N.ERGHY aisbl –
New European Research Grouping
on Fuel Cells and Hydrogen

Hydrogen Project Overview

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

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

• Electrolysis can produce H_2 without GHG, if run on renewable sources.

• **Advanced processes**, e.g. thermo-chemical cycles, can be powered by carbon-free, being more efficient than low temperature processes, reducing power consumption and H_2 cost.

• These processes are very different, thus an objective comparison is difficult to make – e.g. using only efficiency or costs as a criterion.

• **Most promising processes** were assessed (**HIA Task 25**): alkaline and high-temperature electrolysis, iodine-sulfur, hybrid sulfur, iron oxides cycle.

• 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,

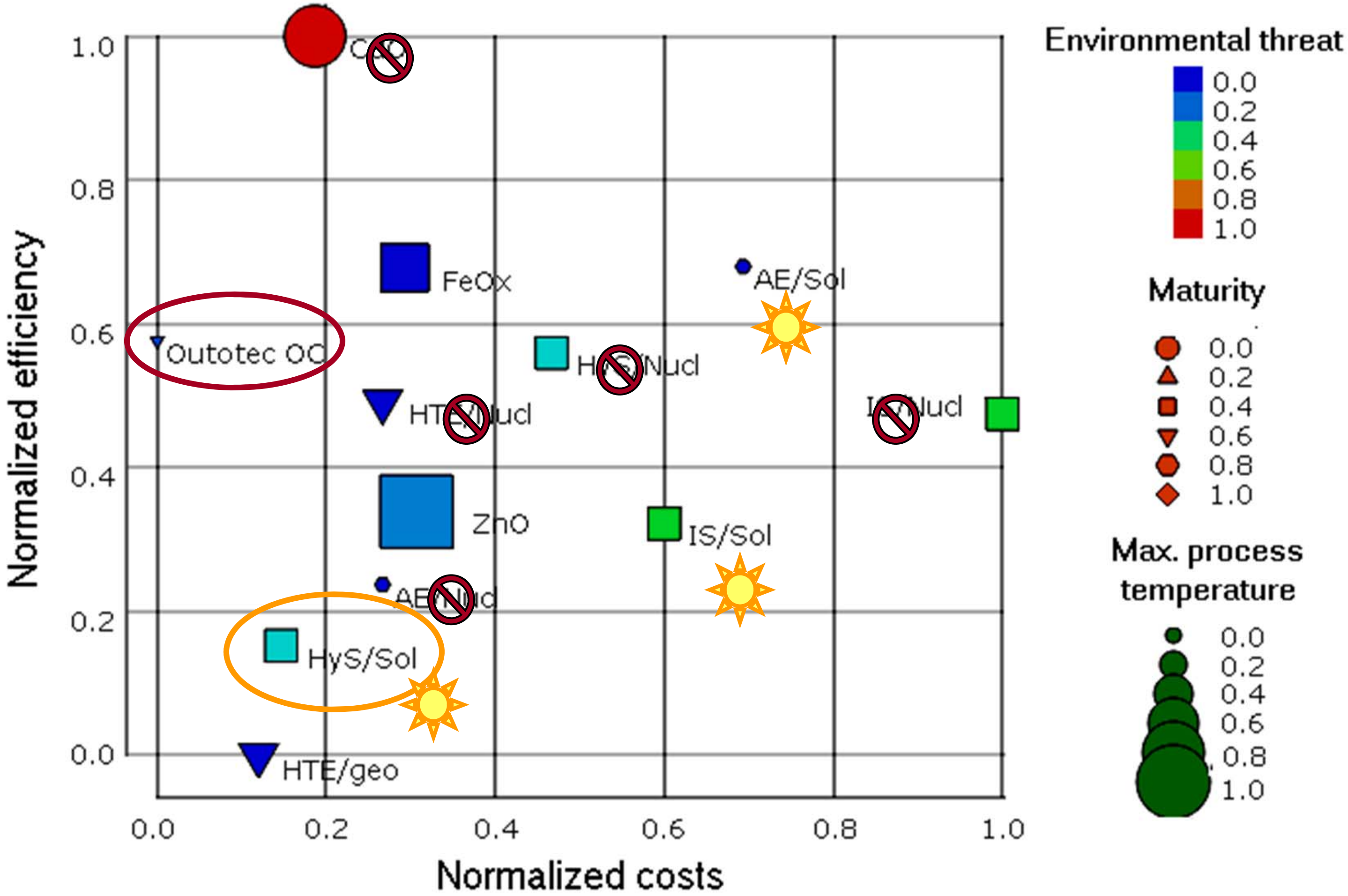
FeOx – iron oxides cycle,

Outotec OC – Outotec open cycle

Sol – solar heat input,

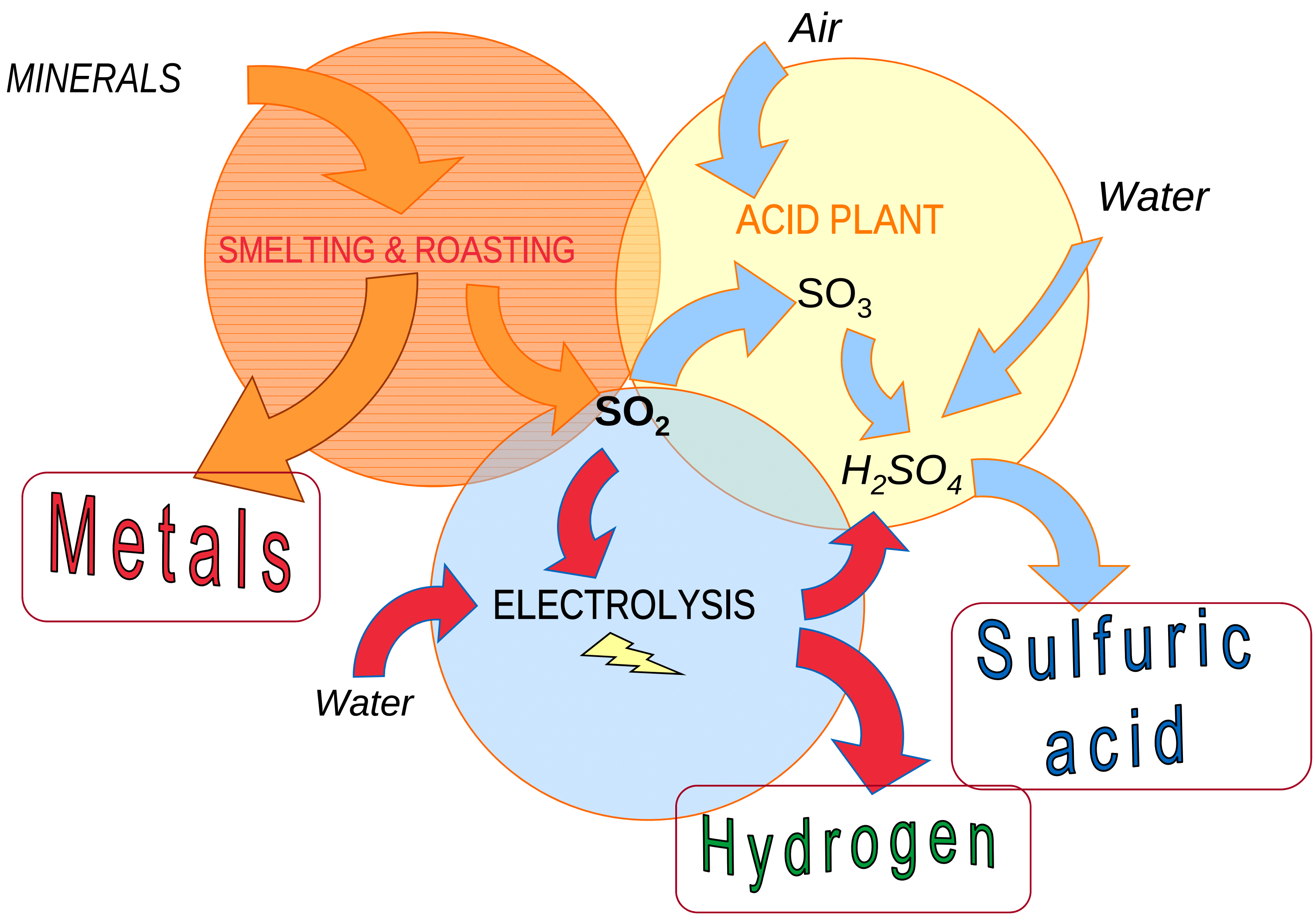
Nucl – nuclear heat input,

Geo – geothermal input.



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

Key process



Outotec® Open Cycle

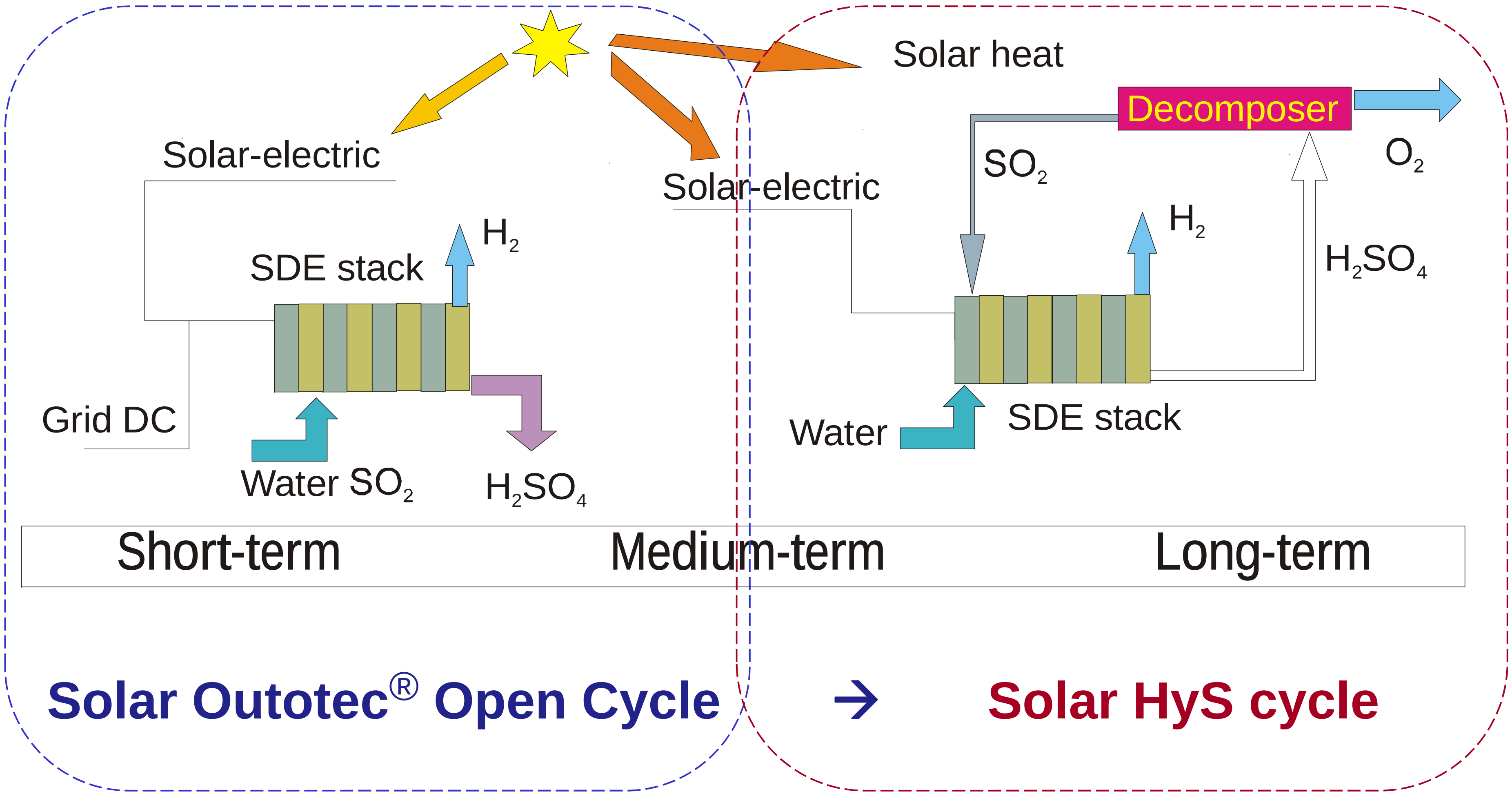
Patented: FI, WO, EA, ZA, US, JP, CN, CA, SA, JR

H_2SO_4?

- ”**More H_2SO_4 is produced than any other chemical in the world**.” *(EC JRC/IPTS report 2006)*
- 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 = <u>5 Mt/a H_2 co-production potential</u>

Project Key Cycles



Why integrated cycles?

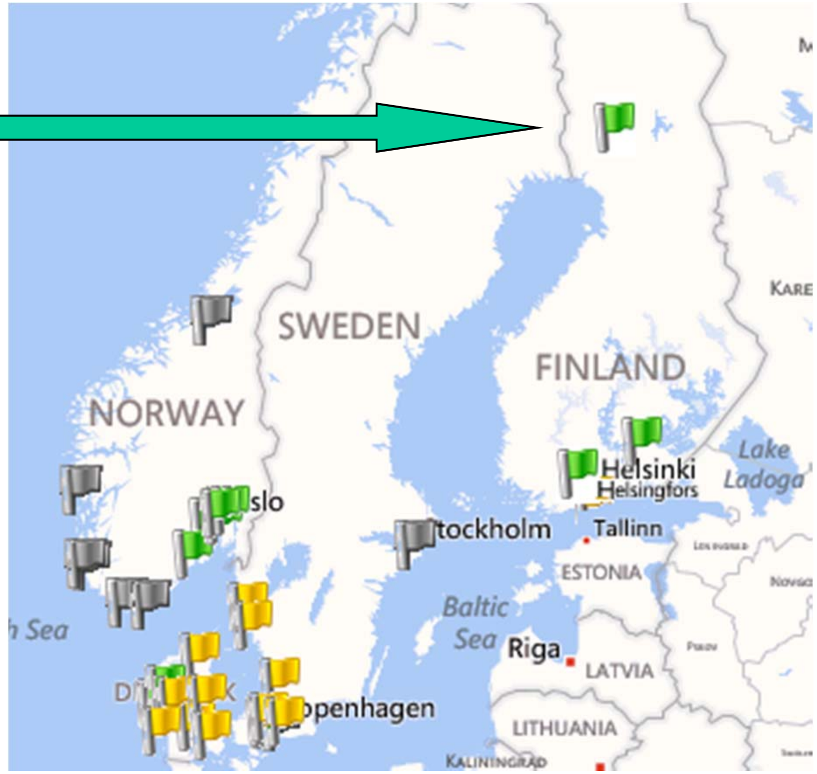
BENEFITS:

- 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 → 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

The most Northern H_2 station opened in 2013



WOIKOSKI - **100 YEARS OF HYDROGEN SUPPLY IN FINLAND**

In cooperation with: Arctic Driving Center (Lapland), H_2-Logic A/S (Denmark)

The most “Southern” H_2 station opened in 2013

Tekes

PORT OF HELSINKI