

The logo for 'CSP today' is set against a green rectangular background. The text 'CSP' is in a bold, white, sans-serif font, while 'today' is in a white, cursive script font. A white underline is positioned beneath the 'today' text. The background of the entire page is a photograph of a solar tower CSP plant, showing a long row of heliostats (mirrors) reflecting sunlight onto a central receiver tower. The sun is visible in the upper left corner, creating a bright glow.

CSP today

**AN OVERVIEW OF CSP IN EUROPE, NORTH AFRICA
AND THE MIDDLE EAST**

October, 2008

Your opinion is very important to us, please write to me with any questions or comments and I'll get back to you as soon as possible

Best Regards,

Carlos Márquez Salazar
Research Director at CSP & CPV Today

carlos@cpvtoday.com

Phone +44 207 3757543

US toll free 1800 814 3459 ext 301

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1. Executive Summary

This overview explores the market potential of Concentrated Solar Power (CSP) in Europe, North Africa and the Middle East. The report covers recent CSP trends and discusses about the costs involved in electricity production from CSP. It also discusses in detail the CSP market development, and forecasts, government support in the form of policies and regulations and outlook of CSP deployment for electricity generation in Europe, North Africa and the Middle East.

CSP involves power generation using solar energy. The sun's rays are reflected off an array of concentrators on to either a network of small tubes running across the face of the mirrors or a large central tower, in which water is turned into steam to drive conventional turbines for generating electricity. Parabolic trough concentrating collectors, power tower/heliostat configurations, and parabolic dish collectors are used in CSP systems.

Today, climate change is a major global concern. The main cause of global warming is CO₂, and at least 90% of its emission volume results from the combustion of fossil fuels (oil, coal, natural gas, etc) for energy generation. Hence, clean energy generation has been the focal point of most regulations aimed at greenhouse gas reduction. In addition, energy security concerns are pushing governments of various countries to include renewable sources such as solar, wind, hydro and geothermal in their national energy portfolios.

Large-scale commercial implementation of CSP has been done in California, USA, which is now a successful model for many CSP promoting countries. According to Western Governors Association (Solar Task Force Report, 2006), CSP generation global capacity is expected to reach 13 GW by 2015, indicating that solar CSP is moving to the forefront of renewable energy technologies.¹ The bulk of new capacity would be seen in the Mediterranean region encompassing Europe, North Africa and Middle East, which could make this region the global hub for CSP generation. The region has abundant solar radiation, cheap land and high electricity demand. These factors have already propelled the growth of the CSP market in the region with countries such as Spain, Algeria, Morocco, Israel and UAE investing in the promotion and development of CSP plants.

CSP implementation involves high costs when compared with other conventional sources and requires government support in the form of subsidies and incentives for making it a profitable proposition for electricity generation. Governments in some countries in the Mediterranean region have taken appropriate initiatives to formulate feed-in tariff laws, to establish government agencies and to set regional CSP capacity targets to promote CSP implementation. This is also encouraging private investors to invest in CSP plants and technologies to harness the full potential of CSP in the region.

Issues such as high initial installation costs, ideal technology for large-scale implementation and attaining grid-parity need to be addressed by the CSP promoters in the region. Hybrid plants combining CSP plants with conventional plants (e.g. coal and natural gas based plants), technological advancements through further research and development in CSP and Public-Private-Partnership model could resolve some of the hindrances and lead the way for large-scale implementation of CSP for producing cleaner and greener energy.

¹ Western Governors Association. 2006. Online. Available at: <http://www.westgov.org/wga/initiatives/cdeac/Solar-full.pdf>.

2. Introduction to CSP

CSP produces electricity by converting solar energy into high temperature heat using diverse mirror configurations. The heat is then used to produce electricity through a conventional generator system using turbine. Currently, research is undertaken on various CSP technologies for varying levels of high temperature generation capabilities and conforming high thermodynamic efficiencies. There are four major CSP systems namely parabolic trough systems, power tower systems/central receiver systems, parabolic dish systems and Fresnel systems.

Parabolic Trough Systems

A parabolic trough system consists of trough-shaped mirror reflectors to concentrate solar radiation on to receiver tubes containing thermal transfer fluid which is heated to produce steam. This is one of the most developed, economically viable and widely accepted CSP technologies. Currently, most of the CSP project under constructions employ this technology.

Power tower systems/Central receiver systems

A power tower system employs an array of large individually tracking plain mirrors (heliostats) to concentrate solar radiation on to a central receiver on top of a tower to produce steam for electricity generation. Currently, CSP plants in Spain such as PS 10 and PS 20 are implementing central receiver system technology.

Parabolic dish systems

Parabolic dish systems are comparatively smaller units consisting of a dish-shaped concentrator that reflects solar radiation onto a receiver mounted at the focal point which heats thermal fluid for power generation. This technology has the advantage of functioning as stand-alone systems and can provide decentralized power. Currently, small CSP projects are planned in USA, Europe and Australia using this technology.

Linear fresnel reflector systems

A linear fresnel reflector system uses an array of flat or slightly curved reflectors which reflect solar rays and concentrate them on elevated inverted linear absorber tube for heating the fluids and converting solar energy to electricity. Spain is implementing a pilot project using this technology which is still in nascent stage. Currently, Fresnel systems is less efficient but also less costly than other CSP technologies.

3. Factors affecting growth of CSP market

1.1.1 Key drivers facilitating the growth of CSP

Rising awareness about global warming and Greenhouse gas emissions

Ever-increasing use of oil, coal and gas (fossil fuels) for energy has contributed to global warming and environmental pollution due to emission of 'greenhouse gases' (GHG) (carbon dioxide, nitrous oxide and methane). These emissions are increasing the level of atmospheric carbon and five other Kyoto GHG (methane, nitrous oxide, sulphur hexafluoride, hydrofluorocarbons, and perfluorocarbons) by 2.7 ppm of CO₂ equivalent (CO₂e) per year. If the level of GHG emission is not curbed, the current rate of emissions would be enough to take greenhouse-gas concentrations to over 650 ppm CO₂e leading to an increase in the global mean temperature by minimum 3°C by 2100 from its pre-industrial level.² The level of emissions needs to be reduced as the world is expected to experience major climate change even if annual GHG emissions remained at year 2000 level (42 GtCO₂).³

According to Greenpeace, the current climatic change is expected to lead to nearly 150,000 additional deaths every year. Millions of people could face an increased risk of hunger, malaria, flooding and water shortages even if there is an average rise of 2°C in the global temperatures.⁴

CSP could contribute to solving given that it produces electricity without generating carbon emissions.

Commitment to Kyoto Protocol

The Kyoto Protocol was framed in 1997 to curb rising climatic disruption and global temperature. The protocol commits to reduce greenhouse gas emissions by 5.2% from their 1990 level by the target period of 2008-2012.

As a result, many countries and regional bodies have adopted reduction targets. For instance, the European Union has committed to achieve an overall reduction of greenhouse emissions by 8% by increasing the proportion of renewable energy in overall energy from 6% in 2005 to 12% by 2010.⁵ This will further boost the adoption of renewable sources of energy such as solar, wind, geothermal and tidal.

² Stern Review. 2006. Report on Climate Change and Environment. Available at: http://www.hm-treasury.gov.uk/media/3/2/Chapter_7_Projecting_the_Growth_of_Greenhouse-Gas_Emissions.pdf

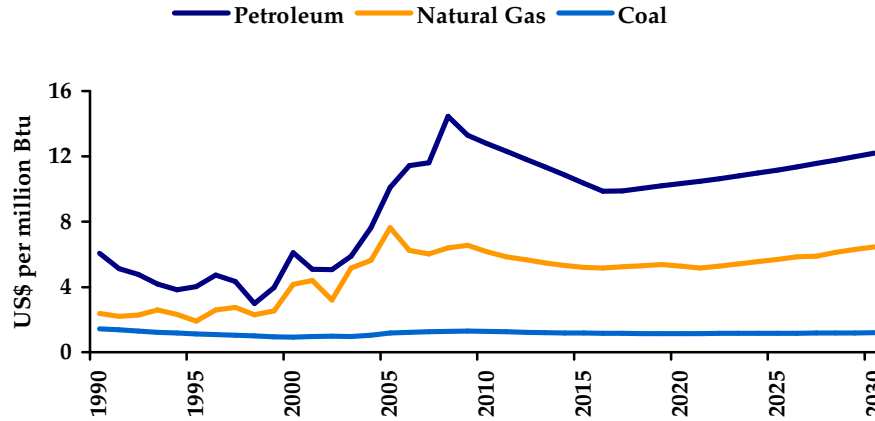
³ Stern Review. 2006. Report on Climate Change and Environment. Available at: http://www.hm-treasury.gov.uk/media/3/2/Chapter_7_Projecting_the_Growth_of_Greenhouse-Gas_Emissions.pdf

⁴ Greenpeace, EREC. January 2007. Energy Revolution Report. Online. Available at: www.greenpeace.org/raw/content/international/press/reports/energy-revolution-a-sustainab.pdf

⁵ Greenpeace, EREC. January 2007. Energy Revolution Report. Online. Available at: www.greenpeace.org/raw/content/international/press/reports/energy-revolution-a-sustainab.pdf

Rise in conventional energy prices

EXHIBIT 1. ENERGY PRICE TRENDS (1990-2030, REFERENCE 2006 DOLLARS)⁶



Petroleum and natural gas prices are expected to move northward in the next 20 years due to demand growth and higher cost supplies reaching the market, according to Energy Information Administration (EIA) 2008 energy prices estimates. In nominal dollars, the average price of crude oil is expected to be about US\$ 113 (based on reference case scenario⁷) to \$ 186 (based on high price scenario) per barrel from approximately US\$ 73 per barrel in 2007. Natural gas prices are also expected to reach US\$ 10.64 per thousand cubic ft in 2030 from US\$ 6.39 per thousand cubic ft in 2007.

Recent price volatility in oil prices has forced nearly all countries to review their energy policy. This is prompting countries which depend on imported fossil fuels, to explore and evaluate alternative sources of energy to generate electricity.

Concerns over future energy supply

World energy demand is set to grow by over 50% up to the year 2030, according to International Energy Agency (IEA) estimates. Energy security concern poses additional threat to current woes of rising GHG levels and increase in prices of fossil fuels.

For these reasons, many countries are seeking to diversify their energy sources for three main sectors - electricity generation, transport and heating/cooling. Oil and gas importing countries want to reduce their reliance on foreign oil and gas imports, and specific fuel categories.

Countries are exploring various sources of renewable energy to reduce their dependence on foreign countries for energy requirements. As solar is the most abundant and geographically spread resource, solar energy offers advantage over other energy sources.

⁶ EIA. 2008. Energy Prices. Online. Available at: <http://www.eia.doe.gov/oiaf/aeo/prices.html>

⁷The reference case assumes that current policies affecting the energy sector remain unchanged throughout the projection period. Although current laws and regulations may change over the next 25 years, and new ones may be created, it is not possible to predict what they will be or how they will be implemented

Government Support and Incentives

Government support in the form of various incentives is essential to facilitate technological development in energy generation using CSP. This would allow CSP to be competitive with other energy generation technologies that operate on fossil fuels and facilitate its deployment in the mass market. In this context, various governments are either in initiation or in the implementation stage of drafting a favourable policy framework for encouraging the development of CSP industry.

Governments are also playing a role in the development of R&D. A prime example is the ECOSTAR plan which is being implemented by the European Commission (EC) in order to help in structuring and implementing CSP projects.

Governments of several countries, including Spain, Portugal, Italy and Greece in Europe, Algeria and Morocco in North Africa, and Israel in the Middle East, have granted incentives in the form of tax relief, capital cost grants, favourable electricity export rates for power generation through CSP. The promotion of different CSP technologies is difficult without such incentives owing to their high costs.

1.1.2 Key inhibitors in the growth of CSP

High cost of electricity

Cost competitiveness is a key barrier for CSP as the cost of producing electricity from CSP was approximately twice as high as electricity produced from fossil fuels in 2007.⁸ The cost of electricity production from CSP is around 15 US\$ cents/kWh, while from natural gas and nuclear it is approximately 4 US\$ cents/kWh and 7 US\$ cents/kWh, respectively.⁹

CSP is viable only in regions with high level of solar irradiance. This criterion combined with high initial investment and increased operational and maintenance costs escalate the cost of electricity produced from CSP. Steady investment in R&D for improving technology and efficiency is imperative to bring down the cost of producing electricity from CSP.

Technology

Most CSP technologies, with the possible exception of the Parabolic Trough, are still in nascent stage and have not achieved cost and scale efficiencies yet. Cost reductions could be achieved through increased R&D focus on areas like developing concentrator components technology, thermal energy storage systems with low-cost fluids and receiver designs involving efficient selective solar coatings. Additionally, implementation of new technologies and improvement in existing technologies at relevant scale would be vital for concentrated solar power to achieve cost competitiveness in the future.

Currently, industrial and private funds do not finance R&D and innovation activities (they only fund installation and operation costs). As a result, there is a shortage of investments in research and innovation activities, which could improve the practical viability of setting up large-scale power CSP plants.¹⁰

Investments in grid infrastructure

The development of grid-infrastructure is important for the wide-spread implementation of CSP. This would enable trade of electricity produced from CSP between adjacent countries. The cost involved in transmitting electricity includes investment costs related to setting up of transmission lines and the cost incurred due to electricity losses during transmission. According to TRANS-CSP estimates, a total cumulative investment of € 47 billion until 2020 and € 395 billion until 2050 will be necessary for CSP and HVDC gridlines installations if exports to Europe from Middle East and North Africa (MENA) region are to be considered.¹¹

Huge Area Requirement

Operationally, the functioning of CSP plants is similar to the working of traditional steam turbines used to make steam for power generation. The difference lies in the resource used, which is solar energy in case of CSP and various fossil fuels in case of traditional plants.

⁸ Guardian UK. 2007. Power tower reflects well on sunny Spain. Online. Available at: <http://www.guardian.co.uk/world/2007/apr/03/spain.renewableenergy>

⁹ New Scientist Print Edition. 2007. High cost of capturing solar energy is diminishing. Online. Available at: http://www.trec-uk.org.uk/articles/new_scientist_2007-05-04.html#5_may_2007

¹⁰ European Commission. 2007. Report on the Workshop on Concentrated Solar Power Technology. Online. Available at: http://ec.europa.eu/energy/res/setplan/doc/csp_workshop/workshop_report_csp_final.pdf

¹¹ DLR. 2007. Trans-Mediterranean Interconnection for Concentrating Solar Power. Online. Available at: http://www.dlr.de/tt/desktopdefault.aspx/tabid-2885/4422_read-6588/

A typical CSP plant requires about 5 to 10 acres of land per MW of installed capacity, depending on the plant's usage of heat storage facility. For achieving cost efficiency, CSP plants (like fossil-fuel run plants) require plant size that range between 100 MW and 300 MW capacities. The size of the collector field for such a plant, particularly one designed to provide heat-storage, is enormous. For example, a zero storage CSP plant requires 5-6 acres of land per MW of installed capacity, which increases to 8 acres per MW for a 6 hour storage plant.¹²

The large area requirement for CSP plants lead to concerns about the potential adverse impact on flora and fauna of the region. There are also concerns regarding the potential destruction of ecology of clean and unused desert land. As CSP plants have to be built on flat areas, CSP plants may compete with agricultural activities for suitable land. This may hamper social and economic activities in certain areas.

Additionally, CSP plants in distant places would require setting up of dedicated high-voltage (HV) transmission lines, which would in turn increase costs and may result in project commissioning delays.¹³

Availability of Water

Availability of water is another critical issue that needs to be addressed for CSP development. CSP plants require continual water supply for steam generation, cooling and cleaning solar mirrors.

According to a research by Christopher Avery (Good Intentions, Unintended Consequences: The Central Arizona Groundwater Replenishment District, 2007), a CSP generating facility can be expected to consume approximately 2.3 – 2.6 million m³ of water, per year for a 280 MW capacity plant. Thus, availability of water for CSP becomes a critical factor for the development of CSP in a particular region.¹⁴

Implementation of CSP Technologies

Lengthy site-specific development cycles for CSP plants may possibly result in significant cost increases. The site-specific development costs could be higher than anticipated due to change in government regulations, political relations with neighboring countries and price of raw materials.

Current limited production of CSP plant components may not be adequate if demand suddenly increases, as it happened in the case of adoption of wind technology. This could drive prices higher and cause schedule delays. Moreover, since CSP is in nascent stage of development, future maintenance costs could be higher than expected.

In many countries, utility contracts and procurement plans are signed based on current CSP technologies like power tower and Fresnel. These technologies are not yet commercially established on a large scale over a long period of time; implementing these unproven technologies entails operational risks.

¹² Public Utilities Fortnightly. 2008. PV vs. Solar Thermal Report. Online. Available at: www.bateswhite.com/news/pdf/07012008_BusinessMoney.pdf

¹³ Public Utilities Fortnightly. 2008. PV vs. Solar Thermal Report. Online. Available at: www.bateswhite.com/news/pdf/07012008_BusinessMoney.pdf

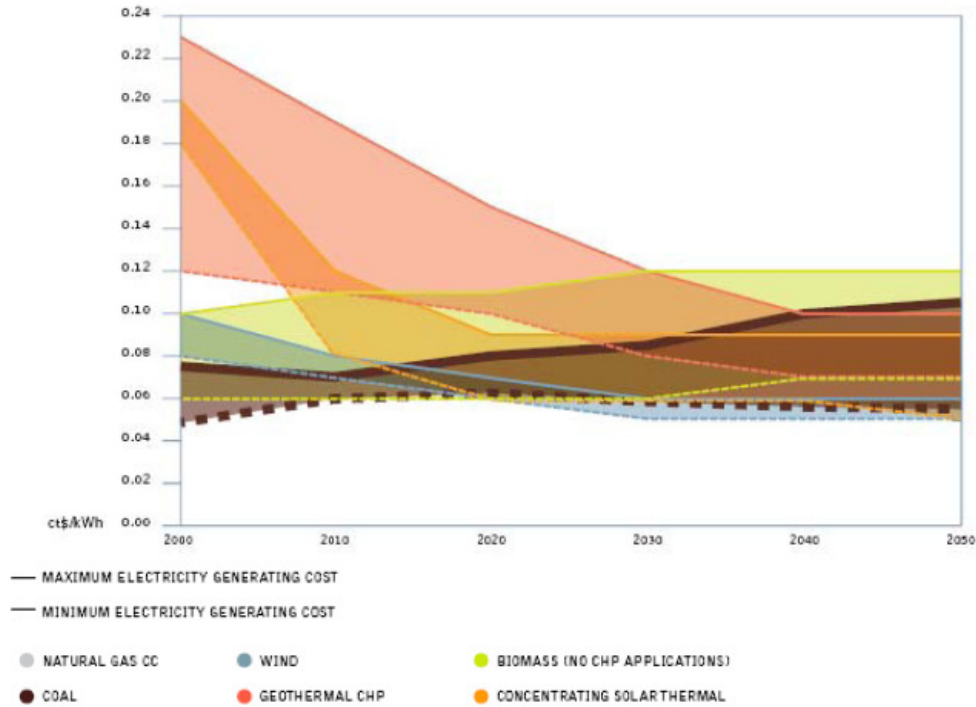
¹⁴ Public Utilities Fortnightly. 2008. PV vs. Solar Thermal Report. Online. Available at: www.bateswhite.com/news/pdf/07012008_BusinessMoney.pdf

1.1.3 Costs involved in production of electricity from CSP

For CSP to be adopted as a large scale electricity generation technology, costs will play an extremely important role. In most of the regions where CSP is being implemented, the cost of electricity generation through CSP is much higher when compared with cost of electricity generation through traditional technologies. With large scale implementation and technological advancements, the cost of generating electricity from CSP is expected to come down. According to a research by Electric Power Research Institute, when the global cumulative deployment level of CSP implementation reaches 4 GW, cost of generating electricity from new plants in 2015 could be as low as 8 US\$ cents/kWh (nominal 2015 dollars) or nearly 5 US\$ cents/kWh (real 2005 dollars).¹⁵

An EREC-Greenpeace study suggests that electricity produced from CSP plants will be cheaper than coal by 2030.¹⁶

EXHIBIT 2. COMPARISON OF ELECTRICITY GENERATING COST THROUGH ALTERNATIVE TECHNOLOGIES¹⁷



The cost of electricity from CSP can be analyzed by evaluating the Initial Investment Costs (IIC), the Operating and Maintenance Costs (O&M) and the Levelized Costs of Energy (LCOE).

¹⁵ EPRI. 2006. Solar Thermal Electric Technology. Online. Available at: www.eprweb.com/public/000000000001012731.pdf

¹⁶ Dr. Alex Marker. 2008. Electricity from Solar Power - Congressional Testimony. Online. Available at: www.seia.org/galleries/default-file/Marker%20Oral%20Testimony%205.6.pdf

¹⁷ Greenpeace, EREC. January 2007. Energy Revolution Report. Online. Available at: www.greenpeace.org/raw/content/international/press/reports/energy-revolution-a-sustainab.pdf

Initial Investment Cost

EXHIBIT 3. BREAK-UP OF INITIAL INVESTMENT COST OF CSP PLANT - 2005
FIGURES ('000 US \$)^{18'19}

Parameter	2007 100 MW	2009 100 MW	2011 150 MW	2015 200 MW
Site Work and Infrastructure	2,455	2,433	2,566	2,681
Solar Field	230,865	205,109	243,059	268,441
HTF System	10,009	9,895	11,896	13,542
Thermal Energy Storage	57,957	57,937	71,320	89,390
Power Block	38,754	38,754	48,899	56,818
Balance of Plant	22,533	22,533	28,432	33,036
Contingency	30,707	28,116	33,742	37,720
Total Direct Costs	393,280	364,776	439,915	501,627
Indirects	101,106	92,814	113,469	129,746
Total Installed Cost	494,386	457,590	553,384	631,373
Cost per MW	4943	4576	3689	3157

According to a study by Black & Veatch (2006), the initial investment costs are expected to come down to around US\$ 457 million in 2009 for a 100 MW capacity as compared with around US\$ 494 million in 2007 as presented in the Exhibit 3. The forecasts also reflect that progressively per MW costs will be lower for higher capacity plants with cost per MW decreasing from 4,943 US\$ / MW in 2007 for a 100 MW plant to 3,157 US\$ /MW in 2015 for a 200 MW plant reflecting a decrease of 8.6% per year.

CURRENT SITUATION OF SOLAR CONCENTRATION TECHNOLOGIES AND ESTIMATE OF COSTS IN SPAIN²⁰

CSP Technology	Technological state	Unit Capacity	Cost of capital (€ / kW)
Cylinder parabolic	Forthcoming Commercial Development	30 MW to 80 MW	4,000- 5000
Tower system	Proven Technical Feasibility	30 MW to 200 MW	2,941
Disk / motor	Forthcoming Technical Feasibility	5 kW to 50 kW	10,000-14,000

¹⁸ NREL. 2006. Economic, Energy, and Environmental Benefits of Concentrating Solar Power in California. Online. Available at: http://www.trec-uk.org.uk/reports/NREL_CSP_2006.pdf

¹⁹ Scenario estimates considering 6 hours storage capability

²⁰ IDEA. 2006. Solar Thermolectric Energy in the Spanish Renewable Energy Plan. Online. Available at: ec.europa.eu/energy/res/events/doc/fresneda_idae.pdf

Among the various technological options available for CSP, cylinder parabolic and tower system seem the most cost effective considering capacity and initial investment costs involved for large scale commercial deployment. Cost of capital for power tower systems is approximately 2941 € / kW and for cylinder parabolic is between 4000-5000 € / kW, with CSP plant capacity in the range of 30 MW to 200 MW.

Operating and Maintenance costs

**EXHIBIT 4. BREAK-UP OF ANNUAL OPERATING & MAINTENANCE OF CSP PLANT
- 2005 FIGURES ('000 US \$)^{21/22}**

Parameter	2007 100 MW*	2009 100 MW*	2011 150 MW*	2015 200 MW*
Labor				
Administration	528	528	554	554
Operations	979	973	1,088	1,158
Maintenance	633	633	664	664
Total Labor	3,018	2,984	3,517	3,926
Miscellaneous	419	415	516	599
Service Contracts	263	259	352	435
Water Treatment	260	265	413	556
Spares and Equipment	669	651	870	1,040
Solar Field Parts and Materials	1,859	1,311	1,457	1,904
Annual Capital Equipment	226	218	320	418
Subtotal	3,695	3,119	3,928	4,953
Total	6,713	6,104	7,445	8,879

According to a study by Black & Veatch (2006), the annual operating and maintenance (O&M) cost involved in CSP plants is expected to decrease over the years with the experience gained from operating the plants.

Labour costs and solar field parts and materials are the largest components of O&M costs and contribute around 45% and 27.7% of the total O&M costs, respectively (2007). With increased R&D and technological improvements, solar field parts and materials costs are expected to decrease to around 21.5% in 2009 for a 100MW CSP plants with 6 hours of heat-storage capacity. However, labour costs are expected to increase as a percentage of the overall costs, accounting for approximately 50% of total costs in 2009.

However, as is evident from the same study, by 2015, most costs are expected to decrease as plants scale up to 200 MW, with the exception of the cost of water treatment as water is scarce in many regions and is being put to multiple uses.

²¹ NREL. 2006. Economic, Energy, and Environmental Benefits of Concentrating Solar Power in California. Online. Available at: http://www.trec-uk.org.uk/reports/NREL_CSP_2006.pdf

²² Scenario estimates considering 6 hours storage capability

Like initial investment costs, the O&M costs are also expected to come down to US\$ 44,400 per MW in 2015 from US\$ 67,100 per MW in 2007 for electricity generation from CSP.

Cost efficiency would increase due to technological advancements, effects of large scale deployment, construction efficiency improvements and scaling up of current capacities. The components and spares repair costs are also expected to decrease due to technological advancements and competitive intensity among spares suppliers.

Levelized Costs of Energy

Levelized Cost of Energy (LCOE)/Levelized Energy Cost (LEC) is defined as total costs of a system over its lifetime divided by the expected energy output over its useful lifetime. LCOE includes all costs through the lifetime of a plant: initial investment, operations and maintenance, cost of fuel, and cost of capital. It is a measurement of the cost of producing energy from a technology and is an important parameter to gauge commercial viability of any electricity generation technology. LCOE is the minimum price at which energy must be sold for any project to break even.

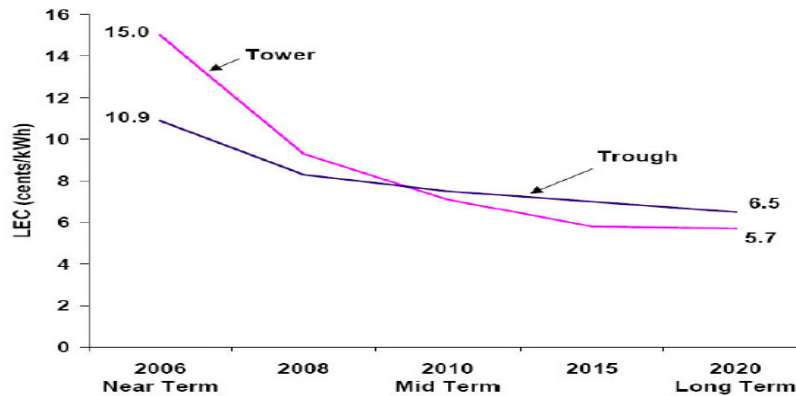
Currently, the parabolic trough system, which uses thermal oil as a heat transfer medium, is the most developed technology. According to the Sargent & Lundy study (Assessment of Parabolic Trough and Power Tower Solar Technology Cost and Performance Forecasts, 2002), the levelized cost of energy (LCOE) for CSP was in the range of 10.0-12.6 US\$ cents/kWh or, stated another way, about US\$ 2,400- US\$ 3,000/kW.²³

In Spain, a number of 50 MW CSP units are planned based on an estimated levelized electricity cost of approximately 17-18 € cents/kWh. Many of these plants are expected to employ thermal storage systems based on molten salts.

Other technologies such as Central Receiver Systems (CRS) and dish-engine systems are currently planned for significantly smaller pilot scale of up to 15 MW. For these small systems, the LEC is significantly higher, ranging from 19-28 € cents/kWh.²⁴

²³ NREL. 2002. Assessment of Parabolic Trough and Power Tower Solar Technology Cost and Performance Forecasts. Online. Available at: www.nrel.gov/csp/pdfs/34440.pdf

²⁴ DLR. 2005. ECOSTAR Study. Online. Available at: http://www.vgb.org/data.o/vgborg_/Forschung/roadmap252.pdf

EXHIBIT 5. LEVELIZED COST OF ENERGY²⁵

Many studies have estimated the LCOE for CSP. Some of the key estimates are given below:

- A Sargent & Lundy analysis says by 2020 LEC is expected to come down to 6.5 ¢ cents/kWh and 5.7 ¢ cents/kWh for trough and tower technologies in CSP.
- A cost reduction down to 5 ¢ cents/kWh at a total installed capacity of 40 GW is expected to be achieved between 2020 and 2025, according to an Athene Study (Report: Deployment of concentrated solar power systems, 2005).²⁶

Factors that will improve the cost-efficiency of CSP plants in future

Adoption of heat-storage systems

CSP offers the possibility of integrating storage systems, which allow power generation after the sun sets. With such storage systems, CSP becomes even more attractive to utilities when compared to other renewable technologies that lack this advantage.

The U.S. Department of Energy (DOE) has initiated a public-private partnership with a combined investment of around US\$ 67.6 million for developing low cost heat-storage system for CSP plants. The investment aims to reduce the cost of electricity produced from CSP from 13–16 US\$ cents/kWh in 2008 (no heat-storage system) to 8–11 US\$ cents/kWh (6 hours of heat-storage) by 2015. With advancements in heat-storage technology, this is expected to be less than 7 US\$ cents/kWh with 12–17 hours of heat-storage by 2020.²⁷

An example of the adoption of heat storage systems in CSP is Solana 1, a 280 MW plant built by Abengoa for the Arizona Public Service Co. in Phoenix, USA.

Hybridization of CSP plants with conventional thermal power plants

The ability to share generation facilities with biomass and the availability of storage facility suggests good potential for CSP to replace high capacity, factor fossil fuel plants. Furthermore, it is also possible to combine solar thermal power plant with conventional thermal power plants leading to cost reductions.

²⁵ Sargent & Laundy. 2005. www.trec-uk.org.uk

²⁶ DLR. 2005. ECOSTAR Study. Online. Available at: http://www.vgb.org/data.o/vgborg_/Forschung/roadmap252.pdf

²⁷ NREL. 2008. DOE to Invest \$35 Million in Concentrating Solar Power Projects. Online. Available at: <http://www.nrel.gov/csp/news/2008/634.html>

A World Bank assessment of the USA/European solar thermal power plant market (“Cost Reduction Study for Solar Thermal Power Plants”, Final Report, May 1999), states that the installed capital costs of near-term trough plants are expected to be in the range of 3,500-2,440 €/kW for 30-200 MW for purely-solar plants and about 1,080 €/kW for 130 MW hybrid ISCC plants with 30 MW equivalent solar capacity. The estimated total power generation costs range from 10 to 7 € cents/kWh for purely-solar plants and less than 7 € cents/ kWh for hybrid ISCC plants.²⁸

This could enable developing countries, where financing large scale CSP plants is more challenging, to make use of CSP as an electricity generating technology in conjunction with existing conventional power plants.

Outlook

For CSP to achieve cost efficiencies comparable with other technologies, well-defined and targeted subsidies that would lower the current high capital and installation costs will have to be provided by the governments. CSP has the potential to be cost-competitive within 10 to 25 years. It has the potential to be a significant electrical power generating technology for developing countries which have abundant solar resources. Hybridization of solar power plants with conventional plants and adoption of thermal energy storage will equip CSP plants to dispatch electricity uninterruptedly.²⁹

The cost of CSP generated electricity is expected to decline in the coming years through technological improvements, scale-up of individual plant MW capacity, increasing deployment rates, competitive pressures, new heat storage systems and advancements in operation and maintenance methods.³⁰

²⁸ Greenpeace, ESTIA. September 2005. Concentrated Solar Thermal Power – Now! Online. Available at: www.greenpeace.org/raw/content/international/press/reports/Concentrated-Solar-Thermal-Power.pdf

²⁹ World Bank, GEF. 2006. Assessment of the World Bank/GEF Strategy for the Market Development of Concentrating Solar Thermal Power. Online. Available at: http://www-wds.worldbank.org/servlet/main?menuPK=64187510&pagePK=64193027&piPK=64187937&theSitePK=523679&entityID=000310607_20060926171106

³⁰ Global Market Initiative.2004.CSP GMI Report. Online. Available at: www.solarpaces.org/_Library/GMI_10.pdf

4. Analysis of CSP markets in the Mediterranean Region

1.2 Europe

EXHIBIT 6. EUROPEAN COUNTRIES - CSP DEVELOPMENT AND POTENTIAL SUMMARY

Location	Planned CSP Capacity (MW) ³¹	Economic Potential - TWh ³²	Technical Potential - TWh ³³	Solar irradiance kWh/m ² /y ³⁴	Feed-in Tariffs
Spain	>1500	1278	1646	2250	27 € cent/ kWh is granted for CSP plants up to 50MW ³⁵
Italy	40	7	88	2000	28 € cent/kWh ³⁶
Greece	50 ³⁷	4	44	1900	> 23 € cent/kWh on the main land > 25 € cent/kWh on non-interconnected islands ³⁸
Portugal	6.5	142	436	2100	> 27 € cent/kWh for CSP plants up to 10MW > 16-20 € cent /kWh for CSP plants beyond 10MW ³⁹

Germany and Spain are among the leaders in the implementation of CSP technology. A number of CSP plants, mainly by Abengoa, Acciona and ACS-Cobra, are under construction in Spain and also in North Africa and the Middle East. Regarding R&D, research centres such as CIEMAT

³¹ Based on currently announced projects

³² DLR. 2005. Concentrating Solar Power in the Mediterranean Region. Online. Available at: http://www.dlr.de/tt/desktopdefault.aspx/tabid-2885/4422_read-6573/

³³ DLR. 2005. Concentrating Solar Power in the Mediterranean Region. Online. Available at: http://www.dlr.de/tt/desktopdefault.aspx/tabid-2885/4422_read-6573/

³⁴ DLR. 2005. Concentrating Solar Power in the Mediterranean Region. Online. Available at: http://www.dlr.de/tt/desktopdefault.aspx/tabid-2885/4422_read-6573/

³⁵ Solar Paces. 2007. Solarpaces News. Online. Available at: <http://www.solarpaces.org/News/news.htm>

³⁶ Solar Paces. 2007. CSP Project Developments in Italy. Online. Available at: <http://www.solarpaces.org/News/Projects/Italy.htm>

³⁷ Greenpeace, ESTIA. September 2005. Concentrated Solar Thermal Power – Now! Online. Available at: www.greenpeace.org/raw/content/international/press/reports/Concentrated-Solar-Thermal-Power.pdf

³⁸ Solar Paces. 2007. Solarpaces News. Online. Available at: <http://www.solarpaces.org/News/news.htm>

³⁹ Solar Paces. 2007. Solarpaces News. Online. Available at: <http://www.solarpaces.org/News/news.htm>

(Spain) and the German Aerospace Centre or DLR and the Fraunhofer Institute for Solar Energy Systems (Germany) have been carrying out numerous initiatives for advancing CSP technology.

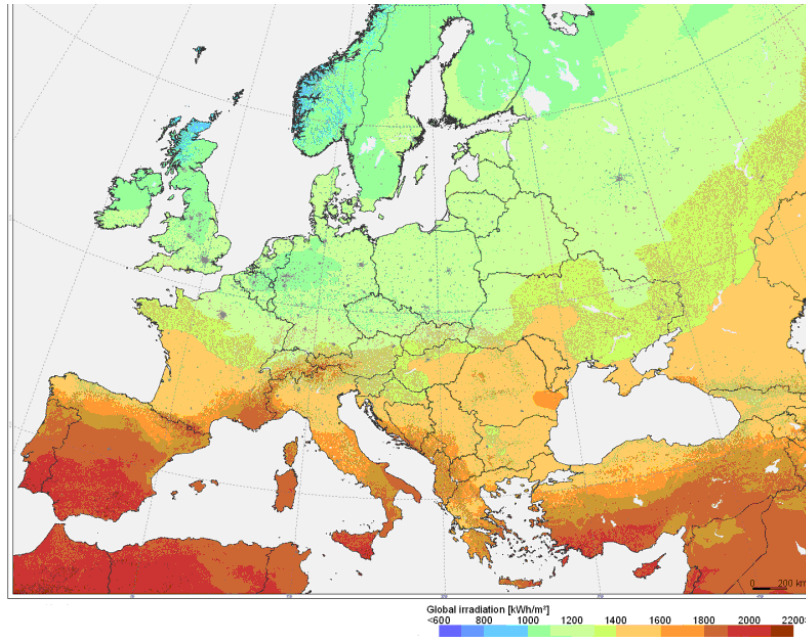
German companies such as MAN Ferrostaal AG and Solar Millennium are leading technology providers and project developers of CSP. For development of CSP market, German Federal Ministry for Environment (BMU) has formulated a long-term strategy that would encourage investments and growth of local CSP companies. In this respect, BMU has contributed € 10 million towards R&D activities aimed at lowering costs and increasing efficiency of CSP technology.⁴⁰

The amount of electricity produced from CSP plants depends on the level of solar irradiance. Solar irradiance differs widely in Europe due to seasonal variations unlike the Middle East and North African (MENA) region where adequate solar irradiance is available throughout the year. Abundant and continuous solar radiance in the MENA opens up the possibility of setting up CSP plants in the North of Africa and exporting the electricity generated to Europe.

⁴⁰ DLR. 2005. Concentrating Solar Power Now Report.. Online. Available at: <http://www.solar-thermie.org/hintergruende/documents/cspnow.pdf>

Solar resources

EXHIBIT 7. SOLAR ELECTRICITY POTENTIAL IN EUROPEAN COUNTRIES⁴¹



Southern Europe with a direct normal irradiance (DNI) of 2000 kWh/m²/year has a higher potential for solar electricity generation and CSP deployment than Northern Europe. Portugal, Spain, Italy, Greece and Turkey are the countries in this region with enough solar radiance to enable the cost effective deployment of CSP.⁴²

Water Resources

Water availability is a prerequisite for the deployment of CSP as water is required for three main functions: steam generation, cooling, and cleaning of solar mirrors. In Europe, the overall abstraction and consumption of water resources is sustainable in the long term. However, in southern European countries, such as Greece and Spain, some areas may face shortage. These areas need to implement efficient water use, especially in agriculture, to prevent seasonal water shortages.

Total water abstraction in the European Union (EU 27) amounted to around 247,000 million m³/year in 2007. On average, 44% of total water abstraction in the EU is used for energy production, 24% for agriculture, 17% for public water supply and 15% for industry. Total water withdrawals in the Europe-30 countries might decrease by approximately 11% between 2000 and 2030. While water consumption is expected to increase in sectors like agriculture, domestic and industry, it is expected to decrease in the electricity generation sector.⁴³

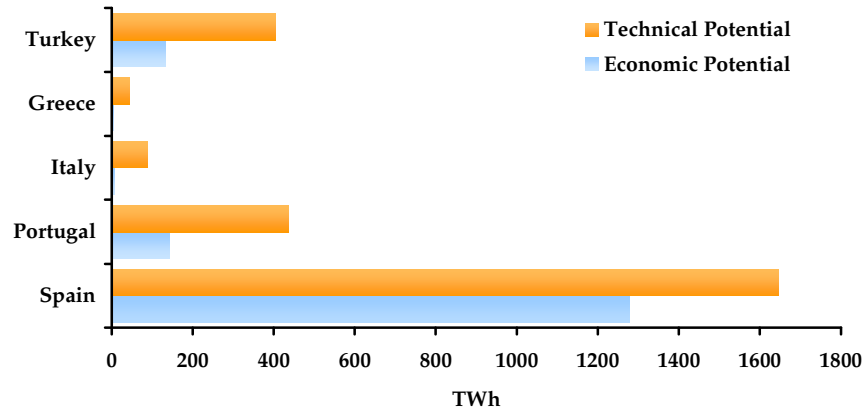
⁴¹ Šúri M., Huld T.A., Dunlop E.D. Ossenbrink H.A., 2007. Potential of solar electricity generation in the European Union member states and candidate countries. *Solar Energy*, 81, 1295–1305, [Online]. Available at :http://re.jrc.ec.europa.eu/pvgis/countries/europe/EU-glob_opta_presentation.png [Accessed August 11, 2008]

⁴² European Commission. 2007. Report on the Workshop on Concentrated Solar Power Technology. Online. Available at: http://ec.europa.eu/energy/res/setplan/doc/csp_workshop/workshop_report_csp_final.pdf

⁴³ Ecologic. 2007. EU Water saving potential. Online. Available at: http://ec.europa.eu/environment/water/quantity/pdf/water_saving_1.pdf

1.2.1.1 Economic and Technical Potential⁴⁴

EXHIBIT 8. ECONOMIC AND TECHNICAL POTENTIAL OF CSP IN EUROPEAN COUNTRIES⁴⁵



According to the DLR (German Aerospace Center), which provides technical and economic potential for CSP in different regions, technical potential is measured based on a threshold DNI of 1800 kWh/m²/y which is minimum required to convert solar energy to electrical energy through CSP whereas economic potential for CSP is capped to a DNI (Direct Normal Irradiance) of 2000 kWh/m²/y.

The economic potential of CSP generation is estimated to be approximately 1,500 TWh/year for EU-15, primarily in Southern European countries.

According to European Solar Thermal Electricity Association (ESTELA) estimates, by 2010 there will be more than 400 MW of electricity generated from CSP connected to the grid and, if necessary measures are taken for development of CSP, it could contribute towards the EU's target of generating 20% of the total electricity demand from renewable sources by the year 2020. Imports of CSP electricity produced in the MENA region would augment the overall electricity contribution from CSP in the European Region.⁴⁶

1.2.1.2 Current energy demand and its growth

According to CERA 2006 report, the EU 15 as a whole will see a declining reserve margin⁴⁷, even after accounting for new projects. The electricity generation capacity is expected to have a deficit of approximately 26 GW in 2010 and the reserve margin is expected to decrease from 22% in 2007 to 10% in 2010.⁴⁸

⁴⁴ Definition. DLR: The economic potential is considered to be limited by a DNI (Direct Normal Irradiance) of 2000 kWh/m²/y. The overall technical potential is considered of CSP threshold DNI of 1800 kWh/m²/y

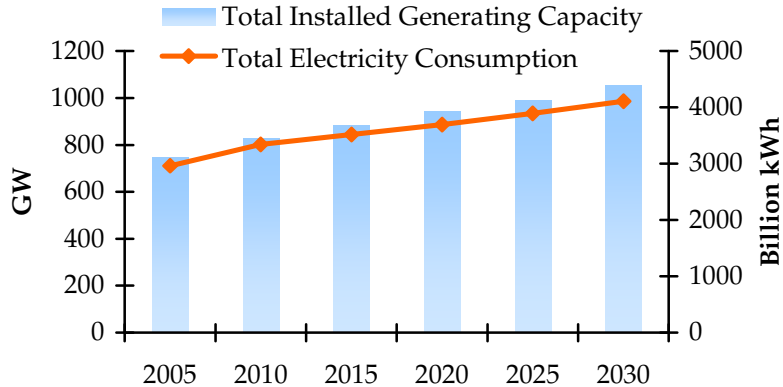
⁴⁵ DLR. 2005. Concentrating Solar Power in the Mediterranean Region. Online. Available at: http://www.dlr.de/tt/desktopdefault.aspx/tabid-2885/4422_read-6573/

⁴⁶ Estela Solar. 2008. Solar Thermal Electricity Report. Online. Available at: www.estelasolar.eu/fileadmin/ESTELAdocs/documents/2008.05.28_ESTELA_DisseminationDocFull.pdf

⁴⁷ Definition: Reserve Margin: The amount of unused available capability of an electric power system at peak load for a utility system as a percentage of total capability. Source: National Council for Science and the Environment. Online. Available at: <http://ncseonline.org/nle/crsreports/briefingbooks/electricity/reliability.cfm#resmar>

⁴⁸ RWE. 2007. Fact Book Generation Capacity in Europe. Online. Available at: www.rwe.com/generator.aspx/investor-relations/property=Data/id=482802/factbook-electricity-download.pdf

EXHIBIT 9. ELECTRICITY DEMAND-SUPPLY SCENARIO IN EUROPEAN COUNTRIES⁴⁹



Currently, factors like fluctuating oil and gas prices, maturity of existing power plants, low availability of power plant components for repairs and high level of political risk are affecting European energy supply.

1.2.1.3 Current electricity production from CSP

Electricity production from CSP is still in a nascent stage in Europe, even though electricity production from other renewable energy sources has gained momentum. The share of renewable sources in electricity generation was approximately 14% in 2005.⁵⁰

The first commercial scale CSP plant in Europe, with a capacity of 11 MW, was inaugurated in southern Spanish city of Seville in March 2007. A parabolic trough plant, Andasol 1, with a 50 MW capacity is expected to start operating before the end of this year.

1.2.1.4 Announced capacity for electricity from CSP

Spain

- Spain has close to 30 projects of 50 MW size in the planning stage. These projects, if successfully implemented, would be three times the objective of 500 MW set by 2010.⁵¹
- According to another estimate by a recent research report by Earth Policy Institute, 60 new CSP plants with total capacity of 2,570 MW are planned for construction in Spain, by 2012.

Germany

- The construction of a solar tower power plant with a capacity of 1.5 MW started in Germany in October 2007. It is expected to generate 1000 MWh of electricity per year effective November 2008.

⁴⁹ EIA, 2006. Annual Energy Outlook. Online. Available at: www.eia.doe.gov/oiaf/aeo

⁵⁰ EU Commission. 2005. EuroStat. Online. Available at: ec.europa.eu/energy/climate_actions/doc/brochure/2008_res_brochure_en.pdf

⁵¹ European Commission. 2007. Report on the Workshop on Concentrated Solar Power Technology. Online. Available at: http://ec.europa.eu/energy/res/setplan/doc/csp_workshop/workshop_report_csp_final.pdf

Italy

- Italy is developing its own CSP technology using molten-salt-cooled parabolic trough collector system in collaboration with ENEA, Italian National Agency for New Technologies, Energy and the Environment. The country is planning to integrate a 5 MW solar field into an existing ENEL gas fired combined cycle Power Station in Sicily⁵²

Please refer to Exhibit 7 for details of announced capacities for electricity from CSP in Europe.

⁵² Solarpaces . 2007. Italy Eurodish. Online. Available at: www.solarpaces.org/Tasks/Task1/EuroDish.htm

1.2.1.5 Comparison between different forecasts for CSP in Europe^{53, 54, 55}

With domestic production and imports from MENA region, the share of electricity from CSP is expected to rise steadily after 2020.

According to an EC report (2007), European CSP capacity is expected to be approximately 2.5 GW, with 1 GW in Spain and the remaining 1.5 GW being split between France, Greece and Italy by 2020.⁵⁶

EXHIBIT 10. COMPARISON OF DEMAND FORECASTS FOR ELECTRICITY FROM CSP IN EUROPE

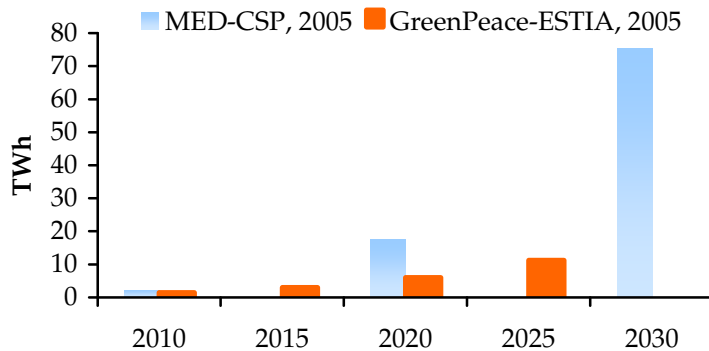
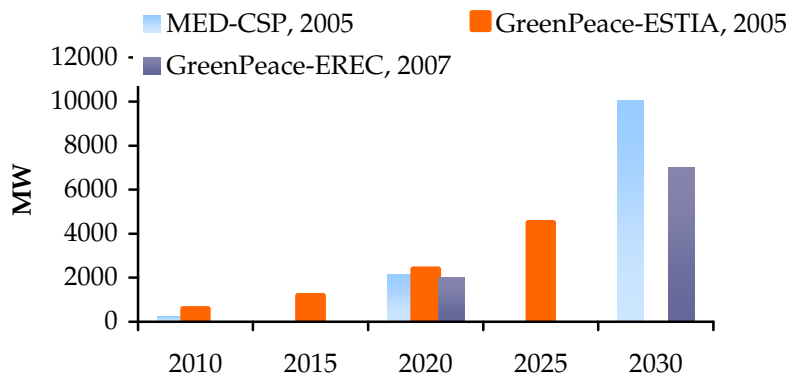


EXHIBIT 11. COMPARISON OF PRODUCTION FORECASTS FOR ELECTRICITY FROM CSP IN EUROPE



The forecasts of MED-CSP and Greenpeace on electricity generation from CSP vary widely, but both offer a positive outlook regarding the CSP potential in Europe. The difference in all the three estimates is due to assumptions taken into consideration while calculating the figures.

⁵³ DLR. 2005. Concentrating Solar Power in the Mediterranean Region. Online. Available at: http://www.dlr.de/tt/desktopdefault.aspx/tabid-2885/4422_read-6573 (Includes data from: Cyprus, Greece, Italy, Malta, Portugal, Spain, Turkey)

⁵⁴ Greenpeace, ESTIA. September 2005. Concentrated Solar Thermal Power – Now! Online. Available at: www.greenpeace.org/raw/content/international/press/reports/Concentrated-Solar-Thermal-Power.pdf (Includes OECD Europe)

⁵⁵ Greenpeace, EREC. January 2007. Energy Revolution Report. Online. Available at: www.energyblueprint.info (Includes OECD Europe)

⁵⁶ European Commission. 2007. Report on the Workshop on Concentrated Solar Power Technology. Online. Available at: http://ec.europa.eu/energy/res/setplan/doc/csp_workshop/workshop_report_csp_final.pdf

- MED-CSP 2005 report considers individual situation of each country in Europe concerning population and economic growth as well as energy requirements. It assumes that economic growth rates will be sufficiently high to close the gap with the US per capita national income by 50% until 2050.
- Greenpeace EREC 2007 report has forecasted using the MESAP/PlaNet simulation model which takes into account the future potential for energy efficiency measures and assumes an average annual growth rate of world GDP of 3.4% for the 2004-2030 time horizons.
- Greenpeace ESTIA 2005 report assumes the first installations will have an annual output of 2,500 MWh, solar field investment costs including all system costs would be at a level of US\$ 6,000/kW installed, and by 2040, the proportion of global electricity demand, which could be satisfied by solar thermal power, will have reached 5%.

1.2.1.6 Political Support: subsidies, tariffs and targets

Government Support

The European Union is promoting the use of renewable energy sources (RES) by integrating it in its environmental policy. Various estimates available provide information on EU's contribution at different level of research and development of CSP.

In terms of planning for implementation of solar power plants, Europe has laid down 7th Framework Programme (FP7) and the Energy Technology plan besides pledging more than £ 5 billion investment in high solar irradiance regions. EU has already contributed with approximately € 25 million for research projects aimed at developing CSP technologies, under the Fifth and Sixth Framework Programmes for Research.⁵⁷ The 7th Framework Programme (FP7) running from 2007 to 2013 is anticipated to invest approximately € 50 billion in solar research.⁵⁸

Based on the findings from research projects undertaken, there would be successive implementation of CSP by national governments and financial institutions. These CSP projects are expected to draw costs of more than £ 200 billion over the next 30 years.⁵⁹

Subsidies and Feed-In-Tariffs

Due to its higher electricity costs, CSP producers find it difficult negotiating for power purchase agreements (PPAs) with utilities, which buy electricity and then distribute it to customers. Introduction of government policy promoting PPAs would ease constraints of utilities that are under pressure to deliver power to the end customer at competitive rates. For instance, the German feed-in law supports renewable energy projects using PPAs and thus eventually reduces the initial investment cost.⁶⁰ It would also make it easier for utilities that are obligated in many areas to purchase energy from renewable sources, to enter into PPAs with CSP companies for electricity production as CSP has a large-scale electricity generation capability. A national-wide Feed-in Tariff law implementation is also seen as an effective way to aid growth for the CSP renewable energy market.⁶¹

⁵⁷ European Commission. 2007. Concentrating Solar Power Report. Online. Available at: http://ec.europa.eu/energy/res/sectors/csp_diss_en.htm

⁵⁸ TREC-UK. 2007. Concentrating Solar Power: From Research to Implementation. Online. Available at: www.trec-uk.org.uk/reports.htm

⁵⁹ GENI. 2007. How Africa's desert sun can bring Europe power. Online. Available at: <http://www.geni.org/globalenergy/library/technical-articles/generation/solar/the-observer/how-africas-desert-sun-can-bring-europe-power/index.shtml>

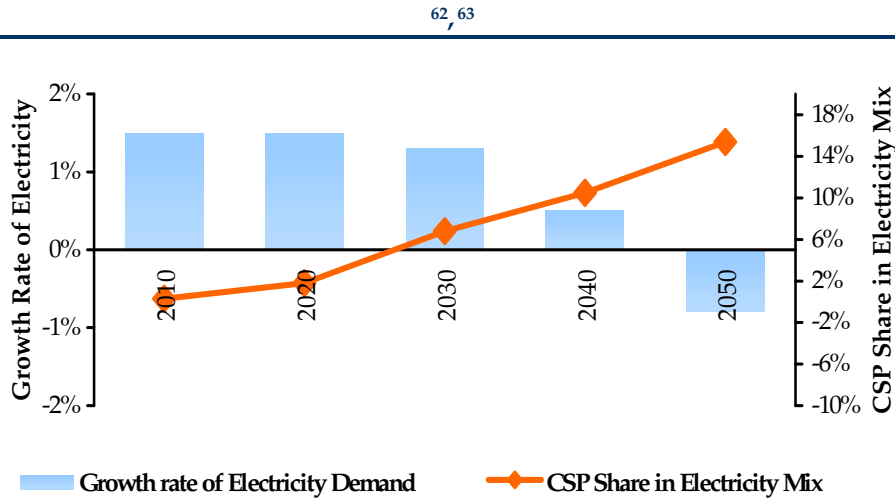
⁶⁰ DLR. 2007. Trans-Mediterranean Interconnection for Concentrating Solar Power. Online. Available at: http://www.dlr.de/tt/desktopdefault.aspx/tabid-2885/4422_read-6588/

⁶¹ Dr. Alex Marker. 2008. Electricity from Solar Power - Congressional Testimony. Online. Available at: www.seia.org/galleries/default-file/Marker%20Oral%20Testimony%205.6.pdf

The Feed-in Tariff (FIT) model for wider adoption of CSP has been implemented in European countries such as Spain, Italy, Greece and Portugal. The details of feed-in-tariffs for major European countries supporting it are presented in exhibit 7.

1.2.1.7 Electricity from CSP as part of the Energy mix in Europe

EXHIBIT 12. GROWTH RATE OF ELECTRICITY DEMAND AND CSP SHARE IN EUROPE



According to European Commission, at maximum penetration in 2020 and 2030, CSP would generate about 1.6% and 5.5% of the projected EU gross electricity consumption.⁶⁴ This is quite similar to the estimated values for the share of CSP in the electricity mix of 1.5% to 6.5% between 2020 and 2030 as calculated by the DLR (2005), which are shown in exhibit 13 (above).

It is expected that Europe will achieve CSP electricity cost of around 5 € cents/kWh in 2020 for areas with high irradiation levels due to reductions in electricity generation cost through volume production, up-scaling of units and technological innovation.⁶⁵

According to TRANS-CSP scenario, this is the expected electricity mix in Europe in 2050:

- 65% European renewable energies
- 17% solar electricity imports
- 18% fossil fuelled backup and peak load power plants⁶⁶

⁶² German Aerospace Center (DLR). 2005. Concentrating Solar Power for the Mediterranean Region. [Online]. Available at: http://www.dlr.de/tt/en/desktopdefault.aspx/tabid-2885/4422_read-6575

⁶³ Includes data from: Cyprus, Greece, Italy, Malta, Portugal, Spain, Turkey

⁶⁴ Commission of the European Communities. 2007. A European Strategic Energy Technology Plan (SET-Plan). Online. Available at: ec.europa.eu/energy/res/setplan/doc/com_2007/2007_technology_map_en.pdf.

⁶⁵ European Commission. 2007. Renewable Electricity Generation. Online. Available at: http://ec.europa.eu/research/transport/pdf/s3_mo1_02_en.pdf

⁶⁶ DESERTEC. 2008. TREC Summary. Online. Available at: http://www.desertec.org/downloads/summary_en.pdf

1.2.1.8 Factors that have hindered CSP in Europe

Lack of Regulation in some EU countries

- In many European countries, concentrated solar power is underdeveloped due to lack of regulation (e.g. in Greece and Portugal) and non-provision of favorable tariffs. Appropriate regulation is required for sharing the risk and cost through financing mechanisms for implementation of higher capacity CSP projects in these countries. There is also a requirement of regulation for opening up of the EU markets for CSP electricity imports from North Africa and Middle East.

Fewer incentives for Integrated Solar Combined Cycle (ISCCs)

- In some European countries subsidies are only granted to purely solar plants. Granting subsidies to hybrid plants could encourage the progressive adoption of CSP. Furthermore, solar output is the same through hybrid operation as a purely-solar plant and also addresses the load requirements in an efficient manner.⁶⁷

Mitigations

To lower the initial installation cost, smaller solar fields can be integrated into conventional plants with a combined cycle at a cost of US\$ 700 to 1500 per kW of installed capacity. Compensation for avoidance of carbon emission will attract investments in CSP plants. According to ESTIA, by introducing “compensation premiums” for avoidance of carbon emissions, the share of CSP capacity can be raised to approximately 50% of the total capacity of ISCC plants.⁶⁸

1.2.1.9 CSP Hotspot Countries in Europe

Spain

With a slew of investment proposals, Spain is one of the leaders in the implementation of CSP technology for electricity generation. Although the current installed capacity is a mere 11 MW, Spain is expected to double its current target of 500 MW installed by 2010 due to an impressive project pipeline.

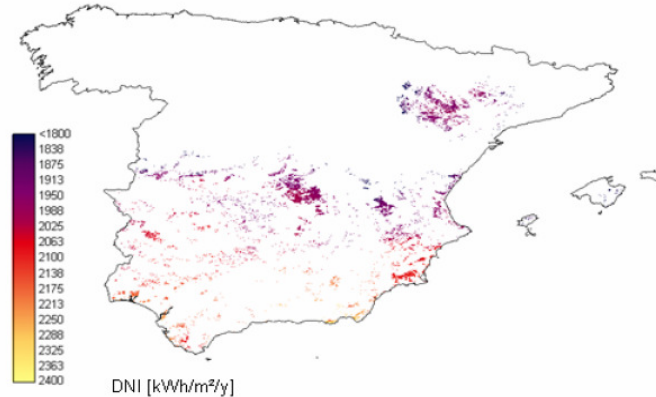
In Spain, most projects under development are parabolic troughs and power towers. Parabolic troughs have shown technical feasibility and have been commercially proven. Commercial and technical feasibility of power towers will be proven by means of experience gained from operating the PS10 and PS 20 plants.

⁶⁷ ESTIA, Solar Millennium. 2001. Project Development Activities Outside of the U.S. Online. Available at: www.nrel.gov/csp/troughnet/pdfs/rainer_arinhoff_proj_devel.pdf

⁶⁸ ESTIA, Solar Millennium. 2001. Project Development Activities Outside of the U.S. Online. Available at: www.nrel.gov/csp/troughnet/pdfs/rainer_arinhoff_proj_devel.pdf

Solar resources

EXHIBIT 13. SOLAR RESOURCES IN SPAIN⁶⁹



With solar radiation ranging from >1800 to maximum of 2400 kWh/m²/year, Spain has an average solar radiation of 2000 kWh/m²/year. The southern part of the country is the most suitable for CSP plants due to a higher incidence of solar irradiance.

Regulatory environment

Government policies

In 2002 Spain became the first European country to specifically grant a feed-in tariff to the CSP sector. This policy combined with abundant solar resources available in Spain has contributed to the growth of the CSP industry.

In 2004, the Spanish government introduced economic reforms in grid-connection for renewable energy sources. This wave of reforms provided the large-scale solar power plants the much-required access to the electricity grid, which led to the creation of solar-energy powered plants market and a region-wide adoption of solar energy.⁷⁰

Subsidies and Tariffs

Under the current Royal Decree 661/2007, CSP producers may opt for two different ways of receiving government support: a fixed feed-in-tariff or a mixed regime under which the CSP producer receives a feed-in-tariff on top of the market price. Under the fixed feed-in-tariff mode, CSP plants of up to 50 MW receive a feed-in-tariff of 27 € cents/kWh for 25 years and 21 € cents/kWh from the 25th year onwards. A gas fired back-up capacity of 12% of annual electricity production is allowed under the fixed feed-in-tariff mode.

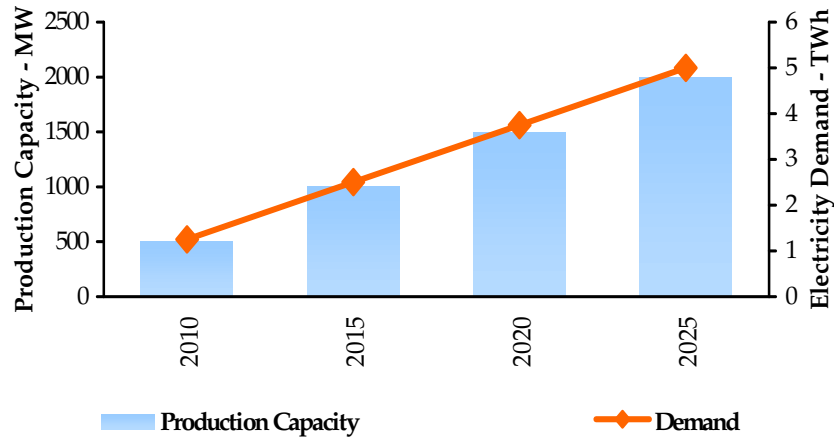
Under the second option, the tariff amounts to a minimum of 25 € cents /kWh and a maximum of 34 € cents/kWh on top of the market price for the first 25 years. The allowed quota for a gas fired back up system is 15% of the annual generation capacity. These conditions will be reviewed by 2010 or once the market has reached a capacity of 500 MW.

⁶⁹ DLR. 2005. Concentrating Solar Power in the Mediterranean Region. Online. Available at: http://www.dlr.de/tt/desktopdefault.aspx/tabid-2885/4422_read-6573/

⁷⁰ Dr. Alex Marker. 2008. Electricity from Solar Power - Congressional Testimony. Online. Available at: http://energy.senate.gov/public/_files/MarkerTestimony070208.pdf

Market outlook in Spain

EXHIBIT 14. DEMAND AND PRODUCTION OF ELECTRICITY FROM CSP IN SPAIN⁷¹



As of early 2008, there were more than 50 CSP projects in Spain either on planning or construction stage, which would total more than 2500 Mw if all of them were built. On Exhibit 6 we list the planned CSP capacity to be at 1500 MW taking into account that not all of these projects will come to fruition. Exhibit 14 estimates that by 2010 there will be 500 MW of CSP connected to grid in Spain (Greenpeace, 2005).

⁷¹ Greenpeace, ESTIA. September 2005. Concentrated Solar Thermal Power – Now! Online. Available at: www.greenpeace.org/raw/content/international/press/reports/Concentrated-Solar-Thermal-Power.pdf

Italy

Italy has initiated the promotion of CSP to increase the share of renewable energy in overall electricity generation. It has direct normal irradiance of approximately 2000 kWh/m²/year. A 28 MW CSP plant financed by government is planned to integrate with an existing ENEL gas fired combined cycle power station in Sicily.⁷²

Subsidies and Tariffs

Recently, Italy announced The Decree of 11 April 2008 that lays down guidelines to encourage production of electricity from grid connected solar thermal plants, including hybrids.

The feed-in-tariff stipulates that net electricity produced by solar thermal plants will be paid 28 € cents/kWh for 25 years on top of the market price. This will be applicable until 2012.

Under the new feed-in tariff law, the maximum cumulative power of all CSP plants eligible for incentives corresponds to 1.5 million m² of cumulative surface. Italy has also laid down a target of total power to be installed by 2016 corresponding to 2 million m² of cumulative surface.⁷³

Market Outlook

The cost of electricity is the highest in Italy as compared to other European countries with approximately 85% energy demand met through imports. The major issues to be tackled in the country are high level of bureaucracy and lack of proper grid infrastructure connecting plants to power grid.

The Italian government is expected to come up with a solar friendly policy framework in 2009 with an objective to bring down the costs of solar power down to competitive levels. A nation wide program is also proposed for increasing investment in domestic research programmes and setting-up a public private partnership for R&D activities on improving CSP technologies⁷⁴

⁷² Solarpaces , 2007. Italy Eurodish. Online. Available at: www.solarpaces.org/Tasks/Task1/EuroDish.htm

⁷³ IEA. 2008. Renewable Database: Feed-In Tariff for Solar Thermodynamic Energy. Online. Available at: <http://www.iea.org/Textbase/pm/?mode=re&id=4106&action=detail>

⁷⁴ IEA. 2005. Italy National Program Report. Online. Available at: www.iea-shc.org/countries/Italy/Italy_National_Program_Report.pdf

1.3 North Africa

The North African region offers a vast potential for production of electricity from CSP due to higher solar irradiance levels. The opportunity for exporting CSP electricity to Europe is one of the major drivers for CSP growth in the region. This would open up new opportunities for economic and technical co-operation between the two regions and in turn help Europe in its long-term CO2 reduction targets.

EXHIBIT 15. NORTH AFRICAN COUNTRIES CSP DEVELOPMENT AND POTENTIAL SUMMARY

Location	Planned CSP Capacity (MW) ⁷⁵	Economic Potential - TWh ⁷⁶	Technical Potential - TWh ⁷⁷	Solar irradiance kWh/m ² /year ⁷⁸	Feed-in-tariff
Algeria	255 ⁷⁹	168,972	169,440	2,700	Yes ⁸⁰
Egypt	30	73,656	73,656	2,800	-
Morocco	30	20,146	20,151	2,600	-

Algeria and Egypt possess a high level of economic potential for development of CSP with generation capabilities around 168,972 TWh and 73,656 TWh, respectively. CSP market in North Africa is in a nascent stage with developments taking place in countries such as Algeria, Egypt and Morocco. Currently, Abengoa is building ISCC plants in Algeria and Morocco and Solar Millennium is building the first CSP plant in Egypt.

⁷⁵ Based on Projects Announced

⁷⁶ DLR. 2005. Concentrating Solar Power in the Mediterranean Region. Online. Available at: http://www.dlr.de/tt/desktopdefault.aspx/tabid-2885/4422_read-6573/

⁷⁷ DLR. 2005. Concentrating Solar Power in the Mediterranean Region. Online. Available at: http://www.dlr.de/tt/desktopdefault.aspx/tabid-2885/4422_read-6573/

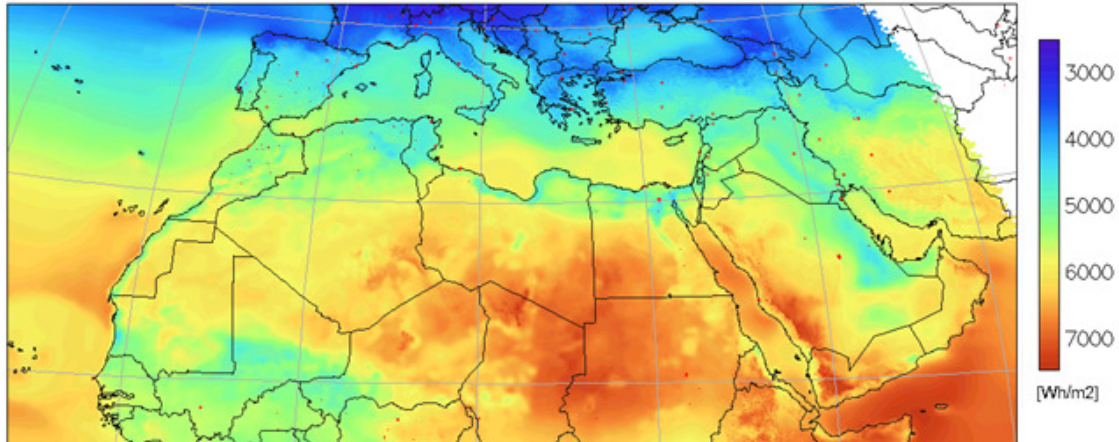
⁷⁸ DLR. 2005. Concentrating Solar Power in the Mediterranean Region. Online. Available at: http://www.dlr.de/tt/desktopdefault.aspx/tabid-2885/4422_read-6573/

⁷⁹ African Energy. 2007. Magazine November Issue. Online. Available at: www.desertec.org/downloads/articles/2007-12-14_african_energy_magazine.pdf

⁸⁰ REN 21. 2007. Global Renewable Status Report. Online. Available at: www.ren21.net/pdf/RE2007_Global_Status_Report.pdf

1.3.1.1 Solar resources

EXHIBIT 16. SOLAR ELECTRICITY POTENTIAL IN AFRICAN COUNTRIES⁸¹



With a favourable solar irradiation (>2300 kWh/m²/year), Morocco, Algeria, Tunisia, Libya and Egypt are well positioned for exploring the power generation potential from CSP.

Algeria possesses 169.44 TWh/year of solar thermal energy, the highest quantity of sunlight in this region, according to the German Space Agency. Morocco also offers great potential for CSP implementation as approximately 30% of the country's surface area receives around 2000 kWh of sunlight per m².

Water Resources

Northern Africa has almost completely used its sustainable sweet water resources and no major increase through exploitation is foreseeable. In future, more fossil fuel will be used for desalination and ground water withdrawal. A linear growth in water demand from 95 billion m³/y in 2007 to 183 billion m³/y in 2050 is expected in North Africa, according to AQUA-CSP 2050 scenario assumptions.

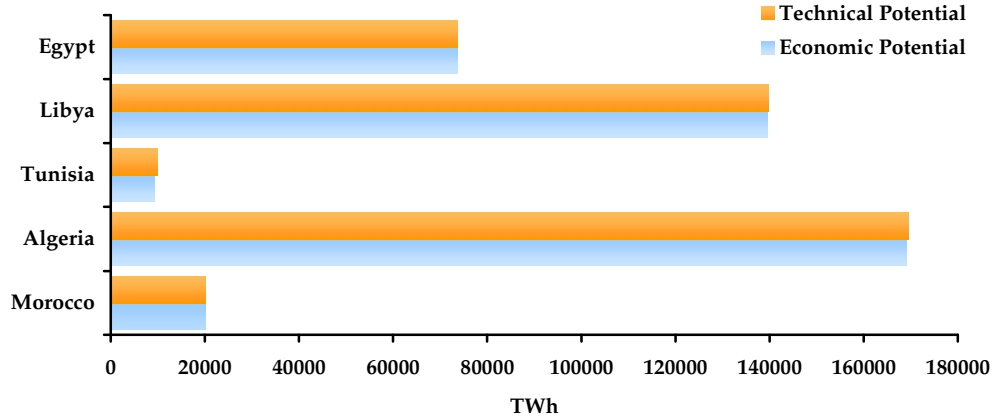
According to AQUA-CSP 2006 scenario, North African countries are expected to witness a declining growth rates for water demand. The region has a wide variation in per capita consumption levels with Egypt and Libya having a consumption of around 1000 m³/cap/year while Algeria consumes only 200 m³/cap/year.⁸²

⁸¹ Huld T., Šúri M., Dunlop E., Albuissou M, Wald L (2005). Integration of HelioClim-1 database into PVGIS to estimate solar electricity potential in Africa. Proceedings from 20th European Photovoltaic Solar Energy Conference and Exhibition, 6-10 June 2005, Barcelona, Spain. [Online] Available at: <http://re.jrc.ec.europa.eu/pvgis/countries/afr/4-gs13.png/>

⁸² DLR. 2006. Concentrating Solar Power for Seawater Desalination. Available at: <http://www.dlr.de/tt/Portaldata/41/Resources/dokumente/institut/system/projects/aqua-csp/AQUA-CSP-Full-Report-Final.pdf>

1.3.1.2 Economic and Technical Potential

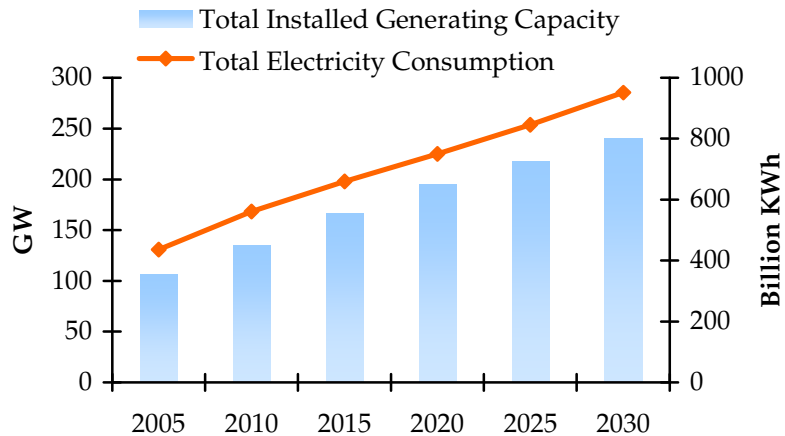
EXHIBIT 17. ECONOMIC AND TECHNICAL POTENTIAL OF CSP IN NORTH AFRICAN COUNTRIES⁸³



The economic potential for production of electricity from CSP in most North African countries is equal to the technical potential as the solar irradiance is higher than 2000 kWh/m²/year. In Algeria, Egypt and Libya, the economic potential is more than 60000 TWh/year, which puts them on the global map of optimum locations for CSP plants, as far as solar resources are concerned. This provides an opportunity to exploit solar energy potential and export surplus electricity to Europe.

1.3.1.3 Current energy demand and its growth

EXHIBIT 18. ELECTRICITY DEMAND-SUPPLY SCENARIO IN NORTH AFRICAN COUNTRIES⁸⁴



⁸³ DLR, 2005. Concentrating Solar Power in the Mediterranean Region. Online. Available at: http://www.dlr.de/tt/desktopdefault.aspx/tabid-2885/4422_read-6573/

⁸⁴ EIA, 2006. Annual Energy Outlook. Online. Available at: www.eia.doe.gov/oiaf/aeo

An increase in population from 150 million in 2005 to 250 million in 2050 would drive the electricity demand and production in the North African region⁸⁵. The total electricity consumption is expected to rise at a CAGR of 3.17% along with the rise in population. The total installed generating capacity is also expected to grow at a CAGR of 3.28% to meet the rising electricity demand and bridge the demand-supply gap.⁸⁶

A growing renewable energy market and its increasing share in overall electricity production would determine the direction of future development of electricity generation in North Africa.⁸⁷

1.3.1.4 Current electricity production from CSP

Although current CSP implementation in the region is minimal, several new projects have been announced to capitalize on solar capabilities in the region as mentioned in exhibit 16.

1.3.1.5 Announced capacity for electricity from CSP

Algeria

- A 140-MW ISCCS plant with 30 MW solar power output is under construction
- NEAL (New Energy Algeria Limited), Algeria's renewable energy agency, has planned three thermal solar hybrid plants to be launched at Naâma in 2010, Meghaïer in 2012 and Hassi R'Mel in 2015. Each plant will have a total combined capacity of 400 MW out of which 75MW is from solar.⁸⁸

Egypt

- Egypt has planned a 150 MW ISCCS plant in which 30 MW would be from solar

Morocco

- A new 230 MW plant with a solar capacity of 30 MW is under construction.

Please refer to Exhibit 15 for details of announced capacities for electricity from CSP in North Africa.

⁸⁵ DLR. 2006. Concentrating Solar Power for Seawater Desalination. Available at: www.menarec.org/resources/CSP+for+Desalination-MENAREC4.pdf

⁸⁶ EIA, 2006. Annual Energy Outlook. Online. Available at: www.eia.doe.gov/oiaf/aeo

⁸⁷ Greenpeace, EREC. 2007. Energy Revolution – African Scenario. Online. Available at: <http://www.energyblueprint.info/regionalscenarios.0.html>

⁸⁸ African Energy. 2007. Magazine November Issue. Online. Available at: www.desertec.org/downloads/articles/2007-12-14_african_energy_magazine.pdf

1.3.1.6 Comparison between different forecasts for CSP in North Africa^{89,90,91}

The estimates from MED-CSP and Greenpeace reports reflect high demand and production capabilities in North Africa due to the higher potential of CSP. Recent developments in planning and construction of CSP projects in Algeria and Morocco have also led to rising expectation for production and demand forecasts in North Africa. The future electricity demand and production from CSP is estimated at more than 120 TWh and 15 GW, respectively by 2030.

EXHIBIT 19. COMPARISON OF DEMAND FORECASTS FOR ELECTRICITY FROM CSP IN NORTH AFRICA

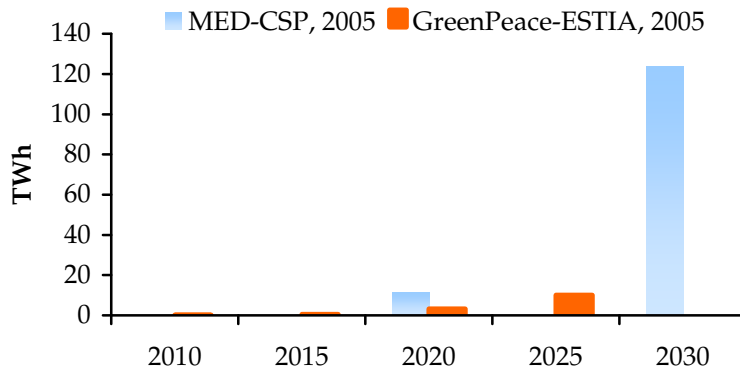
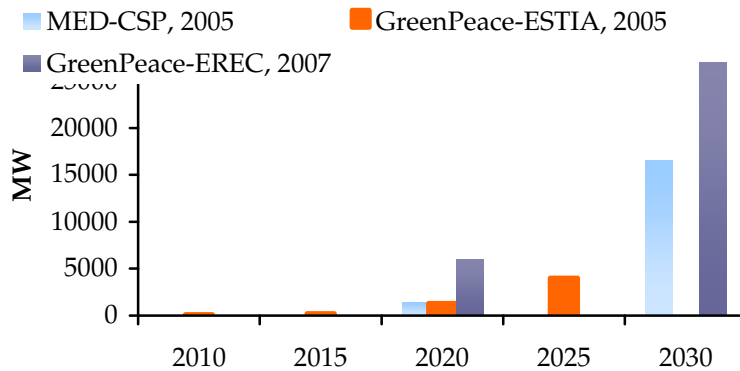


EXHIBIT 20. COMPARISON OF PRODUCTION FORECASTS FOR ELECTRICITY FROM CSP IN NORTH AFRICA



The various forecasts from MED-CSP and Greenpeace for electricity generation from CSP vary widely due to the underlying assumptions. The MED-CSP 2005 report considers the individual situation of each country concerning population growth, economic growth and energy requirements. Greenpeace reports on the other hand focus more on future solar potential, energy efficiency and growth in GDP.

⁸⁹ DLR. 2005. Concentrating Solar Power in the Mediterranean Region. Online. Available at:

http://www.dlr.de/tt/desktopdefault.aspx/tabid-2885/4422_read-6573 (Includes data from: Algeria, Libya, Morocco, Tunisia)

⁹⁰ Greenpeace, ESTIA. September 2005. Concentrated Solar Thermal Power – Now! Online. Available at:

www.greenpeace.org/raw/content/international/press/reports/Concentrated-Solar-Thermal-Power.pdf (Includes Total Africa)

⁹¹ Greenpeace, EREC. January 2007. Energy Revolution Report. Online. Available at: www.energyblueprint.info (Includes Total Africa)

1.3.1.7 Political Support: subsidies, tariffs and targets

Government Support

There is no unified agency in North Africa that works towards the support and development of CSP in the region. Respective governments of Algeria, Morocco and Egypt have taken initiatives to develop CSP in the region.

Algeria

Algeria has formed New Energy Algeria Limited (NEAL), a government agency that undertakes development of CSP projects and initiates partnerships with countries like Germany for the export of electricity produced through CSP. Additionally, it has also set up a national programme that would encourage production from renewable energy sources through its Sustainable Energy Development Plan by 2020.

Egypt

Egypt has formed a New and Renewable Energy Authority (NREA, part of the Ministry of Energy) that is responsible for promotion of renewable energy sources. NREA is overseeing the new CSP plant coming up at El Koraimat near Cairo.⁹²

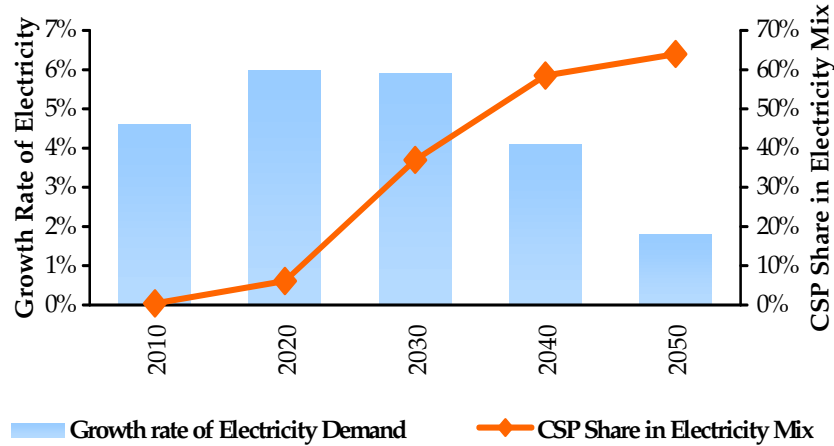
Subsidies and Tariffs

There is a lack of region-wide subsidy or Feed-in laws in North African Region. Moreover, except for Algeria, no country offers a feed-in-tariff system for CSP. Algerian feed-in laws are also somewhat limited as only hybrid systems come under the purview of the feed-in tariff, to the exclusion of purely solar systems. Thus there is very low support from the government in terms of subsidies and tariffs in North African countries.

⁹² Encyclopedia of Earth. 2008. Endowment opportunities from atmospheric resources in Africa. Online. Available at: http://www.eoearth.org/article/Endowment_opportunities_from_atmospheric_resources_in_Africa

1.3.1.8 Electricity from CSP as part of the Energy mix in North Africa

EXHIBIT 21. GROWTH RATE OF ELECTRICITY DEMAND AND CSP SHARE IN NORTH AFRICA ^{93, 94}



The electricity produced from CSP is expected to contribute more than 35% of the total electricity produced in North Africa by 2030. This rise would be primarily after 2020 as the total electricity generation from CSP would increase through efficiencies achieved on account of advancements in CSP technology and higher investments attracted due to its economic potential. This is proven by the fact that Greenpeace estimates that approximately 55% of the electricity produced in Africa will come from renewable energy sources by 2050. Newer renewable technologies such as wind, geothermal and solar energy are expected to contribute 42% of this electricity generation and the rest from other renewable technologies.⁹⁵

1.3.1.9 Factors that have boosted CSP in North Africa

High Irradiance

Technically, North Africa has a potential that far exceeds local demand. Parabolic trough, power towers and parabolic dish concentrators offer good prospects for further development and cost reductions in the region. Developing countries such as Algeria could potentially attract significant foreign investment due to an opportunity to export the surplus electricity produced from CSP through grid connections to European countries.

Creation of jobs through utilization of arid land

CSP plants can be located in the desert and uncultivated lands. Commercial activity in such areas will benefit local communities directly and indirectly. Creation of new jobs and tax revenues are direct benefits and increase in local services to support new jobs created is the indirect benefit.

⁹³ German Aerospace Center (DLR). 2005. Concentrating Solar Power for the Mediterranean Region. [Online]. Available at: http://www.dlr.de/tt/en/desktopdefault.aspx/tabid-2885/4422_read-6575

⁹⁴ Includes data from: Algeria, Libya, Morocco, Tunisia

⁹⁵ Greenpeace, EREC. 2007. Energy Revolution – African Scenario. Online. Available at: <http://www.energyblueprint.info/regionalscenarios.0.html>

According to a survey by ESTIA, for Solar Thermo-Electric Power Plants, every 100 MW installed will provide 400 full-time equivalent manufacturing jobs, 600 contracting and installation jobs and 30 annual jobs in O&M.⁹⁶

1.3.1.10 Factors that have hindered CSP in North Africa

High Initial Cost of Investment:

Owing to high initial capital costs and lack of government subsidies, the investments in CSP in North Africa reflect a slower growth rate.

Mitigations

To decrease the high initial costs incurred by a single entity for CSP implementation, long-term power purchasing guarantees from the government need to be put in place. For e.g. Spain has initiated government regulations for purchasing the solar power supplied to grid that has given a boost to CSP implementation in the region.

Lack of Power Transmission Infrastructure

Solar resources potential is unrealized in North Africa due to deficient investments and lack of concentrated government effort in setting up infrastructure for power transmission and distribution.

Mitigations

The implementation of HVDC power transmission network could be initiated and constant power supply on the grids could be guaranteed by North African countries planning to export electricity generated from CSP. According to a Schott study (Schott Memorandum on Solar. Thermal Power Plant Technology, 2006), the power transmission fees must not be higher than a maximum of 2 € cents/KWh for cost-feasibility of electricity export.⁹⁷

⁹⁶ Estela Solar. 2008. Solar Thermal Electricity Report. Online. Available at: www.estelasolar.eu/fileadmin/ESTELAdocs/documents/2008.05.28_ESTELA_DisseminationDocFull.pdf
⁹⁷ Schott AG. Schott Memorandum on Solar. Thermal Power Plant Technology. 2006. [Online]. Available at: www.schott.com/solar/english/download/schott_memorandum_e.pdf.

1.3.1.11 CSP Hotspot Countries in the North African Region

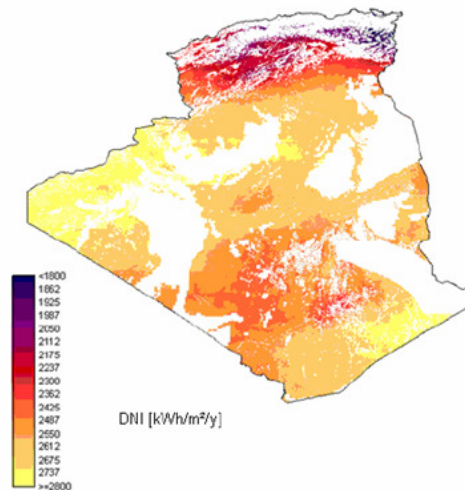
Algeria

With 30 MW of CSP under construction and a feed-in-tariff for solar hybrid plants, Algeria is leading the way for CSP implementation in North Africa. The solar plant in question is currently under construction in Hassi R'Mel and it will integrate 30 MW of CSP capacity into a combined cycle plant for a total of 140 MW.

The country also has ambitious plans to export the electricity generated through CSP to European countries. NEAL is currently seeking approval for a project to build a 3,000 km transmission line capable of supplying 800-1,000 MW solar hybrid energy to Europe. To decrease the power loss and to increase the coverage area, the grid would make use of high-voltage direct current (HVDC) transmission lines. Algeria is targeting 5% of national generating capacity using the ISCC plants by 2015.

Solar resources

EXHIBIT 22. SOLAR RESOURCES IN ALGERIA⁹⁸



With 169,440 TWh/year, Algeria has the highest solar potential in the Mediterranean basin. Coastal areas in Algeria receive an annual solar irradiance of 1,700 kWh/m²/year while highlands and Sahara region receive 1,900 kWh/m²/year and 2,650 kWh/m²/year respectively⁹⁹.

Algeria has land area of 2,381.741 sq. km. It has been estimated that 82% of the total land is available for installation of CSP plants¹⁰⁰.

Regulatory environment

Government policies

⁹⁸ DLR. 2005. Concentrating Solar Power in the Mediterranean Region. Online. Available at: http://www.dlr.de/tt/desktopdefault.aspx/tabid-2885/4422_read-6573/

⁹⁹ Ministry of Energy and Mines. 2007. Guidelines to renewable energies. Available at: http://www.mem-algeria.org/fr/enr/Guide_Enr_ang.pdf

¹⁰⁰ Medina. 2007. Algeria Country Data. Online. Available at: www.uam.es/otroscentros/medina/algeria/allggengeo.htm

The government of Algeria is promoting the use of CSP in existing natural gas plants by integrating concentrated solar power into conventional plants' combined cycles. It has set up capacity targets of 500 MW of CSP implementation in new ISCCS plants until 2010.¹⁰¹

Feed-in Tariffs and Subsidies

Algeria has formulated feed-in law (Algeria's Decree .04-92, March 2004) for promoting renewable energy systems including CSP for both hybrid solar-gas operations in steam cycles, as well as integrated solar and gas- combined cycle plants.

The premium stands at 200% of the price per kWh of electricity produced from facilities using hybrid solar-gas systems, where the minimum contribution of solar energy represents 25% of all primary energy sources. In case contribution of solar energy is less than 25%, the actual premium served is the following¹⁰²:

- For contribution 20% to 25%: the premium is 180%
- For contribution 15% to 20%: the premium is 160%
- For contribution 10% to 15%: the premium is 140%
- For contribution 5% to 10% premium is 100%
- For contribution 0% to 5% premium is zero

Market outlook

Algeria plans to enhance its solar power potential through economic partnership agreements with the EU, which would remove the trade barriers between the two regions. The country already has plans to produce 5% of its electricity, or 500 MW, from renewable sources by 2010 and 10% by 2020. In addition to having excellent solar resources, Algeria has the advantage of having both low cost labour and suitable land.

EXHIBIT 23. NEAL CSP ISCC INVESTMENT PLANS¹⁰³

Launch Year	Location	Solar Capacity (MW)	Total Capacity (MW)
2010	Naâma	75	400
2012	Meghaïer	75	400
2015	Hassi R'Mel (2nd Phase)	75	400

However, some experts feel that the domestic market may find it hard to compete with cheap oil and natural gas available in the country due to the high cost of cables to transmit electricity generated from CSP. It has been estimated that solar-derived electricity costs around 25% more electricity generated from natural gas. This is a considerable disadvantage in a country with ample natural gas reserves.

¹⁰¹ Solar Spaces. 2007. Legislation Promoting CSP Implementation: <http://www.solarpaces.org/Library/Legislation/legislation.htm>

¹⁰² Ministry of Energy and Mines. Feed-in-Tariff: <http://translate.google.co.in/translate?hl=en&sl=fr&u=http://www.mem-algeria.org/&sa=X&oi=translate&resnum=1&ct=result&prev=/search%3Fq%3DAlgeria%2527s%2Benergy%2Bministry%26hl%3Den>

¹⁰³ African Energy. 2007. Magazine November Issue. Online. Available at: www.desertec.org/downloads/articles/2007-12-14_african_energy_magazine.pdf

1.4 Middle East

Estimated power shortages resulting from large scale constructions and rising concerns over the longevity of fossil fuels, has prompted countries in the Middle East to initiate the development of solar power capabilities. Israel, UAE, Iran and Jordan have already laid out plans to explore solar power as an option.

EXHIBIT 24. MIDDLE EAST COUNTRIES CSP DEVELOPMENT AND POTENTIAL SUMMARY

Location	Planned CSP Capacity (MW) ¹⁰⁴	Economic Potential - TWh	Technical Potential - TWh	Solar irradiance kWh/m ² /year	Feed-in-tariff
Israel	100	318	318	2400	> Installed capacity larger than 20 MW - app. 16.3 US\$ cents/kWh > For smaller plants below 20MW in the range of 100 kW to 20 MW - app. 20.4 US\$ cents /kWh ¹⁰⁵
UAE	100 ¹⁰⁶	1988	2078	2200	-
Iran	70	20000	>20000	2200	-
Jordan	30	6429	6434	2700	-

Electricity production from renewable sources is expected to rise in Middle East with an average yearly increase in its renewable electricity production capacity of more than 2.5 times the global average.¹⁰⁷

1.4.1.1 Solar resources

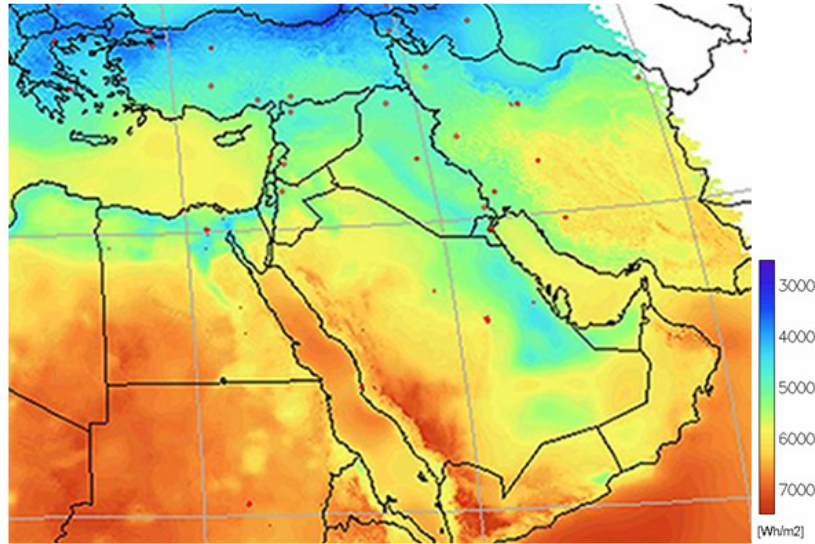
EXHIBIT 25. MIDDLE EAST SOLAR RESOURCES¹⁰⁸

¹⁰⁴ Based on announced projects

¹⁰⁵ Solar Paces. 2007. Solarpaces News. Online. Available at: <http://www.solarpaces.org/News/news.htm>

¹⁰⁶ Masdar. 2008. Masdar Announces Major Progress on Future Energy Strategy. Online. Available at: <http://www.masdaruae.com/text/news-d.aspx?id=51>

¹⁰⁷ Arab Environment. 2007. Egypt tries harnessing Solar Power. Online. Available at: www.arabenvironment.net/archive/2007/2/161471.html



Almost all territory in the Middle East is exposed to high solar irradiance levels. Solar irradiance is higher than 2400 kWh/m²/year in Israel, Jordan and Saudi Arabia.

Water Resources

In Saudi Arabia and Yemen (Arabian Peninsula countries) the demand for water is rising. This is leading to the region's dependability for fresh water to a great extent on non-sustainable sources such as fossil-fuelled desalination and excessive groundwater withdrawal. In these countries, water demand is expected to increase from 34 billion m³/y in 2006 to 72 billion m³/y by 2050.

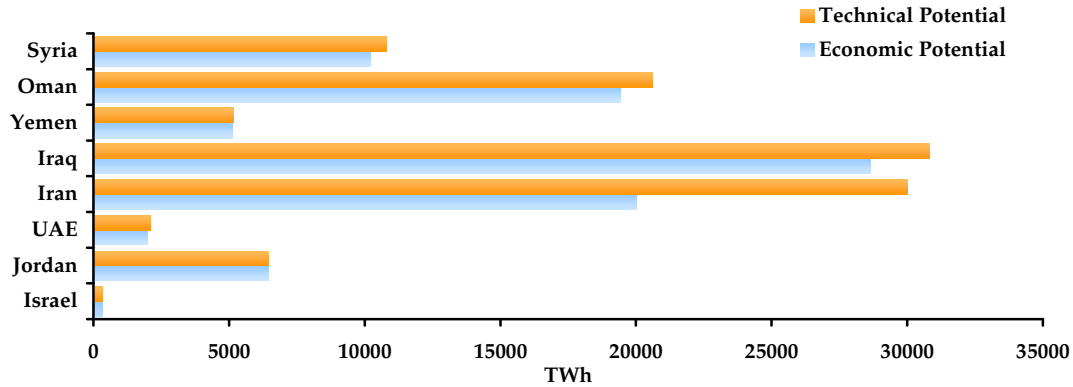
According to a DLR study (Concentrating Solar Power for Seawater Desalination, 2006); there are vast sustainable water resources available in Syria, Jordan, Israel and Iraq, which will be increasingly exploited in the future. The water demand is expected to grow at a CAGR of 0.9% until 2050 i.e., increase from 140 billion m³/y in 2006 to about 210 billion m³/y by 2050.¹⁰⁹

¹⁰⁸ Huld T., Šúri M., Dunlop E., Albuissou M, Wald L (2005). Integration of HelioClim-1 database into PVGIS to estimate solar electricity potential in Africa. Proceedings from 20th European Photovoltaic Solar Energy Conference and Exhibition, 6-10 June 2005, Barcelona, Spain. [Online][Zoomed image for Middle East] Available at: <http://re.jrc.ec.europa.eu/pvgis/countries/afr/4-gs13.png/>

¹⁰⁹ DLR. 2006. Concentrating Solar Power for Seawater Desalination. Available at: <http://www.dlr.de/tt/Portaldata/41/Resources/dokumente/institut/system/projects/aqua-csp/AQUA-CSP-Full-Report-Final.pdf>

1.4.1.2 Economic and Technical Potential

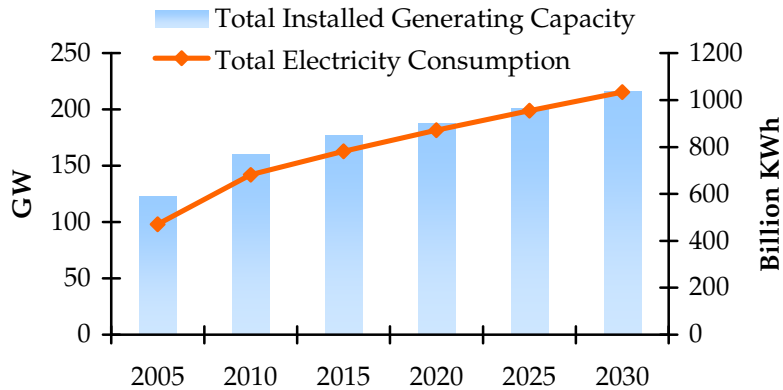
EXHIBIT 26. ECONOMIC AND TECHNICAL POTENTIAL OF CSP IN MIDDLE EAST COUNTRIES¹¹⁰



There is a huge untapped potential for electricity generation from solar energy in the Middle-East due to the high levels of solar irradiance in the region. Israel, UAE and Iran have already laid out plans to implement CSP as a means of tapping into this resource.¹¹¹

1.4.1.3 Current energy demand and energy demand growth

EXHIBIT 27. ELECTRICITY DEMAND-SUPPLY SCENARIO IN MIDDLE EAST COUNTRIES¹¹²



In the last 10 years, the region has witnessed high growth rates in electricity consumption of over 6% per year with Jordan, Lebanon and the UAE rising at even higher growth rates.¹¹³ The

¹¹⁰ DLR. 2005. Concentrating Solar Power in the Mediterranean Region. Online. Available at: http://www.dlr.de/tt/desktopdefault.aspx/tabid-2885/4422_read-6573/

¹¹¹ DLR. 2005. Concentrating Solar Power in the Mediterranean Region. Online. Available at: http://www.dlr.de/tt/desktopdefault.aspx/tabid-2885/4422_read-6573/

¹¹² EIA, 2006. Annual Energy Outlook. Online. Available at: www.eia.doe.gov/oiaf/aeo

¹¹³ MESS. 2005. Middle East Economic Survey. Online. Available at: <http://www.mees.com/postedarticles/oped/v48n49-5OD02.htm>

demand-supply gap is expected to widen as the installed capacity and electricity consumption are expected to increase at CAGR of 1.5% and 2.1%, respectively between 2010 and 2030.

The Middle East is required to invest around US\$ 150 billion for enhancing capacity for generating, transmitting and distributing electricity due to rapid growth in load, caused by population growth and economic development.

The region is also facing the dilemma of using depleting reserves of oil and gas as raw materials for electricity generation, when arguably more of these resources could be exported for revenue generation. In 2006, oil consumption rose by 5.4%, which was faster than in any other region, except China.

1.4.1.4 Current electricity production from CSP

UAE, Israel and Iran have planned a number of projects which would be in production stage by 2015, although there is no current production of electricity from CSP.

1.4.1.5 Announced capacity for electricity from CSP

UAE

- In Abu Dhabi, construction is under-progress for a 500 MW solar power plant with an investment of US\$ 350 million (AED1.3 billion) and it is expected to be operational in 2009.

Israel

- Israel's National Infrastructure Ministry has issued pre-qualifying tenders for two 125 MW solar thermal power plants at Ashalim and is expected to award the contract to the winning bidder on a Build-Operate-Transfer (BOT) model by the end of the 2008.
- Israel has set a national target of generating 500 MW by 2010 and another 1000 MW by 2015 from CSP. The region offers a large area, as the selected site for the first 100 MW has adequate land for 5000 MW of CSP plants.¹¹⁴

Iran

- The government of Iran is planning a 300 MW natural gas-solar hybrid plant with a solar share of 67 MW in the Luth desert in the area of Yazd.¹¹⁵

Please refer to Exhibit 24 for details of announced capacities for electricity from CSP in the Middle East.

¹¹⁴ Solarpaces. 2008. CSP Project developments in Israel. Online. Available at: <http://www.solarpaces.org/News/Projects/Israel.htm>

¹¹⁵ DLR. 2005. Concentrating Solar Power in the Mediterranean Region. Online. Available at: http://www.dlr.de/tt/desktopdefault.aspx/tabid-2885/4422_read-6573

1.4.1.6 Comparison between different forecasts for CSP in Middle East^{116, 117, 118}

EXHIBIT 28. COMPARISON OF DEMAND FORECASTS FOR ELECTRICITY FROM CSP IN MIDDLE EAST

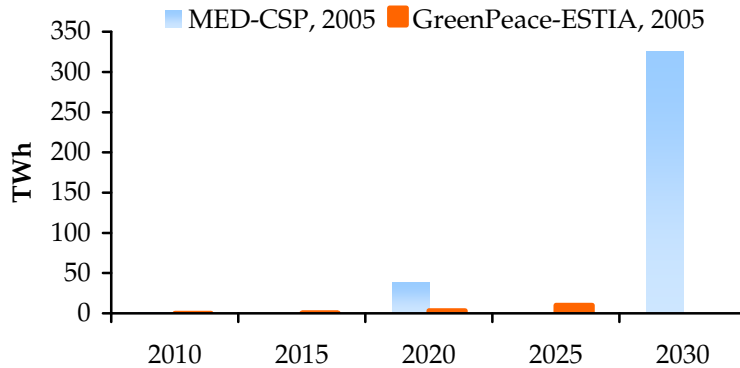
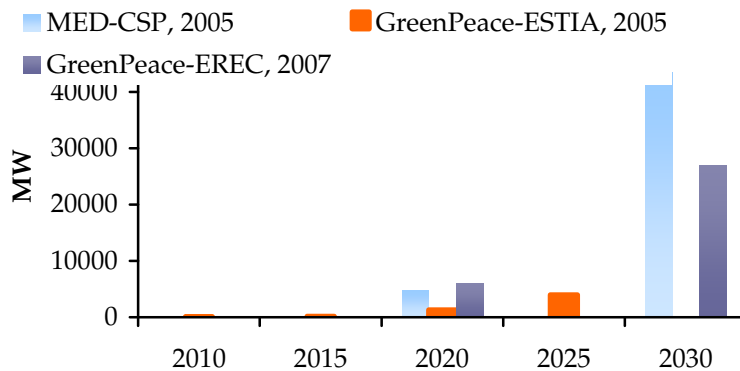


EXHIBIT 29. COMPARISON OF PRODUCTION FORECASTS ELECTRICITY FROM CSP IN FOR MIDDLE EAST



Despite wide variations shown in the estimates for electricity generation from CSP in the Middle East, estimates point out at a substantial increase in generation by 2030. However, this would need government support and a region-wide feed-in-tariff schemes, which none of the Middle East countries, except Israel, offer as of now.

¹¹⁶ DLR. 2005. Concentrating Solar Power in the Mediterranean Region. Online. Available at: http://www.dlr.de/tt/desktopdefault.aspx/tabid-2885/4422_read-6573 (Includes data from: Egypt, Jordan, Israel, Lebanon, Syria, Iran, Iraq, Saudi Arabia, Yemen, Oman, Bahrain, UAE, Qatar, Kuwait)

¹¹⁷ Greenpeace, ESTIA. September 2005. Concentrated Solar Thermal Power – Now! Online. Available at:

www.greenpeace.org/raw/content/international/press/reports/Concentrated-Solar-Thermal-Power.pdf (Includes Total Middle East)

¹¹⁸ Greenpeace, EREC. January 2007. Energy Revolution Report. Online. Available at: www.energyblueprint.info (Includes Total Middle East)

1.4.1.7 Political Support: subsidies, tariffs and targets

Government Support

There is no region-specific legislation for promotion of CSP in the Middle East region. Countries such as UAE, Israel and Iran have initiated CSP implementation.

UAE

UAE has announced the development of a Renewable Energy Division for renewable power generation, green buildings and energy and water conservation. The country has also started 'Masdar Initiative', regional economic development program to expedite the adoption of solar technologies. The Masdar Institute will develop new industries using renewable energy and resources including development of concentrating solar power projects.¹¹⁹

Israel

With an initial parabolic trough plant of 100 MW, the Israeli Ministry of National Infrastructure, overseeing the energy sector, decided in November 2001 to introduce concentrating solar power as a strategic ingredient in the Israel electricity market from 2005.

The country plans to build a new solar station in The Negev desert, which covers 55% of Israel's land, every year for the next 20 years. It also plans to increase renewable energy contribution by 15 to 20% of the total energy generation capacity by 2020.

Iran

Iran has also shown a growing interest in renewable energy technology, including solar power. In an effort to diversify its electricity generation mix, Iran is exploring the possibility of building a hybrid CSP plant in order to take advantage of its abundant solar resource.

Subsidies & Tariffs

In Middle East countries, subsidies for CSP implementation from the government are very limited. The region has no feed-in-laws except for Israel. For installed capacity larger than 20 MW and for smaller plants in the range of approximately 100 kW to 20 MW, Feed-in Tariff FIT is fixed at approximately 16.3 US\$ cents/kWh and 20.4 US\$ cents/kWh, respectively in Israel.¹²⁰

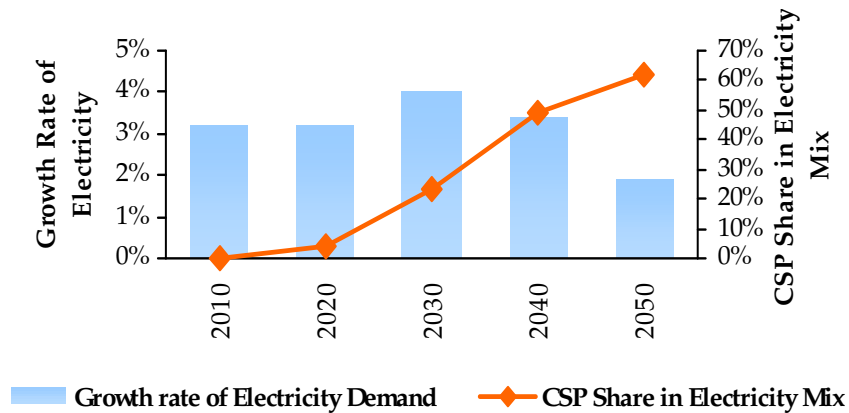
1.4.1.8 Electricity from CSP as part of the Energy mix in Middle East

CSP market share is expected to reach around 20% in the Middle East region by 2030, although at present the share is very low. Increasing awareness of the CSP potential and successful implementation of new CSP plants would lead to this growth. The key drivers for CSP market share growth in the Middle East will be increasing demand of electricity and limited fossil fuel resources for electricity generation.

¹¹⁹ Arabian Business. 2007. Solar Solution Article. Online. Available at: <http://www.arabianbusiness.com/497306-solar-solution?start=1>

¹²⁰ Solar Paces. 2007. Solarpaces News. Online. Available at: <http://www.solarpaces.org/News/news.htm>

EXHIBIT 30. GROWTH RATE OF ELECTRICITY DEMAND AND CSP SHARE IN MIDDLE EAST ^{121, 122}



1.4.1.9 Factors that have boosted CSP in Middle East

Potential for water-desalination through CSP Plants

Water demand from MENA countries will increase from 300 billion m³ in 2007 to over 500 billion m³/year by 2050. Current water supply is already exploited beyond its yield. According to the German Aerospace Center, energy from solar thermal power plants will become one of the most cost effective options for water desalination in MENA within a decade.¹²³

As an example, solar powered water desalination is already utilized in Bahrain. Once complete, the Al Hidd independent water and power plant (IWPP) will triple Al Hidd IWPP’s current desalination capacity from 136 million liters per day (MLD) to 409 MLD.¹²⁴ They have the potential to be expanded to very large units, producing up to 100,000 m³/day of desalted water.¹²⁵

1.4.1.10 Factors that have hindered CSP in Middle East

Limited Government Involvement in Promoting CSP

- Lack of dedicated policy level initiatives for promotion of CSP in the region has hampered the growth of CSP as an option for generating electricity.

Mitigation

- National governments could introduce measures such as tax credits and feed-in-tariffs for CSP producers in order to encourage the adoption of CSP in the region. These policies could also increase the level of foreign direct investments in the region.

¹²¹ German Aerospace Center (DLR). 2005. Concentrating Solar Power for the Mediterranean Region. [Online]. Available at: http://www.dlr.de/tt/en/desktopdefault.aspx/tabid-2885/4422_read-6575

¹²² Includes data from: Bahrain, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syria, UAE, Yemen, Egypt

¹²³ DLR. 2005. Concentrating Solar Power in the Mediterranean Region. Online. Available at:

http://www.dlr.de/tt/desktopdefault.aspx/tabid-2885/4422_read-6573/

¹²⁴ Power Engineering. 2007. Independent Power & Water Plants: Serving up success. Online. Available at:

http://pepei.pennnet.com/display_article/288635/89/ARTCL/none/none/Independent-Power-&-Water-Plants:-Serving-up-success/

¹²⁵ DLR. 2007. Concentrating Solar Power for Seawater Desalination. Online. Available at:

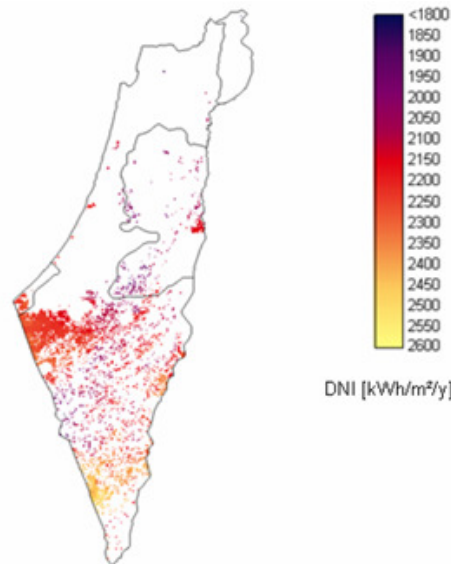
http://www.dlr.de/tt/desktopdefault.aspx/tabid-3525/5497_read-6611/

1.4.1.11 CSP Hotspot Countries in the Middle East Region

Israel

Solar resources

EXHIBIT 31. SOLAR RESOURCES IN ISRAEL¹²⁶



Israel has a high CSP potential with an average annual incident solar irradiance of about 2000 kWh/m²/year. Total land area of Israel is 20,330 sq km; approximately half of this land is covered by the Negev desert, where CSP plants are currently under development.

Regulatory Environment

Government policies

The government of Israel has issued a pre-qualifying tender for constructing two 80-125 MW solar thermal power stations at Ashalim in the Negev desert. The pre-qualifying process runs through July 1, and the government plans to complete the selection process by the end of the year or in early 2009. The solar power plants are expected to be fully operational in 2011.

Additionally, the Ministry of National Infrastructures, which is also responsible for energy sector, has committed to increase the share of alternative and renewable energies, to at least 15- 20% by 2020.¹²⁷ In 2008, Israel and the US entered into an agreement to cooperate on renewable and sustainable energy and development of energy efficiency related technologies¹²⁸.

Subsidies & Tariffs

¹²⁶ DLR. 2005. Concentrating Solar Power in the Mediterranean Region. Online. Available at: http://www.dlr.de/tt/desktopdefault.aspx/tabid-2885/4422_read-6573/

¹²⁷ Ministry of National Infrastructures. 2008. Renewable Energy. Available at: <http://www.mni.gov.il/mni/en-US/Energy/Messages/SpokesmanRenewableEnergy.htm>

¹²⁸ Memorandum of Understanding between Israel and US.2008. Available at: <http://www.mni.gov.il/NR/rdonlyres/BC89C06C-A906-476F-9209-D273E811480D/0/memoradumRenewable.pdf>

In September 2006, new Feed-in Incentives for solar driven Independent Power Plants (IPP) were announced. These incentives are valid for a 20-year period. For plants with installed capacity larger than 20 MW, the tariff for the solar part only is approximately 16.3 US\$ cents/kWh (Nov.2006). The regulations further stipulate that a fossil fuel back-up of no more than 30% of total capacity is allowed. For smaller plants in 100 kW to 20 MW range, the tariff is 20.4 US\$ cents/kWh (Nov.2006) for the first 20 year period.¹²⁹

Market Outlook

The Israeli government has pledged to construct a new solar power station each year for the next 20 years. According to a speech made by Minister of National Infrastructures, Mr. Binyamin (Fouad) Ben-Eliezer at the Renewable Energy and Beyond Conference in Tel Aviv University the country expects to generate 35% of total electricity through solar power stations by the end of the next decade. Under its national CSP programme, the country aims to encompass about 500 MW of CSP capacities by 2010 and another 1,000 MW by 2015¹³⁰.

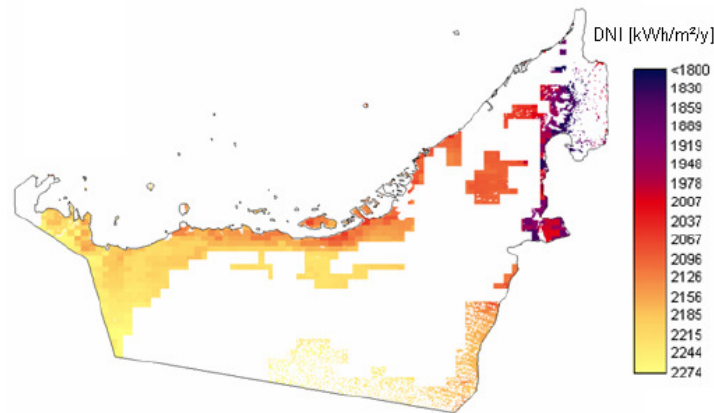
UAE

To tap the country's solar energy potential, UAE is focusing on solar energy for electricity and water desalination. A 100 MW CSP plant is being planned in Abu Dhabi. The tendering process to expand the plant to 500 MW is currently in progress.

Regarding initiatives in R&D, the Swiss centre of electronic and micro technology (CSEM or Centre Suisse d'Electronique et de Microtechnique) is developing a prototype of a floating solar island in Ras Al Khaimah with \$5 million in government funding. The prototype will have 85m in diameter and will produce an average of 250 kw¹³¹.

Solar resources

EXHIBIT 32. SOLAR RESOURCES IN UAE¹³²



The UAE offers excellent solar resources for CSP, receiving an average annual solar irradiance of approximately 2200 kWh/m²/year.

¹²⁹ Solar Spaces. 2006. Israeli Feed-in Tariff for CSP. Available at: <http://www.solarpaces.org/News/news.htm>

¹³⁰ Ministry of National Infrastructures. 2008. Renewable Energy. Available at: <http://www.mni.gov.il/mni/en-US/Energy/Messages/SpokesmanRenewableEnergy.htm>

¹³¹ CSP Today (2008) <http://social.csptoday.com/content/solar-island-prototype-get-completed-year-end>

¹³² DLR. 2005. Concentrating Solar Power in the Mediterranean Region. Online. Available at: http://www.dlr.de/tt/desktopdefault.aspx/tabid-2885/4422_read-6573/

Regulatory Environment

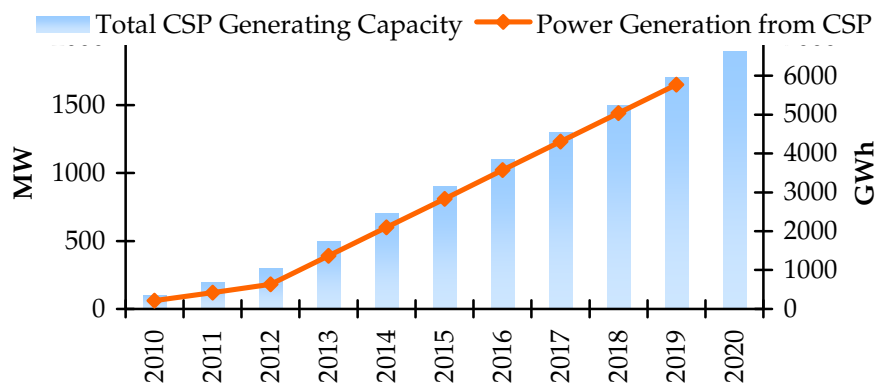
Government Policies

In order to develop and commercialize renewable energy technologies, Abu Dhabi Future Energy Company, has launched “Masdar Initiative” in UAE. A research centre and a graduate-level scientific institute will be set up under the initiative. To encourage renewable technology companies, UAE will host a special “green zone” in 2009. The Massachusetts Institute of Technology is assisting with the educational institute. The Masdar Clean Tech Fund, a US\$ 250 million private equity fund, has been created with Credit Suisse and Consensus Business Group as partners to acquire stakes in clean energy, water and environmental companies.¹³³

Market Outlook

Abu Dhabi aims to be a global and regional leader in the renewable energy market with Masdar wanting the UAE to become an exporter of solar technology by 2015¹³⁴.

EXHIBIT 33. ELECTRICITY FROM CSP - DEMAND-SUPPLY SCENARIO IN UAE¹³⁵



Market Challenge

While the value of land continues to soar on the back of a robust construction sector, there is a rising concern over UAE’s capability to allocate enough space for solar thermal plants. Allocation of large amount of land is one of the challenges for a shift towards the use of alternative energy in UAE. The fact that CSP requires vast areas of land and that land is scarce, and expensive, in this country could make it difficult for CSP to be a cost effective option for producing electricity. Policy makers and developers will have to decide whether electricity production from CSP is the best way of using land in the UAE.

The prototype floating solar island project being tested at Ras Al Khaimah, if successful, can resolve the land availability issue in UAE to a greater extent. The energy produced from solar islands could be used as a feed in thermal plants for power generation and desalination of water.

Contribution of CSP to total Electricity Production

¹³³ Business Intelligence – Middle East. 2007. There is a major new player in the clean technology industry: Gulf oil money. Online. Available at: <http://www.bi-me.com/main.php?c=34&cg=&id=9953&t=1>

¹³⁴ The Financial Times. 2007. Abu Dhabi eyes renewable energy future. Available at: http://www.masdarctf.com/pdf/FT_AbuDhabi.pdf

¹³⁵ DESERTEC. 2008. MASDAR Presentation. Online. Available at: <http://www.desertec.org/index.html>

According to UAE government document “Policy of the UAE on the Evaluation and Potential Development of Peaceful Nuclear Energy”, estimates that renewable energy could contribute to 6-7% of peak demand by 2020.¹³⁶

¹³⁶ UAE (2008) http://www.carnegieendowment.org/static/npp/reports/UAE_white_paper.pdf

Export potential for electricity generated from CSP

In order to reduce costs, increase reliability and energy security and to encourage cooperation within Mediterranean countries of Europe, North Africa and the Middle East, the potential for electricity generation through CSP and distribution through grid connected transmission network is being explored. Transnational power lines are being developed, that could be tapped into by renewable energies.

Potential for export opportunities are explored by North African and Middle East countries along with the European Union. Although losses could be up to 15% for transmission between the Middle East and North Africa (MENA) and Europe, it will be more than offset by efficiency gains through higher levels of solar radiation in MENA, about twice the level in southern Europe. Moreover, there is less seasonality in levels of solar irradiance in MENA than in Europe.¹³⁷

1.4.2 Exporting CSP generated electricity from MENA to Europe

According to the European Commission's Directorate-General for Energy and Transportation, through an interconnected electric grid, MENA could provide the EU with 700 TWh/year of electricity by 2050. Twenty power lines with a capacity of 2.5-5.0 GW could be developed by 2050, providing about 15% of the European electricity demand by solar imports.¹³⁸

EXHIBIT 34. MEDITERRANEAN ELECTRICITY LOOP FOR EXPORTS-IMPORTS¹³⁹



With a wider range of supplying countries, CSP with a super-grid promises a better security of supply. According to TREC-UK, a better technique would be transmitting electricity produced from CSP over a network of smaller transmission lines and submarine cables rather than a few

¹³⁷ DESERTEC. 2008. TREC Summary. Online. Available at: http://www.desertec.org/downloads/summary_en.pdf

¹³⁸ DLR. 2007. Trans-Mediterranean Interconnection for Concentrating Solar Power. Online. Available at: http://www.dlr.de/tt/desktopdefault.aspx/tabid-2885/4422_read-6588/

¹³⁹ World Bank, GEF. 2006. Assessment of the World Bank/GEF Strategy for the Market Development of Concentrating Solar Thermal Power. Online. Available at: http://www-wds.worldbank.org/servlet/main?menuPK=64187510&pagePK=64193027&piPK=64187937&theSitePK=523679&entityID=000310607_20060926171106

large transmission lines. This would make the CSP grids easy to repair and difficult to be damaged by any kind of attack.¹⁴⁰

- North Africa could distribute electricity around Europe using a high voltage direct current (HVDC) super-grid. The loss of energy between North Africa and London would be less than 10% as HVDC loses only about 3% power per 1000 km, as against losses of 50% to 70% for HVAC. Just like upgrading road networks, HVDC may be phased in without the need to replace HVAC grids.
- Germany and The Netherlands have confirmed support for the Desertec proposal of building a network of CSP plants throughout the MENA region and importing electricity from solar energy produced in MENA.

Export potential for electricity generated from CSP in Algeria to Europe

A consortium of investors including Algerian state energy giant Sonatrach, which is a shareholder in NEAL, plans to carry out a project for exporting solar power to Germany through transmission cables which will be routed via Sardinia, northern Italy and Switzerland. The estimated cost of the cable stands at US\$ 2.85 billion.

The 3,000 km (1,875 mile) cable would be laid from the Algerian town of Adrar to the German city of Aachen across the Mediterranean to the island of Sardinia, mainland Italy, Switzerland and Germany.

Electricity for the project will be produced initially from ISCCs plants and would combine solar power with fossil-fuels resources. However, over the long term, the electricity generated would eventually come from solar-only projects. The export of CSP electricity depends on final approval from all the governments involved. Algeria's long-term goal is to export 6,000 MW of solar-generated power to Europe by 2020.

1.4.3 Transmission Networks in the Middle East

The Gulf States Cooperation Council (GCC) initiated the power grid project in 2005 with the objective of establishing an integrated electricity network in the Middle East by 2010. This network is expected to produce 100 GW of additional power over the next 10 years to meet rising demand at an estimated cost of US\$ 100 billion. Saudi Arabia, Qatar, Bahrain, Kuwait, Oman and the United Arab Emirates are the states involved. In the first phase, 13 contracts worth US\$ 1.25 billion to link Saudi Arabia with Kuwait, Bahrain and Qatar will be awarded.

The interconnections between states provide an alternative source of operating reserves and support during emergencies. New renewable energy technologies such as CSP can be set up and transferred across the region to load centres. Through diversification of energy resource, the interconnection can increase system efficiency in an individual GCC country as they can import power from alternate sources such as solar plants.

¹⁴⁰ TREC-UK. 2007. Clean power from deserts. Online. Available at: www.trec-uk.org.uk/resources/csp_talk4.ppt

5. Main Commercial Projects

Main Commercial Projects in Europe and MENA						
Company	Name	Location	Technology	Capacity	Solar Capacity	Status
Acciona						
	La Risca	Alvarado, Badajoz, Spain	Parabolic Trough		50 MW	Under Construction
	Majadas de Tietar	Cáceres, Spain	Parabolic Trough		50 MW	Planning
	Palma del Rio I	Córdoba, Spain	Parabolic Trough		50 MW	Planning
	Palma del Rio II	Córdoba, Spain	Parabolic Trough		50 MW	Under Construction
Abengoa						
	PS 10	Sanlucar la Mayor, Sevilla, Spain	Tower		11MW	Operating
	PS 20	Sanlucar la Mayor, Sevilla, Spain	Tower		20 MW	Under Construction
	Solnova I	Sanlucar la Mayor, Sevilla, Spain	Parabolic Trough		50 MW	Under Construction
	Solnova II	Sanlucar la Mayor, Sevilla, Spain	Parabolic Trough		50 MW	Planning
	Solnova III	Sanlucar la Mayor, Sevilla, Spain	Parabolic Trough		50 MW	Under Construction

	Solnova IV	Sanlúcar la Mayor, Sevilla, Spain	Parabolic Trough		50 MW	Under Construction
	Solnova V	Sanlúcar la Mayor, Sevilla, Spain	Parabolic Trough		50 MW	Planning
	Ecija 1	Ecija, Andalucía, Spain	Parabolic Trough		50 MW	Planning
	Ecija 2	Ecija, Andalucía, Spain	Parabolic Trough		50 MW	Planning
	Helios 1	Ciudad Real, Castilla la Mancha, Spain	Parabolic Trough		50 MW	Planning
	Helios 2	Ciudad Real, Castilla la Mancha, Spain	Parabolic Trough		50 MW	Planning
	Almaden	Albacete, Castilla la Mancha, Spain	Tower		20 MW	Planning
	AZ20	Sanlúcar la Mayor, Sevilla, Spain	Tower		20 MW	Planning
	Aznalcóllar TH	Sanlúcar la Mayor, Sevilla, Spain	Dish Stirling		80 kW	Planning
	Hassi-R'mel ISCC	Hassi-R'mel, Algeria	Parabolic Trough	150 MW	20 MW	Under Construction
	Ain-Ben-Mathar ISSC	Ain-Ben-Mathar, Morocco	Parabolic Trough	470 MW	20 MW	Under Construction

ACS-Cobra						
Ownership 75% ACS-Cobra	Andasol 1	Guadix, Granada, Spain	Parabolic Trough		50 MW (Thermal Storage)	Under Construction
Ownership 75% ACS-Cobra and	Andasol 2	Guadix, Granada, Spain	ParabolicTrough		50 MW (Thermal storage)	Under Construction
	Andasol 4	Guadix, Granada, Spain	Parabolic Trough		50 MW	Planning
	Extresol 1	Badajoz, Spain	Parabolic Trough		50 MW	Under Construction
	Extresol 2	Badajoz, Spain	Parabolic Trough		50 MW	Under Construction
	Extresol 3	Badajoz, Spain	Parabolic Trough		50 MW	Planning
	Manchasol 1	Ciudad Real, Spain	Parabolic Trough		50 MW	Planning
	Manchasol 2	Ciudad Real, Spain	Parabolic Trough		50 MW	Planning
Albisa						
		Cáceres, Saucedilla, Spain	Parabolic Trough		50 MW	Planning
ARIES Ing.						
	Aste 1	Alcázar de San Juan, Spain	Parabolic Trough		50 MW (8hrs storage)	Unknown

	Aste 2	Alcázar de San Juan, Spain	Parabolic Trough		50 MW (8hrs storage)	Unknown
	AXTESOL	Badajoz, Spain	Parabolic Trough		50 MW (8 hrs storage)	Unknown
Iberdrola						
Consortium with Mitsui	Kuraymat ISCC	Kuraymat, Egypt	Parabolic trough	150 MW	40 MW	Under Construction
	Ibersol Zamora	Spain	Parabolic trough		50 MW	Unknown
	Ibersol Badajoz	Spain	Parabolic trough		50 MW	Unknown
	Ibersol Sevilla	Spain	Parabolic trough		50 MW	Unknown
	Ibersol Valdecaballeros I	Spain	Parabolic trough		50 MW	Unknown
	Ibersol Valdecaballeros II	Spain	Parabolic trough		50 MW	Unknown
	Ibersol Almeria	Spain	Parabolic trough		50 MW	Unknown
	Ibersol Murcia	Spain	Parabolic trough		50 MW	Unknown
	Ibersol Albacete	Spain	Parabolic trough		50 MW	Unknown
	Ibersol Puertollano	Spain	Parabolic trough		50 MW	Under Construction
	Ibersol Teruel	Spain	Parabolic trough		50 MW	Unknown
	Ibersol Soria	Spain	Parabolic trough		50 MW	Unknown

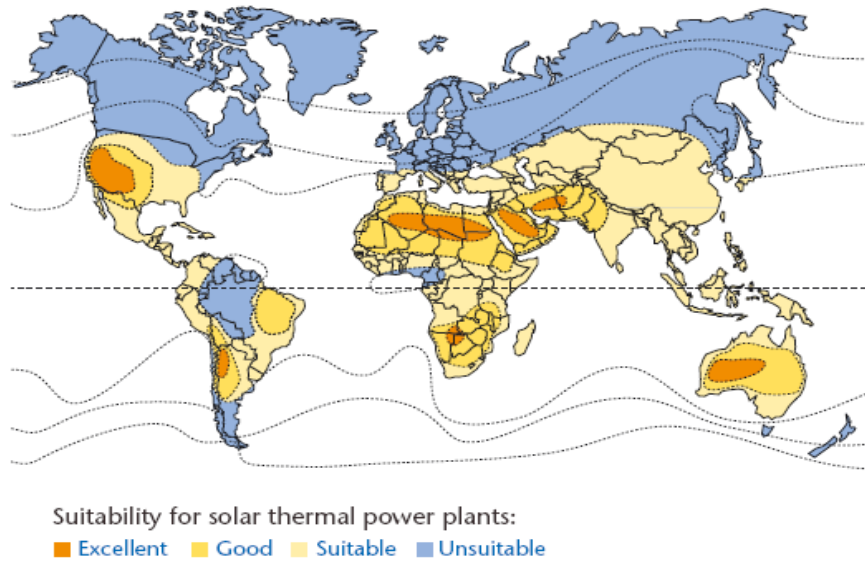
	Ibersol Madrid	Spain	Parabolic trough		50 MW	Unknown
Solar Power Group						
		Gotarrendura, Spain	Fresnel Collector		10 MW	Planning
Solel/Sacyr						
		Lebrija, Spain	Parabolic Trough		50 MW x 3	Under Construction
Torresol						
Ownership: Sener (60%) Masdar (40%)	Gemasolar (previously Solar Tres)	Sevilla, Spain	Tower		17 MW (15hrs storage)	Under Construction
Ownership: Sener (60%) Masdar (40%)	Termesol 50	Sevilla, Spain	Parabolic Trough		50 MW (7 hrs storage)	Under Construction
Ownership: Sener (60%) Masdar (40%)	Arcosol 50	Cadiz, Spain	Parabolic Trough		50 MW (7hrs storage)	
SAMCA						
	-	Aragon, Spain	Parabolic Trough		50 MW	-
	-	Extremadura	Parabolic Trough		50 MW	Under Construction
Solar Millennium						
	Andasol 3	Guadix, Granada, Spain	Parabolic Trough		50 MW (Thermal storage)	Under Construction

Ownership: Solar Millenium (75%), Flabeg, Fitchner and OADYK own the remaining 25%)	Theseus	Crete, Greece	Parabolic Trough		50 MW	Under Construction
Ownership: Solar Millennium (50%) & Neo Energia (50%)	Murciasol 1	Murcia, Spain	-		50 MW (7hrs storage)	-
	Extremasol	Extremadura, Spain	-		50 MW (7hrs storage)	-
Other Projects						
	Archimedes Project	Italy		370 MW	5 MW (Therma 1 storage)	Under Construction
	Negev Dessert	Israel	-		250 MW	Open for Tenders
	Shams 1	UAE	-		100 MW	Open for Tenders
	Yazd ISCC	Iran	-	430 MW	67 MW	-
	Naâma	Algeria	-	400 MW	75 MW	-
	Meghaïer	Algeria	-	400 MW	75 MW	-
	Hassi R'Mel (2nd Phase)	Algeria	-	400 MW	75 MW	-
	-	Portugal	Fresnel		6.5 MW	-

Source: CSP Today

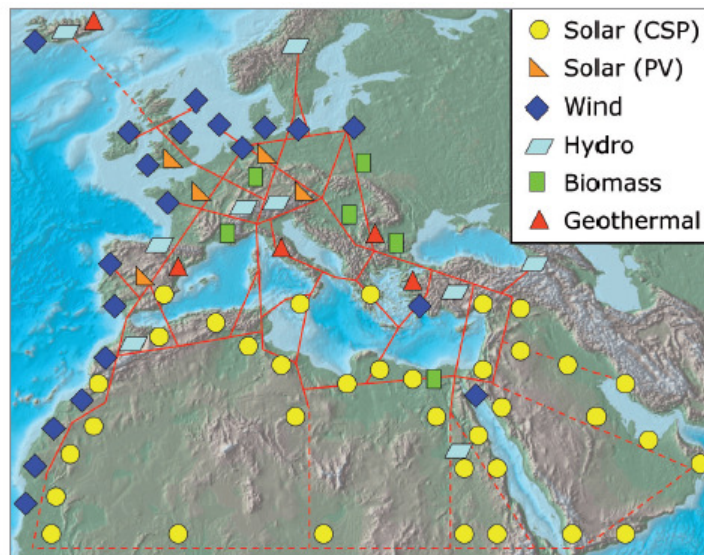
6. Additional Information

Global Solar Resources¹⁴¹



Source: Schott Memorandum: 2006

Proposed EU-MENA Supergrid Structure¹⁴²



Source: DLR 2007

¹⁴¹ Schott AG. Schott Memorandum on Solar. Thermal Power Plant Technology. 2006. [Online]. Available at: www.schott.com/solar/english/download/schott_memorandum_e.pdf. [Accessed August 11, 2008]

¹⁴² DLR. 2007. Trans-Mediterranean Interconnection for Concentrating Solar Power. Online. Available at: http://www.dlr.de/tt/desktopdefault.aspx/tabid-2885/4422_read-6588/

Cost of CSP Plant in Europe¹⁴³ (Source: Commission of the EC, 2007)

Capital investment for solar-only reference systems of 50 MW are currently of the order of 3 300 to 4 500 €/kW. The upper limit accounts for systems with thermal storage to achieve capacity factor of between 5000 to 6000 hours.

Depending on the Direct Normal Irradiation (DNI), the cost of electricity production is currently in the order of 20 c€/kWh (South Europe – DNI: 2000 kWh/m²/a).

For DNI in the range of 2300 or 2700 as encountered in the Sahara region or in the US, the current cost could be decreased by 20% to 30%.

The important resource base in neighbouring Mediterranean countries of Europe makes it possible to envisage importing CSP energy. For a given DNI, cost reduction of the order of 25% to 35% is achievable due to technological innovations and process scaling up to 50 MW. Facility scaling up to 400 MW will result in cost reduction of the order of 14%.

Benefits to Europe by implementation of CSP projects¹⁴⁴ (Source: Commission of the EC, 2007)

Carbon Dioxide Emissions

Realising the maximum potential, CSP energy could potentially avoid up to 35 Mt/year CO₂ in 2020 and 130 Mt/year CO₂ in 2030, with respect to the baseline. The corresponding maximum cumulative avoided CO₂ emission for the period 2010 to 2030 would be up to 1035 MtCO₂.

Security of Supply

The maximum potential achievement for CSP could lead to avoiding up to 10 Mtoe of fossil fuel use in 2020 and 40 Mtoe in 2030. The corresponding maximum cumulative fossil fuel avoidance would be of 315 Mtoe, for the period 2010 to 2030. These figures do not account for the possible needs for fossil-fuel based power back-up to firm CSP capacities.

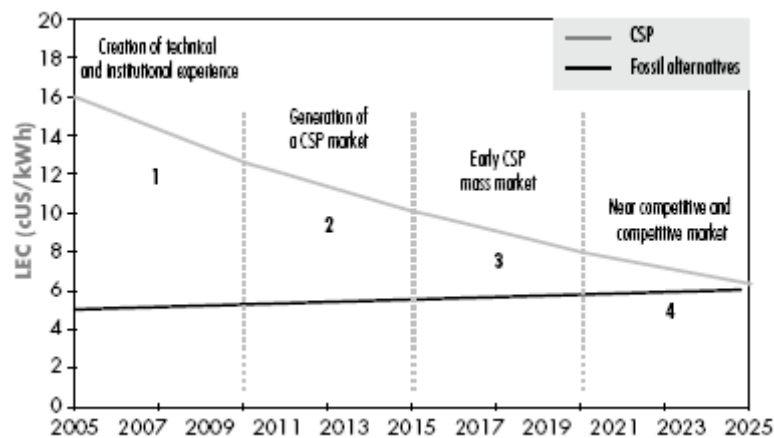
Competitiveness

CSP penetration to its maximum potential will bring about an increase of the overall cost of electricity production up to 0.3% in 2020 and in 2030, with respect to the baseline.

¹⁴³ Commission of the European Communities. 2007. A European Strategic Energy Technology Plan (SET-Plan). Online. Available at: ec.europa.eu/energy/res/setplan/doc/com_2007/2007_technology_map_en.pdf.

¹⁴⁴ Commission of the European Communities. 2007. A European Strategic Energy Technology Plan (SET-Plan). Online. Available at: ec.europa.eu/energy/res/setplan/doc/com_2007/2007_technology_map_en.pdf.

CSP Cost Reduction Curve¹⁴⁵ (World Bank/GEF, 2007)



Detailed Cost Structure of 100-MW CSP Plant¹⁴⁶ (DLR, 2003)

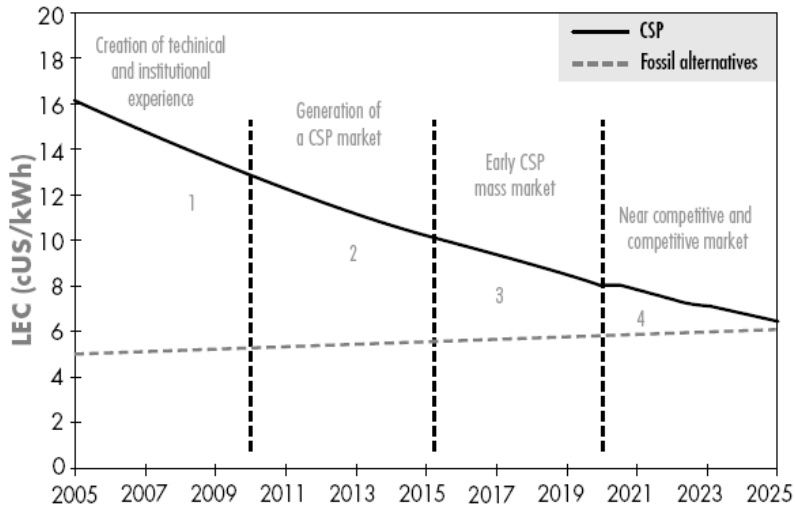
Irrespective of the technology used, a 100 MW solar plant with thermal storage requires:

- 4 km² of land
- 25 000 tons of steel
- 12 000 tons of glass
- 30 000 tons of storage medium
- 20 000 m³ of concrete
- This requires transport by 4000 20 tonnes trucks or 2000 railway wagons
- A 100 MW solar power plant with 9 hour storage means today an investment of 400 million €, 1000 jobs during construction and 100 jobs during the 25 years of operation.

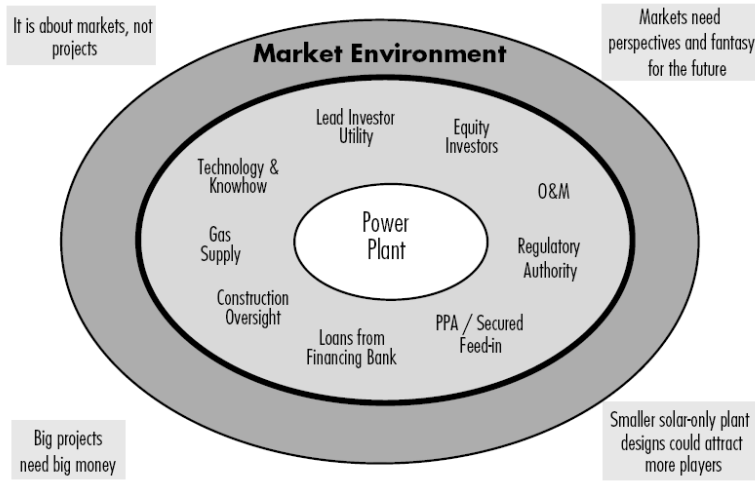
¹⁴⁵ World Bank, GEF. 2006. Assessment of the World Bank/GEF Strategy for the Market Development of Concentrating Solar Thermal Power. Online. Available at: http://www-wds.worldbank.org/servlet/main?menuPK=64187510&pagePK=64193027&piPK=64187937&theSitePK=523679&entityID=000310607_20060926171106

¹⁴⁶ DLR. 2003. Concentrating Solar Power: A Vision for Sustainable Electricity Generation. Online. Available at: www.ecm.auckland.ac.nz/conf/Auckland_2.pdf

Four Stages in the Development of CSP¹⁴⁷ (World Bank/GEF, 2006)



Market Environment for the Introduction of CSP Technology¹⁴⁸ (World Bank/GEF, 2006)



¹⁴⁷ World Bank, GEF. 2006. Assessment of the World Bank/GEF Strategy for the Market Development of Concentrating Solar Thermal Power. Online. Available at: http://www-wds.worldbank.org/servlet/main?menuPK=64187510&pagePK=64193027&piPK=64187937&theSitePK=523679&entityID=000310607_20060926171106

¹⁴⁸ World Bank, GEF. 2006. Assessment of the World Bank/GEF Strategy for the Market Development of Concentrating Solar Thermal Power. Online. Available at: http://www-wds.worldbank.org/servlet/main?menuPK=64187510&pagePK=64193027&piPK=64187937&theSitePK=523679&entityID=000310607_20060926171106

Cost Reduction Potentials Due To Technical Improvements¹⁴⁹ (World Bank/GEF, 2006)

Parabolic Trough	Tower	Linear Fresnel	Dish
Innovative structures (up to 28%)	Larger heliostats above 200 m2 (up to 12%)	Linear Fresnel collector field (up to 3%)	Mass production for 50 MW (38%)
Front surface mirrors (up to 19%)	Larger module size (up to 15%)	Thermal storage (up to 15%)	Brayton instead of Stirling cycle (up to 12%)
Advanced storage (up to 18%)	Ganged heliostats (up to 8%)	Reduced pressure losses (up to 7%)	Improved availability and O&M (up to 11%)
Reduced pressure losses (up to 16%)	Advanced storage (up to 10%)	Dust repellent mirrors (up to 7%)	Increased unit size (up to 9%)
Dust repellent mirrors (up to 16%)	Increased fluid temperature (up to 6%)	Reduced engine costs (up to 6%)	
Increased solar field outlet temperature (up to 15%)	Increased engine efficiency (up to 6%)		

¹⁴⁹ World Bank, GEF. 2006. Assessment of the World Bank/GEF Strategy for the Market Development of Concentrating Solar Thermal Power. Online. Available at: http://www-wds.worldbank.org/servlet/main?menuPK=64187510&pagePK=64193027&piPK=64187937&theSitePK=523679&entityID=000310607_20060926171106

Capacity and Cost Analysis for Export-Import of CSP between Europe and MENA¹⁵⁰ (TREC, 2008)

Year		2020	2030	2040	2050
Transfer Capacity GW		2*5	8*5	14*5	20*5
Electricity Transfer TWh/y		60	230	470	700
Capacity Factor		0.60	0.67	0.75	0.80
Turnover Billion €/y		3.8	12.5	24.0	35.0
Land Area	CSP	15*15	30*30	40*40	50*50
km*km	HVDC	3100*0.1	3600*0.4	3600*0.7	3600*1.0
Investment	CSP	42	143	245	350
Billion €	HVDC	5	20	31	45
Elec. Cost	CSP	0.050	0.045	0.040	0.040
€/kWh	HVDC	0.014	20.010	0.010	0.010

¹⁵⁰ DESERTEC. 2008. TREC Summary. Online. Available at: http://www.desertec.org/downloads/summary_en.pdf

Scenario for CSP Market Development¹⁵¹ (TREC, 2004)

Period	Comment	Total Installed Capacity for Power & Water	Investment	Support Required	Cost Level Achieved for Power & Water *
2004 – 2006	MENA Demand Side Strategy Development and Assessment Phase, Optionally first POSEIDON Plant	0 – 5 MW, 0 – 1.7 Mm ³ /y	0.5 - 20 million US\$	Public Private Partnership, Technology & Resource Assessment Study, Strategy Development, Political Support	5.1 – 7.8 ct/kWh 75 – 90 ct/m ³
2006 – 2010	Technology Transfer Phase	355 MW, 118 Mm ³ /y	1.3 billion US\$	Public Private Partnership, Soft Loans, Grants, Long-Term Power & Water Purchase Agreements, Guaranteed Feed-in Tariffs, Insurance & Guaranties	3.8 – 6.8 ct/kWh 75 – 90 ct/m ³
2010 – 2015	Technology Establishment Phase	2079 MW, 693 Mm ³ /y	7.4 billion US\$	Public Private Partnership, Soft Loans, Grants, Long-Term Power & Water Purchase Agreements, Guaranteed Feed-in Tariffs, Insurance & Guaranties	3 – 6 ct/kWh 60 – 90 ct/m ³
2015 – 2020	Market Settlement Phase	6600 MW, 2200 Mm ³ /y	21.9 billion US\$	Public Private Partnership, Long-Term Power & Water Purchase Agreements, Insurance & Guaranties	3 – 5.2 ct/kWh 29 – 90 ct/m ³
2020 – 2025	Market Expansion Phase	21 GW, 7 billion m ³ /y	80 billion US\$	Public Private Partnership, Long-Term Power & Water Purchase Agreements	3 – 5 ct/kWh 15 – 75 ct/m ³
2025 – 2050	Commercial Phase	450 GW, 150 billion m ³ /y	2000 billion US\$	None	3 – 5 ct/kWh 5 – 65 ct/m ³

* Variation between Reference Scenario (9% Interest Rate, 20 Years Capital Return Period) and Optimized Conditions Scenario (4% Interest Rate, 40 Years Project Life)

¹⁵¹ TREC. 2004. A World Sustainability Project - Solar Thermal Power & Desalination in EU-MENA. Online. Available at: http://www.gezen.nl/wordpress/wp-content/uploads/2006/09/sanaa-paper-and-annex_15-04-2004.pdf