

# Study urges optimization of solar energy development

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A typical solar generating installation. Credit: Rebecca Hernandez

With mounting vigor for combating global climate change, increasing

the use of renewable energy resources such as solar, without compromising natural habitats, is a challenge to the traditional model of utility-scale solar energy installations. Such facilities use vast swaths of land for solar gathering and generating equipment. Until now, studies quantifying the effects on land-cover change and analyses of impacts on protected areas near solar facilities have been limited.

New work from Carnegie's Rebecca R. Hernandez (now at UC-Berkley and Lawrence Berkeley National Lab), Madison K. Hoffacker (now at UC-Riverside's Center for Conservation Biology), and colleagues, published in the *Proceedings of the National Academy of Sciences*, assessed the siting impacts of 161 existing, under construction, and planned utility-scale solar energy facilities in California. Utility-scale solar energy facilities generate at least 1 megawatt, which is enough to power approximately 165 homes. The researchers found that a majority of sites are located in natural California shrub- and scrublands covering about 145 square miles (375 km<sup>2</sup>); 28% are in croplands and pastures; less than 15% are in developed areas; and some 19% are in areas far from existing transmission infrastructure, which has adverse economic, energetic, and environmental consequences.

This study included two kinds of solar technologies, photovoltaics (PV), which use semiconductors, and concentrating solar power (CSP), which use mirrors to focus the sun's rays for generating steam. Previous work by Hernandez and colleagues, published in *Nature Climate Change*, found that these solar technologies in built-up areas could meet California's energy demands three to five times over.

"California, as an early adopter of solar energy, is a model system for understanding the complex siting decisions made by all parties—from developers, to governmental agencies, to stakeholders and communities—involved in utility-scale solar energy development," remarked Hernandez. "Solar energy in developed areas, or for example

on contaminated lands, would have great environmental co-benefits, but this is not what is being emphasized. Instead, we see that 'big solar' is competing for space with natural areas. Knowing this is vital for understanding and creating predictions of a rapidly changing global energy landscape."

In analyzing impacts on protected areas, the researchers calculated the proximity of solar installations to them. The fact that nearly 20% of solar facilities were far (greater than 6 miles, or 10 kilometers) from transmission infrastructure means that the energy must travel farther and therefore have greater energy losses; they cost more to build; and new transmission corridors degrade the natural environment. Michael Allen of UC-Riverside, a co-author on the study stated, "As a goal of reducing the human carbon footprint, and protecting the environment including California's incredible biodiversity, careful planning of siting of facilities and selection of appropriate technologies should become standard."

Almost 30% of all installations were in croplands and pastures. "We were struck by this finding too," Hernandez stated. "We are seeing landowners, particularly in the Central Valley, shift from harvesting crops and forage to harvesting the sun." It is possible that the mounting pressure from drought has made this shift to solar energy an easier decision for farmers, a novel interaction that Hoffacker is currently studying in greater depth.

After evaluating land-cover change from solar facilities, the researchers used the Carnegie Energy and Environmental Compatibility computer model to develop a compatibility index to identify areas of potential and direct conflict with respect to environmental resources California-wide. Compatible areas are areas that are already developed. For photovoltaic technology, they identified some 8,500 square miles (22,028 km<sup>2</sup>) of these compatible areas (11.2% of total PV installations) and 30,000

square miles (77,761 km<sup>2</sup>) of potential compatible areas (71.7% of PV installations). Potentially compatible areas are the next best thing. They are not protected, they would not require heavy site preparation, such as grading steep slopes, and they are within 6 miles (10km) of transmission lines and roads. There are many locally unique considerations that come into this category, for instance view disruption for local residents. Incompatible areas are natural and protected areas. The scientists found that some 55.5% of CSP installations were in either compatible or potentially compatible areas.

Hernandez explained, "If our country wants to reduce greenhouse emissions by 80% of 1990 emissions by 2050, some 27,500 square miles (71,428 km<sup>2</sup>) of land could be required for solar installations, which is about the area of South Carolina. We can increase the land-use efficiency in ways such as decreasing spaces between rows of photovoltaic modules or concentrating solar power mirrors. Better yet, is to locate installations in areas already affected by humans, such as on land fills, over parking lots, and on rooftops and nearest to where the energy is being consumed."

Kara Moore, an applied ecologist at the Center for Population Biology at UC-Davis, who has conducted landmark experimental studies on effectiveness of rare species mitigation within a utility-scale [solar energy](#) facility stated, "This study gives policy-makers clear guidance on the great potential we have to site utility-scale renewable energy more sustainably by building it into our existing human-affected landscapes. By doing so we benefit by simultaneously increasing the efficiency of renewable energy systems and by avoiding unnecessary impacts to our precious remaining natural areas."

**More information:** Solar energy development impacts on land cover change and protected areas, *Proceedings of the National Academy of Sciences*, [www.pnas.org/cgi/doi/10.1073/pnas.1517656112](http://www.pnas.org/cgi/doi/10.1073/pnas.1517656112)

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