Launch Event: Renewable Resource Atlas of the Kingdom of Saudi-Arabia

18th of December 2013

Al Faisaliah Hotel, Riyadh, Kingdom of Saudi-Arabia

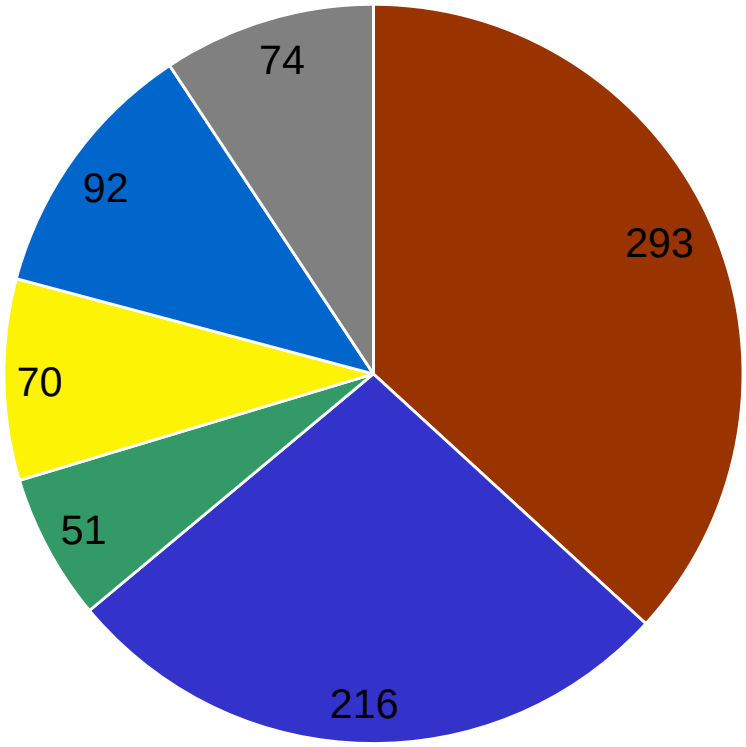
- **Panel Discussion: How Solar Resource Data supports Research and Development**

Jürgen Kern

German Aerospace Center
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.**

All values in € million



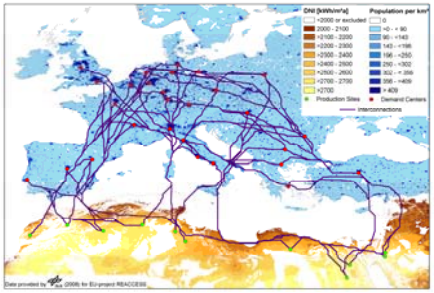
- Space Research and Technology
- Aeronautics
- Transport
- Energy
- Space Administration / DLR Project Management Agency
- Other income / earnings

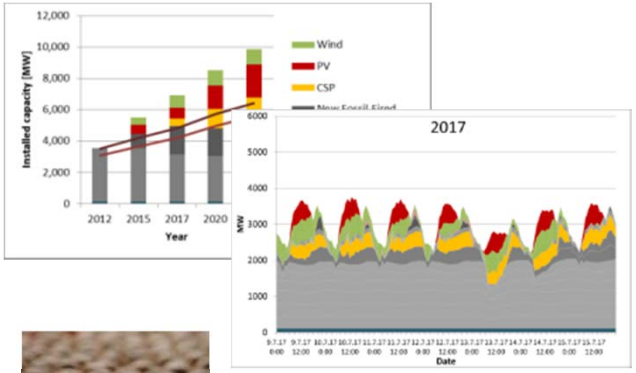
DLR - Who we are

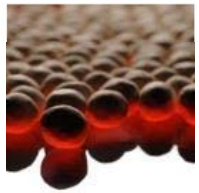
Research Areas

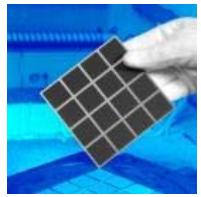
- Aeronautics
- Space Research and Technology
- Transport
- Energy
- Space Administration
- Project Management Agency

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







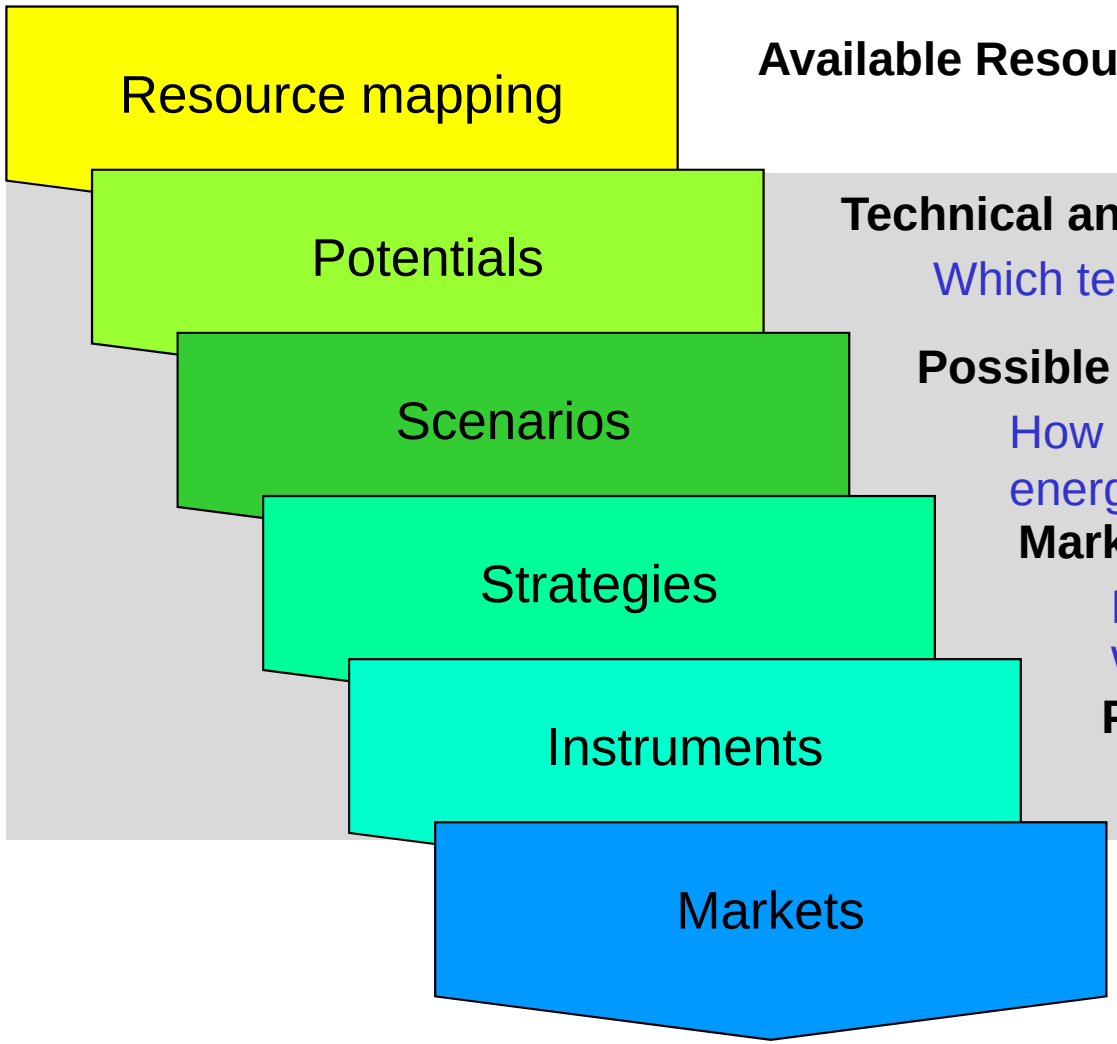


Projects and Milesstone

- 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-
- 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-
- **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

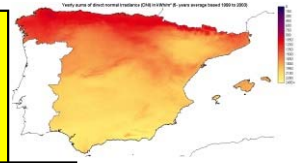
Legislation, incentives

Private investments

Political + Economic Framework

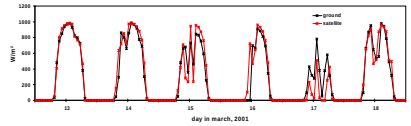
Project Development for Renewable Energy Systems

Resources (Atlas)

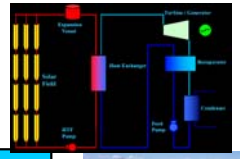


Project development

Resources (time series)

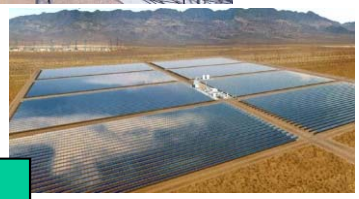


Engineering



Construction

Commissioning



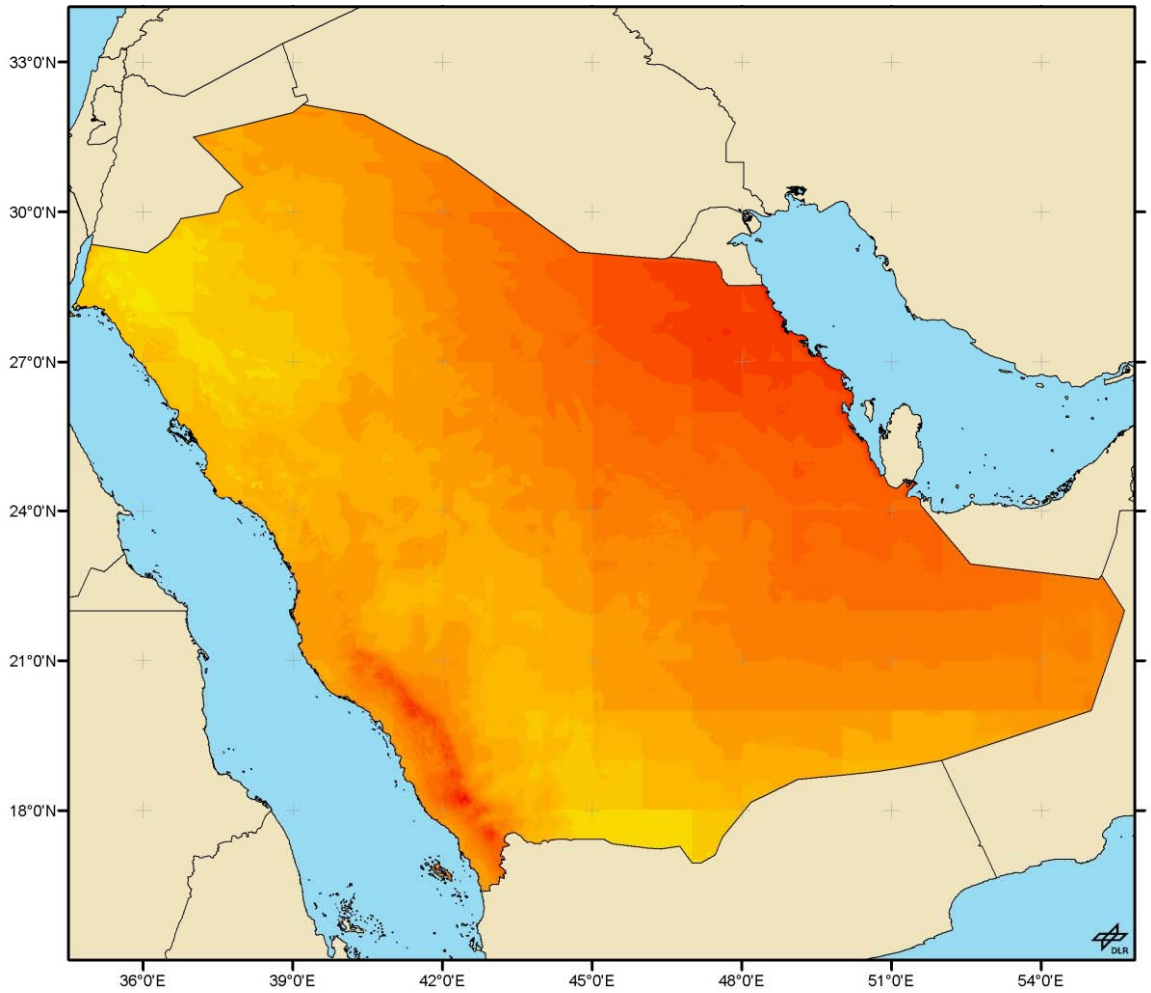
Operation

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

Resources

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

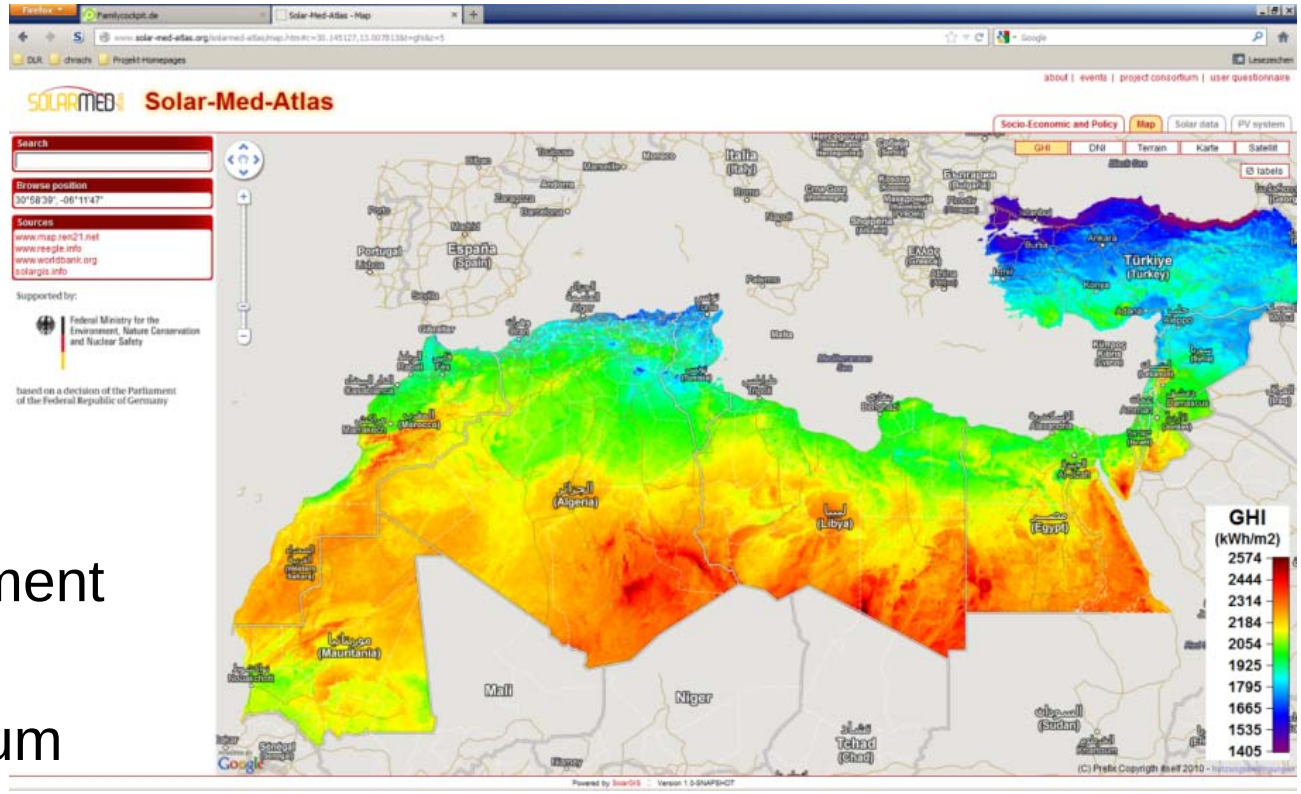
SOLEMI-model (v38) estimates of averaged annual sums
of direct normal irradiation for the time period 1996-2005 (10 years)
using input data of METEOSAT for cloud detection
and additional atmospheric parameters
of ozone (TOMS), precipitable water vapor (NCEP/NCAR)
and aerosol optical thickness (AEROCOM).
The result is sampled at a 30arcsec resolution (~1km)
based on used digital elevation model (GLOBE).

data provided by DLR, 2010

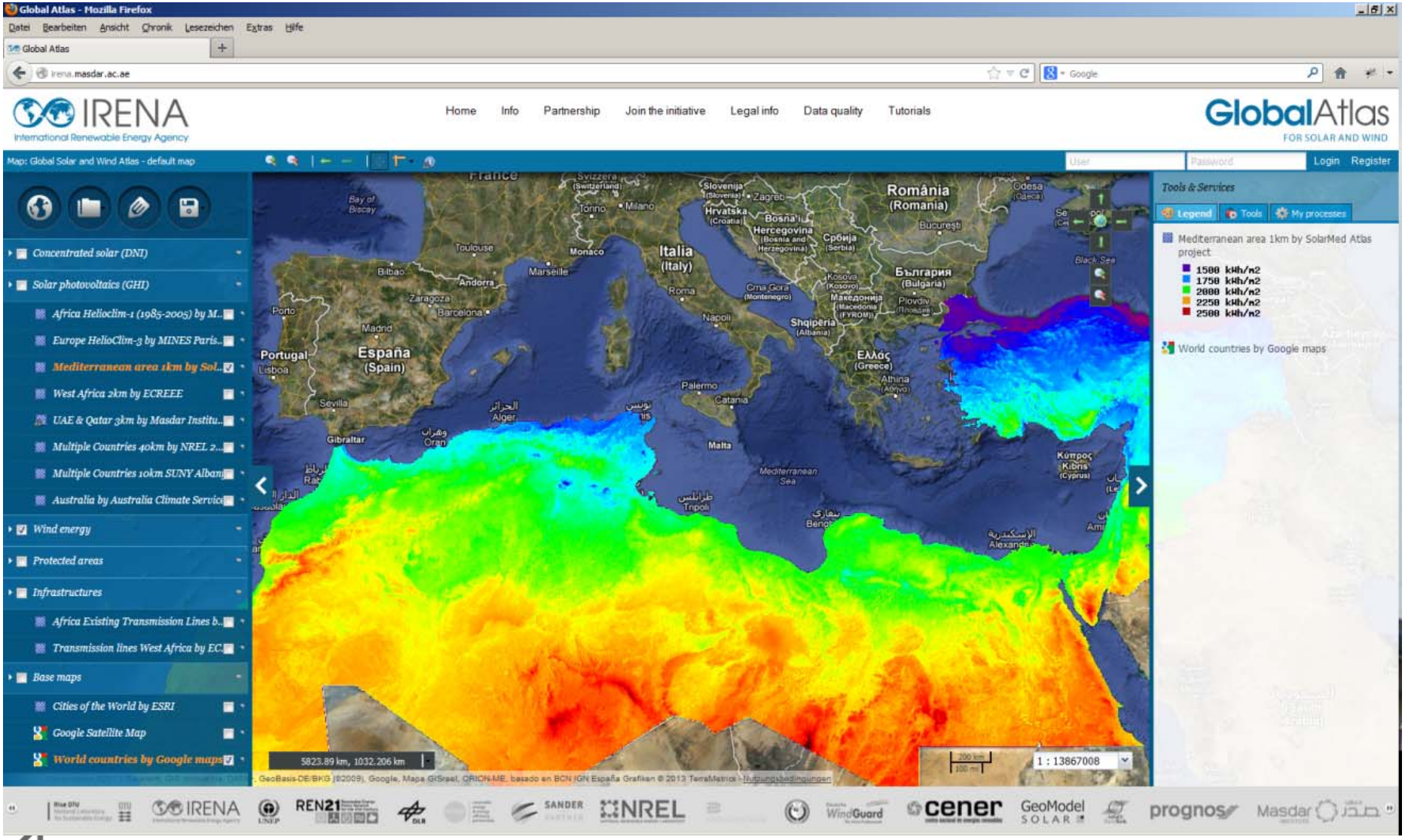
DLR

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



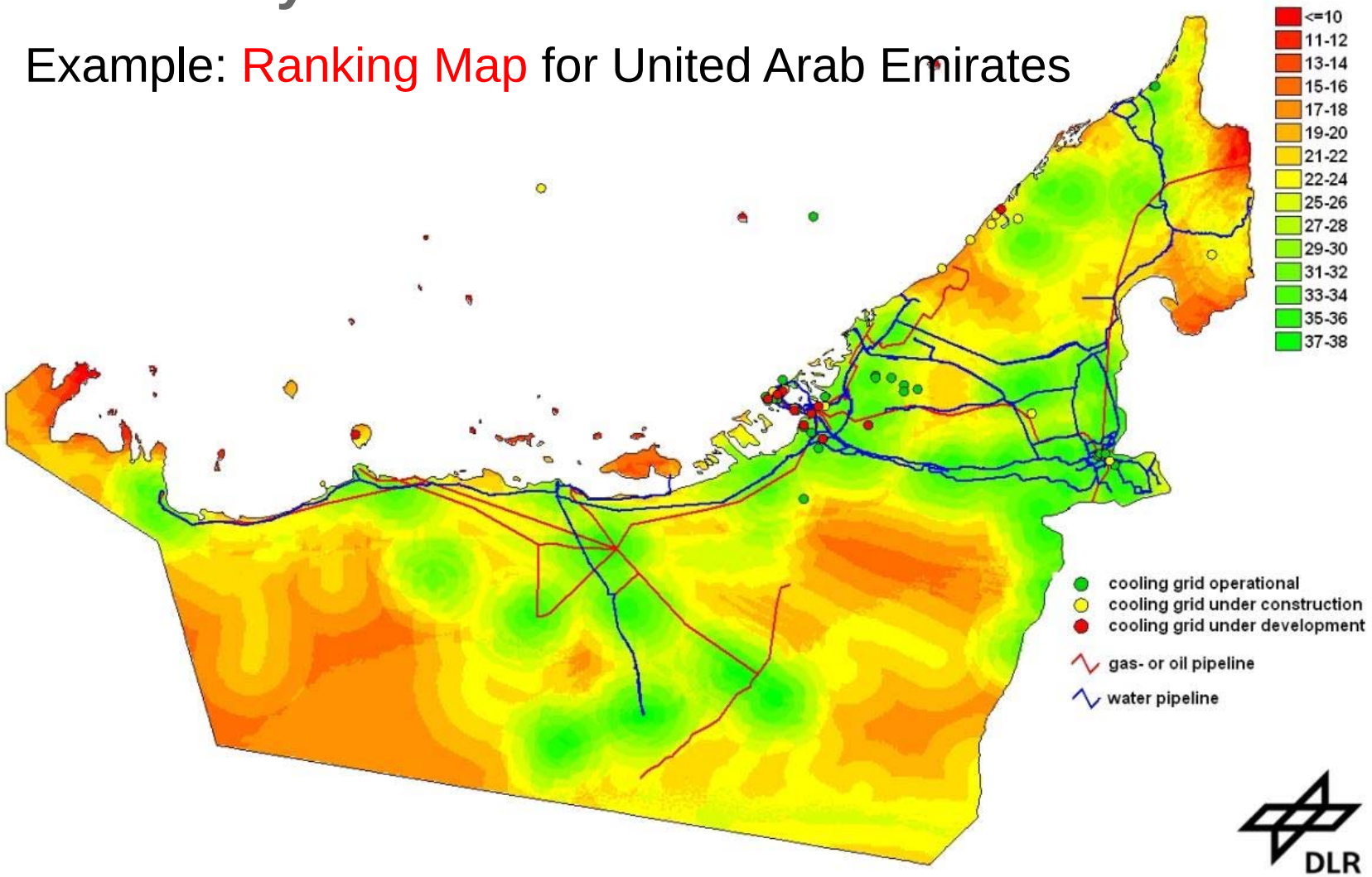
IRENA Global Atlas for Solar & Wind Energy Map Interface



Applications of Solar Resource Data

Site Analysis for PV and CSP

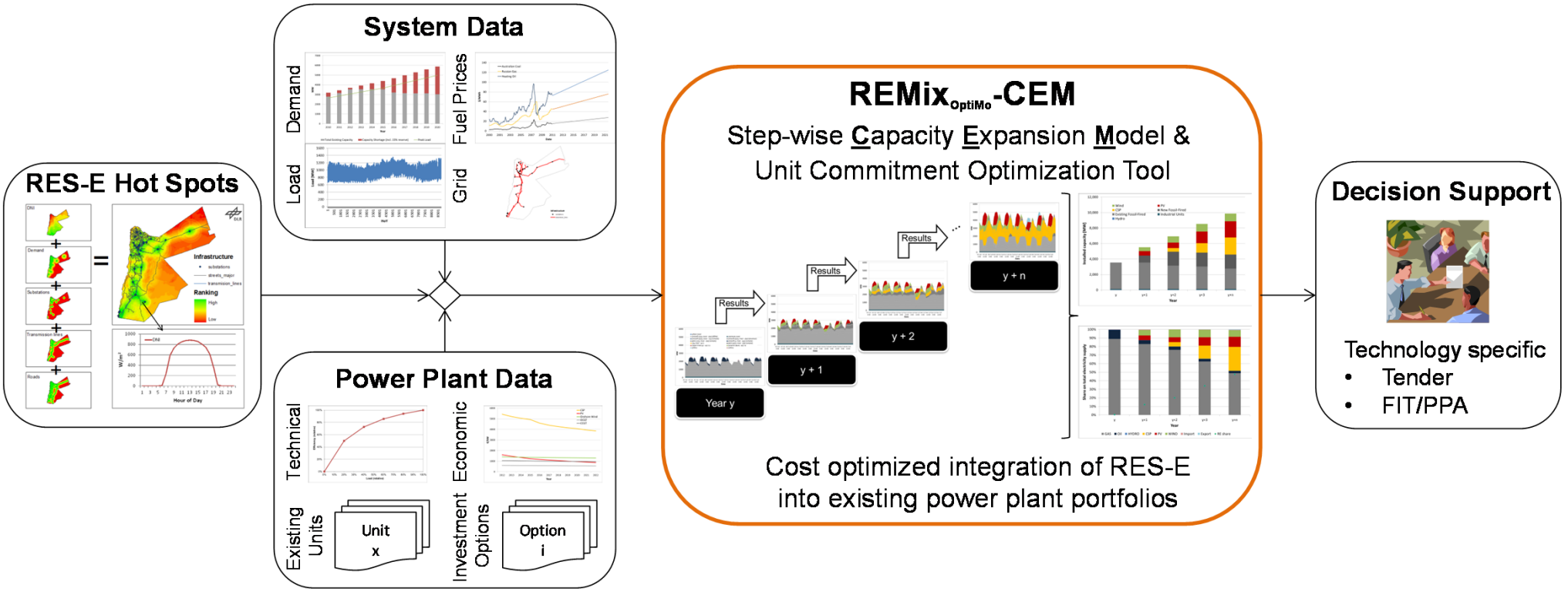
Example: Ranking Map for United Arab Emirates



Ranking map for potential CSP-sites. Data developed within SWERA-MASDAR-UNEP project.

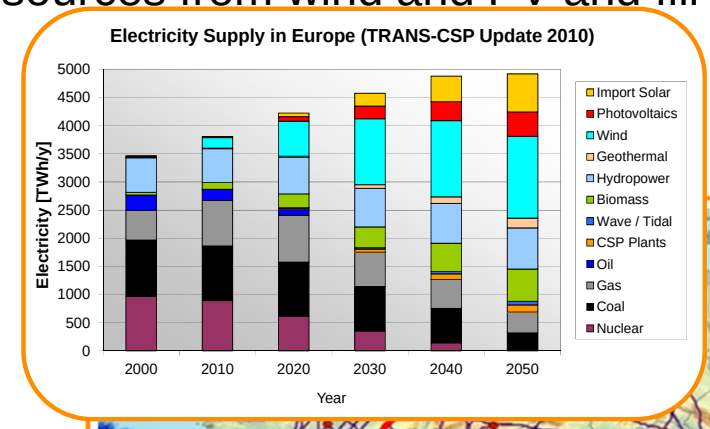
Optimized integration of RES-E technologies into existing power plant portfolios

- 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



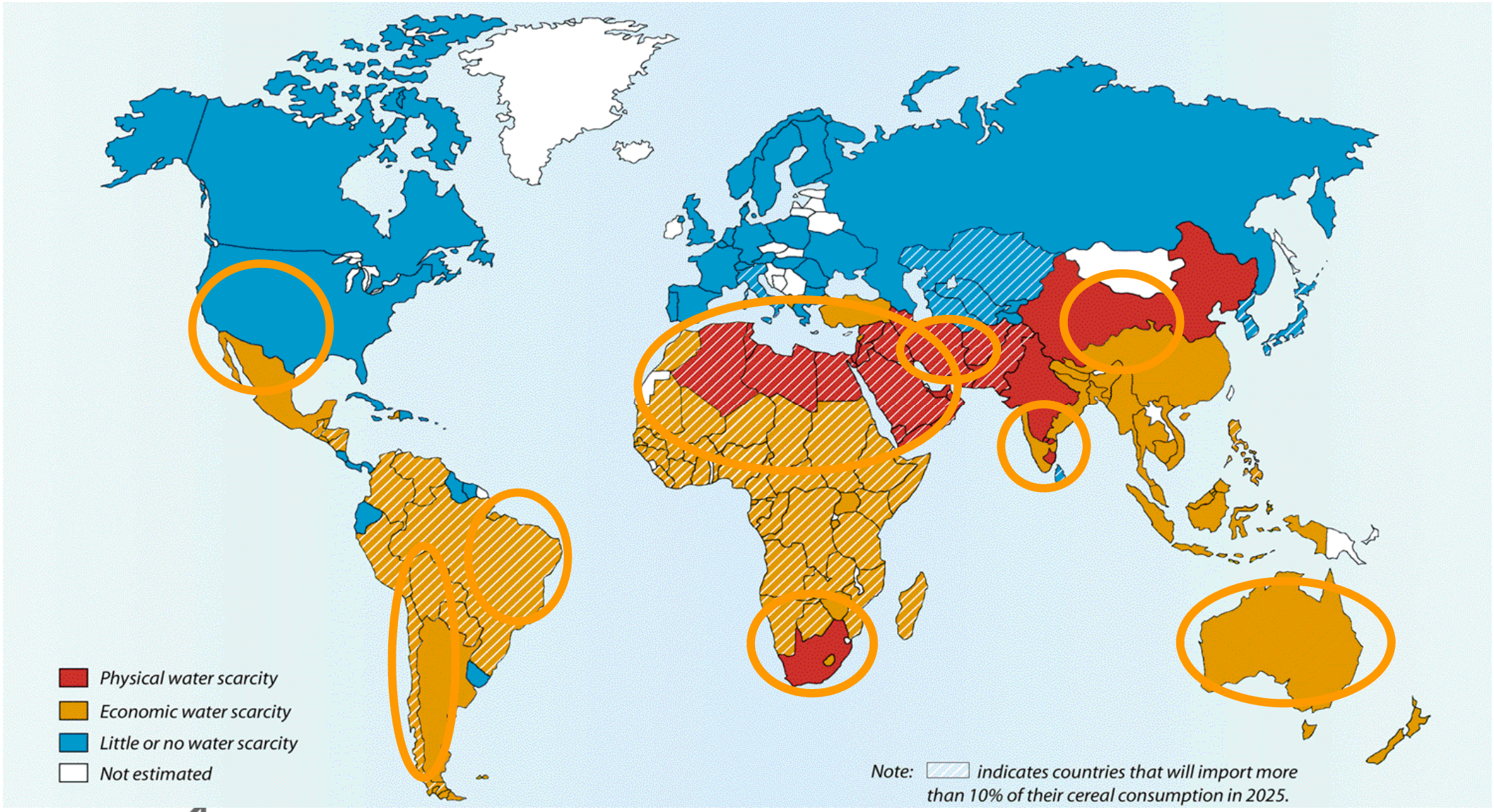
Solar Electricity Imports from MENA/GCC to EU

- Flexible solar power with firm capacity from CSP plants is transfered 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.



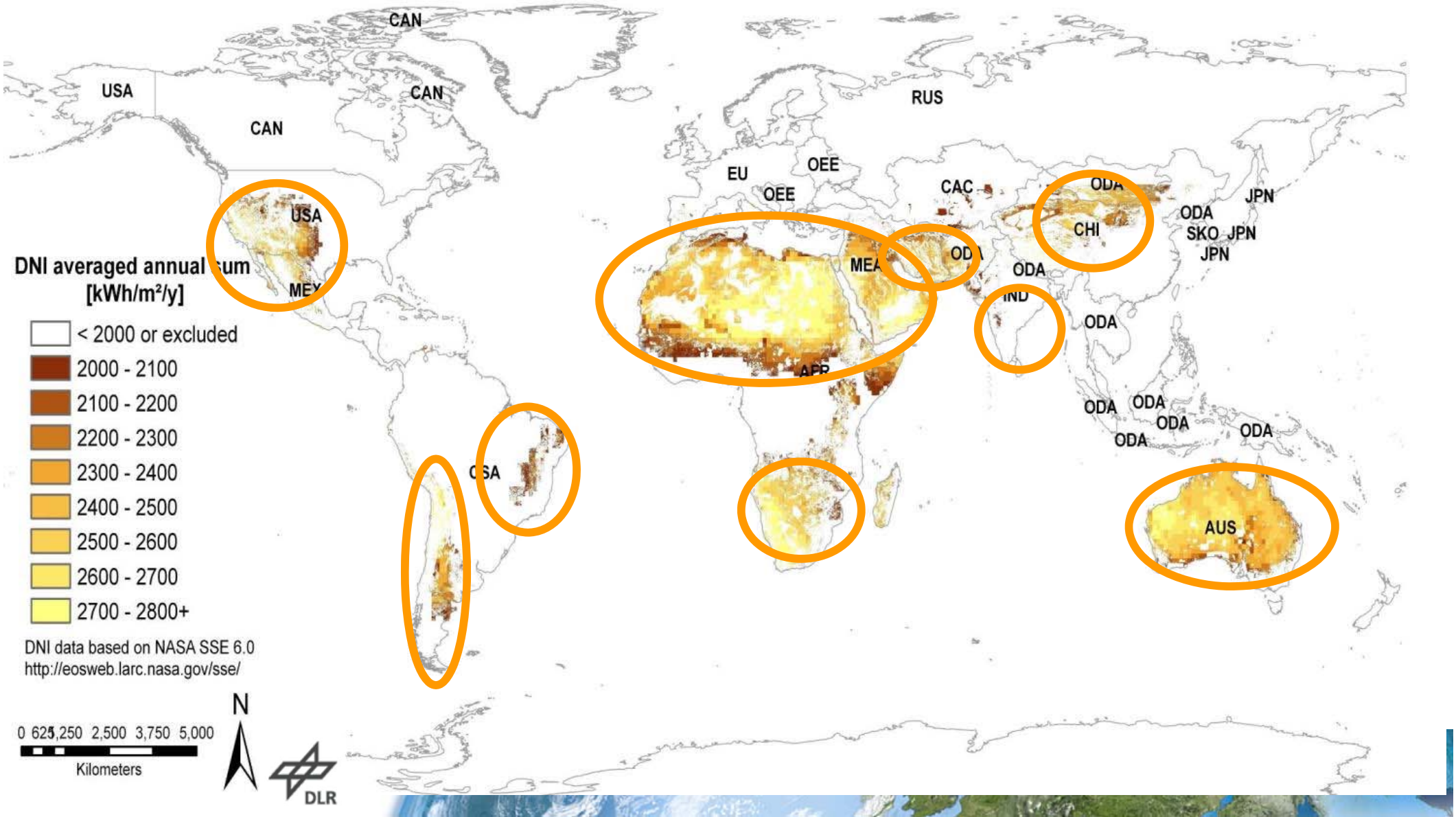
Trieb et al., Energy Policy 42 (2012), 341–353.
doi:10.1016/j.enpol.2011.11.091

Global Water Scarcity



DLR

Global Potential for CSP Solar Power



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
- Solar-Med-Atlas www.solar-med-atlas.org
- IRENA Global Atlas for Solar & Wind Energy www.irena.org/globalatlas
- 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

Contact

Dr. Christoph Schillings	christoph.schillings@dlr.de	+49 711 6862 - 784
Carsten Hoyer-Klick	carsten.hoyer-klick@dlr.de	+49 711 6862 - 728
Dr. Franz Trieb	franz.trieb@dlr.de	+49 711 6862 - 423
Jürgen Kern	juergen.kern@dlr.de	+49 711 6862 - 8119

Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR)
Institute for Technical Thermodynamic
System Analysis and Technology Assessment
Wankelstraße 5 | 70563 Stuttgart | Germany

www.DLR.de/tt/system