Executive Summary

Solar energy development is experiencing significant growth today due to a variety of reasons, including national interest in increasing energy efficiency, reducing dependence on fossil fuels, increasing domestic energy production, and curbing greenhouse gas emissions. This national interest and the availability of high quality solar resources in the California desert have led to proposals for 54 utility-scale solar facilities on public lands. These proposals have forced conservation organizations to consider the tradeoffs between renewable energy generation as a means of combating climate change, and the preservation of the desert's wildlands and biodiversity.

This study analyzes the political, economic, and technological drivers for utility-scale solar development on public lands, as well as the potential impacts to local residents and desert ecology. The goals of this report are to provide a series of qualitative and quantitative analyses of the potential impacts, describe a series of tools for evaluating proposed utility-scale solar energy projects, and develop a series of recommendations for the Bureau of Land Management (BLM) permitting process.

Methodology

We used several methods of analysis:

- We reviewed government policies and programs to identify the key drivers of growth in the solar industry.
- We conducted interviews with desert ecology specialists, conducted extensive literature reviews, and performed Geographic Information Systems (GIS) spatial analyses to evaluate potential impacts to the desert's natural resources.
- We examined developer applications to calculate land and water use efficiency for different types of solar technology.
- We conducted a case study of an operational solar facility in Nevada, a mail survey of residents from three communities in the California desert, and GIS models to analyze impacts to desert residents.
- We surveyed stakeholders and BLM staff to analyze the solar project siting process.

Key Findings

Proposed Solar Technologies

- Project developers choose a type of solar technology for a project using three considerations: technological maturity, solar resource, and cost of installation.
- The majority of applications to the BLM propose the use of concentrated solar power technology with photovoltaic (PV) systems being the second choice of developers.
- As of 2009, according to California Energy Commission (CEC) guidance, new projects are restricted from using "wet" cooling systems. While "dry" cooling systems consume 95 percent less water than "Wet" cooling systems, they also have a five to 20 percent performance penalty.

Political and Economic Drivers

- Policy-based economic incentives are driving development of utility-scale solar development in the California desert and the recent rise in the number of utility-scale projects in development is attributable to two key factors:
    - The longer-term extension of production and investment tax credits to match the development timeline, which can take several years, and
    - The implementation of aggressive Renewable Energy Portfolio Standards (RPS) in California.

- Distributed generation will complement, but not replace, utility-scale solar development and several barriers must be overcome in order to ensure continued growth and adoption of distributed generation.
    - Incentive programs must be streamlined and improved in order to reduce administration costs.
    - Behavioral preferences must be changed in order to increase the number of rooftop solar installations.
- The current federal administration and existing federal policies promote the use of public lands for renewable energy development.

Site-Level Solar Development and Ecological Impacts

Site Engineering

- Once the location of a solar energy facility has been determined, a variety of site engineering processes will need to be performed to prepare a project site for construction. These processes include grading, vegetation removal, the installation of perimeter fencing, and the construction of roads and transmission lines.

Grading and Vegetation Removal

- The amount of grading being proposed for most projects is substantial. Six of the projects we analyzed were planning to move anywhere from 1.7 million to 8.3 million cubic yards of soil. As a comparison, if 8.3 million cubic yards of soil were placed on a football field, the mound of soil would be over one mile in height.
- Grading and vegetation removal procedures have the potential to impact soil stability, dust emissions, fragile biological soil crusts, nutrient cycling, and water infiltration. The impacts to these processes, in turn, are likely to negatively affect plant and animal populations on and near the project site.

Perimeter Fencing

- All the projects include the installation of perimeter fencing, which will act both as security for the site and as an environmental barrier to keep wildlife out of the project site.
- The construction of fencing may disrupt habitat connectivity. Not only does fencing remove habitat within its boundaries, it can also act as a barrier, restricting or completely blocking movement of species. Even if a population will not be affected by loss of habitat within a facility's fenced area, the fencing itself may be difficult to navigate around. If migration corridors are blocked, the viability of a population may be compromised due to gene-flow restriction.

Roads and Transmission Lines

- The new roads constructed for these projects will serve an array of functions including general mobility, access for panel cleaning, and repairs. In some locations, primary roads such as highways already exist, nonetheless, every applicant will need to at least improve existing roads and construct new maintenance roads through the solar panel fields. Additionally, given the relatively remote locations of many of these proposed projects and the limited amount of available capacity on the existing transmission grid, utility-scale solar facilities will also require new sections of transmission to be built.
- Roads and vehicle travel provides an opportunity for the spread of invasive plant species throughout the desert, and invasive plant species can increase the intensity and frequency of wildfires in the desert. Additionally, these roads present a substantial threat to the maintenance and protection of biological soil crusts.

Facility Location and Placement

- The location and placement of the infrastructure on the project site will directly determine the type and intensity of the site-level ecological impacts discussed above. Developers generally look for three key characteristics when selecting a project site: distance to transmission, slope of the land, and the availability of water.

- Solar facilities that are built on top of dry water channels, washes, or playas, or that are constructed on or near alluvial fans (also called bajadas), may interfere with the sediment deposition that sustains desert sand dune systems.
- Solar development may affect species migration if facilities are sited in pre-existing or potential migration corridors, including corridors utilized by both limited-range species (such as desert tortoises) and wide-range species (like bighorn sheep).

Landscape-Level Solar Development and Ecological Impacts

Water Use Efficiency and Impact

- Parabolic trough with "wet" cooling systems consume the most water per MW of generation capacity installed while thin film PV systems consume the most water per MWh electricity produced.
- Based on the projects we analyzed, many of the developers propose at least some use of ground and surface water. Groundwater withdrawal or surface water diversion could negatively affect groundwater dependent vegetation, riparian vegetation, springs, and aquatic habitat. The main alternative to groundwater and surface water would be having water trucked in from an outside source.

Land Use Efficiency and Disturbance

- Dish/engine systems have the highest land use efficiency while thin film PV systems have the lowest land use efficiency. A high land use efficiency indicates that a project can generate a relatively larger amount of electricity per acre of disturbed land.
- Land disturbance can release large amounts of dust, depending on facility placement. Management of dust emissions on facility sites will influence the contribution of solar development to PM10 pollution concentrations in the California desert region with implications for human health.
- Disturbance of biological soil crusts across the California desert landscape could negatively affect the carbon sequestration capabilities of the desert soil and affect regional albedo.

Species Case Studies

- Development of utility-scale solar facilities across the California desert landscape will have negative consequences for the federally threatened desert tortoise (*Gopherus agassizii*), including habitat loss, habitat fragmentation from new roads and other linear corridors, direct mortality from roads, increased prevalence of predators, increased human access, and increased invasive plants and wildfires.
- Solar development could negatively affect wide-ranging species like the desert bighorn sheep (*Ovis canadensis nelsoni*) by depleting water sources on which they depend, and reducing habitat connectivity and obstructing migration corridors, thereby preventing access to vital resources and habitat.
- Cumulative impacts of solar development will likely include the loss and fragmentation of large areas of low-elevation vegetation like the creosote bush (*Larrea tridentata*), with negative implications for desert pollinators. In conjunction with climate change, impacts to pollinators could severely disrupt processes and services that are essential to the desert ecosystem.

Spatial Impacts

- Using three development scenarios to develop a spatial understanding of the ecological and visual impacts of solar development: only "Fast Track" facilities are built (10 facilities), only "Solar Energy Study Area (SESA) Facilities" are built (21 facilities), and "All Proposed Facilities" are built (54 facilities) we found that the SESA development scenario minimized ecological and visual impacts to the California desert landscape.

- Of BLM land not excluded from solar development, the Fast Track scenario would develop 1.15 percent of potentially available acres, the SESA scenario would develop 4.26 percent, and the All Proposed scenario would develop 10.74 percent.
- Using an ecological classification scoring system, analyses for individual facilities and the three development scenarios showed that 34 of the 52 facilities would have "low impact" to sensitive habitat, 12 would have "medium impact," and 6 would have "high impact". Of the three scenarios, the All Proposed scenario had the largest impact to sensitive habitat, followed by the Fast Track scenario, and last was the SESA scenario.
- Distance of a proposed facility to existing transmission lines and slope of the proposed facility site were used as proxies for the amount of disturbance that a facility might have on the landscape. Under the three development scenarios, the All Proposed scenario had the highest minimum distance to transmission, followed by the Fast Track, then SESA scenario. Similarly, the All Proposed scenario had the highest average slope, second was the Fast Track scenario, and the SESA scenario had the lowest average slope.
- A visual impact analysis identified the extent to which visual resources might be affected by solar development across the California desert landscape. Using the three scenarios, a ratio compared the amount of land developed in each scenario with the size of the scenario's visual footprint. The Fast Track scenario had the highest visual footprint to developed acres ratio at 17.64, followed by the All Proposed scenario at 7.79, and the SESA scenario was last at 4.87.

<u>Socioeconomic Impacts</u>

- Utility-scale solar facilities in the California desert will have few long-term socioeconomic impacts on nearby communities. Our case study of Nevada Solar One shows that the nearby community, Boulder City, experienced no impacts to traffic, housing, or public services during the construction of the facility. The most positive impact was the annual lease payment the developers made to the town.
- Unlike Boulder City, which benefits greatly from solar facility Nevada Solar One's annual lease payments, communities in the California desert will not receive rent payments; this is because facilities sited on BLM land will make lease payments directly to the U.S. Treasury.
- Though hundreds of temporary workers will be needed for construction, once in operation each facility will require relatively few full-time employees. Therefore, these facilities are unlikely to result in a significant increase to long-term employment in local communities.
- Demographic data and proposed facility location may be analyzed to help predict a facility's socioeconomic impacts. We utilized this information to predict that the socioeconomic impacts to two towns in the California desert, Lucerne Valley and El Centro.

<u>Community Attitudes</u>

- Of the 625 survey respondents from three communities, the majority, 64 percent, supported utility-scale solar development near their communities. Primary reasons for support included an increase in jobs, more energy for the community, and additional business activity.
- Those who opposed solar development, 17 percent, cited potential water shortages, damage to the natural habitats, and poorer air quality as reasons for concern.
- The distribution of support and opposition did not vary by age or town. Education was correlated to support: our analysis revealed that the more educated respondents were, the less they supported solar.
- The overwhelming majority, 83 percent, have not participated in any of the BLM's public comment opportunities, predominately due to a lack of awareness of these opportunities. Yet, our analyses did not indicate that there was a connection between participation and support, suggesting that the BLM may be missing an opportunity to inform opinion.
- Respondents ranked water as their greatest concern. Our analysis has indicated that the communities' concerns as well as their uncertainty about water are reasonable. Utility-scale solar energy facilities, similar to other industrial operations, have substantial water needs. In an effort to combat the potentially irreversible draw down of desert aquifers, the CEC has issued guidance to developers that dry cooled systems should be utilized and that wet cooled

systems are extremely unlikely to be allowed by the agency. It would be useful to communicate this measure to desert residents to address concerns about impacts to water.

- The survey results also indicate that respondents believe decreased air quality is a relatively unlikely impact of solar development (1.89 on a 5-point scale). This public perception may represent an underestimation of this potential impact since the site engineering associated with development, especially grading and vegetation removal, has a high potential for releasing large dust emissions.
- Survey respondents ranked increased employment opportunities during facility construction and operation as both highly likely and quite valuable. Unfortunately, this optimistic outlook may prove to be unfounded. Although facility construction will create hundreds of temporary jobs, the labor pool in the California desert includes thousands of individuals and residents will face stiff competition for these positions.

Decision-Making Process

- The BLM and CEC have created a joint process for assessing proposed solar facilities which includes joint environmental analysis and public participation opportunities.
- The current BLM process for siting solar facilities was evaluated based on a set of criteria that are found to be key to effective policy/regulation. Based on this set of criteria, the current process was determined to be insufficient in achieving the following: efficiency, clarity, and adequate levels of environmental protection. Additionally, it was found that the current BLM process does not include the consideration of a robust set of alternative options nor does it consider the potential cumulative impacts of multiple projects. Finally, as was confirmed by the results of our stakeholder survey, the process does not include adequate levels of public involvement.
- There are multiple ways the current solar right-of-way (ROW) process could be improved using some components from existing processes for oil and gas leasing and wind ROW grants such as developer guidance documents, BLM processing instructions, identification of areas open for potential development, and the standardization of land leasing rates.

Conclusions and Recommendations

Our research and analysis reveals the many complexities, controversies, and uncertainties that exist within the issue of solar development in the California desert. Despite these challenges, state and federal administrations, solar developers, and renewable energy advocates are exerting pressure on regulatory agencies to finalize the processes necessary to move development forward. Given the unknown impacts of solar development, an adaptive management approach, which includes Best Management Practices (BMPs) and mitigation requirements, should be carefully and thoughtfully developed. An adaptive management approach might require a slower pace of development with a high level of monitoring of constructed facilities in order to measure the true efficacy of BMPs and mitigation measures. If BMPs and mitigation measures are found to be ineffective, the management plan should then be adapted to address these deficiencies.

We have developed recommendations based on our findings, which can be used to establish a siting, development and implementation process that can proceed deliberately and adaptively. Our recommendations aim to improve the solar facility approval process, address potential ecological impacts, and support continued growth of the distributed generation market. We have also identified areas in need of future research.

- The BLM should establish a more transparent and efficient solar siting process that designates areas that are closed or potentially available for solar development. The process should also incorporate a land rental rate, establish minimum land use and water use efficiency standards, and increase public involvement.

- The BLM should define effective environmental mitigation measures, develop alternatives to traditional acquisition-based mitigation, such as opportunities for developers to fund desert research, expand educational opportunities, and finance restoration.
- The BLM should develop and require the use of its own set of BMPs specific to the desert environment. Currently, solar developers are proposing the use of BMPs that may be inappropriate for the region and may result in unanticipated ecological consequences or may be ineffective at reducing impacts.
- Environmental organizations and elected officials should support the expansion and extension of tax credits and other investment incentives for distributed generation in order to support this growing market and help meet the California RPS goal.
- Future research should be conducted in the areas of natural history of the California desert, regional-level impacts, ecological restoration techniques, climate change and the California desert, ecosystem services and the non-market value of the desert, and transmission.

Outlook

In order to meet the California RPS goal of 33 percent renewable energy by 2020, a total of 48 terawatt-hours of new renewable energy must be generated, some of which is likely to come from utility-scale solar energy facilities. As the BLM completes a Programmatic Environmental Impact Statement for solar development, the opportunity exists to incorporate measures that simultaneously improve the overall permitting process, maximize the benefit of renewable electricity generation, and minimize the ecological and socioeconomic impacts of development. Given the current political climate, in which both federal and state governments are prioritizing renewable energy, measures should be identified and implemented swiftly to reduce the likelihood of rapid development without appropriate consideration of negative impacts.