EU-GCC Clean Energy Network Conference "RES Integration in the grid“ Muscat, Oman

EU-GCC Clean Energy Network Conference
"RES Integration in the grid"
13th -15th May, Muscat, Oman, Crown Plaza Hotel

- **Power interconnections: Financial & market aspects**
- Lecture: Desalination with Renewable Energy

Jürgen Kern

German Aerospace Center
Deutsches Zentrum für Luft und Raumfahrt e.V. (DLR)

Research Areas

- Aeronautics
- Space Research and Technology
- Transport
- Energy
- Space Administration
- Project Management Agency

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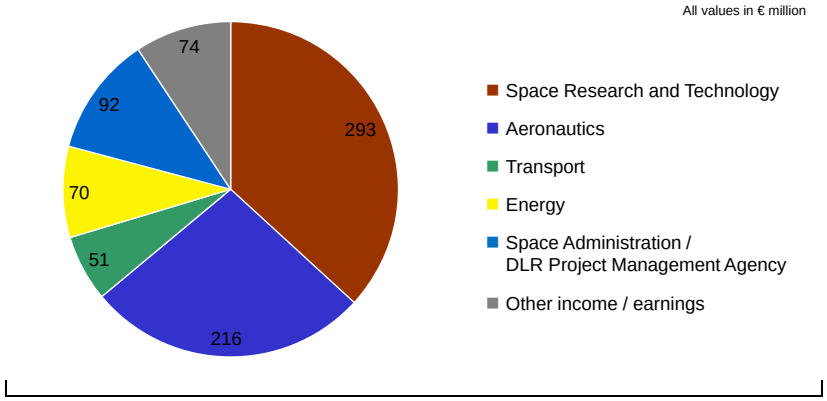
Total income 2011 – Research, operations and management tasks (excluding trustee funding from the Space Administration / DLR Project Management Agency): **€ 796 Mio.**



Participation in the Helmholtz Association

- Success in obtaining program-oriented funding
- Added value from support of the Helmholtz Association
- Helping to shape the organisational development process

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Energy Program Themes

- Efficient and environmentally compatible fossil-fuel power stations
  (turbo machines, combustion chambers, heat exchangers)
- Solar thermal power plant technology, solar conversion
- Thermal and chemical energy storage
- High and low temperature fuel cells
- Systems analysis and technology assessment

- Plataforma Solar de Almería (PSA)

Energy, Renewables and Solar Power

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Energy

Shortage of energy ?

- 25 cm crude oil annually on the hole surface of earth
- 2 millions barrels per square kilometer

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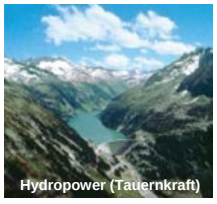
Renewable Energy for Power Generation



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Solar Power Technologies

Market available Technology proofed since 1986

Different Technologies for different use

Solar Power Technologies

Market available Technology

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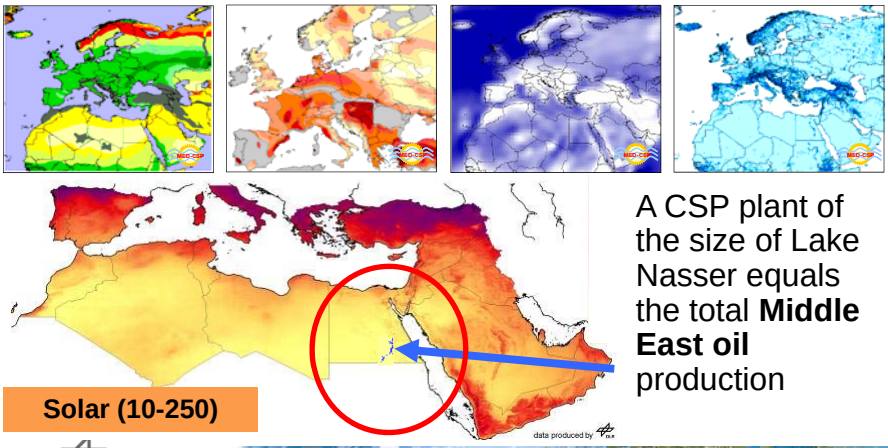
Renewable Electricity Potentials in EUMENA

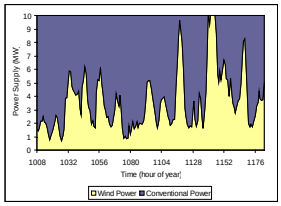
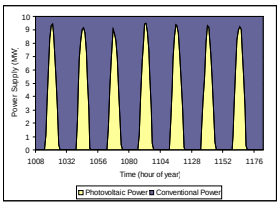
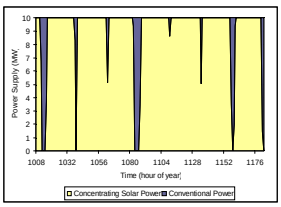
Biomass (0-1) | Geothermal (0-1) | Wind (0-50) | Hydro (0-50)



Solar (10-250)

A CSP plant of the size of Lake Nasser equals the total **Middle East oil** production

Renewable Power – Continuous Capacity

Wind	PV	CSP
		
Power supplied by 10 MW wind capacity and conventional backup power from the grid needed to provide constant 10 MW base load supply.	Power supplied by 10 MW PV capacity and conventional backup power from the grid needed to provide constant 10 MW base load supply.	Solar power provided by a CSP-plant with 16 hour storage and conventional power from fuel from the same plant for constant 10 MW base load supply.

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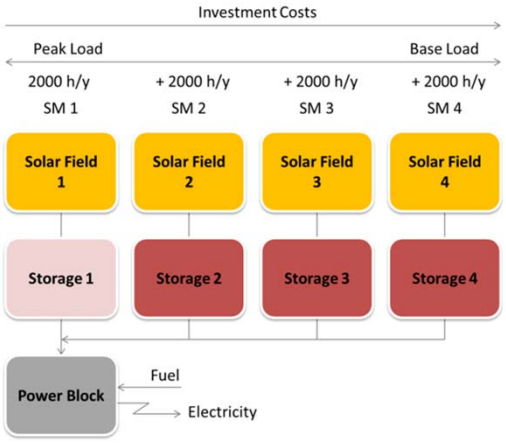
CSP plants can be designed to operate within a certain load segment



- Qualities of CSP Plants:
  - Operating as peak, medium or base load power plant
  - Firm & flexible capacity
  - Power on demand
  - Spinning reserve
  - Combined generation of process heat for industry, cooling, desalination, etc.

Projects and Milesstone

▪ MED-CSP	www.dlr.de/tt/med-csp	2005
▪ TRANS-CSP > DESERTEC	www.dlr.de/tt/trans-csp	2006
▪ AQUA-CSP	www.dlr.de/tt/aqua-csp	2007
▪ MED-CSD		2008-2010
▪ **EU GCC Clean Energy Network**		**2010-**
▪ “Water And Power: Challenges And Solutions”		today
▪ CSP Finance		2011
▪ World Bank MENA Water Outlook		2011
▪ IRENA Solar Atlas		2010-2013
▪ BETTER		2012-
▪ **B**ringing **E**urope and **T**hird countries closer **T**ogether trough **R**enewable **E**nergies		
▪ QatDLR		2012-

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Power interconnections: Financial & market aspects

BETTER: EU-North Africa Case Study The role of Concentrating Solar Power

Objective: (July 2012 - January 2015)

Assess, through case studies, stakeholders involvement and integrated analysis to what extent cooperation with third countries (Art. 9 of the RES Directive) can help Europe achieve its RES targets in 2020 and beyond, through RES imports and by triggering the deployment of RES electricity projects in North Africa, Balkans and Turkey.

Supported by INTELLIGENT ENERGY EUROPE

PARTNERS:

CIEMAT, DLR, ECN, JR, TU-WIEN, OME, NTUA, UNDP, PIK

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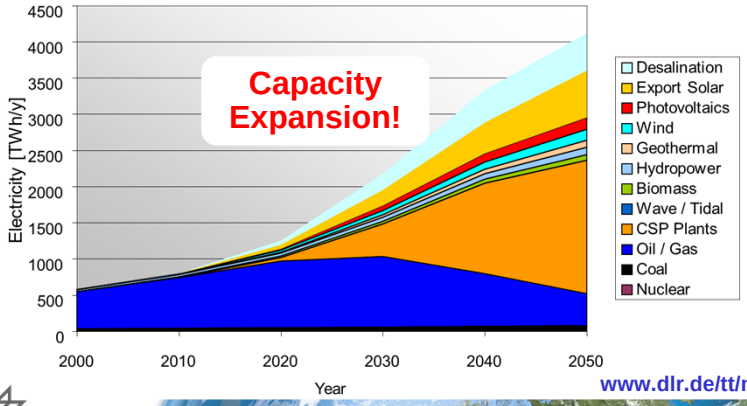
Prospects for RES-E expansion in NA Background

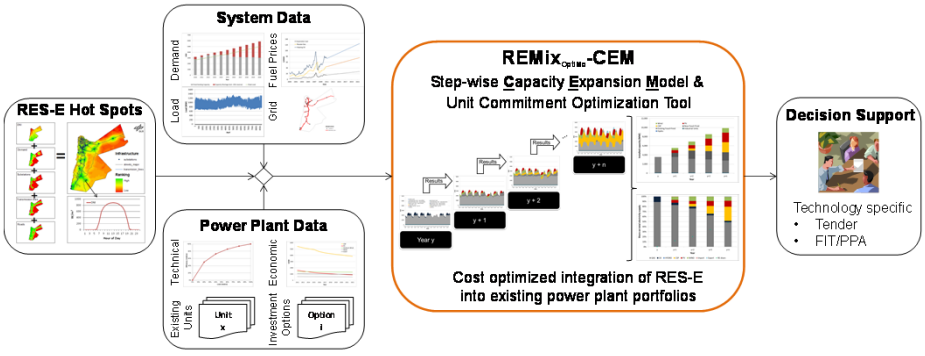
MED-CSP Study 2005:
Electricity supply in the Middle East & North Africa



www.dlr.de/tt/med-csp

Methodology for an optimized integration of RES-E technologies into existing power plant portfolios in MENA

- Emphasis on cost-optimized short-term integration of renewable energy systems for electricity generation (RES-E) and on security of supply
- Results for decision support for electricity authorities and power utilities in MENA



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ReMix-CEM:

Optimization tool for cost efficient integration of renewable energy technologies in MENA countries

- Model for step-wise capacity expansion, replacement and unit commitment optimization (minimization of total system costs)
- Algorithm ensures that RE technologies are only integrated when their utilization contributes to lower total power generation costs
- Starting from present power plant portfolio of the investigated country
- Detailed hourly modeling of technical and economical restrictions and dynamics of each single conventional and RE power generation unit
- Optimization of CSP configuration (solar field and storage size)
- Taking into account all necessary system restrictions (firm capacity requirements, spinning reserve, tertiary reserve, etc.)

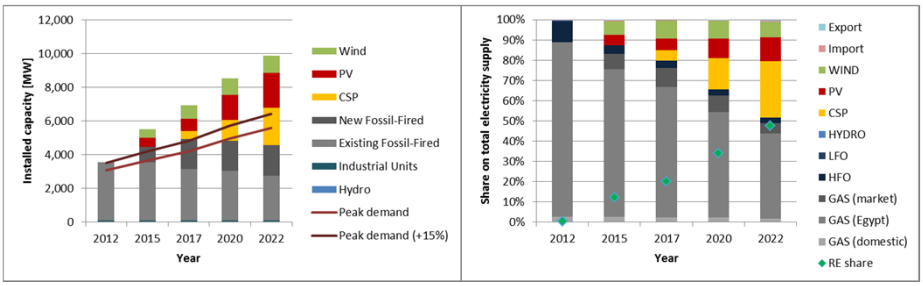
Prospects for RES-E expansion in MENA

ReMix cost optimization model for capacity expansion

Example: Case study for Jordan

Jordan’s situation:

- Strongly increasing electricity demand
- High dependency on fossil fuel imports



Scenario: „base case“

Source: Fichter (DLR) 2012, ReMix-MENA optimization tool

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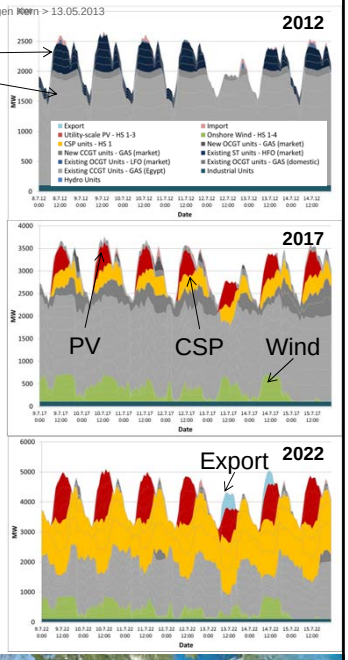
Business case MENA: Jordan

Strongly required firm and flexible renewable power capacity

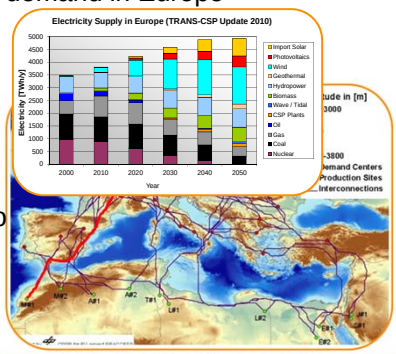
- CSP competitive in the peak and upper-mid merit segment in the short-term.
- CSP providing strongly required **firm and flexible** power capacity.
- Very limited availability of electricity storage and of other flexible and firm RES-E.
- PV and Wind power as cheap “**fuel saver**”
- In the medium-term CSP competitive in mid-merit and base load segment.
- CSP in long-term as back-bone of electricity supply.



Source: Fichter (DLR) 2012, ReMix-MENA optimization tool

Solar Electricity Imports from North Africa to Europe

- Quantification of the demand for solar electricity imports providing flexible power and firm capacity for 30 European countries (TRANS-CSP 2006)
- Identification of 300 potential corridors connecting production sites in North Africa with centers of demand in Europe (REACCESS 2009)
- Selection of 33 potential corridors to provide 700 TWh/yr to Europe by the year 2050 (JEPO 2012)
- Selection and detailed description of a first HVDC corridor connecting a large-scale CSP plant in Morocco with a German center of demand in 2022 (BETTER 2012-2014)



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Prospects for RES-E exports from NA to Europe: Business case EU

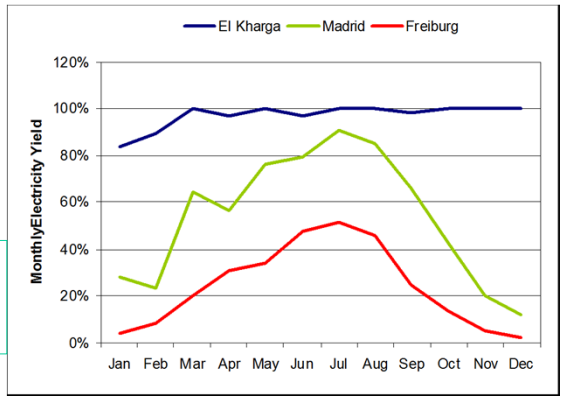
Why CSP imports from North Africa and not from Southern Europe?
Higher CSP availability in MENA → flexible renewable power

MENA:

- More sunny days
- Lower Latitude
- → **lower seasonal variation of electricity yield**

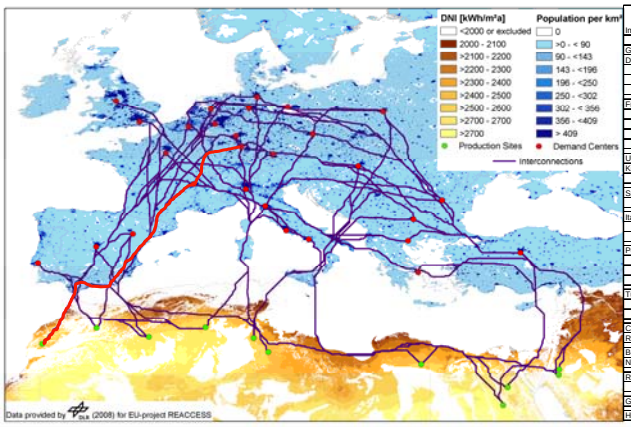
Comparison:

CSP with Solar Multiple 4 at different sites



Business case EU - The TRANS-CSP Concept

Flexible solar power plus 33 additional energy corridors with firm capacity for Europe in 2050



Import Country	Start Point	End Point	Net Import Electricity	Total Length
			TWh/a	km
Germany / Denmark	Morocco #1	Karlsruhe, Germany	23,0	2.917
	Morocco #2	Jülich, Germany	24,5	2.455
	Tunisia #1	Mainz, Germany	23,6	2.160
	Algeria #1	Hannover, Germany	24,1	2.851
	Algeria #2	Munich, Germany	24,9	1.998
France	Morocco #1	Paris, France	18,7	2.306
	Morocco #2	Paris, France	19,8	1.939
	Tunisia #1	Paris, France	21,3	2.195
	Algeria #1	Lion, France	25,3	1.847
	Algeria #2	Lion, France	24,6	2.208
United Kingdom	Morocco #1	London, UK	18,5	2.643
	Morocco #2	London, UK	22,4	2.304
	Algeria #1	Newcastle, UK	24,3	2.748
Spain	Morocco #2	Madrid, Spain	20,7	964
	Algeria #1	Zaragoza, Spain	24,2	1.178
Italy	Algeria #2	Milano, Italy	20,1	1.587
	Tunisia #1	Firenze, Italy	19,3	1.432
	Libya #1	Roma, Italy	20,6	1.761
Poland	Egypt #1	Warszaw	18,9	3.525
	Jordan #1	Warszaw	18,1	3.500
	Egypt #2	Warszaw	22,1	3.817
	Saudi Arabia #1	Warszaw	23,8	3.586
Turkey	Jordan #1	Ankara, Turkey	19,3	2.255
	Saudi Arabia #1	Ankara, Turkey	20,0	2.310
	Saudi Arabia #1	Ankara, Turkey	20,6	2.310
Czech Republic	Algeria #2	Prague, Czech Republic	19,5	2.230
	Libya #1	Prague, Czech Republic	19,0	2.154
Belgium Netherlands	Morocco #1	Brussels, Belgium	19,0	2.612
	Morocco #2	Appledorn, Netherlands	22,1	2.462
Romania	Jordan #1	Bukarest, Romania	15,8	2.502
	Algeria #2	Bukarest, Romania	18,8	2.918
Greece / Bulgaria	Egypt #2	Sophia, Bulgaria	21,5	2.849
Hungary / Slowakia	Libya #1	Budapest, Hungary	24,7	2.254

Flexible solar power import to Germany starting 2022 with 12 ct/kWh (5% WACC, 40 a)

Source: Trieb et al., Energy Policy 42 (2012) 341-353

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Focal points for RES-E deployment

- **Limit RES-E variability:**
  - tap flexible RES-E to provide firm capacity and other grid management functions
  - develop and secure all available flexibility and backup options
- **Limit RES-E cost by increasing investment security:**
  - establish national RES-E administrations and adequate RES-E tariffs
  - provide internationally insured power purchase agreements and further risk mitigation measures specifically adapted to the RES-E sources to be tapped
- **Limit RES-E impacts:**
  - ensure public participation through consultation and cooperative banks
  - enforce thorough environmental and socio-economic impact assessment
- **Establish reliable political framework:**
  - pursue consensus within Europe and Third Countries about future RES-E role
  - establish transparent, stable, fair and predictable framework for RES-E

QatDLR

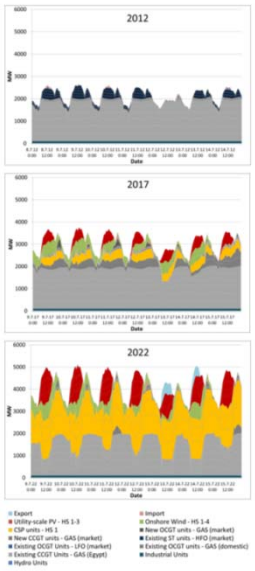
The project QatDLR will define in detail the possibilities and conditions of an innovative power supply for the Arabian Peninsula. It already will perform first analyses on the social, energetic and socio-economic conditions to support specific projects or project developments in Qatar.

Specifically, the project has the following objectives:

- Development of specific conditions in Qatar and the Arabian Peninsula to build a (largely) renewable energy infrastructure
- Analysis and evaluation of concepts for hybrid solar process heat utilization
- Analysis and evaluation of concepts for high-efficiency hybrid solar tower systems
- Development of concepts to increase energy efficiency in buildings and process sector
- The proposed project is in connection with the proposed construction of a long-term cooperation with the government of Qatar, with the aim of to develop a joint research and development institution in Qatar.

Project partners: DLR – Institute for Solar Research, Solar-Institut Jülich, FH Aachen

Funding organisation: Federal Ministry of Economics and Technology (BMWi)



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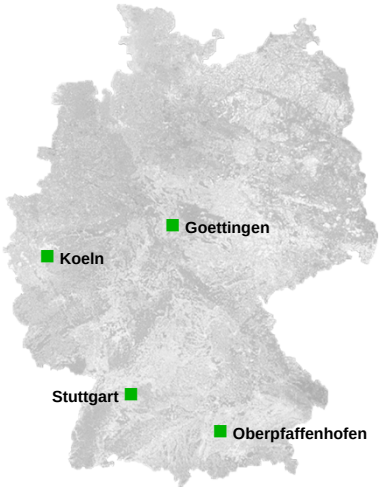
Institutes and Facilities Involved in Energy

- Goettingen
  Institute of Aerodynamics and Flow Technology
- Cologne
  Institutes of Propulsion Technology, **Solar Research** and Materials Research
- Stuttgart
  Institutes of Technical Thermodynamics and Combustion Technology
- Oberpfaffenhofen
  Institute of Communications and Navigation
- Almería (Spain)
  Permanent team from the Institute of Solar Research at the Plataforma Solar de Almería (PSA)



Welcome to DLR Site Stuttgart

Employees: 560
Size of site: 25 860 m²
Research institutes:

- Institute of Structures and Design
- Institute of Vehicle Concepts
- Institute of Technical Physics
- **Institute of Technical Thermodynamics** www.dlr.de/tt
- Institute of Combustion Technology

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Selected publications

- MED-CSP www.dlr.de/tt/med-csp
- TRANS-CSP www.dlr.de/tt/trans-csp
- AQUA-CSP www.dlr.de/tt/aqua-csp
- MED-CSD www.med-csd-ec.eu/eng/
- MENA Regional Water Outlook www.dlr.de/tt/menawater
- Financing concentrating solar power in the Middle East and North Africa – Subsidy or investments? Energy Policy 39 (2011) 307-317 http://dx.doi.org/10.1016/j.enpol.2010.09.045
- Solar electricity imports from Middle East and North Africa to Europe Energy Policy 42 (2012) 341-353 http://dx.doi.org/10.1016/j.enpol.2011.11.091

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