National Renewable Energy Laboratory
Innovation for Our Energy Future

A national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy

Concentrating Solar Deployment Systems (CSDS) – A New Model for Estimating U.S. Concentrating Solar Power Market Potential

Concentrating Solar Deployment Systems (CSDS) is a computer model of expansion of generation and transmission capacity in the U.S. electric sector. The model is focused on addressing the most significant market issues for renewables – transmission and resource variability. It minimizes system-wide costs of meeting loads, reserve requirements, and emission constraints by building and operating new generators and transmission every two years from 2000 to 2050.

CSDS attempts to examine these issues primarily by using a much higher level of geographic disaggregation than other models. CSDS can, therefore, model distances for transmission and resource correlation directly instead of making assumptions. Much of the data inputs to CSDS are tied to these regions (358 in the United States) and derived from a detailed GIS model/database of the renewable resources, transmission grid, and existing plant data.

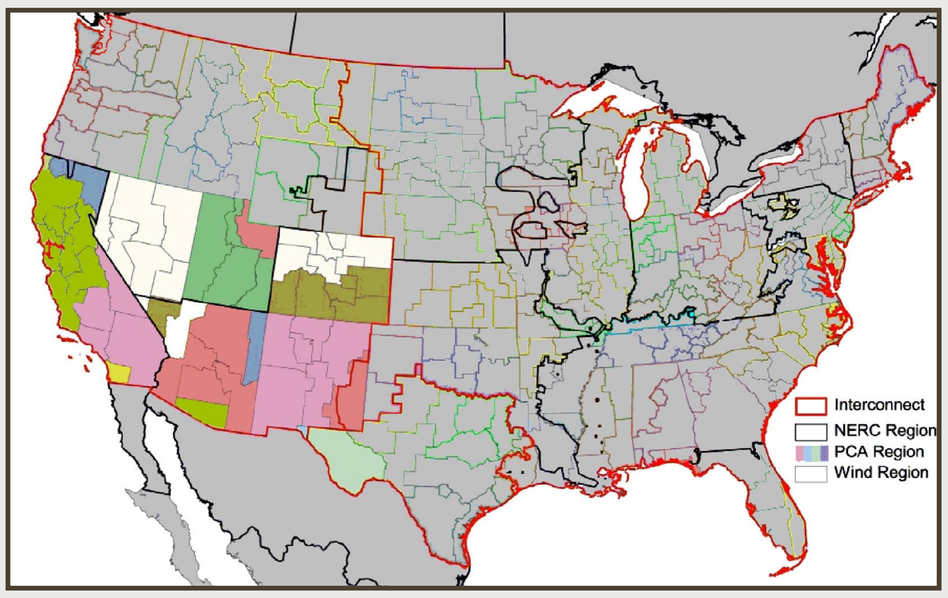

Figure 1: CSDS regions are only in seven southwestern states

The viable solar resource areas are located within the southwestern states, and only regions within the Southwest are allowed to build CSP plants **(Figure 1)**. Note that conventional generation and other renewables are modeled for the entire country.

BASE CASE ASSUMPTIONS AND RESULTS

The model currently assumes a 100 MW parabolic trough plant with six hours of storage. The storage assumption greatly simplifies the treatment of resource variability and allows an assumption of dispatchability. In this analysis, the Base Case relies heavily on the Reference Case scenario of the U.S. Energy Information *Agency Annual Energy Outlook for 2005* for inputs including electricity demand, fossil fuel prices, existing federal energy policies, and the cost and performance of non-renewable electric generating technologies.

With these Base Case inputs, CSDS estimates that parabolic troughs will provide about 55 GW of capacity in 2050 **(Figure 2)**. This capacity is dominantly provided by excellent solar resource. Although there are many drivers for this market penetration, this growth is largely attributable to improvements in the cost and performance of trough power plants.

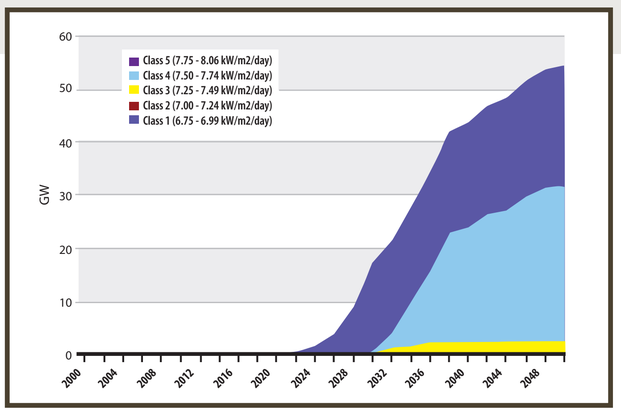

Figure 2: National capacity for the CSDS Base Case

Another question CSDS can answer is where the future CSP capacity will be located. Based on the GIS inputs to CSDS, transmission, some siting issues, and load location and load growth, the model selects the economically best sites for each period to add new capacity **(Figure 3)**. Expectedly, these are locations throughout the Southwest with class 5 solar and close to large loads.

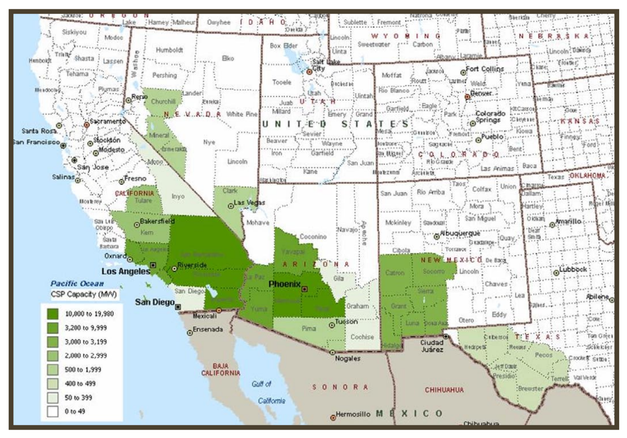

Figure 3: Projected CSP capacity (MW) by region in 2050

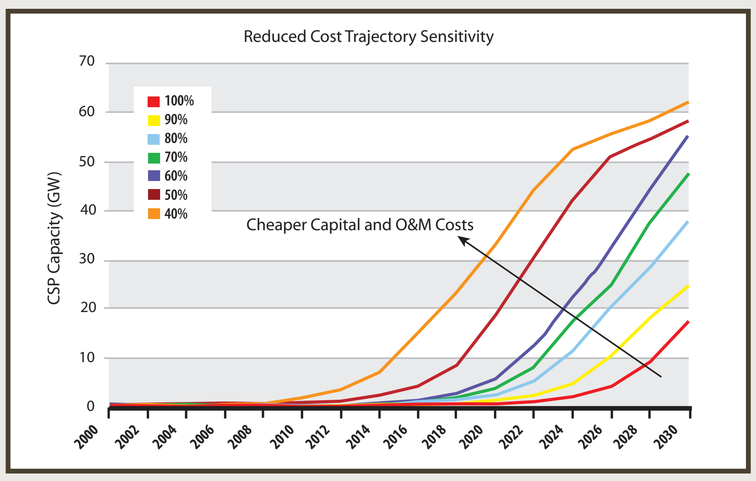

Figure 4: Cost reduction impact on CSP capacity penetration

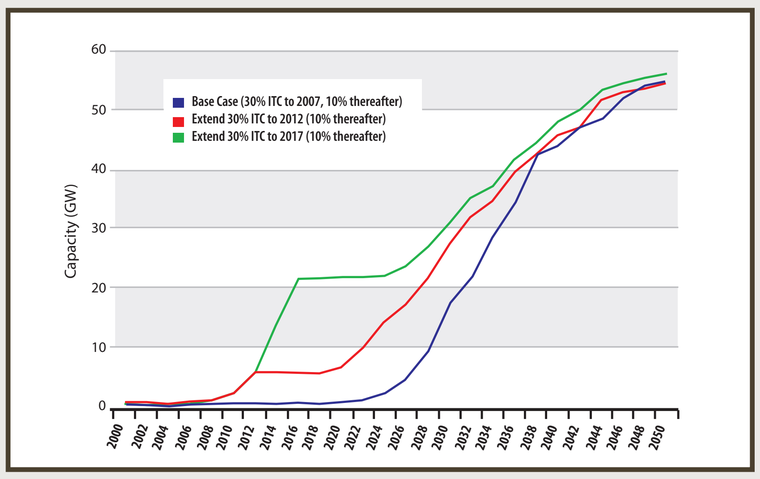

Figure 5: Impact of investment tax credit extension

SENSITIVITY CASES FOR FEDERAL POLICIES

The real power of this model is to examine the impact of various policies on the penetration of CSP into the U.S. electric market. Research and development improvements, policy incentives, and financial options are all methods for lowering the cost of CSP. To model these many impacts in aggregate, a methodology is to simply lower the total "cost trajectory" through time. In other words, we can take the Base Case solar cost trajectory and lower it by a certain percentage **(Figure 4).**

Extension of the Investment Tax Credit

The Energy Policy Act of 2005 added a 30% investment tax credit (ITC) until 2007 on top of the existing permanent 10% investment tax credit for solar power. We examined the impact of extending the ITC.

Continuing the ITC to 2017 will significantly increase CSP capacity **(Figure 5)**. However, as might be expected, with continued R&D-driven improvements in solar power plants and increasing fossil fuel prices, after 30 years, the amount of CSP capacity installed is less dependent on the ITC extension and that effect starts to be damped out.

CONCLUSIONS

- CSDS can give an idea of the location of future CSP deployment and CSP generation wheeling.
- CSDS is capable of examining the possibilities of a high-penetration CSP vision.
- This tool can be used to examine a variety of future federal and state policy impacts as well as technology and competitive market impacts.

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