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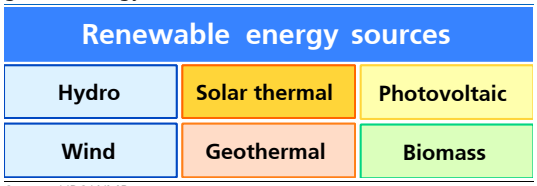
Renewable energy

Solar thermal - a new power giant is awakening

- The following report focuses on concentrated solar power (CSP), a sub-category of solar thermal energy.
- We believe CSP production is about to step out of the shadow of wind and photovoltaics (PV) as it is playing an increasingly important role in sustainable power generation.
- The investable universe for CSP is currently very small. However, with possible initial public offerings (IPOs) of specialized companies and the strong involvement of utilities, the universe may broaden soon.

Fig. 1: Renewable energy sources
There is enough renewable potential to provide for global energy demand.



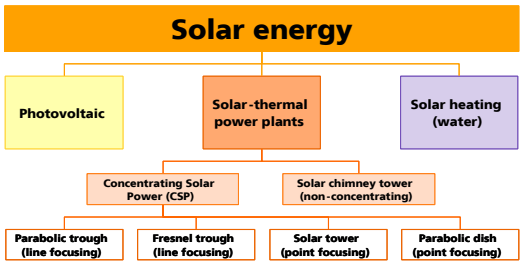
Source: UBS WMR

Solar thermal energy – taking off

Wind and photovoltaics are two renewables that have been in the spotlight of the financial markets for quite a while now. However, other renewables such as solar thermal, geothermal, biomass, wave and tides are beginning to emerge from the shadow of wind and PV (see Fig. 1). Some of them are already offering interesting and expanding investment opportunities while also helping contribute to more sustainable and diversified power generation. Thus, three investment themes will focus on these "other renewables". This report is covering solar thermal with a special focus on CSP (see Fig. 2).

Theoretically, less than 3% of the total area of the Sahara desert covered with CSP plants would be sufficient to meet the world's total electricity demand. In this context, the recently announced Desertec Initiative fits very well. Companies such as Siemens, Deutsche Bank, E.ON and ABB are aiming at the development of CSP and wind power plants in the Middle East and Northern Africa that would be able to supply 15% of Europe's electricity demand by 2050. Obviously, the initiative has a very long-term perspective and we expect no immediate market effects. Nonetheless, it shows the potential of CSP and could represent an interesting long-term opportunity for companies involved in CSP.

Fig. 2: Solar energy technologies
Most capacity is currently installed in solar heating.



Source: Solar Millennium, UBS WMR

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Technology description

Solar thermal energy can be subdivided by collector type into low-, medium-, or high-temperature installations.

- Low-temperature collectors are, for example, used for heating swimming pools.
- Medium collectors can produce hot water for residential and commercial buildings using well established, simple and cost-efficient technologies.
- High-temperature installations, which are used to produce electricity, are also known as CSP, which we will focus on in the following.

While PV is turning solar radiation directly into electricity, CSP is using solar radiation to produce heat that is used to power a turbine or a Stirling engine. In the turbine version, the heat is produced by concentrating the sunlight using reflectors (e.g., parabolic mirrors) so that it can be absorbed by a receiver that contains a heat transfer medium (e.g., absorber tubes with a synthetic oil). The heated transfer medium is pumped through a heat exchanger, where steam is generated to drive a steam turbine and produce electricity. Solar thermal plants can also be designed for hybrid operation, where alternative fuels can be used to bridge insufficient radiation intensity. Solar thermal power stations work basically like conventional steam power stations and are large multi-MW power plants normally in the range of 50 MW to 250 MW in capacity. In the US, there are even projects for plants with up to 1,000 MW in capacity.

For commercial use, CSP is best deployable in regions with high direct solar radiation. This is typically the case for the regions between 35 degrees latitude south (Buenos Aires-Cape Town-Canberra) and north (Gibraltar-Tehran-Kyoto-Memphis). Compared to PV, CSP plants are more appropriate for the central generation of electricity and is the solar alternative to conventional utility-scale power generation. An advantage of solar thermal technology is that it already offers the possibility of solar energy storage, allowing extended turbine operation and power production for some hours at times when the sun isn't shining (e.g. cloudy days, night). Solar energy can be stored in liquid or solid mediums such as molten salts, concrete or ceramic. Consequently, it is suitable to provide for peak and base load electricity.

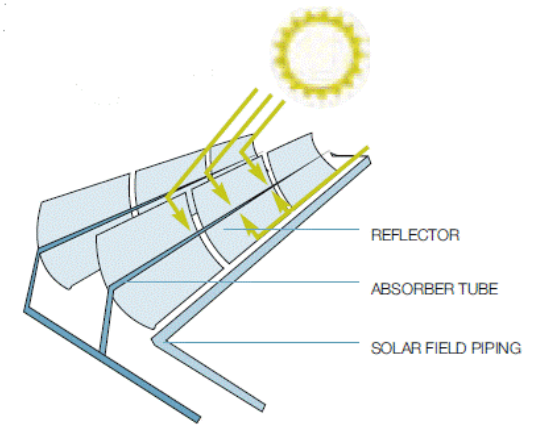
Parabolic trough technology is dominating the market

There are four main types of CSP technology used to concentrate and collect sunlight in order to to turn it into heat:

1. Parabolic trough (see Fig. 3);
2. Fresnel trough/reflector (see Fig. 4);
3. Solar tower (central receiver) (see Fig. 5); and
4. Parabolic dish (dish sterling) (see Fig. 6).

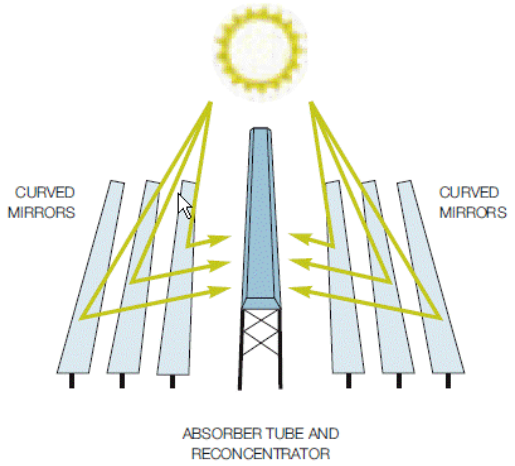
Currently, commercial use is basically limited to the parabolic trough technology, which makes up more than 90% of installed and under construction capacity. We also expect trough technology to remain the dominant technology for the foreseeable future. However, through more R&D other technologies could step out of their niches and gain

Fig. 3: Parabolic trough



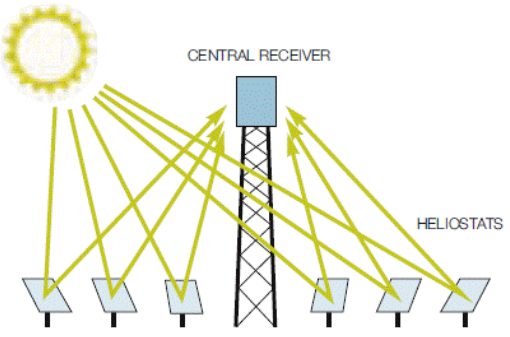
Source: Greenpeace International et al. (2009)

Fig. 4: Fresnel trough/reflector



Source: Greenpeace International et al. (2009)

Fig. 5: Solar tower



Source: Greenpeace International et al. (2009)

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significantly more market share due to a steeper learning curve.

As the most mature and proven technology, **parabolic trough** uses trough-shaped mirror reflectors to concentrate sunlight onto receiver tubes situated at the focal line of the trough, where a thermal transfer fluid is heated. **Fresnel technology** is similar to parabolic trough, but it uses flat or less-shaped mirrors to concentrate the sunlight on one absorber pipe. In **solar tower systems** (also known as central receiver systems) an array of sun-tracking large mirrors (heliostats) concentrate sunlight on one focal surface on top of a tower containing a heat transfer medium. **Parabolic dishes** (dish sterling) are relatively small power units with a dish-shaped reflector similar to large satellite dishes to concentrate sunlight on a Stirling engine to produce electricity. A big advantage of the Stirling engine is that it works without water and with very low maintenance. Temperatures for both these latter technologies are significantly higher (550 - >1,000°C) than for the parabolic trough and Fresnel technologies (400 - 500°C).

It is not clear yet which of these technologies will ultimately dominate the market as they each have their advantages and disadvantages. Apart from these four concentrating technologies, there also exists a non-concentrating technology: solar chimney tower technology, which is in an early stage. In this system, air is heated under a huge collector roof. The heated air then rises up a large chimney and powers horizontal wind turbines.

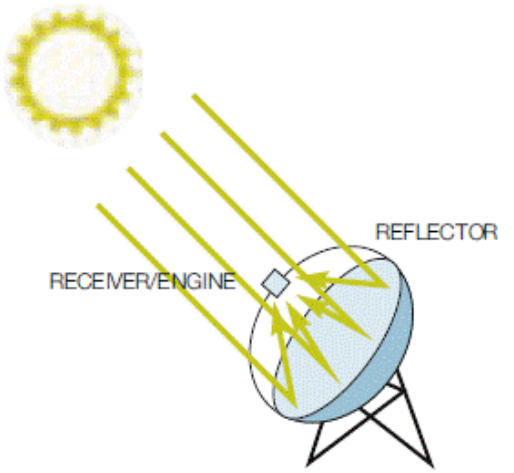
CSP market: We see strong growth ahead

We believe the CSP market is on the point of taking off. After a long period of stagnation, the market is now evolving more dynamically. Interestingly, for regions in the sun belt, CSP offers similar opportunities as large offshore wind farms in Europe. However, so far it is still a tiny market as there was only about 0.5 GW capacity installed globally by end-2008 (see Fig. 7) compared to the more successful low- and medium-temperature solar water heating that has reached already a capacity of 145 GW thermal.

Utilities are increasingly entering the project-driven market as CSP is a good way to produce large-scale electricity at peak demand times based on a renewable source. The project pipeline has increased accordingly and projects under construction will add at least 1 GW by 2011. Growth rates of around 35% p.a. for the next years could result in an installed global capacity of 20 GW by 2020 as depicted in Fig. 8 (installed wind capacity in 2008: 121 GW).

The CSP market is led by Spain and the US. Positive drivers for market growth are declining production costs and the more favorable political environment. In the past, the Spanish market could profit from feed-in tariffs for CSP plants creating a strong growth in local installation. It is likely that in autumn 2009 the feed-in tariffs for CSP will be lowered. However, the reduction might not turn out to be as pronounced as the industry lobby for CSP (utilities, ACS, Abengoa) is quite strong and the feed-in tariffs for CSP are at relatively reasonable levels. The US is likely to be the upcoming key market given its large project pipeline, which is based on a favorable regulatory framework that includes tax incentives and the Renewable Portfolio Standard (RPS). Under the RPS, utilities are obliged to produce a certain fraction of their electricity from renewable energy sources. In addition, the US profits from the existence of an

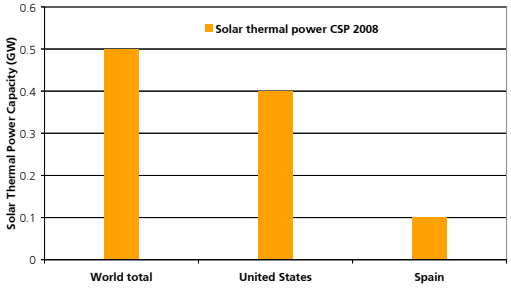
Fig. 6: Parabolic dish (dish sterling)



Source: Greenpeace International et al. (2009)

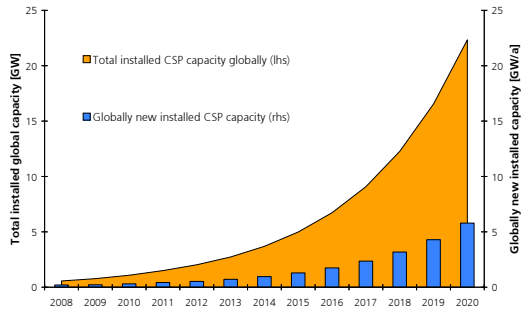
Fig. 7: CSP capacity in 2008

For comparison: total global power capacity is 4,700 GW whereas 280 GW are renewables, excluding large hydro.



Source: REN21 (2009), UBS WMR

Fig. 8: CSP growth expectations



Source: UBS WMR

abundance of favorable sites (e.g., California, Nevada, Arizona, New Mexico, and Texas).

Costs expected to come down

Roughly 80% of costs stem from construction and only 20% from operations, which is not surprising as the fuel to power the plant is provided by the sun for free. CSP electricity production costs per kWh are lower than for PV but belong to the highest among the renewables. Thanks to technological progress, mass production of components, the scaling-up of plant size and growing market competition, we expect rapid cost reductions (see Table 1). Minimal costs for the latest large-scale projects on optimal sites are at around USD 0.15/kWh. Similar costs, as for conventional power generation below USD 0.1/kWh, should be achieved in the medium term.

The sustainability aspect - a minor issue

The energy payback of CSP for the manufacturing and installing of the equipment is around six months, which is similar to the one for wind energy. Most of the material used for CSP power plants can be recycled (e.g. concrete, glass, steel) and the overall environmental impact of such power plants is relatively negligible. However, water requirements for certain CSP technologies have to be taken into account and the land requests are huge. For one MW of capacity, between 25-40,000 sq m of land is needed. A 100 MW plant built in Spain may require about 4 sq km in order to deliver electricity for up to 400,000 people.

Investment opportunities are small yet, but will increase

The solar thermal value chain encompasses project development and financing, supply of engineering and components, construction and operation. Currently, there are a few players in the market delivering critical components (e.g., receivers, mirrors) for CSP technology. With Solar Millennium as a project developer and technology provider, we have identified just one listed pure play. Abengoa, as another important player in this area, shows solar-related sales (including PV and solar thermal) of 2.1% of total sales. Alongside the specialist companies, construction players like ACS Cobra or MAN Ferrostaal are involved. Increasingly, independent power producers and utilities like Acciona, Iberdrola, FPL, PG&E, Enel, Endesa or EDP are active in the rapidly growing CSP market. CSP is about to play a more important role in the production of sustainable power generation. However, the stock universe in solar thermal energy is small and for most companies involved in this area CSP accounts for only a tiny portion of their business activities. However, with possible IPOs of specialized companies and the stronger involvement of larger companies such as utilities, the investment universe may broaden over time and enable increased investment opportunities.

Key risks

Risks include, but are not limited to: regulatory changes/withdrawal of political support, emergence of competing and disruptive technologies from other renewables, component shortages given strong growth expectations, geopolitical and financing risks.

Literature

Greenpeace International; IEA SolarPACES; European Solar Thermal Electricity Association (ESTELA); CSP Global Outlook 09 (2009)

Tab. 1: Electricity production costs

CSP not yet competitive, but approaching fossil fuels cost.

US Cents/kWh	2009	2020-30
CSP	15-40	4-10
Wind	4-15	3-8
PV	25-80	6-25
Coal (with CCS*)	3.5-6.0	4-5.5 (6.0-8.5)
Gas (with CCS*)	4-7	5-8 (7-10)

*CCS: Carbon capture and storage technology applied (i.e. burning fossil fuels creates CO2 that is not released into the atmosphere but rather captured and stored).

Source: IEA, IPPC, EPRI, UBS WMR

Tab. 2: Companies active in CSP

Area	Company	Sales % in solar	Country	Main Technology
Project developer	Abengoa	2.1	ES	Trough/Tower
	Acciona	<5%	ES	Trough
	ACS	<1%	ES	Trough
	MAN Ferrostaal [1]	<0.1%	DE	Trough
	Solar Millennium	100	DE	Trough
Engineering / Components	Ausra [1]	100%	US	Fresnel
	eSolar [1]	100%	US	Tower
	Schott AG [1]	<5%	DE	Trough
	Stirling Energy Systems [1]	100%	US	Parabolic dish
	Solel [1]	100%	IL	Trough
Operators / Utilities	EDP	<0.1%	FR	
	FPL	<1%	US	
	Iberdrola Renovables	<0.1%	ES	

1) not listed companies

Source: UBS WMR

Note: Table 2 lists some companies engaged in CSP. Our list of companies is a selection from a small universe of about 25 companies. We selected the companies with the highest CSP revenue ratios in each of the three areas, taking a maximum of five companies per area. For areas without listed companies we depict not listed companies reflecting different technologies. **This is not a list of recommendations and is by no means comprehensive.**

Appendix

If you require further information on the instrument or issuers mentioned in this publication, or you require general information on UBS Wealth Management Research including research policies and statistics regarding past recommendations, please contact either your Client Advisor or the mailbox UBS-research@ubs.com giving your country of residence.

Disclosures (9 September 2009)
Abengoa 1. Acciona 1. ACS 2, 3. EDP Renovaveis. FPL Group Inc. 2, 3, 4, 5, 6, 7, 8. Iberdrola Renovables S.A. 3.

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7 This company/entity is, or within the past 12 months has been, a client of UBS Securities LLC, and non-securities services are being, or have been, provided.
8 UBS AG, its affiliates or subsidiaries expect to receive or intend to seek compensation for investment banking services from this company/entity within the next three months.

Appendix

Terms and Abbreviations

Term / Abbreviation	Description / Definition	Term / Abbreviation	Description / Definition
1H, 2H, etc. or 1H07, 2H07, etc.	First half, second half, etc. or first half 2007, second half 2007, etc.	1Q, 2Q, etc. or 1Q07, 2Q07, etc.	First quarter, second quarter, etc. or first quarter 2007, second quarter 2007, etc.
2007E, 2008E, etc.	2007 estimate, 2008 estimate, etc.	ADR	American depositary receipt
AUM	Assets under management = total value of own and third-party assets managed	bn	Billion
bp or bps	Basis point or basis points (100 bps = 1 percentage point)	BVPS	Book value per share = shareholders' equity divided by the number of shares
CAGR	Compound annual growth rate	Cant Inc/Capita	Cantonal income per capita (Switzerland only)
Capex	Capital expenditures	CFO	1) Cash flow from operations, 2) Chief financial officer
Cost/Inc Ratio (%)	Costs as a percentage of income	CPI	Consumer price index
CR	Combined ratio = ratio of claims and expenses as a percentage of premiums (for insurance companies)	CY	Calendar year
DCF	Discounted cash flow	DDM	Dividend discount model
Dividend Yield (%)	Dividend per share divided by price per share	DPS	Dividend per share
EBIT	Earnings before interest and taxes	EBIT Margin (%)	EBIT divided by revenues
EBIT (D)A	Earnings before interest, taxes, (depreciation) and amortization	EBITDA Margin (%)	EBITDA divided by revenues
EBITDA/Net Interest	EBITDA divided by net interest expense	EBITDAR	Earnings before interest, taxes, depreciation, amortization and rental expense
EFVR	Estimated fair value range	EmV	Embedded value = net asset value + present value of forecasted future profits (for life insurers)
EPS	Earnings per share	Equity Ratio (%)	Shareholders' equity divided by total assets
EV	Enterprise value = market value of equity, preferred equity, outstanding net debt and minorities	FCF	Free cash flow = cash a company generates above outlays required to maintain/expand its asset base
FCF Yield (%)	Free cash flow divided by market capitalization	FFO	Funds from operations
FY	Fiscal year / financial year	GDP	Gross domestic product
Gross Margin (%)	Gross profit divided by revenues	h/h	Half-year over half-year; half on half
Interbank Ratio	Interbank deposits due from banks divided by interbank deposits due to banks	Interest Coverage	Ratio that expresses the number of times interest expenses are covered by earnings
Interest exp	Interest expense	ISIN	International securities identification number
LLP/Net Int Inc (%)	Loan loss provisions divided by net interest income	LLR/Gross Loans (%)	Loan loss reserves divided by gross loans
Market cap	Number of all shares of a company (at the end of the quarter) times closing price	m/m	Month-over-month; month on month
mn	Million	n.a.	Not available or not applicable
NAV	Net asset value	Net Debt	Short- and long-term interest-bearing debt minus cash and cash equivalents
Net Int Margin (%)	Net interest income divided by average interest-bearing assets	Net Margin (%)	Net income divided by revenues
n.m. or NM	Not meaningful	NPL	Non-performing loans
Op Margin (%)	Operating income divided by revenues	p.a.	Per annum (per year)
P/BV	Price to book value	P/E	Price to earnings
P/E Relative	P/E relative to the market	P/EmV	Price to embedded value
PEG Ratio	P/E ratio divided by earnings growth	PPI	Producer price index
Prim Bal/Cur Rev (%)	Primary balance divided by current revenue (total revenue minus capital revenue)	Profit Margin (%)	Net income divided by revenues
ROA (%)	Return on assets	ROCE (%)	Return on capital employed = EBIT divided by difference between total assets & current liabilities
ROE (%)	Return on equity	ROAE (%)	Return on average equity
ROIC (%)	Return on invested capital	Solvency Ratio (%)	Ratio of shareholders' equity to net premiums written (for insurance companies)

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Appendix

Term / Abbreviation	Description / Definition	Term / Abbreviation	Description / Definition
Tax Burden Index	Swiss tax index; 100 = average tax burden of all cantons	Tier 1 Ratio (%)	Tier 1 capital divided by risk-weighted assets; describes a bank's capital adequacy
tn	Trillion	Valor	Swiss company identifier
WACC	Weighted average cost of capital	UBS WMR	UBS Wealth Management Research
y/y	Year-over-year; year on year	YTD	Year-to-date

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