Energy Production above and Biomass Production below a Linear Fresnel Collector Field in a CSP Multipurpose Plant

Photos: Solarmundo

Greenhouse Visualization: DLR
Multipurpose Plant for the Development of Arid Regions

- Solar collector and partially shaded crops
- Thermal desalination plant
- Salt production
- Freeland crops
- Pasture
- Wood
- Steam
- Power block
- Brine
- Sea water
- Electricity
- Sweet water
Deserts as Powerhouses and Water Works

www.desertec.org
One Square Kilometre of Desert Land using Concentrating Solar Thermal Power can produce up to:

- 250 Million kWh/year of Electricity
- 60 Million m³/year of Desalted Seawater
## Considering Sustainability

<table>
<thead>
<tr>
<th>Why not use ...?</th>
<th>Because it does not satisfy the criteria for sustainability, e.g. ...</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nuclear</strong></td>
<td>Radioactive waste disposal has not been solved in 50 years of commercial operation</td>
</tr>
<tr>
<td></td>
<td>Decommissioning cost 8000 €/kW</td>
</tr>
<tr>
<td></td>
<td><a href="http://www.nda.gov.uk">www.nda.gov.uk</a></td>
</tr>
<tr>
<td>Wind, PV, Hydropower, Geothermal, Biomass</td>
<td>Yes, but potential already needed for growing electricity demand in MENA</td>
</tr>
<tr>
<td></td>
<td><a href="http://www.dlr.de/tt/med-csp">www.dlr.de/tt/med-csp</a></td>
</tr>
<tr>
<td><strong>Coal</strong></td>
<td>No infrastructure, no domestic source, climate change, exhaustible</td>
</tr>
<tr>
<td><strong>Oil, Gas</strong></td>
<td>Yes, but expensive and exhaustible</td>
</tr>
</tbody>
</table>
Concentrating Solar Power for the Mediterranean Region

Trans-Mediterranean Interconnection for Concentrating Solar Power

Concentrating Solar Power for Sea Water Desalination

www.menarec.org

MENAREC 2
Amman, Jordan
May 2005

MENAREC 3
Cairo, Egypt
June 2006

MENAREC 4
Damascus, Syria
June 2007
CSP Plant at Kramer Junction, California on the Grid since 1989
The Future evolved to Present ...
as from 14.03.2008 the “MEDITERRANEAN UNION”
proposed by Mr. Sarkozy and Ms. Merkel is REALITY
Berlin, 19.04.2007
Ministerial Conference on Renewable Energy

FORGING ENERGY PARTNERSHIP

German Minister of Economic Cooperation:

We want to forge an energy partnership with Africa for sustainable energy management.

Heidemarie Wieczorek-Zeul
A Ground breaking Idea

German Federal Minister of Environment:

Studies on potential by the German Aerospace Center find that solar thermal power plants in southern Europe and northern Africa could play an important role in securing a sustainable European energy supply.....

The idea is ground-breaking: it means that in 20 to 30 years we can procure part of our energy from solar power plants in North Africa. ....one day, the European "super grid" will be able to transfer electricity produced in solar thermal power plants to central Europe – without any power cuts!
The Idea of an EU-MENA Renewable Energy Link using HVDC Power Transmission Technology

Source: ABB 2004

Global Power Systems for Sustainable Energy Development at IEEE PES 2004 General Meeting, Denver, 6–12 June 2004
Renewable Energies around the Mediterranean
A study commissioned by the Federal Ministry of Environment and conducted by the German Aerospace Center DLR
Countries analysed within the MED-CSP and TRANS-CSP Studies
Growing Electricity Demand in Southern EU-MENA
Renewable Energy Resource Mapping

Economic Potential TWh/y
(Demand 2050 ≈ 4000 TWh/y)

Geothermal Energy

Wind Energy

Hydropower

Concentrating Solar Power

PV
Concentrating Solar Power

relevant for Power Stations are 5 MW to 1000 MW

<table>
<thead>
<tr>
<th>System Type</th>
<th>Capacity Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parabolic Trough</td>
<td>5-600 MW</td>
</tr>
<tr>
<td>Solar Tower</td>
<td>5-100 MW</td>
</tr>
<tr>
<td>Linear Fresnel</td>
<td>5-600 MW</td>
</tr>
<tr>
<td>Parabolic Dish</td>
<td>0.5-50 kW</td>
</tr>
</tbody>
</table>

Source: DLR
Parabolic trough Technology
Following a German Patent from 1906

Frank Shuman built in Maady 1912 the first CSP facility

He wrote: “One thing I am sure of; the human race should either utilize solar energy directly or go back to pre-civilization”.
CSP-Plant in California
Solar Hybrid Power Station with Desalination

Step 1: Solar field in Hybrid operation for day and night service.

Step 2: Solar field with Heat Storage for Night operation + fossil boiler as reserve.

Desalination (MED) with Waste Heat
Advanced Design: Flat Mirrors

Best collection of the Sunrays. Simple, cost effective and usage of area underneath mirrors is possible.
Automated Cleaning ...
. less cleaning water & it is not wasted

In the shadow plants need less irrigation water
CSP in action
Economic Site Ranking

Calculation of the economic site ranking from the electricity yield and the project costs

North Africa – Solarthermal Electricity Generation Cost Ranking

A Solar Power Plant of the Size of Lake Nasser equals the total Middle East Oil Production

The North African Solar Energy equals 1,000,000 Barrels of Oil per km² yearly
At any time, peak power demand is covered with an extra of 25% reserve capacity.
3 Samples for EU-MENA HVDC Interconnection
Production cost in 2050 4ct/kWh, Transportation 1 ct/kWh

3 x 5 GW x 7000 h/a = 105 TWh/a
Cost of Electricity... 2050 about 7 ct/kWh in Germany

RUE
Rational Use of Energy

RES
Renewable Energy Systems

CCS
Carbon Capture & Sequestration

TRANS-CSP Mix: Energy Mix as described here incl. RUE, RES and CCS
Mix 2000: Maintaining exactly the Power Mix like in the Year 2000 with CCS
No Nuclear: Mix like in the Year 2000, but substituting Nuclear by Coal & CCS
Short term planning and Electricity export possibilities

This Area 32x32 km = 1000 km² gives 50% of Germany’s electricity

Source NREA

Source MoEE
The Requirements in Egypt are different than those of Europe...

• Not only Electricity is needed ...
  ... 6-8% increase yearly

• Water is also needed ...
  ... One more Nile by 2050
Unsubsidised cost of electricity of CSP versus natural gas CC

Discount rate 5%, economic life 25 years, fuel cost 25 €/MWh, fuel cost escalation 1%/y, irradiance 2400 kWh/m²/y, real €2007, €/$=1
This difference is used to support water desalination.

Cost of water from CSP/MED plants. Please note that before 2020 water could be produced as bye-product without cost.
Electricity Scenario for Egypt
to start a gradual transition to renewables

Giga Watt installed

Year

2000 2010 2020 2030 2040 2050

CSP  Wind  Hydro  Convent.
Thank You