Concentrating solar radiation to produce fuels and other base materials

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Martin Roeb

Martin.roeb@dlr.de

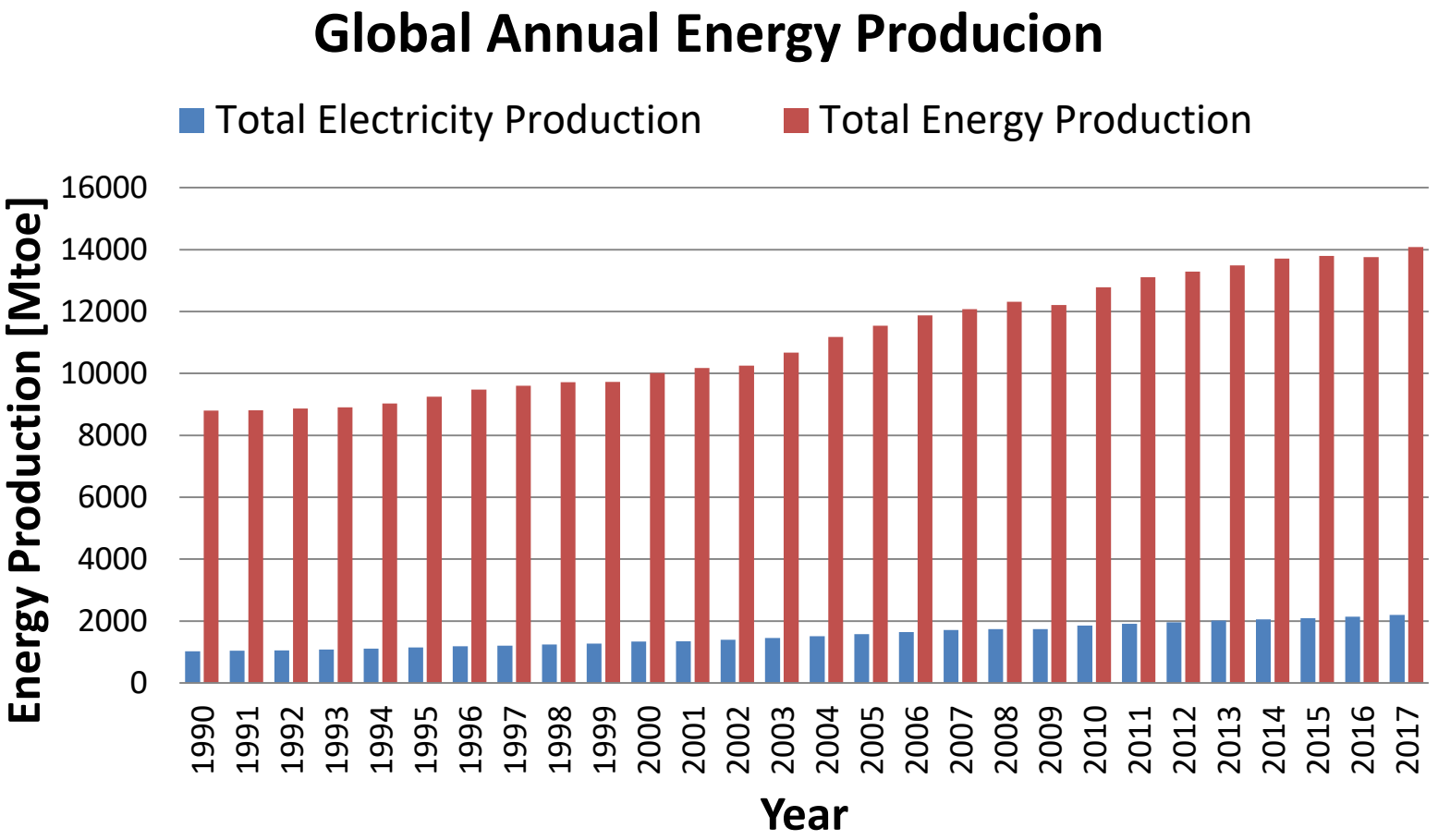
Solar Thermal Power Plants

Solar thermal plants can provide storable and controllable renewable power and process heat

- Heat can be stored at a lower cost than electricity
- storage tanks can keep the solar high tempererature heat for up to 18 hours

Solarthermisches Kraftwerk Bookport/Südafrika mit thermischem Energiespeicher.
Bild: TSK Flagsol

Energy Production

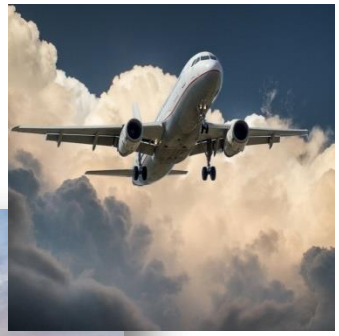


Energy Consumption

If electrical energy is only 13% of the total energy production, where does the rest of the energy goes to?





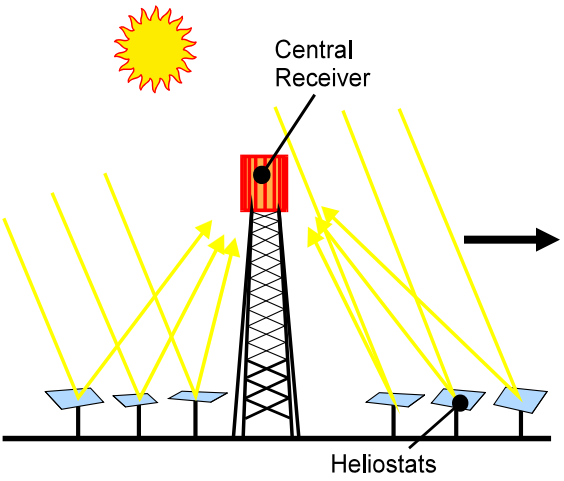





Solar Thermal Production of Fuels, Chemical Commodities, and Base Materials

Calcination	Coal- and Petrochemistry	Nitrogen chemistry	Metall production and Metallurgy	Sulfur Chemistry
Cement	Coal Gasification	Ammonia	Melting	Sulfuric Acid Recycling
Clinker	Coal Drying	Nitrate	Recycling	Hybrid-Sulfur Cycle
Lime	Cracking	Ammonia-Nitrate	Reduction of Metal oxides	Sulfur as Storage Medium
$CaCO_3$-Looping	Reforming	Molten Salts	Treatment of Metal Ores	Sulfur as Fertilizer
$Ca(OH)_2$-Looping	Gasification	Fertilisers	Production of inorganic Pigments	
(Phosphat)	Syngas Production	Air separation		
	CO2 and H2O splitting			
	Electrolysis			

Principle of solar thermochemical Processes



Solar Tower

Resources
Raw Materials

Heat

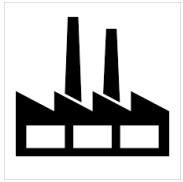
Chemical
Reactor

Intermediates

Down Stream
Processes

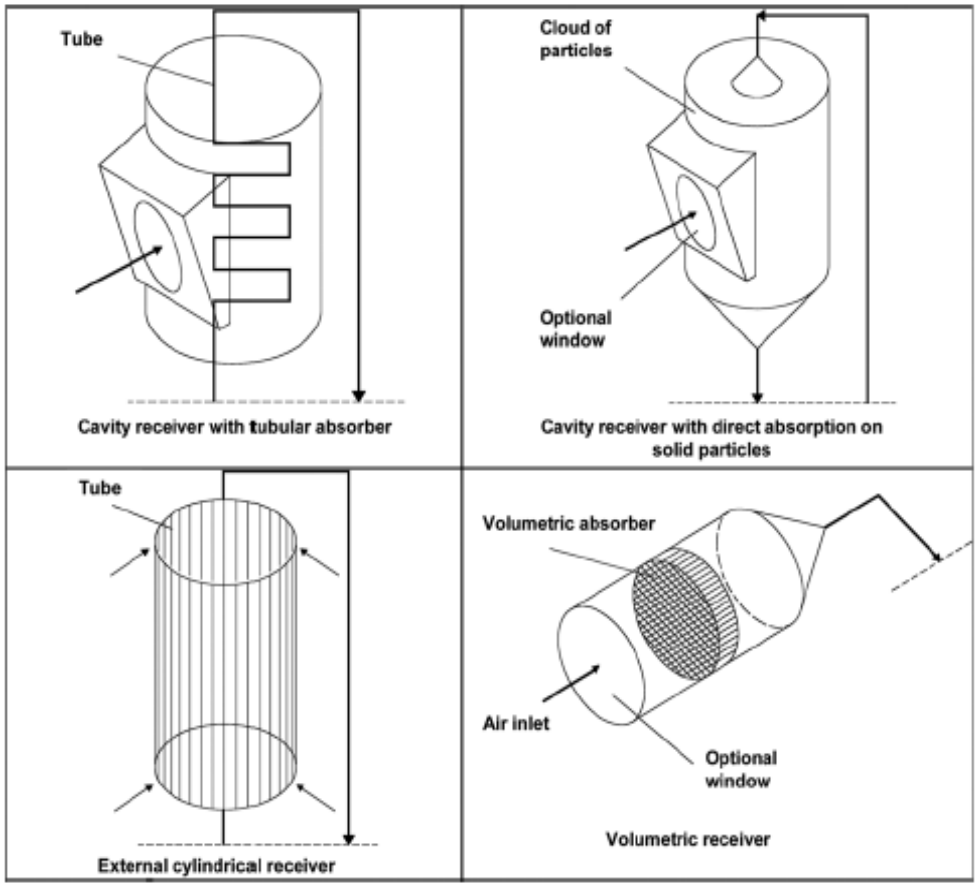
Products

Commodities

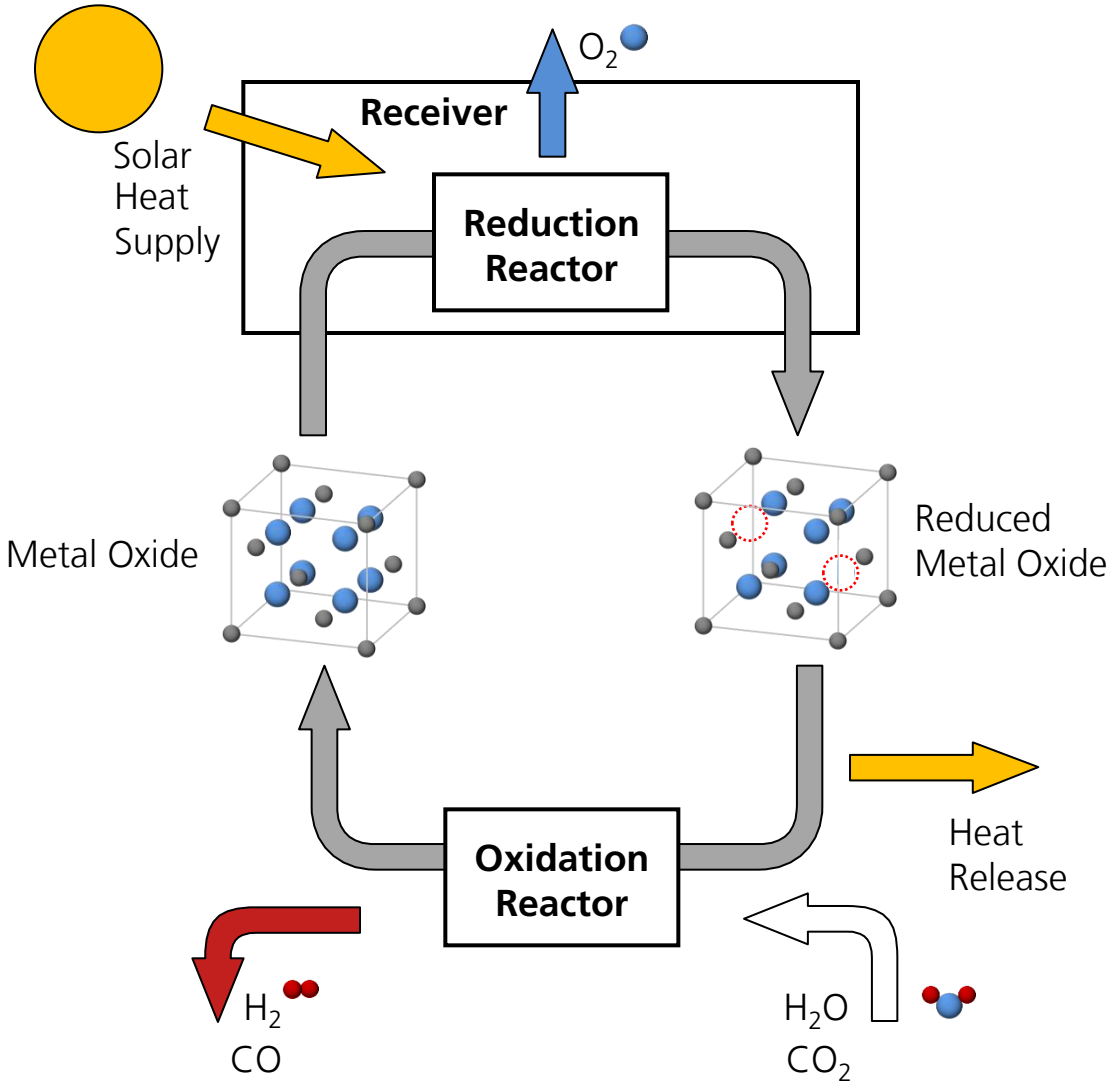


Fuels

Solar Interfaces to heat chemical reactions



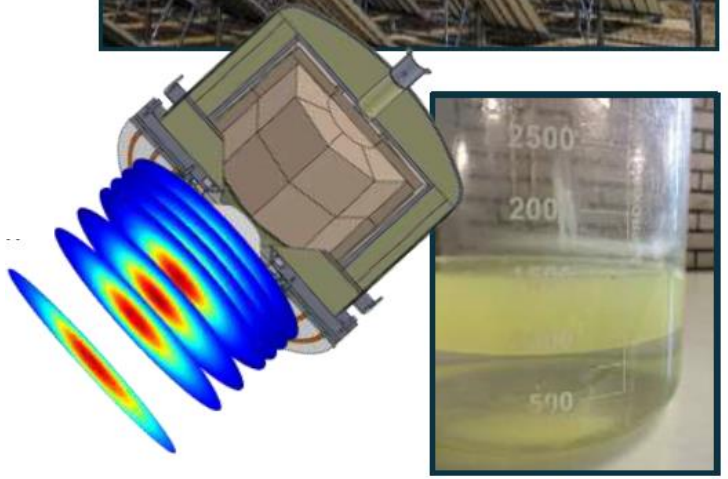
Thermochemical Redox-Cycles

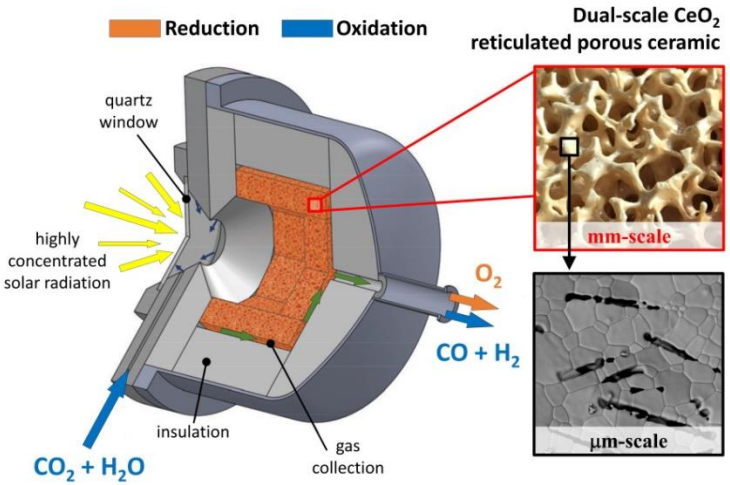


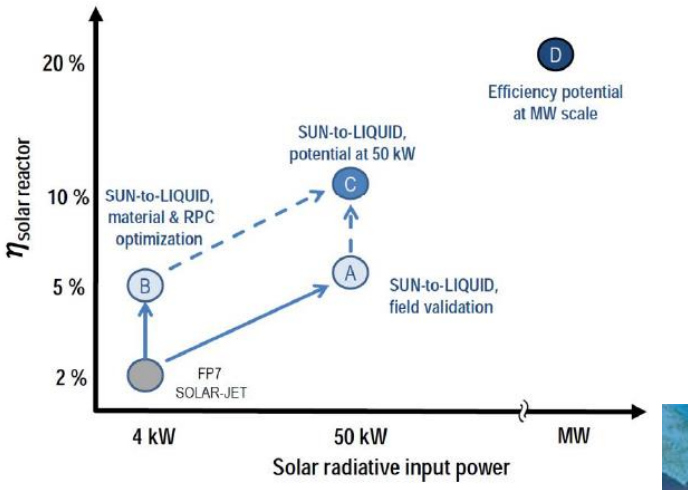
Project SUNlight-to-LIQUID: Integrated solar thermochemical synthesis of liquid hydrocarbon fuels

Aim

Demonstration of solar ceria redox cycle for kerosine production at at 50kW scale







Fraction of E27 agricultural surface to provide European Kerosene demand of 2005:

BTL 20.7 Mha

HVO 60.2 Mha

8 %

25 %

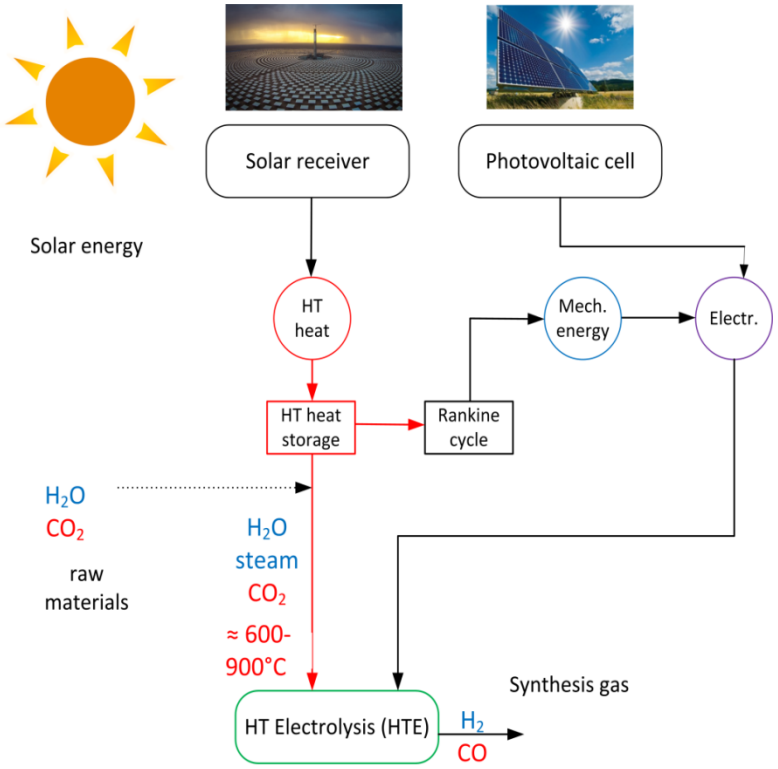
0.5 %

European agricultural area 245 Mha

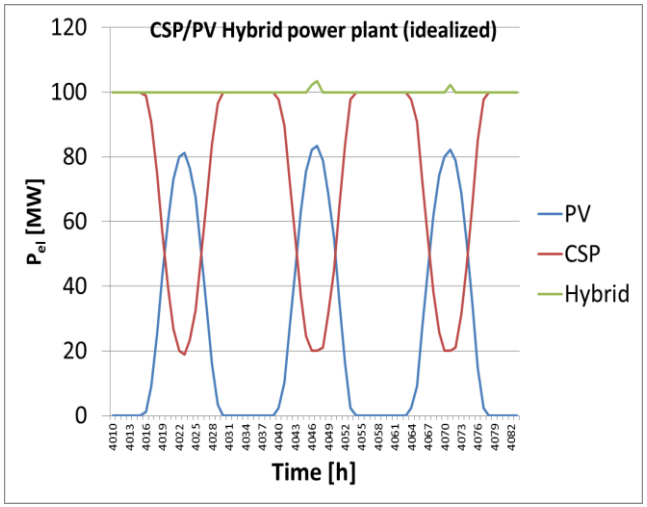
SUN-to-LIQUID 1.3 Mha

Data:
EIA (2008), International Energy Annual 2006
FAO (2010), ResourceSTAT-Land 2005
Bauhaus Luftfahrt Inventory of Energy Crops
Mha: Million Hectare

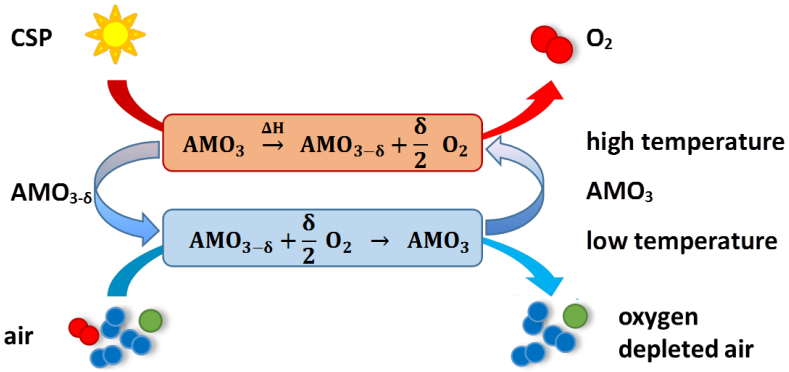
High temperature electrolysis powered by CSP/PV hybrid power station



- ✓ cheap PV + cheap thermal storage
  - ➢ low LCOE and high FLH
  - ➢ HT heat lowers P_{el} demand
  - ➢ $\eta_{HTE} \approx 0.75\text{-}0.85$



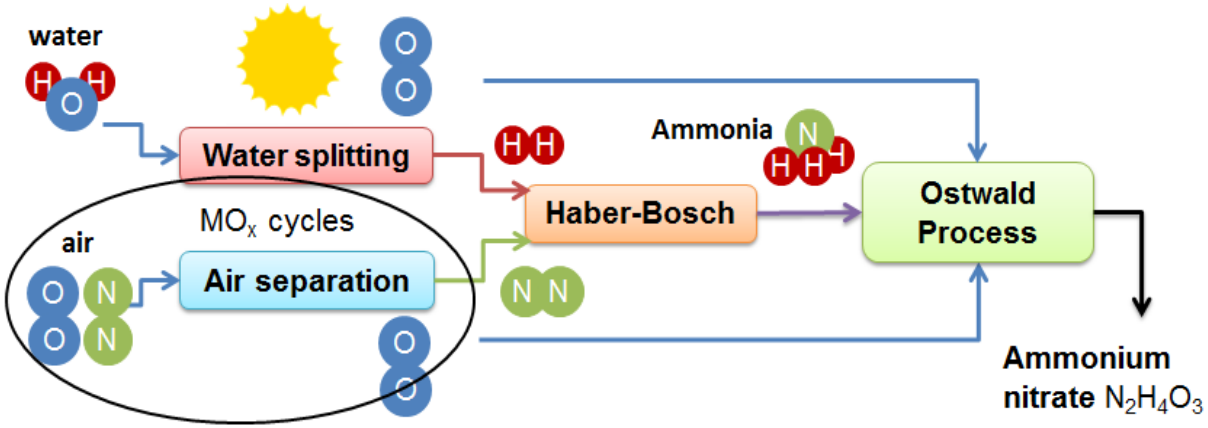
Project DÜSOL: Solar Ammonia und Fertilizer Production



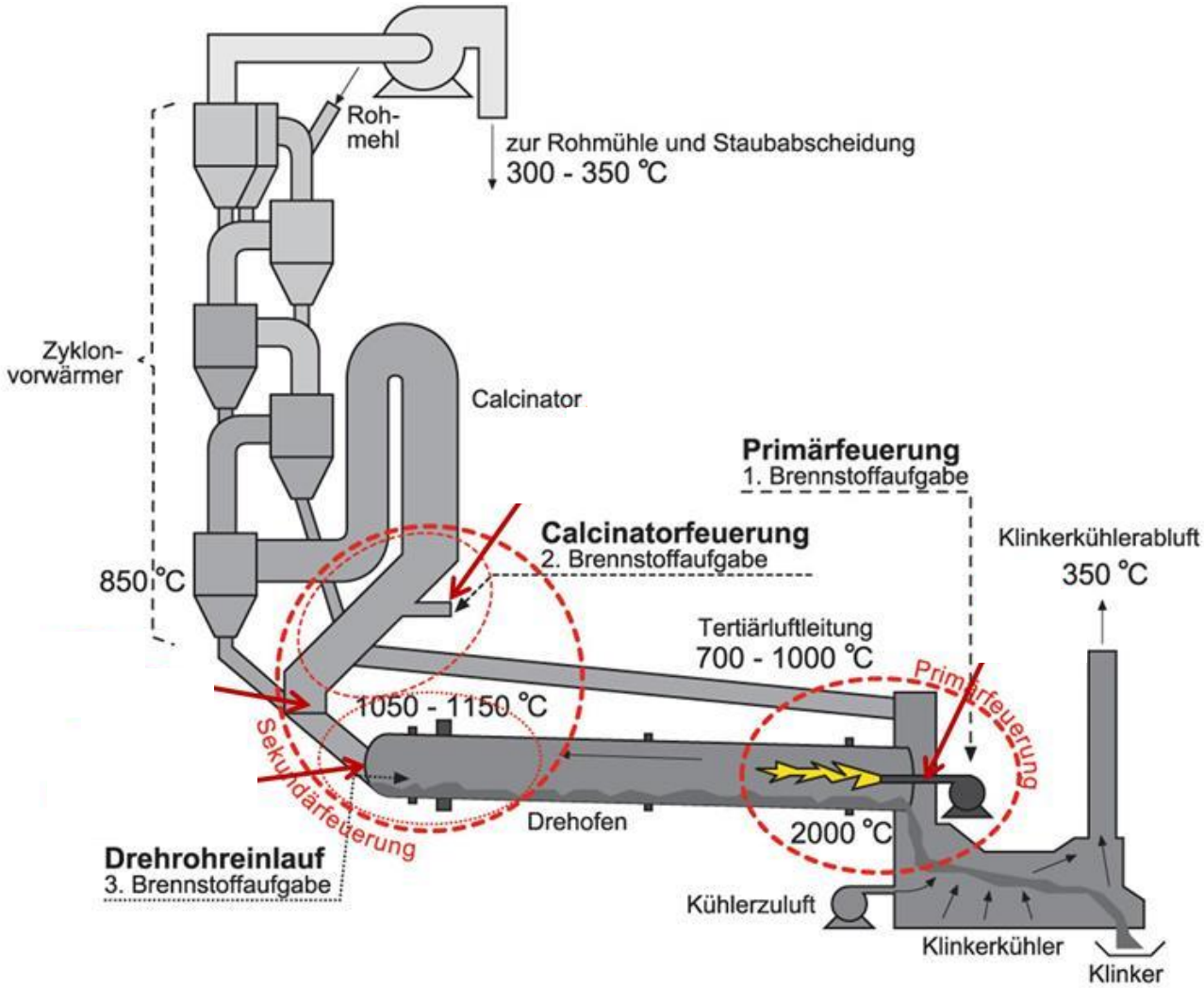
→ **production of nitrogen or oxygen for industrial applications**

→ **nitrogen: application in ammonia production (currently > 1% of world primary energy consumption[1])**

[1] Erisman, J. W.; Sutton, M. A.; Galloway, J.; Klimont, Z.; Winiwarter, W., How a century of ammonia synthesis changed the world. Nature Geosci 2008, 1, (10), 636-639.

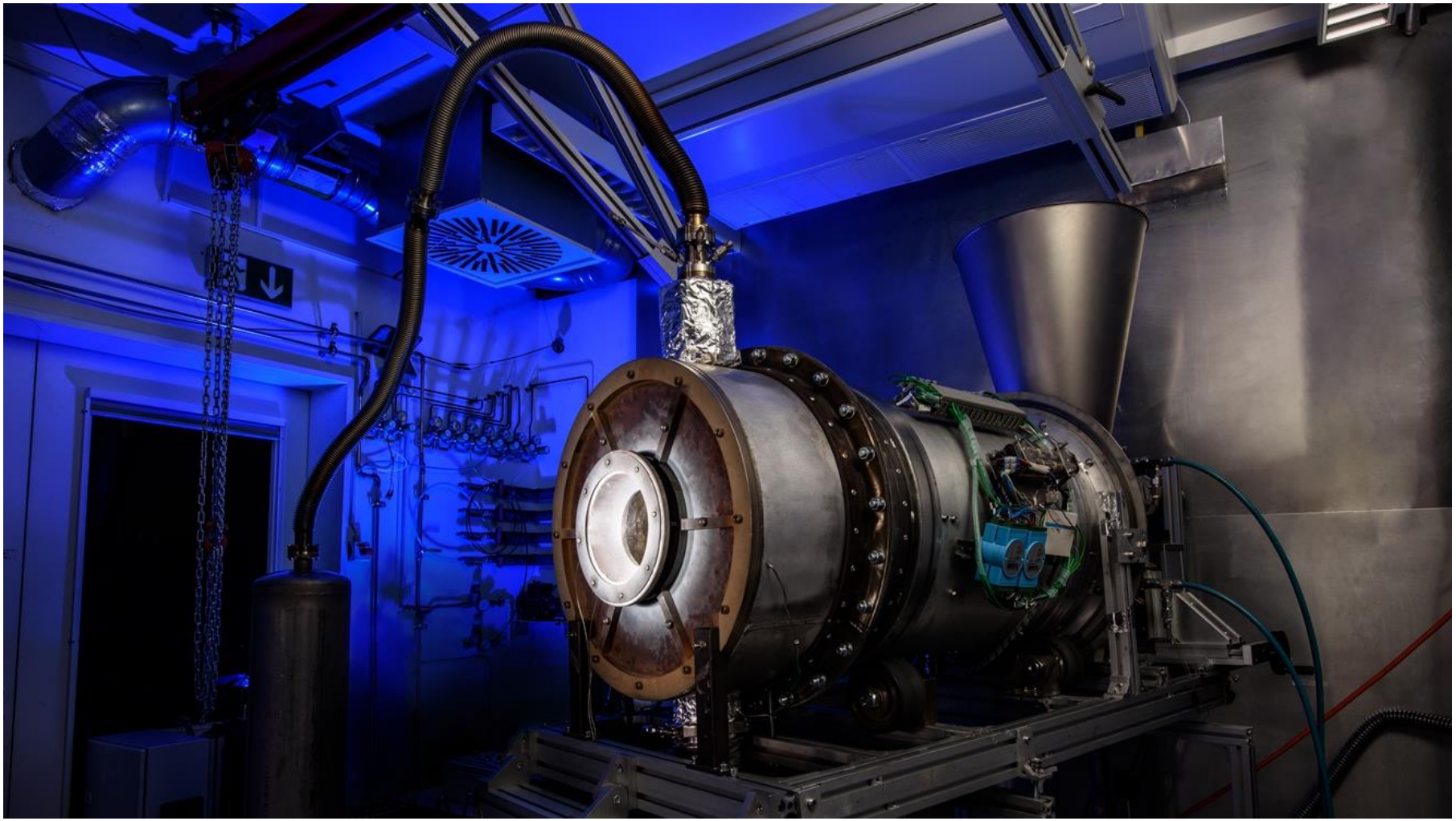


EU-Project SOLPART: Solar Cement Production



[http://www.wtert.eu/default.asp?Menue=13&ShowDok=49]

Solar Rotary Kiln for Calcination in Solar Simulator



Thermochemical sulfur storage cycle for baseload solar power production

S

$SO_2 + H_2O$

Sulphuric Acid Decomposition

SO_2 Disproportionation

Sulphuric acid plant

H_2SO_4

Thank you very much for your attention!