Europe-Middle-East-North-Africa Energy Security based on Trans-Mediterranean Cooperation

Franz Trieb

NATO Headquarters, Brussels, September 24, 2009

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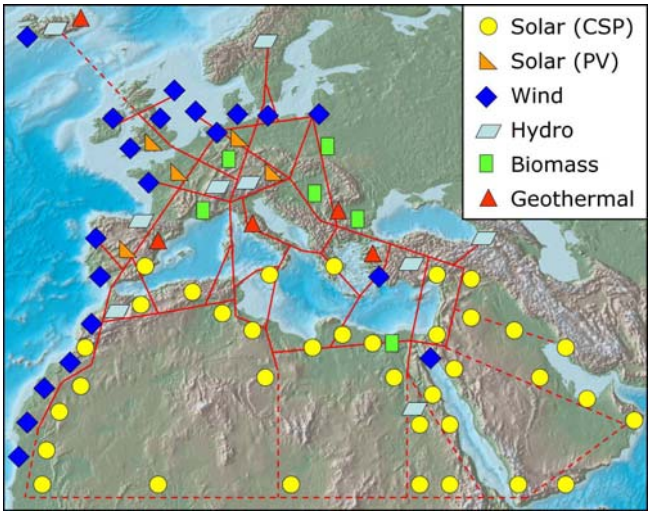
Trans-Mediterranean High Voltage Direct Current Electricity Grid: Interstate Highways for Renewable Electricity in EUMENA

TREC
Clean Power from the Deserts
Trans-Mediterranean Renewable Energy Cooperation
In conjunction with The Club of Rome

THE CLUB OF ROME



EUMENA:
Europe
Middle East
North Africa

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Folie 2

Studies:

Assessment of the renewable energy potential for the sustainable supply of electricity and water in 50 countries of Europe, the Middle East and North Africa taking into consideration the option of Concentrating Solar Power (CSP).

Bundesministerium
für Umwelt, Naturschutz
und Reaktorsicherheit

Criteria for Sustainable Electricity Supply:

✓ **Inexpensive**
- low electricity cost
- no long term subsidies

✓ **Secure**
- diversified and redundant supply
- power on demand
- based on inexhaustible resources
- available or at least visible technology
- capacities expandable in time

✓ **Compatible**
- low pollution
- climate protection
- low risks for health and environment
- fair access

Portfolio of Energy Sources for Electricity:

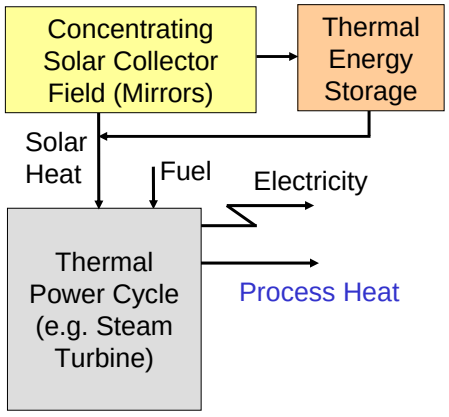
- ✓ **Coal, Lignite**
- ✓ **Oil, Gas**
- ✓ **Nuclear Fission,** Fusion
- ✓ **Concentrating Solar Power (CSP)**
- ✓ **Geothermal Power (Hot Dry Rock)**
- ✓ **Biomass**
- ✓ **Hydropower**
- ✓ **Wind Power**
- ✓ **Photovoltaic**
- ✓ **Wave / Tidal**

ideally stored primary energy

storable primary energy

fluctuating primary energy

Principle of a Concentrating Solar Thermal Power Plant



- concentrated, easily storable solar thermal energy as fuel saver
- spinning reserve
- firm capacity, power on demand
- combined generation of process heat for cooling, industry, desalination, etc.

Renewable Energy Technologies

Hydropower

Concentrating Solar Power

Biomass

Geothermal

Tides

Waves

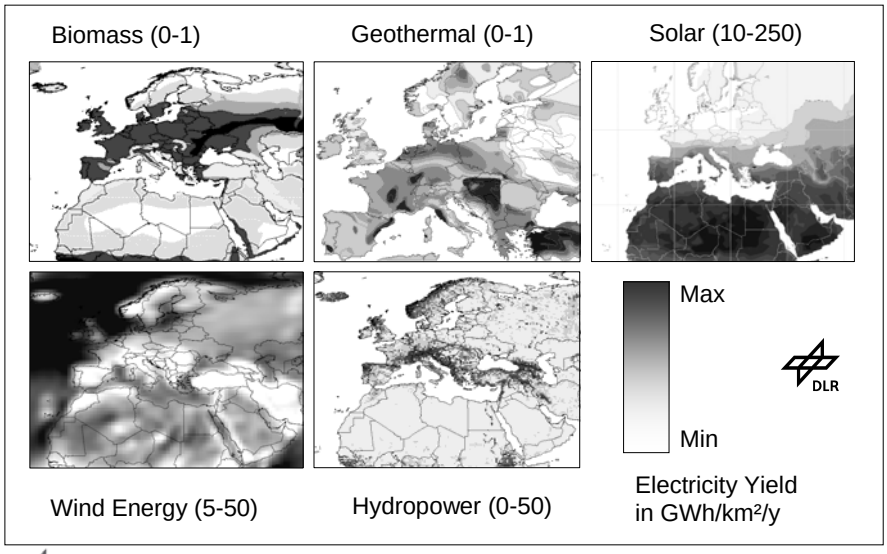
Photovoltaic

Wind Power

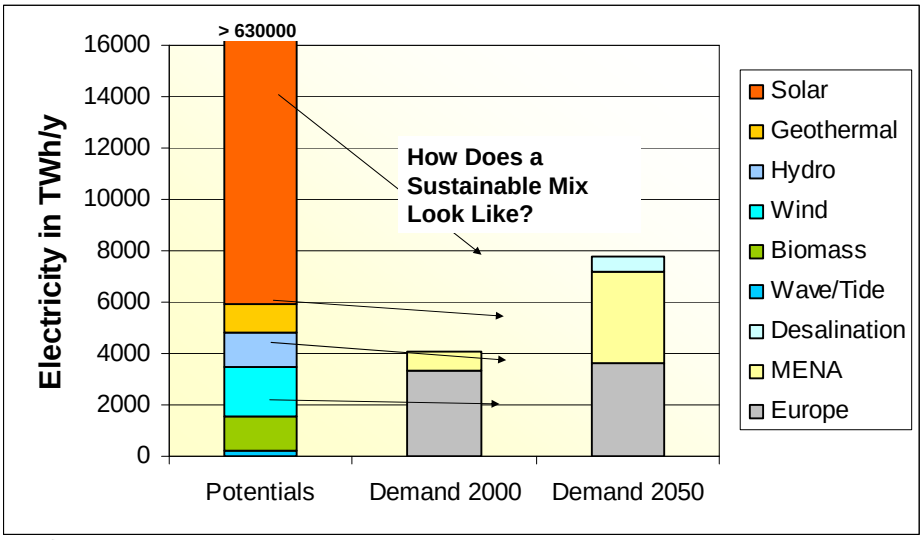
High Voltage Direct Current Transmission in China

Voltage:	± 800.000 Volt
Power:	6400 Megawatt
Length:	2070 km
Source:	Hydropower

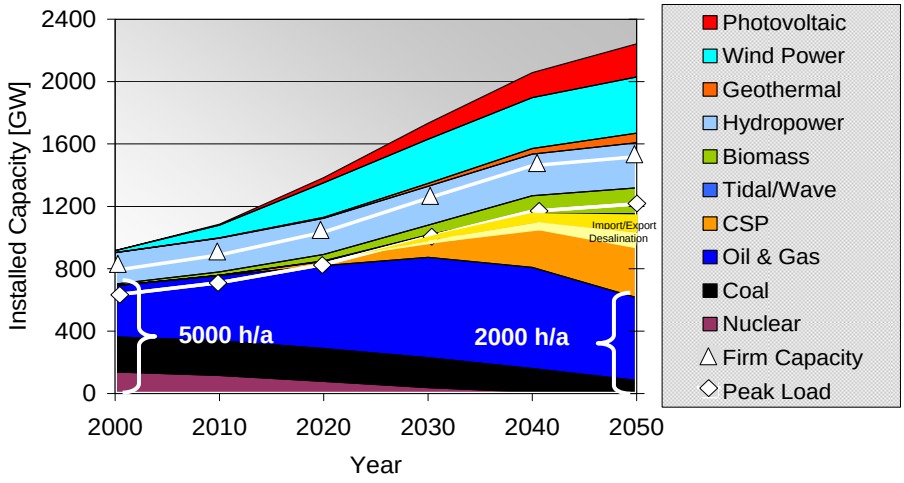
Renewable Electricity Potential in Europe, Middle East & North Africa



Economic Renewable Electricity Potentials vs. Demand in EUMENA



Installed Capacity vs. Peak Load in EUMENA

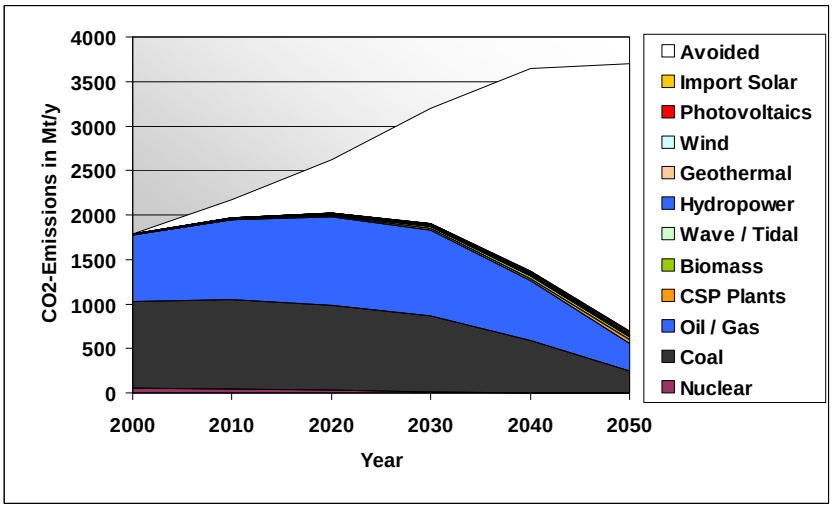


➔ **100 % availability plus 25 % reserve capacity**

Availability and Redundancy

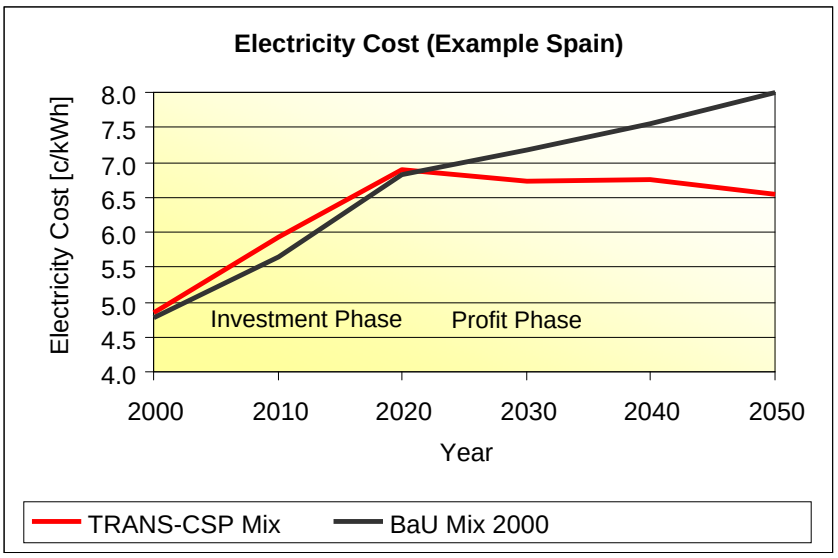
- **Power on Demand by a Mix of Fluctuating and Balancing Sources**
- **Increased Number of Non-Correlated Energy Sources**
- **Increased Number and Reduced Average Size of Power Plants**
- **Increased Number of Supply Regions**
- **Additional HVDC Grid Infrastructure for Long-Distance Transfer**
- **Domestic Sources Dominate the Electricity Mix**
- **Renewable Sources Dominate the Electricity Mix**
- **Strategy Based on Proven Technologies**

Carbon emissions of EUMENA power sector are reduced to 38 % until 2050 in spite of a quickly growing demand



Environmental Security

- Reduced Life Cycle Greenhouse Gas Emissions of Power Generation
- Reduced Risks of Nuclear Radiation and Proliferation
- Reduced Local Pollution by Combustion Products
- Optimal Land Use (1%) through Diversified Mix
- Technology based on Recyclable Materials



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$€_{2000}$, Fuel Cost: IEA / WEO 2005, after 2020 CCS

Folie 15

Economic Security

- **Economic Risk Hedged by Increased Portfolio**
- **Intrinsic Trend to Lower Cost and Lower Price Volatility**
- **Energy Cost Stabilization through Investment in New Sources**
- **Prevention of Cost Escalation due to Environmental Constraints**
- **Prevention of Cost Escalation due to Scarcity**
- **Reduction of Energy Subsidies in Europe and MENA**

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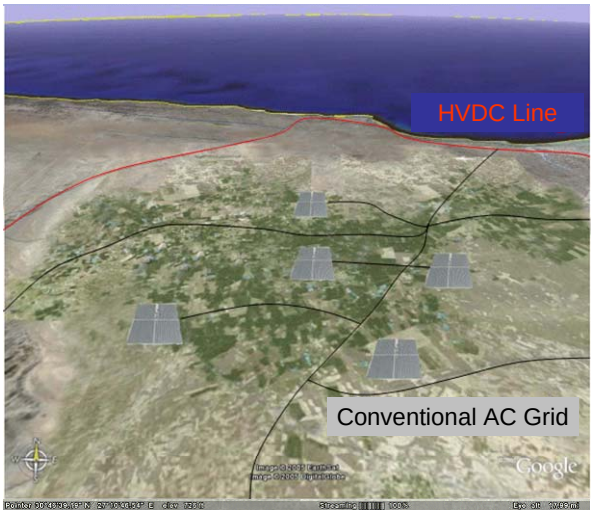
Solar Power & Desalination Plants



Energy,
Water,
Food,
Labor and
Income

for further
300 Million
People
in MENA ?

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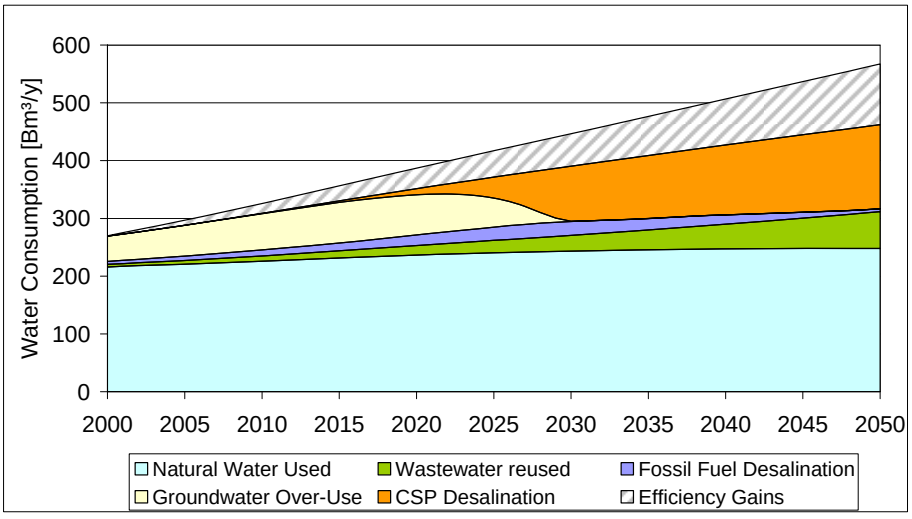
(artist view created with Google Earth)

AQUA-CSP Scenario for Middle East & North Africa



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www.dlr.de/tt/aqua-csp

Political Security

- **Conflict Prevention between EU and MENA Reducing Pressure on Fuels**
- **Conflict Prevention in MENA Solving Energy and Water Scarcity**
- **Conflict Prevention in Europe Increasing Energy Diversity**
- **Reduction of European Energy Import Dependency**
- **Addition of Energy Corridors for European Supply**
- **Initiating EU-MENA (Energy) Partnership**

Challenges

- **Requires New Structures and New Thinking (Change of Paradigm)**
- **Requires Long-Term Financing Scheme for Large Infrastructure**
- **Based on International Cooperation and Interdependencies**
- **Higher Complexity than Using Ideally Stored Fossil Energy Sources**
- **More Stakeholders Involved due to Decentralized Generation**
- **Cultural and Political Differences in EUMENA**
- **Lobby Groups Acting Against Each Other**
- **Speed of Environmental Change and Conflict Potentials**

Thank You!

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Some Background Information

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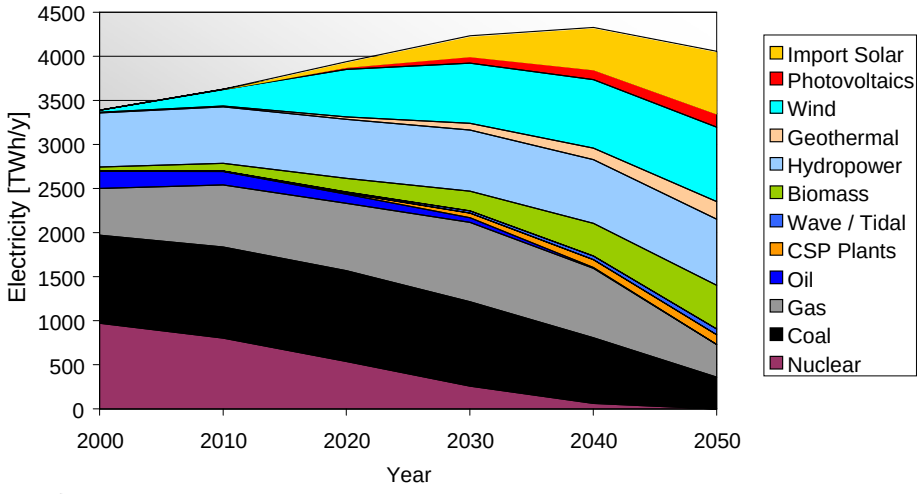
Total EU-MENA HVDC Interconnection 2020 – 2050 *

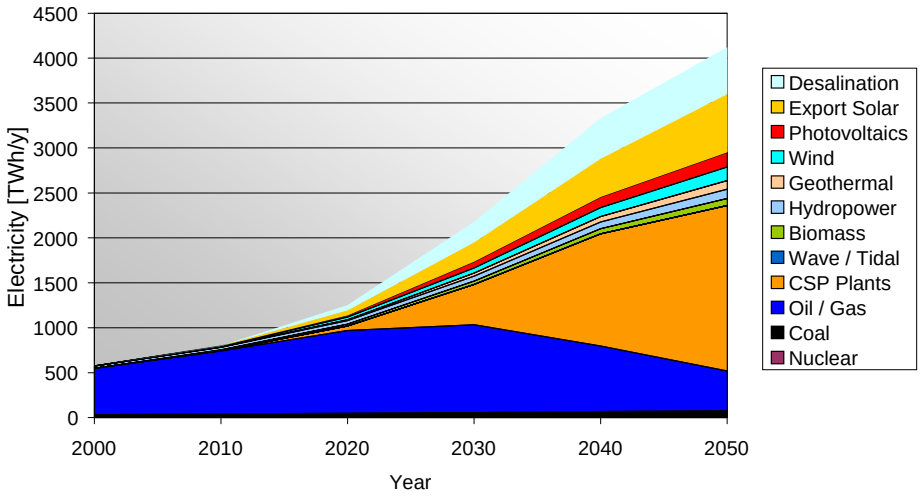
Year		2020	2030	2040	2050
Lines x Capacity GW		4 x 2.5	16 x 2.5	28 x 2.5	40 x 2.5
Transfer TWh/y		60	230	470	700
Capacity Factor		0.60	0.67	0.75	0.80
Turnover Billion €/y		3.8	12.5	24	35
Land Area km x km	CSP HVDC	15 x 15 3100 x 0.1	30 x 30 3600 x 0.4	40 x 40 3600 x 0.7	50 x 50 3600 x 1.0
Cum. Investment Billion €	CSP HVDC	42 5	134 16	245 31	350 45
Elec. Cost €/kWh	CSP HVDC	0.050 0.014	0.045 0.010	0.040 0.010	0.040 0.010

* All countries analysed in TRANS-CSP

Electricity Supply in Europe (TRANS-CSP Scenario)



Electricity Supply in the Middle East & North Africa



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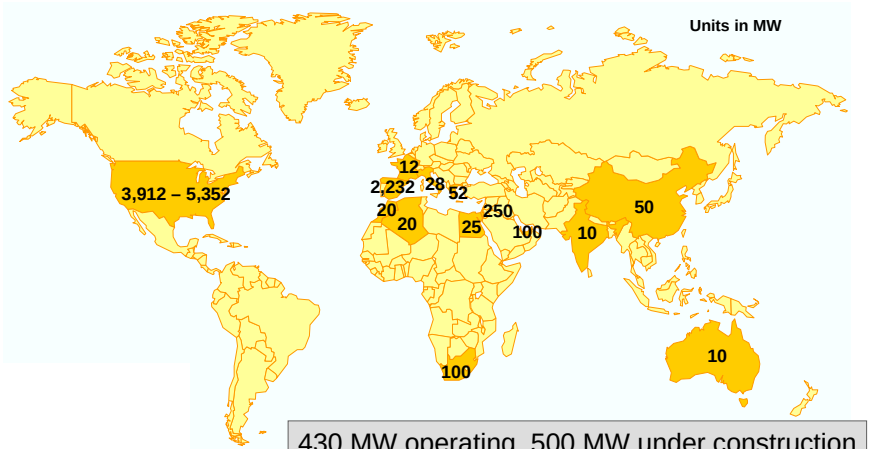
Concentrating Solar Power Projects 2009



430 MW operating, 500 MW under construction
~8,000 MW under development

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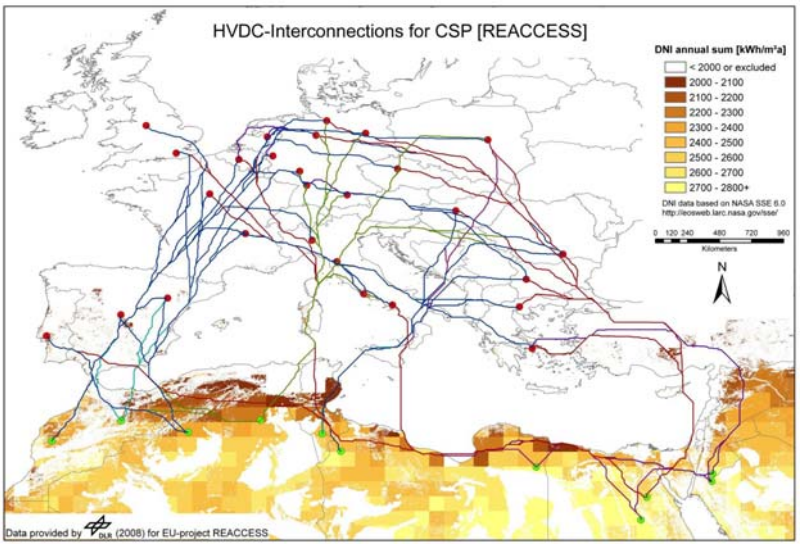
Solar Electricity Corridors to Europe: REACCESS



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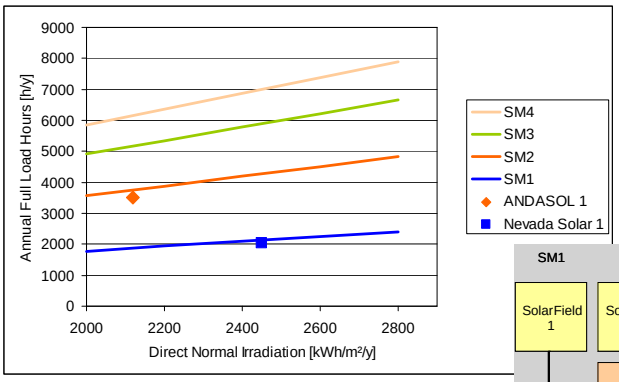
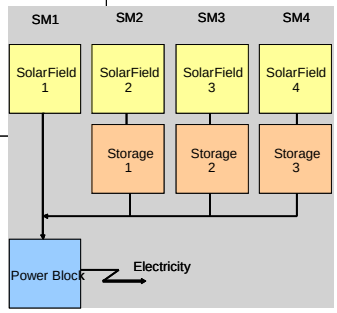
Folie 27

Effect of Thermal Energy Storage on the Availability of CSP





SM = Solar Multiple
1 Solar Field = 6000 m²/MW
1 Storage = 6 hours (full load)

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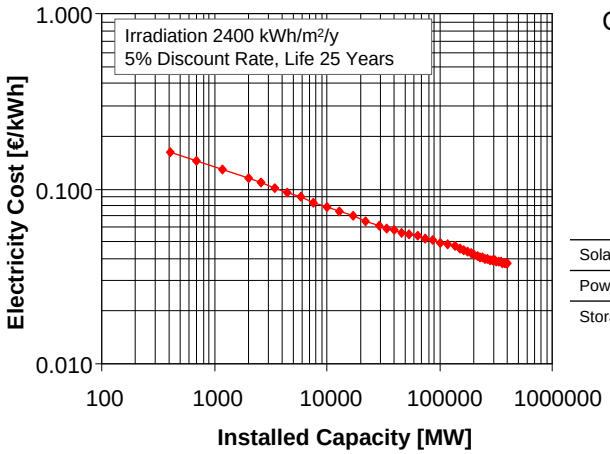
Cost of Concentrating Solar Power

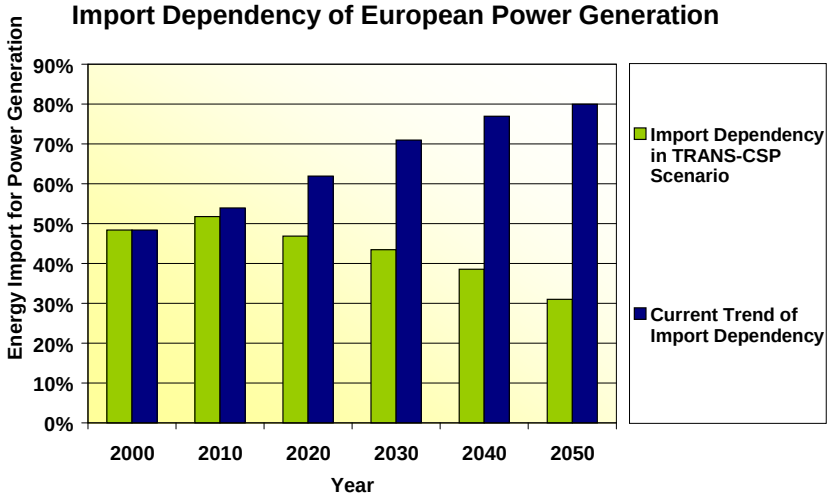


CSP Learning Curve

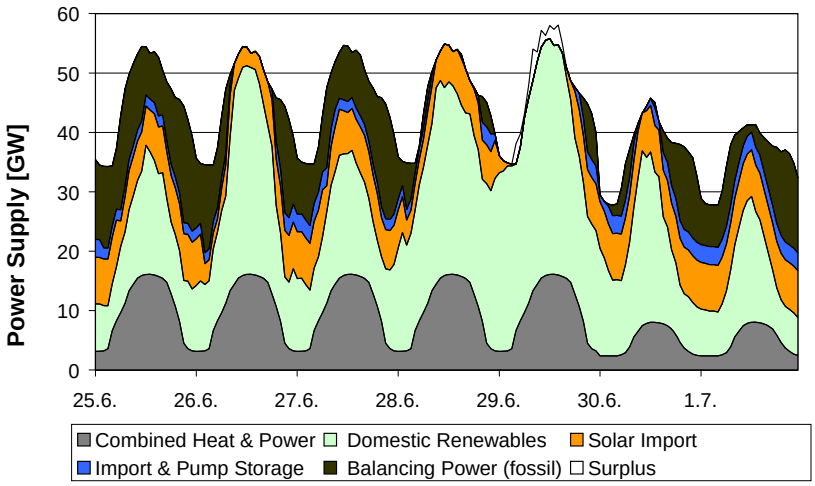
$$c_x = c_0 \left(\frac{P_x}{P_0} \right)^{\frac{\log PR}{\log 2}}$$

	Progress Ratio (PR)	Start 2005 (c0)
Solar Field	90%	360 €/m2
Power Block	98%	1200 €/kW
Storage	92%	60 €/kWh

Import Dependency of European Power Generation



Firm Power Capacity based on Renewables and Fuel (no fossil or nuclear base load supply)



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Hourly Model Germany 2050 (TRANS-CSP)

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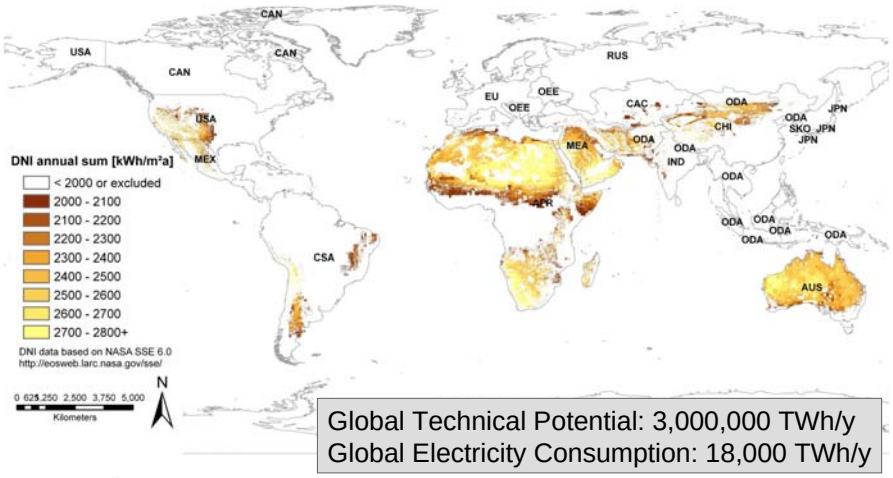
Global Potential for Concentrating Solar Power



Global Technical Potential: 3,000,000 TWh/y
Global Electricity Consumption: 18,000 TWh/y

Data provided by DLR (2008) for EU-project REACCESS

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