Launch Event: Renewable Resource Atlas of the Kingdom of Saudi-Arabia
18th of December 2013
Al Faisaliah Hotel, Riyadh, Kingdom of Saudi-Arabia

- Panel Discussion: How Solar Resource Data supports Research and Development

Jürgen Kern

German Aerospace Center Knowledge for Tomorrow
Deutsches Zentrum für Luft und Raumfahrt e.V. (DLR)
Total income 2011 – Research, operations and management tasks (excluding trustee funding from the Space Administration / DLR Project Management Agency): € 796 Mio.
DLR - Who we are

Research Areas

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

- Solar Research
- Wind Energy Research
- Systems Analysis
- Thermal & Chemical Storage
- High & low Temp. Fuel Cells
- Combustion & Gas Turbine Technologies
Projects and Milestone

- MED-CSP [www.dlr.de/tt/med-csp](http://www.dlr.de/tt/med-csp) 2005
- TRANS-CSP > DESERTEC [www.dlr.de/tt/trans-csp](http://www.dlr.de/tt/trans-csp) 2006
- AQUA-CSP [www.dlr.de/tt/aqua-csp](http://www.dlr.de/tt/aqua-csp) 2007
- MED-CSD 2008-2010
- EU GCC Clean Energy Network 2010-
- CSP Finance 2011
- World Bank MENA Water Outlook 2011
- IRENA Solar Atlas 2010-2013
- BETTER 2012-
  - Bringing Europe and Third countries closer Together trough Renewable Energies
- QatDLR 2012-
- DLR-KA.CARE Cooperation on CSP Research 2013-
  - Joint Saudi Arabian - German CSP Research Workshop -11
  - Launt Event: Renewable Resource Atlas of the KSA today
From Resources to Markets and Projects
Getting Renewable Energy to Work

Available Resources

Technical and economic potentials
Which technologies are feasible?

Possible capacity development
How can they contribute to the national energy system?

Market introduction
How to get them into the market?
Where to start?

Political and financial instruments
Legislation, incentives

Private investments

Resource mapping

Potentials

Scenarios

Strategies

Instruments

Markets

Political + Economic Framework
Project Development for Renewable Energy Systems

Finding suitable sites with high resolution maps and economic evaluations

Detailed engineering with site specific data with high temporal resolution as input to simulation software
Direct Normal Irradiation for Kingdom Saudi Arabia

Averaged Annual Sum [kWh/m²]

- > 2600
- < 2550 - 2600
- < 2500 - 2550
- < 2450 - 2500
- < 2400 - 2450
- < 2350 - 2400
- < 2300 - 2350
- < 2250 - 2300
- < 2200 - 2250
- < 2150 - 2200
- < 2100 - 2150
- < 2050 - 2100
- < 2000 - 2050
- < 1950 - 2000
- <= 1950

SOLEMI model (v.3.0) estimates of averaged annual sums of direct normal irradiation for the time period 1996-2005 (10 years) using input data of METEOSAT for cloud detection and additional atmospheric parameters of ozone (TOCM), precipitable water vapor (NCEP/NCAR) and aerosol optical thickness (AEROCOM). The result is sampled at a 30 arcmin resolution (~1km) based on used digital elevation model (GLOIRE).

Data provided by DLR, 2010.
Solar Resource Assessment (SOLEMI – Solar Energy Mining) e.g.: Solar Atlas for the Mediterranean

- GHI and DNI
- 20 years of satellite based data (1991-2010)
- Data access via web-portal
- Funded by German Ministry of Environment (BMU)
- European Consortium

www.solar-med-atlas.org
IRENA Global Atlas for Solar & Wind Energy
Map Interface
Applications of Solar Resource Data
Site Analysis for PV and CSP

Example: Ranking Map for United Arab Emirates

Ranking map for potential CSP-sites. Data developed within SWERA-MASDAR-UNEP project.
Optimized integration of RES-E technologies into existing power plant portfolios

- 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

System Data
- Load
- Grid
- Fuel Prices

REMIXoptiCEM
Step-wise Capacity Expansion Model & Unit Commitment Optimization Tool

Decision Support
- Technology specific
- Tender
- FIT/PPA

Cost optimized integration of RES-E into existing power plant portfolios
Solar Electricity Imports from MENA/GCC to EU

- Flexible solar power with firm capacity from CSP plants is transferred directly via point-to-point HVDC links from production sites in NA to European demand centers.
- CSP imports complement European sources from wind and PV and fill the remaining gaps.
- Export is not linked to or required for domestic demand in NA.
- Import capacity will always be lower than reserve capacity.
- About 40 HVDC links will provide 700 TWh/a (15% of demand) with 100 GW (7% of total) capacity.
- Point-to-point-links can be bundled and eventually interconnected to form a HVDC grid in the long term.
- CSP-HVDC links will reduce need for grid, storage and backup capacity.
Global Water Scarcity

Note: Light grey indicates countries that will import more than 10% of their cereal consumption in 2025.
Global Potential for CSP Solar Power

DNI averaged annual sum [kWh/m²/y]

- < 2000 or excluded
- 2000 - 2100
- 2100 - 2200
- 2200 - 2300
- 2300 - 2400
- 2400 - 2500
- 2500 - 2600
- 2600 - 2700
- 2700 - 2800+

DNI data based on NASA SSE 6.0
http://eowsweb.larc.nasa.gov/sse/

Kilometers

0 625 1250 2500 3750 5000

USA  CAN  EU  OEE  CAC  ODA  CHI  AUS
Selected publications

- MED-CSP  [www.dlr.de/tt/med-csp](http://www.dlr.de/tt/med-csp)
- TRANS-CSP [www.dlr.de/tt/trans-csp](http://www.dlr.de/tt/trans-csp)
- AQUA-CSP [www.dlr.de/tt/aqua-csp](http://www.dlr.de/tt/aqua-csp)
- MENA Regional Water Outlook [www.dlr.de/tt/menawater](http://www.dlr.de/tt/menawater)
- 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](http://dx.doi.org/10.1016/j.enpol.2011.11.091)
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