ECN

Energy research Centre of the Netherlands

SEVENTH FRAMEWORK PROGRAMME

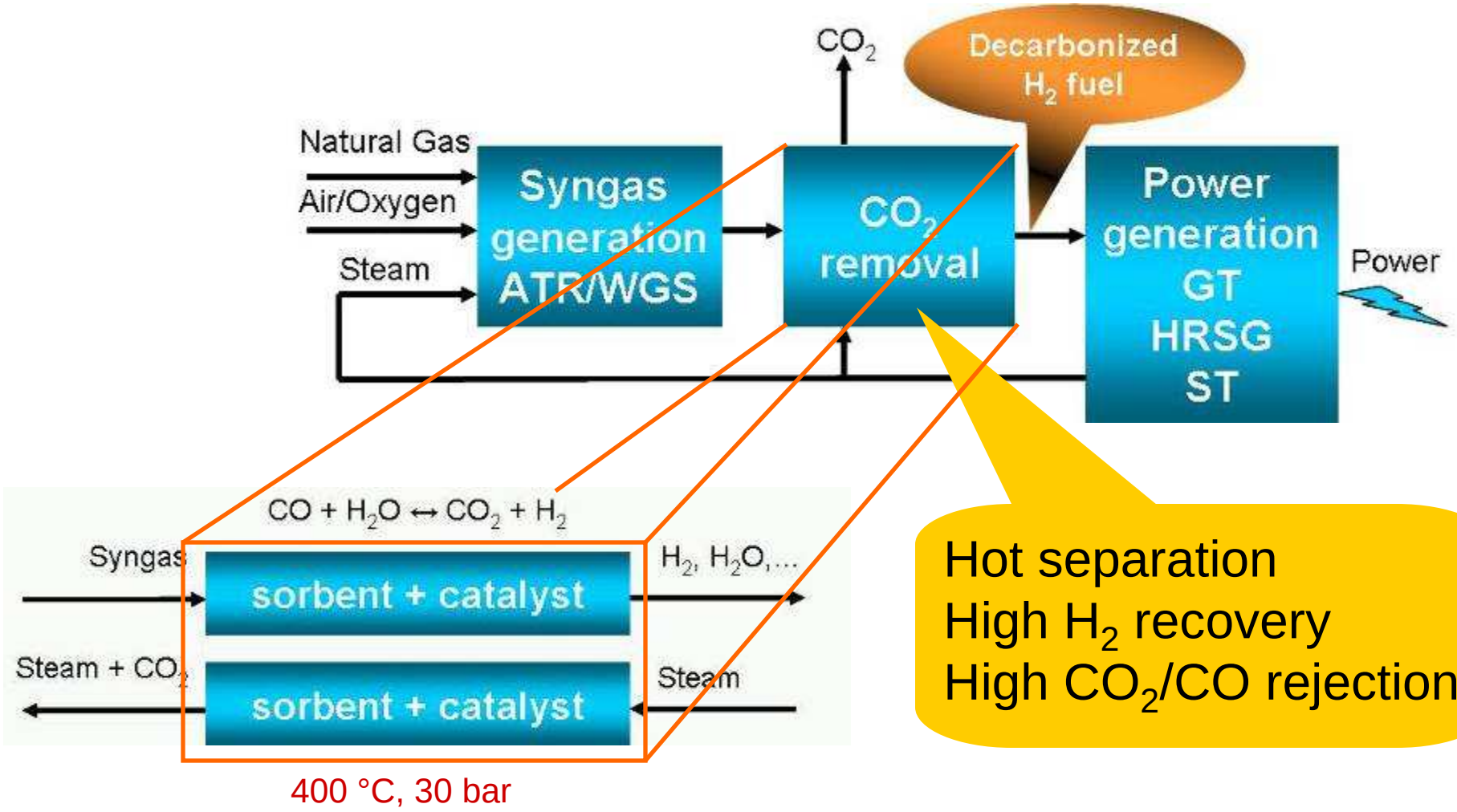
CArbon-free Electricity by SEWGS:
Advanced materials,Reactor-, and process design
CAESAR

European conference on CCS Research, Development and Demonstration
10 – 11 February 2009, Grand Hotel Oslo

CAESAR Introduction

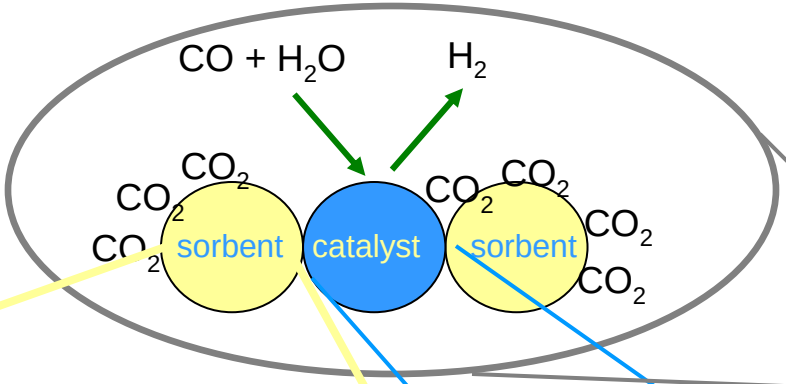
- Small or medium-scale R&D focused FP7 project
- Builds on the SEWGS knowledge gained in CACHET
- Five partners involved:
  - AP (UK)
  - BP (UK)
  - ECN (NL)
  - SINTEF (No)
  - PTM (It)
- 4 years project, started 1 Jan 2008
- Budget 3,1 Meuro

Sorption-Enhanced Water-Gas Shift (SEWGS)



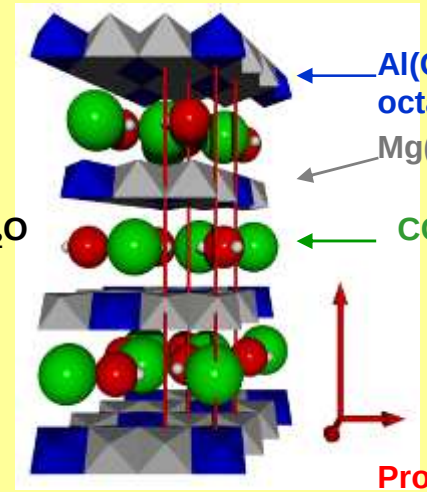
Materials

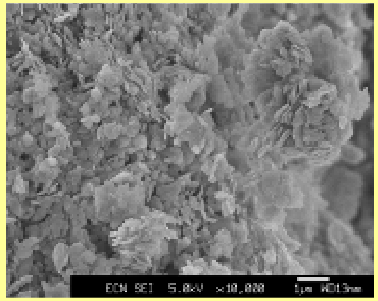
Le Chatelier's Principle



Fe-Cr

$Mg_6Al_2(OH)_{16}CO_3.4H_2O$

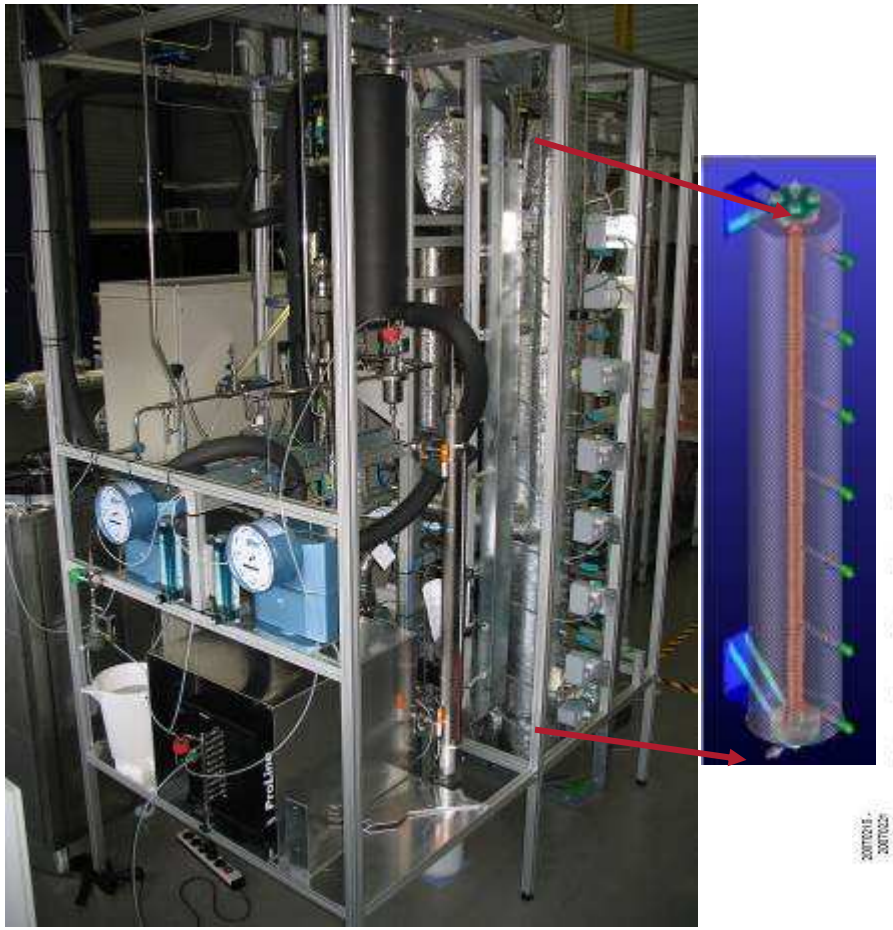




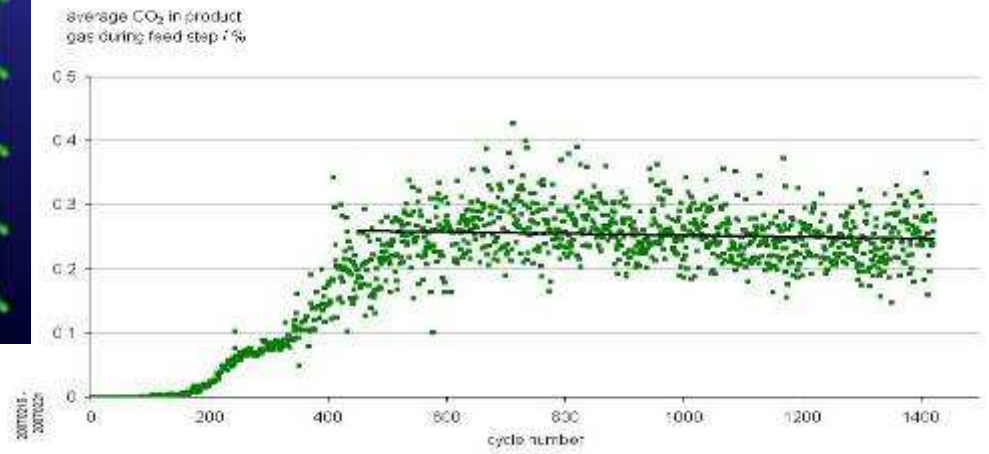
Promoted with K_2CO_3

Hydrotalcite (layered clay)

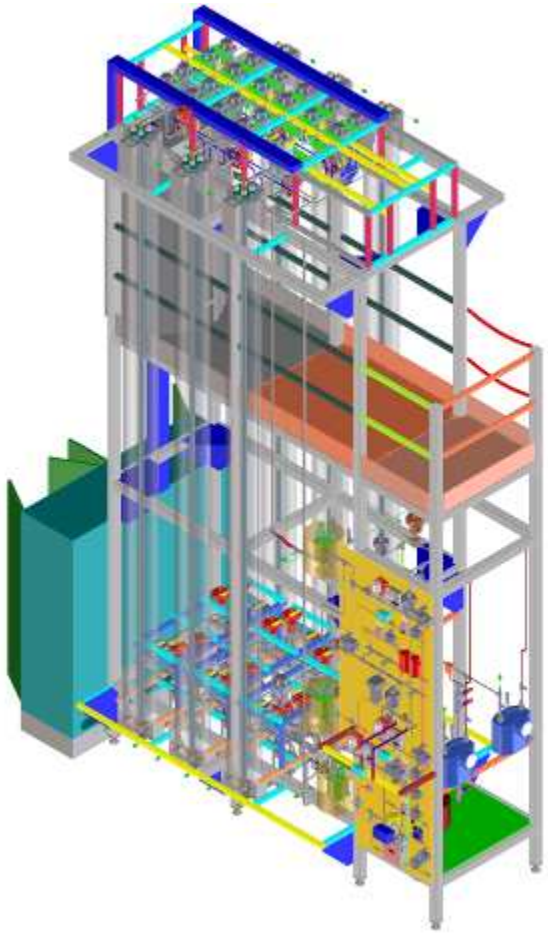
CAESAR: Builds on CACHET SEWGS



- Process development
- Single column unit
- Test cyclic stability of sorbents under WGS conditions



CAESAR: Builds on CACHET SEWGS



Why CAESAR?

- CACHET results showed that novel/improved sorbents are needed for low-cost CO_2 capture with SEWGS;
  - to develop novel sorbents, insight in reaction mechanisms is necessary.
- Novel reactor concepts offer the potential of a more efficient and more economic process.
  - Reactor modelling is essential to develop novel reactor concepts.
- To improve its chances on the market, the SEWGS process should also be made suited for other applications i.e. IGCC and industrial processes (belts furnace gas)

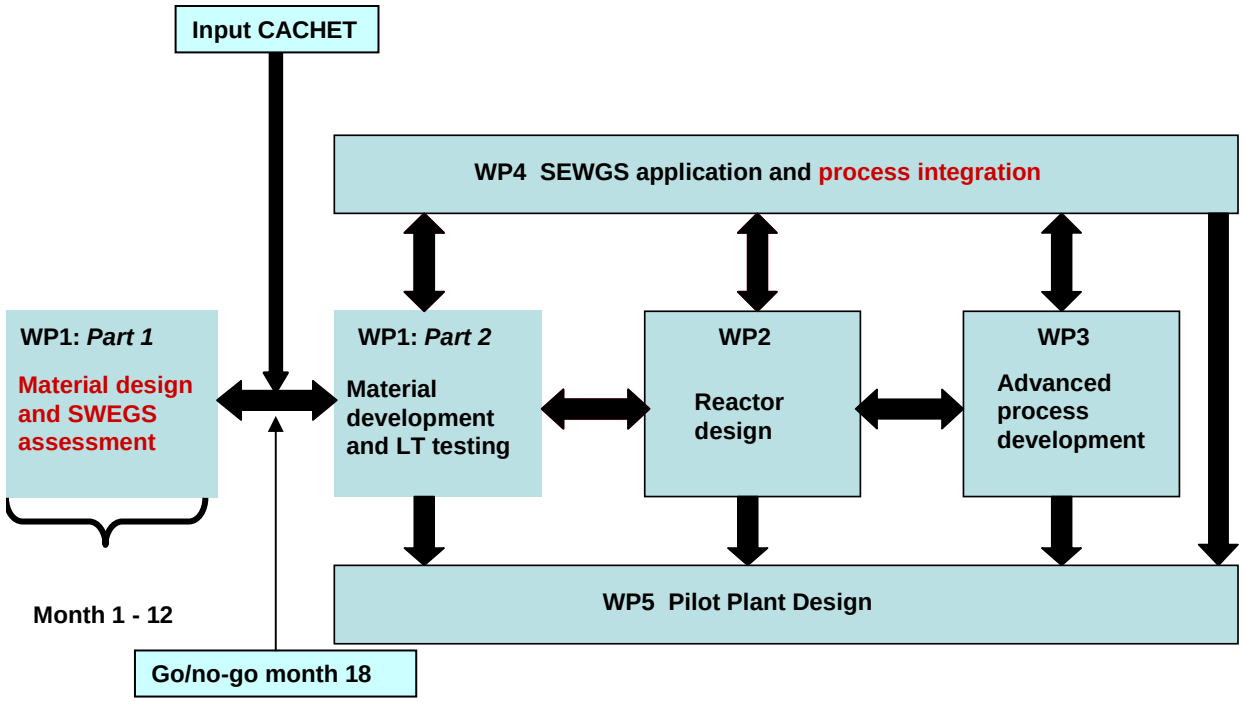
Objectives

Reduction of energy penalty and costs of the SEWGS CO_2 capture process through optimization of materials, reactor- and process design.

- Optimized SEWGS process CO_2 avoidance costs could be reduced with 50%
  - This is translated into an overall steam/CO_2 ratio of 2, compared to a current state of the art level of more than 4.

- Focus on the application of the optimized SEWGS process for pre-combustion CO_2 capture in NGCC's
  - but also look into the application of the SEWGS process in IGCC power plants.

Project approach



- Material design and development
  Month 1- 36
- Reactor design
  Month 13 - 36
- Advanced process development
  Month 18 - 45
- SEWGS application and process integration
  Month 13 - 48
- Pilot plant design
  Month 30 - 48
- Project management, dissemination and use/exploitation planning

In red: Activities in first 18 months up to go/no-go decision

Head line results of sorbent material development (See presentation of Paul Cobden)

Work to increase the working capacity and mechanical stability of sorbent

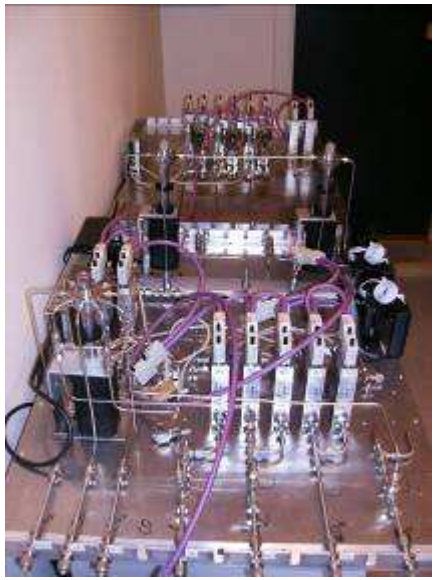
- ECN have prepared several impregnated aluminas to improve the adsorption capacity. The aluminas were impregnated with alkali, alkaline earth, and transition metals and promoted with K.
  - Cyclic adsorption capacities at 350 and 400 C were tested. No breakthrough in terms of capacity yet.

- ECN have also developed new preparation procedures in order to improve sorbent mechanical strength whilst maintaining, or even enhancing, high adsorption capacities.
  - Crush experiments showed that a new preparation procedure can double the mechanical strength of a hydrotalcite material.

Head line results of sorbent material development

- SINTEF have synthesised a set of 11 new sorbents.
  - A screening test by TGA is performed for all new sorbents and compared with the reference material HTC.
  - The three most promising sorbents are selected for further development.

- Further, SINTEF automated and commissioned a PSA (pressure swing adsorption) unit with automated LabView program.
  - The reference hydrotalcite material was tested in this unit under 5, 10 and 20 atm pressures and 400 °C, for both dry and wet conditions.
  - A magnetic suspension balance was commissioned for testing of sorbents under extreme conditions (high pressures and temperatures, corrosive conditions)



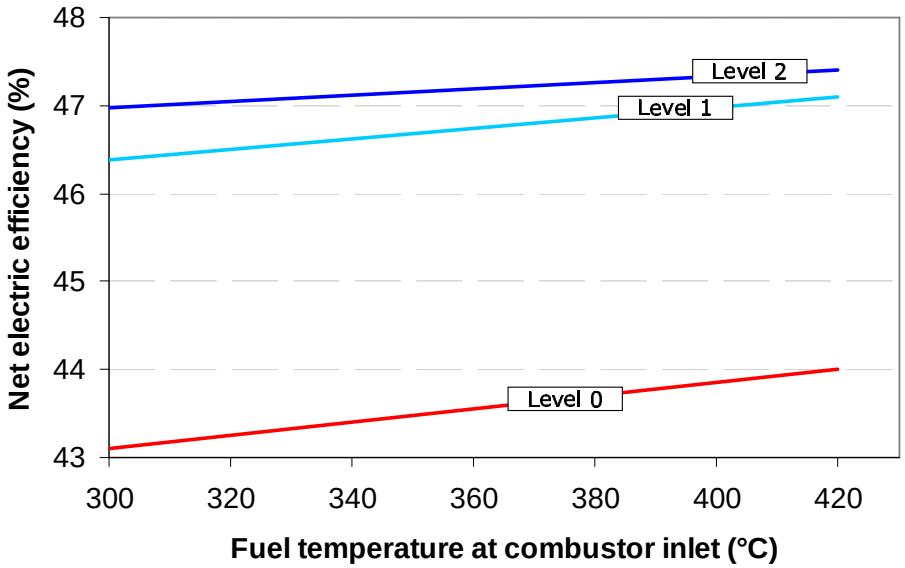
Head line results of catalyst screening

Work to benchmark commercial shift catalysts under realistic cyclic SEWGS operating conditions.

- ECN have finished a desk study with regard to the stability of sour gas shift catalysts under the specific cyclic process conditions in a SEWGS unit
- ECN have completed the commissioning and start-up of a test unit for testing of sweet shift catalysts under pressures up to 30 bar.
- SINTEF have completed the modification of a test unit (fixed bed quarts reactor) for the testing of sour shift catalysts

Head line results of SEWGS assessments (See p-resenation of Giampaolo Manzolini)

- Three different levels of SEWGS integration in the HRSG (heat recovery steam generator) of a NGCC have been assessed by Politecnico Milano
- Basic scheme IGCC + SEWGS established
- Common Framework for CCS



Level 0: The hydrogen island (ATR+SEWGS) and the heat recovery steam cycle are almost decoupled.

Level 2: A full integration of ATR + SEWGS in the NGCC

Economics of 3 integration issues will be assessed.

In practice, integration could be limited by operational issues and metal dusting issues.

Recap

- CAESAR project builds on CACHET SEWGS
- First 12 month emphasis on sorbent development and process feasibility for NGCC and IGCC
- Improved sorbent capacity demonstrated
  - K_2CO_3-promoted promoted-aluminas
  - HTCs with improved preparation procedure
- Improved mechanical strength
  - Shown for an improved preparation procedure
- Proper integration of the SEWGS process in NGCC will improve power generation efficiencies

More info on SEWGS

www.cachetco2.eu