



# **Concentrated Solar Power (CSP)**

## **Options and Perspectives in Tunisia**

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**In collaboration with M. Röger, L. Qoaider, M. Eck**

**AHK Expert Workshop Tunis, 14.2.2012**



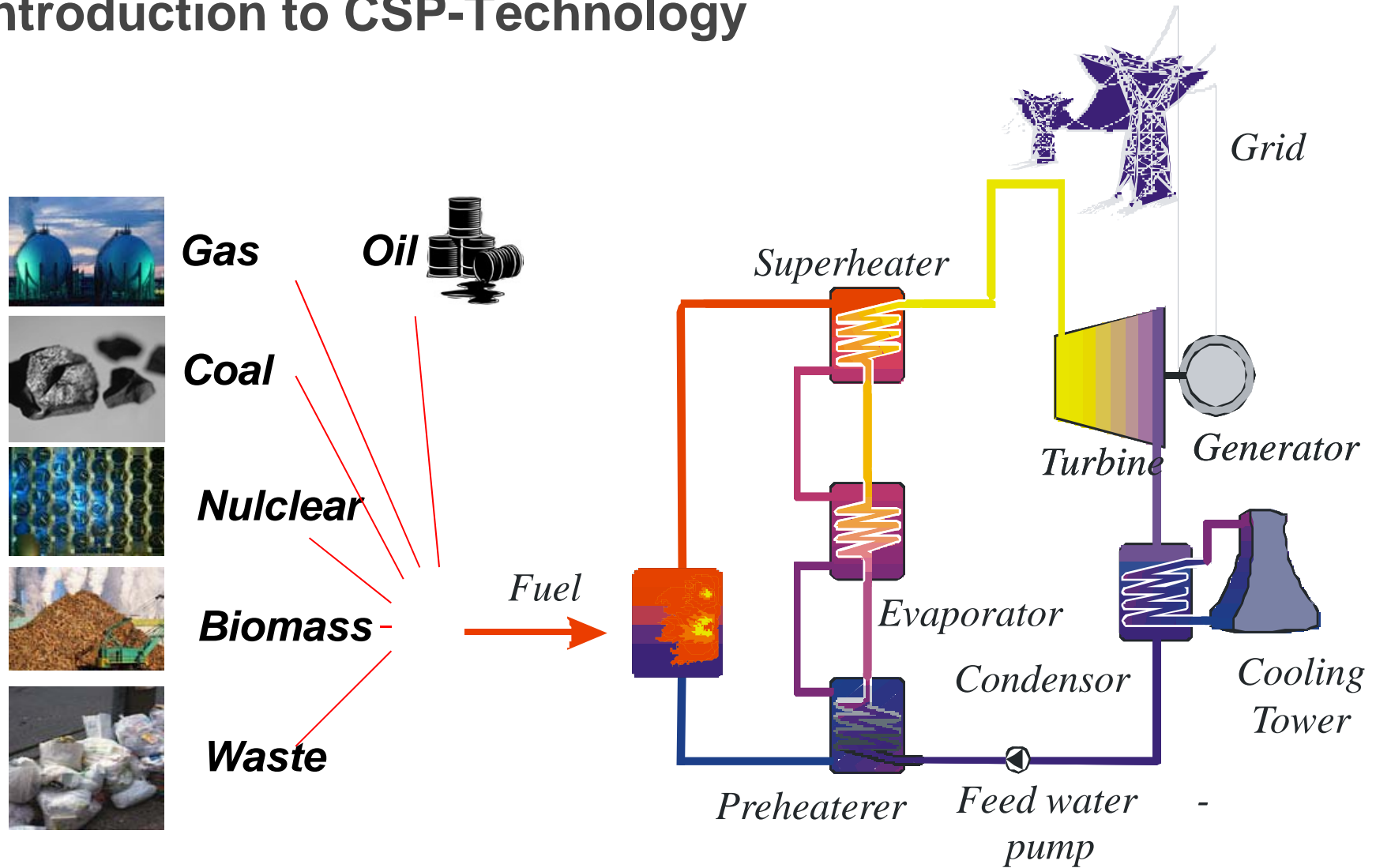
Deutsches Zentrum  
für Luft- und Raumfahrt e.V.  
in der Helmholtz-Gemeinschaft



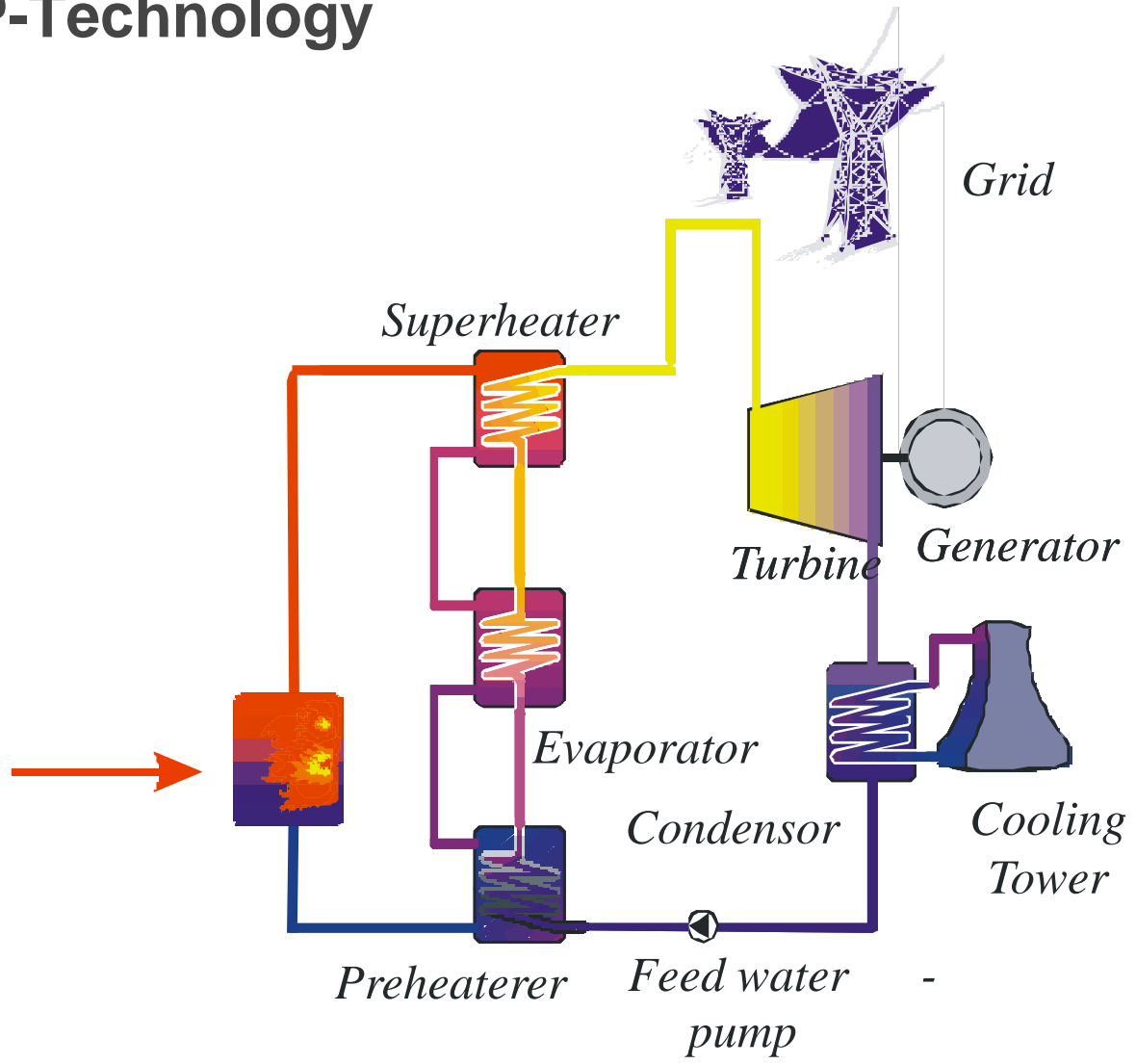
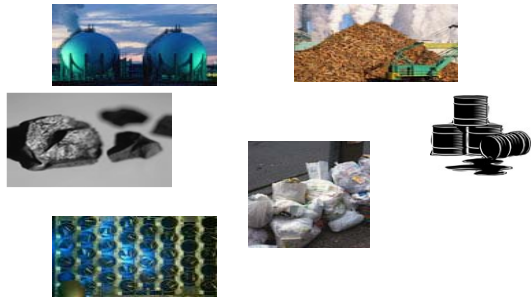
## Outline

- Introduction into CSP-Technology
- Why is CSP important for EU, MENA and Tunisia
- Current CSP-projects
- The Potential in Tunisia
- EnerMENA – Support Initiative of the German Government

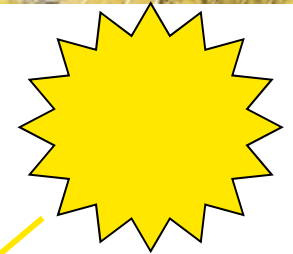
# Introduction to CSP-Technology



# Introduction to CSP-Technology

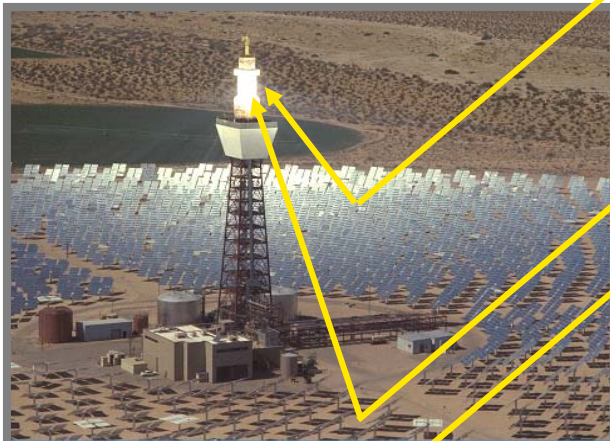


# Introduction into CSP Technology



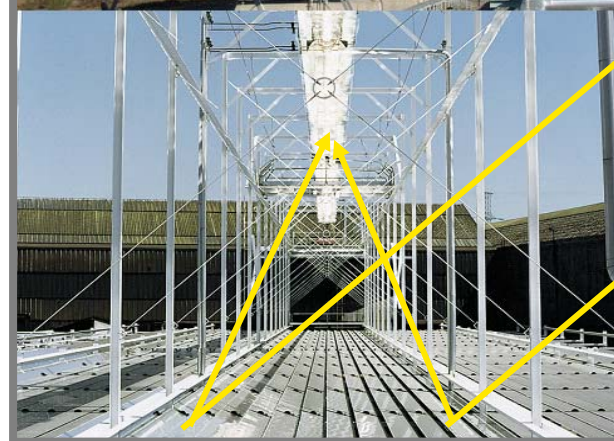
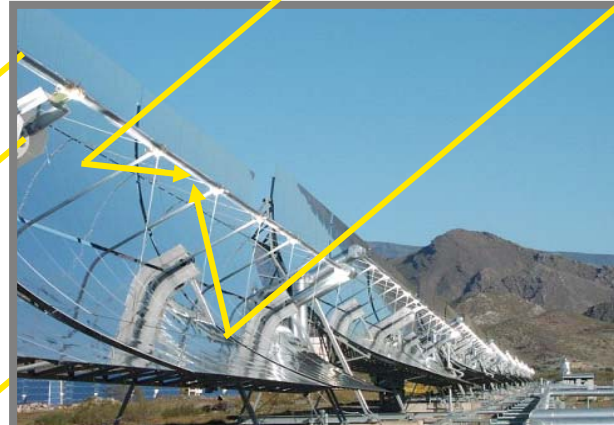
*Up to 1000° C Gas turbines, Motors*

*Solar tower (SNL)*



*Dish-Stirling (SBP)*

*Parabolic trough (PSA)*



*Linear Fresnel (MAN/SPG)*

*Up to 550° C steam turbines*



- 
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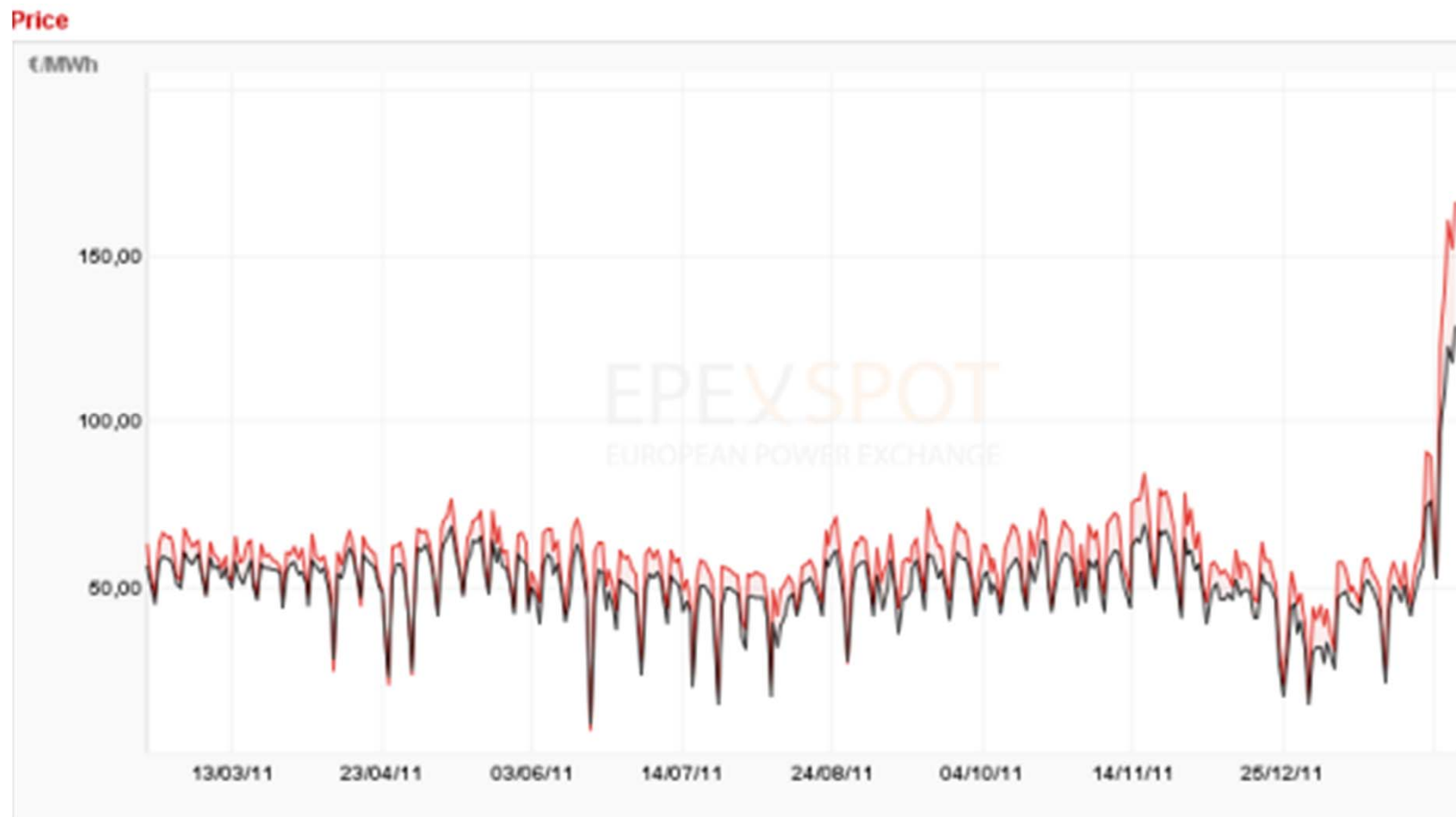


## Why is CSP-Technology important for EU and MENA

- The German Nuclear Power Exit Strategy
  - All Nuclear Power Stations will be switched off by 2022
- Energy Concept 2050: 100% Renewable Energy
- Dependency of Electricity Price on Weather Conditions

# Why is CSP-Technology important for EU and MENA

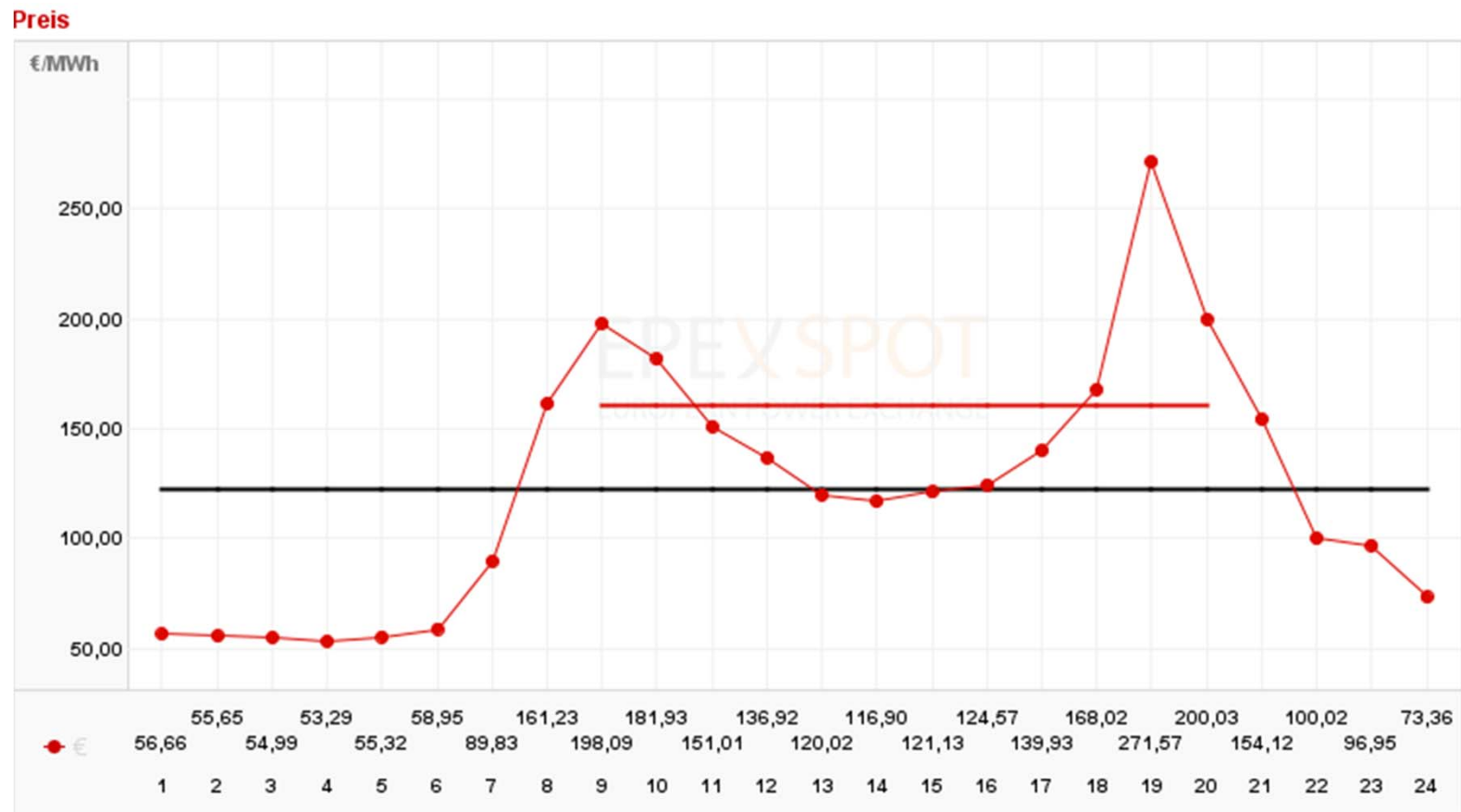
## Price Peaks on the Electricity Market





# Why is CSP-Technology important for EU and MENA

Load peak caused by weather conditions, February 2, 2012



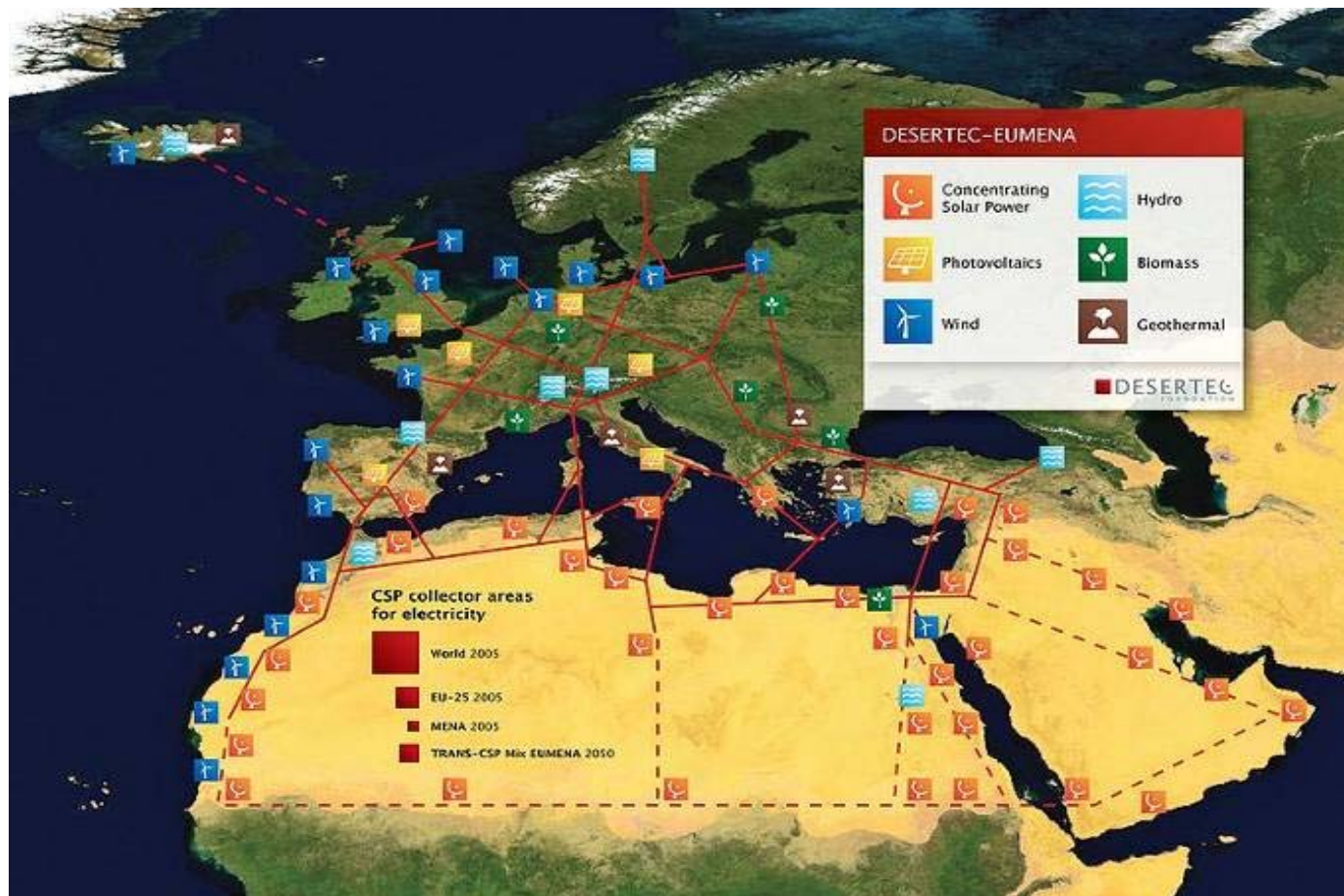


## Why is CSP-Technology important for EU and MENA

- Solar Thermal power plants with **thermal storage**
- HVDC lines
- The DESERTEC Concept

# Why is CSP-Technology important for EU and MENA

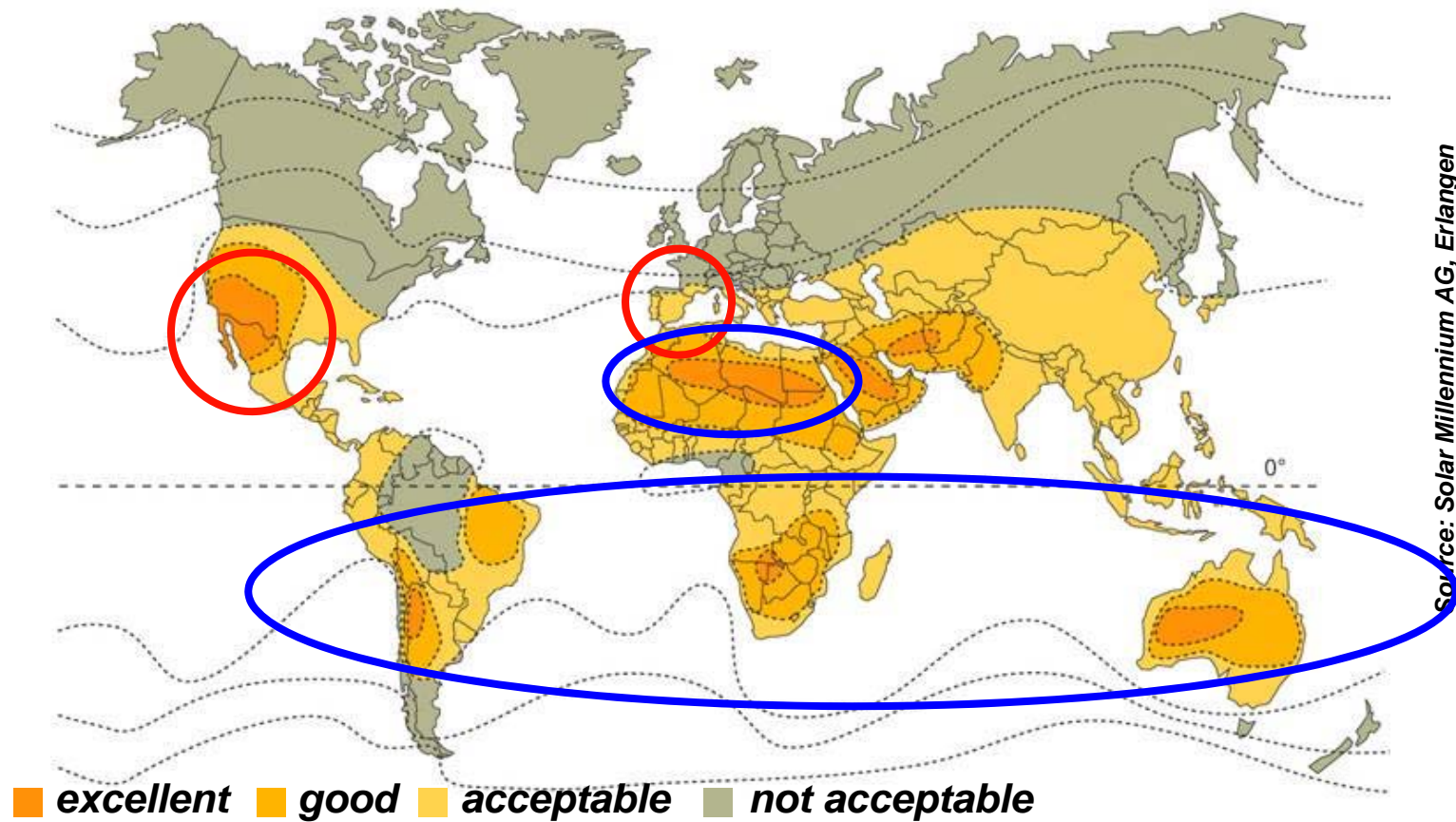
The DESERTEC concept



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# Current CSP Projects

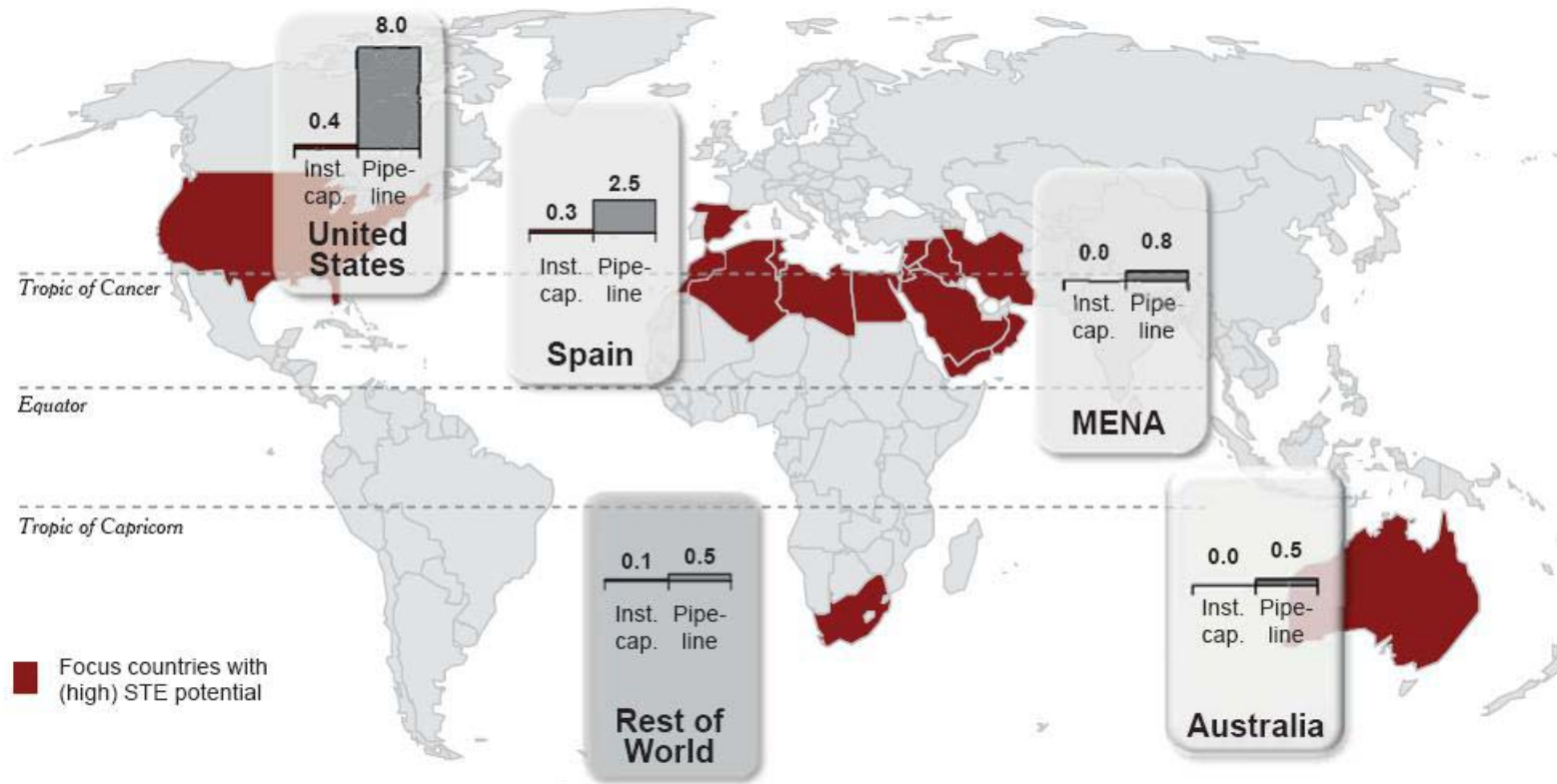
## Global Potential



# Current CSP Projects

## Status Quo Worldwide

Source: for current information see:  
[www.solarpaces.org](http://www.solarpaces.org)



**total**  
**7.000 - 8.500 MW**

**Source:** The World Bank study: Middle East and North Africa Region, Assessment of the Local Manufacturing Potential for Concentrated Solar Power (CSP) Projects

# Current CSP Projects

Morocco: Ain Beni Matar



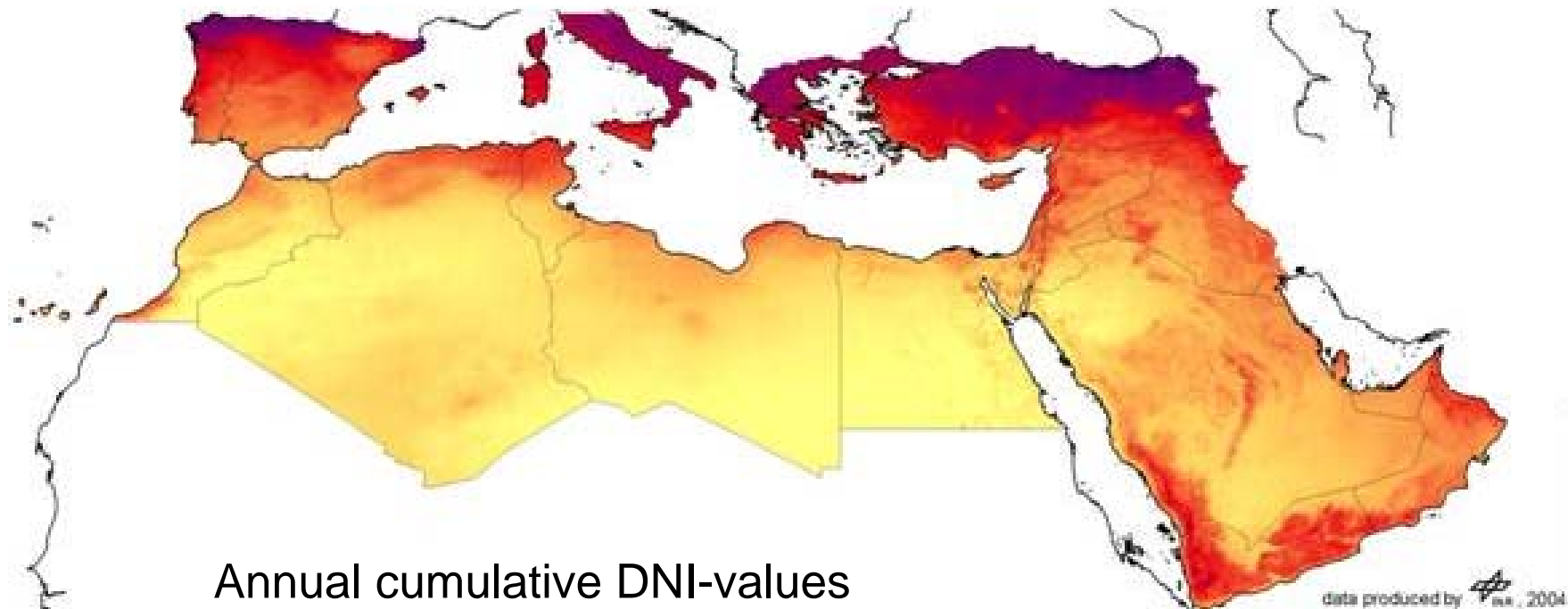
- **Owner: ONE**
- **EPC conventional CC-plant: Abener**
- **EPC solar field + 2 year O&M: Abener**
- **Groundbreaking: 2008**
- **Commissioning: 5/2011**
- **Solar field size: 180.000 m<sup>2</sup>**
- **Solar share (yearly): 4%**

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# The Potential in Tunisia

## Solar Radiation Data



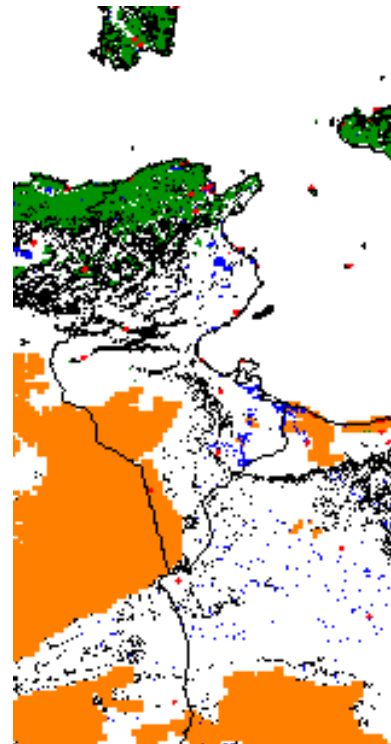
Annual cumulative DNI-values  
of up to 3000 kW/m<sup>2</sup>

data produced by  2004

# The Potential in Tunisia

## Exclusion Areas

- no exclusion
- urban or industrial use
- hydrography
- protected area
- land cover
- geomorphology
- topography



# The Potential in Tunisia

## The El-Borma Case Study



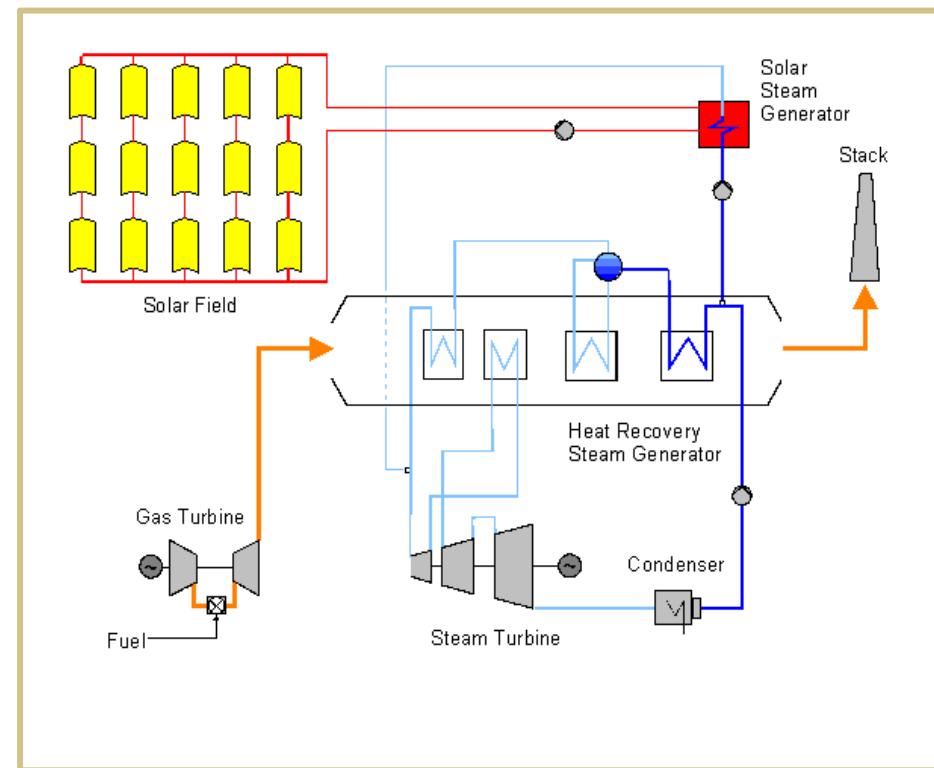
- Biggest Tunisian Oil Field
- Utilization since 1966 capacity today: 10000 b/d
- *Need: New 43 MW off-grid electricity supply*
- Idea: Integrated Solar Combined Cycle System (ISCCS)



# The Potential in Tunisia

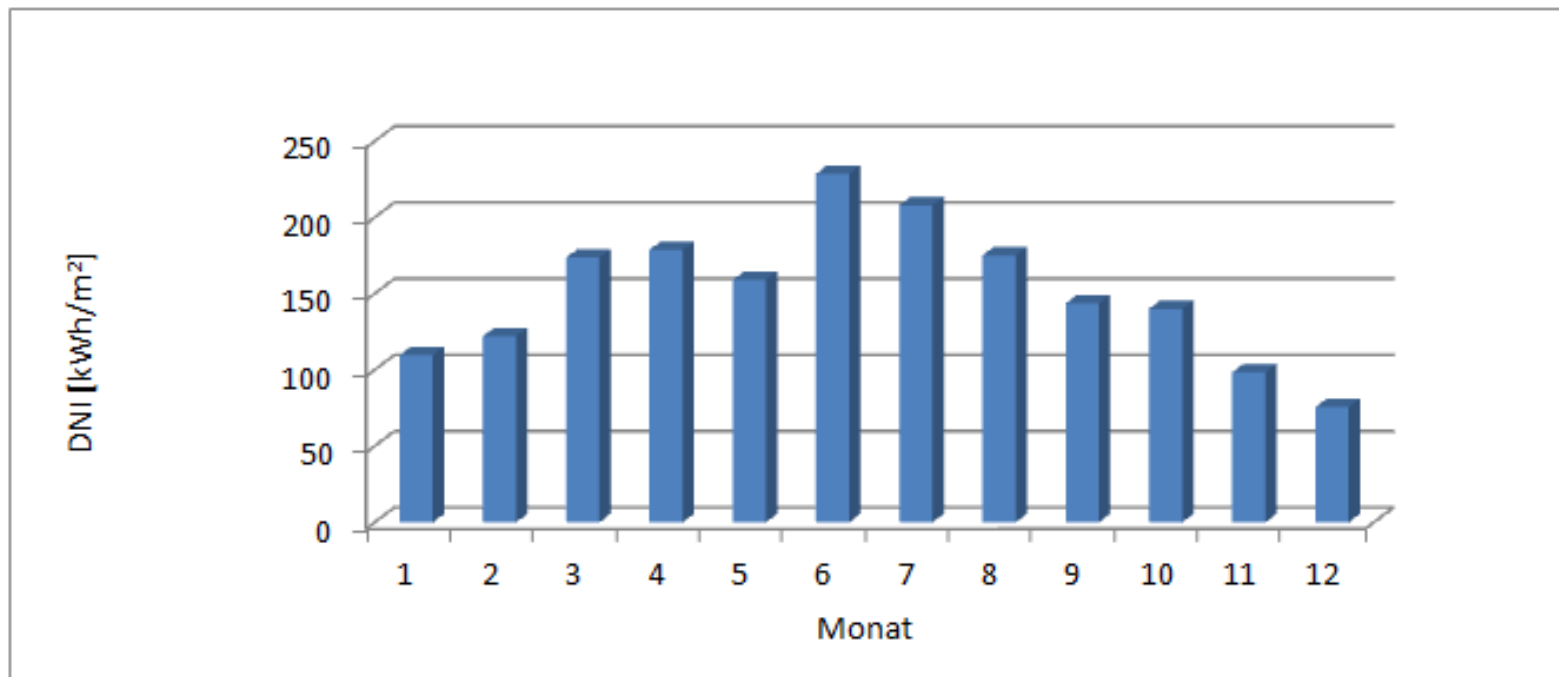
## The El-Borma Case Study

- system considered: parallel solar steam generation
- solar tower (air receiver)
- direct steam parabolic trough
- tools: *Epsilon*, *Greenius*
- steam parameter:
  - 440°C
  - 45 bar



# The Potential in Tunisia

El-Borma Radiation Data: 1814 kWh/m<sup>2</sup>/y



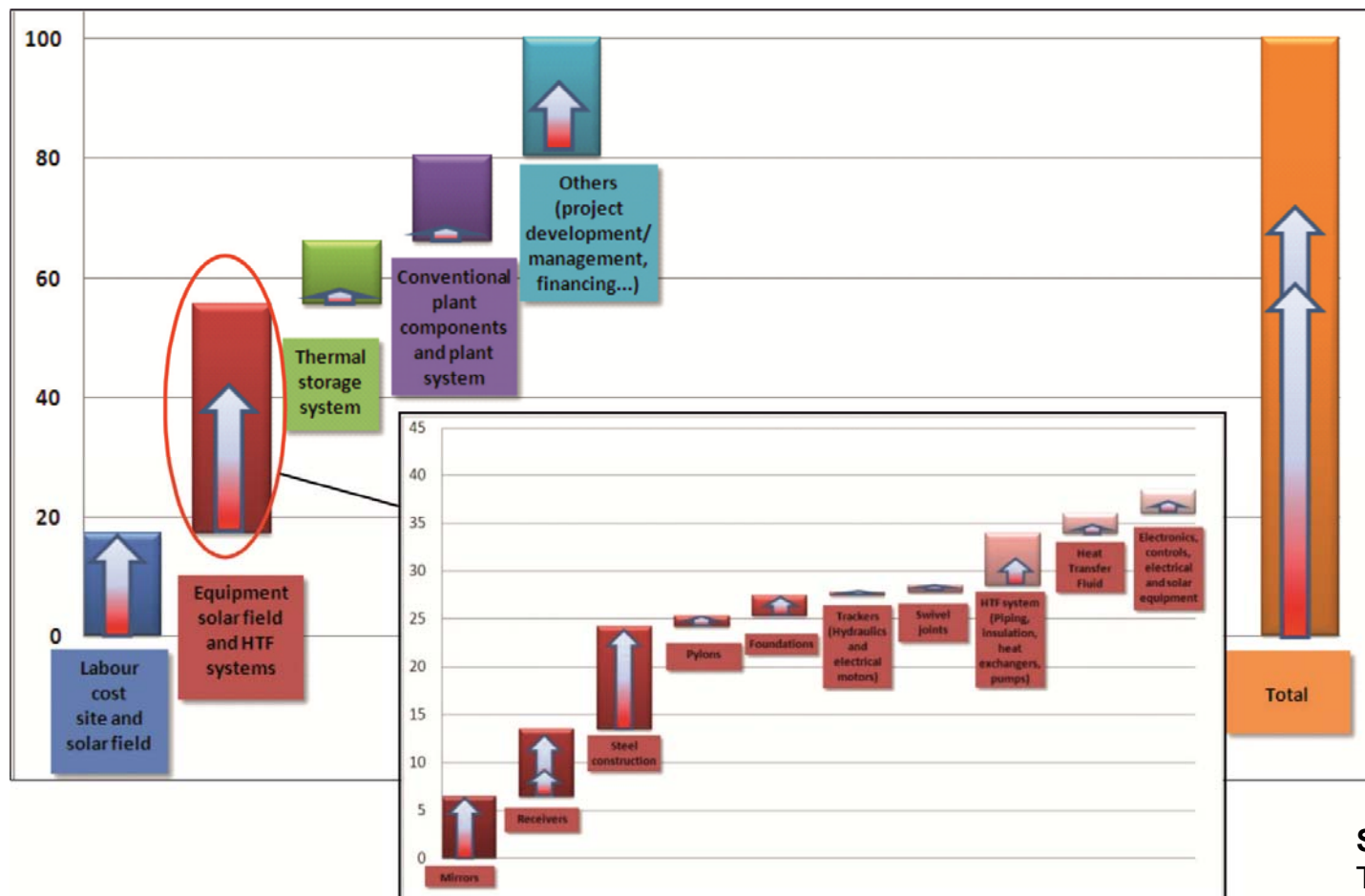
# The Potential in Tunisia

## Results of the El-Borma Case Study

		Parabolic Trough	Solar Tower
Solar generated Electricity	Mwh <sub>el</sub>	10250	10273
	%	2,72	2,73
Fuel Save	MWh <sub>th</sub>	21883	21935
Fuel Save	t	1575	1579
Mirror Area	m <sup>2</sup>	50458	46862
Gross solar field area	ha	16	23

# The Potential in Tunisia

## Local Manufacturing Potential



Source:  
The World Bank study

# The Potential in Tunisia

## Local Manufacturing Potential: Summary

### Strengths

- Low labor cost
- High solar potentials
- Strong GDP growth
- High electricity demand
- Strong industrial sector
- Proximity of Italy
- Large export industry
- ...

### Weaknesses

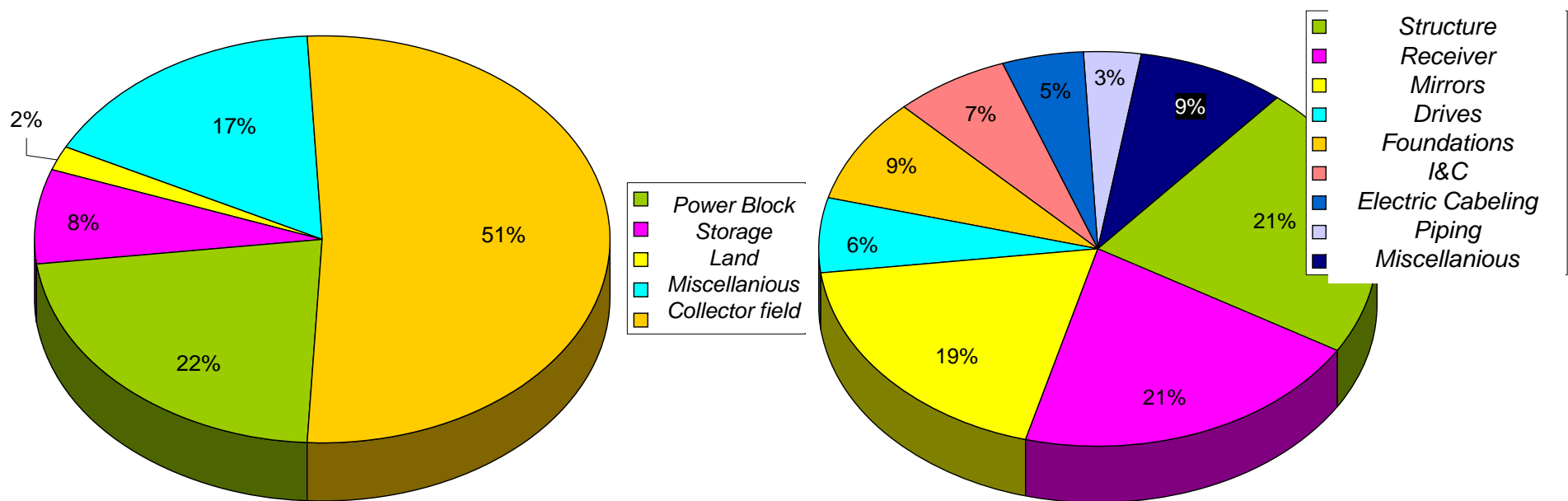
- Administrative and legal barriers
- Lack of financial markets
- Higher capital costs
- Energy highly subsidized at 75%
- No fiscal, institutional and legislative -  
framework for RE development  
(under development)
- Insufficiently developed infrastructure
- No specialized training programs for RE
- ...



# The Potential in Tunisia

How can the local value be increased

- **Solar thermal power plants feature a high fraction of conventional technologies in the value-added chain**



**Cost break-down parabolic trough plants**

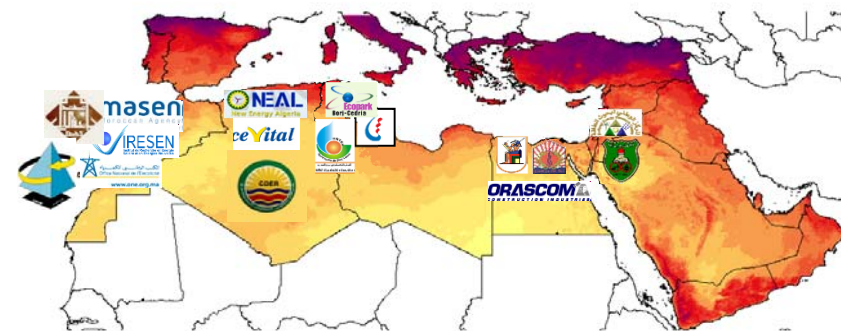
**Cost break-down parabolic trough collector**

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# enerMENA

main objective

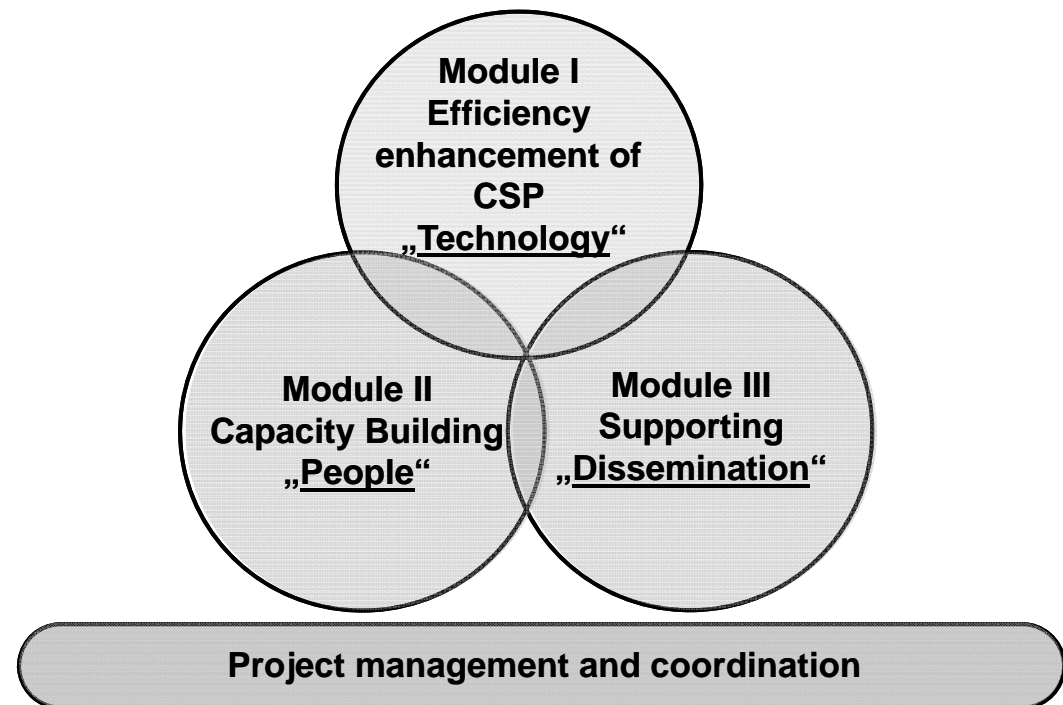
- Initiative by the German Government
- Support the implementation of CSP technology in MENA
- Based on the DESERTEC Concept
- Focusses on
  - Capacity Building
  - Know-how transfer
  - Efficiency Enhancement



Partners: Jordan, Egypt, Tunisia, Algeria & Morocco

# enerMENA

## Modular Approach

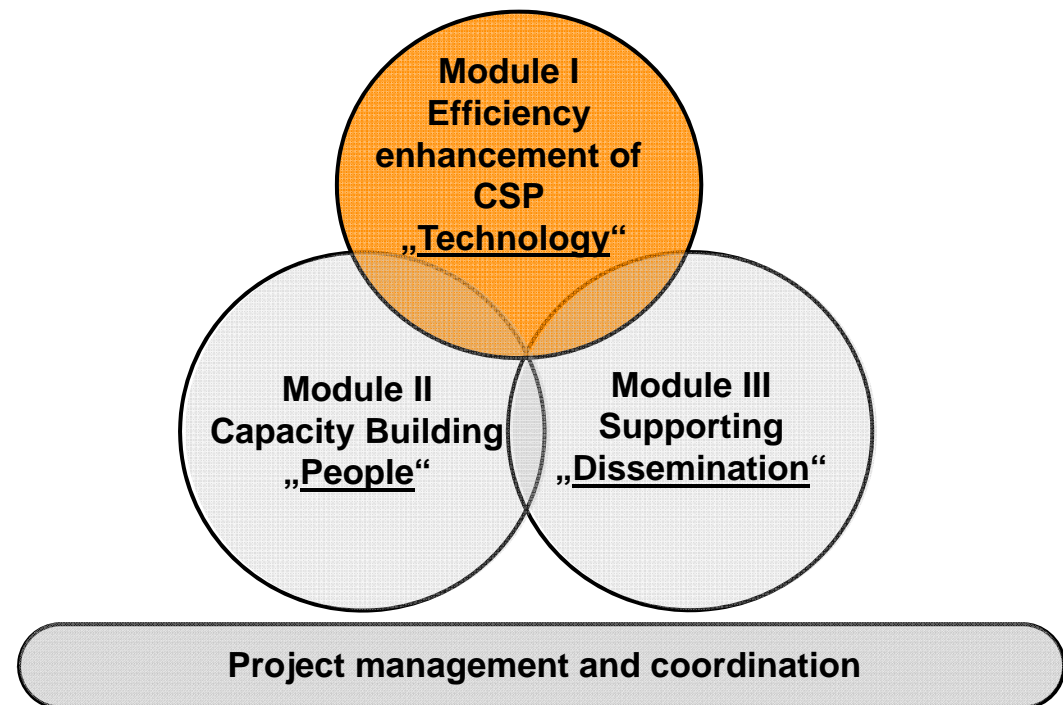


# enerMENA

## ”Technology” Module

### Activities

- Technical **Training Program**: PSA in Almeria 11/2010 (eM-CB01)
- Five mobile measurement **laboratories**
- Development of an optical and thermal measurement technology for **quality control** of collectors



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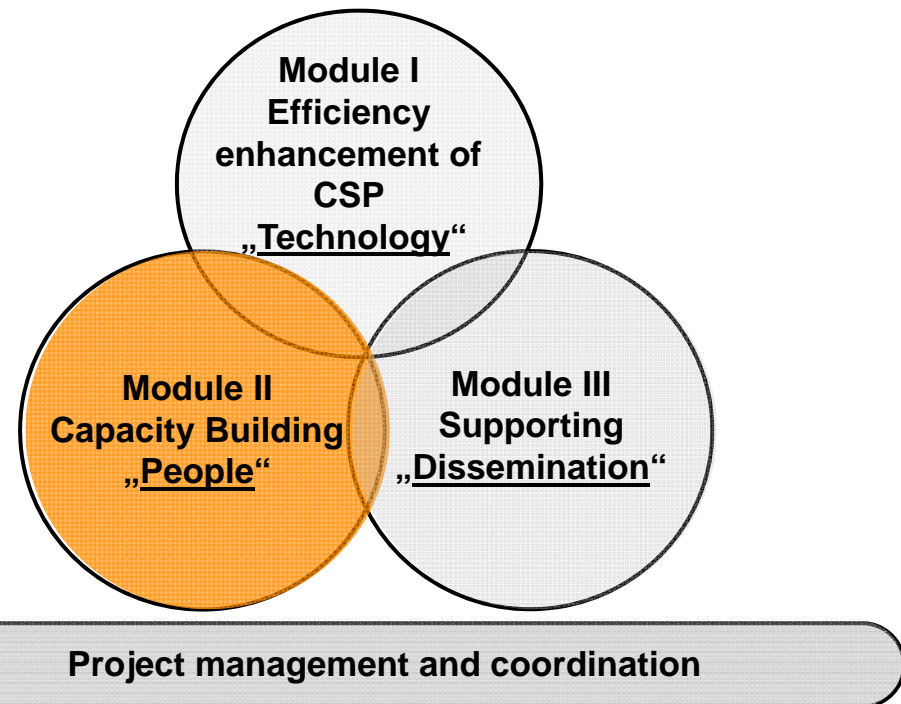


# enerMENA

## “People” Module

### Activities

- Technical **Training Program**: PSA in Almeria 11/2010 (eM-CB01)
- Establish local CSP technical teams
- Prepare expert training materials,
- Organize of eM-CB02 at Technopole Tunisia in November 2011
- Preparing CSP teaching materials for universities
- 4 international workshops with MENA experts
- Lectures implemented in Jordan

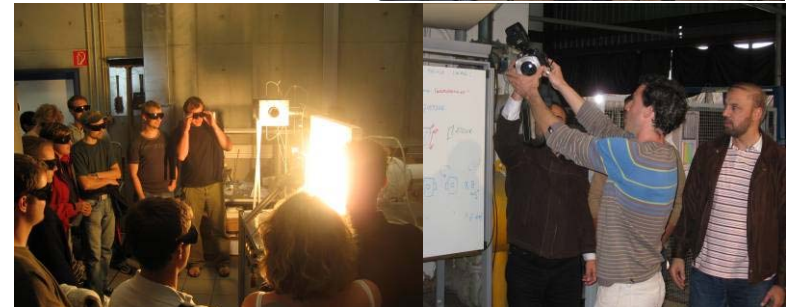


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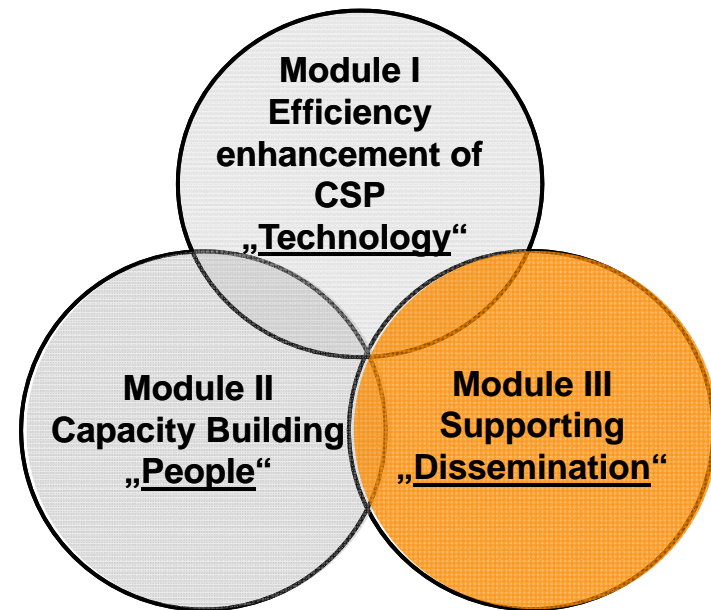


# enerMENA

## ”Dissemination” Module

### Activities

- Preparation of **coaching material** for yield analysis and project planning methodology
- Installation of eight **Meteo-stations** to overcome insufficient data base (not yet completed)
- “Project Planning” **training program** in November 2010.
- Establishment of local **contact points** for information dissemination at partner institutions.



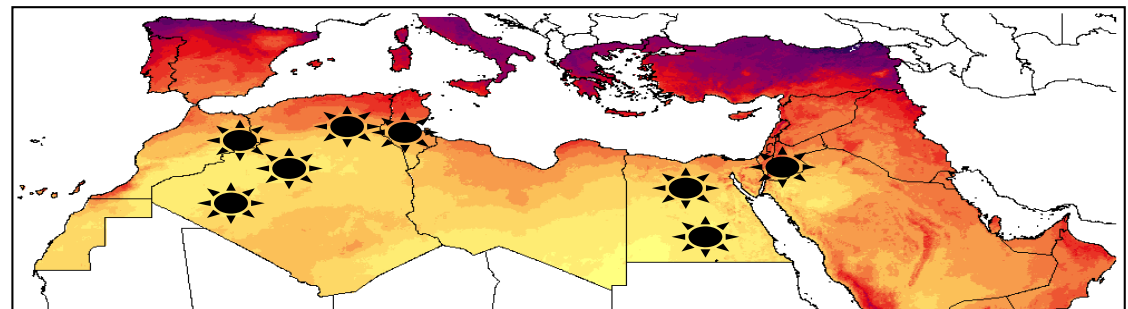
Project management and coordination

# enerMENA

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## Summary

- CSP provides a mature utility scale power technology
- Numerous projects realised worldwide
- Increasing electricity demand from RE in Europe
- Desertec concept demands substantial contribution North-Africa
- Tunisia with excellent potential
- EnerMENA – aims at providing capacity building support



**Thank you for your attention!**

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