



INSTITUT FÜR  
ENERGIETECHNIK UND  
THERMODYNAMIK  
Institute for Energy Systems and Thermodynamics

# AUSTRIA – RESEARCH PERSPECTIVE: CSP research at Vienna University of Technology

Markus Haider

April 2011

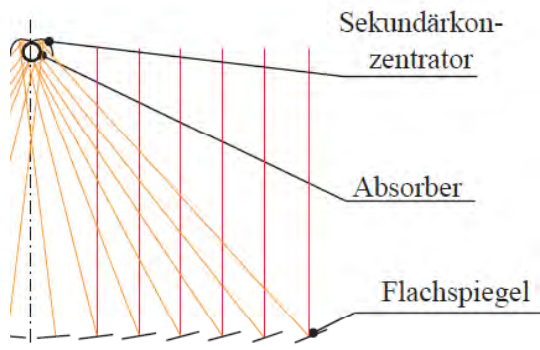
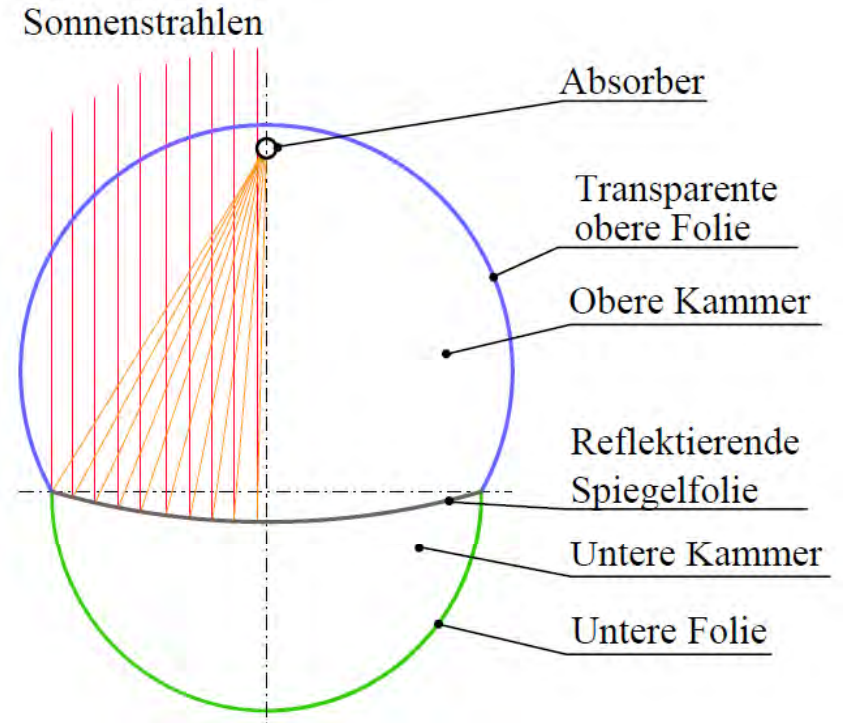
- (1) Optical, mechanical and thermal analysis of Pneumatic Pre-stressed Concentrators**
- (2) Design of Offshore Solar Systems**
- (3) High Temperature Energy Storage**
- (4) Thermally Assisted Photo-electro-chemical Water-splitting  
(SOLID OXIDE PHOTO-ELECTROCHEMICAL CELLS)**

## PPC – the third linear concentration technology

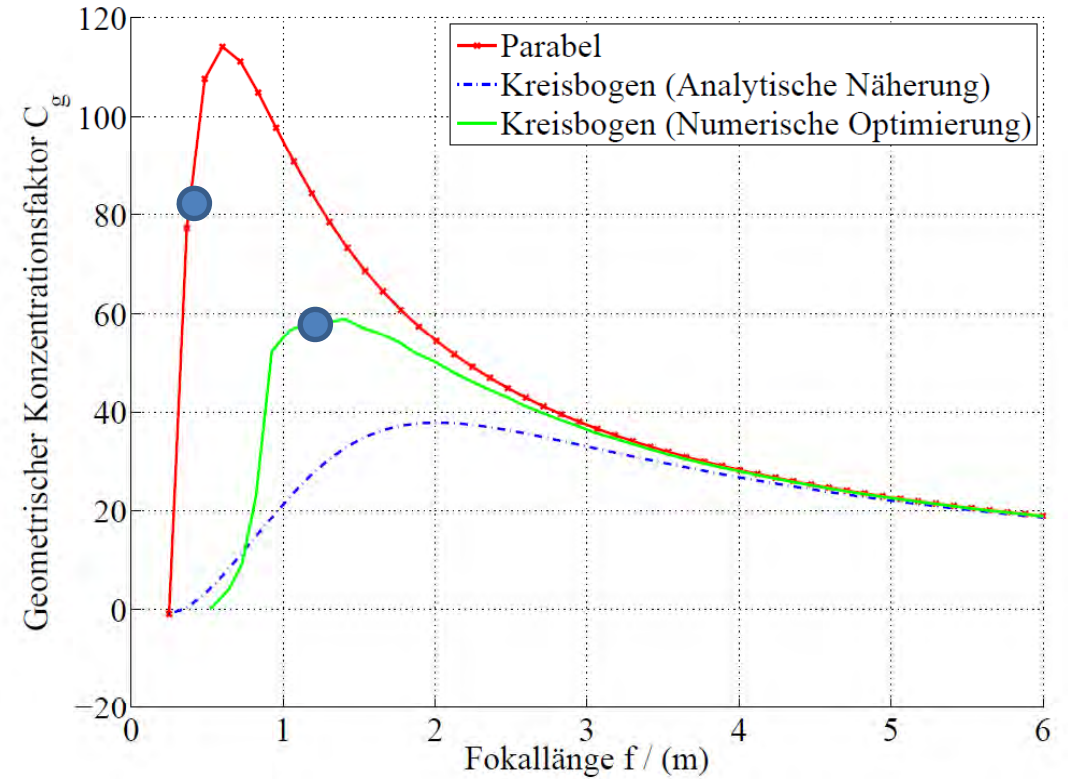
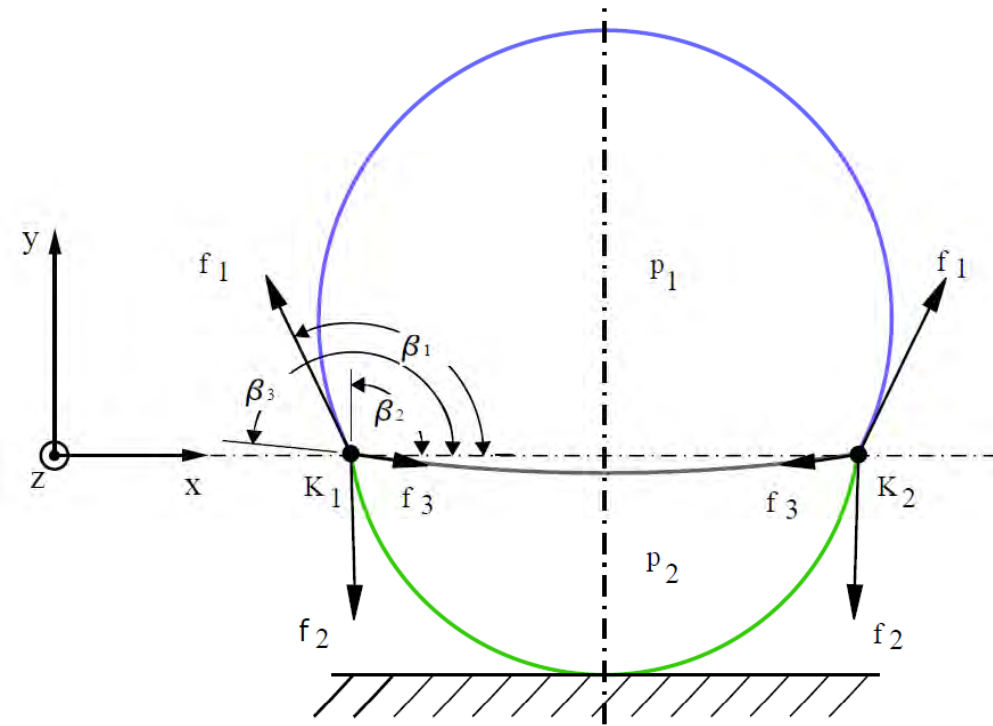


- Area Weight: ~28/130 kg/m<sup>2</sup>
- Geometric Concentration: ~83 suns
- Optical efficiency ( $\eta_{opt,0}$ ): ~77%

- Area Weight: ~16/XX kg/m<sup>2</sup>
- Geometric Concentration: ~60-65 suns
- Optical efficiency ( $\eta_{opt,0}$ ): ~61-70%



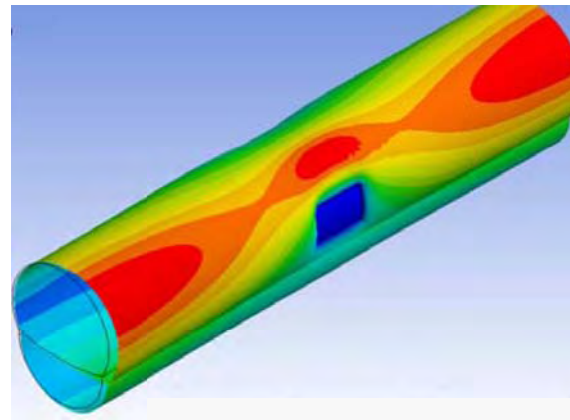
- Area Weight: ~**(5) – 13** /XX kg/m<sup>2</sup>
- Geometric Concentration: ~**58** / 116 suns
- Optical efficiency: ( $\eta_{opt,0}$ ): ~**67** %



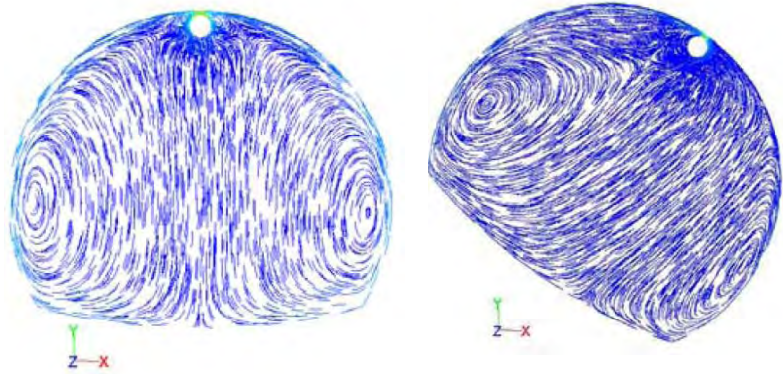
2-D- optical/mechanical models

2D-Analysis: Geometric concentration factor for Variable focal length at constant aperture width (1m)

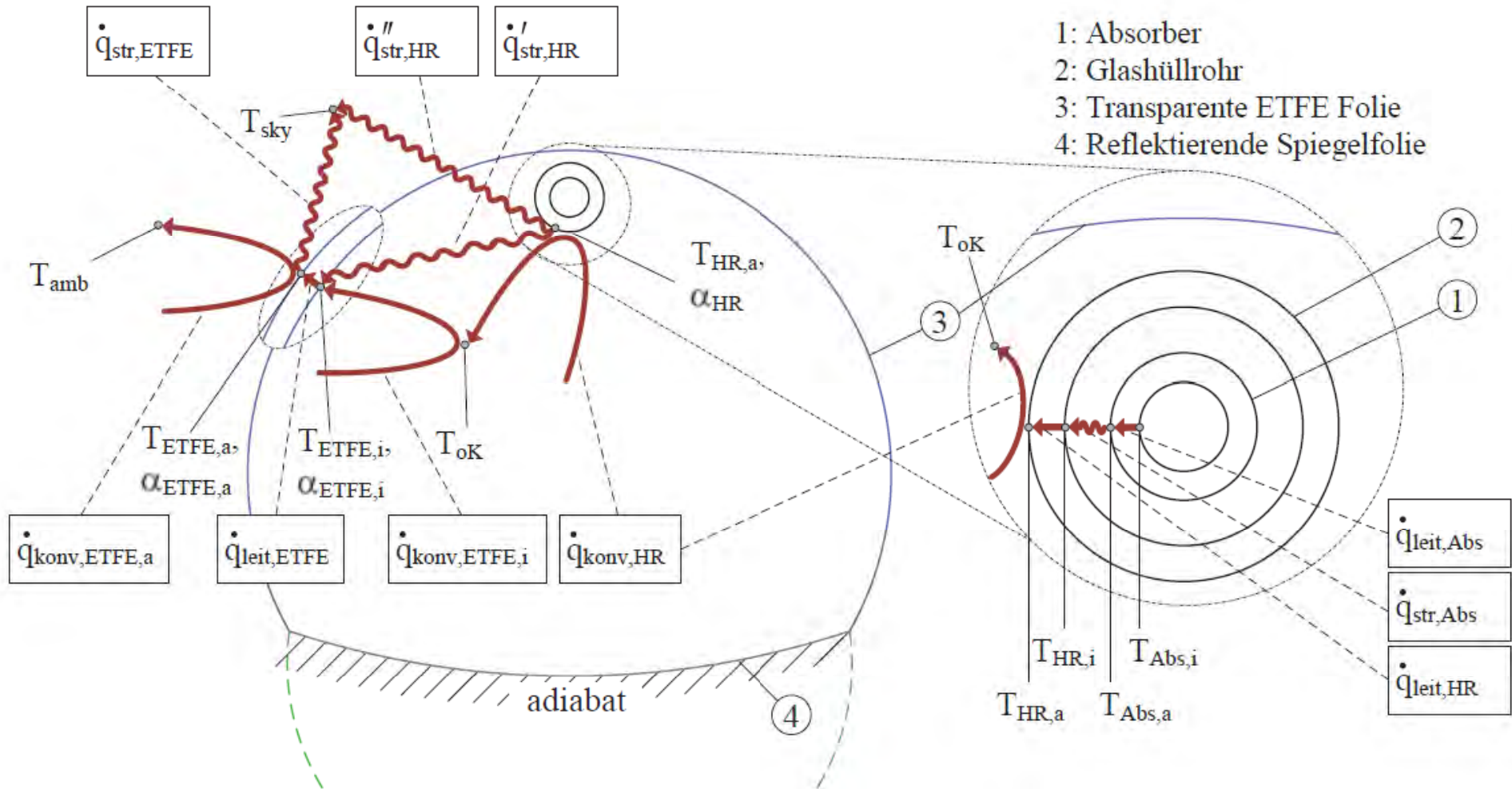
3-D- FEM + raytracing analysis (IAM)

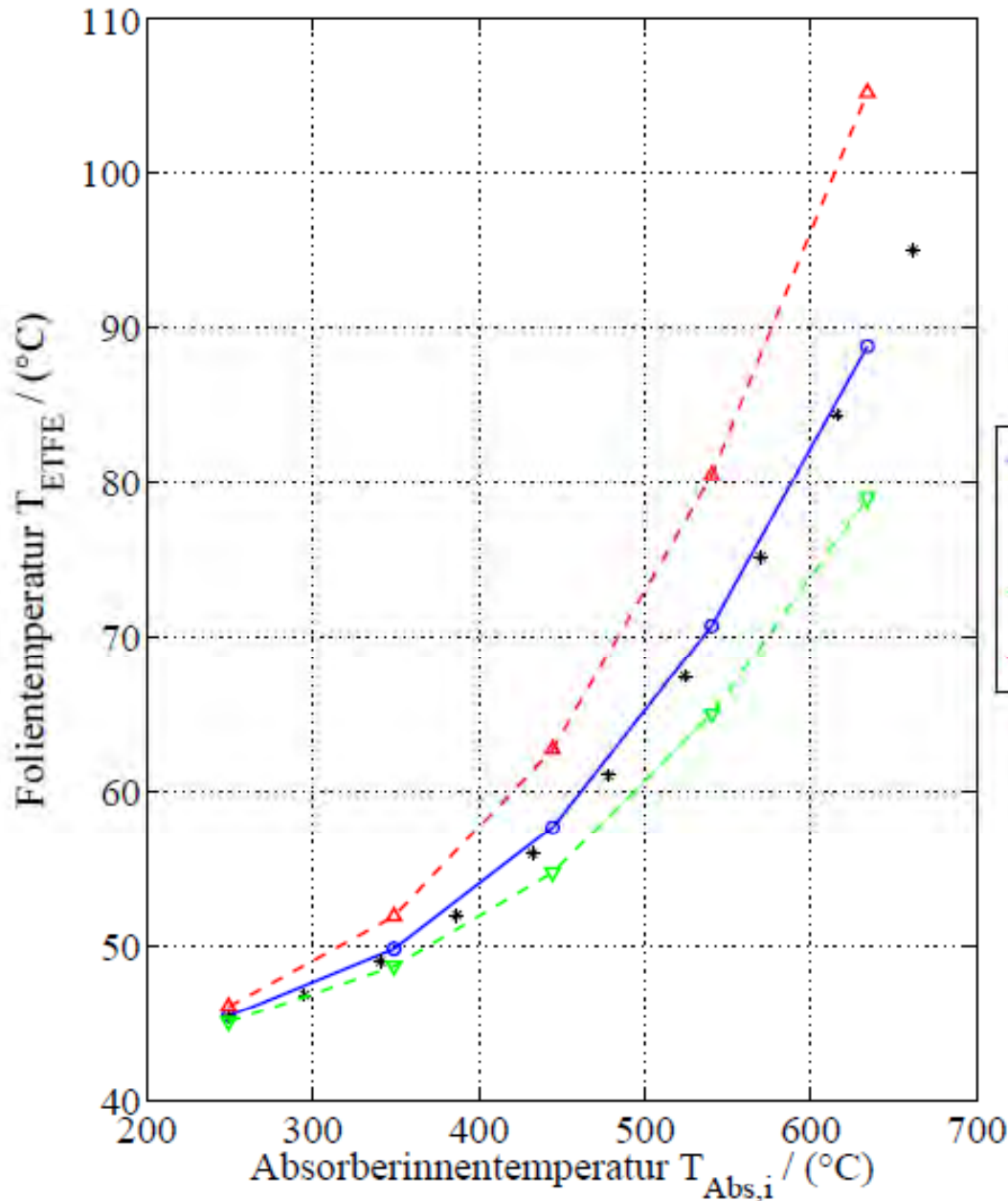


(IAM = incident angle modifier) (Funktion in Abhängigkeit des Einfallswinkels)

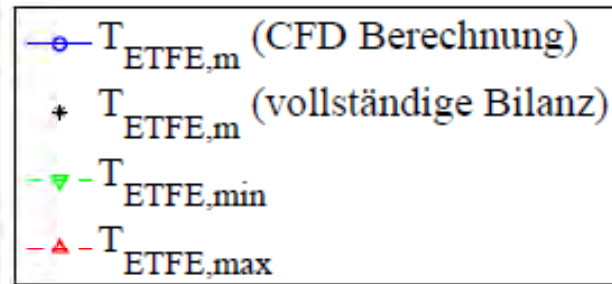


## Thermal Analysis of the Upper Air Chamber





## Maximum Membrane Temperatures

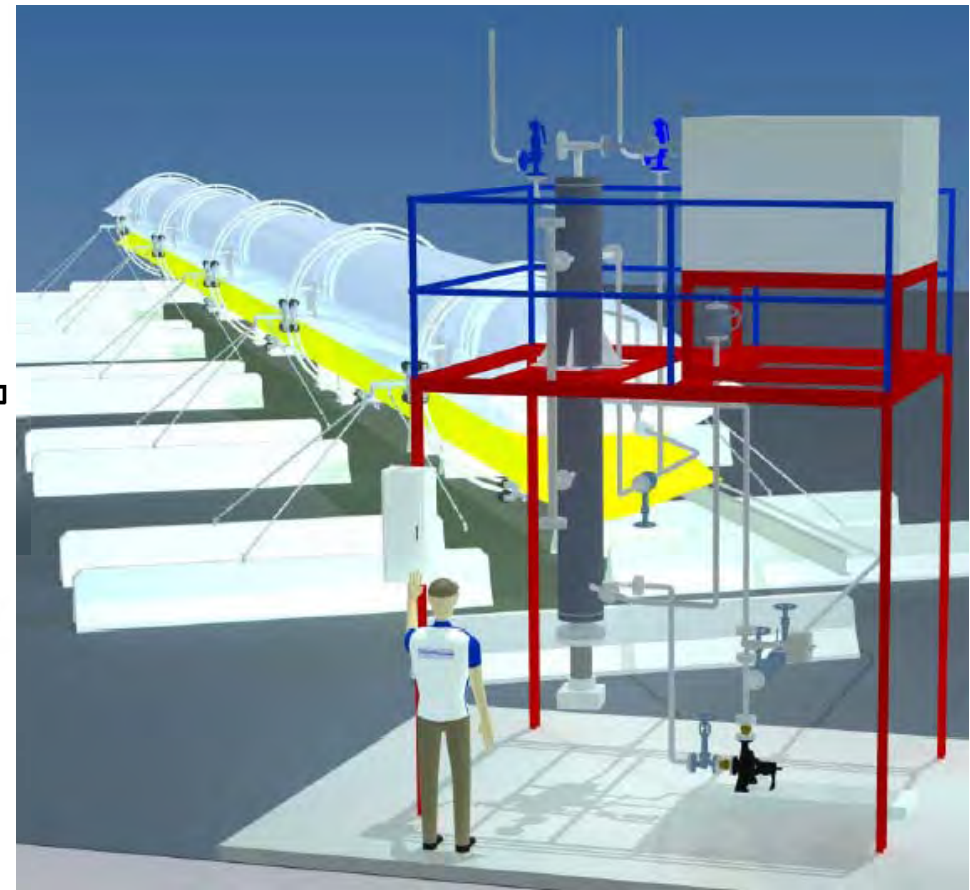
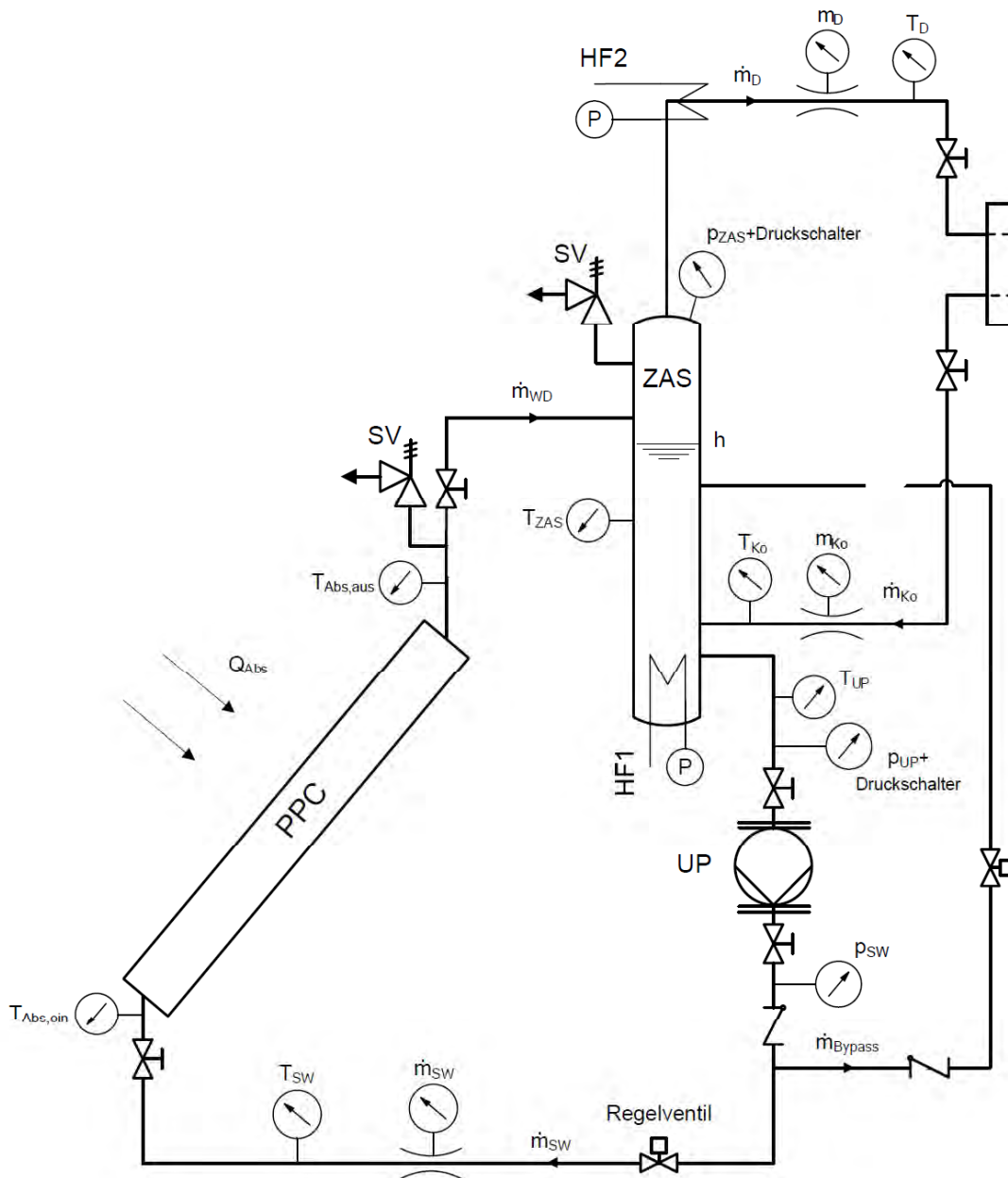


Material	T °C	E (Zug) N/mm <sup>2</sup>	$R_e$ N/mm <sup>2</sup>
ETFE	20	857.6	22.0
	45	653.7	12.0
	55	555.2	8.5
	65	467.3	7.5
PVC-PG	20	865.9	90.0
	45	823.1	74.0
	55	750.2	69.0
	65	665.9	62.0
ALU-PET	20	3225.0	108.0
	45	3367.4	87.0
	55	3288.8	77.0
	65	3358.5	55.0

## PPC-DSG Test Rig

Capacity: 20kWth

Operation pressure:  
25-110bara



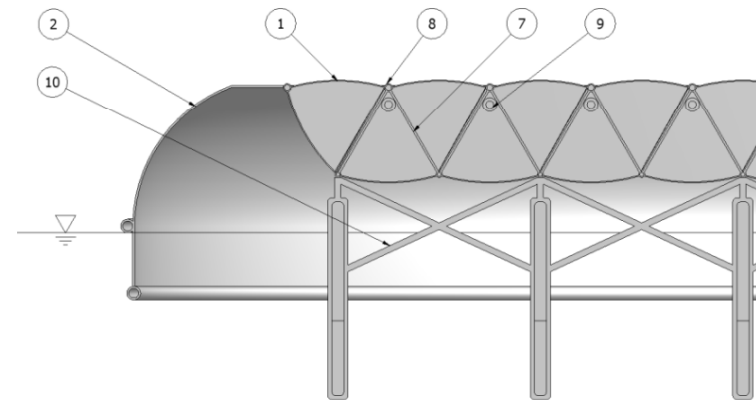


- Doctoral College (3PhD's)
- Patent 1&2 filed in March 2010
- Patent 3 to be filed in April 2011
- Cooperation with Scottish and French Offshore Organizations

## Main Ideas:

- Flexible air chamber confinement
- Modular & lightweight design
- Vertical axis tracking
- Maximum synergy to HELIOTUBE

## Diversification of DESERTEC



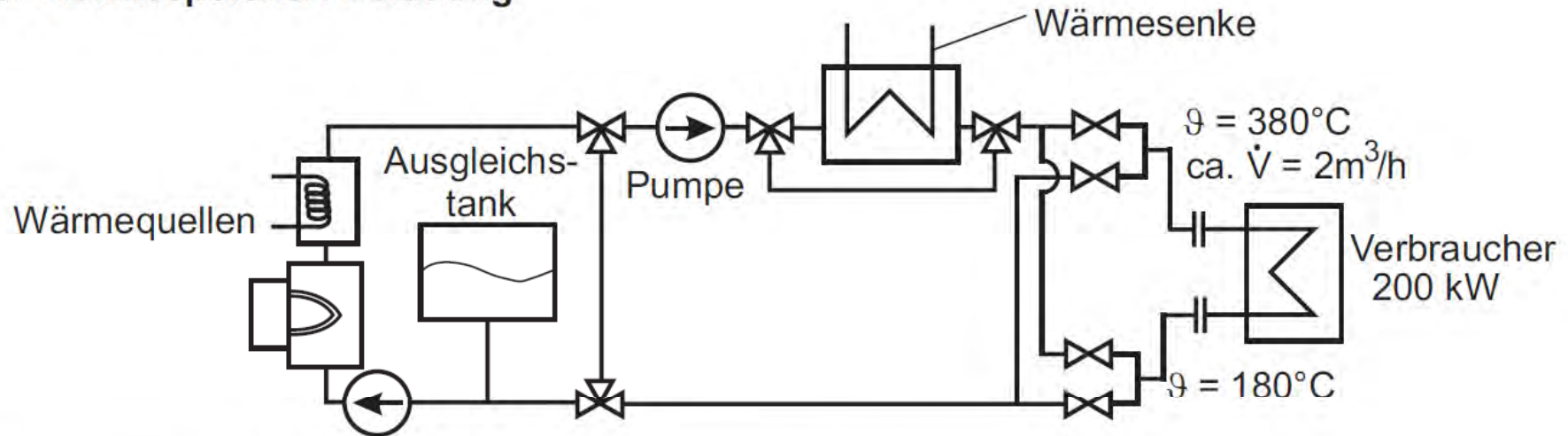
### Many Challenges:

- Flotation and Tracking Stability
- Cost
- Interfaces between Solar Platform and Power Island
- Option CPV

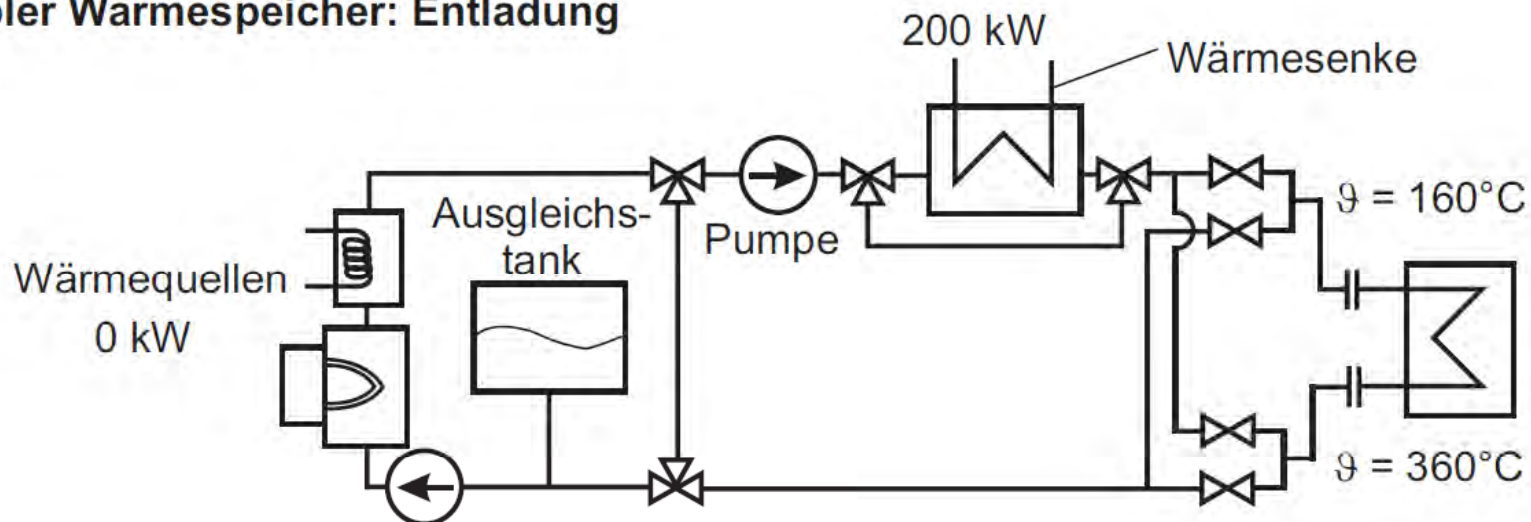


## Commissioning: October 2011

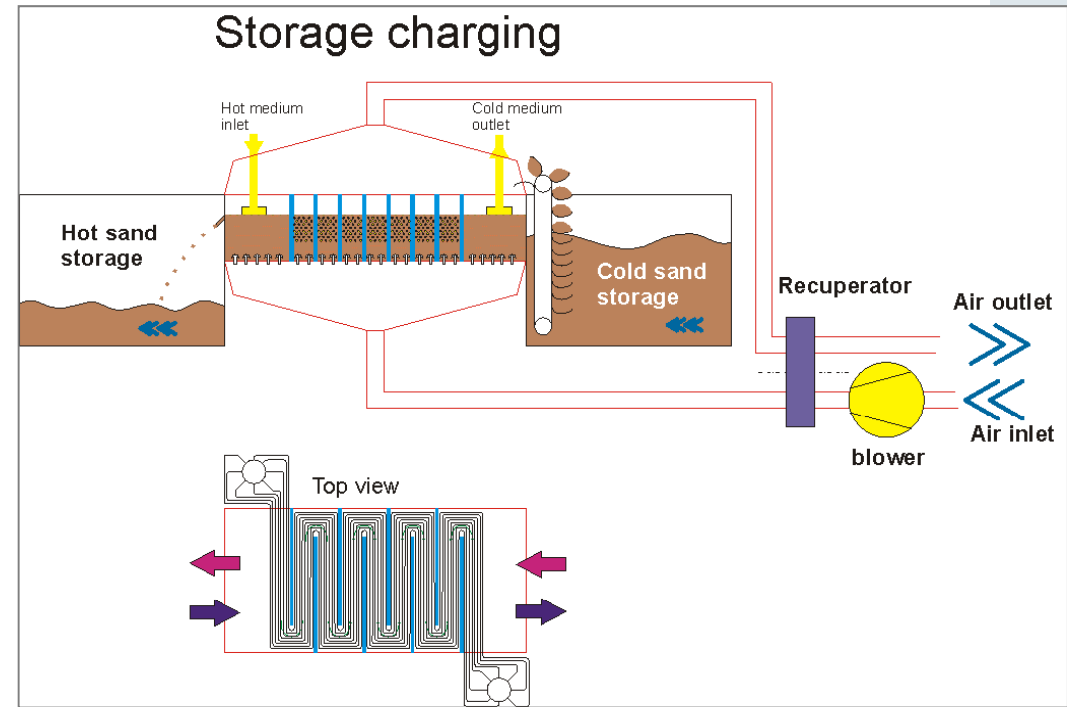
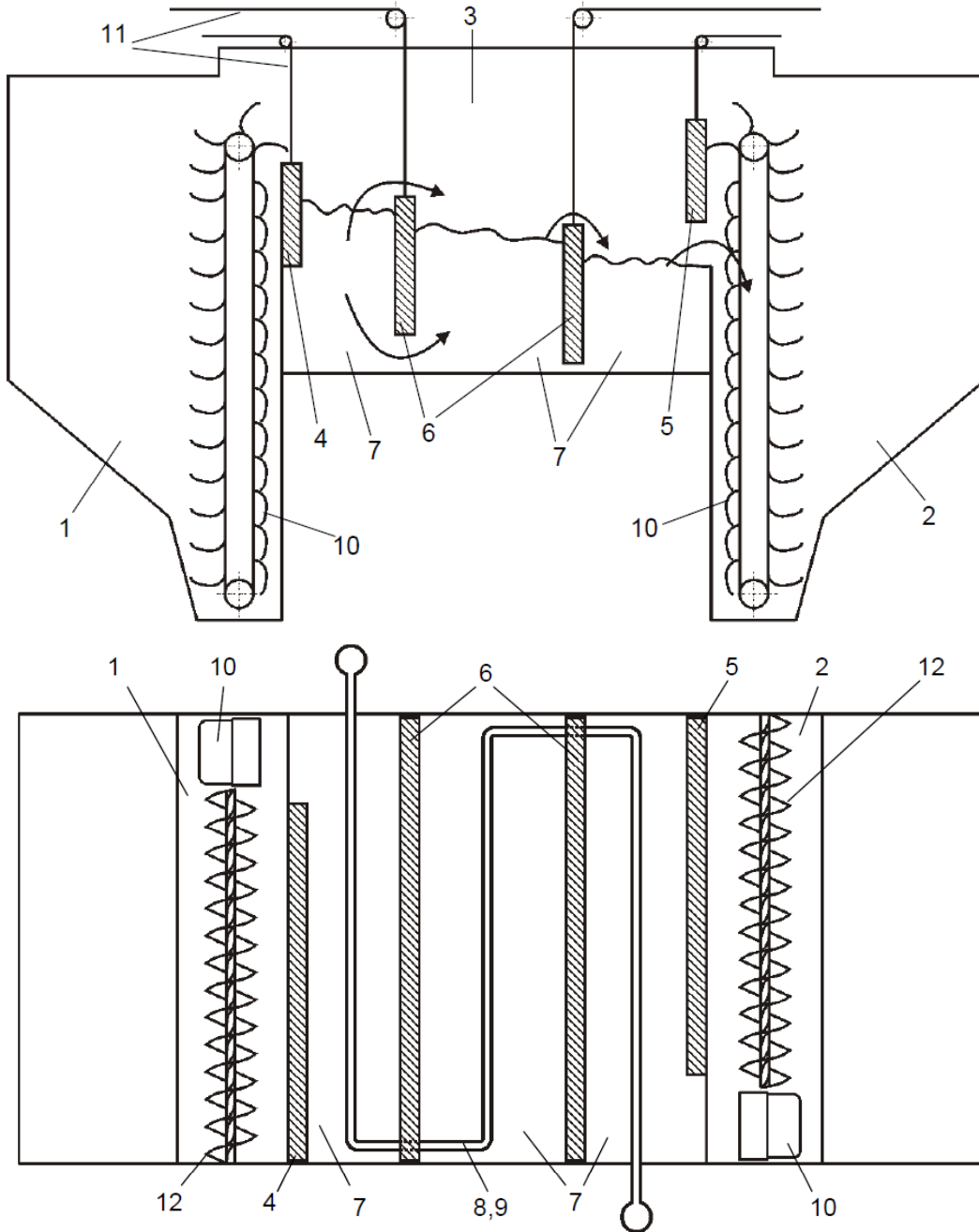
### Sensibler Wärmespeicher: Beladung



### Sensibler Wärmespeicher: Entladung

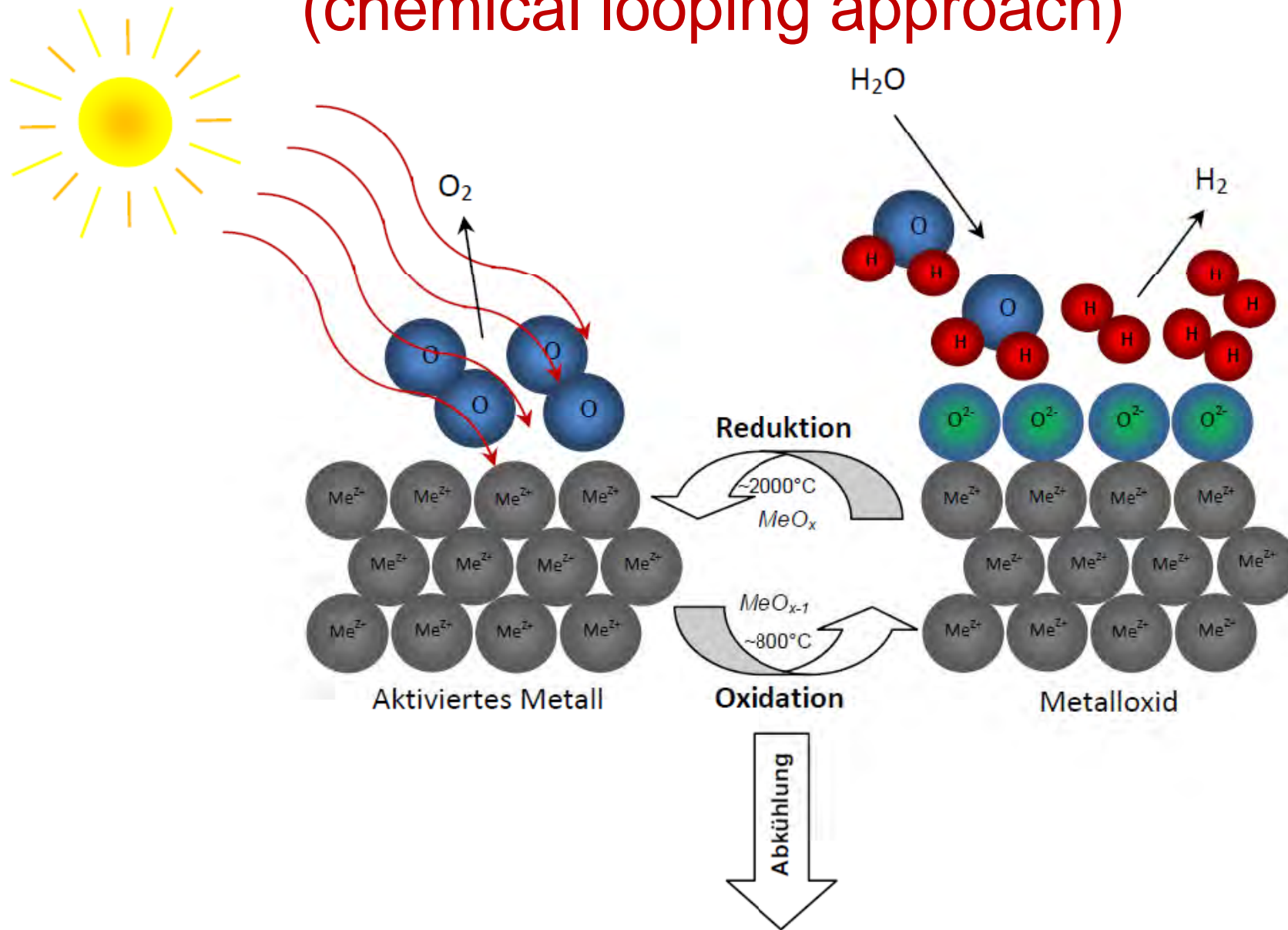


# 3 – Thermal Energy Storage

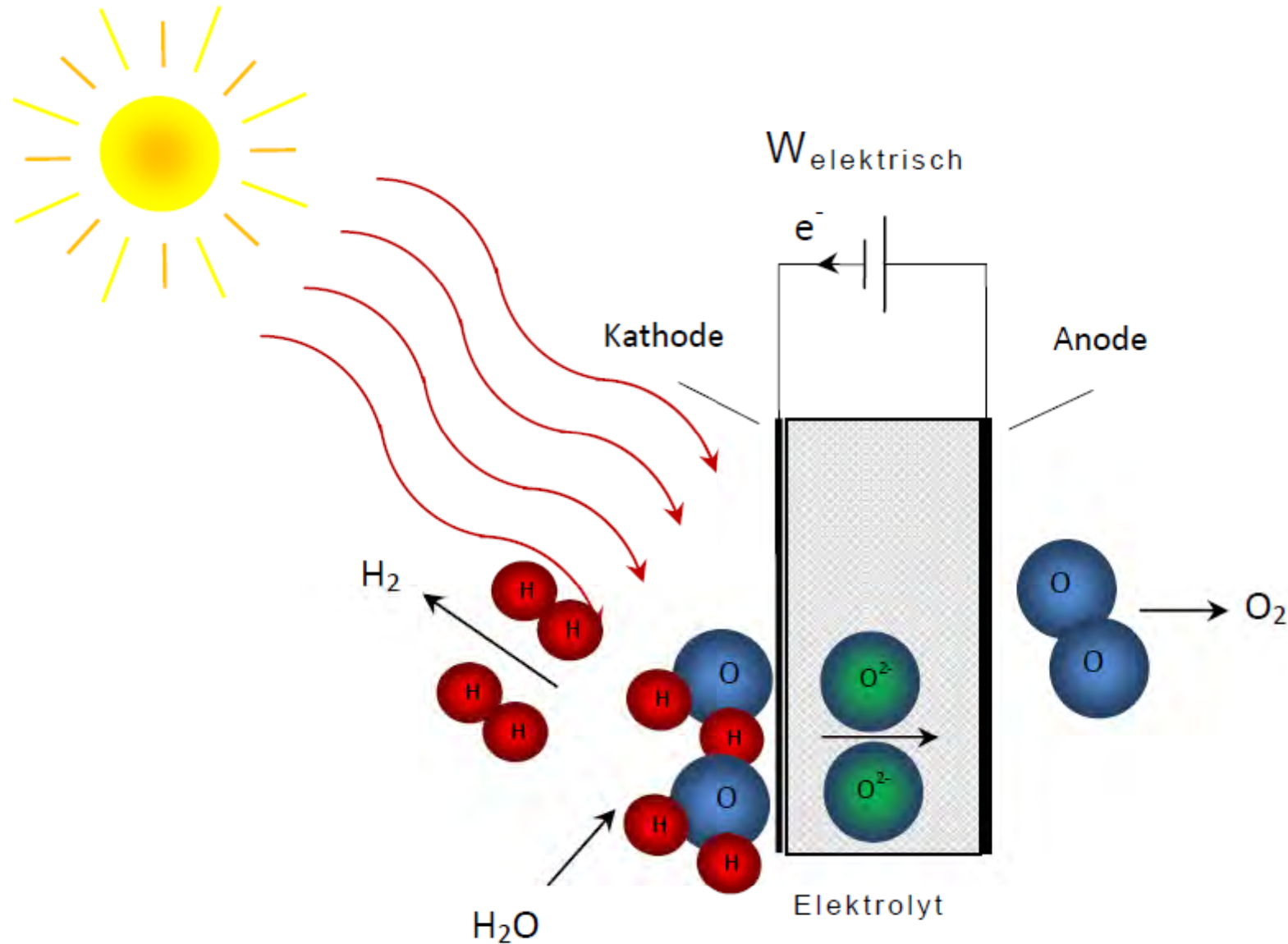


**Application: CSP, CAS**  
**Commissioning:**  
**October 2011**

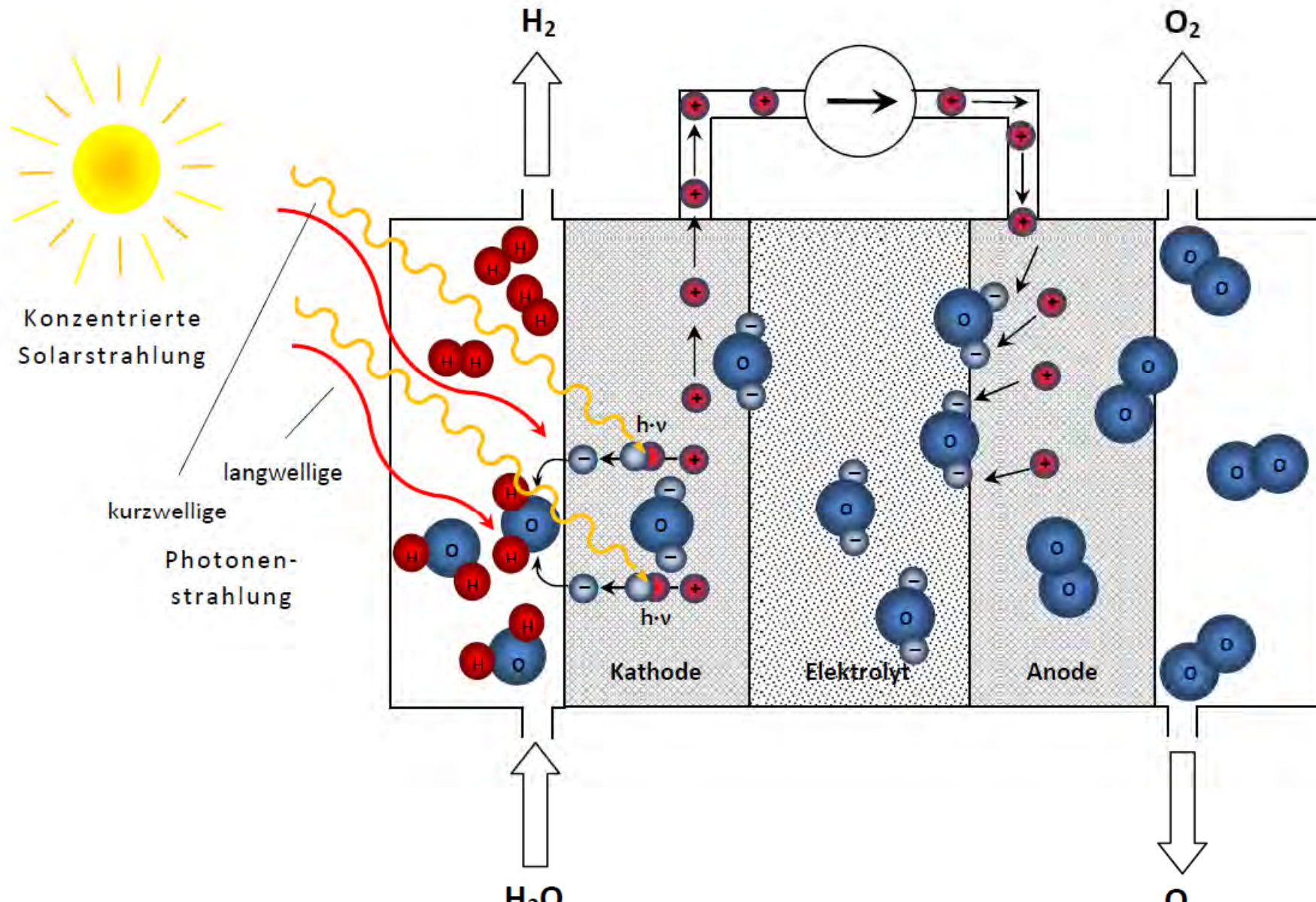
## From TWO-STEP WATER SPLITTING (chemical looping approach)



## VIA solar assisted High Temperature Electrolysis



## TO Solid Oxide Photo-Electrochemical Cells Thermally Assisted Photo-electro-chemical Water-splitting

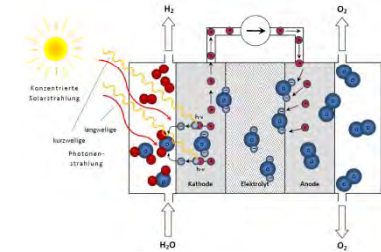


## MOTIVATION for Solid Oxide Photo-Electrochemical Cells

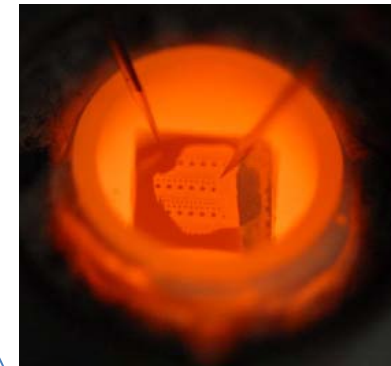
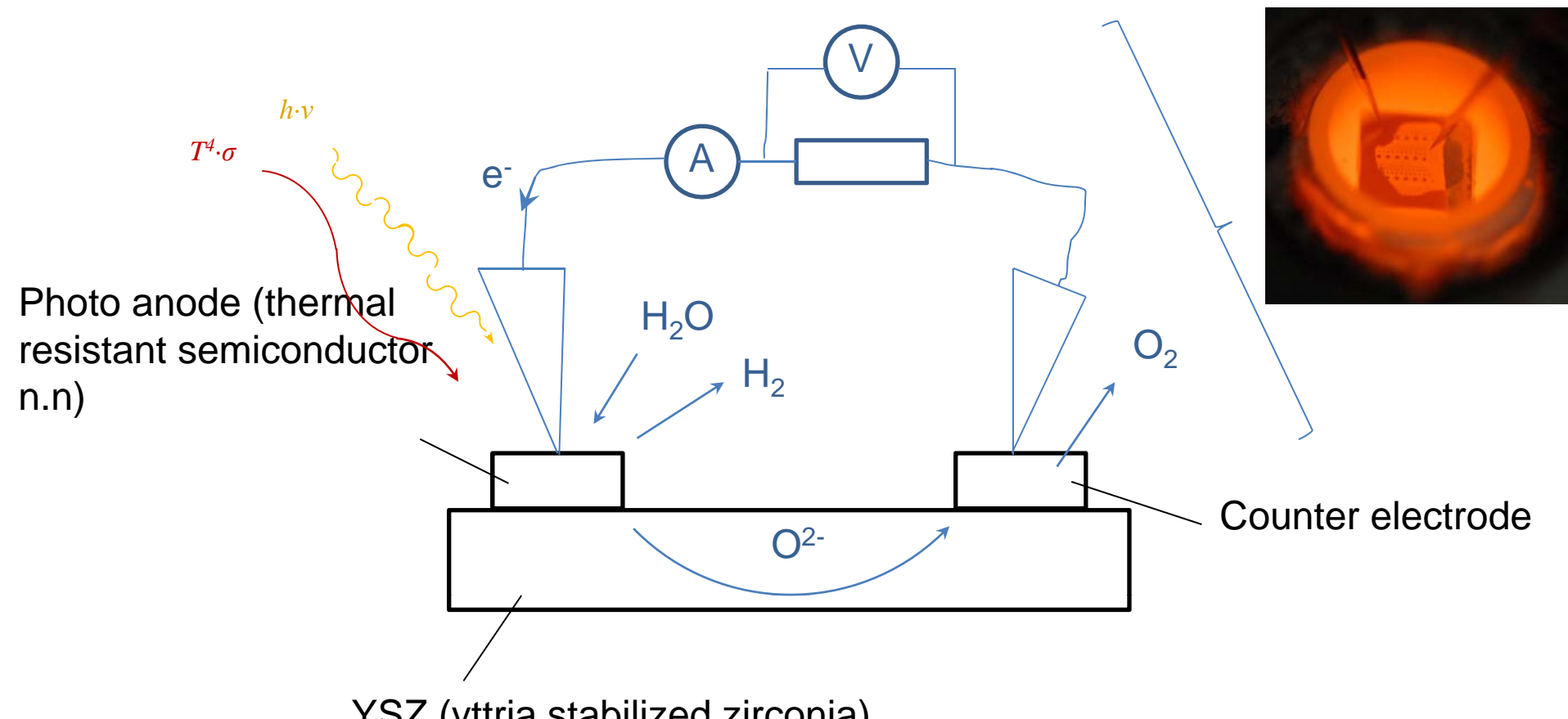
- (1) **Two Step Water Splitting** (Solar-driven thermochemical cycles) => only the thermal energy effects the hydrogen production.
- (2) For the **photo-electrochemical hydrogen production** a photo-induced current is used to split water, whereas the thermal energy of the solar radiation remains unused.
  - **NEW APPROACH:** using the **photonic energy** AND the **thermal energy** of solar radiation.
  - in **pre-experimental study** the potential of a new method for one-step, **thermal assisted photo-electrochemical energy conversion** is investigated currently.

## STATUS: Solid Oxide Photo-Electrochemical Cells

- Patent filed
- Material qualification tests running



Cell architecture for the **pre-experimental study**:



**THANK  
YOU !**