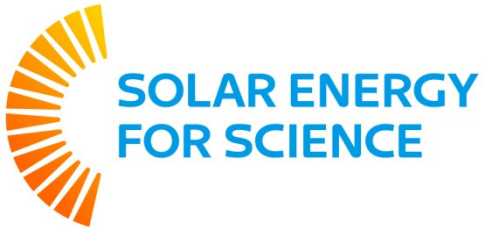
# Solar Energy for Science




## A new energy/science partnership between Europe and MENA

an initiative by DESY
co-organized by DLR

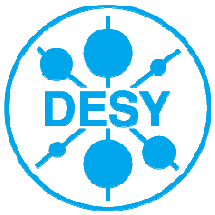

Workshop on „Renewable Energy Concepts for Mega-Science Projects demonstrated at the SKA and its Pathfinders“

Berlin, 07 April 2011

in cooperation with
SESAME and Academy of
Scientific Research & Technology, Egypt




Frank Lehner
DESY



# DESY


Hamburg

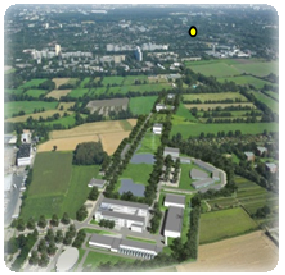
Zeuthen

**Member of Helmholtz Association**

**Mission:**

Development, construction, operation and scientific exploitation of accelerators

Provide (open) access and services for national and international users



- **Accelerators**
- **Photon Science**
- **Particle and Astroparticle Physics**

**Research Collaboration with leading labs worldwide**

**Budget ~ 180 Mio €/a**
**Employees ~ 1900**

**Research Infrastructures: DORIS, FLASH (-II), PETRA-III, XFEL, TIER-2**

**External Users: ~ 3000/year from 45 countries**

# Motivation

SOLAR ENERGY FOR SCIENCE

- Our science policy mandate: construction, operation and exploitation of large research infrastructures
- large research infrastructures are energy intensive
  - synchrotron radiation sources, neutron sources, X-Ray lasers, high magnetic field facilities, high performance computing, …
  - DESY (w/o XFEL): 20 MW Power, 210 GWh/year, about 110 kt CO2/year
  - future development of energy prices, volatility ?
  - how climate neutral/sustainable should research centers be?
  - =>Question of energy supply is of strategic relevance
- Goal: have on a long-term a reliable, sustainable and economic energy supply for large research infrastructures



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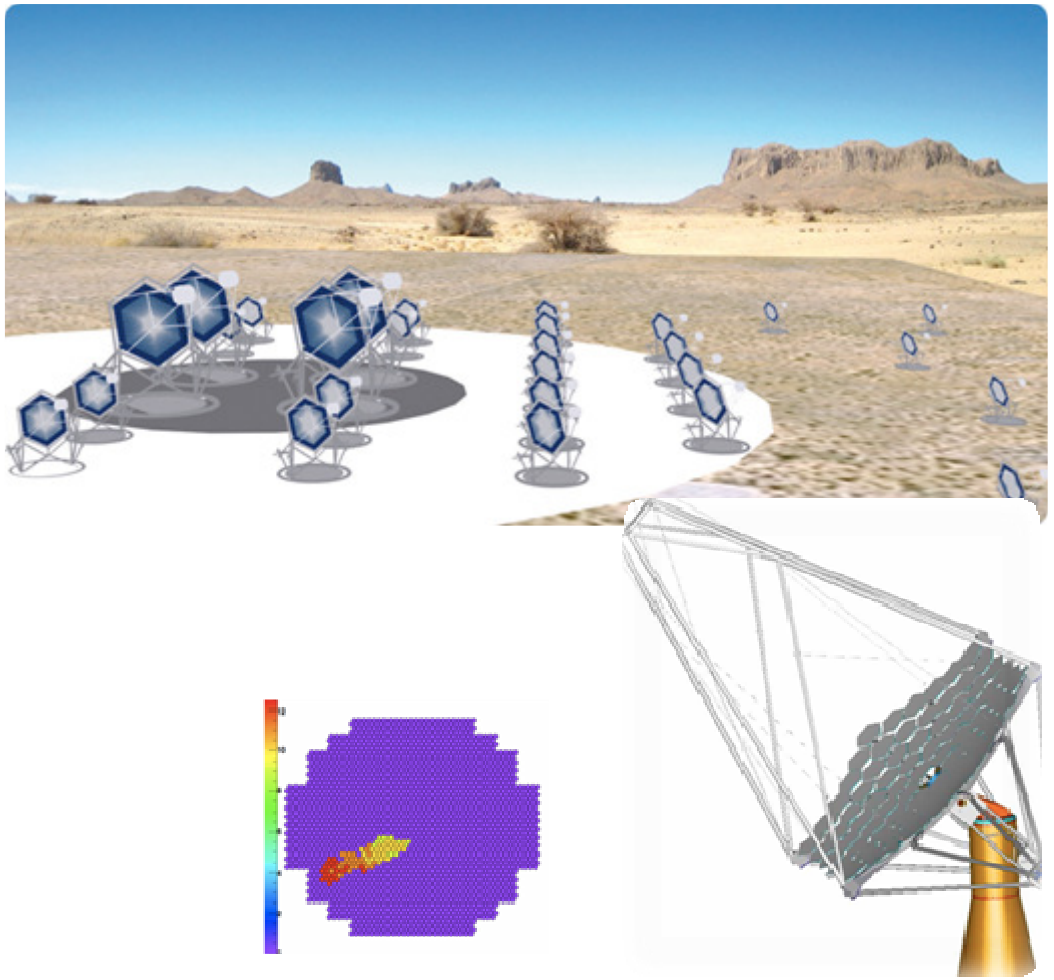
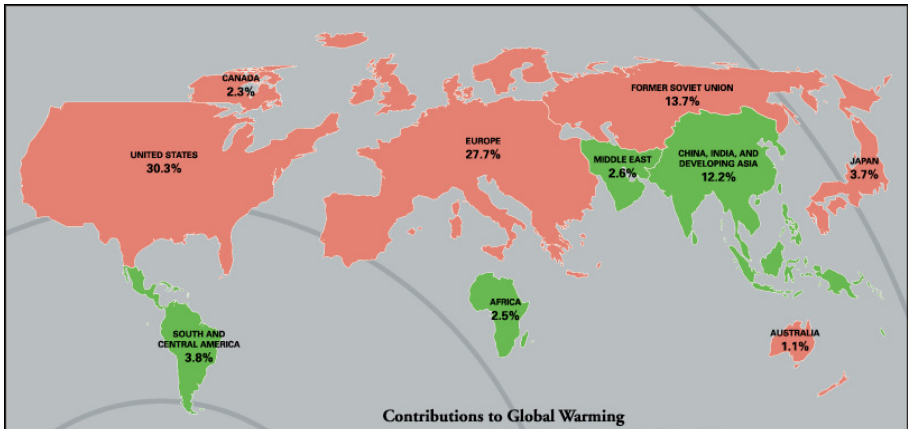
# Cherenkov Telescope Array

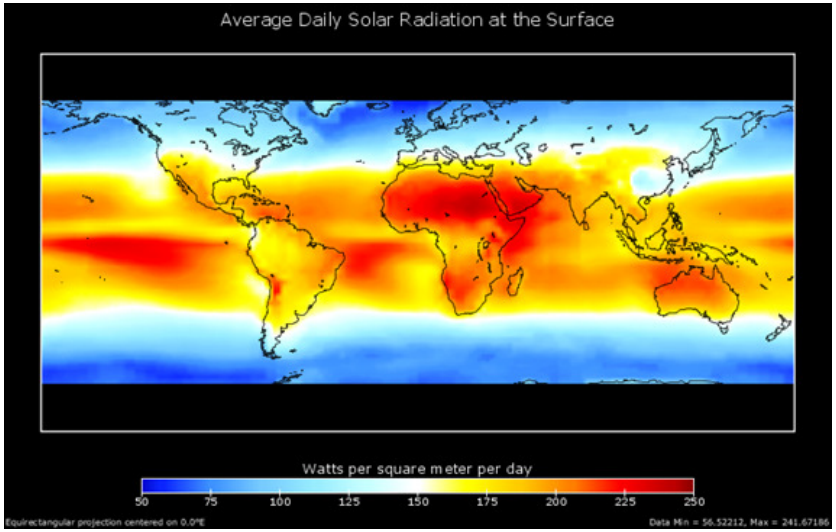
- DESY engaged in CTA
- remote Research Infrastructure for high energy gamma astronomy



# The global picture – asymmetric/complementary

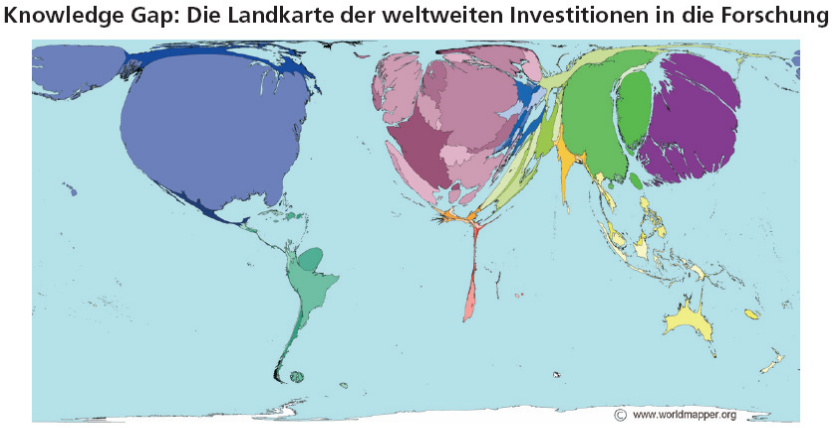



Historic CO2-emissions




Solar potential

Energy consumption

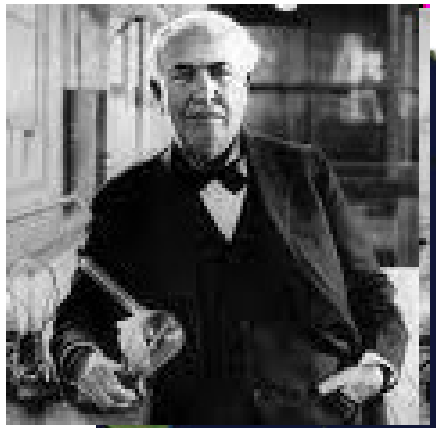


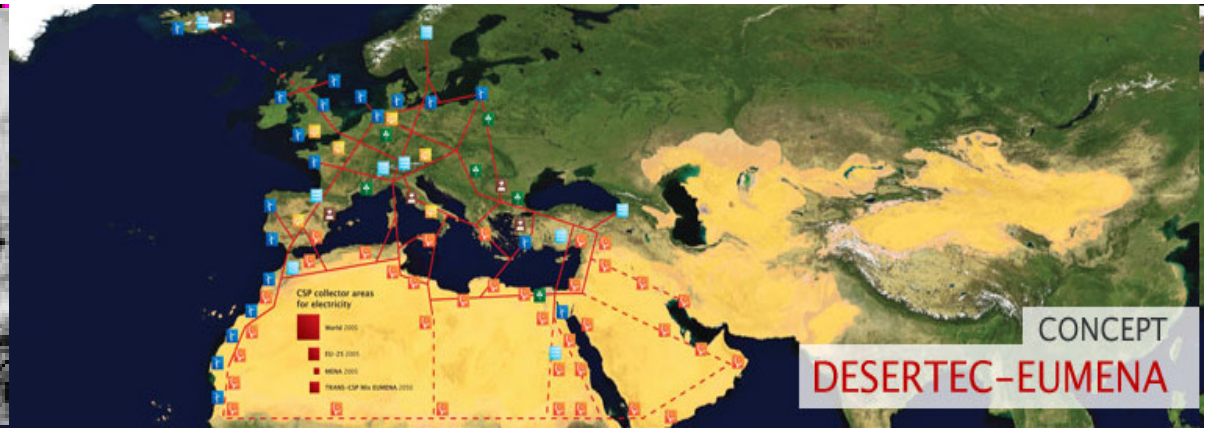

Knowledge production

# Renewable Energy from the Deserts

SOLAR ENERGY FOR SCIENCE

- Renewable energy from the desert regions of the Middle East and Northern Africa (MENA)
  - Reduce carbon, provide reliable energy supply
  - reduce „energy poverty“ in MENA, drinking water supply
  - Economic and sustainable growth, peace, stability („from a shatterbelt to a Gateway“)
  - Support reform and modernization process in MENA !!!!
  - Sustainable development of geopolitical interest in Europe (Neighborhood politics)






*I'd put my money on the sun and solar energy. What a source of power! I hope we don't have to wait till oil and coal run out before we tackle that.*
**Thomas Alva Edison, 1847-1931**



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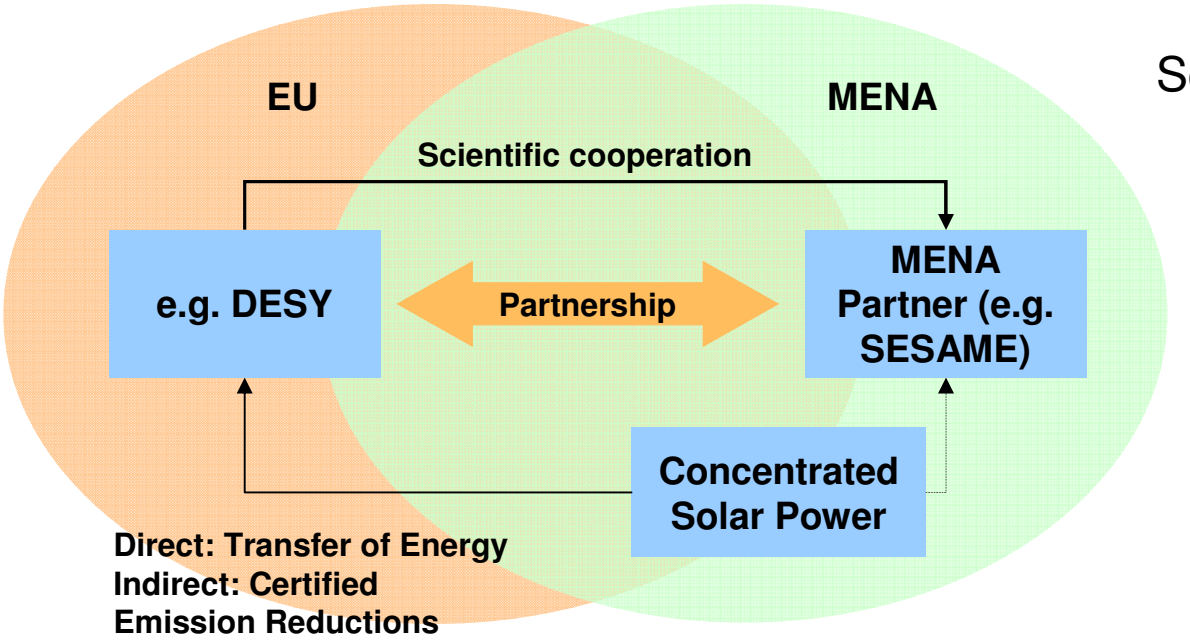
# Energizing the MENA Deserts

- Fascinating prospects for a win-win situation – however, it requires
  - favorable political regulations and conditions (in export-/import countries)
  - incentives for private investments, e.g. feed-in tariffs
  - upgrade of power grid infrastructure
  - Communication/advocacy in MENA region
  - Visible added value and benefits in MENA, e.g. increased security of energy supplies, jobs, economic wealth, infrastructure, value chain in MENA, ...
- Proposal: embark on Energy/Science Partnership between EU and MENA (Solar Energy for Science)
  - Understand EU-MENA as one area of common interest in energy supply, water, climate protection and science & technology exchange
  - coupling of sustainable energy supply MENA-EU to scientific, technology, education transfer/collaboration
  - partnership could give long-term perspectives to MENA now, Science can contribute to build bridges
  - Such a mechanism can be additional incentive to intensify post-Kyoto climate politics

# Concept of a joint energy/science partnership

SOLAR ENERGY FOR SCIENCE

Science can build bridges




- Enhance S&T cooperation with MENA partners as stimulus for governments to promote renewable energies in MENA
  - coupling of sustainable energy supply MENA-EU to scientific, technology, education transfer/collaboration
  - partnership can help to overcome obstacles, remove regulatory hurdles
- Prospect/Vision for EU-MENA: direct physical transfer of solar energy (via high voltage DC transmission lines) – swap knowledge, education and S&T versus energy ("in-kind contribution)



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# SESAME

- SESAME – “Synchrotron-Light for Experimental Science and Applications in the Middle East” in Jordan
- developed under UNESCO auspices and modeled after CERN governance, nine member states
- state-of-the-art third generation synchrotron source - to be operational in 2015
- BESSY I – as donation from Germany - serves as 800 MeV Booster
- it will significantly strengthen fundamental research in the region with application in physics, material science, chemistry, life sciences, …
- first three planned beamlines
  - protein crystallography
  - X-Ray absorption Fine Structure / X-Ray Flourescence Spectroscopy
  - IR Beamline

“a quintessential science for peace project” (UNESCO)

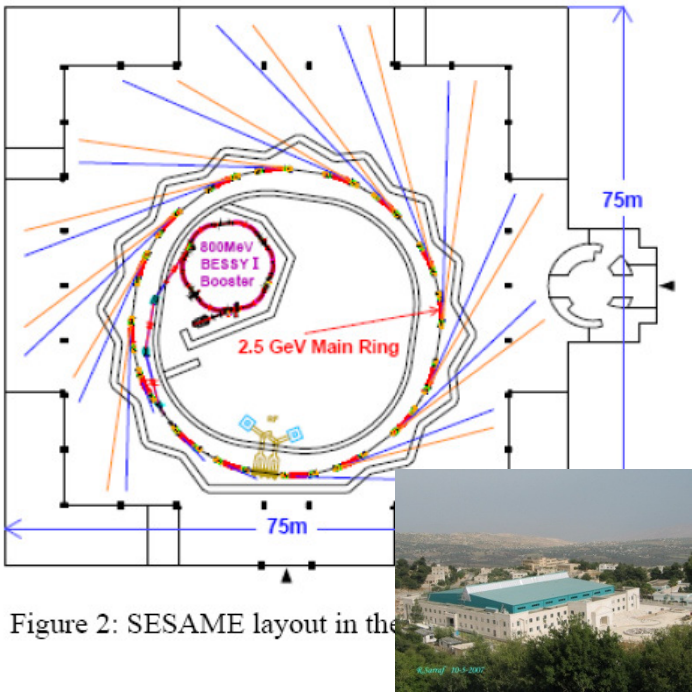


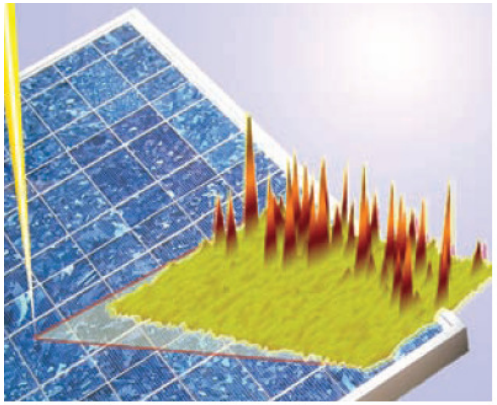

Figure 2: SESAME layout in the

Table 1: SESAME design parameters.

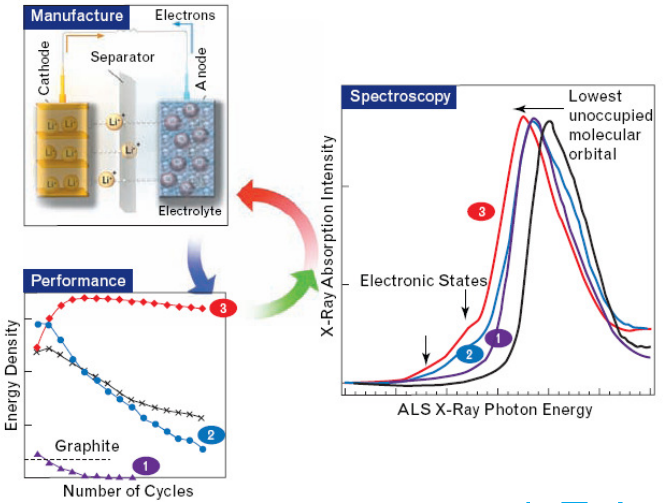
| | |
|---|---|
| Energy (GeV) | 2.5 |
| Circumference (m) | 133.12 |
| N. of Periods | 8 |
| Dipole field (T) | 1.455 |
| Dipole field index | 11 |
| $Q_x$ - $Q_z$ | 7.23 – 6.19 |
| Mom. Compaction | 0.00829 |
| N. Emitt.(nm.rad) | 26.0 |
| $U_0$ (keV/turn) | 589.7 |
| $\tau_\varepsilon$, $\tau_x$, $\tau_z$ (ms) | 2.80, 2.28, 3.77 |
| RF freq. (MHz) | 499.564 |
| Harmonic Number | 222 |
| Peak Voltage(MV) | 2.4 |
| Synch. Freq. (kHz) | 37.18 |
| $\sigma_L$ (cm) | 1.15 |
| Current (mA) | 400 |
| N. of bunches | 200 |
| 1/e Lifetime(hrs) | 16.9 |

# Research Renewable Energy and Synchrotron Sources

- Synchrotron Radiation Sources have unique analytical potential for R&D on renewable energies
- Photovoltaics
  - e.g. Metal impurities in solar cells – X-Ray flourescence spectroscopy
- Fuel cells
  - In-situ determination of local electro-chemical potentials at electrodes, catalysts
- Energy Storage / Batteries
  - Charge/Discharge Processes in Li-Polymer Batteries
- …
- In general functional structures/materials at nanoscale

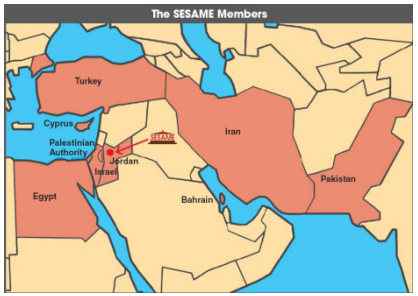


Artist's depiction of an intense beam of synchrotron light striking a solar cell and the resulting fluorescence image of the distribution of iron impurities. Courtesy of T. Buonassisi (MIT). [Buonassisi et al., *Nat. Mater.* **4**, 676 (2005) ; Buonassisi et al., *Appl. Phys. Lett.* **89**, 042102 (2006); Buonassisi et al., *Acta Mater.* **55**, 6119 (2007).]



# SESAME as anchor point

- Deployment of Solar Energy in MENA and export to Europe requires cross-border collaboration and capacity building
- SESAME serves as a symbol for international collaboration uniting scientists from all over the region, including Middle Eastern nations and Israel. Iran sits next to Israel in Council.
- A joint science/energy collaboration with SESAME could be a perfect showcase to foster MENA solar energy R&D, production and exportation
  - foster renewable energy research at SESAME - collaboration/community and capacity building
  - Build a flagship solar energy plant connected to SESAME under international patronage (UNESCO, …)
  - as reference, demonstrate all key features of energy production and cross-border transfer that is necessary for the “energy from the desert” concept



# Symposium Solar Energy for Science – 19/20 May 2011
# DESY - Hamburg

- Organizers:
  - DESY, Prof. Dr. Helmut Dosch
  - German Aerospace Center DLR, Prof. Dr. Robert Pitz-Paal
  - in cooperation with Egyptian Academy of Scientific Research, Prof. Dr. Maged El-Sherbiny and SESAME, Prof. Dr. Khaled Toukan
- Patronage: UNESCO
- Chairman of Advisory Board: Klaus Töpfer
- Topics
  - Climate Change, Renewable Energy and Societal and Developmental Challenges
  - Science, Sustainability and Responsibility
  - Solar Energy Projects in MENA and around the world
  - Bridging Solar Energy from MENA to Europe
  - Scientific & Educational Projects in MENA as Anchor Points for Collaboration and Capacity Building
  - Towards a Science / Energy Partnership

DLR DESY SOLAR ENERGY FOR SCIENCE

SESAME ASRT

BUILDING BRIDGES

SYMPOSIUM
19/20 MAY 2011
DESY HAMBURG
GERMANY
www.solar4science.de

UNESCO United Nations Educational, Scientific and Cultural Organization
With the support of Natural Sciences Sector

ZEIT-Stiftung Ebelin und Gerd Bucerius

http://www.solar4science.de



DESY

# Objectives of Symposium

SOLAR ENERGY FOR SCIENCE

> raising awareness of the importance of renewable energies in MENA in view of global challenges

> emphasizing science and scientific cooperation between Europe and MENA as crucial driver for capacity building and as facilitator for a sustainable development

> developing a process to shape a future energy/science partnership

> promoting and formulating action plans for further activities

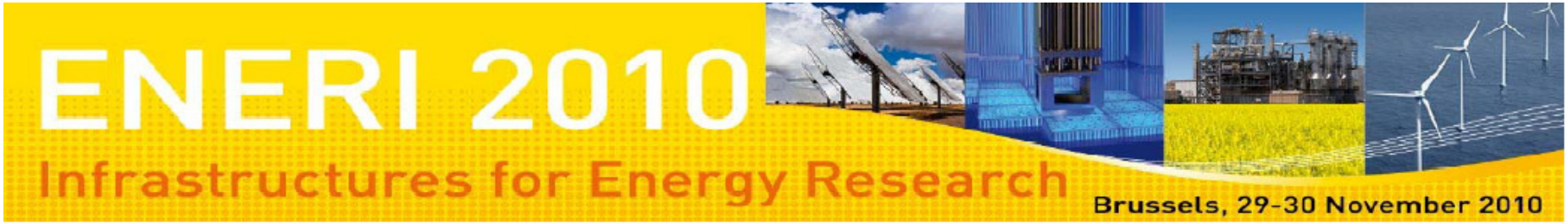
> receiving broad support from policy- and decision-makers

# Plan for a Technical workshop – winter 2011

- Proposal of a CSP pilot project that acts as showcase for „Solar Energy for Science“
  - 5-10 MW pre-commercial demonstrator solar power plant
  - Attractive for private and public partners from Europe and MENA and for mobilizing investments and funds on national and international levels
- ~50 Experts from research institutions, industry and authorities from Europe and MENA Involvement of private sector is highly desired
- Goal: Kick-Off Feasibility Study by 2012
- Provision of visible regional benefits and added value in terms of technology advancement, sustainability and international cooperation and coordination.
  - **Technology**: Innovative small plants are direly needed and are perceived as a step towards the further development of commercial plants. Demonstration of technology advancements and improvements as compared to existing plants with the goal to increase performance, flexibility, reliability.
  - **Sustainability:** Various sustainable criteria in terms of economic, social and environmental developments considered
  - **Cooperation and Coordination**: Reinforce cross-border cooperation and coordination in MENA and strengthen the scientific links between Europe and MENA to contribute to the Euro-Mediterranean Research and Innovation Area

Winter 2011 in Egypt or Jordan

# European Research Infrastructures




**Conclusions:**

4. Likewise, the use of the existing energy-intensive multi-purpose and basic science Research Infrastructures, including e-Infrastructures should be further explored and new energy-efficient ways of operation in performing research should be demonstrated.

**ERF Workshop on Energy Management at large RIs**

ERF European Association of National Research Facilities Open to International Access

- Energy efficiency and optimization
- Energy procurement, generation and supply strategies

13/14 October 2011 – DESY, Hamburg