General introduction CSP Technologies and grid management

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Outline

1. CSP Technologies
2. Characteristics of CSP
3. Market und Cost Development
4. Benefits for a Mix of PV und CSP
5. Conclusions
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Concentrating Solar Technologies

Photovoltaics (PV)

- Sunlight
  - ELECTRICITY

Concentrating Solar Power (CSP)

- Sunlight
  - Concentration
    - HEAT
      - Turbine
        - ELECTRICITY
      - SOLAR FUELS
        - Thermal Heat Storage

Concentrating Solar Technologies

Solar Concentrating Technology is able to produce clean **PROCESS HEAT** at any temperature
CSP-System

Solar thermal power plants
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<table>
<thead>
<tr>
<th>Characteristics</th>
<th>PV Solar Resource</th>
<th>CSP Direct Radiation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block size</td>
<td>mWatt to some 100 MW</td>
<td>10 MW to some 100 MW</td>
</tr>
<tr>
<td>Installation:</td>
<td>everywhere (roof top etc.)</td>
<td>flat unused land</td>
</tr>
<tr>
<td>Capacity:</td>
<td>700 – 2000 full load hours</td>
<td>2000 – 7000 full load hours</td>
</tr>
<tr>
<td>Back-up Capacity</td>
<td>external (e.g. gas turbine)</td>
<td>therm. Storage / fossil backup</td>
</tr>
<tr>
<td>Inst. Power (2015)</td>
<td>227 GW</td>
<td>5 GW</td>
</tr>
<tr>
<td>LCOE</td>
<td>0,03 – 0,13 €/kWh</td>
<td>0,06 – 0,20 €/kWh</td>
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</tbody>
</table>
CSP with thermal storage and fossil back provides reliable dispatchable power at no additional cost.
CSP only suitable in areas with high direct normal radiation
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Market forecast CSP 2025

- 8.5 GWe will be installed until 2020
- Currently 2 GWe under construction
- 5 GWe installed in 2015
- 18.5 GWe planned until 2025

Confused and Planned

Historisch

Heliokon

Significant change in market share between Power Tower and Trough

- 2020 Tower: 40%
- 2020 Trough: 60%
- 2025 Tower: 40%
- 2025 Trough: 60%

Source: Leoni / Heliokon Analysis, 2016
Cost for CSP and PV have dropped strongly with their deployment

- CSP deployment is smaller than PV today, thus it still has higher costs

![Graph showing the cost evolution of CSP and PV](chart13.png)
CSP Market Perspectives until 2025

- Estimated installed capacity until 2025: 10 - 20 GW (plus 5-15 GW)

- Accumulated investment in CSP until 2025
  25 – 75 Billion EUR

- Annual Volume on O&M Contracts in 2025:
  1 – 2 Billion EUR per Jahr

- Additional Capacity in the field of process heat
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High shares of cheap Wind and PV capacity lead to a strongly fluctuating residual load that need to be covered by other technologies.
PV and CSP

- Two technologies that complement each other perfectly in many regions of the world, in particular if large shares of fossil fuel cannot be used.

Scenario for Electricity Supply for North Africa for 2015 based on high shares of renewable energies *

*Results from the EU Better Study (www.better-project.net)
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Conclusions

• PV and CSP with storage and hybridization are complementary technologies:
  • PV: provides power,
  • CSP: Energy + secured power

• PV market is booming since today often the most cost-effective option

• CSP is at the beginning of the learning curve:
  
  **further cost reduction is expected**
Thank you for your attention

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