Draft
CSP Global Market Initiative

25 September 2003

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Introduction

Solar energy is the most evenly distributed and readily available renewable energy resource on the planet. Solar thermal power plants, which make use of this concentrating solar power (CSP) technology have the capability to meet a significant percentage of the future global electricity demand without technological, economic or resource limitations, specifically in sun-belt regions such as the southwest U.S., southern Europe and parts of the developing world. This capability and the ability of solar thermal power plants to dispatch power as needed during peak demand periods has motivated development banks, such as the Global Environment Facility (GEF), the World Bank, the European Investment Bank and the German Kreditanstalt für Wiederaufbau (KfW), as well as the Global Environment Facility (GEF), the European Union and the U.S. Department of Energy, to support the implementation of this technology.

Improved CSP systems have been used since the 1970's to generate electricity or to provide heat thus displacing the need for electricity. The investment of $1.2 billion in nine commercial parabolic trough solar power plants in the Californian Mojave desert between 1984 and 1991 is one example that demonstrates the market readiness of CSP. Today, these California plants are operating reliably and have produced more than 50% of all solar electricity in the world. The CSP industry anticipates that solar electricity generation costs will be fully competitive with fossil-based grid connected power generation costs once an initial 5,000 MWe of new solar capacity has been installed globally.

CSP technologies are at the threshold of extensive commercial deployment. In the U.S., Nevada Power recently signed a power purchase agreement for a 50 MWe solar trough power plant near Hoover Dam. In late 2002, Spain implemented a very attractive feed-in law, exclusively dedicated to solar thermal power, that will has triggered investments of about € 0.6 billion for an initial 4 projects totaling 150 MW. And, two of the four GEF-funded CSP projects, each with investments of about $160 million, are currently in the bidding phase. Another 600 MW of CSP plants are under development.

At the First International Executive Conference on Concentrating Solar Power in June 2002 in Berlin, Germany, the GEF, the KfW, the German Federal Ministry for the Environment (BMU), the European Solar Thermal Power Industry Association (ESTIA) and the American Solar Energy Industries Association (SEIA) discussed a Global Market Initiative for CSP, and defined strategies towards the rapid and large-scale market introduction of the technology. This commitment was published as the Declaration of Berlin, which was registered as a UNEP Market Facilitation WSSD Type-II Partnership for Concentrating Solar Power Technologies.

The participating stakeholder groups of the *Declaration of Berlin* are now urging the implementation of this **Global Market Initiative** to accelerate the entry of CSP into the market.

Policy

All new technologies cost more, as did cellular phones and laptop computers in the 1970's compared to present day costs with their advanced designs and mass production. The same

principles apply to CSP, which has not yet mass-produced or optimized many of its components, nor experienced a significant growth in the relatively small industry. Many countries and states have solid experience in commercializing these new energy technologies, and they have adopted proven approaches to lower their costs, enhance the businesses that produce and deliver them, and protect consumer by achieving greater reliability and lower costs. However, a visible, reliable and growing market for solar thermal power with normal risk levels must be established in order for many project developers and CSP equipment suppliers to make the needed long-term investments to achieve lower costs.

There are three basic policy areas that will significantly impact the increased use of concentrated solar power:

I. Political and technological targets to trigger new power markets

- Establish a consistent basis of national laws and regulations, such as feed-in tariffs specifically earmarked for CSP, to pave the way for reaching the anticipated renewable supply targets committed in Kyoto.
- Establish Renewable Portfolio Standards that encourage actual "portfolios" of electricity and thermal generation from renewables, and insure that the locally available energy resources are evenly utilized and encouraged.
- Make green tariff schemes available for electricity imports from high insolation areas in neighboring states and/or countries.

II. Regulatory improvements

- Avoid limitations on capacity or operating strategies that make the technology introduction more costly.
- Remove archaic laws to interconnection which will allow concentrated solar plants to more easily hook into the electric grid at the end user (customer), distribution or transmission points.

III. Improve financing mechanisms

- Create a clearing mechanism that makes emission trading (CDM) bankable.
- Institute Production Tax Credits (PTCs) as wind energy now enjoys and which catapulted the technology globally. Maintain investment tax credits to assist in the initial capital investments before CSP plants begin to produce power.
- Establish loan guarantee programs via existing windows at multilateral banks, existing US national lending programs such as SBA, RUS, FmHA, Regional Power Administrations, and global environmental programs such as GEF, UNEP, and UNDP. These programs allow private sector banking institutions to do the necessary project due diligence while providing them with some extra insurance to loan on new technology projects which are inherently more risky.

Benefits

While varying slightly with region, demands on the electrical grid normally peak in the spring and summer months during the afternoon and early evening hours. Because the solar resource peaks near these same times, concentrating solar radiation to provide electricity, and power absorption coolers for air-conditioning is a natural match. Concentrating solar usage would

lower the strain on the electric grid at a time when high demand occurs. Furthermore, by integrating solar thermal storage or supplemental boilers into the system configuration, solar thermal power plants are dispatchable, that is, they can produce electricity to exactly match peak demands.

Concentrating solar power systems can be built in a range of sizes from 25 kW to 100's of MW, allowing them to be sited close to the load or centrally. Providing electricity in a distributed manner can provide important electric grid security. Generating electricity from a domestic source of energy that cannot be disrupted or whose resource does not change in cost has significant economic and national security advantages.

In many regions of the world, one square kilometer of land is enough to generate as much as 100-200 gigawatt hours (GWh) of solar electricity per year using solar thermal technology. This is equivalent to the annual production of a 50 MW conventional coal or gas-fired power plant. Over the total life cycle of a solar thermal power system, its output would be equivalent to the energy contained in 16 million barrels of oil. Worldwide, the exploitation of less than 1% of the total solar thermal potential would be enough to meet the recommendations of the United Nations' Intergovernmental Panel on Climate Change for the long-term stabilization of the climate.

Concentrating Solar Power

Solar thermal power generation using concentrating collectors, commonly referred to as Concentrating Solar Power (CSP), involves the conversion of solar radiation to thermal energy, which is then used to run a conventional power system. Solar thermal is a viable alternative to conventional energy systems and, depending on the particular technology, is suited to either distributed generation on the kW scale or to centralized power generation on scales up to several hundred MW. Concentrating Solar Power systems utilize parabolic trough concentrating collectors, power tower/heliostat configurations, and parabolic dish collectors. Parabolic trough and power tower systems typically run conventional power units, such as steam turbines, while parabolic dish systems power a small engine at the focal point of the collector.

Parabolic Trough and Power Tower Plants

Parabolic trough (Figure 1) and power tower (Figure 2) solar systems generate high-pressure steam to drive conventional steam turbine generators in sizes from 30 to 200 MW or to augment combined cycle power plants. Solar field sizes vary with the annual intensity of the sun. These systems can achieve peak solar-to-electric efficiencies of over 20% and use about 5 acres (or 2 hectares) of land for each MW produced. Instantaneous electrical output during a typical summer day remains quite constant from early morning to early evening.

Figure 1. Parabolic trough system

Figure 2. Power tower system

An important characteristic of solar thermal systems is their ability to dispatch power on demand by using a thermal storage system or augmenting a fossil-fired boiler. Because time-of-use prices of electric power can be significant, the value of the solar energy is enhanced, and the more predictable output is better for planning and matching peak demand.

Thus, solar thermal plants with cost-effective storage or natural gas hybridization can deliver power to the utility grid when that power is most needed, not just when the sun is shining.

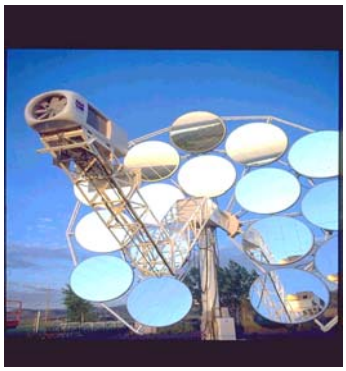


Figure 3. Parabolic dish focused on heat engine

Parabolic Dish with Heat Engine

A parabolic dish solar power system (Figure 3) converts the sun's energy to electricity by focusing the sun's rays on a heat engine located at the dish's focal point. The dish is pointed directly at the sun by the use of a dual-axis tracking system consisting of a drive motor, gearing, and controls. The mirrored surface of the reflectors can be made of glass, film, or polished metal such as aluminum, though mirrored glass is most frequently used. Dish/engine systems are valuable for distributed power applications, with unit outputs of about 25 kW. Units can be installed in groups to achieve MW-scale systems. Kilowatt-scale dish/engine systems have demonstrated solar-to-electric efficiencies of near 30%, which is higher than for any other solar electric system.

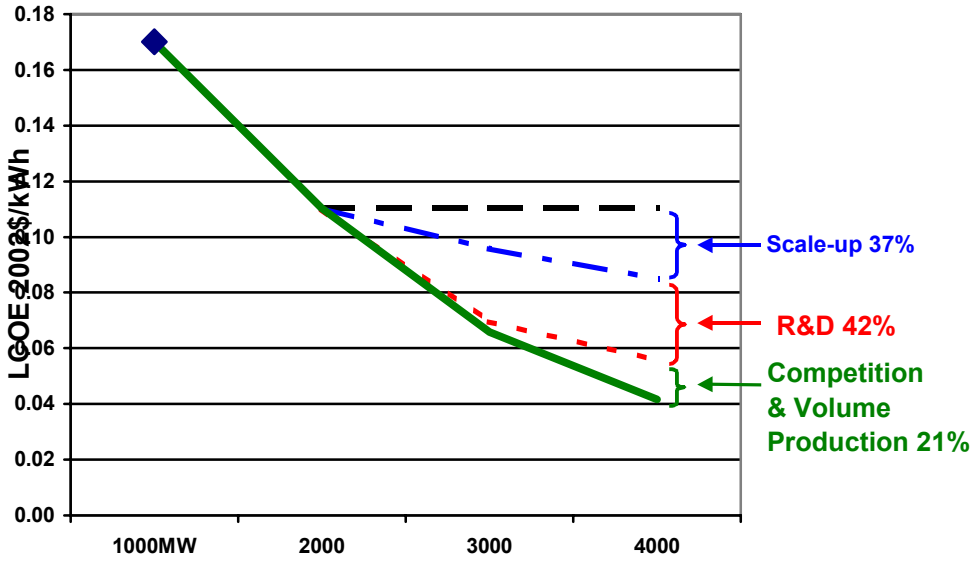
CSP Costs

The experience with the commercial implementation and operation of the nine parabolic trough plants (known as the SEGS plants) in the Mojave desert of California, built in the late 1980's and early 1990's and operating continuously since then, shows that power generation costs could be reduced in only 7 years from an initial $ 0.25/kWh for the first 14 MW unit to just $ 0.13 /kWh for the last 80 MW unit.

The cost of energy can be expected to be further reduced in future years through technology improvements, scaling-up individual plant MW capacity, increasing deployment rates, competitive pressures, use of thermal storage, and advancements in operation & maintenance methods. The cost of energy also can be reduced through lower cost financing and tax or investment incentives.

These factors were considered in a recent independent and comprehensive evaluation by Sargent & Lundy Engineers that found future plants have the potential to directly compete with fossil power (see Figure below). While scaling-up plant size offers the easiest opportunity for reducing the cost of power, a number of technology R&D advances have been identified that

also can significantly reduce costs. These include increasing the collector size, improvements in receiver selective coatings, and development of advanced thermal storage technologies. Finally, increased commercial competition and volume production of solar field components and subsystems will come into play to further reduce the cost of electricity.



This graph was derived from an assessment of parabolic trough and power tower solar technology cost and performance forecast by Sargent & Lundy.

Global Market Initiative (GMI)

Recent activities indicate that CSP technologies are at the threshold of very extensive commercial deployment. One of the primary market barriers is a lack of knowledge about the current technology and near-term potential of CSP by energy policy makers, regulators, general contractors and would-be owners and users. With increased awareness of the numerous benefits of using the solar thermal energy resources around the world, it is anticipated that new CSP projects will soon come on stream. There are about 10 advanced projects underway around the world, totaling over 1000 MW of new solar capacity.

With the understanding that these projects would come online faster and be more commercial viable if there was a forum for collaboration among interested countries and states, an international public-private partnership has been proposed to meet this need. The goal of this partnership, called the CSP Global Market Initiative, is to facilitate the building of 5,000 MW of CSP power worldwide over the next 10 years. Participation is open to governments in countries or states with adequate solar thermal resources or that have an industrial capability in CSP, but lack the adequate solar thermal resources, and who accept the framework proposed below.

The overall benefit of participation is that the success of CSP projects in participating countries will be enhanced through the sharing of experiences and lessons learned. Related benefits include access to:

- A network of CSP project developers,
- Technical assistance across a range of issues from compatibility of CSP to utility capital expansion plans to design of bid packages,

- Project development know-how and invitations to periodic lessons-learned workshops,
- Assistance in identifying and securing subsidies, and in identifying necessary supportive policies.

The result of this collaboration will be the significant acceleration in the process from the initial decision to build a CSP plant to commissioning.

Different Strategies for Different Regions

Today's CSP technologies require a minimum direct normal solar radiation level of 1,900 kWh/m2/a. This can be found in many countries around the Sunbelt of the world. However, adequate solar radiation is just the beginning. Successful CSP projects require adequate tariffs, long-term power contracts with credit worthy off-takers, access to commercial financing and where needed, subsidies and supportive policies.

To take advantage of the different situations and needs of both developed and developing countries, the GMI will use three different strategies.

(1) Region I

In southern Europe, Israel, and the southwestern US, most of the essential elements of the GMI (described below) already exist or could reasonably be expected. In these countries, existing CSP-specific targets or portfolio standards will create market-based demand and a feed-in law or system benefit charge, both of which rely on the ratepayers to cover the price gap.

In Region I, political support is primarily needed to make targets, policies and tariffs stable and predictable so that commercial financing can be secured. Tariffs should reflect different levels of solar radiation intensity so that each region, country or state with radiation patterns above 1,900 kWh/m2/a has the chance to built-up this strategic "backstop" technology. Eventually, tariff harmonization schemes may help to ensure that the resource is more evenly built. Capacity restrictions for individual projects should be removed to make best use of economies of scale to help drive prices lower. Alternatively, the demand may be aggregated to assure that CSP plants are built in sizes of 50 MWs or larger.

(2) Region II

For developing countries that are or will soon be connected to Region I countries by a power grid, such as Mexico and North Africa, power generated from CSP plants built in these countries may be sold to Region I countries and could receive a premium price. As a result of excellent solar radiation resources and good grid connections, the southwestern US and northern Mexico as well as southern Europe and North Africa are two such regions.

In Region II, political initiative is primarily needed for formulating a fair scheme that accounts for both improved tariffs for clean energy generated in the Region II countries allowing a benefit from enhanced feed-in tariffs for such energy that is imported into their service territory.

To avoid large tariff differences between cheap bulk fossil-based energy and solar power generation, access to favorable Region I tariffs should only be offered when

subsidies are no longer available on fossil power production in Region II.

The tariff difference can be further reduced through a blend of CDM (i.e., carbon tax credits), and preferential financing, such as the EU's energy sector infrastructural support MEDA Program for Region II.

(3) Region III

For other developing countries, not interconnected to the grid of Region I countries, such as Brazil, India, Iran, Jordan and South Africa, preferential financing in the form of subsidies (could be grants, soft loans, carbon credits, CDM, green premiums, etc.) provided by Region I sources will be required to support the Region III group of countries' desire for development of clean CSP power plants.

An example of such sources is the $0.5 billion dollars for renewable energy that was announced by German Chancellor, Mr. Gerhard Schroeder, in his UN Environmental Summit speech in Johannesburg in September 2002.

In the medium term, the Region III countries will profit from closing the price gap as a result of growing installed CSP capacity in Regions I and II.

Recognizing that financial resources are limited, Region II and III countries, therefore, must contribute something to help reduce the cost of the CSP plants, such as free or low cost land, infrastructure and grid access, etc.

Major Elements of the GMI

In return for the benefits described above, each country or state participating in the GMI must meet the following six requirements:

(1) Targets

Participating countries or states must set targets for CSP capacity. These targets may be a specific number of MW over a certain period of time, such as 350 MW in a specific country before 2015 or may be a growing percentage of CSP within the new capacity to be built over a certain period of time, such as 1% per year for the next 10 years. These targets must apply to CSP specifically and should reflect the relative magnitude of that country's or state's solar thermal energy resource. At least 100 MW of CSP capacity must be targeted to be built in each participating country or state during the first five years of the GMI.

(2) Tariffs

A tariff that is adequate to pay for the difference between the cost of CSP power and the cost of competing fossil or nuclear-based power with the same attributes is required in participating countries or states. A feed-in law or public benefit charge (in which the rate payers cover the incremental cost) is the preferred approach in Region I and may be, to some extent applicable in Region II. Subsidies will be required in those developing countries not connected to the grid of countries with feed-in laws or public benefit charges that are allowable in those situations. These subsidies should be provided by donor organizations that participate in the GMI.

(3) Financing

Project financing, if possible with long-term, low interest debt, must be made available in participating countries or states. If the tariff is sufficient, preferential financing is not needed, that is cost-covering tariffs for CSP will allow for conventional project financing. Concessional financing is needed to compensate for lower tariffs. Instruments and support for risk reduction and protection will be required as circumstances dictates.

(4) Policies

A series of specific favorable policy instruments are needed to facilitate CSP power plants. These include:

- Assured grid access at fair cost.
- Streamlined and transparent permitting and licensing.
- Tax breaks and credits suitable for capital-intensive and clean technologies.
- The development and trading of emission and/or green certificates is encouraged.

(5) Bidding

Bids are required for those projects that cannot be implemented as IPPs with cost gap covering tariffs or wherever preferential financing is needed. Bidding is mandatory for project engineering, procurement, construction, operations and maintenance. The initiative will provide guidelines for efficient and cost effective project implementation in accordance with the best of industry standards for power stations.

(6) Contracts

The use of long-term power purchase agreements or similar long-term contracts with credit-worthy off-takers, or long-term feed-in law is required in participating countries or states. An acceptable alternative is equity ownership by public organizations.

Organization, Structure and Management

The Global Environment Facility (GEF) has agreed to endorse and sponsor the CSP Global Market Initiative (GMI). The GEF and the CSP industry will jointly form a CSP GMI Advisory Board initially consisting of 2-3 highly respected and well-known business leaders from Region I and Europe plus 1 board member representing Region II and 1 board member from Region III.

This Advisory Board will provide overall guidance for the GMI and assure that the market introduction strategy is well conceived, well communicated and jointly agreed-upon between the stakeholders and regions. They will also assure that the Initiative proceeds in a timely manner and with minimal delays.

In order to represent the participating countries and states, an Executive Committee will be formed to support the Advisory Board, to provide input and to assure the effective and successful implementation of the Initiative.

This Executive Committee will consist of senior people, representing power project development, power project finance, CSP industry and government. Each participating country and state will be entitled to one Executive Committee seat and will pay an annual membership fee of $50,000 to support the management of the Initiative. The GEF, through an existing project, will provide matching funds. The Executive Committee is envisioned to include representatives from the following countries and states:

Algeria	Jordan
Arizona	Mexico
California	Morocco
Egypt	Nevada
Germany	New Mexico
Greece	South Africa
Iran	Spain
Israel	Turkey
Italy	

The Advisory Board and the Executive Committee will be supported by a small management team. This management team will be completely funded out of the above participating country and state's annual contributions and the GEF matching funds.