METHODOLOGY

We utilized the following methods to collect and analyze data. Methods are organized by research question:

What are the policies and incentives driving utility-scale solar in the California desert?

How are policy decisions and incentives driving the development of the solar industry and how are they driving development of utility-scale solar?

We reviewed historical and current federal and state policies affecting investment and development decisions within the solar industry. Further insights were gained by attending the Greentech Media Solar Summit conference held in Phoenix, Arizona, on March 30 and 31, 2010.

How do the policy and management incentives and disincentives at the federal, state, and local levels affect siting solar projects on public lands?

We performed a literature review of existing federal, state, and local policies that affect siting solar projects on public lands. Additionally, policies were identified through interviews with BLM staff and environmental organizations.

How will the different forms of solar energy development affect the ecology of the California desert?

What are the resource and infrastructure needs of various proposed technologies?

We performed a literature review of sources such as peer-reviewed journal articles, news articles, and policies and memos from the CEC and interviewed nine developers and other industry professionals working in this field by phone and in person.

What are the relative land use efficiencies of each of the "fast-track" solar energy facility proposals?

Our analysis began by summing the total area of the site that is to be developed either with roads, transmission lines, solar panel systems, main building complexes, or other planned infrastructure. This total then is referred to as the "direct disturbance area". We calculated the "actual annual electricity production" that will be generated by the facility by multiplying the nameplate capacity in total MW by the capacity factor. The capacity factor is the average percentage of time that the solar facility is expected to operate at full capacity.[1] In order to quantify the relative impact of the facility footprint size and the actual amount of energy produced by the facility, the analysis then used two metrics:

1. The amount of "direct disturbance area" required per megawatt-hour (MWh) produced as the "actual annual electricity production".
2. The amount of energy produced in MWh per amount of land area used as "direct disturbance area". These two metrics are the inverse of one another, but provide two different perspectives on how efficiently the proposed facility will utilize the landscape.

All of the data compiled into this analysis tool were taken directly from the documentation submitted by the applicant as part of the Application For Certification (AFC). The reader should note that the AFC documents for photovoltaic (PV) projects were not readily accessible online and we were unable to obtain copies of the applications from the BLM. Therefore, in order to estimate the land-use efficiency of PV projects, we relied on two assumptions: first, that the ratio of disturbed area to total site area of PV projects was similar to Concentrating Solar Power (CSP) projects, and second, that the estimated capacity factor for PV projects was 11 percent. For the first assumption, we calculated the average ratio of disturbed land to total site area for the 10 other projects listed below and converted this to a percentage (in this case, on average 53 percent of the site area was disturbed), which we then applied to the PV projects to estimate disturbance area. As PV systems are similar to parabolic trough systems, they have to be constructed in long, contiguous rows and are therefore likely to have similar footprints. For the second assumption, we calculated an estimated thin-film PV capacity factor of 11 percent.[2] This estimated capacity factor is based on the operating capacity factors of PV facilities that were built in Germany in the past three years.

What current stressors should be considered in order to understand the impact that utility-scale solar development might have on California desert ecosystems? What direct and indirect impacts of utility-scale solar development on key species, natural communities, and landscape-level ecological processes should be taken into consideration by decision makers?

We performed a literature review of desert ecology and conducted in-person and telephone interviews of 20 scientists with expertise in California desert ecology from universities, federal and state agencies, and environmental organizations to obtain qualitative data on the potential impacts of solar development and how these impacts may exacerbate current stressors in the California desert. We asked experts about their primary concerns, predicted impacts to key species, natural communities, and ecological processes, potential cumulative impacts, mitigation of potential impacts, policy barriers, and areas where research is lacking. These interviews helped us identify the ecological processes that are both essential for ecosystem functioning as well as those most at risk to impact. We also identified the types of impacts species are likely to face as a result of development. We combined the knowledge from interviews and the literature review with our research on technology-specific site engineering, landscape modifications, and facility parameters to extrapolate the likely impacts of utility-scale development in the CDCA.

Can landscape suitability and desert-wide impacts be identified and analyzed spatially?

What areas may be in high conflict with solar development in the California desert due to land management designations? What areas of the desert present a high degree of conflict for building solar facilities due to known occurrences of species habitats? What areas of the desert would be visually affected by solar development? How can solar facility impacts and needs be analyzed spatially given certain development scenarios?

We used Geographic Information Systems (GIS) and gathered publicly available data from the BLM, U.S. Fish and Wildlife Service (FWS), and U.S. Geological Survey National Map Seamless Server, as well as an academic subscription to the California Natural Diversity Database (CNDDB). We developed and assigned quantitative ranking and classification systems to spatial data using ESRI ArcGIS and analyzed results in Excel. We analyzed spatial categories that included land management designation, rare and endangered species occurrences, visual resources, percent slope, and distance to transmission. The context for our analyses was three potential development scenarios:

1. Only proposed solar facilities labeled as “fast track” applications are built (10 projects total).
2. Only proposed solar facilities located in Solar Energy Study Areas (SESAs) are built (22 projects total).
3. All currently proposed solar facilities (as of March 2010) are built (54 projects total).

How will solar development affect desert residents, and are their opinions and information gaps being addressed?

What are the socioeconomic impacts of utility-scale solar facilities?

We conducted a literature review of academic, government, and industry studies on the socioeconomic effects of solar energy development. Several studies used models to predict solar development job creation; these job predictions were compared to job creation projections for several proposed facilities in the California desert. A review of academic literature on the socioeconomic effects of oil, gas, and wind energy development was completed. From these results, inferences were made about solar development's likely effects on nearby communities.

How can demographic data and facility location be used to predict socioeconomic impacts?

Using two California desert communities as examples, demographic data were analyzed to predict the effects that solar development might have on the local workforce and housing market. Drawing on observations from a solar facility in operation in Nevada, inferences were made on how a community's distance from a facility, the project site's previous land use, and the site's owner (a public or private entity), will influence the facility's community effects.

What are the socioeconomic impacts of existing utility-scale solar facilities and how might the impacts of future facilities be similar and/or different?

We completed an in-depth case study of Nevada Solar One, a solar facility in Nevada. Our research goal was to infer the socioeconomic effects of utility-scale solar facilities proposed for the California desert by researching the impacts of facilities already in existence. Because many of the proposed facilities have nameplate capacities of at least 50 MW, we limited our research to facilities with comparable output. We assumed it would be difficult to locate individuals knowledgeable of older facilities. We therefore limited our research to facilities built within the past 10 years.

Data collection was mostly comprised of interviews. Our questionnaire, designed to be administered over the phone, covered a variety of topics, including general impressions of the facility and

surrounding areas. The questionnaire also asked the interviewees to give their opinion on how the facility may have affected the local area, in such areas as traffic, public roads, employment, municipal revenue, and local stores. Questions covered impacts both during facility construction and operation. Over the course of the project, eight individuals were interviewed. We identified individuals to interview through internet searches and from recommendations made by other interviewees. All interviews took place from July to November 2009. Interviewees included a Boulder City elected official, a community development planner, a representative from Acciona Solar Power (the facility developer), a representative from NV Energy (the utility purchasing Nevada Solar One's power), and an individual from a local business development organization.

How do existing communities view proposed solar developments? What are the information gaps for local stakeholders and what sources of information do they use? What are the perceived types and likelihoods of impacts?

A stakeholder survey was conducted on residents in these communities in the California desert. Prior to this study, little research had been done to assess local communities' attitudes about utility-scale solar energy development. Basic methodology is provided below. Further information on the survey, including more detailed methodology, can be found in Appendix A.

Target Respondents

Three communities in the California Desert region were selected to receive the stakeholder survey: El Centro, Lucerne Valley, and Newberry Springs. Three criteria were used to select these communities.

1. Current stage of the proposed project: To capture the most informed opinions possible, we selected communities that had already held at least one public meeting regarding the proposed solar project.
2. Proximity to a proposed solar project: To ensure that those surveyed were representative of true community stakeholders, we only considered locations within 25 miles of a proposed solar energy project. This proximity requirement was designed to maximize the likelihood that the individuals surveyed in fact had a vested interest in the construction of these projects.
3. Population size: For statistical reasons, we chose to only survey communities that were 1,500 residents or more. The community of Newberry Springs did require a partial exception to this rule. Though Newberry Springs included land parcels that were owned by over 1,500 unique persons, many of these were "absentee owners", meaning that they owned the land and title, but did not permanently reside in the community.

Survey Instrument Development

Prior to identifying locations and developing survey questions, we developed research objectives to guide our work and to form the basis of the survey instrument. The objectives, designed as a set of questions, were in part derived from what we identified as underexplored or altogether missing information from academic literature and current discourse. These questions were pre-tested by representatives from environmental organizations and desert communities. The questions developed in the stakeholder survey addressed these questions and captured demographic information to allow us to perform statistical analyses that explored the relationship between each community's perceptions and the respondents' age, education, and length of residence in the California desert region. Overall, there were 14 questions asked, three of which were demographic in nature. Of the 14, two were open response: "What do you think are the positive impacts of these facilities?" and, "What do you think are the negative impacts of these facilities?" The remaining 12 questions required respondents to either choose one of a set of ranked options, or to check all that applied, most of which offered the option to fill-in a response.

Survey Instrument and Dissemination

The survey instrument was distributed by mail and included both a paper copy of the survey with a stamped and addressed return envelope, and a website link that respondents could use if they preferred. A total of 5,079 surveys were mailed; households received two copies of the survey, one in English and one in Spanish, as census figures indicated a high level of Hispanic populations in these communities. 624 response were received, between early December 2009 and the end of January 2010.

Survey Response Analysis

We analyzed the results of our survey in three primary ways: first, we calculated the mean response for each question as an aggregate number from the sample and by four demographic categories using a contingency table; second, we placed those in favor of and those opposed to solar into two groups, and calculated the means and variances of each question using two-sample t-test to identify divergence of opinion and statistical significance; third, we read each open-response question and assigned a numerical value to individual words or phrases as they appeared, such as "jobs" or "green," which we then coupled with a qualitative analysis to identify issue gaps in our close ended questions. Where we spotted patterns in the data, we conducted chi-squared tests and regression analyses to ensure statistical significance and dependence or correlation. See Appendix A for additional detail.

How are decisions being made in the solar energy siting process?

What is the current process for siting solar facilities on public lands?

In order to determine the current process for siting solar facilities on public lands, 22 in-person and telephone interviews were conducted with BLM staff involved in solar facility siting at the state office, California Desert District (CDD) office, and all field offices within the CDD, as well as with staff members of the California Public Utilities Commission (CPUC), California Energy Commission (CEC), Department Of Defense (DOD), National Park Service (NPS), and FWS involved in the solar facility siting process or with management jurisdiction within the CDCA. All interviewees were asked to explain their roles in the current siting process.

What are the strengths and weaknesses of the process?

A critical evaluation of the BLM's right-of-way process as it is being applied to solar facilities was conducted using a set of normative criteria. These criteria included: efficiency of the process, clarity of process, consideration of a robust set of options, level of environmental protection, consideration of spatial and temporal scale, and public engagement. The evaluation of the process was supplemented by interviews with staff from the BLM, CEC, CPUC, DOD, NPS, and FWS. Interviewees provided their opinions on the strengths and weaknesses of the current solar siting process. Additionally, a targeted internet-based survey of desert-region city and county governments, citizens groups, chambers of commerce, environmental organizations, recreation organizations, and tribes was conducted. This organizational survey was designed to determine the level of participation in the BLM process by organizations and what these organizations considered strengths and weaknesses of the BLM’s process as well as the most important aspects of the process. Two hundred and sixty five surveys were sent and 41 responses were received. Additionally, the stakeholder survey was used to determine the level of public engagement by individual residents.

What aspects of existing alternative processes would be beneficial for the solar siting process?

We conducted a literature review of two processes used for energy generation, the wind energy right-of-way process. This knowledge informed a comparative analysis of these two processes, using the set of normative criteria identified for the solar right-of-way process analysis. The comparative analysis looked at which parts of the processes can be or are already used for solar and if they would work with the CEC process.

What changes and improvements can be adopted to more effectively site solar facilities with minimal ecological impact?

How should the current solar siting process be changed and improved?

Recommendations were formulated following analysis of data collected to answer our research questions on how decisions are being made in the solar energy siting process. These recommendations stemmed from the strengths and weaknesses identified through the evaluation of the current process, as well as from our analysis of alternative processes used for siting energy development on public lands.

What mitigation and design measures can developers take to reduce the ecological impacts of utility-scale solar development in the California desert?

Six proposed solar facility applications were selected for an analysis of Biological Resources Best Management Practices (BMPs) and mitigation measures. In our analysis, we differentiate between the terms “best management practice” (BMP) and “mitigation”: BMPs are used on site to reduce the impacts of development on biological resources, while mitigation is used off site. The same six facilities were used in both the BMP and mitigation analysis. BMPs were not attributed to specific solar facilities, though some language from the applications was used to describe the BMPs. Our ecological analysis and interviews with scientists provided the background information necessary to construct informed recommendations for BMPs and mitigation measures.

CITATIONS

Chapter 1

[1] Randolph, J., G.M. Masters, *Energy for Sustainability: Technology, Planning, and Policy*, (London, England: Island Press, 2008), 61.
[2] David Appleyard, "Utility-Scale Thin-Film: Three New Plants in Germany Total Almost 50 MW", *Renewable Energy World Magazine*, March 11, 2009, http://www.renewableenergyworld.com/rea/news/article/2009/03/utility-scale-thin-film-three-new-plants-in-germany-total-almost-50-mw.