

Chapter 3: Solar Thermal Electric

Summary

Solar energy can be converted to useful forms of energy through two main processes: solar-electric or solar-thermal. In the simplest use of the solar-thermal process, solar radiation is converted into hot water for domestic use. Additionally, solar radiation can heat water, organic fluids, or other materials that are then used to drive expansion turbines for the generation of electricity.

Concentrating Solar Power (CSP), also known as solar thermal electric, uses reflective materials to concentrate sunlight onto a thermal receiver that absorbs and converts it into heat. The heated fluid in the receiver is then used in a steam generator or engine to produce electricity. Numerous CSP technologies have been developed for power generation applications.

From a utilization perspective, there are two major applications: small scale or distributed and central plant or station. CSP is an example of central station solar energy. For the central station application the equipment is typically sited remotely from the load centers. This often requires construction of additional utility infrastructure to deliver the energy to the loads.

Numerous solar technologies and variations have been proposed over the last 30 years by industry and researchers in the United States and abroad. The leading CSP candidate technologies for utility-scale applications are parabolic troughs, molten-salt power towers, and parabolic dishes with Stirling engines. Parabolic dishes with Stirling engines can be used singularly as a distributed resource or in groups in a utility-scale power plant.

A description with photos of each technology exists in Appendix E, Solar Thermal – Concentrated Solar Power.

3.1 CSP in California

In California, there are nine Solar Electric Generating Systems (SEGS) located in the California Mojave Desert. These are the world's largest solar power plants. These plants, developed by Luz International Limited (Luz) between 1984 and 1990, range in size from 14 to 80 MW and comprise 354 MW of installed electric generating capacity.

3.2 CSP in the San Diego Region

Although there are no CSP plants currently in the San Diego region, Southern California is potentially the best location in the world for the development of large-scale solar thermal power plants per NREL's findings in Appendix E. The correlation between electric energy demand and solar output is strong during the summer months when peak power demand occurs. This desert region is unique for the proximity of such an excellent solar resource to a highly populated residential and commercial region.

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Provided the existing transmission capacity constraints can be resolved, the AC and DC transmission network running through the region enables solar electric generation to be distributed to major load centers throughout California.

3.3 CSP Technical Potential

As a result of the above factors, the world’s largest and most successful solar electric power facilities are sited in Southern California and sell power to Southern California Edison (SCE). According to the Renewable Energy Atlas of the West, the southwest portion of the United States has the greatest potential for CSP in the world.

In February 2005, NREL completed a full CSP study for the San Diego region. It has been included in its entirety in Appendix E, Solar Thermal – Concentrated Solar Power.

The gross technical potential for the San Diego/Imperial County region was calculated by the National Renewable Energy Laboratory’s (NREL). A summary of NREL’s findings are shown in Table 3.1.

Table 3.1: NREL’s Technical Potential for CSP

NREL Solar Siting Analysis Results March 2005 (Solar Resource > 6.75 kWh/m² 2-day)		
	Technical Potential (GW)	Area (km²)
San Diego- Borrego Springs	6.0	130
Imperial Valley	290	5,800

Applying this available, non-conflicted land filter to NREL’s technical potential resulted in a final technical potential of 29 GW for the Imperial County.

As with other renewable technologies, these gross results were used by the Study Group as a starting point. The Study Group determined that additional filtering was appropriate to develop a final technical potential that would be consistent with the approach taken for other renewable sources. The results of these filters are described below and are summarized in Table 3.2 below.

To account for land-use conflicts, the Study Group used Imperial County’s estimates of undeveloped and non-agriculture acreage for its calculations. Applying this available, non-conflicted land filter to NREL’s technical potential resulted in a final technical potential of 29 GW for the Imperial County.

NREL’s recommended slope requirement of 1% slope was applied to estimates of the available undeveloped and unrestrained land. This resulted in technical potential of 2.9 GW for Borrego Springs.

A similar approach was used for NREL’s Borrego Springs findings, along with an additional filter to account for slope requirements.¹ The Study Group applied NREL’s recommended slope requirement of 1% slope to estimates of the available undeveloped and unrestrained land. This resulted in technical potential of 2.9 GW for Borrego Springs.

¹ The land studied in Imperial County was essentially flat and did not require a slope filter.

Table 3.2: Technical Potential for CSP after Filtering

(Solar Resource > 6.75 kWh/m² - day) Technical Potential in GW. Area in (km²)					
San Diego – Borrego Springs			Imperial Valley		
Land Filtered for:	GW	km²	Land Filtered for:	GW	km²
Undeveloped Land with a 1% Slope	2.9	58	Non-Agriculture Land	29	580

3.4 Drivers and Barriers

In Appendix E, NREL has done a full analysis of drivers and barriers for this technology as they exist in February 2005.

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Even after application of appropriate technical potential filters (Table 3.2), CSP presents a very large potential resource for the Region. Resolving the land use, transmission, and cost issues related to this resource will pave the way for deployment of this technical potential in coming years.

The Study Group plans additional study of this potential resource in our next phase.