EnviroAtlas
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Fact Sheet
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Area of Solar Energy

This EnviroAtlas national map estimates the square kilometers of area contained within each 12-digit hydrologic unit (HUC). HUCs were used as the framework to summarize the average annual daily potential watt hours of solar energy that could be harvested per square meter. This map represents the area of land that receives solar energy, but it does not take into account land cover, ownership, land use, or aspect.

Why is solar energy important?

Solar energy represents a freely available, seemingly inexhaustible, ecosystem service. More solar energy strikes the earth's surface in 1½ hours than all the energy consumed worldwide in the year 2001.[1] The earth's surface in the temperate zone receives about 150 watts of solar energy per square meter.[1] This solar potential is expressed in the EnviroAtlas map Average Annual Daily Potential, measured in kilowatt hours per square meter per day ($kWh/m^2/day$). Though it overestimates actual electricity generation capacity, gross potential is a good indicator of regional solar resources. The Average Annual Daily Potential map shows that the best opportunities for commercial solar power generation are located in the southwestern U.S. Large commercial solar developments are most profitable in areas with average annual daily potential greater than 6 $kWh/m^2/day$.[2]

Since 2009, the federal government has been promoting large industrial solar energy projects on federal land in California, Arizona, and Nevada as part of an overall climate change mitigation strategy. Fossil-fuel-generated electricity contributes about 40% of carbon dioxide emissions in the U.S.[3] Increasing the contribution of renewable energy sources is expected to reduce future carbon dioxide emissions. The main obstacle to capturing abundant but diffuse solar energy for power generation is converting it to electrical power in a cost-effective manner. One common commercial technology uses arrays of photovoltaic (PV) cells to directly convert solar energy into electricity (see image). Concentrating solar energy plants (CSPs, such as power towers or parabolic troughs) concentrate reflected sunlight into an intense direct beam to create steam.[2,4]

Though they create clean energy, commercial solar projects can be very land-intensive. Two new solar projects in California, Ivanpah and Topaz, cover 5.6 and 9.5 square miles, respectively. Large solar developments may block wildlife travel routes and disrupt breeding populations.[3,5,6] Concentrating solar plants create zones of superheated air as high as 800° F that burn and kill passing birds, bats, and insects in flight. Steam-producing CSP tower plants require 1000 gal of water per 1000 MW hours of electricity produced, adding more demand to limited desert water supplies.[5] Future expansion of commercial solar energy will require careful consideration of environmental tradeoffs.

Photo: PV Solar, Minnesota, Solar Connection, Inc., Creative Commons

When compared to other nations in the northern hemisphere, the U.S. has exceptionally high solar potential, which is not limited to the Southwest. Germany has lower daily solar potential than either the northeastern or northwestern U.S., yet it was the global leader in PV solar capacity in 2011 with 35.6% of the world's share of solar PV power production.[7] Rooftop solar capacity in the U.S., though growing, is largely untapped.[8] Rooftop solar potential is estimated at over 800 terawatt-hours (TWh, equivalent to 800 billion kilowatt-hours) of energy.[4] Federal, state, and local subsidies have helped to increase rooftop solar applications by making PV solar more affordable for the average home or business owner. The current federal solar tax credit (through 2021) allows up to 30% of the cost of a new solar system.

How can I use this information?

This EnviroAtlas national map, Area of Solar Energy, gives the area of each 12-digit HUC in square kilometers. A companion map, Average Annual Daily Potential, estimates the average daily potential watt hours of solar energy that could be captured per square meter within each 12-digit HUC. The two maps together illustrate the solar energy

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potential across a given area without taking into account land use, ownership, land cover, or aspect. The maps provide planners and the general public with a national and regional view of gross solar energy potential. These maps can help inform discussions about the benefits and environmental tradeoffs of commercial and private solar applications.

The solar energy potential map may be overlaid and compared with other EnviroAtlas maps depicting land cover and habitat, such as protected areas, ecoregions, GAP ecological systems, and connectivity. These data layers along with information on species distributions and habitat needs can help to assess the adequacy of reserves, remaining habitat core areas, and movement corridors for wildlife near large existing or proposed solar developments.

How were these data created?

Area of solar energy data were created by calculating the area within the 12-digit HUC boundaries. The values represent the area of earth's surface receiving solar energy; they can be compared to corresponding values of Average Annual Daily Potential measured in kilowatt hours per square meter per day (kWh/m^2/day). The area of solar energy map does not take into account land use, ownership, land cover, or aspect.

What are the limitations of these data?

The amount of solar energy striking the earth's surface varies by latitude, season, and time of day. This map represents an estimate of gross solar potential, which overestimates actual electricity generation capacity. A map of technical potential would omit areas where solar applications are unlikely, such as forested areas and northern aspects. The estimation of the area of solar energy within 12-digit HUCs is based on environmental factors and does not take into account the viability of installing solar systems.

How can I access these data?

EnviroAtlas data can be viewed in the interactive map, accessed through web services, or downloaded. The solar energy data used to create this map may be downloaded at the NREL website. NREL has also developed dynamic maps and analysis tools to help apply renewable energy data.

Where can I get more information?

A selection of resources related to the environmental benefits and possible effects of solar development is listed below. For additional information on how the data were created, access the metadata for the data layer from the drop down menu on the interactive map table of contents and click again on metadata at the bottom of the metadata summary page for more details. To ask specific questions about this data layer, please contact the EnviroAtlas Team.

Acknowledgments

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Selected Publications

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