

CSP Development at EU level

Experiences and lessons learned from the research perspective

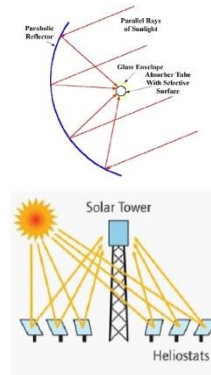
Peter Heller,
CSP Seville 2017
22.-23.11.2017

Knowledge for Tomorrow



Deployment of CSP

Oil Crisis 1973



Principle

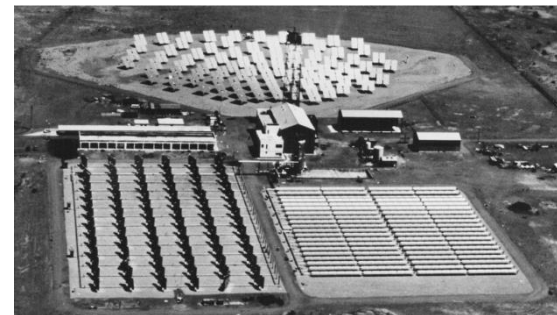


1889 Solar Printing Press

Vision



Uptake



1980 SSPS, Almeria, Spain

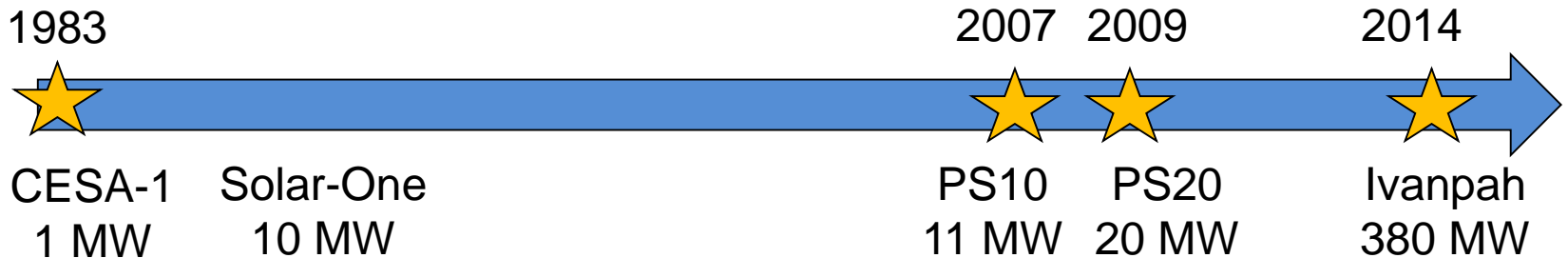


Research Facilities



Commercial Projects

Water/Steam Cycles in towers



Storage

0.5h
Steam
storage

1h
Steam
storage

Superheated



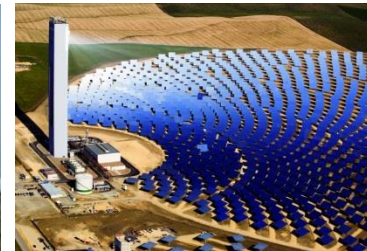
CESA-1n

Saturated



PS10

Superheated



PS20

Superheated

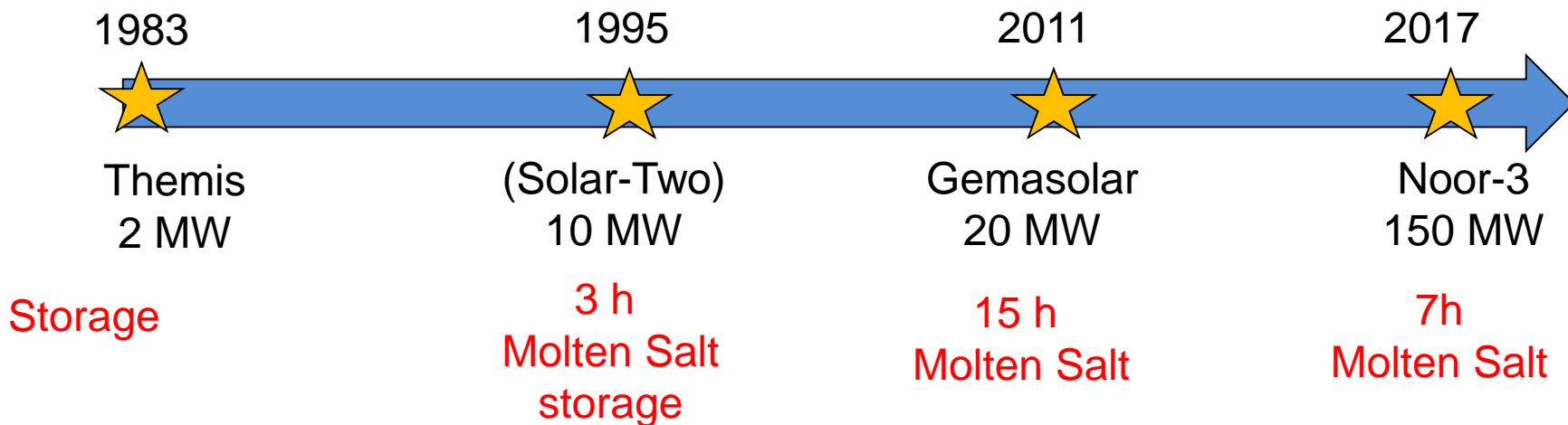


Ivanpah

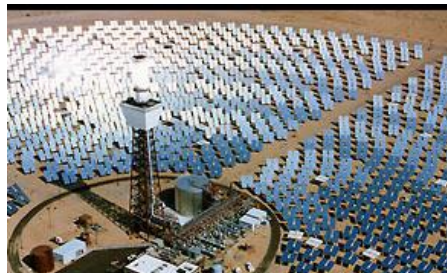


Commercial Projects

Molten Salt Cycles in towers



Themis



Solar-Two



Gemasolar

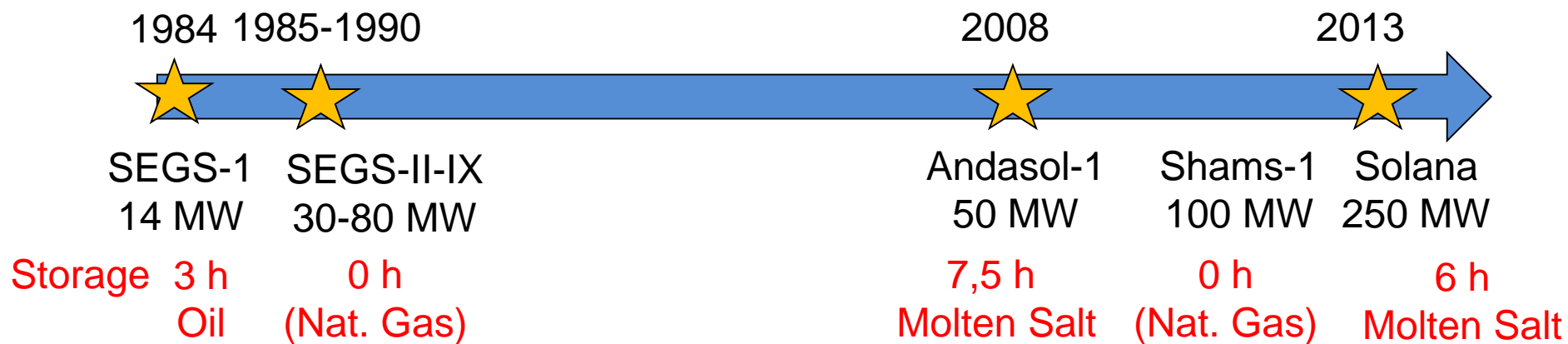


INOOR-3



Commercial Projects

Steam Cycles in parabolic troughs



SEGS-I-IX



Andasol-1



Solana



State of the Art Technology 2017

Solar Tower (Molten Salt)
Molten Salt Storage

Parabolic Trough (Thermal Oil)
Molten Salt Storage

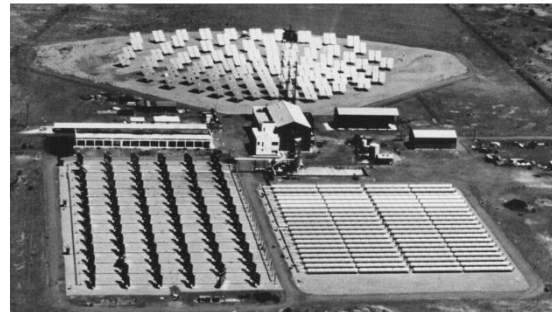


CSP with PV

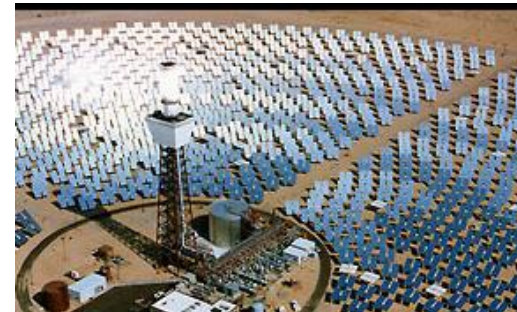


Based on R&D:

1975-1995
>20 years



SSPS, Almeria, Spain



Solar-Two



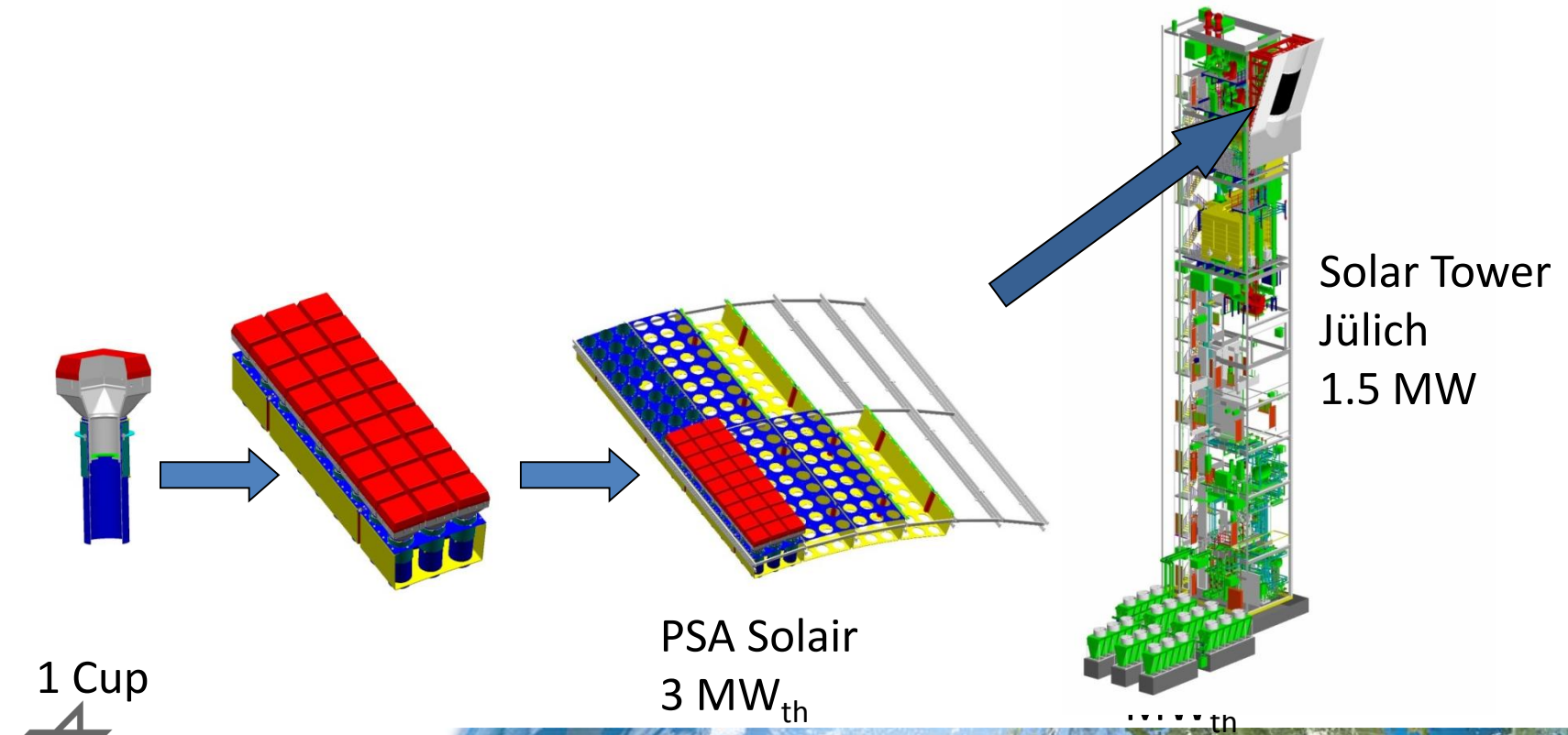
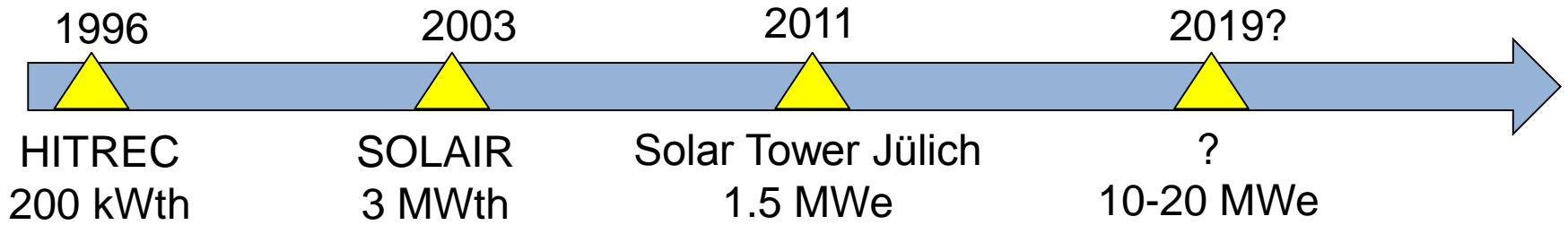
Cost Reduction



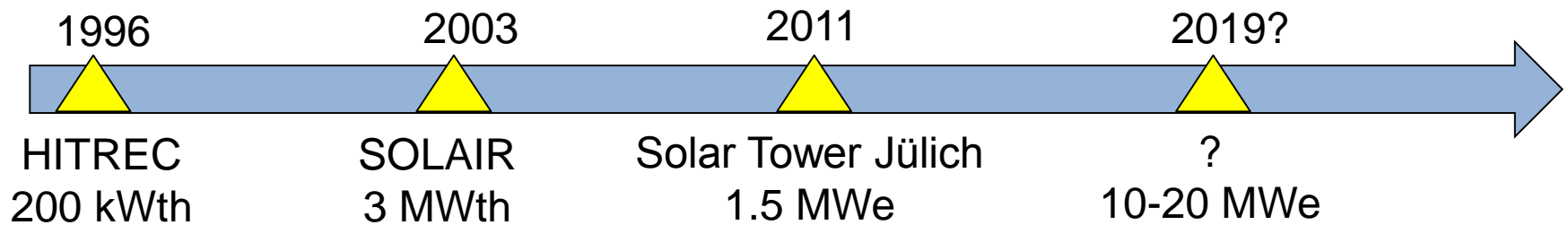
16.09.2017: DEWA awards AED14.2 billion largest CSP project in the world with a record bid of USD 7.3 cents per kW/h to generate 700MW



R&D Projects: Open Volumetric Air Receiver



R&D Projects: Open Volumetric Air Receiver



Why such slow advances:

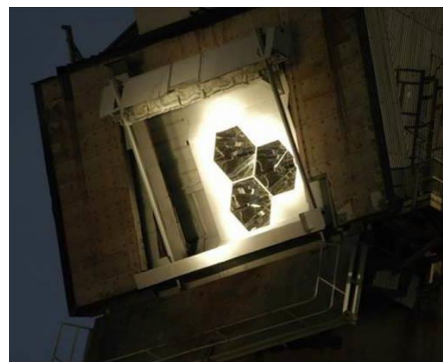
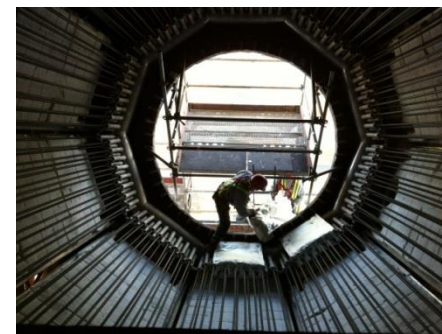
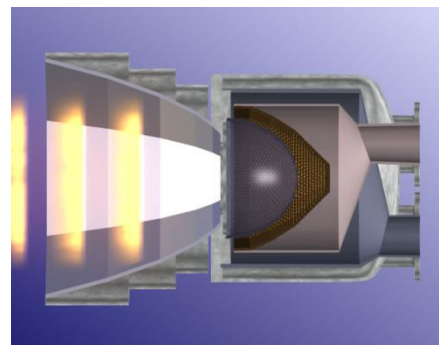
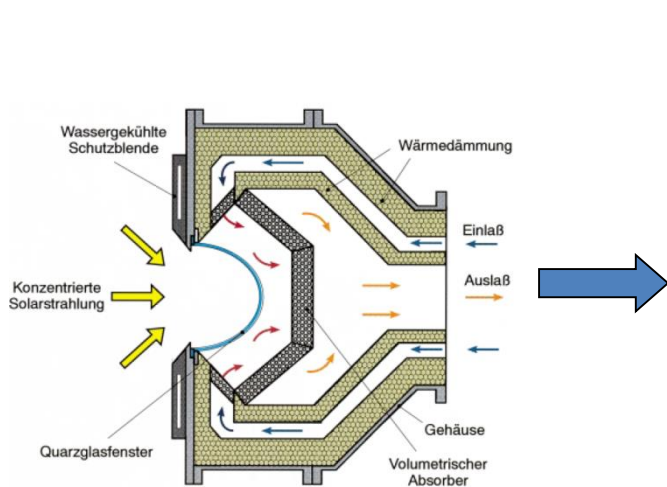
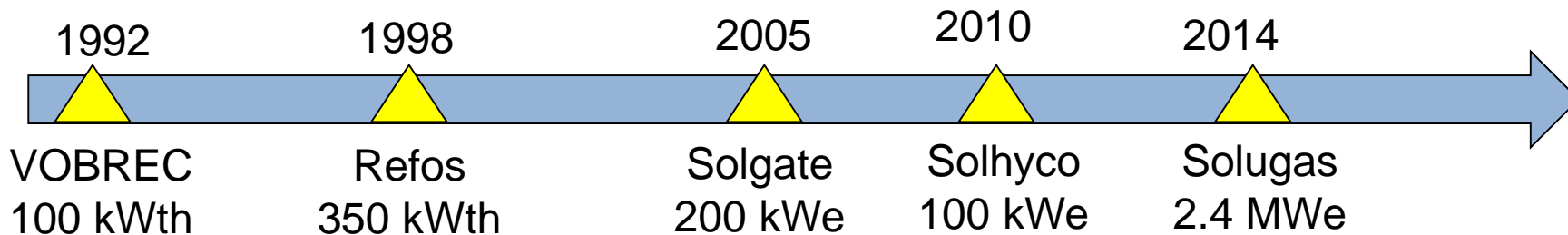
- no industrial interest 1996-2006
- several small R&D projects

Competitive with Molten Salt Towers?

Scalability given?



R&D Projects: Solar-Hybrid Gas Turbine System

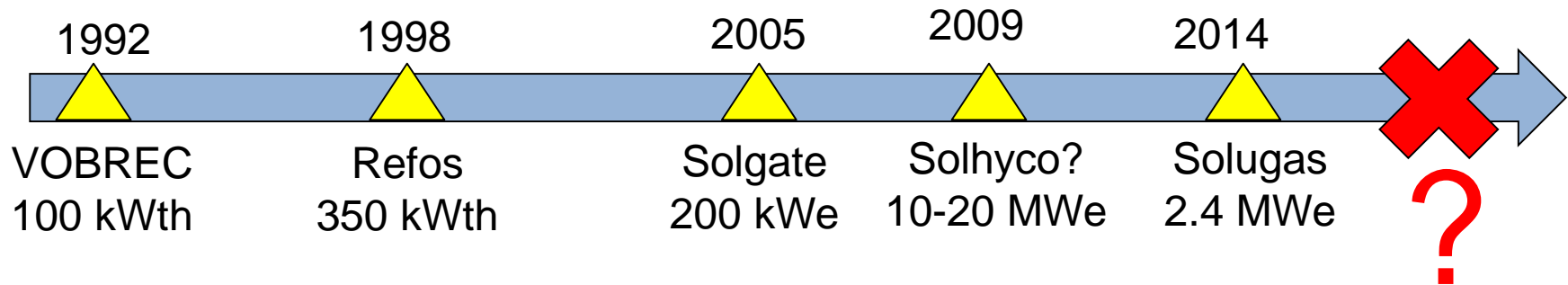


Refos/Solgate, Almeria

Solugas, Seville



R&D Projects: Solar Gas Turbine System



Receiver developments:

- volumetric pressurized ceramic receiver
- metallic tube receiver

Applications:

- solar hybrid gas turbine (GT or Combined Cycle)
- solar hybrid cogeneration (micro gas turbine)

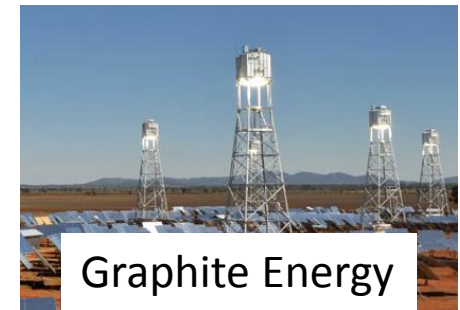
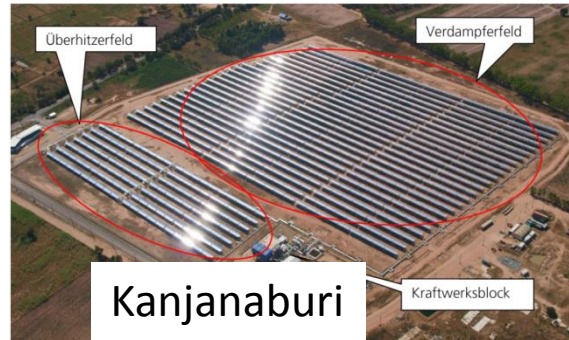
Expectations:

- hybrid (fossil-solar) not „en vogue“
- competitiveness unclear
- major investment necessary for next steps



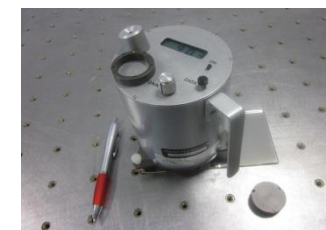
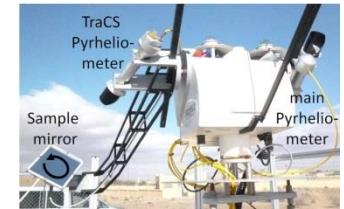
Others

- Direct Steam Generation
- Fresnel Systems
- Dish/Stirling
- Supercritical CO2
- Liquid Metal (Sodium, Lead, ...) or Graphite Receivers
- Particle Receiver



Further R&D and Services

- Project development
 - Meteo analysis: prediction of DNI, soiling, extinction,
- Operation:
 - Reduce water consumption
 - Predict DNI with forecast/nowcasting systems
 - Measure soiling rate, optimize cleaning
 - Monitor performance of solar field
 - Durability assessment
- Training and capacity building
 - reference course CSP
 - Training of personnel



Lessons learned

- Innovation speed >20 yrs
- Industry interest/support
- Continuity of development (support from funding agencies)
- Demonstration of new promising technologies
- Operation may be optimized
- Potential for further cost reduction



Thank you for your attention !

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