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Concentrated Solar Power Fact Sheet

EGRS 352
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General Overview:

Concentrated solar power utilizes mirrors in order to collect sunlight and re-radiate that captured sunlight to energy forming generators. This energy that is produced in those generators can then be used for electricity purposes. There are four main types of CSP devices: Parabolic Troughs, Solar Towers, Linear Fresnel Collectors, and Dish Stirlings

Parabolic Troughs

-Made of solar collectors in the form of mirrors and heat receivers
-Parabolic shaped device that concentrates sunlight onto a central tube that lies on the focal line in the trough
-Heat Transfer Fluid circulated through the central absorbing tube (fluid usually synthetic oils or molten salt)

Solar Towers

-Field of mirrors which direct incoming sunlight to a central receiver that converts the received light into energy
-heat directed at the receiver powers a "thermodynamic cycle" which converts the energy into electrical power.
-Use of water/steam or molten salt in order to power the turbines
-Higher efficiency with higher temperatures

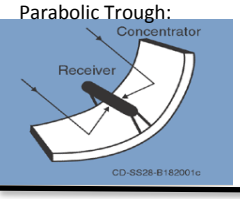
Dish Stirlings

-Parabolic dishes similar to satellite dishes
-Reflect solar irradiation onto a receiver (either stirling engine or micro turbine) at the focal point of the dish
-This device requires the Sun to be tracked in two axes
-Can possibly have the highest efficiency of all of the CSP methods
-Uses a dry cooling system which differentiates it from the other methods
-Does not have to be on level terrain- can be on uneven areas

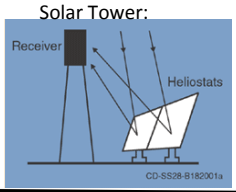
Linear Fresnel Collectors

-Very similar to Parabolic troughs
-Series of long and flat/ curved mirrors at varying angles to concentrate sunlight to a receiver
-line of mirrors have a single-axis tracking system in order to ensure that sunlight is always concentrated on the receiver
-much cheaper process and easier to assemble

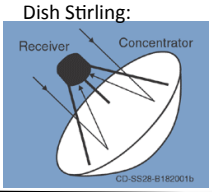
Parabolic Trough:



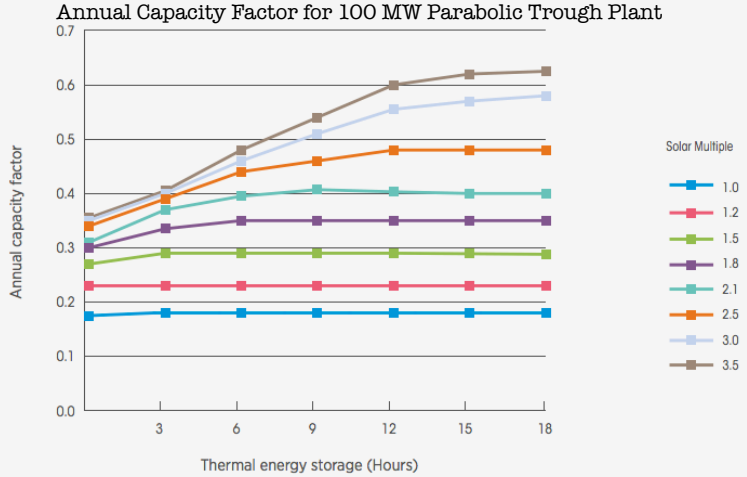
Solar Tower:



Dish Stirling:



Annual Capacity Factor for 100 MW Parabolic Trough Plant



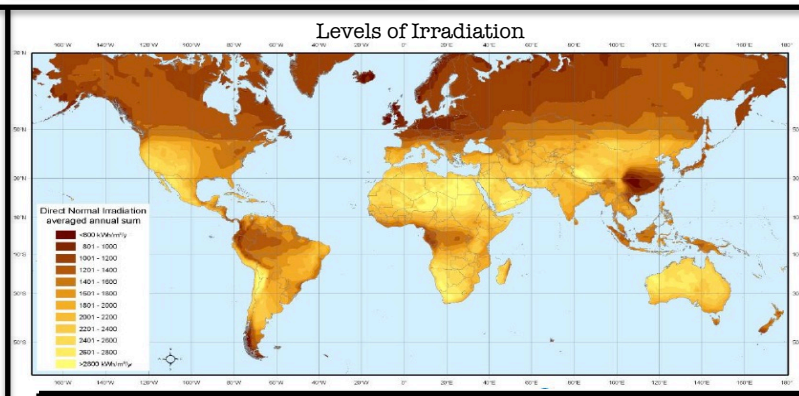
Formula for levelized cost of electricity (LCOE)

$$\frac{\sum_{t=1}^{n} \frac{I_t + M_t + F_t}{(1+r)^t}}{\sum_{t=1}^{n} \frac{E_t}{(1+r)^t}}$$

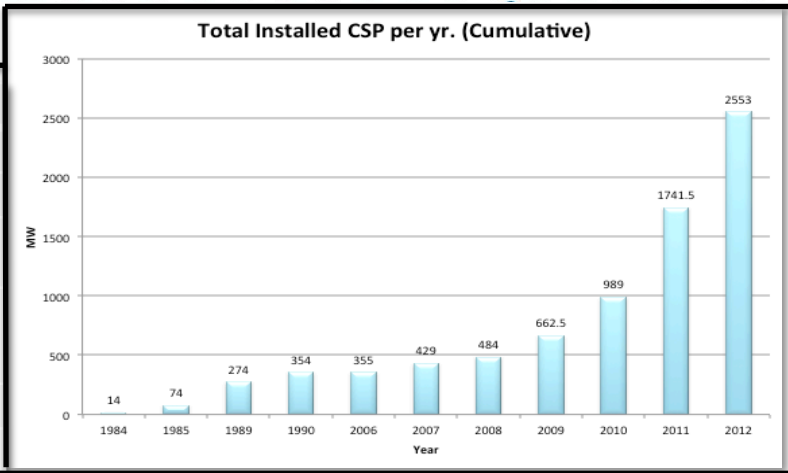
Key:

LCOE: average lifetime levelized cost of electricity generation
I_t: investment expenditures in the year t
M_t: O&M expenditures in the year t
F_t: Fuel expenditures in year t
E_t: Electricity generation in year t
r: rate of discount
n: life of the system

Levels of Irradiation



Total Installed CSP per yr. (Cumulative)



Cost of a 50 MW Parabolic Trough plant:

	Cost (2010 USD)	Share (%)
Labor cost	62.4	17.1
Equipment	140.3	38.5
Thermal Storage System	38.4	10.5
Conventional Plant components & plant system	52.0	14.3
Others	71.0	19.5
Total	364	100

.	Parabolic Trough	Solar Tower	Linear Fresnel	Dish Stirling
Typical Capacity (MW)	100-300	10-200	10-200	0.01-0.025
Operating Temp (Celcius)	350-550	250-565	390	550-750
Grid Stability	Med- High	High	Med.	Low
Cycle	Superheated Rankine steam cycle	Superheated Rankine steam cycle	Superheated Rankine steam cycle	Stirling
Suitability for air cooling	Low to good	Good	Low	Best
Storage with molten salt	Comercially available	Commercially available	Possible (not proven)	Possible (not proven)
Receiver/absorber	Absorber attached to collector	External surface/cavity receiver	Fixed absorber	Absorber attached to collector
Storage system	Indirect two tank molten salt	Direct two tank molten salt	Short term pressurized steam	N/A
Annual Capacity Factor (%)	25-28	55	22-24	25-28

More Information

Useful CSP diagrams:

-Concentrating Solar Power (CSP) Technology. (n.d.). *Concentrating Solar Power (CSP) Technology*. Retrieved April 8, 2014, from http://solareis.anl.gov/guide/solar/csp/

Installment Values:

-CSP Facts and Figures. (n.d.). *CSP World*. Retrieved April 9, 2014, from http://www.csp-world.com/resources/csp-facts-figures

Why CSP?:

- Clean, reliable power from domestic renewable energy
- Operate at high annual efficiencies – Firm power delivery when integrated with thermal storage
- Easily integrated into the power grid
- Boosts national economy by creating many new solar companies and jobs.

Taken from:
Concentrating Solar Power. (n.d.). *Solar Energy Development Programmatic*. Retrieved April 8, 2014, from http://solareis.anl.gov/documents/docs/NR

Basic overview of CSP:

-Konrad, T. (2006). They do it with mirrors: Concentrating Solar Power. *Clean Energy Wonk*. Retrieved April 8, 2014, from http://cleanenergywonk.com/2006/12/07/they-do-it-with-mirrors-concentrating-solar-power/

US Dept. Of Energy:

-Concentrating Solar Power (CSP) Technology. (n.d.). *Concentrating Solar Power (CSP) Technology*. Retrieved April 8, 2014, from http://solareis.anl.gov/guide/solar/csp/

-Concentrating Solar Power. (n.d.). *Solar Energy Development Programmatic*. Retrieved April 8, 2014, from http://solareis.anl.gov/documents/docs/NR