HPS2 High Performance Solar @ EMSP

Michael Wittmann
Why Concentrated Solar Power CSP?
Market forecast of IEA WEO

Steam cycle-based renewables

<table>
<thead>
<tr>
<th>Average electrical capacity addition 2012-2030 [MW/y]</th>
<th>CSP</th>
<th>Geothermal</th>
<th>Biomass</th>
<th>World (all technologies)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEA Current Policy</td>
<td>1,303</td>
<td>921</td>
<td>5,416</td>
<td>'12-'30 CAGR%</td>
</tr>
<tr>
<td>IEA New Policy</td>
<td>2,206</td>
<td>1,337</td>
<td>6,612</td>
<td>2.7%</td>
</tr>
<tr>
<td>IEA 450</td>
<td>4,627</td>
<td>2,043</td>
<td>9,144</td>
<td>2.6%</td>
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<tr>
<th>Total electrical capacity IEA Current Policy [GW]</th>
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<tr>
<td>2012</td>
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<td>3</td>
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Strong growth potential - CSP highly scenario-sensitive

Why Molten Salt?
Comparison to state of the art: synthetic oil

• CSP Solar Power Plants have the purpose to produce CO2-free, renewable and **dispatchable** (in comparison to PV and wind plants) electricity

• Dispatchability is achieved using a thermal energy storage

• Comparison of state-of-the-art-technology with molten-salt-technology:
  
  • Life steam parameters and power block efficiency:
    • State-of-the-art: 386 °C / 100 bar: **39.2%**
    • Molten salt: 550 °C / 150 bar: **45.5%**
  
  • HTF-pump auxiliary load:
    • State-of-the-art: 6-7 %
    • Molten salt: 1-2 %
  
  • Volume of thermal energy storage at same capacity:
    • State-of-the-art: 100 %
    • Molten salt @550 °C: 36 %
  
  • Direct storage of HTF opens fully independent operateability of solar field and power block
HPS2 @ EMSP
Crystillization point for further projects

Our objective:
HPS2 strives to demonstrate the feasibility of operation of a solar thermal power plant in a safe and reliable manner.

Legend:
- SF Solar Field
- TES Thermal Energy Storage
- SGS Steam Generating System
- BOP Balance of Plant
- CR Control Room I&C
- Infra Infrastructure
Who is HPS2?

**Industry Partners**
- Solar Field EPC and Collector Structure
- Impedance Heating/EHT
- Molten Salt HCE and Mirrors
- Ca-based Nitrate Salts
- Steam Generating System and W/S cycle

**Technology Partners**
- O&M Team (South Africa)
- O&M Team (Spain)
- O&M Team (Germany)
- O&M Team (Portugal)

**Research Institutes (Partner)**
- Project Coordinator/ EPC/ Process Design/Scientific Program
- Site Owner and Scientific Program, Molten Salt Piping

**Sub-Contractors (selection)**
- DCS system (SPPA-T3000)
- Electrical/I&C scope
Pictures of the construction site
Workers on Site

• Construction Start 20.12.2017

• As of 19.09.2018
  • 19 different companies from Portugal, Spain and Germany contracted by HPS2 that worked on-site

  (e.g. Notified Bodies, Mechanical, Civil companies, Security, Industrial Cleaning Companies, Welding Companies, Fitters, Iron Workers, Gardeners, etc.)

• As of 19.09.2018:
  • In 24,480 working hours there is ZER0 injuries with loss time of any worker!
The HPS2 process
The HPS2 process
Overview
The HPS2 process
Op: SF antifreeze
The HPS2 process
Op: SF start-up
The HPS2 process
Op: SF normal
The HPS2 process
Combined: SF normal, SGS antifreeze
The HPS2 process
Combined: SF normal, SGS startup/shutdown
The HPS2 process
Combined: SF normal, SGS normal
The HPS2 process
Combined: SF normal, SGS startup/shutdown
The HPS2 process
Combined: SF normal, SGS antifreeze
Thank you for your attention!

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**Acknowledgements:**
- IPES
- University of Èvora – Team of Catedra ER, Team of Administration
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- Workers on Site