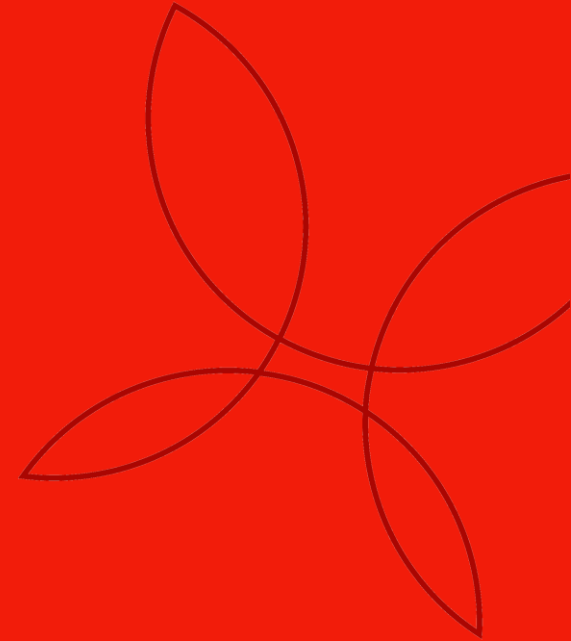




Climate &
Renewables

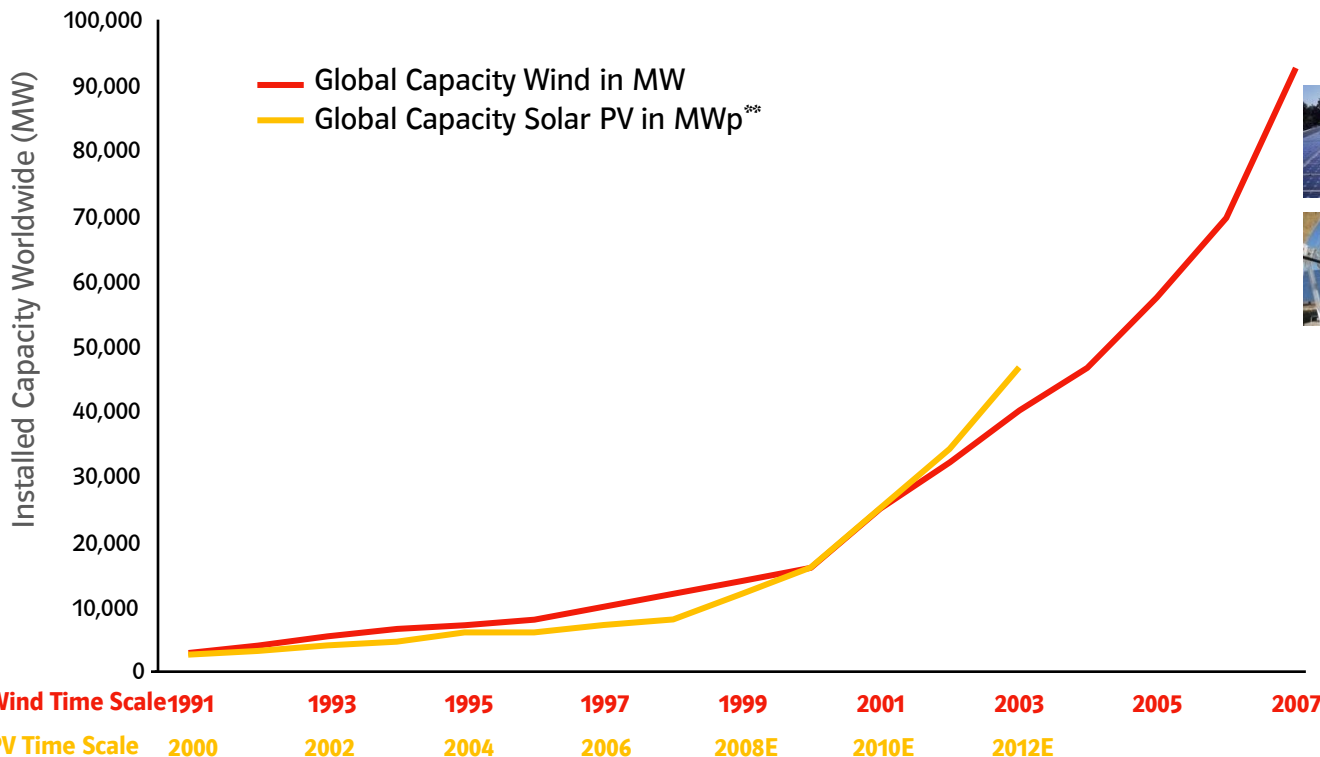


EC&R and Abengoa partnership: Helioenergy I & II



November 25th, 2009

Solar will be "the next wind" and EC&R wants to stand on two legs: PV* and CSP*

Wind and Solar installed capacity per year



Installed capacity per technology [GW]

	<u>2008</u>	<u>2020</u>
 PV	13	~140
 CSP	<1	~20

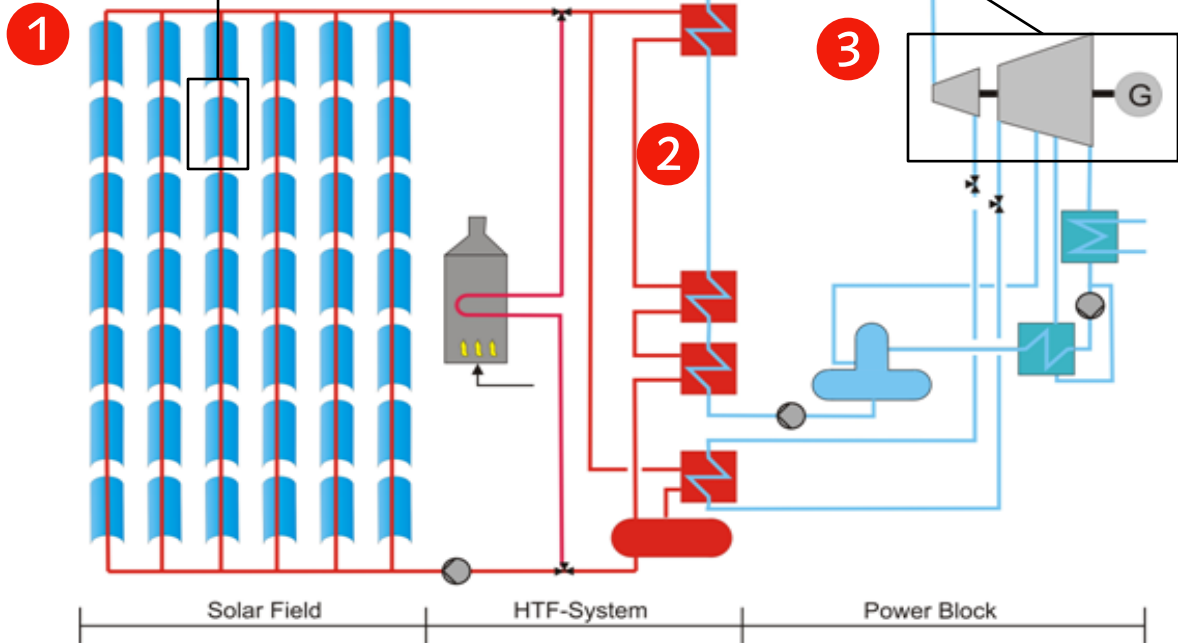
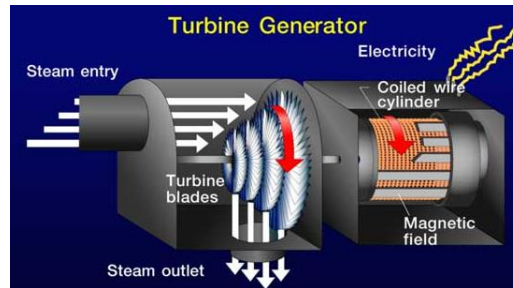
**Global Potential [GW]
50,000 - 80,000**

*PV = Photovoltaic, CSP = Concentrated Solar Power
 ** Megawatt peak: maximum electric power output of a solar cell
 Source: EPIA, GWEA, EWEA

PV and CSP are not competing, but complementary technologies, and EC&R will be an active player in both

	PV	CSP
Name	<ul style="list-style-type: none"> • Photovoltaic 	<ul style="list-style-type: none"> • Concentrated Solar Power
Characteristics	<ul style="list-style-type: none"> • Semi-conductor technology 	<ul style="list-style-type: none"> • Concentrates light with mirrors to generate electricity via a conventional steam cycle
Main technologies	<ul style="list-style-type: none"> • Crystalline silicon • Thin film 	<ul style="list-style-type: none"> • Parabolic trough (commercial) • Solar Tower (pilot), Fresnel & Dish (R&D)
Advantages	<ul style="list-style-type: none"> • Wide geographical applicability • Largest potential for cost reduction • Works on diffuse light 	<ul style="list-style-type: none"> • Large scale implementation • Lowest current costs • Energy can be stored • Part of technology well known to Utilities
Disadvantages	<ul style="list-style-type: none"> • Small scale • No storage 	<ul style="list-style-type: none"> • Can only make use of direct radiation • Needs water for cooling and flat land
EC&R involvement	<ul style="list-style-type: none"> • Recent opening of first solar PV farm • Acquired French PV developer • Several co-location (wind/PV, coal or gas/PV) projects in Italy • >500 MW EC&R pipeline 	<ul style="list-style-type: none"> • Helioenergy I & II: JV with Abengoa JV for 2 X 50 MW CSP plants in Spain • Major role in Desertec Industrial Initiative • Major international research initiative on CSP storage technologies launched in 09





CSP uses mirrors to focus solar radiation on a surface which is then transferred into a conventional power generation cycle



CSP Electricity Generation Cycle

- 1 Solar collectors use solar power to heat a fluid (oil, molten salt, steam, etc...)
- 2 The heat transfer fluid is passed through heat exchangers to heat water and produce steam
- 3 Steam is passed through a steam turbine to produce electricity as in a conventional power generation cycle

There are four major CSP technologies in different stages of development

CSP Technologies	Parabolic Trough	Solar Tower	Linear Fresnel	Solar Dish
Description	 <p>Curved mirrors focus radiation onto a oil filled receiver tube at mirror's centre. Oil is then used to raise steam & drive turbine</p>	 <p>Field of mirrors focus radiation onto a receiver on top of a tower. Thermal energy is used to raise steam and drive a turbine</p>	 <p>Series of long, flat mirrors focus radiation onto a oil filled receiver tube above. Oil is then used to raise steam & drive turbine</p>	 <p>Parabolic reflective dish focuses radiation onto a Sterling engine which generates electricity</p>
Single unit capacity	50-280 MW	15-50 MW	0.3 MW	0.025 MW
Efficiency	10-25%	10-30%	9-17%	16-30%
Temperature	350-415 °C	250-565 °C	270-500 °C	750-800 °C
Storage	Salt storage optional	Salt storage optional	Not yet integrated	Not available
Maturity/ Capacity installed	Commercial 420 MW	Pilot 11 MW	R&D 6MW	R&D Trials
Advantages	<ul style="list-style-type: none"> • 30 years experience • Low costs 	<ul style="list-style-type: none"> • Higher efficiency 	<ul style="list-style-type: none"> • Theoretically lower costs 	<ul style="list-style-type: none"> • Modular • Theoretically higher eff.

Helioenergy I & II -Parabolic Trough at Écija, the Frying Pan of Spain



Key information

- Project distance from Seville: ~90km
- Site Area: 210 ha (pre storage)
- 2x50MW Parabolic Trough plants
- Co-located, joint team on the ground
- Both with storage option
- Annual (grid) production: 190 GWh
- COD: 2011-2012