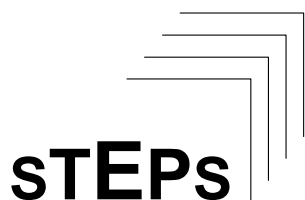


Expert System for Solar Thermal Power Stations

Deutsches Zentrum für Luft- und Raumfahrt e.V.

Institute of Technical Thermodynamics

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Solar radiation and land resources for solar thermal power plant technology

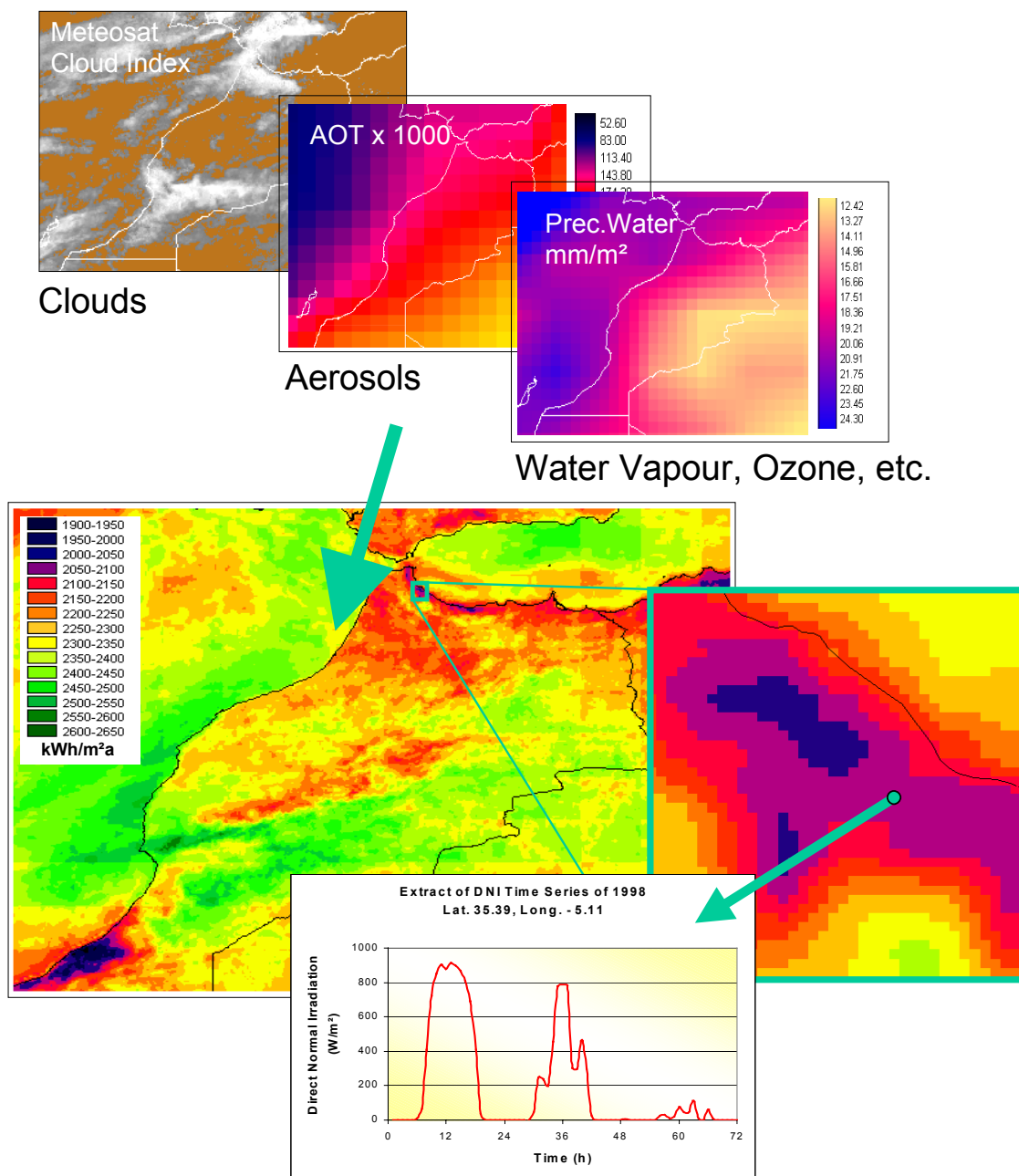
Solar thermal power plants are commercially proven in more than a decade of successful operation. The technical principle is simple: high temperature heat from concentrating solar collectors is used to operate a conventional thermal power cycle, like e.g. a steam turbine. Thermal energy storage and backup-firing guarantee full power availability. Combined generation of heat and power is a unique capability of this type of solar power plants. In the medium term, many countries may not only cover a significant part of their electricity demand by solar thermal power, but may start to export solar electricity and solar hydrogen and - using the waste heat of power generation - produce large amounts of desalted water to develop agriculture and forestry in arid zones and in regions endangered by growing deserts.

An efficient worldwide expansion of solar thermal power plant technology requires reliable data on the quality of the solar energy resource and on the availability of appropriate sites. The German Aerospace Center DLR uses its remote sensing capabilities and international geographic information sources to provide a detailed and well founded database to support most activities of industry, authorities and funding institutions related to solar thermal power expansion, like e.g.:

- Solar Energy Resource Assessment
- Site Selection
- Analysis of Solar Power Potentials and Build-Out Scenarios
- Market Studies and Expansion Plans
- Feasibility Studies and Tender Preparation
- Project Development and Engineering
- Assessment of Socio-Economic and Environmental Impacts and Benefits

Geo-referenced data with a spatial resolution of 1 kilometer can be supplied as maps and in standard formats for processing in geographic information systems (GIS). In-depth information on the direct solar irradiation resource is provided as hourly time series, that can be used for detailed modelling of the technical and economical performance of solar thermal power facilities.

Solar Energy Resource Assessment



*Fig. 1: Direct Normal Irradiation in Morocco:
Spatial Distribution of Annual Sums and Site Specific Time Series*

The solar beam radiation is calculated for each hour of the year taking into consideration the different components of the atmosphere like clouds, aerosols, water vapour and others that are identified by satellite remote sensing technologies. The analysis shows the microclimatic characteristics of the region. For each point of the map, an hourly time series of the radiation intensity can be extracted for in-depth modelling and economic assessment of solar power plant performance.

Site Qualification

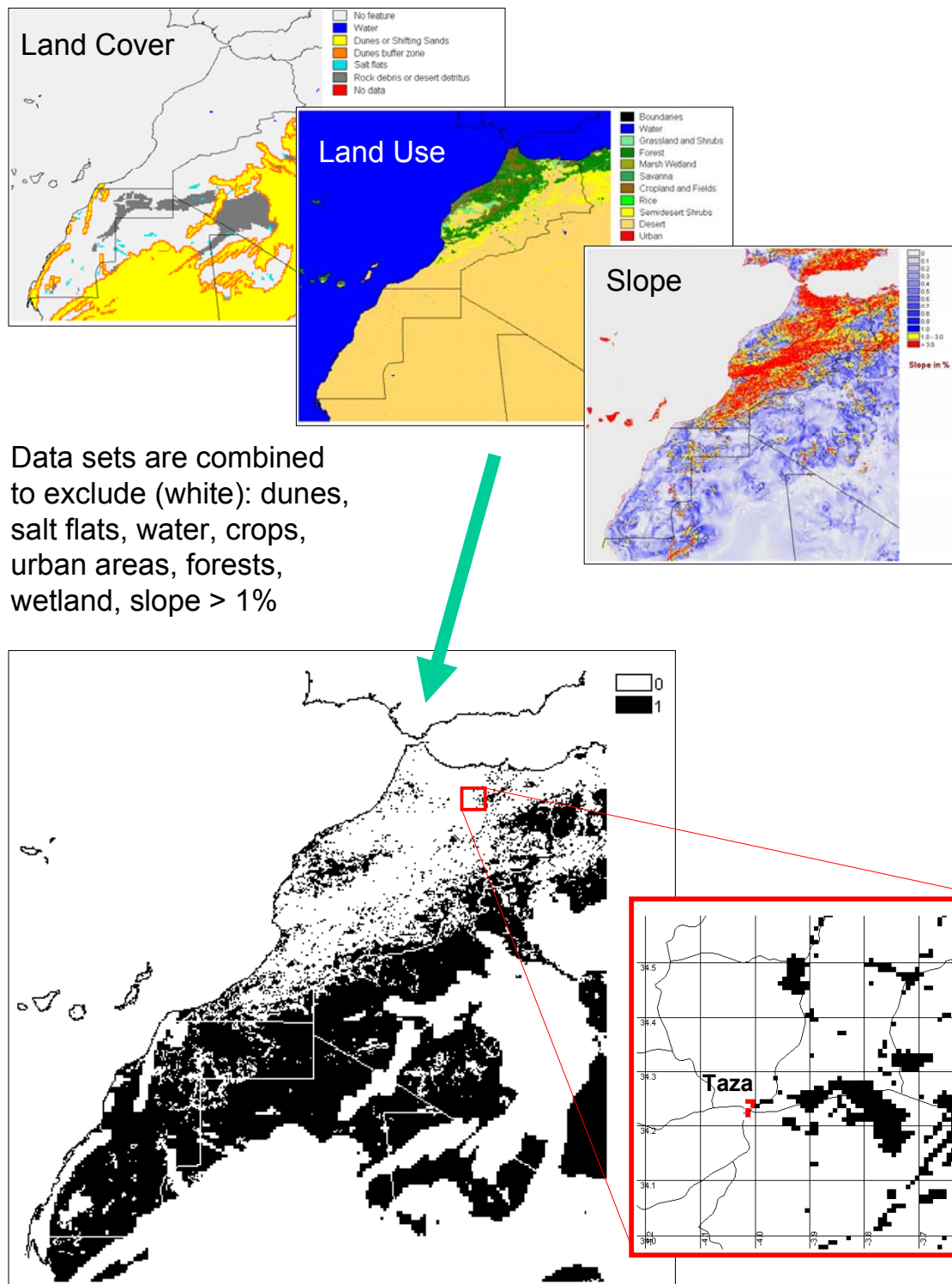


Fig. 2: Pre-Qualification of Sites for Solar Power Plants in North-Western Africa with respect to Land Cover, Land Use and Slope (1 km spatial Resolution)

Site Ranking by Solar Radiation

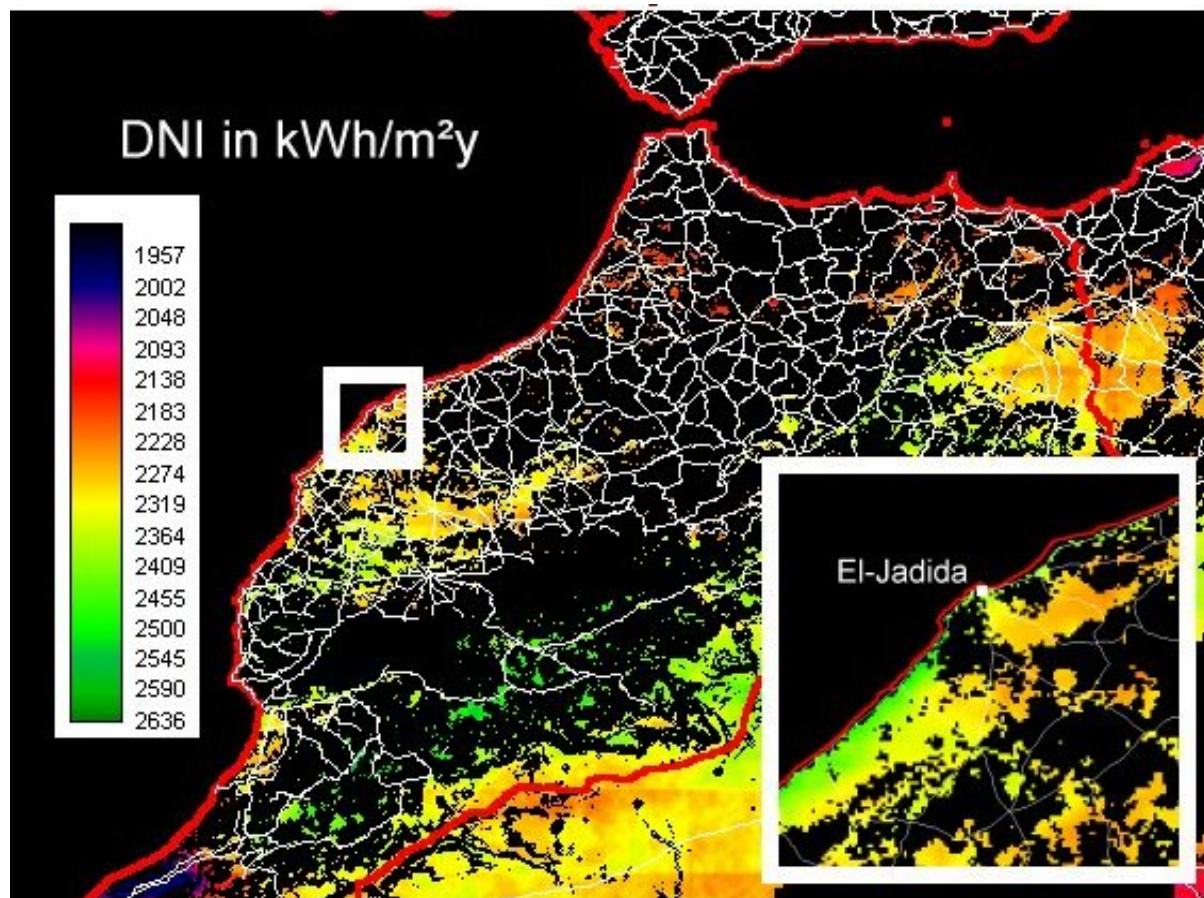


Fig. 3: Site Ranking with respect to Direct Normal Irradiation in Morocco

Combining resource data on direct normal irradiation (DNI) and site qualification data, a ranking of suitable sites with respect to the annual solar radiation intensity is obtained. This methodology allows for systematic project development and site selection, facilitating very much the initial steps of such power projects and reducing its risks considerably.

Further technical and economic ranking of sites is obtained from system modelling and performance simulation for every suitable point of the map, showing a new classification by e.g. electricity yield, infrastructure cost and electricity cost, as shown on the following page for a specific solar power plant configuration and for the total area of Northern Africa.

Site Ranking by Performance and Cost

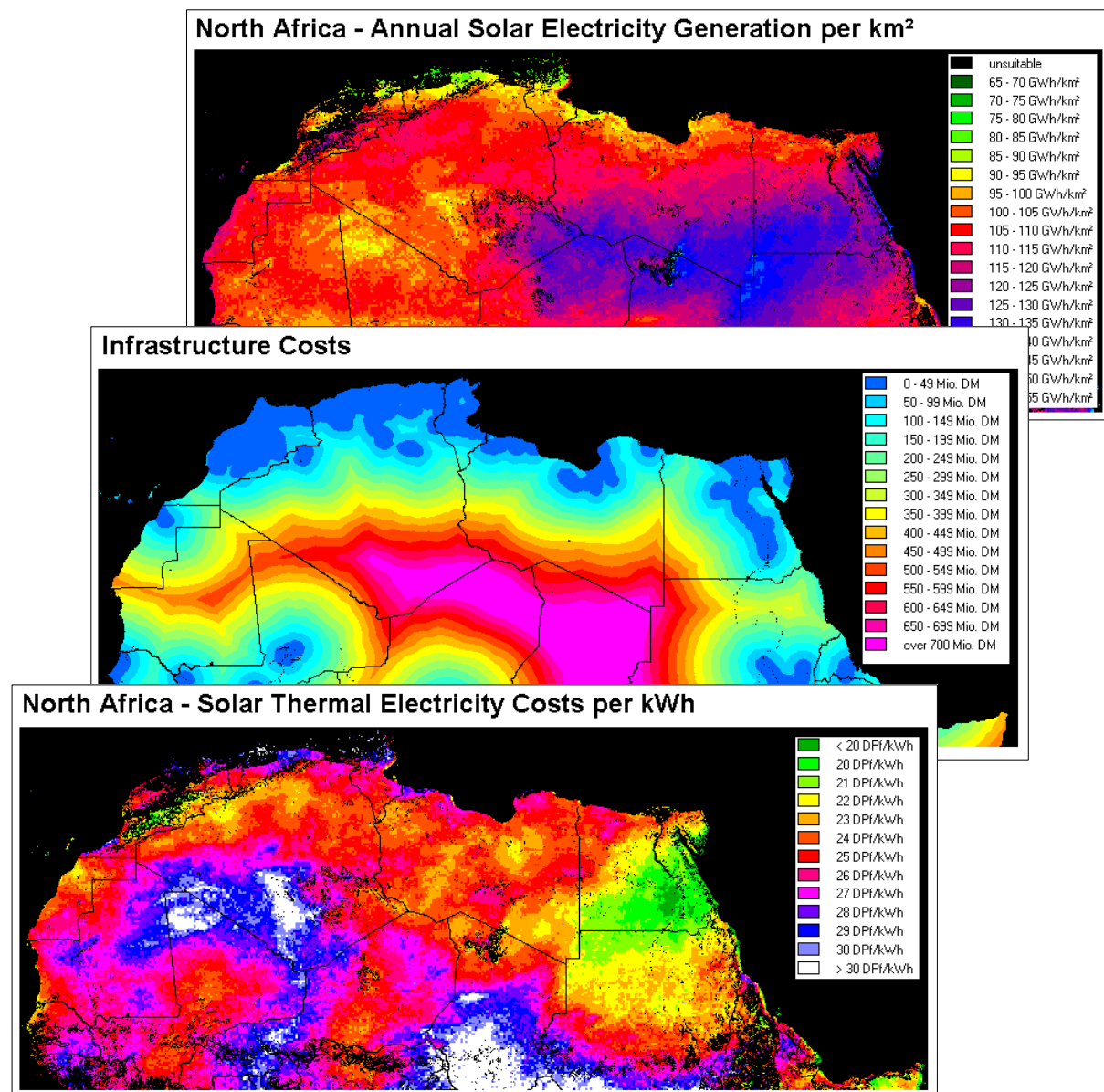


Fig. 4: Ranking of potential Sites for Solar Thermal Power Plants in Northern Africa with respect to the Solar Electricity Yield, Infrastructure Costs and Solar Electricity Costs

Note: The maps and graphics within this document are meant to demonstrate the concept only; they should not be used for other purposes, as not all relevant criteria have been applied for site qualification and site ranking. DLR does not respond for any possible damage caused by the use of this data. The shown boundaries do not necessarily imply international agreement or legal acceptance.

Products

1. Solar Energy Resource Assessment:

- GIS-Datasets and Country Maps of Annual Sum of the Direct Normal Irradiation Resource (Solar Radiation Atlas, Resolution 1x1 km²)
- GIS-Datasets and Country Maps of Monthly Sums of Direct Normal Irradiation
- Site-Specific Annual Time Series of Hourly Means of DNI
- Other Meteorological Parameters on Request
- Comprehensive Documentation.

2. Site Qualification:

- Includes Solar Resource Analysis described above
- Site Qualification for Solar Thermal Power Stations regarding Land Cover, Land Use, Slope, Infrastructure, Hydrology, Natural and Political Risks, Protected Areas etc. (GIS Datasets + Maps, Resolution 1x1 km²)
- Site-Ranking with respect to Solar Energy Yield (GIS + Map)
- Site-Ranking with respect to Solar Electricity Cost (GIS + Map)
- Further Products on Request
- Comprehensive Documentation.

Applications

- Market Assessment Studies
- Potential-Cost-Analysis
- Feasibility of Solar Power Plants and Solar Combined Heat and Power Systems
- Tender Preparation and Engineering
- Scenarios of Renewable Energy Expansion
- Assessment of the Socio-Economic Benefits of Solar Thermal Power Expansion
- Life Cycle Assessment of (avoided) Emissions
- Assessment of Export Capabilities of Solar Electricity and/or Solar Hydrogen
- Research and Development
- Advisory Services and Training, etc.

To find out more on solar resource assessment and on solar thermal power plants, please contact:

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