Solar Water Projects

Integrated Solar Production of Power, Water and Cooling Energy

Egyptian-German Symposium, "Solar Thermal Power and Desalination"
German Egyptian Year of Science and Technology (2007)
Cairo November 11th-12th, 2007

Jürgen Kern (Dipl. Ing.)
Managing Director
Kernenergien - the solar power company

Solar Water Projects

Structure

- kernenergien – the solar power company
- solar technologies: concentrating solar power CSP
- sea water desalination and solar desalination
- solar process heat and solar cooling
- integrated technologies
- solar resources and potentials
- the ‘solar water’ projects
- benefits
- conclusions and action
solar water projects

kernenergien
the solar power company

- kernenergien – the solar power company?
  - [diet] kernenergien [de]: nuclear energy [en]
  - antagonism to solar energy?
  - using the largest nuclear fusion reactor
  - in the safest and most effective way
  - the sun

TRANS-CSP
Comparing Strategies for Electricity in Europe

Electricity Mix dominated by Renewable Energy / Fossil Backup
- Diversified supply and renewable resources
- Domestic sources dominate the electricity mix
- Low vulnerability of decentralised generation
- Low hazardous waste, recyclable materials
- Low risk of contamination or major accidents
- Requires public investment over limited time
- Low environmental impact
- Trend to lower cost and low price volatility
- Power on demand by a well balanced mix
- Based on proven and demonstrated technologies

Electricity Mix dominated by Fossil Fuels and Nuclear Power
- Supply based on few and limited resources
- Energy imports dominate the electricity mix
- High vulnerability of large generation units
- Unsolved disposal of nuclear waste and CO₂
- Risks of nuclear proliferation and accidents
- Requires long-term continuous subsidisation
- Climate change and pollution
- Trend to higher cost and high price volatility
- (decommissioning & waste mgmt. 600 €/kW ! /NDA 2002/)
- Power on demand by ideally stored energy
- Still requires major technical breakthroughs:
  - Safe fission and breeder technology
  - Commercial fusion reactor
  - Carbon capture and sequestration
solar water projects

Solar Power Technologies

Concentrating Solar Thermal Power CSP

Technologies
- Tower / Heliostats
  - Medium Air
    - 600-1200 °C
  - Parabolic Troughs
    - Medium Oil/Steam
    - 390-550 °C
- Fresnel
  - Medium Steam
  - 270-550 °C
- Paraboloid/Dish
  - Small units < 50 kW remote
  - Helium/Hydrogen
  - 600-1200 °C

Source: Sandia National Laboratories Applied Energy Photo Database

Market available technology
Status of CSP Projects (March 2007)

- **Tower**
  - PS10: 10 MWel in operation

- **Trough**
  - Nevada SolarOne: 64 MWel in operation
  - AndaSol I & II: 50 MWel in construction

- **Fresnel**
  - Novatec Biosol Fresnel: first steam
  - MAN / SPG Fresnel Demo: first steam

**Solucar PS10**
- **Towers**
  - 50,000 m²
  - Pre-commercial operation >2006

**Nevada Solar One**
- **Trough SEGS**
  - 250,000 m²
  - Commercial on grid 2007

**AndaSol I & II**
- **Trough SKAL-ET**
  - 500,000 m²
  - Commercial on grid 2008
Seawater Desalination

- State of the art conventional / fossil
- Saudi Arabia
- > 70% of potable water
- Shuaiba 500,000 m³/d
- More 1 Bill. m³/year
- World-wide
- More 5 Bill. m³/year
- Methods
  - MSF / MVC
  - MED Multi-Effect-Distillation
  - Reverse Osmosis
- Costs (investment)
  - MED 975-1350 $/m³/day
  - RO 825-1500 $/m³/day

Solar Desalination: Fresh water production

- Infrastructure not developed
- Small villages in rural areas
- Decentralised settlements
- Small islands
- Electric power / square m
- Heat / square m
- Solar collectors
- PV / Wind
- MD
- MED
- RO
- VC
- EDR
Solar Desalination: Fresh water production

Infrastructure developed
- Large settlements
- Cities
- Hotels, Resorts

Large scale, well developed desalination systems produce up to 200,000 m³ per day.

Power Plant Configurations of integrated plants

Solar water projects
### Integrated Power Plants

#### Conventional vs. Integration

<table>
<thead>
<tr>
<th>Power Plant</th>
<th>Electric Power</th>
<th>Cooling</th>
<th>Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas 85 MW</td>
<td>32.5 MW</td>
<td>10 MW</td>
<td>400 t/h</td>
</tr>
<tr>
<td>90%</td>
<td>38% eff</td>
<td>40 MW</td>
<td></td>
</tr>
<tr>
<td>Gas 79 MW</td>
<td>15 MW</td>
<td>10 MW</td>
<td>400 t/h</td>
</tr>
<tr>
<td>Solar 15 MW</td>
<td>10 MW</td>
<td>10 MW</td>
<td></td>
</tr>
<tr>
<td>Heat Input 100°C</td>
<td>Compression Chiller</td>
<td>22 MW + 18 MW = 40 MW</td>
<td></td>
</tr>
<tr>
<td>Desalination</td>
<td>Absorption Chiller</td>
<td>22 MW + 18 MW = 40 MW</td>
<td></td>
</tr>
</tbody>
</table>

#### Renewable Electricity Potentials in EUMENA

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>Yield (GWh/㎢/y)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomass</td>
<td>(0-1)</td>
</tr>
<tr>
<td>Wind</td>
<td>(0-50)</td>
</tr>
<tr>
<td>Geothermal</td>
<td>(0-1)</td>
</tr>
<tr>
<td>Solar</td>
<td>(10-250)</td>
</tr>
<tr>
<td>Hydropower</td>
<td>(0-50)</td>
</tr>
</tbody>
</table>

A CSP plant of the size of Lake Nasser equals the total Middle East oil production.
Solar Potential of Egypt

Technical Potential: 73656 TWh/y (DNI > 1800 kWh/m²/y)
Economic Potential: 73655 TWh/y (DNI > 2000 kWh/m²/y)
Power Demand 2000: 71 TWh/y
Power Demand 2050: 631 TWh/y (Scenario CG/HE)
Tentative CSP 2050: 395 TWh/y (Scenario CG/HE)
Coastal Potential: 496 TWh/y (< 20 m a. s. l.)
Water Demand 2050: 256 TWh/y (Power for Desalination)

Aqaba Hotel & Resort AYLA OASIS
- Lagoons (75 hectares)
- Hotels (1,540 rooms)
- Residential (2,884 Units)
- Retail & Commercial (100,000 m²)
- Recreational:
  - Golf Course / 27 holes

- Solar thermal power plant with seawater desalination and district cooling:
  - Power (electric): 8.5 MW
  - Electricity production: 75 GWh/year
  - Power (therm): 40 MW
  - Chilled production: 140 GWh/year
  - Desalted water: 10,000 t/day
  - Water production: 2.6 Mill. t/year

- Ayla: 5 Stars + 1 Green Star + 1 Solar Star

Jordan Integrated Solar Power & Water
The 'Jordan Solar Water' Project schematic process diagram

- Sun
- Solar Field
- GEN
- Electr. 8.5 MW
- MED
- Water 10,000 t/d
- CC
- Chill 40 MW
- AC
- Aux
- Gas
- Boiler Steam
- Steam Turbine

The Solar Water Projects - Phases

- Research and Development 2004 -
  - BMU SOLWATER Study 2005/2006
  - EC MED-CSD Study 2008-
- Basic Project Development 2005 - 2007
  - Aqaba, JOR 2005
  - Canarias, E 2006
  - Egypt / Syria 2007
  - Malta, Oman, Kuwait, ...
- Project Finance Design 2006 -
- Project Implementation 2008 -
- Construction 2008 - 2009
- Operation 2010
Conclusions

- Well balanced mix of renewable energy technologies
- Solar CSP Technologies are available
- Desalination is state of the art
- Cooling nets are state of the art
- Growing market for water and cooling
- Solar insurance against rising prices
The deployment of renewable energies must be accelerated by adequate policy instruments that motivate private investment. Feed-in laws or Power purchase agreements for renewables will create comparable markets. Build up portfolios for development, construction and operation of commercial power plants as direct investments and partnerships with project and technology developers. Pilot projects will demonstrate the technical and economical power and clients will wisely invest in ‘lighthouse’ projects to profit early from the sun. Policy instruments • Power purchase agreements • Investment strategy • Pilot projects • Profitable commercial projects

**Action**