Concentrated Solar Power Fact Sheet

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

**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

**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

Formula for levelized cost of electricity (LCOE)

\[
\text{LCOE} = \frac{\sum_{t=0}^{n} \left( I_t + M_t + F_t \right)}{(1+r)^t} + \frac{\sum_{t=0}^{n} E_t}{(1+r)^t}
\]

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

### Cost of a 50 MW Parabolic Trough Plant:

<table>
<thead>
<tr>
<th>Cost (2010 USD)</th>
<th>Share (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor cost</td>
<td>62.4</td>
</tr>
<tr>
<td>Equipment</td>
<td>140.3</td>
</tr>
<tr>
<td>Thermal Storage System</td>
<td>38.4</td>
</tr>
<tr>
<td>Conventional Plant components &amp; plant system</td>
<td>52.0</td>
</tr>
<tr>
<td>Others</td>
<td>71.0</td>
</tr>
<tr>
<td>Total</td>
<td>364</td>
</tr>
</tbody>
</table>

### Levels of Irradiation

### Total Installed CSP per yr. (Cumulative)

<table>
<thead>
<tr>
<th>Typical Capacity (MW)</th>
<th>Parabolic Trough</th>
<th>Solar Tower</th>
<th>Linear Fresnel</th>
<th>Dish Stirling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grid Stability</td>
<td>Med. High</td>
<td>High</td>
<td>Med.</td>
<td>Low</td>
</tr>
<tr>
<td>Cycle</td>
<td>Superheated Rankine steam cycle</td>
<td>Superheated Rankine steam cycle</td>
<td>Superheated Rankine steam cycle</td>
<td>Stirling</td>
</tr>
<tr>
<td>Suitability for air cooling</td>
<td>Low to good</td>
<td>Good</td>
<td>Low</td>
<td>Best</td>
</tr>
<tr>
<td>Storage with molten salt</td>
<td>Commerially available</td>
<td>Commerially available</td>
<td>Possible (not proven)</td>
<td>Possible (not proven)</td>
</tr>
<tr>
<td>Receiver/absorber</td>
<td>Absorber attached to collector</td>
<td>External surface/cavity receiver</td>
<td>Fixed absorber</td>
<td>Absorber attached to collector</td>
</tr>
<tr>
<td>Storage system</td>
<td>Indirect two tank molten salt</td>
<td>Direct two tank molten salt</td>
<td>Short term pressurized steam</td>
<td>N/A</td>
</tr>
<tr>
<td>Annual Capacity Factor (%)</td>
<td>25-28</td>
<td>22-24</td>
<td>25-28</td>
<td></td>
</tr>
</tbody>
</table>
More Information

Useful CSP diagrams:


Installment Values:


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:

Basic overview of CSP:


US Dept. Of Energy:
