Concentrated Solar Power (CSP)
Options and Perspectives in Tunisia

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Outline

- Introduction into CSP-Technology
- Why is CSP important for EU, MENA and Tunisia
- Current CSP-projects
- The Potential in Tunisia
- EnerMENA – Support Initiative of the German Government
Introduction to CSP-Technology

Gas
Coal
Nuclear
Biomass
Waste

Fuel

Superheater
Evaporator
Condenser
Preheater
Feed water pump

Turbine
Generator
Cooling Tower

Grid

Feed water - pump
Introduction to CSP-Technology
Introduction into CSP Technology

- Solar tower (SNL)
- Dish-Stirling (SBP)
- Linear Fresnel (MAN/SPG)
- Parabolic trough (PSA)

Up to 1000 °C Gas turbines, Motors
Up to 550 °C Steam turbines
Introduction into CSP-Technology

Why is CSP important for EU, MENA and Tunisia

Current CSP-projects

The Potential in Tunisia

EnerMENA – Support Initiative of the German Government
Why is CSP-Technology important for EU and MENA

→ The German Nuclear Power Exit Strategy
  → All Nuclear Power Stations will be switched off by 2022
→ Energy Concept 2050: 100% Renewable Energy
→ Dependency of Electricity Price on Weather Conditions
Why is CSP-Technology important for EU and MENA
Price Peaks on the Electricity Market
Why is CSP-Technology important for EU and MENA

Load peak caused by weather conditions, February 2, 2012
Why is CSP-Technology important for EU and MENA

- Solar Thermal power plants with thermal storage
- HVDC lines
- The DESERTEC Concept
Introduction into CSP-Technology

Why is CSP important for EU, MENA and Tunisia

Current CSP-projects

The Potential in Tunisia

EnerMENA – Support Initiative of the German Government
Current CSP Projects
Global Potential

Source: Solar Millennium AG, Erlangen
Current CSP Projects
Status Quo Worldwide

Source: for current information see: www.solarpaces.org


**Total**
7,000 - 8,500 MW
Current CSP Projects
Morocco: Ain Beni Matar

- **Owner:** ONE
- **EPC conventional CC-plant:** Abener
- **EPC solar field + 2 year O&M:** Abener
- **Groundbreaking:** 2008
- **Commissioning:** 5/2011
- **Solar field size:** 180,000 m²
- **Solar share (yearly):** 4%
Introduction into CSP-Technology
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EnerMENA – Support Initiative of the German Government
The Potential in Tunisia

Solar Radiation Data

Annual cumulative DNI-values of up to 3000 kW/m²
The Potential in Tunisia

Exclusion Areas

- no exclusion
- urban or industrial use
- hydrography
- protected area
- land cover
- geomorphology
- topography
The Potential in Tunisia
The El-Borma Case Study

- Biggest Tunisian Oil Field
- Utilization since 1966 capacity today: 10000 b/d
- *Need: New 43 MW off-grid electricity supply*
- Idea: *Integrated Solar Combined Cycle System (ISCCS)*
The Potential in Tunisia
The El-Borma Case Study

- system considered: parallel solar steam generation
- solar tower (air receiver)
- direct steam parabolic trough
- tools: Ebsilon, Greenius
- steam parameter:
  - 440°C
  - 45 bar
The Potential in Tunisia

El-Borma Radiation Data: 1814 kWh/m²/y
The Potential in Tunisia
Results of the El-Borma Case Study

<table>
<thead>
<tr>
<th></th>
<th>Parabolic Trough</th>
<th>Solar Tower</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar generated Electricity</td>
<td>$M_{\text{wh}}^{\text{el}}$</td>
<td>10250</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>2,72</td>
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<tr>
<td>Fuel Save</td>
<td>$M_{\text{Wh}}^{\text{th}}$</td>
<td>21883</td>
</tr>
<tr>
<td>Fuel Save</td>
<td>t</td>
<td>1575</td>
</tr>
<tr>
<td>Mirror Area</td>
<td>m²</td>
<td>50458</td>
</tr>
<tr>
<td>Gross solar field area</td>
<td>ha</td>
<td>16</td>
</tr>
</tbody>
</table>
The Potential in Tunisia
Local Manufacturing Potential

Source: The World Bank study
### The Potential in Tunisia

#### Local Manufacturing Potential: Summary

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
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</thead>
<tbody>
<tr>
<td>- Low labor cost</td>
<td>- Administrative and legal barriers</td>
</tr>
<tr>
<td>- High solar potentials</td>
<td>- Lack of financial markets</td>
</tr>
<tr>
<td>- Strong GDP growth</td>
<td>- Higher capital costs</td>
</tr>
<tr>
<td>- High electricity demand</td>
<td>- Energy highly subsidized at 75%</td>
</tr>
<tr>
<td>- Strong industrial sector</td>
<td>- No fiscal, institutional and legislative framework for RE development (under development)</td>
</tr>
<tr>
<td>- Proximity of Italy</td>
<td>- Insufficiently developed infrastructure</td>
</tr>
<tr>
<td>- Large export industry</td>
<td>- No specialized training programs for RE</td>
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<tr>
<td>- ...</td>
<td>- ...</td>
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</tbody>
</table>
The Potential in Tunisia
How can the local value be increased

- **Solar thermal power plants feature a high fraction of conventional technologies in the value-added chain**

Cost break-down parabolic trough plants  
Cost break-down parabolic trough collector
Introduction into CSP-Technology
Why is CSP important for EU, MENA and Tunisia
Current CSP-projects
The Potential in Tunisia
EnerMENA – Support Initiative of the German Government
enerMENA
main objective

- Initiative by the German Government
- Support the implementation of CSP technology in MENA
- Based on the DESERTEC Concept
- Focusses on
  - Capacity Building
  - Know-how transfer
  - Efficiency Enhancement

Partners: Jordan, Egypt, Tunisia, Algeria & Morocco
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Modular Approach

Module I
Efficiency enhancement of CSP
"Technology"

Module II
Capacity Building
"People"

Module III
Supporting Dissemination

Project management and coordination
enerMENA
”Technology” Module

Activities
➢ Technical Training Program: PSA in Almeria 11/2010 (eM-CB01)
➢ Five mobile measurement laboratories
➢ Development of an optical and thermal measurement technology for quality control of collectors
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"Technology” Module

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enerMENA
“People” Module

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- Technical **Training Program**: PSA in Almeria 11/2010 (eM-CB01)
- Establish local CSP technical teams
- Prepare expert training materials,
- Organize of eM-CB02 at Technopole Tunisia in November 2011
- Preparing CSP teaching materials for universities
- 4 international workshops with MENA experts
- Lectures implemented in Jordan

Module I  
Efficiency enhancement of CSP “Technology“

Module II  
Capacity Building „People“

Module III  
Supporting „Dissemination“

Project management and coordination
enerMENA
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“Dissemination” Module

**Activities**

- Preparation of **coaching material** for yield analysis and project planning methodology
- Installation of eight **Meteo-stations** to overcome insufficient data base (not yet completed)
- “Project Planning” **training program** in November 2010.
- Establishment of local **contact points** for information dissemination at partner institutions.
enerMENA
”Dissemination” Module

Activities

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Summary

- CSP provides a mature utility scale power technology
- Numerous projects realised worldwide
- Increasing electricity demand from RE in Europe
- Desertec concept demands substantial contribution North-Africa
- Tunisia with excellent potential
- EnerMENA – aims at providing capacity building support
Thank you for your attention!