ENVIRONMENTAL IMPACTS OF LARGE-SCALE SOLAR PROJECTS

Here we summarize concerns regarding the environmental impacts of massive solar project infrastructure development in the desert. This summary is focused on California, where many projects are in process on public lands. Much of the impetus for this large number of projects comes from California's goal of meeting 33% of its energy needs through centralized renewable energy generation — i.e., a 33% "renewable portfolio standard (RPS)" by 2015. We also include some discussion of impacts in Colorado's San Luis Valley, another area where industrial-scale solar projects are proposed on both private and public land. Many of the impacts in these states can be extrapolated to other states.

While work is proceeding on the draft Desert Renewable Energy Conservation Plan (DRECP)[1] for California and the Bureau of Land Management's Solar Programmatic Environmental Impact Statement (PEIS)[2], at this time there is virtually no guidance for agencies or solar companies to make informed decisions that will reduce the environmental impacts of these projects.

Some of what we know of the potential impacts, and most of what we know about the quality of environmental analysis being conducted, has come from the environmental review documents for large solar power projects now requesting certification by the California Energy Commission,[3] and from reviews by the California Public Utilities Commission[4].

Energy development footprint

Utility-scale solar thermal and photovoltaic developments are typically designed in the 200 to 500 megawatt (MW) range with project footprints of 1,000 to 7,000 acres. Meeting the goal of 80,000 MW of concentrated solar thermal generation under California's 33% RPS will require 500,000 acres of land. Such large impact areas on desert lands will have lasting effects on the viability of species, habitats, and ecosystem functions. As explained in the accompanying brief on public lands, the total public land area under application for industrial-scale solar as of July 2010 was just under 1.1 million acres.

Transmission footprint

The new transmission line rights-of-way associated with many projects constitute a significant and often-ignored impact of industrial desert solar. Almost all existing transmission lines from large solar projects will need to be upgraded, causing widening and new linear desert ecosystem disturbance far from actual project sites, and multiplying environmental impacts.

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[1] http://www.energy.ca.gov/33by2020/documents/index.html#2010meetings
[2] http://solareis.anl.gov/
[3] http://www.energy.ca.gov/siting/solar/index.html
[4] http://docs.cpuc.ca.gov/efile/RULINGS/119573.pdf

Impact on the environment

Impacts are summarized in these categories:

1. Soils
2. Water resources
3. Desert ecosystems
4. Air quality
5. Significant species
6. Corridors
7. Important bird areas
8. Visual and sound pollution

Soils

Parabolic-trough solar thermal power plants require 100% vegetation removal and grading to remove features such as low hills and swales and create uniform topography. Even so-called Low Impact Design projects using heliostat-mirrors aimed at central power towers, Stirling engine dishes, and ground-mounted photovoltaic arrays require scraping areas around fixtures and for access roads. The results are soil compaction, soil removal, and erosion.
In a preliminary Low Impact Design of Ivanpah Solar Electric Generating System in California, approximately 412,600 cubic yards of vegetation would be mowed and mulched, and 245,000 cubic yards of soil would be cut, moved, and filled — enough material to fill Yankee Stadium three-quarters full.

Proposed project sites are often located in flood plains or on alluvial fans that convey stormwater between mountains and valleys. Many projects are proposed to be built over ephemeral mountain and desert washes which carry large floods. Flood-control measures such as berms, artificial cement channels, detention basins, and soil-cementing provide an additional source of ecosystem disruption in such areas.

Water Resources

Water for cooling tower "makeup" — flushing the cooling towers of accumulated salts and sediments — process water makeup, and other industrial uses such as mirror and panel washing would be supplied from on-site groundwater wells. It is uncertain how much make-up water will need to be added in closed-system solar thermal plants: the steam system would have to be blown down (water drained to maintain chemical and solids levels in boilers). If dust problems have been underestimated, mirrors may have to be washed more often to maintain optimal operating conditions. At some plants mirror washing has to be conducted as often as once a week.

The Abengoa Mojave Solar Project proposes pumping water for wet-cooling from the Harper Lake Basin's aquifer, so critically in overdraft that it is in adjudication. The Ridgecrest Solar Power Project proposes to use drinking water from the Indian Wells Valley Water District city water supply tank, which pumps wells in a basin also in critical overdraft.

Even in basins that are not yet overdrawn, a single project could have significant impacts. The Ivanpah Solar Electric Generating System facilities would require pumping groundwater from a new well for water lost in the dry-cooling process, and wash water for the heliostats, as well as potable water for power plant worker water needs. Approximately 16,000 gallons of water per night would be used for mirror washing, almost 6 million gallons per year, or 18 acre-feet. Estimates for mirror-washing water run as high as 42.6 acre-feet per year.

Solar thermal plants will need evaporation ponds or blow-down ponds associated with generator cooling. Solids and chemicals associated with rust control procedures will accumulate in this ponded water. They can enter the groundwater and affect drinking water supplies and aquifer water quality.

<u>Desert Ecosystems</u>
Many solar projects are proposed for sites in the Mojave and Sonoran deserts that have rich and diverse biological resources. These include large intact areas of creosote-bursage scrub that are relatively free of weeds, have only light (and easily reversible) livestock grazing, see little off-road vehicle use except on designated tracks; and have no other development disturbance. Rare plant communities exist on many of these sites. Ephemeral streams contain unique plant associations that provide valuable wildlife habitat.

Cryptobiotic crust, a surface crust of soil particles bound together by organic materials, is a critical—and fragile— component of the desert ecosystem. Crusts are predominantly composed of cyanobacteria, green and brown algae, mosses, lichens, liverworts, and fungi. They contribute to soil stability, atmospheric nitrogen fixation, nutrient contributions to plants, and soil-plant-water relations. Living soil crusts also store CO2 and their removal may reduce organic offsets to anthropogenic greenhouse gas emissions. Once removed or disturbed, cryptobiotic crusts are slow to recover. On sites in the Mojave Desert disturbed 82 years ago, some species of lichen have yet to re-colonize the slowly regrowing crusts.

"King Clone," a creosote bush clone ring in the southern Mojave Desert, is 11,700 years old. Many desert plants have lifespans reaching thousands of years.

It is proposed that when power plants are decommissioned and facilities removed, restoration and revegetation will be conducted on the sites, but restoration has been found to be problematic at other sites in arid ecosystems with large-scale disturbance, such as open-pit mines.

Desert and high elevation valley environments provide “ecosystem services”— environmental processes and resources that we often take for granted, such as providing pollinators for crops, maintaining biodiversity, contributing to climate stability, and preserving and building soils and maintaining watersheds and flood control. Only when they are lost to development such as large-scale solar plants do we recognize how essential they are.

In Colorado, the San Luis Valley contains one of the largest complexes of wetlands in the Southwest. The value of wetland ecosystems as carbon sinks is well established.[5]

Regional Air Quality

Original desert soils are a sink for dust until mechanically disturbed. Large-scale disturbance of desert soils would result in an increase in wind-borne dust. Many projects are located in air basins with federal designations of "nonattainment" for federal particulate matter (PM2.5 and PM10), and state-level ozone nonattainment. Without adequate fugitive dust mitigation, projects have the potential to exceed the PM10 threshold during construction and operation, and could cause localized exceedances during construction. Under the National Environmental Policy Act (NEPA), this potential exceedance of federal air quality standards would be considered a direct, adverse, significant impact. Erosion from clearing is likely to substantially increase the amount of airborne particulate matter during strong wind events. To control dust, large amounts of water will have to be used on roads and scraped areas. Soil binders and dust suppressants will also be used during operation to control dust: petroleum-based products will have long-term impacts on soils, making restoration of vegetation problematic; while less-toxic organic and water-based suppressants are only 80-90% as effective with and must be reapplied every two to three years, thus increasing the facility's water use.

In Colorado, increased particulates blown onto surrounding snow-covered peaks have accelerated spring snowmelt. The dust absorbs heat from sunlight and melts the snow more quickly. This could have detrimental effects on the region's agricultural sector.[6]

Significant Species

State and federal protected species, and rare or sensitive species identified by Bureau of Land Management, state agencies, and organizations like California Native Plant Society, and the Colorado Natural Heritage Program, are often present on project sites. These include species such as desert tortoise (*Gopherus agassizii*), Mojave ground squirrel (*Xerospermophilus mohavensis*), burrowing owl (*Athene cunicularia)*, golden eagle (*Aquila chrysaetos*), LeConte's thrasher (*Toxostoma lecontei*), Gila monster (*Heloderma suspectum*), Mojave fringe-toed lizard (*Uma scoparia*), flat-tailed horned lizard (*Phrynosoma Mcallii*), bighorn sheep (*Ovis canadensis*), and many rare native plants, including a lupine in the California desert that may be new to science. Because many projects are on a fast-track schedule, time may not be allotted to carry out surveys in late summer and autumn when many plants flower after monsoonal rains; many species may thus be missed. In certain counties, cacti and

Already imperiled desert tortoise populations are likely to be severely impacted by solar development.

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[5] http://www.epa.gov/climatechange/emissions/co2_human.html

[6] http://articles.latimes.com/2009/may/24/nation/na-pink-snow24

yuccas are protected and must be transplanted out of project footprints. Several of these species and genetically unique populations are under review for listing by US Fish and Wildlife Service, and cumulative solar project development will only increase the need for protection.

Problems and confusion concerning mitigation for such species have arisen several times for many projects. At the Ridgecrest Solar Power Project, for example, mitigation for desert tortoise and Mojave ground squirrel has been unresolved even after several workshops hosted by BLM and the California Energy Commission, with US Fish and Wildlife Service and California Department of Fish and Game in attendance. Questions have arisen about how enough land would be acquired for habitat mitigation and translocation of animals off the construction site. Many enhancement measures (such as tortoise exclusion fencing) are untested or have not worked, raising concern among biologists regarding whether the mitigation fund and habitat acquisition would actually provide any benefits to species. A mitigation fund further abstracts the actions taken on lands elsewhere from the impacts on the project sites. Agencies have not yet determined how to match up actual project impacts to large regional mitigation programs without violating legal protections for species.

Wildlife Corridors

Biologists have recognized the importance of maintaining the integrity of wildlife corridors, which enable animals to migrate and thus allow gene flow among populations. Survival of a species depends on resilience of its populations to environmental fluctuations, and this resilience is bolstered by large areas of habitat, movement corridors, and connectivity of genetic populations so that natural variation in the species can allow adaptation to changes. Resilience is reduced by habitat fragmentation, degradation, and competition from invasive species such as weedy plants increasing on lands disturbed by development (a new impact in desert ecosystems).

Building large solar projects in Chuckwalla Valley, for example, involves more than just removing Mojave fringe-toed lizard habitat. These animals are specialized on sand habitat, and cannot survive on rocky ground. Several solar projects will block part of the sand corridor, where sand is blown gradually over the years by winds from dry lakebeds and stream channels.

Bighorn sheep and Desert tortoise both need migration corridors to move between mountain ranges. The cumulative impacts of renewable build-out in Ivanpah Valley could reduce the widespread tortoise population to small, isolated fragments of populations with no gene flow between them. Such circumstances can lead to extirpation of these small populations, as inbreeding increases and leads to reduced fitness and lack of resilience to natural disasters, disease, and climate change.

The sheer size of these solar facilities will create barriers between populations and potentially disrupt eons old migration patterns. As local populations are lost or isolated, linkages are lost. Connections between metapopulations (groups of local populations) must be kept intact. In the past, biologists looked at the size and quality of patches, but now there is more interest in the "matrix," the areas between patches that provide connectivity.[7] The size and quality of habitat

[7] Hilty, Jodi, William Lidicker, and Adina Merenlender. 2006. Corridor Ecology: The Science and Practice of Linking Landscapes for Biodiversity Conservation. Island Press: Washington, DC.

patches has been shown in studies to be a poor predictor of occupancy, and the matrix may be more important.

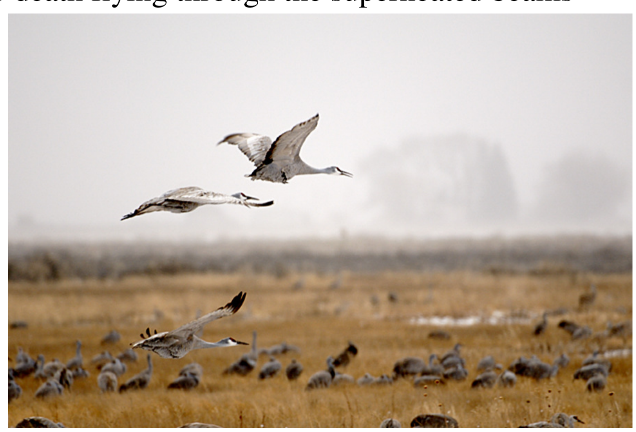
Many proposed solar projects would be located squarely in the middle of connectivity corridors: the Ridgecrest Solar Power Project, for example, would block a major connectivity area for the Mojave ground squirrel. Mitigation measures cannot actually mitigate very site-specific qualities such as connectivity. Certain projects have been sited directly in unique corridors that connect genetic populations of a species—other lands cannot replace this function.

Important Bird Areas

The potential impacts on avian species of industrial-scale energy development are of significant concern. The National Audubon Society has identified areas vital to bird species— including common and game species as well as rare species— and designated them as Important Bird Areas (IBAs). Clark Mountain in the East Mojave Peaks IBA,[8] with monsoonal-influenced montane forests, is a critical breeding area for birds not found elsewhere in California, and is also adjacent to the proposed three-tower Ivanpah project.

Migratory Hepatic tanagers and Whip-poor-wills have rare breeding populations on Clark Mountain. No studies have been undertaken on how migrating birds would be affected by burn injuries sustained from flying through the beams of concentrated sunlight, although it is known that migrating or foraging birds have been burned to death flying through the superheated beams of sunlight aimed at central receiver towers at the much smaller Solar One installation formerly at Daggett, California.[9] With no information, no mitigation plan can be developed.

The San Luis Valley, Colorado serves as a major biannual stopover point for over 30,000 migrant Sandhill Cranes (*Grus Canadensis tabida*) as well as other migrant species, such as White-faced Ibis (*Plegadis chichi*), Black-necked stilt (*Himantopus mexicanus*) and other waterbirds that breed and nest in the Valley. The impact of square miles of solar arrays on the San Luis Valley migrant bird populations is largely unknown but potentially significant and irreversible.



Colorado's San Luis Valley is a critical stopover in the annual migration of Sand Hill Cranes.

Visual and Sound Impacts

In the San Luis Valley retreat and agricultural tourism is a vital and growing part of the regional economy. In addition, many residents have moved to the area to leave urban life and enjoy the area's beauty. Industrial solar development on the scale currently being proposed there will change the rural character of the region and degrade world-class visual and historical resources. Tessera Solar is proposing to install over 35,000 40-foot- high SunCatcher units, each powered

[8] http://iba.audubon.org/iba/profileReport.do?siteId=264&navSite=search&pagerOffset=0&page=1

[9] McCrary, Michael D., Robert L. McKernan, Ralph W. Schreiber, William D. Wagner, and Terry C. Sciarrotta, Avian Mortality at a Solar Energy Power Plant. Journal of Field Ornithology, 57(2): 135-141.

by a 4-cylinder Stirling Engine. The noise levels produced could adversely impact a nearby community with over 24 internationally renowned retreat centers as well as the Great Sand Dunes National Park, the quietest National Park in the nation.[10]

[10] http://www.eenews.net/public/Landletter/2009/10/08/1