 6 and Table 2.

Three of the selected projects, Calexico, Mount Signal, and Centinela, are found in the southwestern corner of the Imperial Valley and are located within very close proximity of one another. We included each of these as a separate case study in our analysis. While these projects are colocated, they exhibit interesting differences in permitting, mitigation ratios, and costs, allowing us to investigate these factors as part of our analysis.

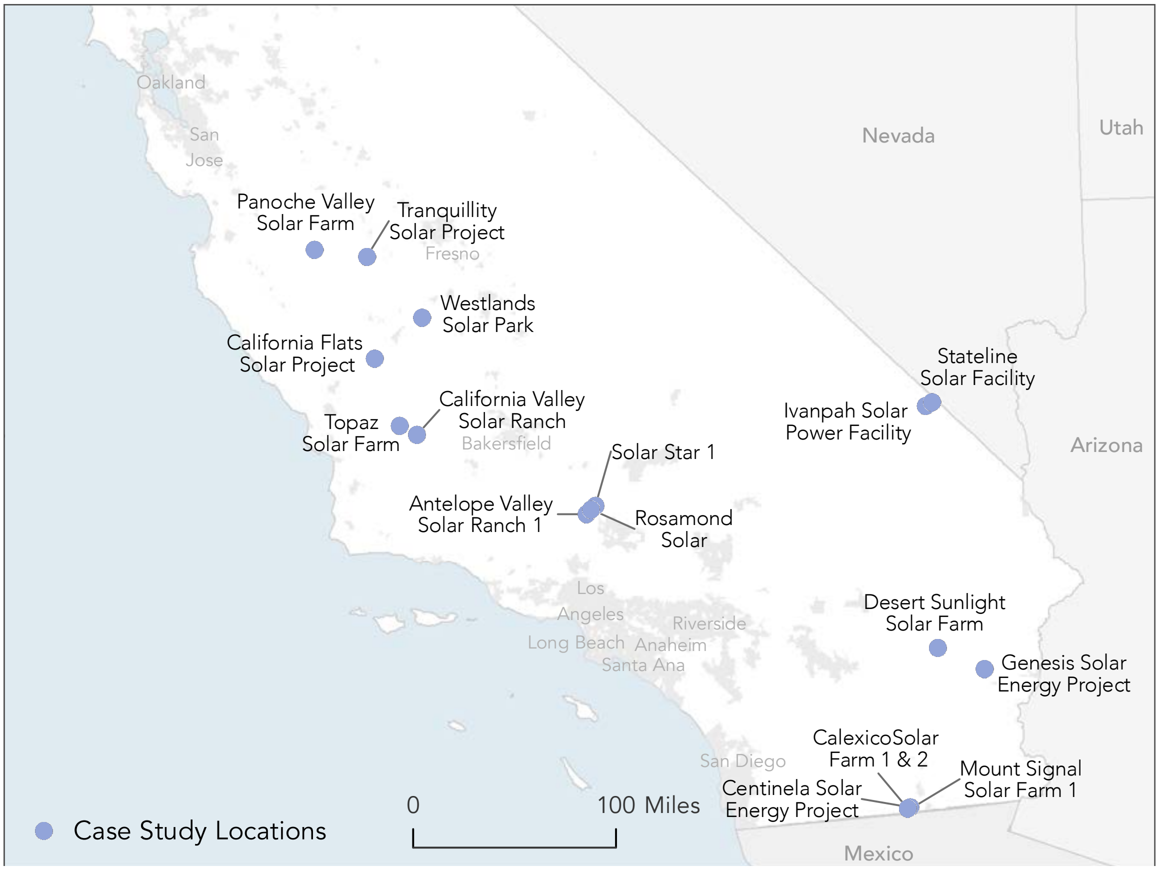

Figure 6. USSE Case Study locations

Source: CEC (2016); ECONorthwest (July 2019).

Table 2. USSE Project Case Study Information

Project Name	MW	Acres	Biodiversity Classification	TNC-Mojave Report Classification	TNC-San Joaquin Report Classification	Status	County	Date in Operation	Land Type	% Public Lands	BLM Acres
Antelope Valley Solar Ranch 1	230	2,093	Low	Highly Converted	-	Operating	Los Angeles	2014	Private	0%	-
Calexico Solar Farm 1 & 2	400	1,332	Low	Highly Converted	-	Under Development	Imperial	2014	Private	0%	-
California Flats Solar Project	280	3,000	High		High	Under Development	Monterey	2018	Private	0%	-
California Valley Solar Ranch	250	1,966	High		High	Operating	San Luis Obispo	2012	Private	0%	-
Centinela Solar Energy Project	170	2,067	Low	Highly Converted	-	Operating	Imperial County	2013	Public/ Private	1%	19
Desert Sunlight Solar Farm	550	4,410	High	Ecologically Intact	-	Operating	Riverside	2015	Public	94%	4,165
Genesis Solar Energy Project	250	1,950	High	Ecologically Core	-	Operating	Riverside	2013	Public	100%	4,640
Ivanpah Solar Power Facility	377	3,472	High	Ecologically Core	-	Operating	San Bernardino	2014	Public	100%	3,472
Mount Signal Solar Farm 1	200	1,440	Low	Highly Converted	-	Operating	Imperial	2014	Private	0%	-
Panoche Valley Solar Farm	247	2,506	High		High	Under Construction	San Benito	-	Private	0%	-
Stateline Solar Facility	300	1,685	High	Ecologically Core	-	Operating	San Bernardino	2015	Public	100%	1,685
Topaz Solar Farm	550	3,510	High		High	Operating	San Luis Obispo	2014	Private	0%	-
Rosamond Solar	90	486	Low	Highly Converted	-	Under Development	Kern	-	Private	0%	-
Solar Star 1	318	4,200	Low	Highly Converted	-	Operating	Kern	2013	Private	0%	-
Tranquillity Solar Project	200	1,900	Low		Low	Operating	Fresno	2015	Private	0%	-
Westlands Solar Park	18	85	Low		Low	Operating	Fresno	2014	Private	0%	-

Note: *Under development* meant final permits were not issued; *under construction* meant permits issued, construction underway, but plant not yet operational.

4.2 Biodiversity Value Category Assignment

Biodiversity value was assigned to USSE project locations using four prior land-use and ecological assessments for three California geographies (see Table 3 for more information). In cases where a project footprint fell across lands of more than one biodiversity category, we assigned the project to the biodiversity category that overlapped with the majority of the project footprint.

1a) TNC's *Mojave Desert Ecoregional Assessment* (Randall et al., 2010). In 2010, The Nature Conservancy completed the *Mojave Desert Ecoregional Assessment,* which characterizes conservation values across 32.1 million acres of the desert Southwest. This is a wall-to-wall assessment—all lands are categorized as one of four conservation value categories: Ecologically Core, Ecologically Intact, Moderately Degraded, or Highly Converted.

1b) TNC's *A Framework for Effective Conservation Management of the Sonoran Desert in California* (Conservation Biology Institute [CBI] and The Nature Conservancy, 2009). In 2009, TNC completed *A Framework for Effective Conservation Management of the Sonoran Desert in California,* which provides a framework for effective conservation management that encompasses a regional perspective in addressing threats. To guide our identification of conservation opportunities, we identified multiple conservation targets and used these, in concert with an evaluation of landscape integrity, to divide the study area into four broad categories of landscape integrity and conservation value. The *Framework* biodiversity categories were later cross-walked to the *Mojave Desert Ecoregional Assessment* biodiversity classifications. For this reason, we used a single data layer that included both the Mojave and the Sonoran Deserts to assign biodiversity value to USSE case study projects across the entire area of the California desert.

2) TNC's *Western San Joaquin Valley Least Conflict Solar Energy Assessment* (Butterfield et al., 2013). In 2013, The Nature Conservancy completed the *Western San Joaquin Valley Least Conflict Solar Energy Assessment,* which characterized the land-use and conservation constraints and opportunities associated with siting solar energy facilities across ~5.7 million acres of the valley. The approach identified areas with high conservation value that were important to avoid when planning energy infrastructure, as well as areas of lower environmental conflict potentially suitable for development. While the approach focused on refining the conservation values in the study area, the report also classified the region's agricultural resources using simple, broadly applicable classes to begin to assess trade-offs or synergies between agricultural production, habitat conservation, and energy development.

3) UC Berkeley's Center for Law, Energy & the Environment (CLEE) and Conservation Biology Institute's *A Path Forward: Identifying Least-Conflict Solar PV Development in California's San Joaquin Valley* (Pearce et al., 2016). In 2016, UC Berkeley published the results from a stakeholder-led process to explore how multiple and diverse parties could quickly (within six months) identify least-conflict lands for solar energy development. The process utilized advanced mapping software (Data Basin San Joaquin Valley Gateway—www.sjvp.databasin.org) to generate a series of stakeholder group maps that identified their priority and avoidance areas for solar energy. The project team combined the results of each stakeholder group's mapping exercises and identified 470,000 acres of least-conflict land. For classification of USSE projects in this study, we used the "Environmental Conservation Stakeholder Mapping" results (pp. 19–26 in the report and spatial data available on Data Basin San Joaquin Valley Gateway).

Half (eight) of the projects selected as case studies were built on lands that, prior to development, were characterized as high biodiversity value. The other half (eight) were built on lands characterized as low biodiversity value. Originally, one project located on lands of moderate biodiversity value was selected, but because it was the sole project representing this category, the decision was made to remove it.

Table 3. Biodiversity Value Categories Used in This Study

TNC Mojave Desert Ecoregional Assessment & Sonoran Desert Conservation Framework[6]	TNC Western San Joaquin Valley Least Conflict Solar Energy Assessment	A Path Forward: Least-Conflict Solar Development in the San Joaquin Valley[7]		This Study
Ecologically Core & Ecologically Intact	High Biodiversity Conservation Value	Very High & High	→	High Biodiversity Value
Moderately Degraded	Moderate Biodiversity Conservation Value	Moderately High & Moderately Low	→	Moderate Biodiversity Value
Highly Converted	Low Biodiversity Conservation Value	Least Conflict	→	Low Biodiversity Value

4.3 Cost Estimation

For all case study projects, we compiled details on permitting timeframes, project acreage, mitigation acreage by habitat type, land ownership, geography, whether a habitat management plan was required (if it was, for what species), and relevant solar capacity details from formal state or federal approval documentation[8]. This data allowed us to examine underlying drivers of permitting costs (e.g., length of time, mitigation ratios) and how they differ by biodiversity category.

We also collected all available cost data. This included data on costs of land acquisition and management for mitigation, habitat management plans, and costs of reclamation bonding. Where available, we used mitigation cost data specific to individual case studies. In most cases, where case study–specific cost data were not available, we used representative unit costs from other comparable USSE projects to estimate mitigation and habitat management plan costs for each case study. The mitigation costs for land acquisitions include the estimated purchase price for

[6] As mentioned in the text, the *Mojave Desert Ecoregional Assessment* was supplemented by *A Framework for Effective Conservation Management of the Sonoran Desert in California* for categorization of case study projects that were sited within the Sonoran Desert of California. The link in the table shows the data layer with the Sonoran conservation value categories cross-walked to reflect the Mojave conservation value categories.

[7] In cases where a USSE case study project has two different values assigned under the TNC *Western San Joaquin Valley Assessment* and the *SJV—A Path Forward* reports, we used the TNC assessment values.

[8] (1) The Record of Decision, and/or (2) Land Use Plan Amendment where BLM is the lead permitting agency, or (3) Conditional Use Permits where counties were the lead permitting agency.

mitigation lands. However, we were unable to include additional costs associated with land acquisition, such as staff time at land trusts and agencies that are involved in accepting mitigation properties or real estate due diligence costs (e.g., appraisals, surveys) and closing costs. Other than the habitat management plans documented in environmental reviews, we did not account for endowment costs to provide for monitoring, administration, enforcement, or other services to ensure conservation purposes of the mitigation are maintained. The representative unit costs were verified for accuracy by several industry stakeholders.

Mitigation and habitat management plan cost-related data were summed for all USSE project case studies and classified by biodiversity value, revealing differences in costs per acre related to biodiversity value. Because this was a case study approach, differences in costs are best considered in aggregate (i.e., by biodiversity category), rather than as precise project-specific cost estimates. We did not attempt to estimate all costs for USSE projects, but rather focused on those that vary from project to project that are assumed to be associated with site biodiversity value, as outlined above.

4.4 USSE Case Study Results

4.4.1 Permitting Costs and Timeframe

Among our case studies, low biodiversity value sites exhibit lower total time from project announcement to permit issuance (Figure 7), with low biodiversity sites taking on average 13 months and high biodiversity sites taking 35 months. Permitting timelines are also impacted by engineering and design for application materials (surveys, engineering designs, architectural plans, renderings, etc.), jurisdiction staff time to process the applications, and any legal due diligence. The trends from the case study analysis suggest that siting projects on lands categorized as having low biodiversity value can shorten permitting timeframes and therefore accelerate deployment of clean energy.

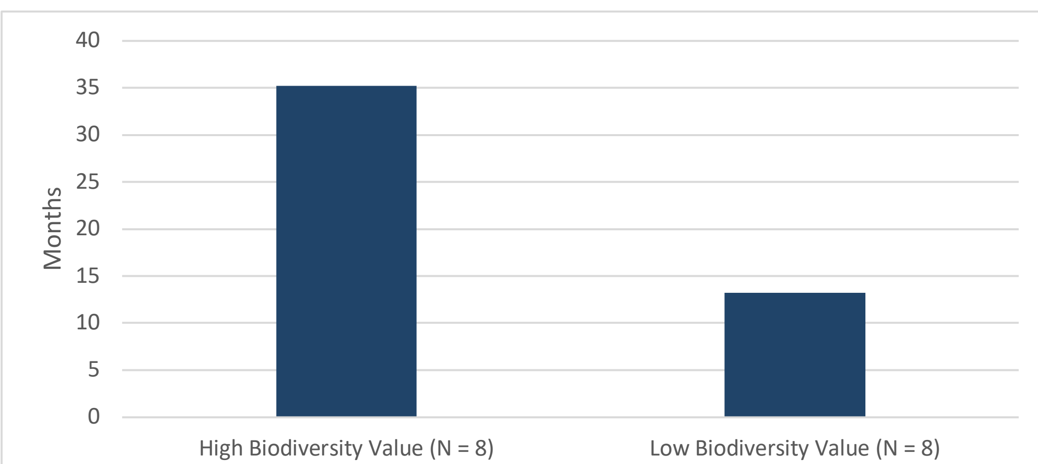

Figure 7. Time from project announcement to permit issuance

4.4.2 Compensatory Mitigation and Habitat Management Costs

Results from our case study analysis show that high biodiversity value sites are associated with much higher land acquisition requirements to compensate for unavoidable impacts on site. The selection of projects sited in low biodiversity value areas had an average mitigation ratio of 0.13, compared with 2.95 for the eight case study projects sited in high biodiversity value lands (Figure 8).

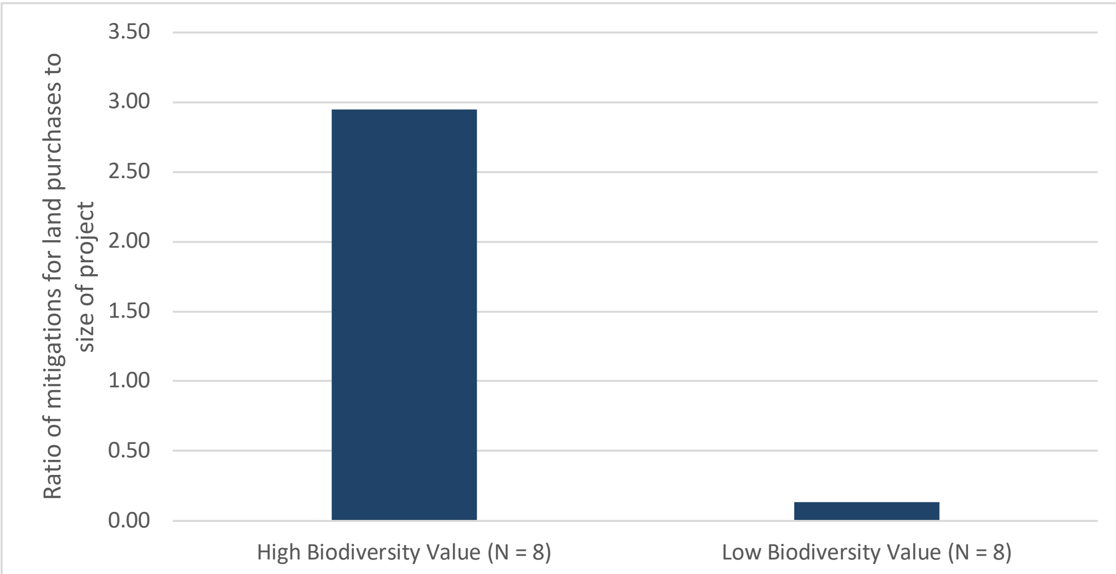

Figure 8. Habitat mitigation ratios for projects sited in landscapes with high versus low biodiversity value

The case study analysis also revealed that mitigation costs, including habitat management, generally correspond to the level of biodiversity value at the site, as almost all low biodiversity value sites had lower mitigation costs than the high biodiversity value sites (Figure 9). When averaged by biodiversity value, the cost differences for habitat mitigation and species management plans are substantial on a $/watt (Figure 10) and $/acre (Figure 11) basis. On average, USSE case study projects sited on low biodiversity value sites benefited from a $0.14/watt or $9,000/acre savings, compared with the case study projects on high biodiversity value lands.

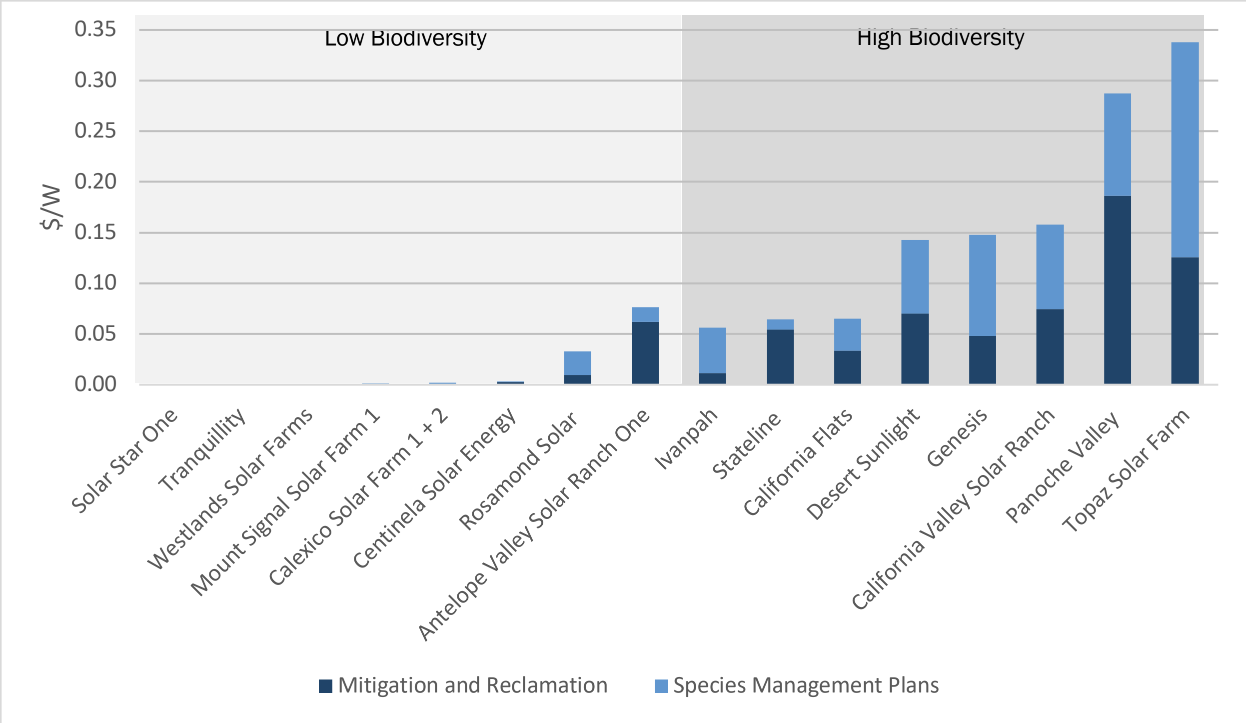

Figure 9. Estimated Mitigation and Management Cost by Case Study Project ($/W)
Source: Analysis of case studies.

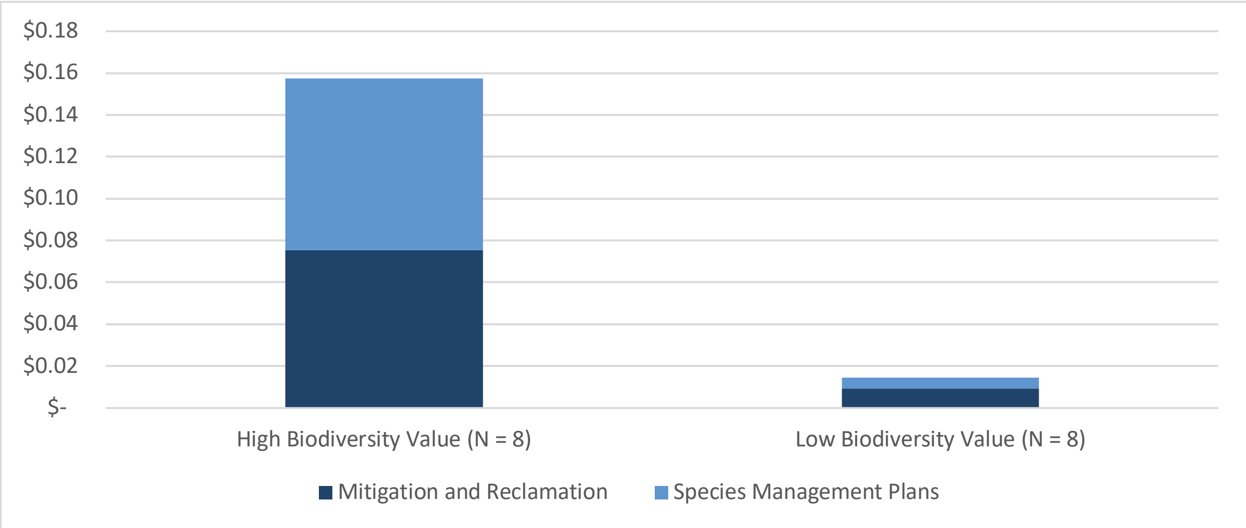

Figure 10. Estimated Mitigation and Management Cost by Biodiversity Category ($/W)
Source: Analysis of case studies.

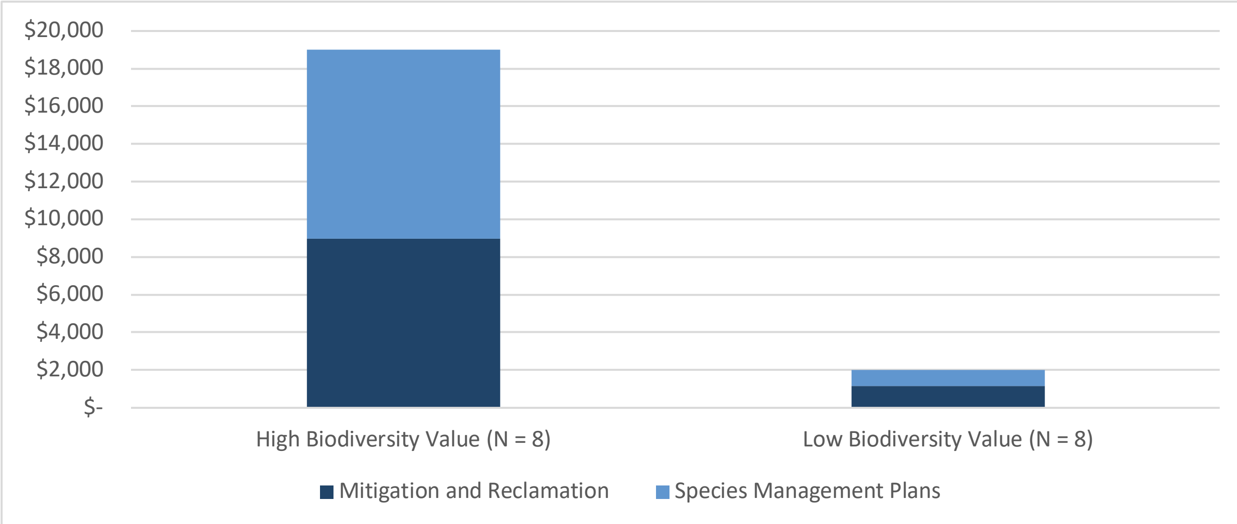

Figure 11. Estimated Mitigation and Management Costs by Biodiversity Category ($/Acre)
Source: Analysis based on National Renewable Energy Lab standard of 7 MW per acre.

4.5 Case Study Analysis Discussion

The results from the case study analysis suggest that low-impact siting of USSE in California may be more cost-effective for developers than siting in areas of high biodiversity value.

The longer average permitting timelines observed for case study projects sited on lands of high biodiversity value may translate into greater overall cost of the project, which would go beyond the cost differences quantified for these case studies. The environmental permitting process for USSE projects on lands of high biodiversity value can necessitate direct costs for developers in terms of staff time and complications for scheduling labor and capital investments, as well as potentially jeopardizing land, capital, and financing negotiations. Lengthy time delays can also introduce uncertainty to a project for investors and partners. For a representative project worth $100 million (e.g., 100 MW project at $1/W), a 22-month delay at a 7 percent interest (discount) rate declines to $88.3 million, a loss of $11.7 million in value.

USSE sites in high biodiversity value areas tend to require greater compensatory mitigation, resulting in higher costs for overall mitigation and species management plans. Even though solar projects in areas of low biodiversity value may have mitigation requirements for unavoidable impacts to specific species (e.g., the Swainson's hawk uses previously disturbed agricultural lands for foraging habitat), the results of the case study analysis suggest that the variation in costs between low and high biodiversity value is substantial.

The costs associated with siting decisions become proportionally larger as the installed cost of solar drops. Based on the background research included in Section 3.6, the most recent estimates for average installed price of solar energy range from $1.03 to $1.58 per watt (Figure 4). However, in California, LBNL reported an average installed price for PV to be $2.47/watt. Using the *Green Light Study* findings, average mitigation costs are just under $0.16 per watt for high biodiversity value sites and not even $0.02 per watt for low biodiversity value sites, a $0.14/watt cost savings (Figure 10). Assuming a $2.47/watt average installed price for solar energy, this cost savings is 5.7 percent of total installed costs. Using the national averages from Figure 4, this cost saving is 8.7 to 13.6 percent of total installed costs. This margin is particularly substantial as the market becomes more competitive and costs of solar projects are expected to decline further. For example, if total installed costs decline to below $1/watt, the cost savings represent close to 15 percent of total installed solar price.

While compensatory mitigation is a major contributor to overall USSE project costs in California, it is likely less of a driver in other western states. The Department of Interior issued an Instruction Memorandum in July 2018 directing federal agencies to abandon compensatory mitigation on BLM lands unless required by state law, the federal Endangered Species Act, or other federal law (e.g., the Clean Water Act). In states such as California that have strong requirements for habitat and species mitigation, compensatory mitigation remains a driver of overall USSE project cost; however, in other states where state natural resource protection is weaker, this may not be the case. It would be helpful to have a companion study to this one that explores the economic benefits of low-impact solar outside of California.

4.5.1 Limitations of Case Study Analysis

The methods we used to select case studies and conduct our analyses provide one view of the costs and benefits associated with the siting of solar energy on high vs. low biodiversity value lands in California's San Joaquin Valley and Mojave and Sonoran Deserts. However, there are limitations to our approach. Subjectivity and bias were potentially introduced into the project selection process by requiring author familiarity with included projects, thereby not including all projects that met the other selection criteria. Due to this, our final set of 16 case studies may not be representative of the full range of projects that exist on the ground, as they represent only 2.6 percent of the total database of projects. It is important to note, however, that the 16 USSE case studies used in this report represent 41 percent of total installed capacity (MW). The majority (80 percent) of projects in the database are under 100 MWs, and more than one-third of the database included projects that are 5 MWs or smaller.

Based on the sampling strategy used to select case study projects, we can conclude differences between our two groups of case studies (the eight contained within the high biodiversity value category and the eight contained within the low biodiversity category) but cannot conclude that the differences will hold across all USSE projects in California. The differences that we see between our two groups are not necessarily indicative that siting within a biodiversity value category will always predict project costs or benefits to developers. A more robust study to understand how this holds across all project sizes and ecological regions of the state requires more time, primary data, and geographic variation.

The estimation of case study costs relied on publicly available data. Fourteen of the case studies relied upon "generic" unit costs for species-specific mitigation and habitat management plans, derived from publicly available data for USSE projects—one each from the San Joaquin Valley and the Mojave Desert. Although these unit costs were validated with industry experts, they were derived from a sample size of one; a larger data set would allow for unit costs to employ averages or ranges. Furthermore, the same unit costs were applied across both low and high biodiversity value categories within a given region, so that the cost estimates do not evaluate or reflect any variation in unit costs between biodiversity value categories that may exist.

4.5.2 Recommendations

We recommend that future investigations be conducted to further elucidate the relationships between USSE costs and biodiversity values that we have documented in the *Green Light Study*. While we have uncovered some preliminary patterns among the case study projects, additional studies could employ an approach that would allow for broader applicability of the results. Specifically, we would recommend setting *a priori* rules for the selection of projects from a data set that includes a complete list of projects within the study area. Ideally, the criteria that are used for selection should be quantitative or categorical variables that are easy to determine and define. Once selections are made using the criteria, the entire subset of projects that meet the criteria should be included in statistical analyses.

Future investigations should also seek to compile a larger sample size of unit costs of mitigation and habitat management plans to enable evaluations of any variations by biodiversity category, as well as the use of average costs or cost ranges when estimating mitigation and habitat management costs.

5 Stakeholder Interviews

This section contains the key findings and themes from the stakeholder interviews conducted for this report. The interviews were used to gather information from multiple perspectives including renewable energy developers, natural resource agencies, wildlife experts, and policy makers. The eight interviewees have extensive experience in the siting and planning of USSE development in California. Questions focused on factors driving solar project siting decisions, with specific investigation of factors relating to habitat and biodiversity conditions. Eight interviews were conducted during the summer and fall of 2018. Due to the potential proprietary and sensitive nature of conversation topics from a business perspective, interviewees and their specific responses are kept anonymous. The primary questions for the interviews were:

1. At a high level, what is the process for selecting a solar PV project location?
2. What are the key factors/criteria considered when selecting a solar PV project location?
    a. How do these rank against each other? Or what is the order in which they are considered?
        i. Can you speak to how the costs or savings related to each category compare to the others—as specifically or generally as you can speak to (e.g., in orders of magnitude)?
3. Based on your experience selecting project locations, what are some key lessons learned for minimizing costs, delays, public relations incidents, and other undesirable situations?
    a. What differences do you see based on land ownership type (public vs. private)?
    b. What differences do you see based on region (San Joaquin Valley vs. Mojave and Sonoran Deserts)?
4. What is your framework/formula to calculate costs and benefits associated with siting decisions?
5. Where might we find sources of data/information (public or otherwise) to quantify the costs and benefits associated with siting decisions?

5.1 Key Findings

Finding 1: Transmission costs and interconnection are major drivers for USSE developer siting decisions.
USSE project viability is highly dependent on the availability of transmission capacity to bring the electricity to markets. Putting a project too far from transmission or near congested transmission can make a project cost-prohibitive. One interviewee described a tenfold difference in project capital costs depending on proximity to available transmission capacity. To attract funding to a project, developers need to have a power purchase agreement in hand, and illustrating a competitive price often means siting near transmission corridors that have minimal congestion or are relatively inexpensive to interconnect. Our interviewees suggested that planning efforts for transmission infrastructure should prioritize connections to lands with low biodiversity value that currently lack sufficient transmission infrastructure. Interviewees suggested that in many cases, the least conflict lands—landfills, brownfields, impaired farmlands, etc.—are not being selected for development because the price point for interconnecting these lands to transmission is still too high.

Finding 2: Permitting certainty is an important driver for solar facility site selection.
Interviewees mentioned that sites that allow for certainty in getting land-use entitlement and wildlife agency permitting are desirable for solar developments. Interviewees mentioned that developers will screen sites for potential civil, environmental, and regulatory issues and look to county policies that will help or hinder the development of solar at a particular site. The anticipated mitigation requirements at a site, particularly whether a site has species that are protected under state or federal law, or if the land is classified as Important Farmland, are important factors for site selection as well. Several interviewees mentioned they often consider the biodiversity value of the site; however, it was noted that not all developers do this, and some portion of developers at any given moment are new to the business, or new to California, and unaware of the time and financial cost risk of sites with high biodiversity value.

Finding 3: Land biodiversity value does not always predict presence or absence of threatened or endangered species.
Interviewees mentioned that there are places where the biodiversity value of the land is low according to TNC or other assessments, but there is still the presence of sensitive, threatened, or endangered species that require some mitigation. The most prominent example of this is the foraging habitat value for the Swainson's hawk of former or current agricultural lands in the Antelope Valley or San Joaquin Valley. California requires compensatory mitigation to offset loss of foraging habitat for this species. While often less of a mitigation requirement than at high biodiversity value solar energy sites, there is still a requirement to offset impacts at an otherwise low-impact site for solar energy.

Finding 4: Land prices are a driver for solar facility site selection.
The cost of land, either for acquisition and ownership or lease on public or private land, is a major siting driver. One interviewee noted that the cost of acquiring or leasing intact rangelands is much lower than that for marginal agricultural lands due to water rights and irrigation infrastructure, even though marginal agricultural lands typically have lower habitat value than intact rangelands. Another interviewee noted that a lot of farmland is held by residential and commercial developers with long-term (20–50 years) development plans, particularly within five or so miles of existing communities in the San Joaquin Valley. These are lands that could be low-impact solar sites but are selling at a premium because of their development potential. All interviewees noted that land prices are dynamic in California but that land with surface water rights or contracts will likely remain more expensive than land without surface water rights.

Finding 5: Zones or preidentified areas for low-impact solar energy development are a consideration in solar site selection, but they need to be coupled with more incentives for development.
Renewable energy and conservation planning on private lands, similar to the stakeholder-led process for the San Joaquin Valley, could help identify low-impact lands for USSE development. Some interviewees suggested that the second phase of the DRECP, which was slated to focus on private lands, would help this effort to find low-conflict lands in the western Mojave regions. Developers need clear guidance from regulators that can provide assurance that siting in low biodiversity value areas will result in reduced permitting and mitigation costs. Otherwise, ambiguous regulatory cost differences between high and low biodiversity value sites can remove this consideration from the siting decision.

Finding 6: Purchasers of renewable energy can be drivers for low-impact renewable energy.
Purchasers of renewable energy (e.g., CCAs, Investor Owned Utilities [IOUs]) can become drivers for low-impact renewable energy by requiring disclosures about ecological sensitivities in requests for proposals for new USSE projects. CCAs, as local agencies, are taking over more of the renewable energy procurement market and can play a role in driving low-impact energy. Additionally, with a focus on more local procurement, CCAs could be a driver of USSE projects closer to urban power loads, which are more likely to be previously disturbed by other land uses and therefore likely low-impact sites for solar.

Finding 7: Water availability is a constraint in developing USSE on low-impact sites.
There are water-use benefits to shifting from agriculture to solar development, but acquiring water for use at solar projects can be a development constraint, especially on lands where groundwater is adjudicated or there are no available water rights. Some counties, such as Fresno County, encourage solar development that does not require substantial water for dust control, washing modules, and other construction activities.

Finding 8: Mitigation costs vary significantly from county to county in California and are not set in advance.
Interviewees noted that there is a lack of consistency in how mitigation for federally or state-protected species is applied. One interviewee noted that mitigation is a negotiation and is based on the political makeup of the county, such as the composition of the planning commission.

Finding 9: Counties have few incentives for investing in planning or zoning for renewable energy development.
Due to a solar tax exemption (see Appendix C for more information), counties do not receive the same tax revenue from solar as they do for other land uses and, therefore, do not push to shift marginally productive or drainage-impaired agricultural or vacant lands to solar, especially if there is resistance or a threat of litigation. Furthermore, county farm bureaus, grower industry groups, and other stakeholders find agricultural lands important to regional economies, and thus counties, especially in the Central Valley, focus efforts on ensuring farming is maintained on all lands that can and should be farmed. For this reason, Central Valley counties (e.g., Merced, Fresno) have made efforts to direct solar to areas of land that will not be irrigable due to pre-existing drainage problems. Some counties received state funding from the California Energy Commission to do renewable energy planning countywide, which resulted in an array of local policies, some more friendly to solar than others. Kings County, for example, has an ordinance that is in alignment with TNC-suggested landscape planning for solar development.

6 Conclusions

The *Green Light Study* indicates that there are multiple benefits—cost savings, efficiency, nature conservation—when biodiversity values are integrated into solar energy site selection decisions in California. The economic benefits come in the form of faster permitting timelines and lower costs for habitat mitigation and management for projects that are sited on lands with lower biodiversity value. The cost savings of close to $0.14/watt for the *Green Light Study* projects are becoming relatively more important as other solar electricity costs decline. If total installed USSE project pricing declines to $1/watt, low-impact solar siting could provide a 14 percent overall cost savings.

The habitat-related cost trends in this report are at play in the context of numerous other siting-related cost considerations. From the stakeholder interviews, we learned the key factors driving solar energy siting decisions include the ability to secure land for development at low cost, the availability of access to transmission interconnection, the ability to secure a contract with a purchaser of electricity, and the existence of county provisions that support or deter low-impact solar siting. These factors that developers consider in solar energy site selection don't always lead developers to the low biodiversity value sites and the documented benefits in this case study. As California prepares for the next wave of solar energy development, it is essential to consider potential cost savings of aligning the drivers of solar energy site selection with conservation information.

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8 Appendices

Appendix A. Regional Maps

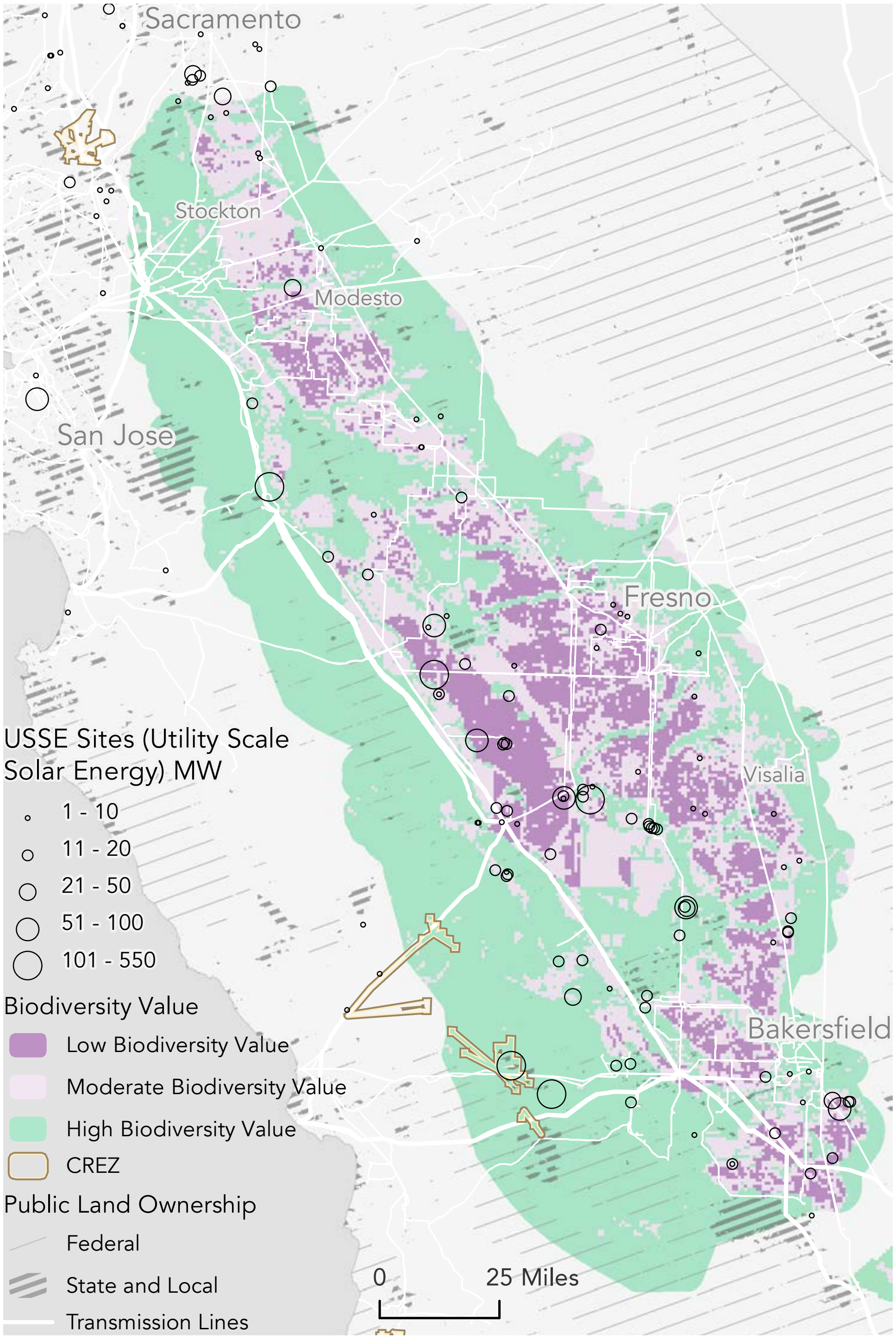

Figure 12. San Joaquin Valley USSE Development
Source: CEC (2016); CDOF (2018); TNC (2019); ECONorthwest (2019).

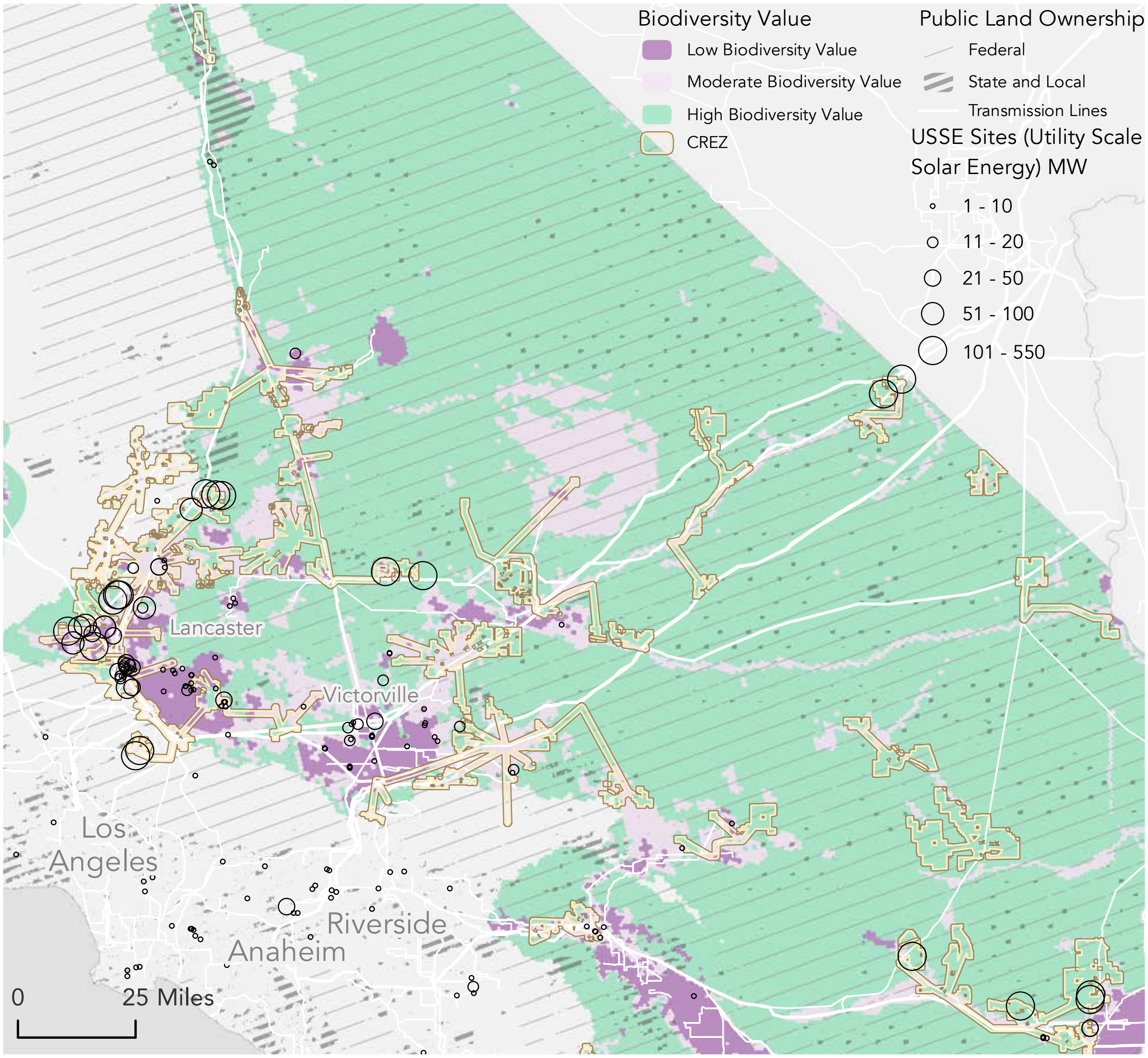

Figure 13. Mojave Desert USSE Development
Source: CEC (2016); CDOF (2018); TNC (2019); ECONorthwest (2019).

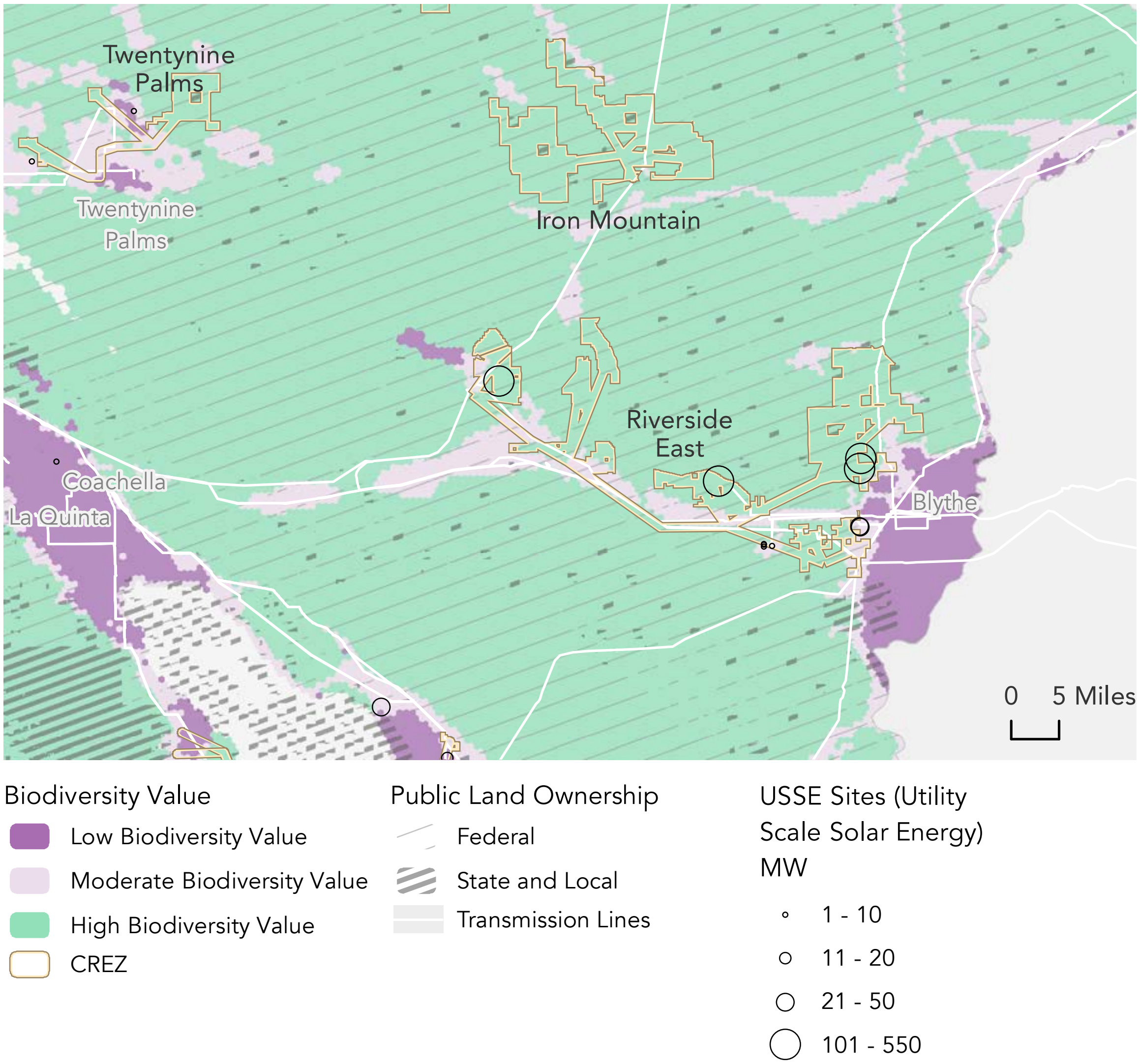

Figure 14. Riverside East USSE Development
Source: CEC (2016); CDOF (2018); TNC (2019); ECONorthwest (2019).

Appendix B. Landscape-scale Planning for USSE Resources

There have been several landscape-scale plans for renewable energy development in California and the Southwest, including:

1) Desert Renewable Energy Conservation Plan (DRECP). From 2009 to 2016, California developed the Desert Renewable Energy Conservation Plan (DRECP) to identify places where solar, wind, and geothermal facilities could be sited with minimal biodiversity, cultural, and recreation resource conflicts in the California desert. The DRECP, which resulted in a 2016 BLM Record of Decision and a new Land Use Plan Amendment, identifies public lands for renewable energy development and offers permitting incentives for developing in these areas. The DRECP covers 10.5 million acres of public land in the Mojave and Colorado Deserts in California. The DRECP was informed by stakeholders at all levels of governance, and from multiple sectors of society, and by a team of Independent Science Advisors.
2) Bureau of Land Management (BLM) Solar Energy Program (Western Solar Plan). The DRECP built off a parallel federal effort to identify areas for utility-scale solar energy across six southwestern states. The Record of Decision (ROD) for the final Programmatic Environmental Impact Statement (PEIS) was finalized in October 2012. The BLM's Western Solar Plan identified 19 Solar Energy Zones that are well-suited for utility-scale production of solar energy. In these zones, BLM will prioritize solar energy and associated transmission infrastructure development. The plan also identified exclusion areas where solar energy is not appropriate on public lands.
3) The report titled, *A Path Forward: Identifying Least-Conflict Solar PV Development in California's San Joaquin Valley*, documents the collaborative process of identifying least-conflict lands for solar PV using information from multiple stakeholder groups. The effort, completed in May 2016, identified 470,000 acres (1,902 km^2) of least-conflict lands, which was about 5 percent of the 9.5 million acres considered in the San Joaquin Valley. The stakeholder-led approach utilized a collaborative mapping platform—the San Joaquin Valley Gateway—to efficiently identify least-conflict lands for renewable energy development.

In addition to landscape-scale plans and mapping of least-conflict lands, there are several other reports, research papers, and mapping resources available to assist in the integration of environmental and land-use considerations into renewable energy siting decisions. Some of them are listed here:

- In 2018, a report produced by UC Berkeley's Center for Law, Energy & the Environment on USSE siting in California (*A New Solar Landscape*) focused on how to improve the quality of county-level planning. The report recommends key steps that local, state, and federal policy makers can take to improve county-level solar planning, including increasing support for transmission infrastructure, improving the nexus between environmental benefits from USSE project siting and CEQA mitigation requirements, linking appropriate siting to expediated CEQA review, and improving collaboration among stakeholders.
- In a research paper from the University of California, Davis's Aridlab, Hoffacker et al. (2017) used a classification scheme to identify what they call "land-sparing" solar project areas. They find that 15 percent of the Central Valley in California is available and compatible for

"land-sparing" solar energy development. The "land-sparing" opportunity areas include lands with salt-affected soils, reservoirs for floating photovoltaics, rooftops and parking lots, and contaminated sites such as brownfields.

- The U.S. Environmental Protection Agency's RE-Powering America's Land database has identified about 1.7 million acres (6,880 km^2) of lands in California appropriate for solar development on brownfields, Resource Conservation and Recovery Act sites, abandoned mines and landfills, and other sites disturbed by industrial activities.

The California Energy Commission has developed an Energy Infrastructure Planning Analyst tool that integrates environmental, land-use, and climate adaptation information into a map-based platform that can be used to inform renewable energy siting decisions.

Appendix C. Solar Energy Tax Incentives

Some counties offer tax exclusions for construction of new solar energy projects until the property changes ownership. In 2018, members of the University of California, Los Angeles (UCLA) and the University of California, Berkeley (UC Berkeley) Schools of Law met with state and local officials, representatives within the solar PV industry, conservationists, agricultural leaders, and land-use experts to discuss methodologies for better site placement for utility-scale solar PV projects.[9] To optimize siting decisions, the participants discussed "landscape-level planning" for counties to ensure stakeholders would benefit from land-use decisions.[10] In order to be practical, the land must be cost-effective, have the appropriate infrastructure, and be able to support the demand for energy. Because of their role as land-use authorities, counties will become an increasingly important variable in expediting solar PV projects and attaining the State's energy goals. While complete avoidance of sensitive lands is the most effective way to facilitate a project, this is not always feasible. Therefore, it is becoming increasingly important to evaluate the trade-offs associated with construction of a new utility-scale solar PV project and conservation.

According to the California tax code, an *active solar energy system* is

> "a system that uses solar devices, which are thermally isolated from living space or any other area where the energy is used, to provide for the collection, storage, or distribution of solar energy. […] An active solar energy system includes storage devices, power conditioning equipment, transfer equipment, and parts related to the functioning of those items."[11]

Whenever a valuable addition is made to real property, the addition is regarded as "new construction and is assessed at current market value."[12] New construction is defined as,

> "either (1) any addition to real property (including fixtures), or (2) any alteration of land or of an improvement (including fixtures) which constitutes a major rehabilitation thereof or converts the property to a different use."[13]

In 1980, California Proposition 7, the Tax Assessments of Solar Energy Improvements Amendment, was passed to include utility-scale, industrial, and commercial systems as active solar energy systems, making them subject to the new construction property tax incentive.[14] Importantly, this is not a tax exemption; it is an *exclusion,* which means it cannot be used to change the assessed value of an existing property and is terminated after a change in ownership occurs.[15] Under a partial change of ownership, "the portion of the system that changed ownership would be assessable."[16]

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[9] Elkind and Lamm, 2018, p. 2.

[10] Ibid.

[11] Revenue and Taxation Code § 73.

[12] State Board of Equalization. *Guidelines for Active Solar Energy Systems New Construction Exclusion;* State Board of Equalization: Sacramento, CA, 2012, p 2.

[13] Revenue and Taxation Code § 73.

[14] Ballotpedia. *California Proposition 7, Tax Assessments of Solar Energy Improvements (1980);* Ballotpedia: Middleton, WI, 2019. https://ballotpedia.org/California_Proposition_7,_Tax_Assessments_of_Solar_Energy_Improvements_(1980).

[15] State Board of Equalization, 2012.

[16] State Board of Equalization, 2012, p. 3; State Board of Equalization. *Assessors' Handbook: Section 401;* State Board of Equalization: Sacramento, CA, 2010.

This stipulation can prevent counties from reassessing the properties, since some developers may choose this option to avoid tax liability. To overcome this, some counties have required that solar PV projects pay county sales tax to make up for potential lost revenue; however, counties have taken different approaches to remedying this issue. For example, Riverside County charges either public safety or acreage fees.[17]

In 2008, Section 73 of the California Revenue and Taxation Code was amended to include new construction of active solar energy systems so long as "the owner-builder did not already receive an exclusion for the same active solar energy system and only if the initial purchaser purchased the new building prior to that building becoming subject to reassessment to the owner-builder."[18] The exclusion applies to solar energy systems installed between January 1, 1999, and December 31, 2024.[19] The rebate amount is equivalent to 100 percent of the system value, while the rebate amount for dual-use equipment is equal to 75 percent of the system value. Components that qualify for the exclusion include parts, transfer equipment, power conditioning equipment, and storage devices. Ducts and pipes that carry solar energy are eligible for an exemption equivalent to 75 percent of their value.[20]

Kern County, which generates nearly half of the state's solar and wind energy, facilitated the construction of utility-scale solar projects that totaled $32 billion in investment during FY2017–2018. This also generated 8,000 construction jobs and 1,500 permanent renewable energy jobs. Kern County surpassed its 2010 goal to permit 10,000 megawatts (MW) by reaching 12,500 MW. [21]

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[17] Elkind and Lamm, 2018, p 29.

[18] U.S. Department of Energy. *Property Tax Exclusion for Solar Energy Systems;* U.S. Department of Energy: Washington, D.C., 2019. https://www.energy.gov/savings/property-tax-exclusion-solar-energy-systems.

[19] Ibid.

[20] DSIRE. *Property Tax Exclusion for Solar Energy Systems;* NC Clean Energy Technology Center: Raleigh, NC, 2019. http://programs.dsireusa.org/system/program/detail/558.

[21] Kern County. *Fiscal Year 2017–18 Adopted Budget;* Kern County: Bakersfield, CA, 2017. https://www.kerncounty.com/cao/budget/fy1718/rec/recommendedbudgetfinalcompactopt.pdf.