
# Project Overview

SEVENTH FRAMEWORK PROGRAMME

New Energy World JU
fuel cells & hydrogen for sustainability

**SEVEN FRAMEWORK PROGRAMME**
**FCH-JU-2012-1**

**SP1-JTI-FCH.2012.2.5 :**
**Thermo-electrical-chemical processes with solar heat sources**

Project acronym: **SOL2HY2**

Project full title:

# Solar To Hydrogen Hybrid Cycles

PARTNERS:

ENGINSOFT

Aalto University

DLR Deutsches Zentrum für Luft- und Raumfahrt e.V. in der Helmholtz-Gemeinschaft

ENEA
Ente per le Nuove tecnologie, l'Energia e l'Ambiente

Outotec

WOIKOSKI
KAASUT | HITSAUS

# Project background

New Energy World JU
fuel cells & hydrogen for sustainability

**Fuel Cells and Hydrogen Joint Undertaking (FCH JU)**

## 2012 Call for Proposals

**Horizontal application areas**: Transportation & Refuelling Infrastructure; **Hydrogen Production**, Storage & Distribution; Stationary Power Generation & CHP; and Early Markets.

**Topic**: SP1-JTI-FCH.2012.2.5 **Thermo-electrical-chemical processes with solar heat sources** (Collaborative Project)

# Topic: SP1-JTI-FCH.2012.2.5

## Thermo-electrical-chemical processes with solar heat sources

**Call Topic Objectives:**

**Basic and applied research** on **materials and key components** for the most efficient thermo-electrical-chemical water splitting cycles: to improve the **technical & economic feasibility** of these processes for **$CO_2$-free hydrogen production** with focus on the scale up of the technology.

The **solar interface**, **solar reactors**, **materials performance** and **process strategies** have been identified as aspects crucial for a reliable and economic operation of a respective plant.

# Thermochemical cycles

- Recently only alkaline electrolysis can produce $H_2$ without greenhouse gases, if run on renewable electricity source.
- Advanced processes, such as thermo-chemical cycles, can be powered by carbon-free sources (nuclear and concentrated solar energy), being more efficient than low temperature processes, reducing power consumption and $H_2$ cost.
- These processes are very different (process characteristics, maturity, etc.), thus an objective comparison is difficult to make – e.g. using only efficiency or costs as a criterion.
- Most promising processes were assessed by IEA and DoE: AE (alkaline electrolysis), HTE (high-temperature electrolysis), IS (iodine-sulfur, based in Bunsen reaction), HyS (hybrid sulfur) and FeOx (iron oxides cycle). Sometimes cycles based on CdO and CuCl are also included, but they have less benefits due to different reasons.
- Of all studied cycles, HyS-based one was prioritized as having the best potential in medium-term.

*O. Galzim e.a., J. Multicrit. Decis. Mak., 1, (2011), 177-204*

# Cycles comparison (IEA Task 25)

**AE** – alkaline electrolysis,

**HTE** – high-temperature electrolysis,

**IS** – iodine-sulphur,

**HyS** – hybrid sulphur,

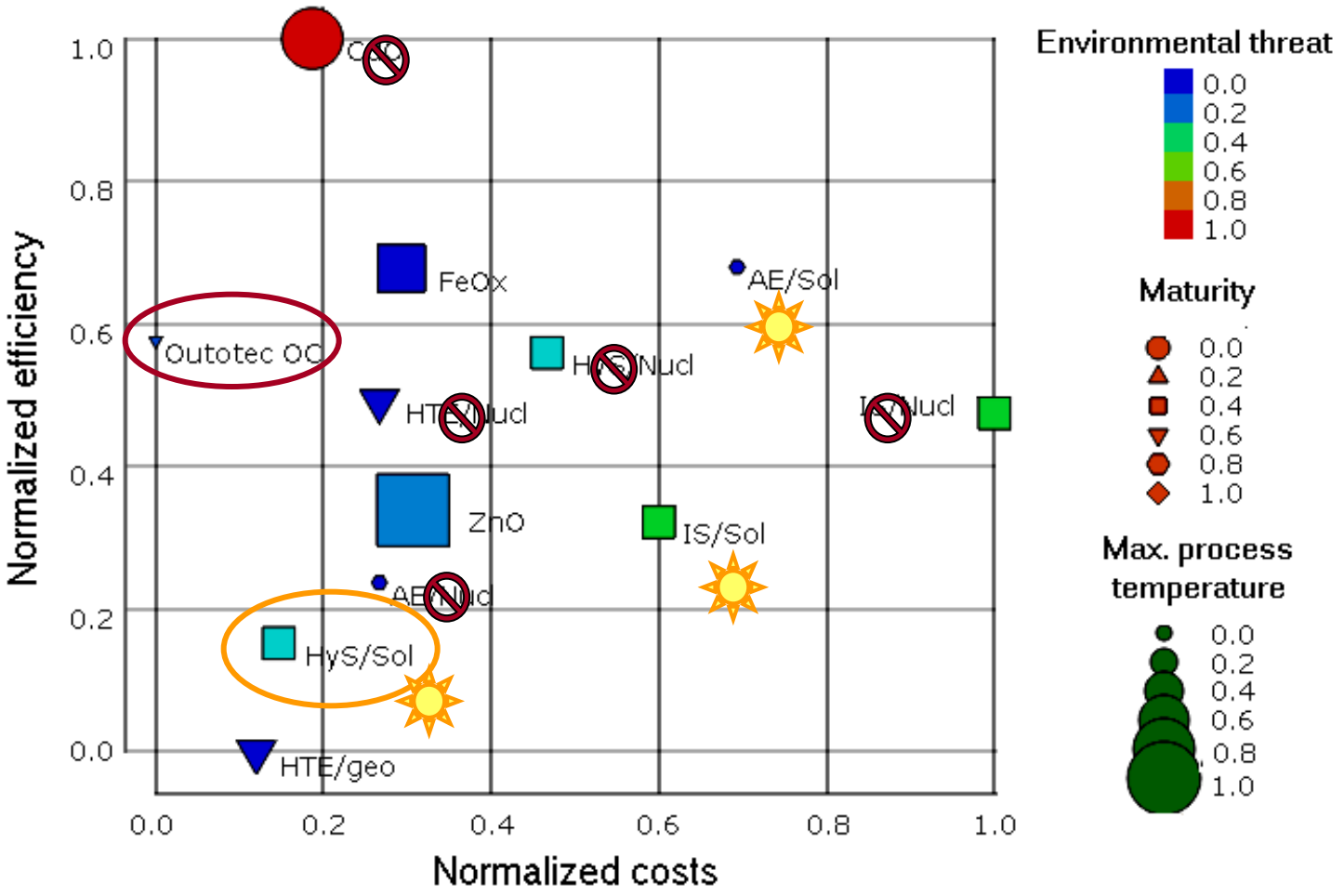
**FeOx** – iron oxides cycle,

**Outotec OC** – Outotec open cycle

***Sol*** **–** *solar heat input,*

***Nucl*** *– nuclear heat input,*

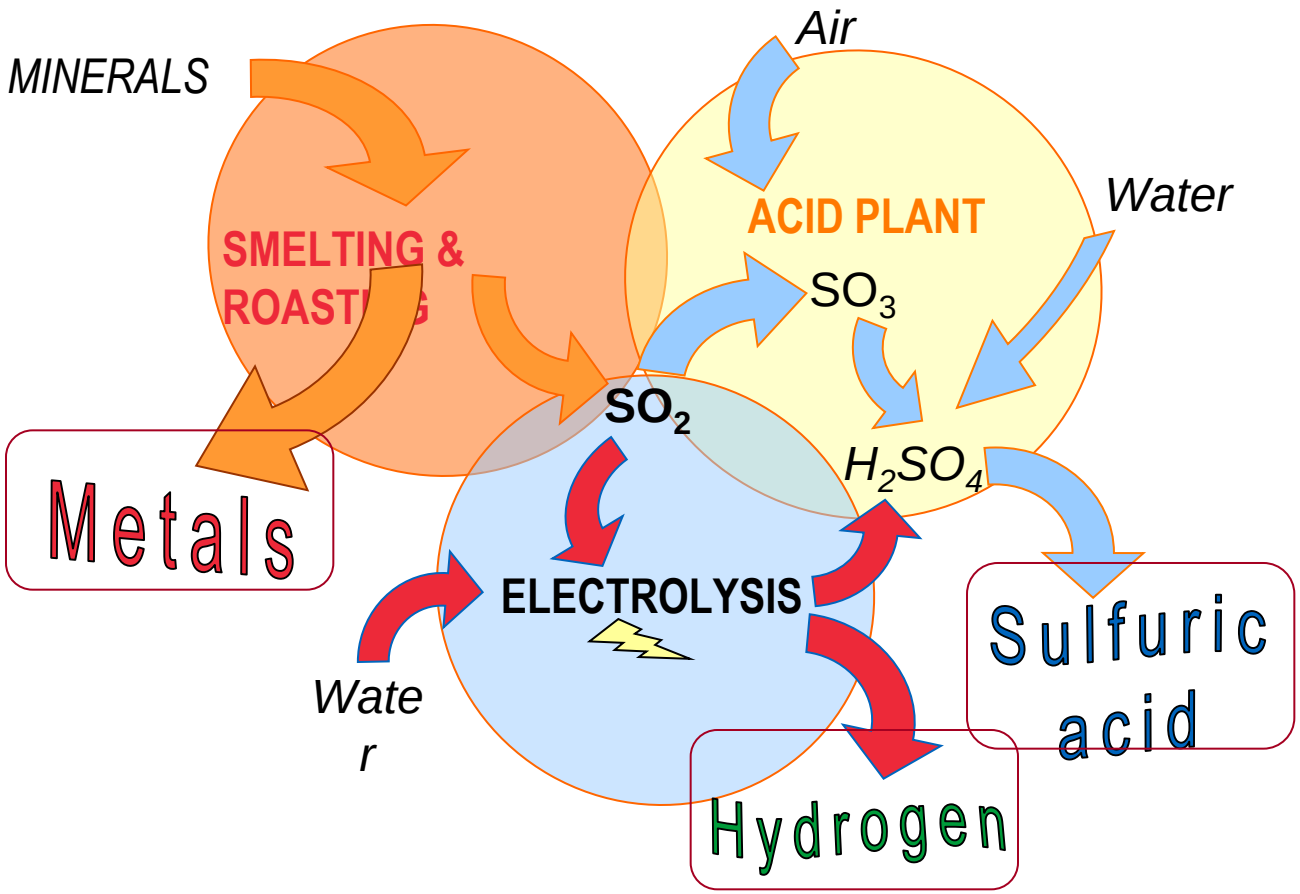
***Geo*** *– geothermal input.*




*A. Lokkiluoto e.a., Environm. Devel. Sustain. (2012), 529-540.*

# Key process

## Outotec® Open Cycle




*Patented: FI, WO, EA, ZA, US, JP, CN, CA, SA, JR*

# H2SO4?

- ”**More $H_2SO_4$ is produced than any other chemical in the world**.” *(European Commission JRC/IPTS report 2006)*
- About 200-250 Mt of acid is produced annually worldwide
- Used in fertilizers production, for dehydrating in organic chemical and petrochemical processes, production of $TiO_2$, HCl, HF, pickling/descaling steel, leaching Cu, U and V, electrolytic baths for nonferrous-metal purification and plating, etc.

***250 Mt/a acid = 5 Mt/a $H_2$ co-production potential***

# Why integrated cycles?

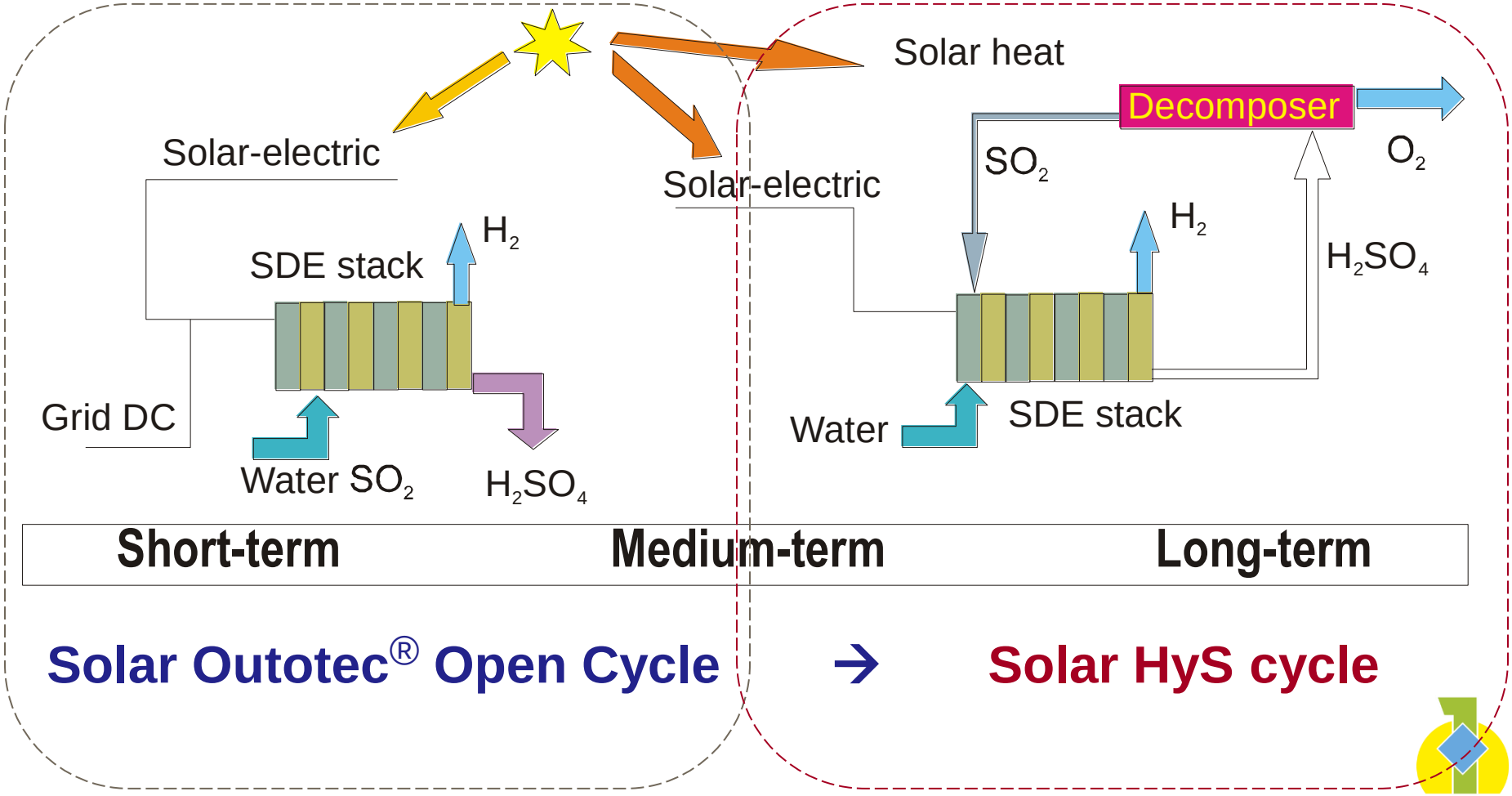
**BENEFITS:**

- more options to efficiently recycle material streams
- efficient share of equipment
- efficient generation and use of utilities
- increased heat integration
- efficient share of treatment facilities, e.g. treatment of waste waters
- reduced bulk storage and, hence, less emissions from storage
- reduced loading/unloading of raw materials and, hence, less emissions
- more options for recycling condensates, process waters, etc.

**However:**

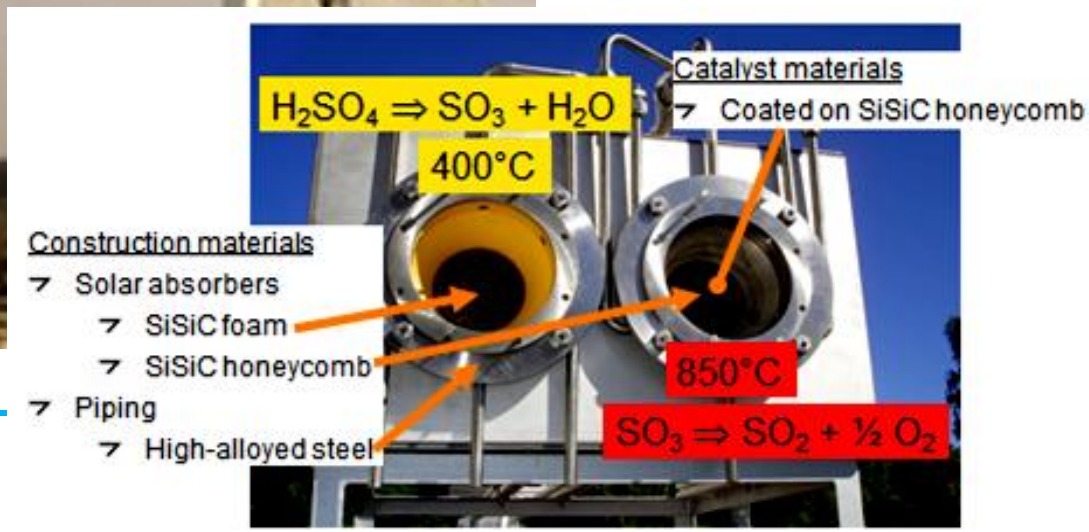
- integration might decrease the operational flexibility (shutdown for maintenance might cause shutdown of dependent processes)
- Co-products demand and supply might mismatch

# Project Key Cycles

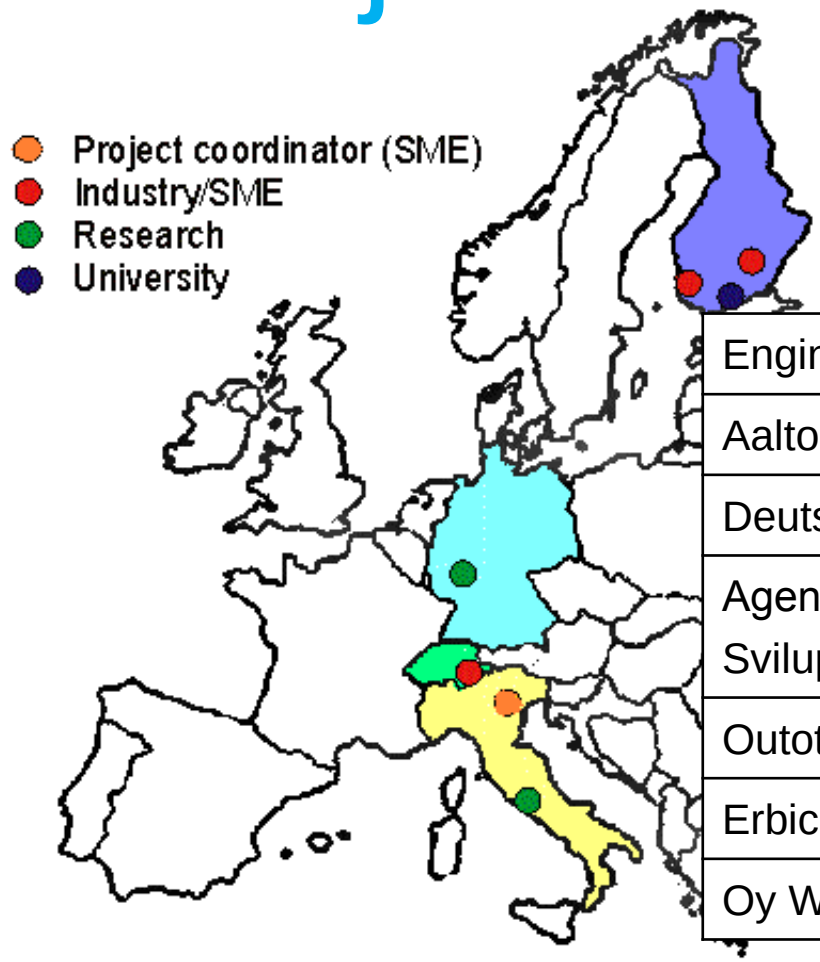


# Solar Tower


Receiver 22.7m² (Intratec, Saint-Gobain)
Tower 60m (Züblin)
2150 Heliostats á 8.2 m² (SHP/AUSRA)
therm. Storage 1h
Turbine 1.5 MWe (KKK-Siemens)
Full capacity hours: ca. 1000 h (Storage)
Electricity Production Energie 1350 MWh/a


$H_2SO_4 \Rightarrow SO_3 + H_2O$
400°C
Catalyst materials
Coated on SiSiC honeycomb
Construction materials
Solar absorbers
SiSiC foam
SiSiC honeycomb
Piping
High-alloyed steel
850°C
$SO_3 \Rightarrow SO_2 + ½ O_2$

# Project consortium




| | |
|---|---|
| EnginSoft S.p.A.(coordinator) | ITA |
| Aalto-korkeakoulusäätiö ☼ | FIN |
| Deutsches Zentrum für Luft- und Raumfahrt e.V. ☼ | GER |
| Agenzia per le Nuove Tecnologie, l'Energia e lo Sviluppo Economico Sostenibile ☼ | ITA |
| Outotec (Finland) Oy | FIN |
| Erbicol S.A. | SUI |
| Oy Woikoski AB | FIN |

☼ - *N.ERGHY members*

# Coordination Tool

***www.eucoord.com***

## The cloud platform for FP7 Projects Management:

- Project structure and consortium management
- Financial accounting
- Automatic Reports generation
- Project Web-site creation
- Comunication and dissemination

ENGIN SOFT


**EUCOORD's main features**

**Automatic procedures** for FP7 Projects accounting, reports generation, comunication management ...

**What is it?**

SEVENTH FRAMEWORK PROGRAMME

EUCOORD is a **web-based application** for Project Management and Financial Accounting of FP7 Research Projects

**Start using EUCOORD**

Freely register and test EUCoord's functionalities and its **user friendly interface**