

# Clean Power from Deserts – The DESERTEC Academic Initiative

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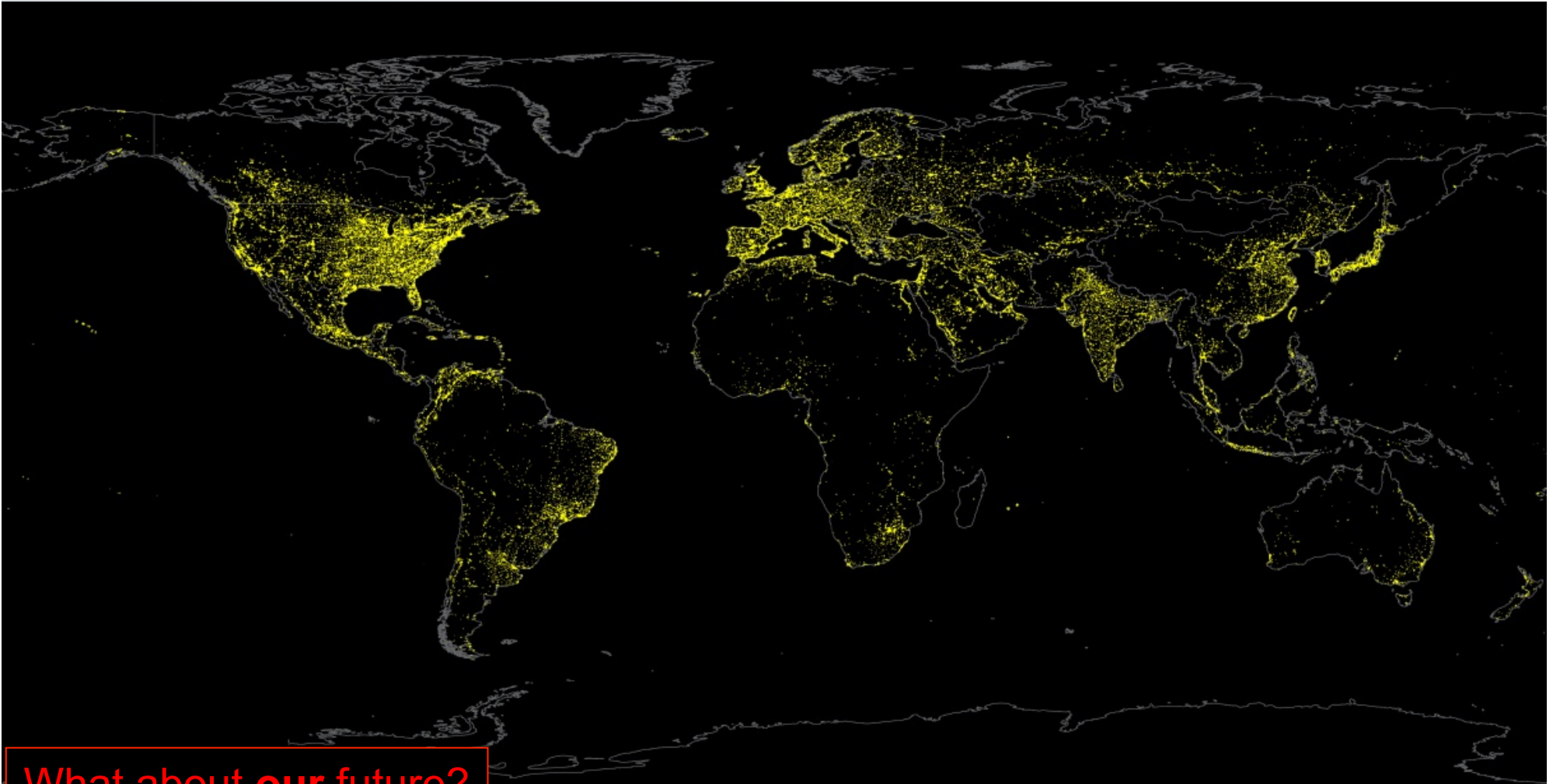
# Motivation



- Growing world population
  - Growing energy demand per capita
  - 2010: ~12 000 GW
  - 2060: ~37 000 GW ?
- (1 GW<sub>el</sub> = 1 nuclear power plant)

# Earth at night...

The world of the poor people is dark



What about **our** future?

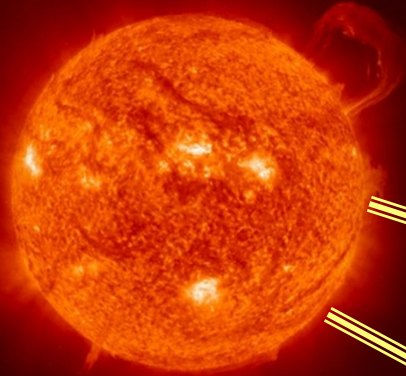
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16.03.11

 **DESERTEC**  
FOUNDATION



# We need to use nuclear fusion energy now!

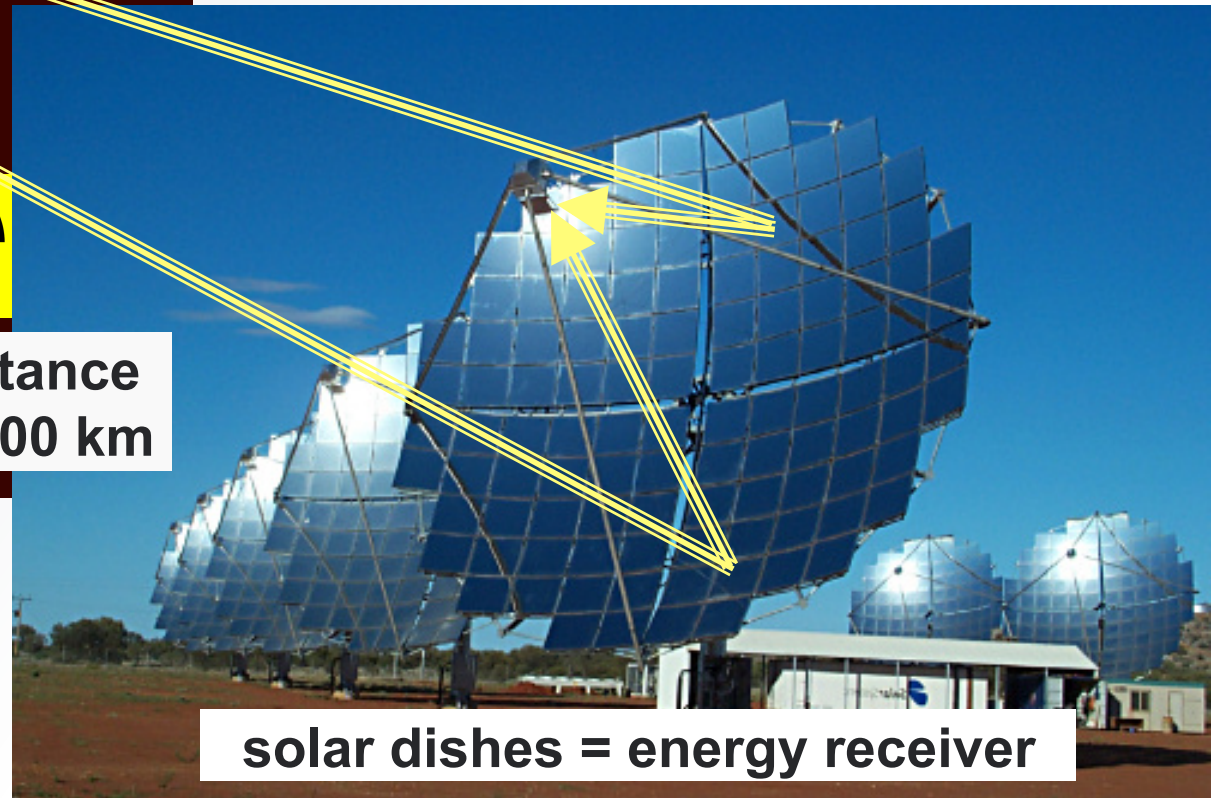
**Do not wait for ITER!**



**The sun is our  
fusion reactor**



**Safety distance  
150 000 000 km**



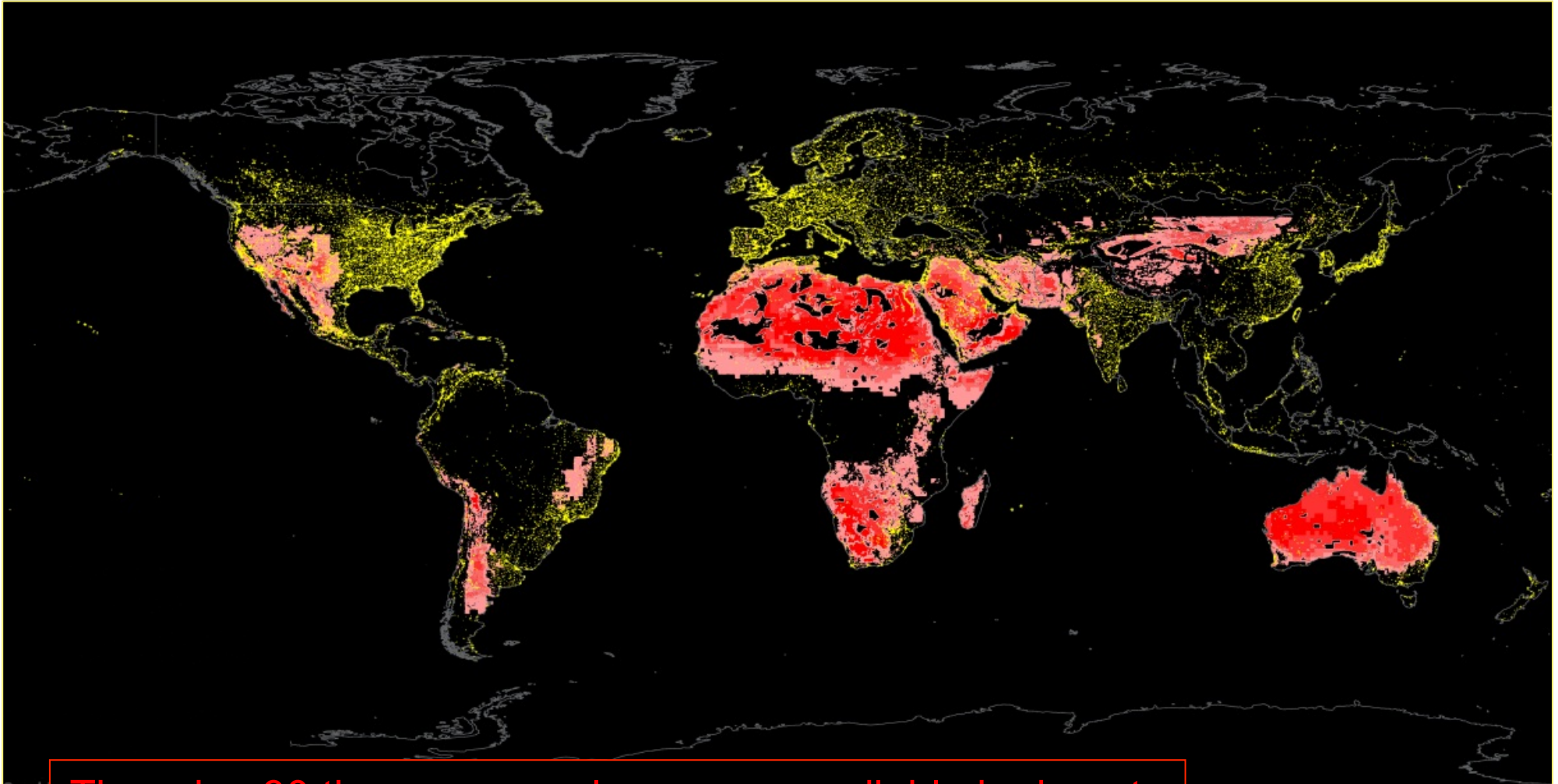
**solar dishes = energy receiver**



# There is abundant solar irradiation in deserts

Solar energy potential:  $\sim 340\,000\text{ GW}_{el}$

(all year average; day & night average, current technology, 4.5% land use factor)



Graph  
Based

There is  $\sim 30$  times more solar energy available in deserts than needed to solve all energy problems on earth

# Concentrating Solar Thermal Power (CSP): In commercial use for more than 20 years

Kramer Junction (USA), operating since 1990





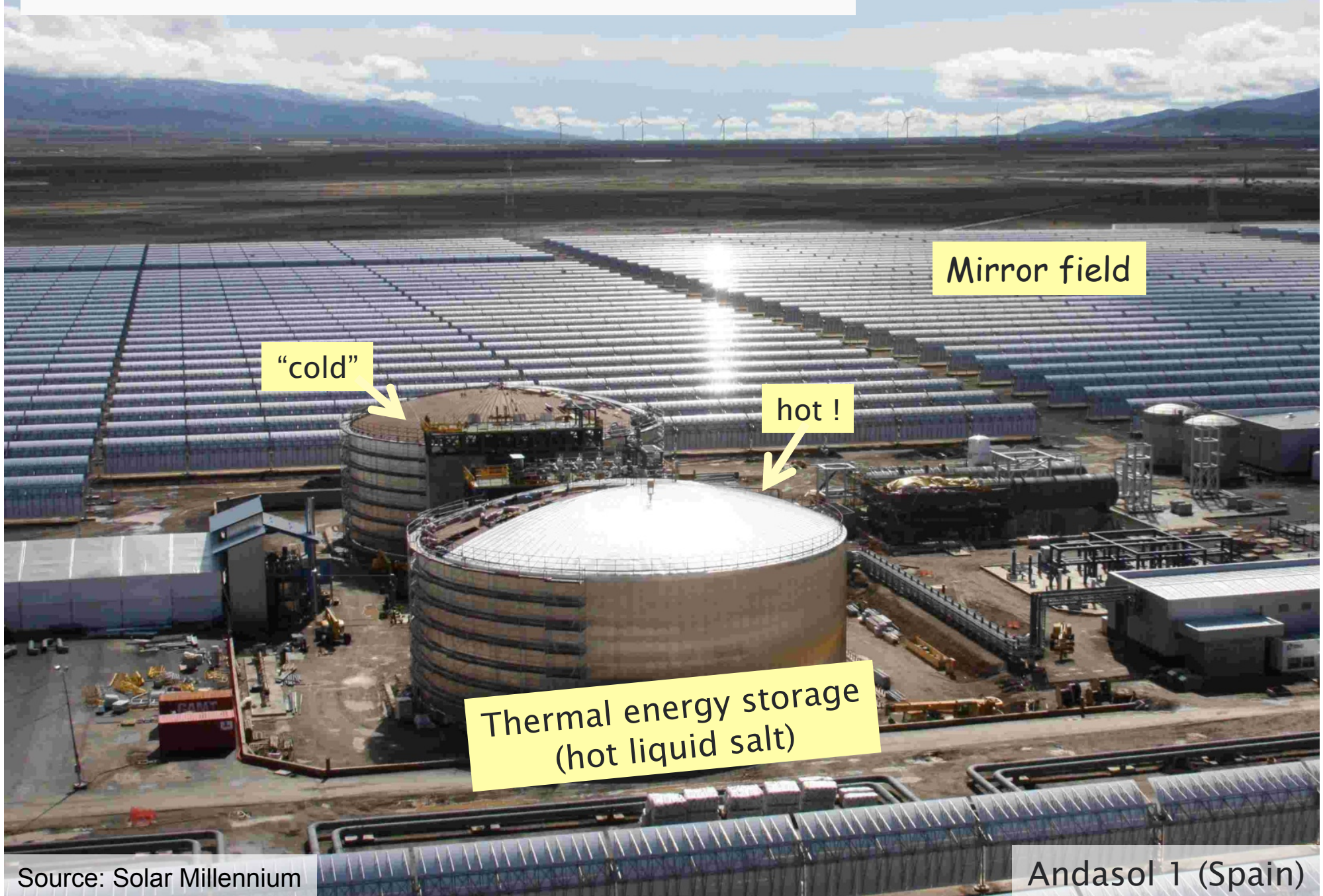


**Lunar Power at night?**

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# Solar power day and night (2009)



Mirror field

“cold”

hot !

Thermal energy storage  
(hot liquid salt)

# How to bring the power to the people?



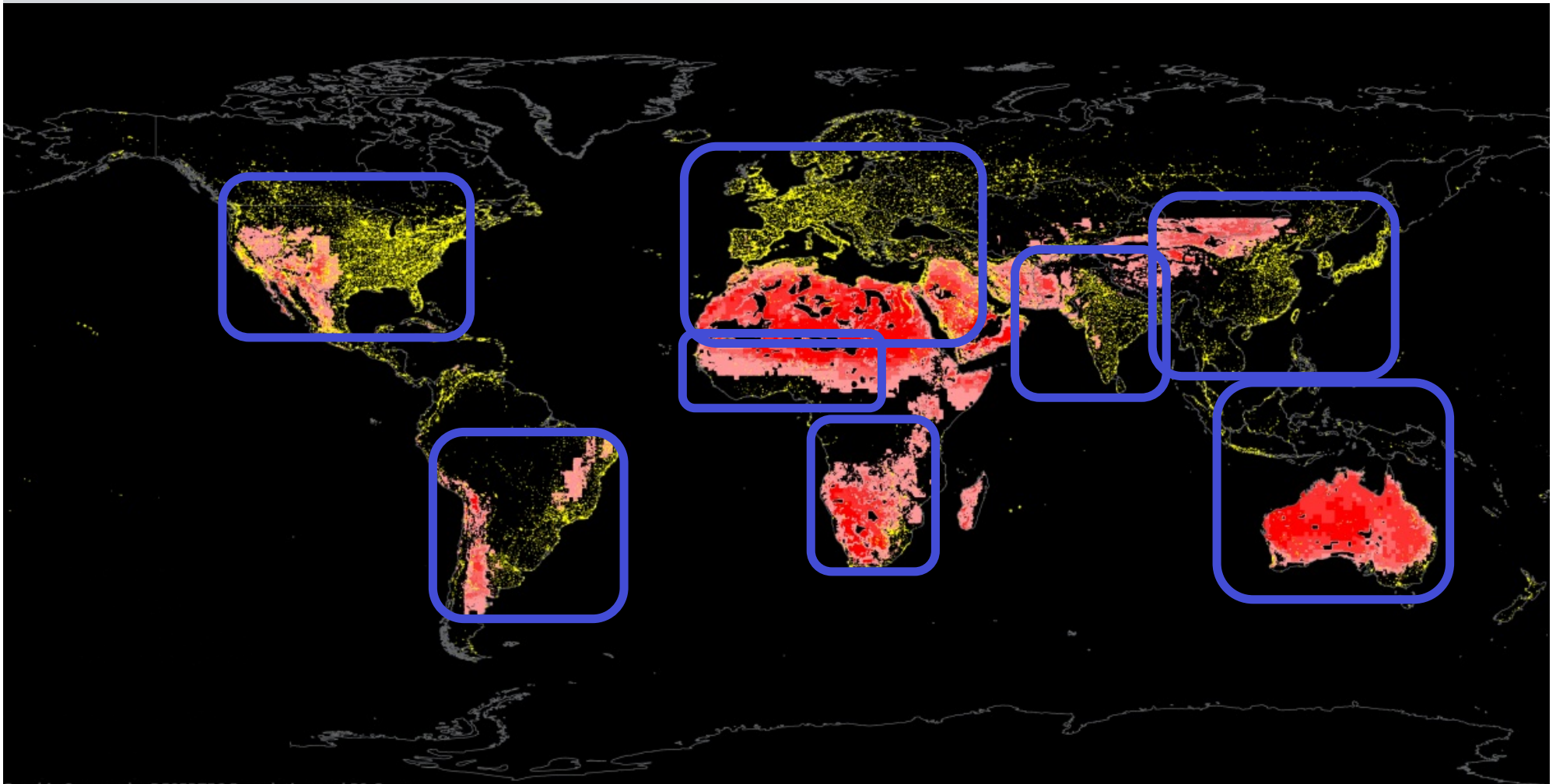
- By cable!
- High voltage ( $\sim 900$  kV)
- Direct current (+/-)
- Power loss  $\sim 10\%$  over 3000 km



# The DESERTEC concept: world wide solutions

90% of the world population lives within 3000 km from deserts

Special regions of interest:



Graphic Concept by DESERTEC Foundation and P3 Group  
Based on Data from NASA and German Aerospace Center (DLR)

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# Why CSP?

## What about photovoltaic and wind power?

- Wind power is cheaper than PV, but it fluctuates.
- PV is (currently) cheaper than CSP, but there is no PV-power at night.
- Only CSP can provide solar power day and night (@GigaWatt scale). That is the reason why CSP is of special importance in a global DESERTEC concept.
- Nevertheless, we need a **mix of all renewable energy sources**



# Centralized or decentralised energy supply? Local power supply or smart super grids?

## Case A: Rural area in Namibia.

1 inhabitant per km<sup>2</sup>

- Forget about long power lines!
- Use PV panels or dish sterling engines in small villages (or wind, biomass etc.)



# Centralized or decentralised energy supply? Local power supply or smart super grids?

## Case B: Big city in Europe

- Forget about **100% local** renewable energy supply!
- A grid is **cheaper and less polluting** than any local electricity storage to compensate fluctuations of demand and of supply by solar or wind power





# Centralized or decentralised energy supply? Local power supply or smart super grids?

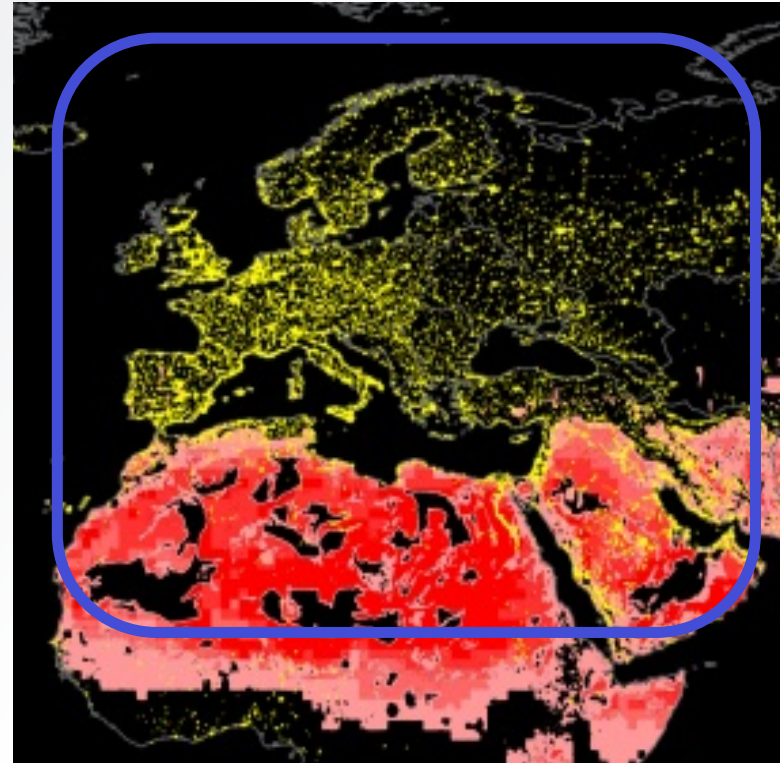


## Use your grid in an optimal way:

- to average out fluctuations of renewable energies (on a scale of 3000 km!)
- to adjust the power consumption to the actual power production  
e.g. by tariffs that allow to switch off certain consumers at peak times  
(today it is done usually in the opposite way only)

# Europe and MENA: a special situation

- Europe:
  - large power demand
  - large potential of fluctuating off-shore wind power
  - know-how in solar technology
- MENA (Middle East and North Africa):
  - rapidly increasing demand for power and for water desalination
  - huge potential of solar and wind power



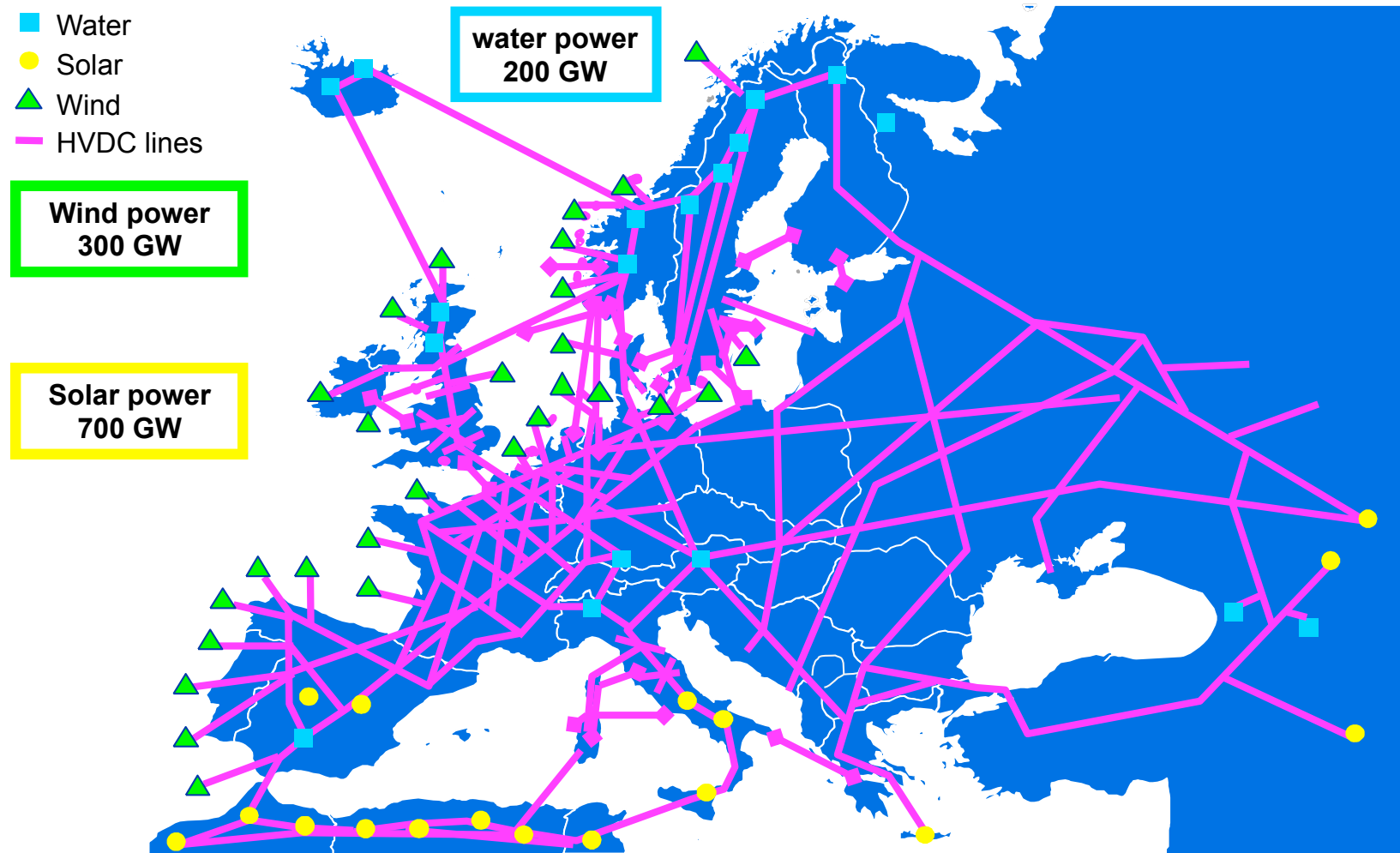
# DESERTEC: Producing clean electricity where it is physically and economically most viable





# Europe needs a strong HVDC net

for stabilization and to **average out fluctuations** of renewable sources



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(example)





# Europe and Africa: a special situation



Tunisia, 2011



Spain, 2008



JUSTUS-LIEBIG-  
UNIVERSITÄT  
GIESSEN



Border Europe-Africa



# Europe and MENA: a special situation

- Europe needs:
  - a secure energy supply

Even more important:

- a secure neighbourhood



- Africa needs
  - Energy and water
  - Jobs
  - Perspectives



# The energy revolution begins....

2009: DESERTEC industrial initiative

It's about connecting people,  
cultures and continents.



*It is not only about energy!*



**Dii**

Renewable energy  
bridging continents

# Industry initiative Dii GmbH: Enabling DESERTEC in EU-MENA

- Initiated by the DESERTEC Foundation and Munich Re
- Founded in October 2009
- Objectives until 2012:
  - Studies for a technical, economical and political and regulatory framework
  - Preparations for first reference projects
  - Long-term roll-out plan for DESERTEC in EU-MENA





# Industry initiative Dii GmbH:

1 + 16 voting shareholders

## Non-profit foundation



## Companies from industry and financial sector



## Joint venture



# Industry initiative Dii GmbH:

24 associated partners





# The energy revolution begins....

2010: France takes initiative as well: TRANSGREEN





# D.U.N. DESERTEC University Network

Oct. 2010

- An international academic research and innovation network of *institutions* (not countries!)
- Contributing to the implementation of the DESERTEC concept by
  - Exploiting synergies among the institutions (public & private, North & South)
  - Developing Human Resources in the Desert Countries (Education, R & D), spreading the relevant knowledge
  - Maximising the “local content” of DESERTEC energy systems
  - Extend the DESERTEC Studies to the other desert regions





# D.U.N. DESERTEC University Network

## 19 founding members:

DESERTEC Foundation, Hamburg

Cairo University, Giza

University of Jordan, Amman

Centre de Recherches et des Technologies de l'Energie,  
Borj-Cedria

Ecole Nationale d'Ingénieurs de Tunis, Université Tunis-El-  
Manar

USTO (Université des Science et des Technologies  
d'Oran), Oran

UDES (Unité de Développement des Équipements  
Solaires), Algiers

Ecole Nationale de l'Industrie Minérale, Agdal, Rabat

Ecole Nationale Supérieure d'Electricité et de Mécanique  
(ENSEM-UH2C), Casablanca

CNRST (Centre National pour la Recherche Scientifique et  
Technique), Rabat

Al-Fateh University, Tripoli

National Authority for Scientific Research, Tripoli

Center for Solar Energy Research and Studies (CSERS),  
Tripoli

Sebha University, Sebha

Ecole Nationale d'Ingenieurs de Monastir, Université de  
Monastir

Université de Gafsa, Gafsa

German University in Cairo, New Cairo City

University of Alexandria, Alexandria

Jordan University of Science & Technology, Irbid

## ■ Additional members are welcome!



 [English](#)

 [Deutsch](#)

 [Français](#)



# SolarBridge<sup>e</sup>



... comme nous formons  
le monde de nos enfants

## SolarBridge - un pont entre l'Afrique et l'Europe

- [Les buts de SolarBridge](#)
- [L'énergie solaire pour les débutants](#)
- [Une devinette SolarBridge](#) (en allemand)
- [Une conférence avec des étudiants de l'Afrique du Nord](#)
- [Des réchauds solaires pour le Bangladesh](#) (en allemand)
- [A contacter](#) <http://www.physik.uni-giessen.de/dueren/solarbridge/>

The AKE (Arbeitskreis Energie der DPG) is involved since many years

A first conference with African students was organized in 2000

SolarBridge webpage in the year 2000:  
Basic concept described in 3 languages

# BUILDING BRIDGES

An initiative by



## SOLAR ENERGY FOR SCIENCE

A joint energy/science partnership between Europe and MENA to promote sustainable development in view of global challenges.

### Topics

Climate Change, Renewable Energy and Societal and Developmental Challenges

Science, Sustainability and Global Responsibility

Solar Energy Projects in MENA and elsewhere

Bridging Solar Energy from MENA to Europe

Scientific and Educational Projects with MENA: Anchor Points for Collaboration and Capacity Building

Round Table:  
Towards a Science/Energy Partnership

### International Advisory Board

Chair: Prof. Dr. Dr. h.c. mult. Klaus Töpfer,  
Executive Director of the Institute for  
Advanced Sustainability Studies,  
former Director UNEP

### Organisers

Deutsches Elektronen-Synchrotron DESY  
[www.desy.de](http://www.desy.de)

German Aerospace Center DLR,  
Institute of Technical Thermodynamics,  
Solar Research  
[www.dlr.de](http://www.dlr.de)

### Contact

Solar Energy for Science Secretariat  
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Phone: +49 40 8998 5613  
Fax: +49 40 8998 4304

## SYMPOSIUM 19/20 MAY 2011 DESY HAMBURG GERMANY

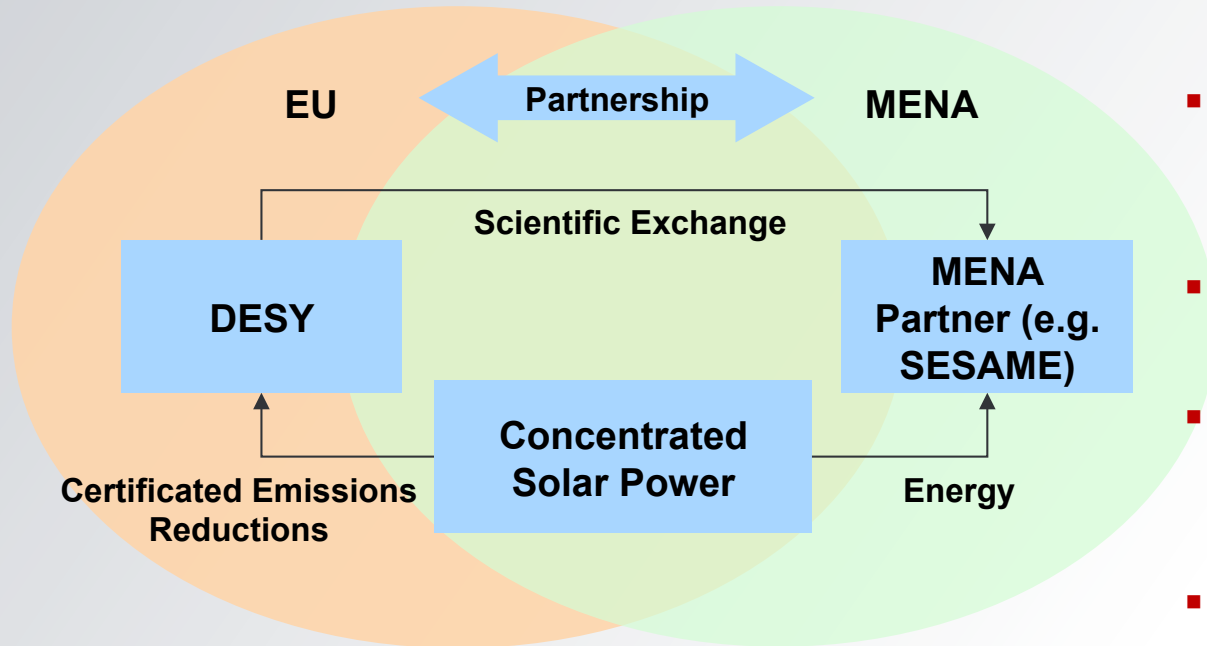
[www.solar4science.de](http://www.solar4science.de)

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# Solar Energy for Science – Model for linked scientific and energy supply cooperation



- High demand for energy to operate DESY research facilities
- Goal: Sustainable energy supply
- Short-term: Indirect transfer of energy through CERs
- Outlook: Direct transmission of Concentrated Solar Power (CSP)

- > CSP located in MENA
- > scientific exchange as an incentive for MENA
- > CSP energy supply of MENA research facility (e.g. SESAME)

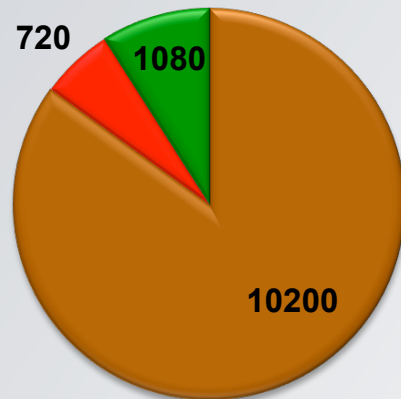


# SEPA - solar energy partnership with Africa

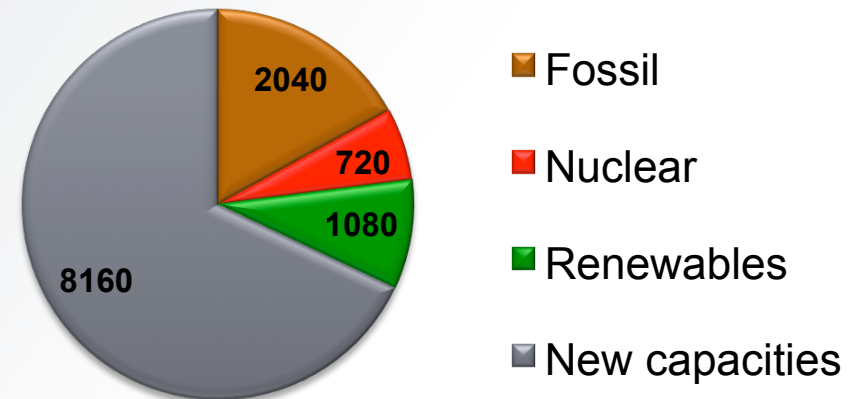
- interdisciplinary research group at Univ. Giessen
- International workshops SEPA08, SEPA09, SEPA10 in Giessen
- DAAD international summer school:  
**Use of Solar Energy as Contribution to a Sustainable Development**  
(all developing countries, not only Africa)  
May 30 - June 07, 2011 in Giessen
- SEPA11: Sept. 2011 in Namibia
- SEPA12: in Senegal

# Mission impossible...

World Power 2011  
(in GW)



World Power 2060?  
80% reduction of fossil (in GW)



(all numbers are approximate)

**The equivalent of 33 000  
additional nuclear reactors  
is needed within 50 years!**



# Mission impossible...

- human resources are limited
  - > 300000 nuclear engineers needed if we go nuclear
- resources of material are limited
  - do we need rare earths in PV?
- time is too short
  - governments, legislation and industry are not prepared for an efficient, international restructuring of our world energy supply

# Research and development

Examples:

- **ITER fusion reactor:**  
16 billion €
- **Kalkar fast breeder reactor:**  
7 billion Mark (Germany 1972)
- **PBMR high temperature reactor:**  
1 billion € (South Africa only; Germany much more)
- **Solar power tower Jülich:**  
0.02 billion €



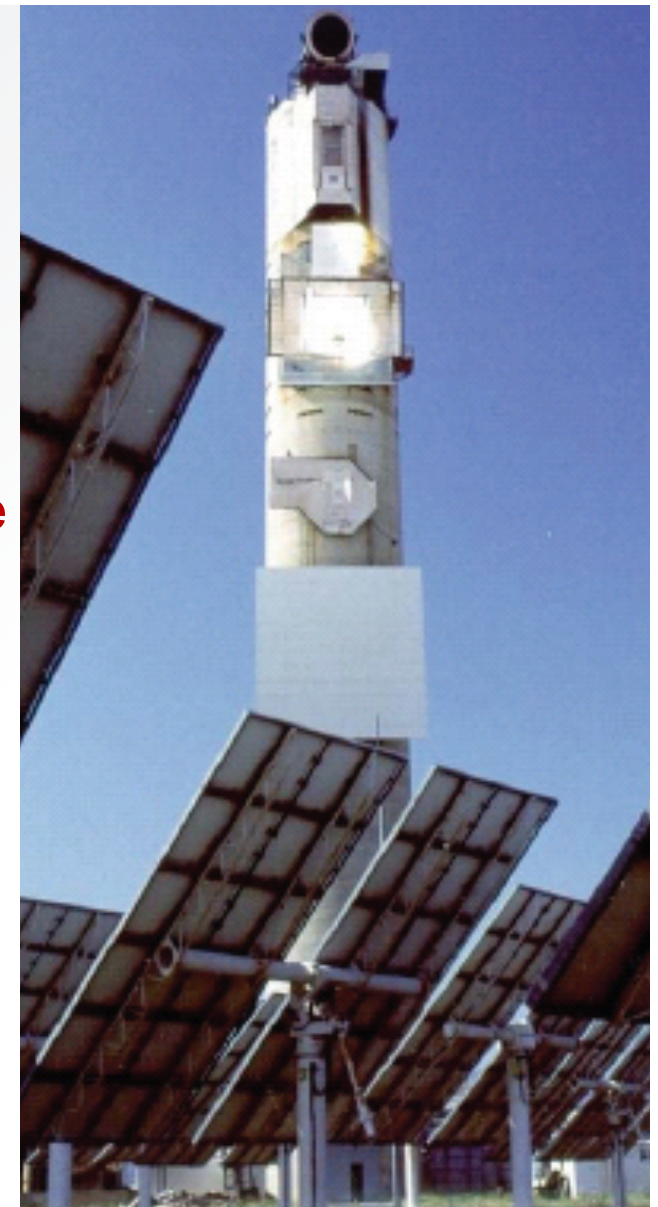
# Research and development

Urgent answers needed: How to build...

- ... large scale power plants with limited resources in man and material?
- ... efficient thermal heat storage @GigaWatt scale using e.g. sand as medium
- ... large scale water pump storage using e.g. Fjords in Scandinavia

For mobile application: How to produce ...

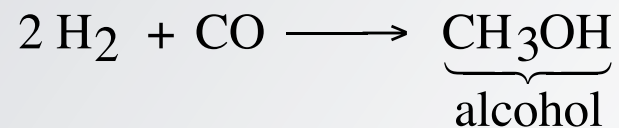
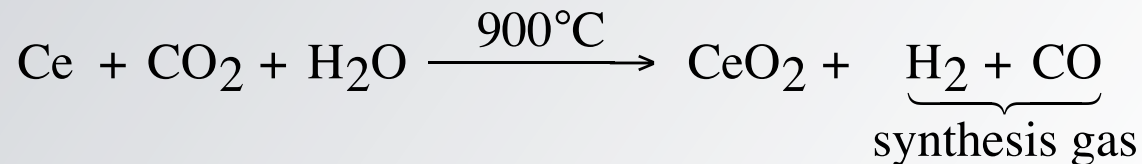
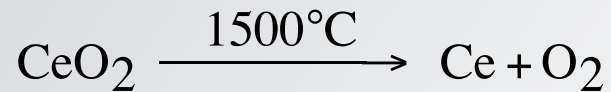
- ... synthetic fuels from catalytic reactions at high temperature using CSP (e.g. alcohol from CO<sub>2</sub>)





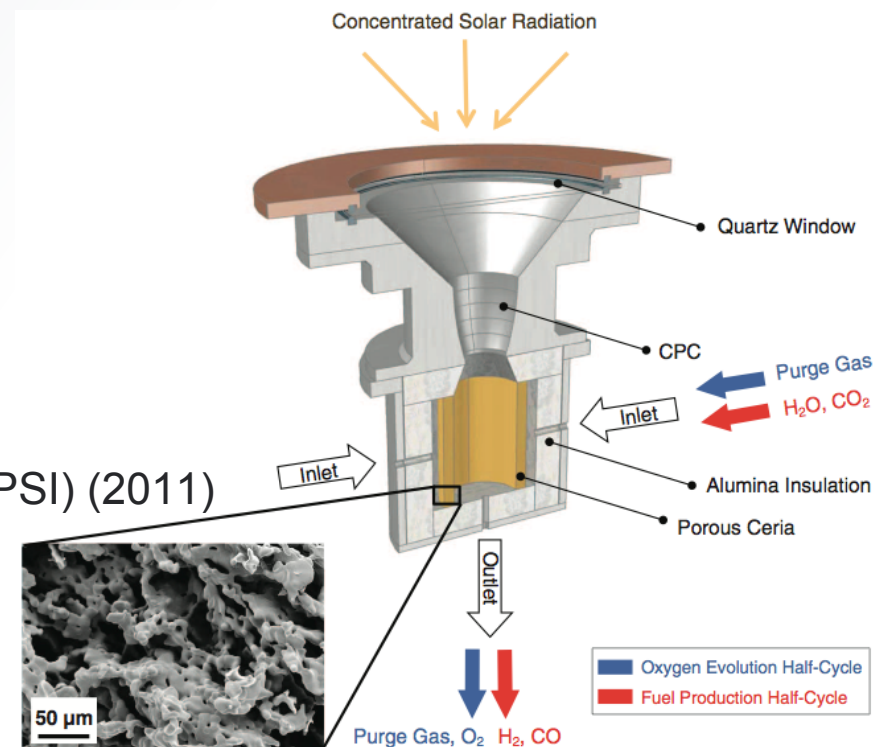
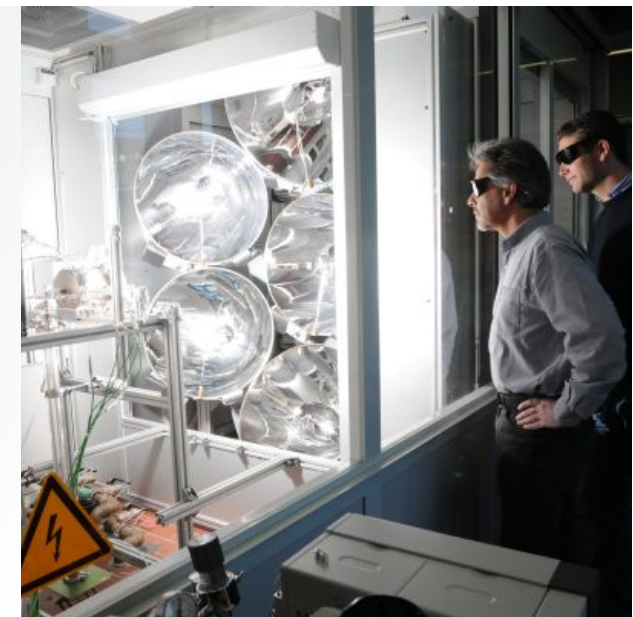
# Technological break-through: Sun + H<sub>2</sub>O + CO<sub>2</sub> = liquid fuel + O<sub>2</sub>

- Ceriumoxid is catalyser in CSP application



- 0.8% efficiency achieved
- 16-20% or more may be possible

Aldo Steinfeld ETH Zürich and Paul Scherrer Institut (PSI) (2011)

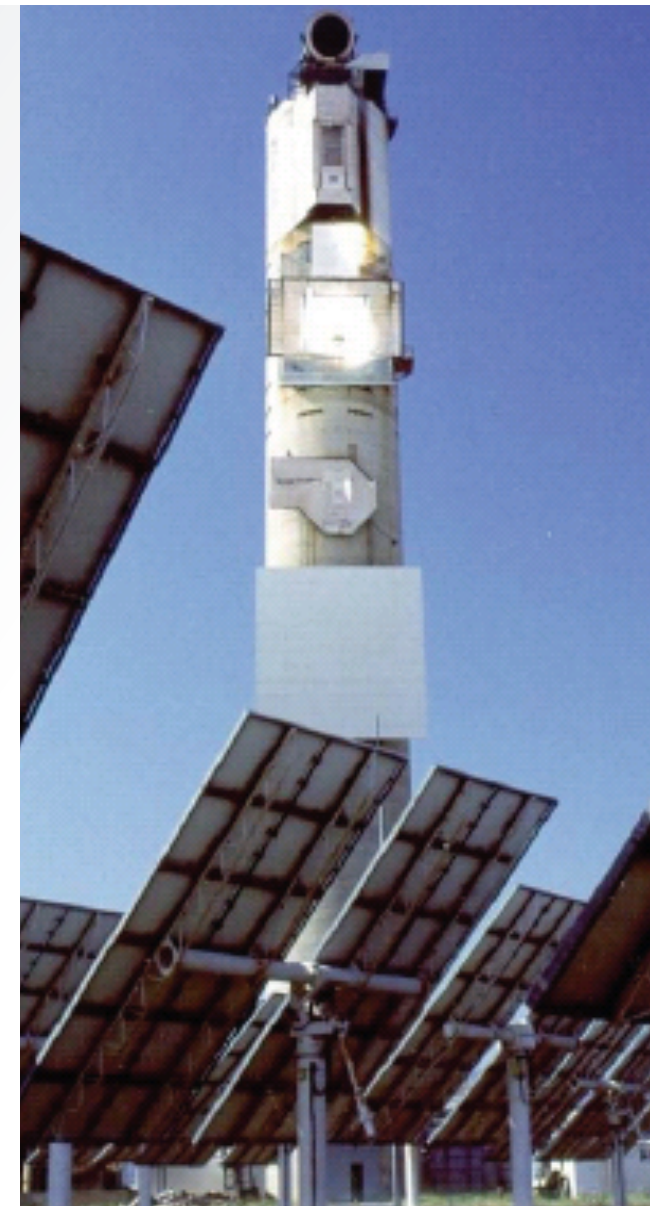


# Research and development

Urgent answers needed concerning

... funding, legislation, implementation, political acceptance, socio-economic transitions

How to convert our society in a stable and timely manner?



# CERN

is a prominent example of a research institute that is

- beyond commercial interest
- beyond political opportunism
- operated by scientists that are highly motivated and target-oriented
- operated internationally beyond national and cultural borders (Europe, US, Russia, China,...already at times of the cold war)
- funded by member states
- with an outcome that is at the limit of the doable: the LHC-Weltmaschine
- and a spin-off that changed our society: the world-wide-web





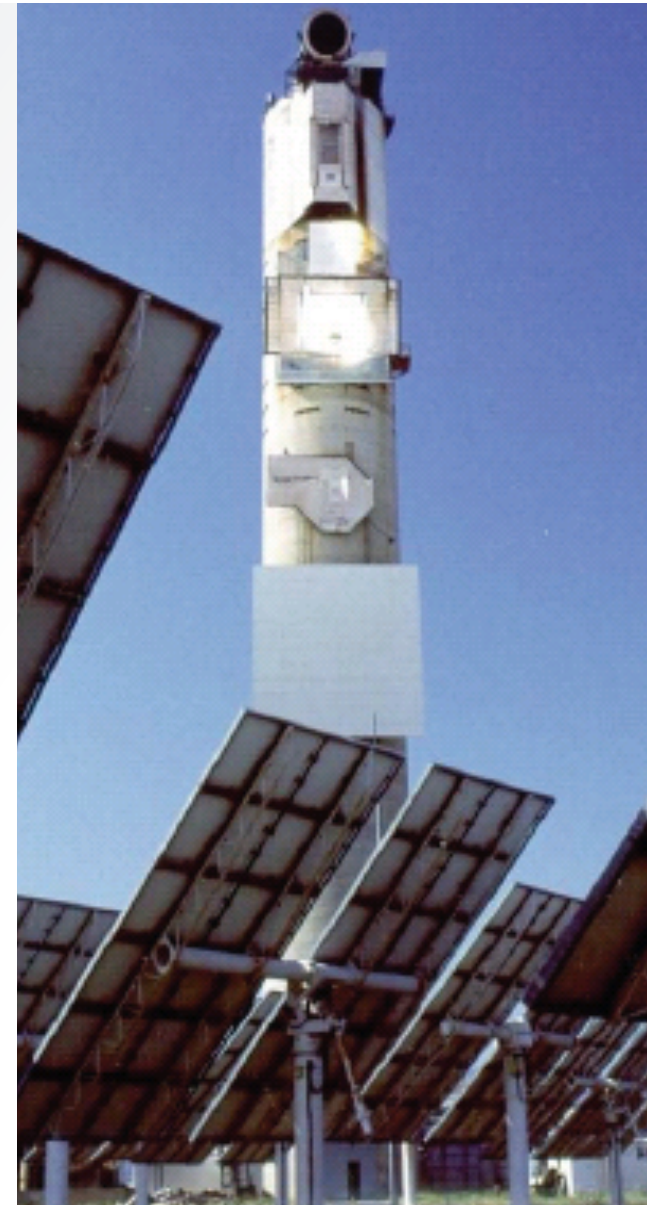
# Research and development

Urgent answers needed concerning

... funding, legislation, implementation, political acceptance, socio-economic transitions

How to convert our society in a stable and timely manner?

What about an international, transdisciplinary  
DESERTEC research centre  
to attack the urgent problem of the  
world energy supply?



# The right project at the right time



## References & acknowledgements

I have to thank many people and institutions for input and support, especially

- DESERTEC, DUN, Dii,
- AKE, SEPA, DESY, ...
- G. Knies, G. Luther, M. Miled, K. Richter, F. Trieb, O. Steinmetz, ...
- Google, Wikipedia, ...

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**The right project at the right time for Africa and Europe**

**... and for Japan and China**

**... and the rest of the world**

## Mittwoch, 17:30-18:00, 30 min, Talk

Time: Wednesday 17:30–19:15

### Invited Talk

AKE 12.1 Wed 17:30 BEY 118

**Clean Power from Deserts - The DESERTEC Academic Initiative** — •MICHAEL DÜREN — II. Phys. Inst., Univ. Giessen

The DESERTEC concept is simple and convincing: The abundance of solar radiation in the deserts of our planet exceeds by far the global energy demand. Using concentrating solar power plants with thermal storage, solar energy can be made available 24 h a day and can be used as a base load and to average out the fluctuations of other renewable energy sources like wind power. A large scale high voltage DC grid is required which connects the distributed sources of renewable energy with the distributed consumers on a scale of several thousand kilometres. Many large countries have their own deserts like USA, China, Australia and many others. A DESERTEC project as a joint venture of European and MENA (Middle East & North Africa) countries faces many political and legal challenges. However, the prospects of such a project for Europe are high. Not only electricity desalinated water and a lot of jobs will be generated, but more important such a project reduces the economical north-south gradient and generates a peace keeping political and economic interconnection between the EU and MENA. The DESERTEC Industrial Initiative (DII GmbH) was founded in 2009 to create a roll out plan for a possible European - MENA future project on a financial scale of about 400 billion Euros. A DESERTEC University Network was founded in 2010. An Academic Initiative is required to examine the options, prerequisites and implications of the DESERTEC concept from an interdisciplinary scientific point of view.