Concentrating Solar Power for Seawater Desalination

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Principle of a Concentrating Solar Thermal Power Plant

- concentrated, easily storable solar thermal energy as fuel saver
- firm capacity, power on demand
- combined generation of process heat for cooling, industry, desalination, etc.
Concentrating Solar Thermal Power Technologies

- Parabolic trough (PSA)
- Solar tower (SNL)
  - Up to 1550 °C
- Linear Fresnel (SPG/MAN)
- Parabolic dish (SBP)
  - Up to 1400 °C

Steam Turbines

Gas Turbines

Engines

Concentrating Solar Thermal Power for Seawater Desalination

Heat Only
- Solar Field
- Storage
- MED
  - Solar heat
  - Grid
  - Fuel
- Water
- Power

Power Only
- Solar Field
- Storage
- RO
  - Solar heat
  - Fuel
- Water
- Power

Combined Heat & Power
- Solar Field
- Storage
- MED
  - Solar heat
  - Fuel
  - Heat
- Water
- Power

MED: Multi-Effect-Distillation; RO: Reverse Osmosis Membrane Desalination
MENA Population will grow from 300 Million to 600 Million

Source: United Nations 2006
Agricultural Municipal Industrial

Freshwater Demand [billion m³/y]

Year

2000 2010 2020 2030 2040 2050

Sustainable Water

Deficit 2000 50 Bm³/year
Deficit 2050 150 Bm³/year

Non-sustainable supply could be stopped by 2030 if CSP is introduced at maximum possible speed
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

Unsubsidised Cost of Water from CSP versus Natural Gas CC/RO

Discount rate 5%, economic life 25 years, fuel cost 25 €/MWh, fuel cost escalation 1 %/y, irradiance 2400 kWh/m²/y, real €2007, RO power 4.5 kWh/m³
CSP Market Potential in EUMENA

- Installed Capacity (GW)
  - Desalination
  - Export Electricity
  - Local Electricity


Installed Capacity:
- 2000: 100 GW
- 2010: 200 GW
- 2020: 300 GW
- 2030: 400 GW
- 2040: 500 GW
- 2050: 600 GW

Direct Solar Irradiance in EUMENA in kWh/m²/y

- 1 km² is enough to desalinate 165,000 m³/day.
- 50 km x 50 km are needed to avoid the MENA water deficit in 2050.

Solar irradiance 2400 kWh/m²/year x 10 % CSP efficiency / 4 kWh/m³ RO power consumption / 365 days/year = 0.165 m³/m²/day
Concentrating Solar Power for Electricity, Cooling and Desalination

Example: Ayla Oasis Resort, Aqaba, Jordan

Solar Field  Storage

Power Plant

MED  AC

Water  Cooling  Power

MED  Multi-Effect-Desalination
AC  Absorption Chiller
Deserts as Powerhouses and Water Works

Full Reports and Country Data:
http://www.dlr.de/tt/med-csp
http://www.dlr.de/tt/trans-csp
http://www.dlr.de/tt/aqua-csp

Thank You!