New methods to examine the potential of concentrating thermal solar power

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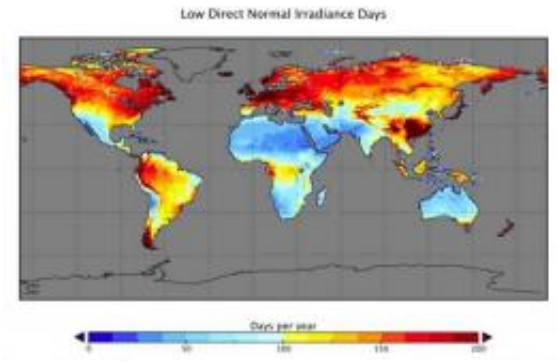

The average number of days per year when thermal CSP power plants cannot operate due to low direct normal irradiance levels. During many of these days, these plants are expected to still produce power using a backup system using natural gas or biomass. This feature allows CSP plants to produce reliable power year-round. Reprinted from Energy Policy, Vol 38, Author(s), Zhang, Y., SJ Smith, GP Kyle, and PW Stackhouse Jr., Pages 7884-7897, Copyright 2010, with permission from Elsevier.

New data and methods have been developed to examine the potential for thermal concentrating solar power (CSP) plants to help meet energy and environmental goals. Researchers at Pacific Northwest National Laboratory, University of Maryland, and NASA analyzed the interactions between CSP plants and the electricity system and found that CSP power plants have the potential to supply a significant fraction of future electricity needs.

CSP technologies hold a promise of clean, domestic power around the world. CSP systems convert the thermal energy in sunlight into electricity. Global use of this technology is projected to grow substantially in the near future with numerous plants under construction worldwide. The potential of solar power technologies is difficult to evaluate, however, because the energy-economic models used to inform decision-makers are not designed to simulate variable renewable resources. The results of this study can be used to produce more realistic estimates of their potential contribution.

The operation of CSP power plants and their interaction with electric loads, by time of day and season, were analyzed to determine how this technology could be realistically incorporated into energy-economic models. A key characteristic of CSP power plants is their ability to supply reliable power through the use of a low-cost backup option referred to as hybrid plants, whereby natural gas, or even biomass, can be combusted in a low-cost boiler or heating unit to supply power on cloudy days.

Plant performance depended on two key parameters: the number of cloudy days in which power plants cannot operate, and the average amount of sunshine on operational days. This research showed that an accurate characterization of the number of such "no operational" days is key to a realistic characterization of this technology. No existing data sets provided global estimates of this parameter, so the necessary values were estimated using regressions developed from the U.S. National Solar Radiation Database in conjunction with a global solar resource data set developed by NASA. The technology representation and data developed in this work were then implemented in the Global Change Assessment Model (GCAM) to examine how CSP technologies might compete with other electricity supply technologies in 14 global regions. Using the GCAM integrated assessment model, the researchers found that, even under relatively modest assumptions for technological improvement,

from 2-10% of electricity supply in various global regions might come from CSP technologies by the end of the century. This work also found that, even assuming the development of thermal storage technologies, gas or biomass use during cloudy days becomes a substantial portion of plant costs in the future as fuel prices increase and CSP plant capital costs fall.

The methodologies and data developed in this research can potentially be used in many energy-economic models to more realistically examine the potential of CSP technologies. A detailed study of the potential of renewable energy more broadly using this and related work using the GCAM model is underway at PNNL. The work reported here highlighted the importance of estimating new solar resource parameters, which may be possible with the next generation of solar resource assessments being conducted by NASA. The role of CSP backup operation should be more thoroughly examined in detailed renewable energy analyses.

More information: Zhang Y, et al, 2009. "Modeling the Potential for Thermal Concentrating Solar Power Technologies." *Energy Policy* 38:7884-7897. Available online.

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