Synergistic SuperGrid for Transmitting Energy Overseas 2011
Collecting the SuperGrid Puzzle & Moving Closer to Reality

InnoQube

Trans-Mediterranean Interconnection for Concentrating Solar Power

Franz Trieb

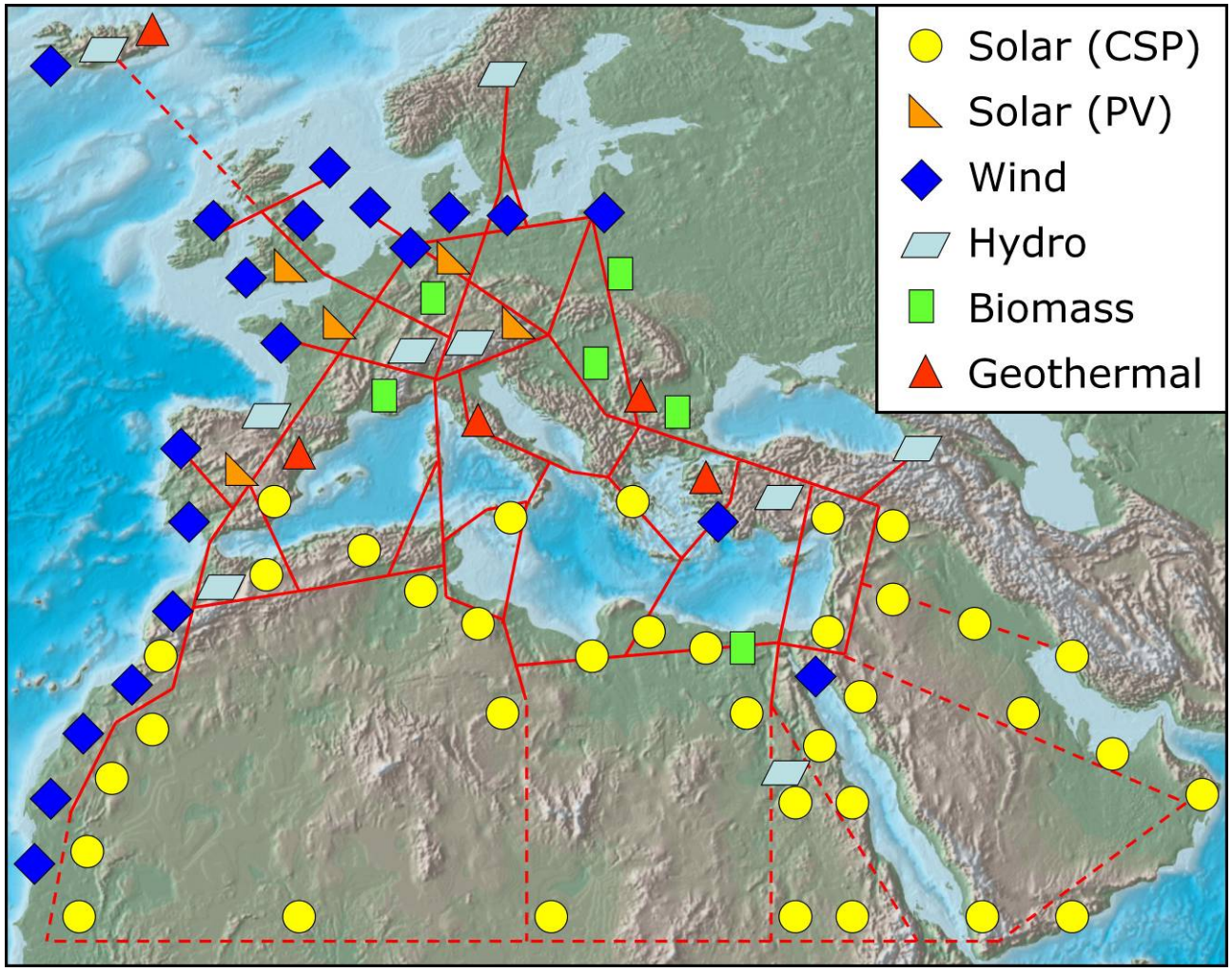
Synergistic Supergrid Conference, London, January 19-21, 2010

DLR Deutsches Zentrum für Luft- und Raumfahrt e.V.
in der Helmholtz-Gemeinschaft

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

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

Portfolio of Energy Sources for Electricity:

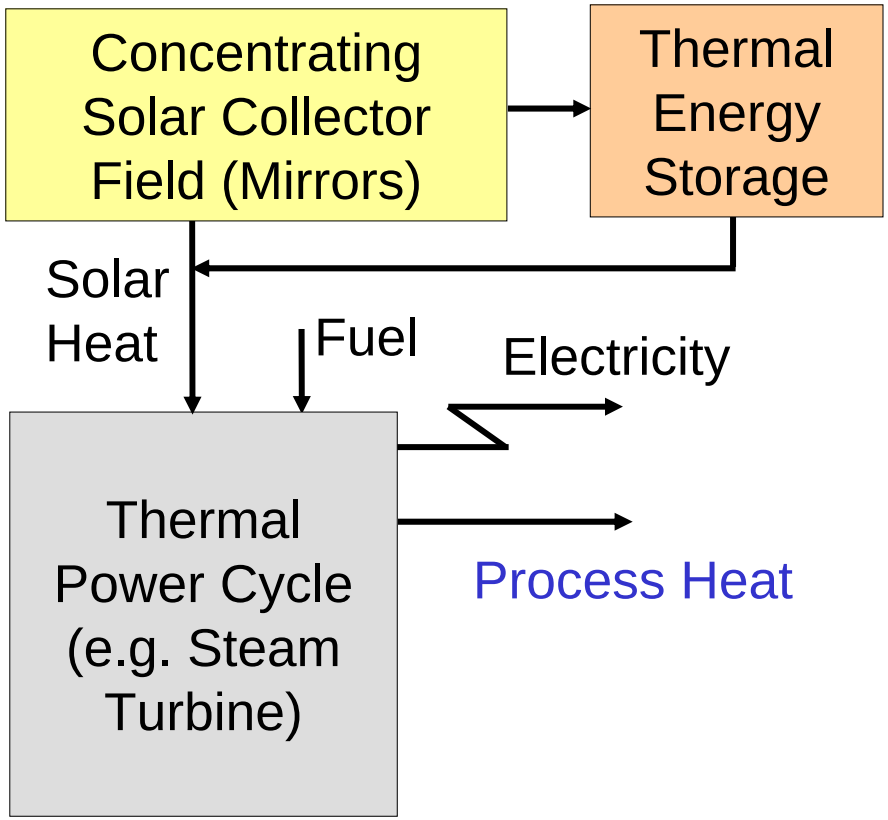
- ✓ Coal, Lignite
- ✓ Oil, Gas
- ✓ Nuclear Fission, Fusion
- ✓ Concentrating Solar Power (CSP)
- ✓ Geothermal Power (Hot Dry Rock)
- ✓ Biomass
- ✓ Hydropower
- ✓ Wind Power
- ✓ Photovoltaic
- ✓ Wave / Tidal

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.

ANDASOL, Guadix, Spain
Capacity 2 x 50 MW_{el}
Storage 2 x 1000 MWh_{th}

Renewable Energy Technologies

Geothermal

Hydropower

Concentrating
Solar Power

Biomass

Tides

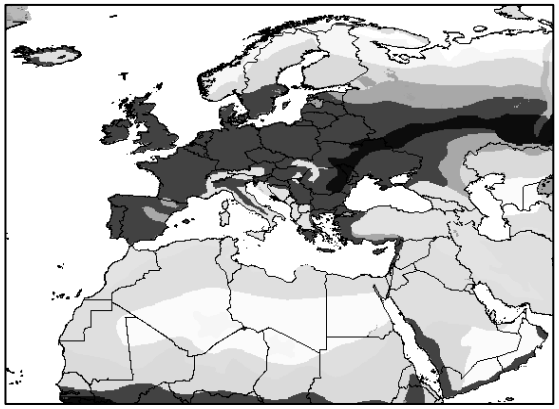
Waves

Photovoltaic

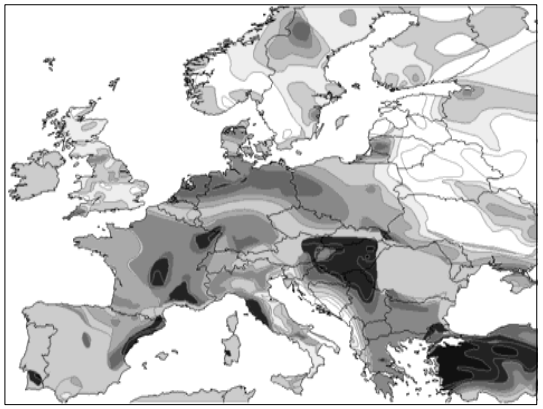
Wind Power

Renewable Electricity Potential in Europe, Middle East & North Africa

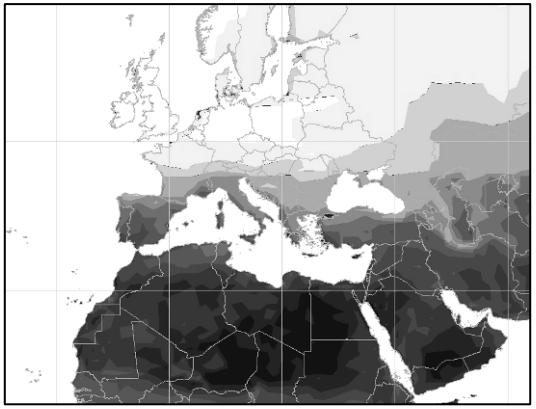
Biomass (0-1)

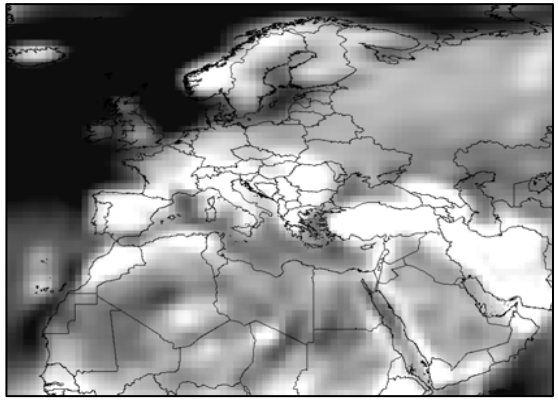


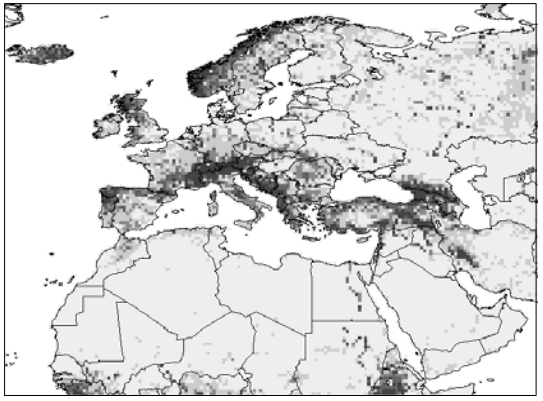
Geothermal (0-1)



Solar (10-250)







Max

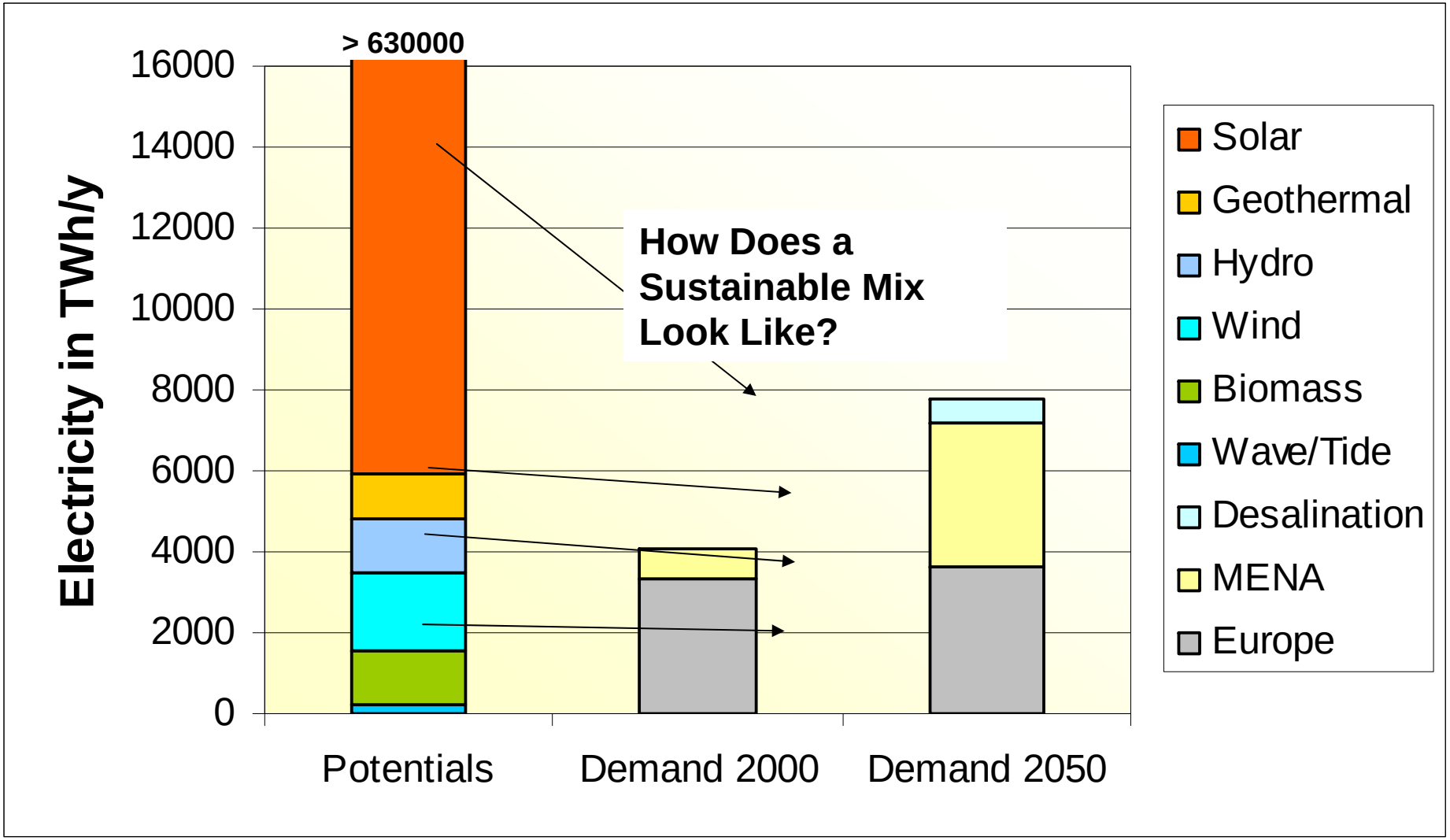
Min

Electricity Yield
in GWh/km²/y

Wind Energy (5-50)

Hydropower (0-50)

Economic Renewable Electricity Potentials vs. Demand in EUMENA



Criteria for Sustainable Electricity Supply:

✓ **Inexpensive**

low cost
no long term subsidies

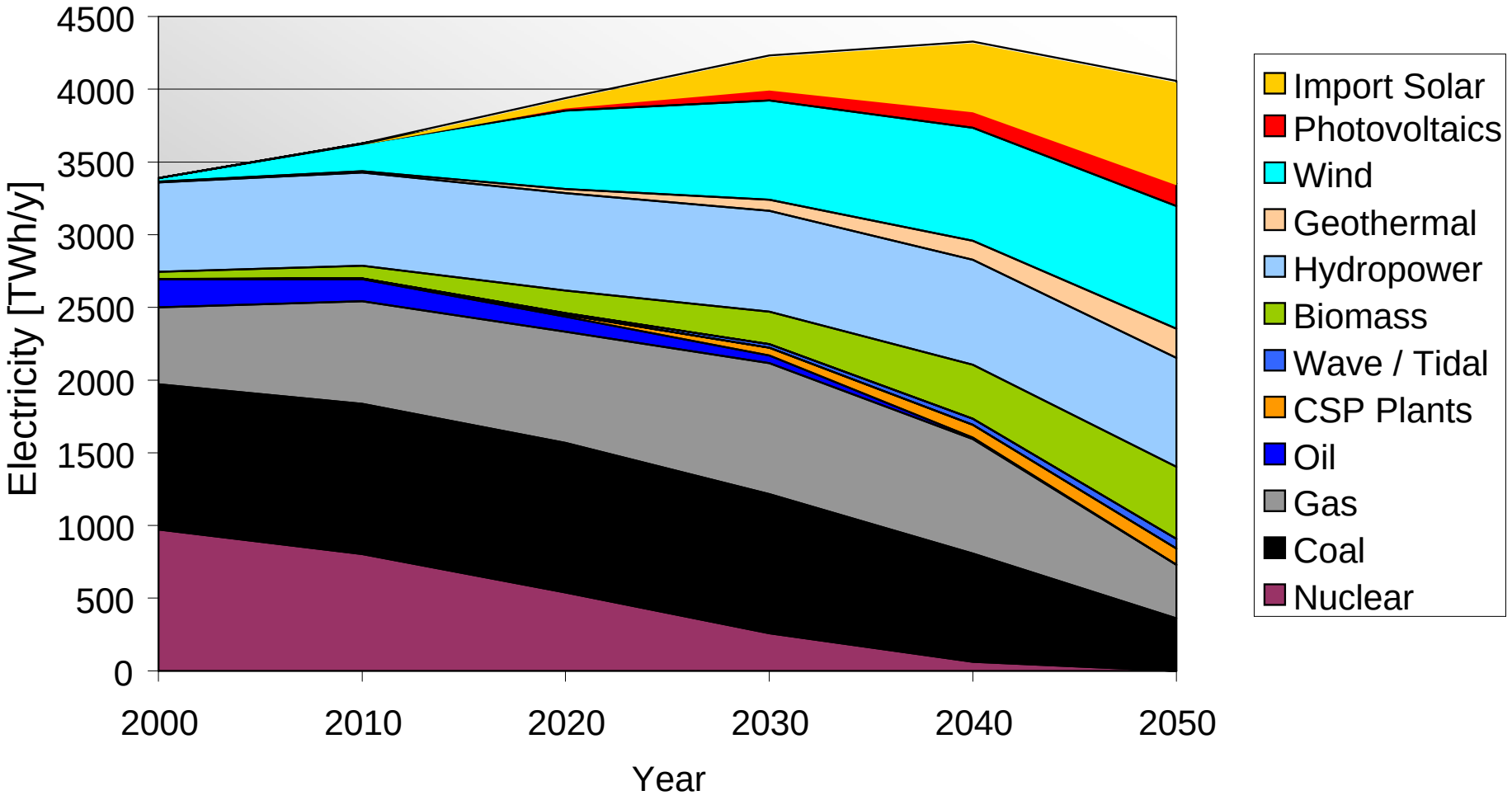
✓ **Secure**

diversified and redundant supply
power on demand
inexhaustible resources
available technology

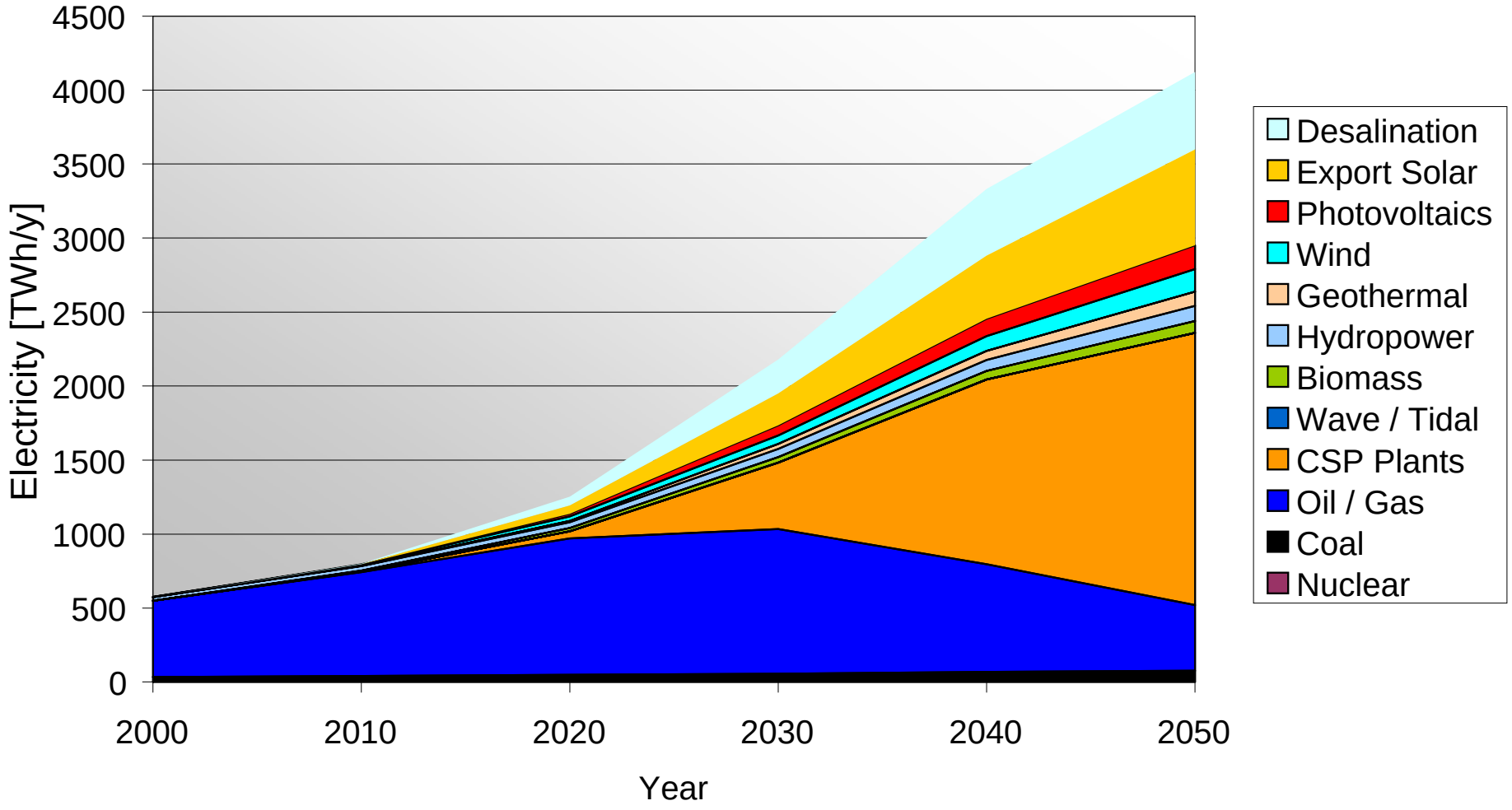
✓ **Compatible**

low pollution
climate protection
low risks for health and environment
fair access

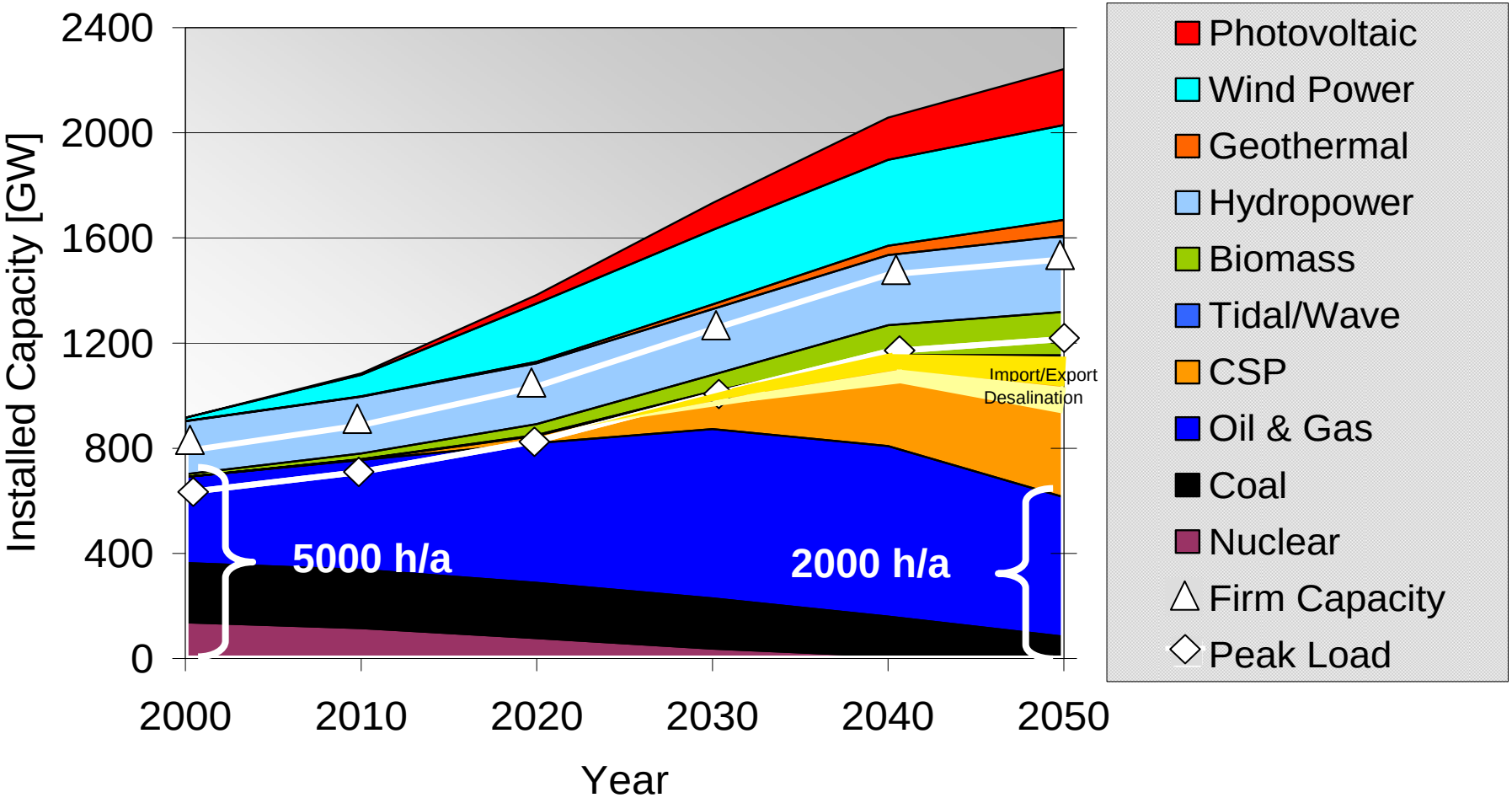
Electricity Supply in Europe (TRANS-CSP Scenario)



Electricity Supply in the Middle East & North Africa

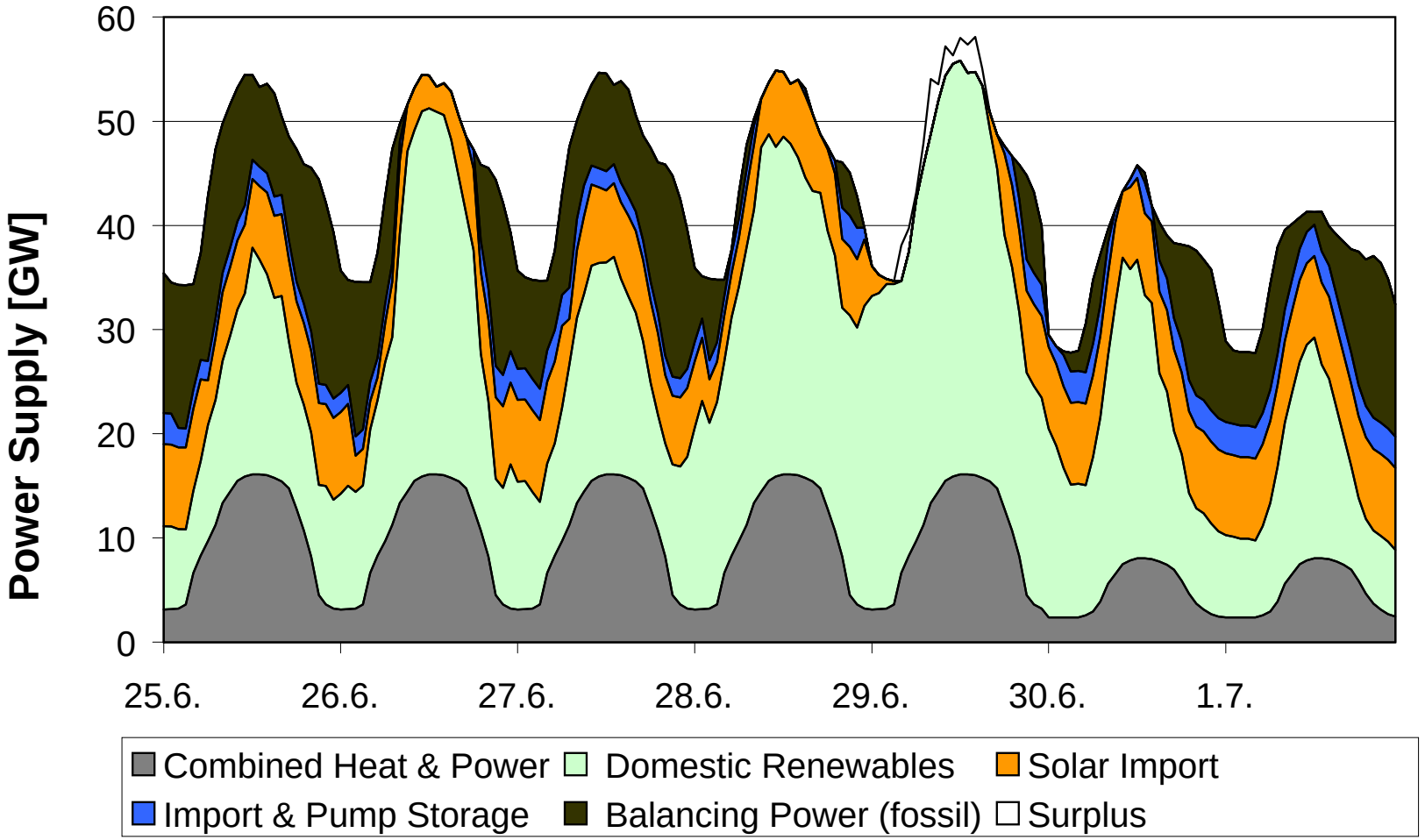


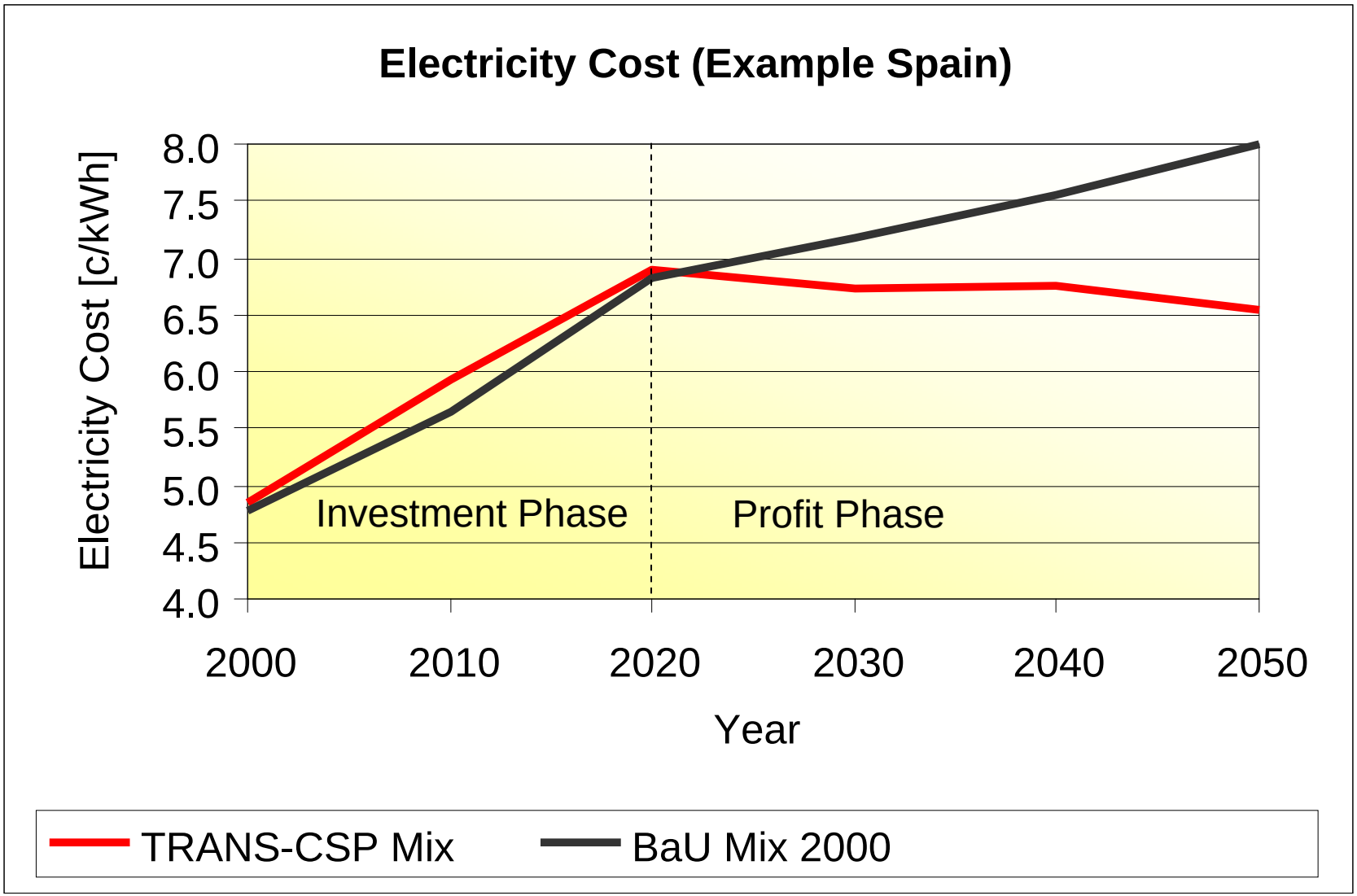
Installed Capacity vs. Peak Load in EUMENA

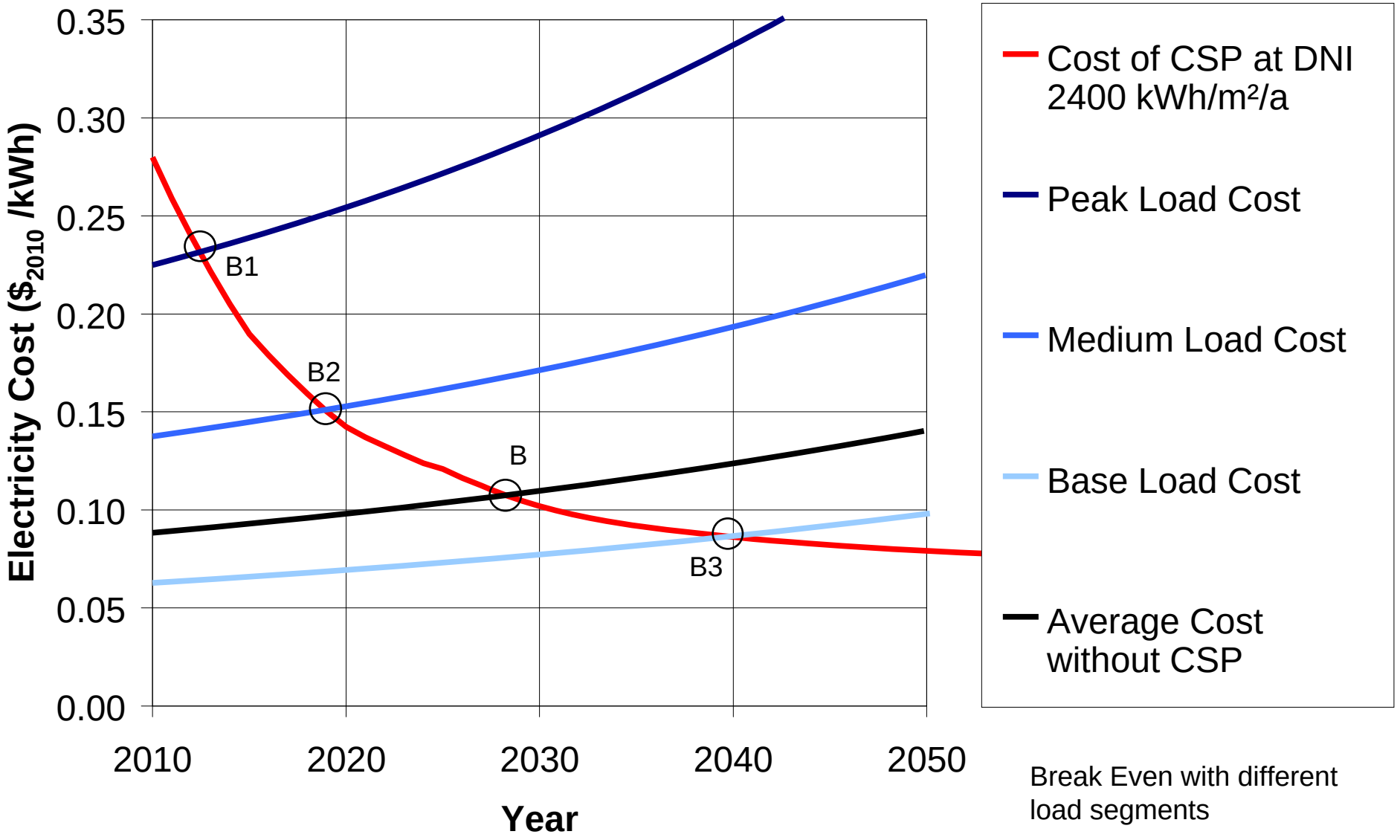


➔ **100 % availability plus 25 % reserve capacity**

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




Electricity Cost (Example Spain)
Electricity Cost [c/kWh]
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
Investment Phase
Profit Phase
2000
2010
2020
2030
2040
2050
Year
TRANS-CSP Mix
BaU Mix 2000



Break Even with different load segments

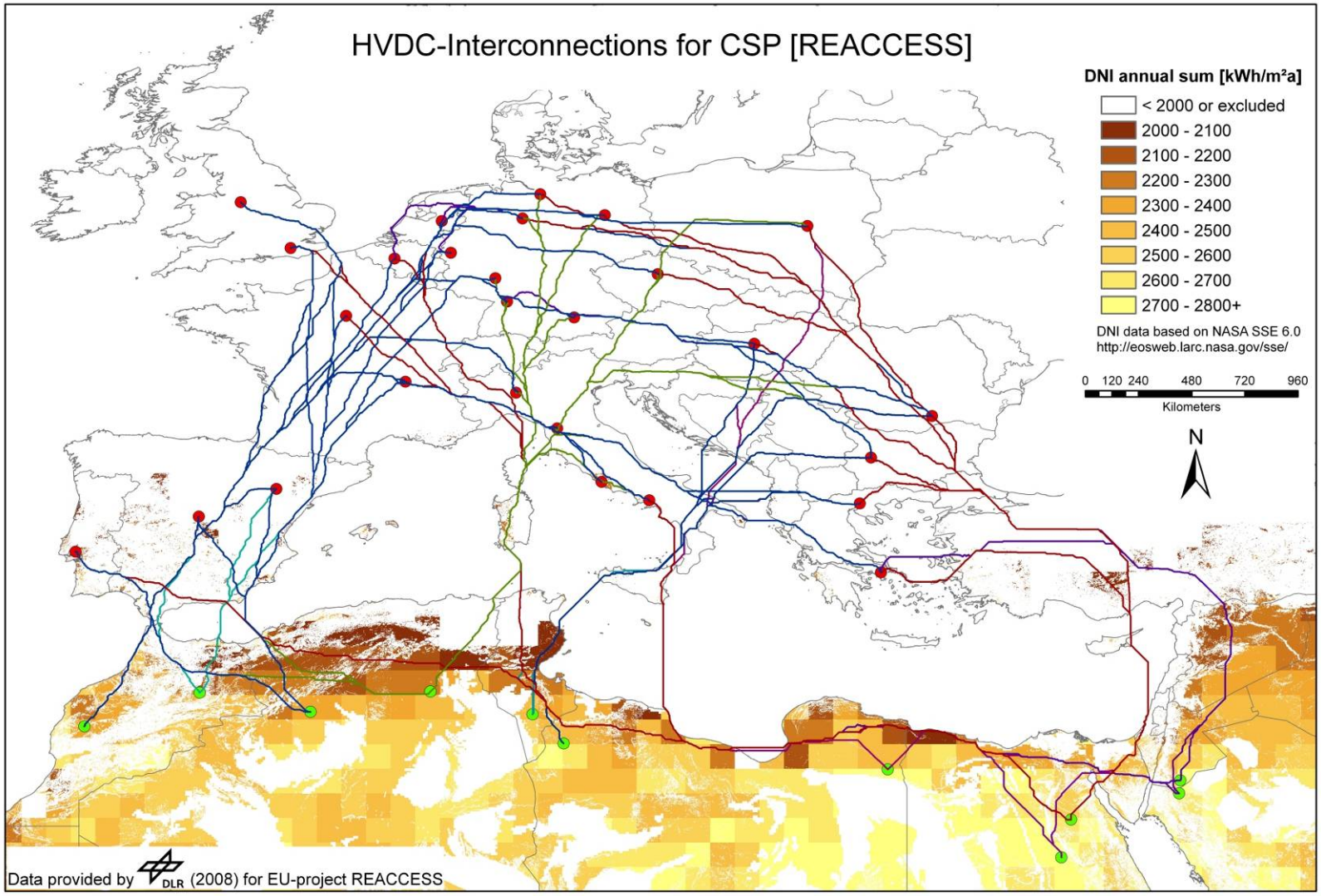
Solar Power & Desalination Plants

Energy,
Water,
Food,
Labor and
Income

for further
300 Million
People
in MENA ?

(artist view created with Google Earth)

Solar Electricity Corridors to Europe: REACCESS



High Voltage Direct Current Transmission in China

Voltage:	± 800.000 Volt
Power:	6400 Megawatt
Length:	2070 km
Source:	Hydropower
Losses:	7%
Setup Time:	2 years

Opportunities

- Power on Demand by a Mix of Fluctuating and Balancing Sources
- Increased Number of Sources and Supply Regions
- Strategy is Based on Proven Technologies
- Reduced Pollution and Climate Change
- Optimal Land Use (1%) through Diversified Mix
- Intrinsic Trend to Lower Cost and Lower Price Volatility
- Conflict Prevention Solving Energy and Water Scarcity
- 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!