CSP: Flexible Solar Energy On-Demand for an Evolving Grid

‘Peaker’
(≤6 hours of storage)

‘Baseload’
(≥12 hours of storage)

By choosing the size of the solar field and thermal energy storage, the same CSP technology can be configured to meet evolving demands of the grid.
CSP in the international market

After stop of CSP markets in Spain and the US in 2016 new markets arise in South Africa, Morocco, China and UAE

Market size = 800 - 1000 MW / year
Operational Experience in Europe

The Spanish CSP operational fleet consist of 49 Plants with 2.300 MW. These plants entered in operation between 2007 - 2013.

The plants doesn’t show degradation signs and they are continuously breaking specific records. 2019 is getting the maximum cumulative yield.

Lessons learned on specific operational issues are part of the knowhow of the Spanish companies for design and operation of future plants.

<table>
<thead>
<tr>
<th>Type</th>
<th>Plants</th>
<th>Power (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parabolic Trough 50 MW</td>
<td>27</td>
<td>1350</td>
</tr>
<tr>
<td>without Storage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parabolic Trough 50 MW</td>
<td>17</td>
<td>850</td>
</tr>
<tr>
<td>With Storage</td>
<td></td>
<td></td>
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<tr>
<td>Saturated Steam Tower</td>
<td>2</td>
<td>31</td>
</tr>
<tr>
<td>Molten Salt tower with</td>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>storage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fresnel</td>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td>Hybrid Solar/Biomass</td>
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<td>22</td>
</tr>
<tr>
<td>TOTAL</td>
<td>49</td>
<td>2303</td>
</tr>
</tbody>
</table>

- 10% of instantaneous contribution has been achieved. 8% is oftenly achieved in summer months.
- 3 weeks have been running some plants in a non stop 24/7 mode. Gemasolar, in particular, reached 36 non stop days at nominal power.
- The cumulative record till June have been achieved in 2019.
Cost Renewable Electricity
Hybrid renewable systems provide low cost \and\ flexible operation.

Concentrating solar power (CSP) \hspace{1cm} PV plus battery

Image © NREL / Al Hicks
CSP and PV can produce complementary power

- Two forms of solar energy generation with differing characteristics can be used to meet market demands
- Optimized production from CSP can overlap PV
- *Cumulative* production of a paired plant exacerbates grid challenges or induces PV curtailment
- Goal: Shift CSP production using thermal storage to generate “around” PV
Introduction of Dubai 950MW CSP+PV Project

Most competitive price—USD 7.3 cents/kWh

Power Structure

Price Difference

Revenue Structure
190 MW PV CSP Hybrid Awarded in Morroco

NOOR MIDELT HYBRID SOLAR PLANT

Consortium of EDF Renewables, Masdar and Green of Africa named as successful bidder for Morocco’s landmark Noor Midelt Phase 1 hybrid solar project.

The world’s first advanced hybridisation of concentrated solar power (CSP) and photovoltaic (PV) technologies.

The plant will be located 20km north of the town of Midelt in central Morocco.

800 MW Total capacity

Tariff at peak hours set at a record-low 0.68 Moroccan dirhams per kilowatt-hour.

USD 7 cents/kWh new record set in Morocco CSP-PV hybrid IMAGE@MASEN
Photovoltaic Plant

- 100 MW
- 392,000 PV panels
- Single-axis tracker
- 300 hectares
- In Operation
CSP Plant

110 MW
10,600 heliostats, 140 m² each
Tower of 243 meters
17.5 hours of storage
In Construction

A Landmark Project

First CSP plant in Latin America
PPAs competitively awarded in 2014
Overcame many external challenges
Under construction
Expected COD – May 2020
IEA SolarPACES

- **IEA SolarPACES VISION**
  Our vision is that concentrating solar technologies contribute significantly to the delivery of clean, sustainable energy worldwide.

- **IEA SolarPACES MISSION**
  Our mission is to facilitate technology development, market deployment and energy partnerships for sustainable, reliable, efficient and cost-competitive concentrating solar technologies by providing leadership as the international network of independent experts.
Currently SolarPACES has 19 members: Austria, Australia, Brazil, Chile, China, European Commission (DG RESEARCH and DG TREN), France, Germany, Greece, Israel, Italy, Mexico, Morocco, Republic of Korea, South Africa, Spain, Switzerland, United Arab Emirates and United States of America.

Potential new members are: Namibia, Portugal,