The Desert of Egypt as Everlasting Power House for Energy and Water

Cairo 14-15 May 2008

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Echnaton adores the blessing power of the sun

و أما بنعمة ربك فحدّث

(سورة الضحى)

الشمس من نعم الله ...

و جعلنا سراجا وهّاجا

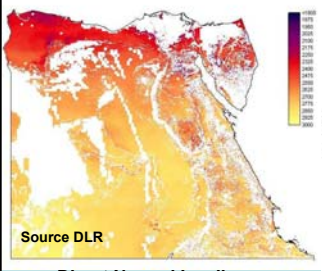
(سورة النبأ)

... لذلك نتحدث بها

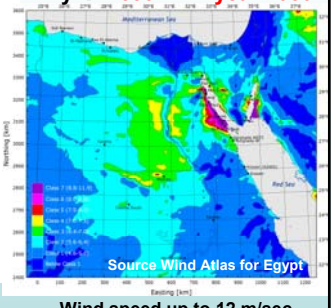
Egypt enjoys excellent Renewable Energy Resources

Hydro Power from the Nile: Potential 15 TWh/year

Electricity Demand 2007 ~100 TWh/y → ~630 TWh/year 2050

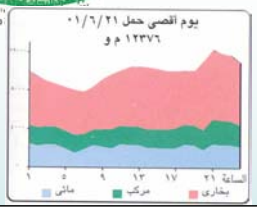


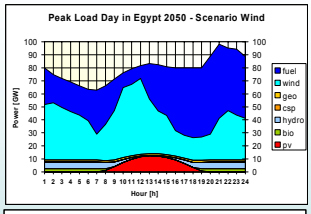
Direct Normal Irradiance up to 3200 kWh/m²/year
Potential 73 656 TWh/year

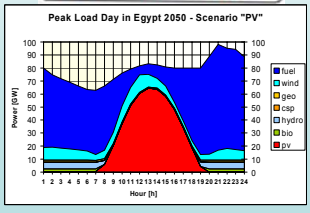


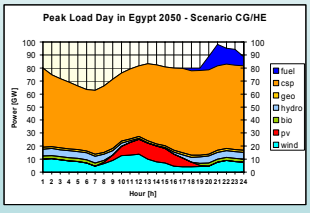
Wind speed up to 12 m/sec
Potential 90 TWh/year

Load Characteristics



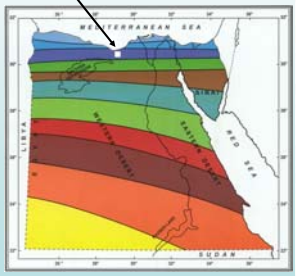






Short term planning and Electricity export possibilities

This Area 32x32 km = 1000 km² gives 10% of Europe's electricity



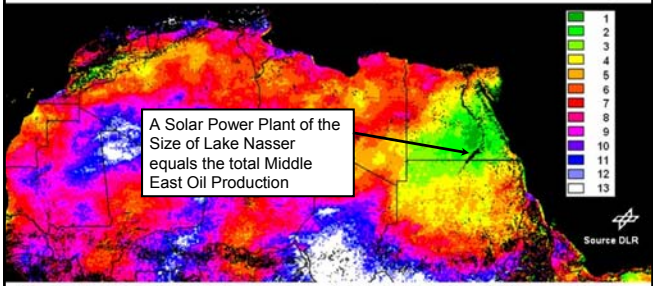
Source NREA

Source MoEE

Economic Site Ranking

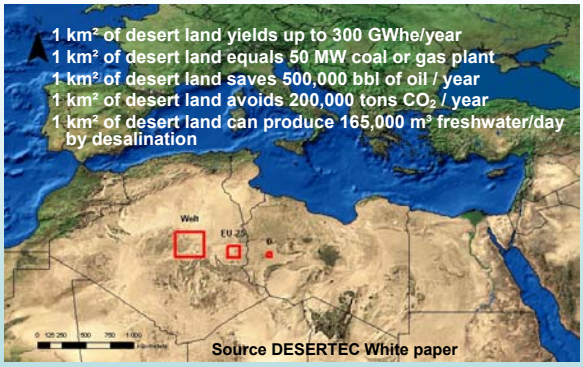
Calculation of the economic site ranking from the electricity yield and the project costs

North Africa – Solarthermal Electricity Generation Cost Ranking

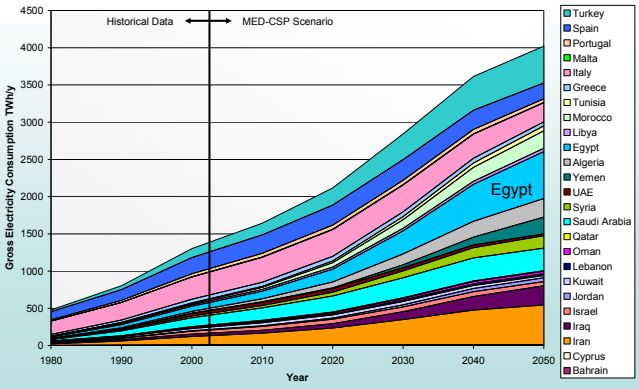


The North African Solar Energy equals 1 000 000 Barrels of Oil per km² yearly

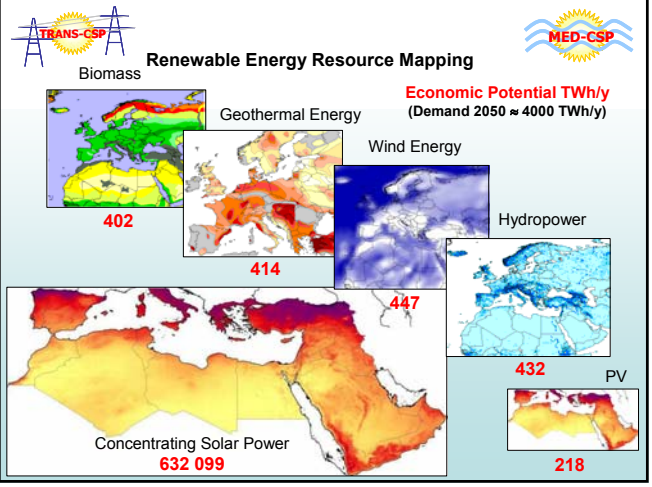
How much land do they need?



Growing Electricity Demand in Southern EU-MENA

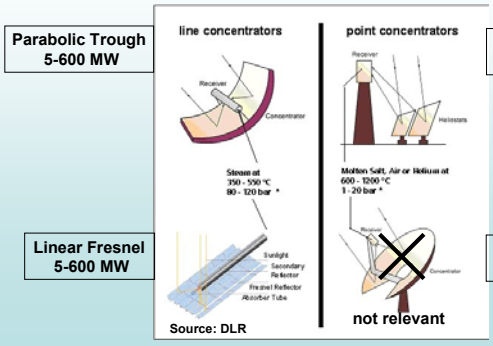


Renewable Energy Resource Mapping

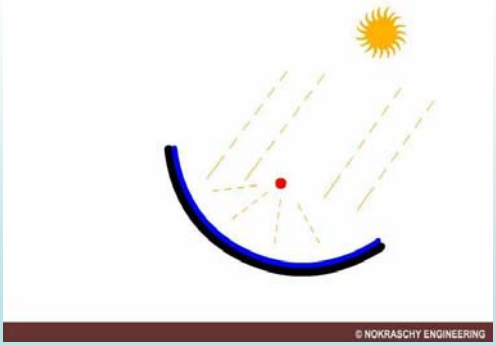


Concentrating Solar Power

relevant for Power Stations are 5 MW to 1000 MW

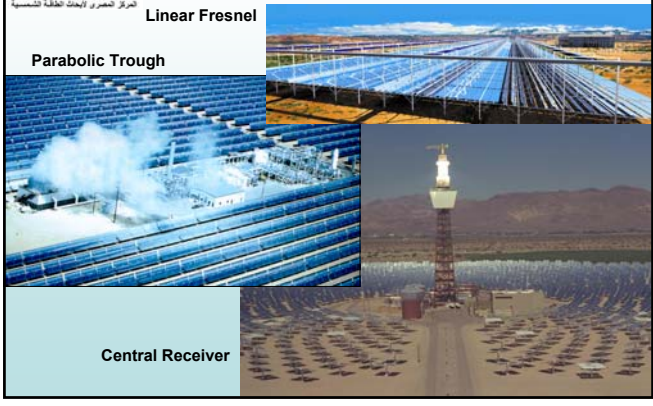


Parabolic trough Technology



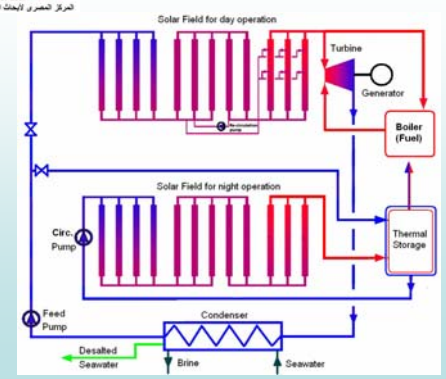
Proven Technology of the past century

CONCENTRATING SOLAR POWER TECHNOLOGIES



CSP-Plant in California since 1985

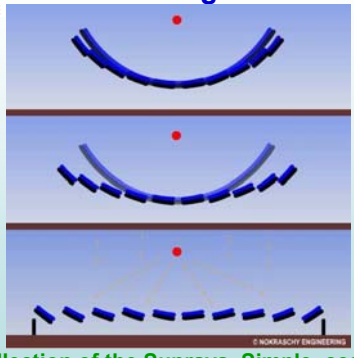
Solar Hybrid Power Station with Desalination



1. Step: Solar field in Hybrid operation for day and night service.
2. Step: Solar field with Heat Storage for Night operation + fossil boiler as reserve.

Desalination (MED) with Waste Heat

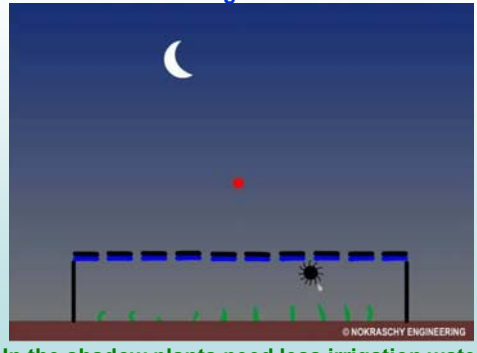
Advanced Design: Flat Mirrors



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



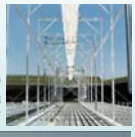
In the shadow plants need less irrigation water

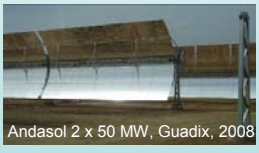
CSP in action

Achievements

Novatec Murcia, 2007

MAN/SPG Almeria 2007





Commercial CSP Technology in Europe

ANDASOL

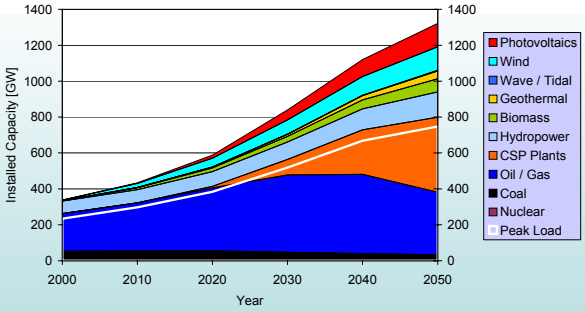
Parabolic Trough (50 MW) using thermal oil heat transfer fluid and molten salt storage (7 h)

Source: Prof. Pitz-Paal, DLR

TRANS-CSP

MED-CSP

Installed Capacity of Southern EU-MENA



At any time, peak power demand is covered with an extra 25 % reserve capacity

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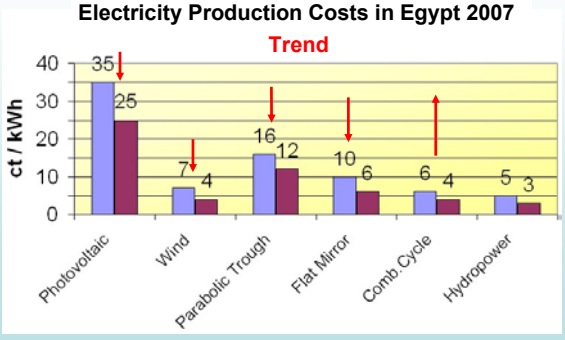
Electricity Production Costs in Egypt 2007



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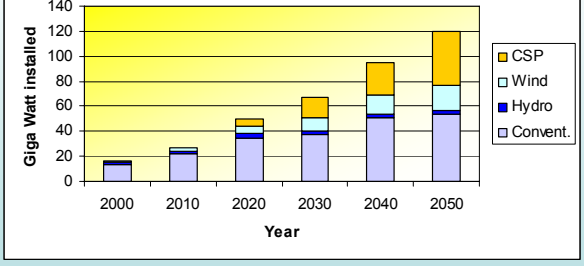
Electricity Scenario for Egypt

to start a gradual transition to renewables



Achievable with wise subsidies = temporary support

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What is a wise subsidy?

- **Support a Product ?**
  - ➔ Subsidy increases with price of Product
    Oil 20 $/BBL ➔ 125 $/BBL
    Gas 6 $/MMBTU ➔ 11.5 $/MMBTU

- **Support a Technology ?**
  - ➔ Subsidy decreases with development of Technology
    Wind electricity 16 ct/kWh ➔ 3 ct/kWh
    Solar electricity 22 ct/kWh ➔ 8 ct/kWh
    reduction expected till 2050 ➔ 4 ct/kWh

Solar electricity now equivalent to:
50-60 $/BBL Oil or 10-12 $/MMBTU Gas

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AQUA-CSP

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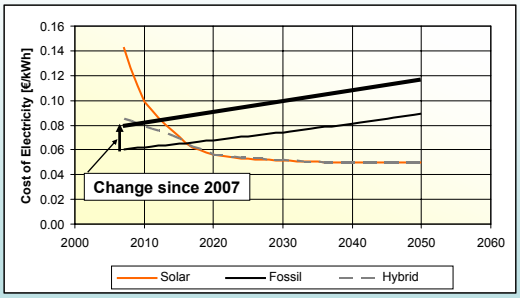
Unsubsidised cost of electricity of CSP versus natural gas CC



Discount rate 5%, economic life 25 years, fuel cost 25 €/MWh, fuel cost escalation 1 %/y, irradiance 2400 kWh/m²/y, real €2007, €/$=1

What are Egypt's Priorities?

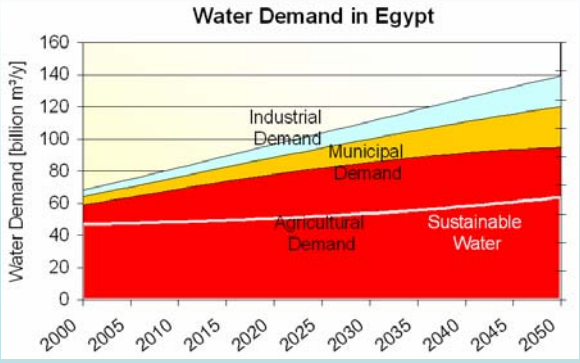
- Not only Electricity is needed …

  … 6-8% increase yearly

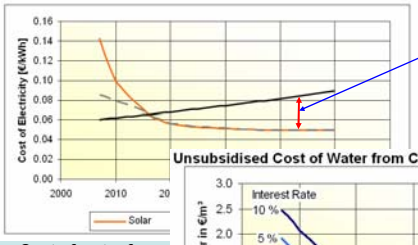
- Water is also needed …much more urgent

  … One more Nile by 2050

Water Demand in Egypt

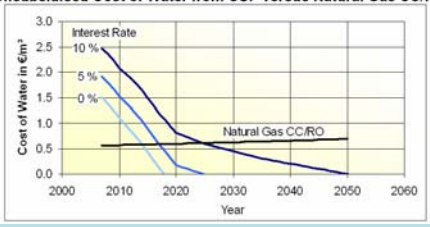


Unsubsidised cost of electricity of CSP versus natural gas CC



This diffirence is used to support water desalination

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



Cost of water from CSP/MED plants. Please note that before 2020 water could be produced as bye-product without cost

A Ground breaking Idea

German Federal Minister of Environment:

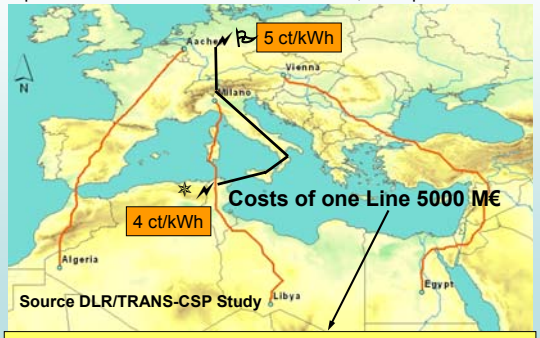
Sigmar Gabriel

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!

Till 2050

The CSP in North Africa will cost 4 ct/kWh

3 Samples for EU-MENA HVDC Interconnection; transport cost 1 ct/kWh



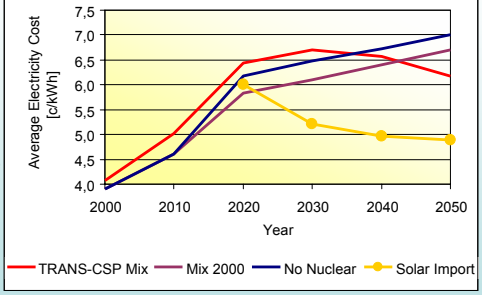
Public Private Partenship Company from Europe and MENA

Cost of convent. elect. mix in 2050 ~7ct/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

A Practical Case:

- A European company establishes together with a company from Egypt a Low Cost Solar Power Station in Egypt.
- Solar-Hybrid concept is preferred to ensure supply on demand.
- The solar electricity share of at least 20% will be transmitted to Europe (Transmission costs 1 ct/kWh with HVDC lines). The conventional share will be consumed in Egypt.
- Beside electricity, desalted water will be produced from the waste heat of the power station, thus boosting the economies.
- Electricity may be used to produce clean Hydrogen

A framework shall govern such a co-operation

General Ideas for the Framework

- Renewable energy shall be produced where it is most economical. For example in MENA countries
  - **Wind 10 m/s (gulf of Suez and Atlas mountains)**
  - **Sun 3000 kWh/m²/y (nearly all over the Sahara)**
- Agreements between country groups or bilateral agreements are suitable to reach the goal.
- Mutual benefit is aimed in this co-operation.
- At the start phase strong support from the European country to the MENA country will accelerate the development.
- Clean electricity and Hydrogen from MENA shall cover about 15% of Europe´s demand.

What can Egypt do?

- Transfer the subsidy for electricity generation from gas to electricity for the end users, with special support for renewables **(see German Law)**.
- Offer free land and infrastructure to the investor.
- Buy the conventional electricity share **(for example at 2.5 ct/kWh depending on fuel price)**
- Buy the desalted water produced from waste heat **(for example at 50 ct/m³)**
- Guarantee by law capital security.
- Free from taxes for the first 10 years.

What can the European country do?

- Set a quota for clean electricity, which is increased each year by 1% points over the actual value for each electricity producer. This is compatible with the target of 20% in 2020.
- Extend support to clean electricity and clean Hydrogen for supplies from outside the country.
- Set support for clean electricity import over the price of local electricity production, assumed now 4 ct/kWh:
  - for example 8 ct/kWh for solar electricity ➔ 12 ct/kWh
  - for example 4 ct/kWh for wind electricity ➔ 8 ct/kWh
- The support is valid only for the clean share of a hybrid system.
- The support is guaranteed for 10 years.
- After 10 years it is reduced by 10% points each year.

What are the „Win-win-objectives“?

- **Europe wins:**
  - Clean and cheaper electricity and Hydrogen.
  - **Employment** due to machinery export.
  - Diversification of energy sources.
- **Egypt wins:**
  - **Water, water and again water.**
  - Sells electricity and Hydrogen for a reasonable price.
  - Social and economic development.
- **Environment wins:**
  - **Less CO_2** emission.
  - This system encourages developing low cost equipment and extending solar share to 100% using heat storage.

Egypt has the possibility of marketing a new product