Current CSP Project Development

The current development of CSP projects is very dynamic and therefore difficult to assess. At the end of 2008 approximately 482 MW capacity of commercial plants were in operation of which almost 419 MW were installed in the USA, 63 MW in Spain and 0.36 MW in Australia. The concept mostly used is parabolic trough mirrors with an overall capacity of 468.8 MW. The remaining 13.36 MW are a tower project in Spain with 11 MW, a Fresnel reflector system with 2 MW in Spain and another one in Australia with 0.36 MW capacity (Table 1).

Most of the existing capacity was built in a period from the mid 80ies to the early 90ies. The development back then was ascribed to the oil shock in the late 70ies and the resulting rise of electricity prices. As the prices declined shortly afterwards no further CSP projects were initiated due to the decreased competitiveness and the missing political promotion.

Table 1: CSP plants in operation in March 2009.

Plant name	Net Power Capacity [MW_e]	Type	Constructor	Country	Year of initial operation
SEGS 1	13,8	Parabolic trough	Luz	USA	1985
SEGS 2	30	Parabolic trough	Luz	USA	1986
SEGS 3	30	Parabolic trough	Luz	USA	1987
SEGS 4	30	Parabolic trough	Luz	USA	1987
SEGS 5	30	Parabolic trough	Luz	USA	1988
SEGS 6	30	Parabolic trough	Luz	USA	1989
SEGS 7	30	Parabolic trough	Luz	USA	1989
SEGS 8	80	Parabolic trough	Luz	USA	1990
SEGS 9	80	Parabolic trough	Luz	USA	1991
Arizona Public Services Saguaro Project	1	Parabolic trough	Solargenix Energy	USA	2006
Nevada Solar One	64	Parabolic trough	Acciona/ Solargenix Energy	USA	2007
PS10	11	Tower	Abengoa Solar	Spain	2007
Liddell Power Station	0.36	Fresnel reflector		Australia	2007
Andasol 1	50	Parabolic trough	Solar Millenium and ACS/Cobra	Spain	2009
Puerto Errado 1	2	Fresnel reflector	Tubo Sol Murcia, S.A.	Spain	2009

As the use of renewable energies became more important in the recent years and several governments adopted promotion schemes, the use of CSP is experiencing a revival. In 2007 three installations with a total capacity of about 75 MW came into operation followed by another installation with 52 MW in 2008.

Another 16 projects were under construction at the end of 2008 summing up to a capacity of 540 MW (Table 2). Again Spain with 389 MW and the USA with 86 MW are the largest

contributors to this development. The remaining projects are constructed in Egypt (25 MW) as well as Algeria (20 MW) and Morocco (20 MW).

Table 2: CSP plants under construction at the end of 2008.

Plant name	**Net Power Capacity [MW_e]**	**Type**	**Constructor**	**Country**
Martin Next Generation Solar Energy Center	75	ISCC	FPL	USA
Andasol 2	50	Parabolic trough	Solar Millenium and ACS/Cobra	Spain
Andasol 3	50	Parabolic trough	MAN Solar Millenium (JV MAN Ferrostaal + SM), Duro Felguera S.A. Energía, Gijón [2]	Spain
Extresol 1	50	Parabolic trough	ACS/Cobra	Spain
Solnova 1	50	Parabolic trough	Abengoa Solar	Spain
Solnova 3	50	Parabolic trough	Abengoa Solar	Spain
Puertollano	50	Parabolic trough	Iberdrola	Spain
La Risca 1 or Alvarado	50	Parabolic trough	Acciona	Spain
Kuraymat Plant	25	ISCC	Solar Millenium	Egypt
Hassi R'mel	20	ISCC	Abengoa Solar	Algeria
Ain Beni Mathar Plant	20	ISCC	Abengoa Solar	Morocco
PS 20	20	Tower	Abengoa Solar	Spain
Solar Tres	19	Tower	Sener/Torrosol	Spain
Esolar Demonstrator	5	Tower	Esolar	USA
Kimberlina	5	Fresnel	Ausra	USA
Keahole Solar Power	1	Parabolic trough	Sopogy	USA

The dominating technology is once again parabolic trough. Eight projects use this technology summing up to an overall installation of 351 MW. Another four projects are hybrid installations so called Integrated Solar Combined Cycle (ISCC) plants. This technology combines a solar field of parabolic trough collectors with a gas fire combined cycle plant. The capacities referred to in Table 2 are the solar share of the overall capacity. The tower technology is applied in three projects under construction at the moment aiming for 44 MW of installed capacity. The Fresnel technology is currently in the process of installation in one project in the USA. Figure 1 shows CSP capacities currently in operation or under construction per country.

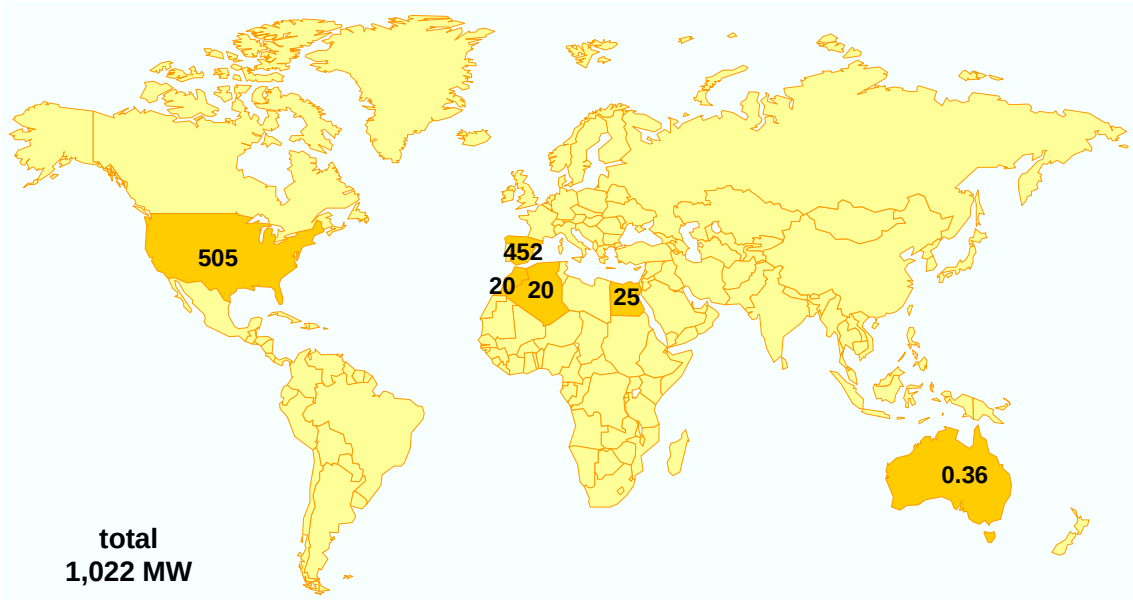

Figure 1: CSP capacities in operation or under construction at the end of 2008.

It is not clear how large the number of currently planned installations is. Declarations of intend can be found on many different levels regarding existing technology as well as demonstration projects of new technological developments. The status of many of these projects is constantly changing. Figure 2 and the following Tables give an overview of announced projects at the end of 2008 excluding political goals like Chinas target to install 1,000 MW CSP capacity until 2020.

Overall 5,975 to 7,415 MW planned capacity of CSP plants could be identified on a project level that was announced until the end of 2008 (Figure 2). The countries that account for the majority of these projects are once again the USA and Spain. Table 3 shows a detailed list of the announced installations in the USA that amounted to 3,407 to 4,847 MW. Another 1,980 MW are planned in Spain (Table 4). It can be observed that the list of projects in Spain is a lot larger than the one in the United States even though the overall announced capacity is smaller. The reason for this is the promotion scheme of Spain that provides a feed in tariff for installations up to 50 MW. The remaining announcements of another 588 MW planned capacity can be found in various other countries (Table 5).

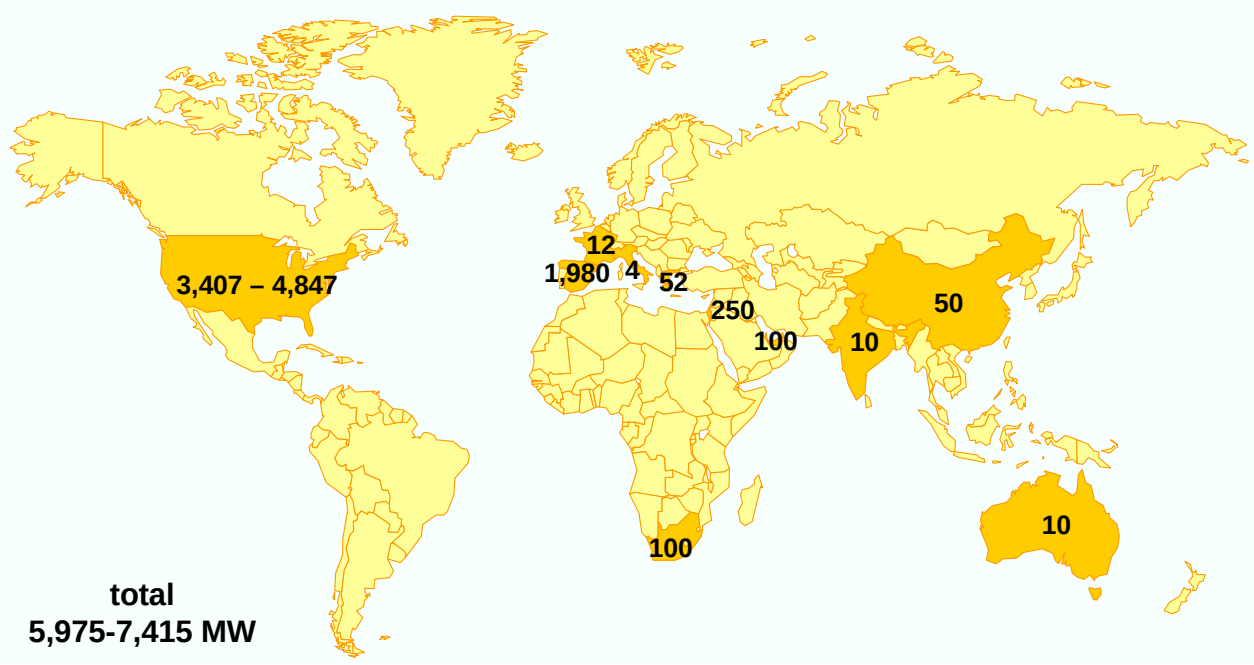

Figure 2: Announced CSP installations at the end of 2008.

Table 3: Announced CSP installations in the USA.

Plant name	Net Power Capacity [MW_e]	Type	Constructor	Country
Ivanpah 1	123	Tower	Brightsource	USA
Ivanpah 2	100	Tower	Brightsource	USA
Ivanpah 3	200	Tower	Brightsource	USA
(Brightsource other)	100 (+400)	Tower	Brightsource	USA
Mojave Solar Park	553	Parabolic trough	Solel	USA
SES Solar One	500 (+300)	Dish	Stirling Energy Systems	USA
SES Solar Two	300 (+600)	Dish	Stirling Energy Systems	USA
Solana	280	Parabolic trough	Abengoa	USA
Carrizo Solar Farm	177	Fresnel	Ausra	USA
Beacon Solar Energy Project	250	Parabolic trough	FPL	USA
Gaskell Sun Tower	105-245	Tower	Esolar	USA
San Joaquin Solar 1 & 2	107	Parabolic trough	Martifer Renewables	USA
City of Palmdale Hybrid Power Project	62	ISCC		USA
Harper Lake Energy Park	500	Parabolic trough		USA
Victorville 2 Hybrid Power Project	50	ISCC		USA

Table 4: Announced CSP installations in Spain.

Plant name	**Net Power Capacity [MW_e]**	**Type**	**Constructor**	**Country**
Lebrija 1	50	Parabolic trough	Solel	Spain
Andasol 4	50	Parabolic trough	ACS/Cobra	Spain
Extresol 2	50	Parabolic trough	ACS/Cobra	Spain
Extresol 3	50	Parabolic trough	ACS/Cobra	Spain
Manchasol 1	50	Parabolic trough	ACS/Cobra	Spain
Manchasol 2	50	Parabolic trough	ACS/Cobra	Spain
Andasol 5	50	Parabolic trough	Solar Millenium	Spain
Andasol 6	50	Parabolic trough	Solar Millenium	Spain
Andasol 7	50	Parabolic trough	Solar Millenium	Spain
Solnova 2	50	Parabolic trough	Abengoa	Spain
Solnova 4	50	Parabolic trough	Abengoa	Spain
Solnova 5	50	Parabolic trough	Abengoa	Spain
AZ 20	20	Tower	Abengoa	Spain
Aznalcollar TH	0,08	Dish	Abengoa	Spain
Ecija 1	50	Parabolic trough	Abengoa	Spain
Ecija 2	50	Parabolic trough	Abengoa	Spain
Helios 1	50	Parabolic trough	Abengoa	Spain
Helios 2	50	Parabolic trough	Abengoa	Spain
Almaden Plant	20	Tower	Abengoa	Spain
Termesol 50	50	Parabolic trough	Sener	Spain
Arcosol 50	50	Parabolic trough	Sener	Spain
Ibersol Badajoz	50	Parabolic trough	Iberdrola	Spain
Ibersol Valdecaballeros 1	50	Parabolic trough	Iberdrola	Spain
Ibersol Valdecaballeros 2	50	Parabolic trough	Iberdrola	Spain
Ibersol Sevilla	50	Parabolic trough	Iberdrola	Spain
Ibersol Almería	50	Parabolic trough	Iberdrola	Spain
Ibersol Albacete	50	Parabolic trough	Iberdrola	Spain
Ibersol Murcia	50	Parabolic trough	Iberdrola	Spain
Ibersol Zamora	50	Parabolic trough	Iberdrola	Spain
Enerstar Villena Power Plant	50	Parabolic trough	Enerstar	Spain
Gotasol	10	Fresnel	Solar Power Group	Spain
Aste 1 A	50	Parabolic trough	Aries	Spain
Aste 1 B	50	Parabolic trough	Aries	Spain
Aste 3	50	Parabolic trough	Aries	Spain
Aste 4	50	Parabolic trough	Aries	Spain
Astexol 1	50	Parabolic trough	Aries	Spain
Astexol 2	50	Parabolic trough	Aries	Spain
Puerto Errado 2	30	Fresnel	Tubo Sol Murcia, S.A.	Spain
La Risca 2	50	Parabolic trough	Acciona	Spain
Palma del Rio 1	50	Parabolic trough	Acciona	Spain
Palma del Rio 2	50	Parabolic trough	Acciona	Spain
Consol 1	50	Parabolic trough	Conergy	Spain
Consol 2	50	Parabolic trough	Conergy	Spain

Table 5: Announced CSP installations various countries.

Plant name	Net Power Capacity [MW_e]	Type	Constructor	Country
Ashalim	250	Parabolic trough		Israel
Uppington	100	Tower	Eskom	South Africa
Shams	100	Parabolic trough		ABU DHABI
Cloncurry solar power station	10	Tower	Ergon Energy	Australia
Archimede	3,75	ISCC	Enel etc.	Italy
Solenha	12	Parabolic trough	Solar Euromed	France
Theseus Project	52	Parabolic trough	Solar Millenium	Greece
	50	Parabolic trough	Solar Millenium	China
	10		ACME	India

As the development is rapid and many projects might have slipped through the collection displayed above a number of other publications will be referenced in the following.

Already in May 2008 New Energy Finance published an overview of planned CSP capacities that amounted to 6.7 GW (Figure 3). This figure is including projects that are past the "site banking" stage. Again the US is the most important market followed by Spain.

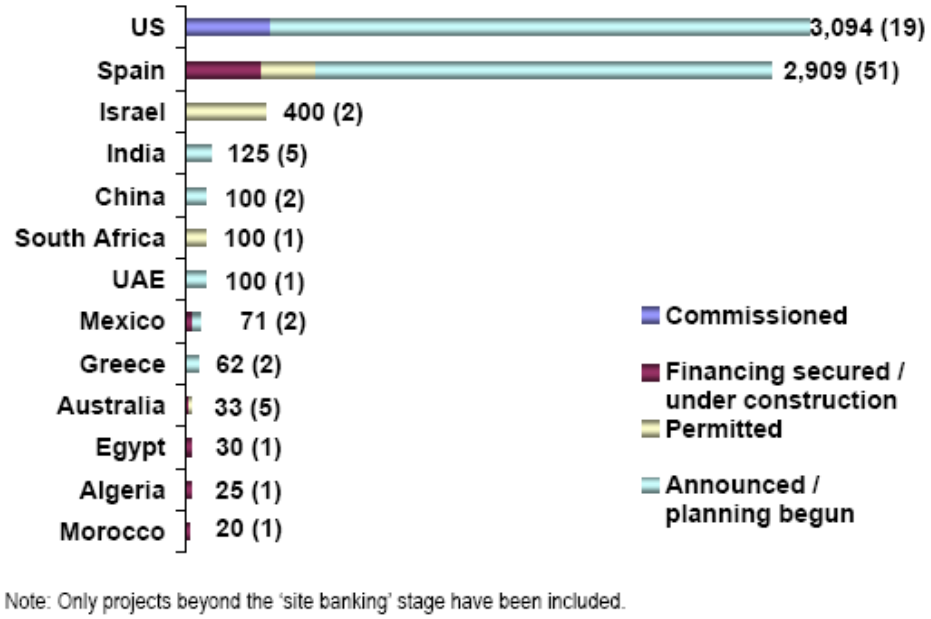

Figure 3: The global CSP pipeline, by geography in MW (New Energy Finance, 2008).

On the basis of the announcements made by the CSP industry the Prometheus Institute expects 11 GW of total installed CSP capacity in 2012 (Prometheus Institute, 2008). As can be seen in Figure 4 not only solar thermal technology is included in this figure but also Concentrated Photovoltaic systems (CPV). Disregarding this figure together with the so called "other" technologies that are still at the development stage a total installed capacity of 8 GW CSP is expected until 2012.

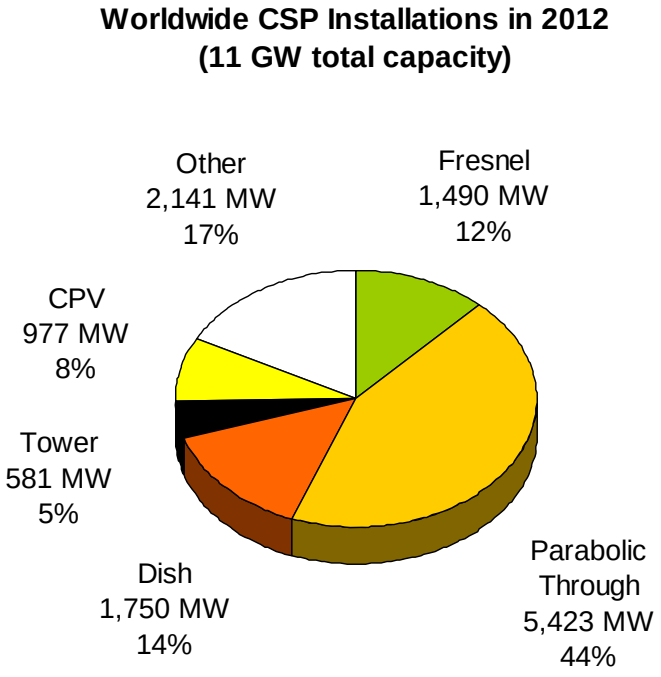

Figure 4: Worldwide CSP installations – distribution by technology in 2012 (Prometheus Institute 2008).

The actual development of CSP installations in the coming years however, will not only depend on the intention of project developers but also on permission procedures as well as the capacities of equipment manufacturers. Some data regarding the installation time and required workforce can already be obtained from experience with existing projects. Andasol 1 with a capacity of 50 MW for example had a construction time of 2 to 2.5 years. During this period up to 500 people where engaged in this activity. For the operation period about 40 people are expected to be employed at the site (Solar Millennium, 2008).

A realistic assumption regarding the dynamic development of projects as well as the expansion of equipment manufacturers is to have 5,000 MW overall installed CSP capacity by 2015.