IET-AAU Fuel Cell System Research

Fuel Cell Systems & Optimization

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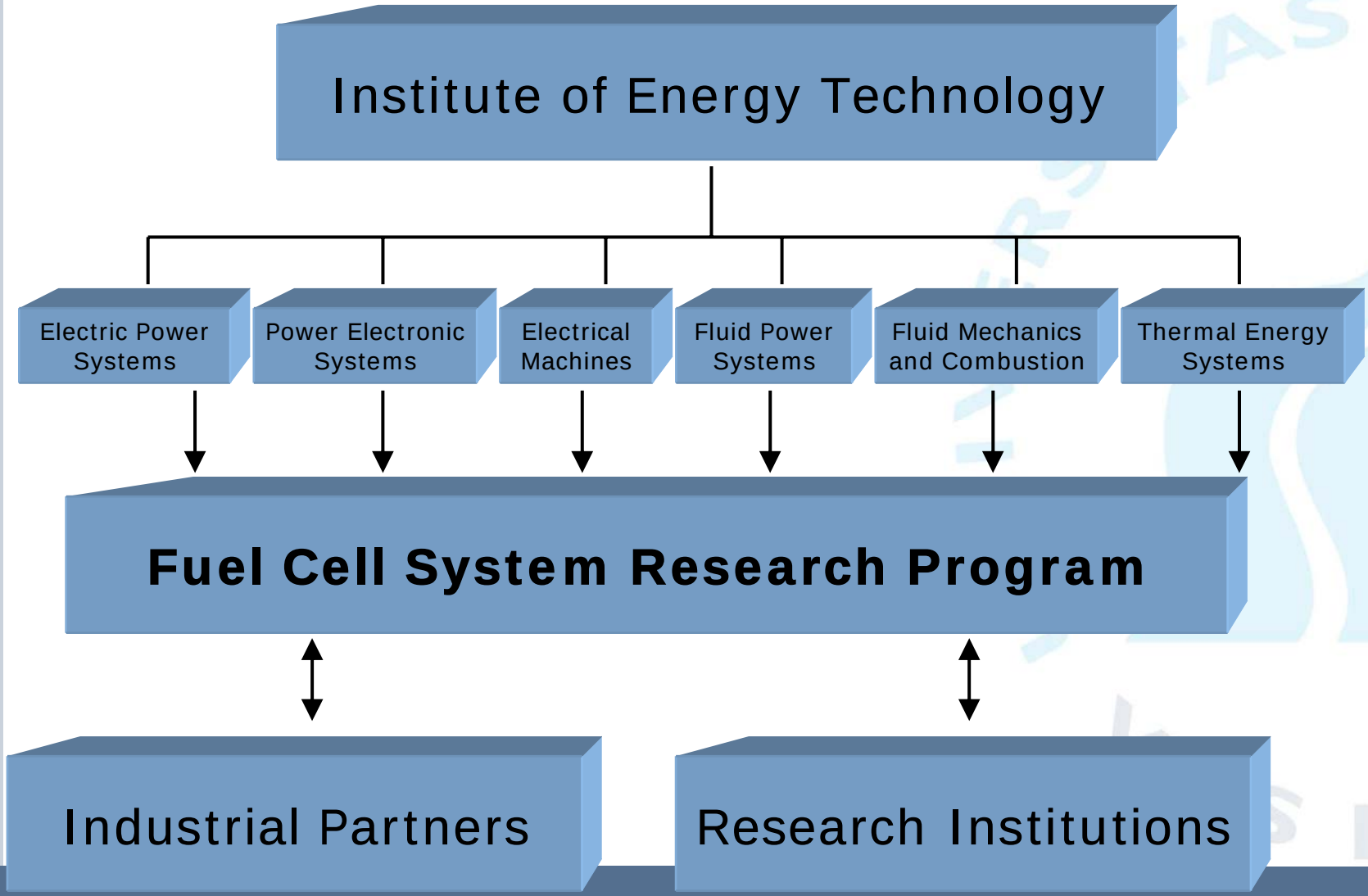
Research program organisation



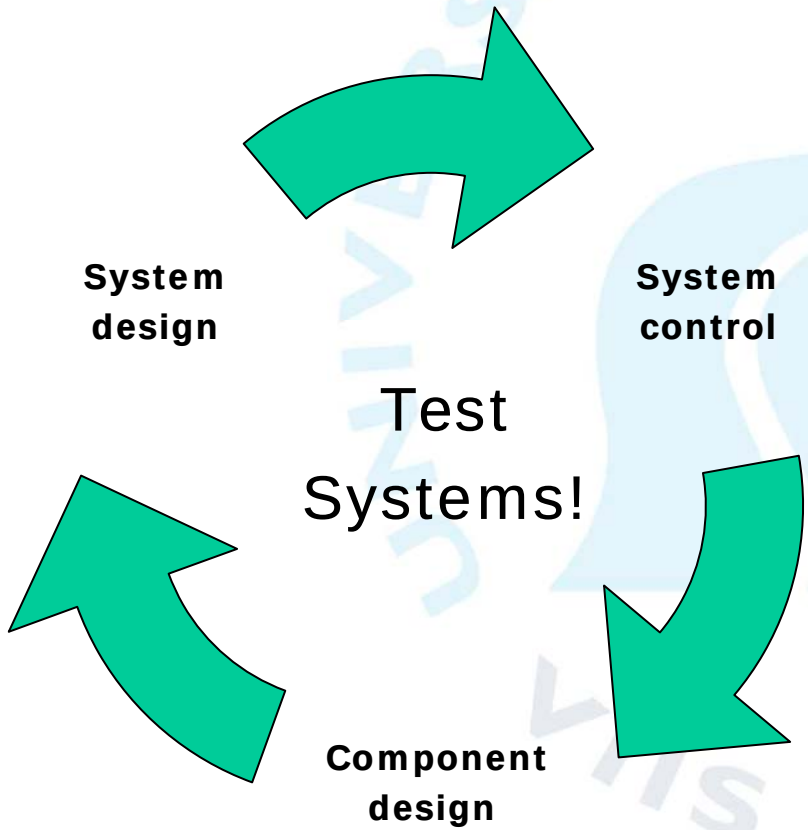
Fuel cell research programme

Mission

- To promote sustainable energy production by conducting definitive leading edge research at international level in fuel cell technology.

Main Research Areas

- Fluid mechanics
- System modeling and optimization
- Advanced system control
- Power electronics



Stack and system test facilities

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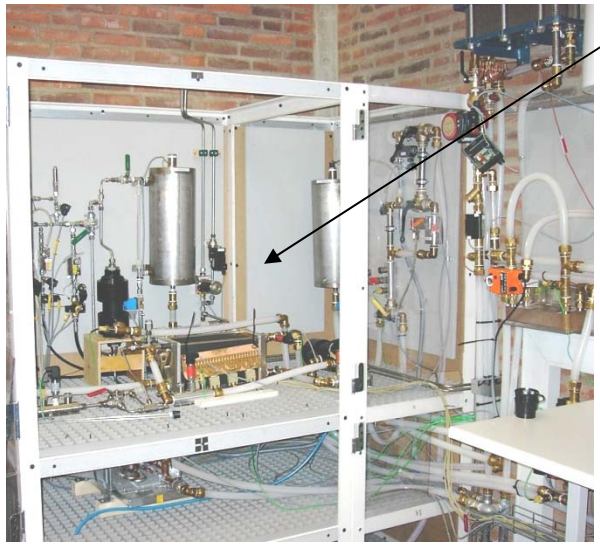
IET-AAU Fuel Cell Research



Advanced stack tests
-Gas composition
-Humidity (anode, cathode)
-Heat management
(All Stack Types < 200°C)

-We tested several PEM stacks from the worlds major stack manufacturers.

Single cell test facilities
- LT-PEM/HT-PEM
- DMFC

System test facilities
Including reformers

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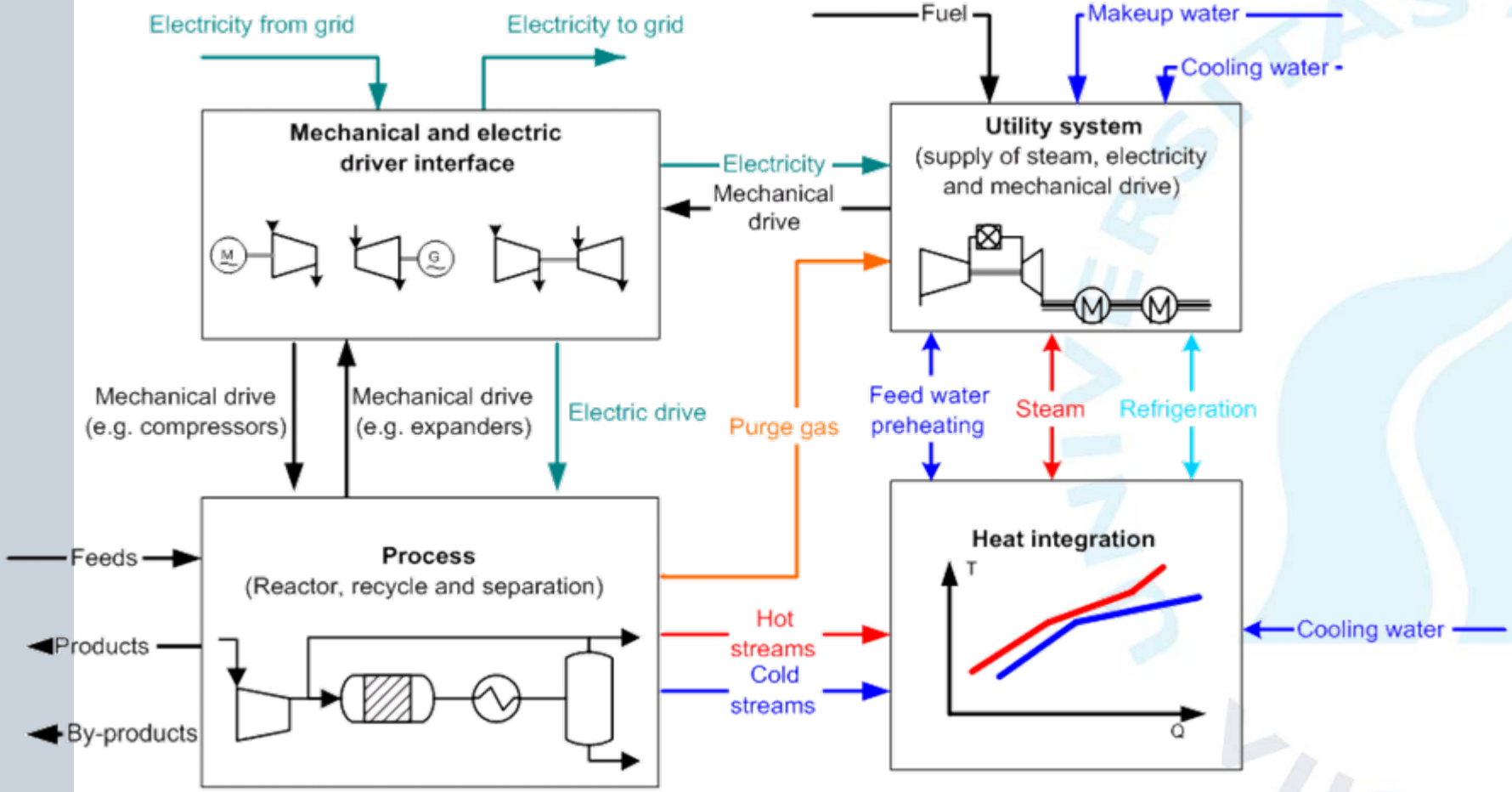
Integrated design vs. simplicity?



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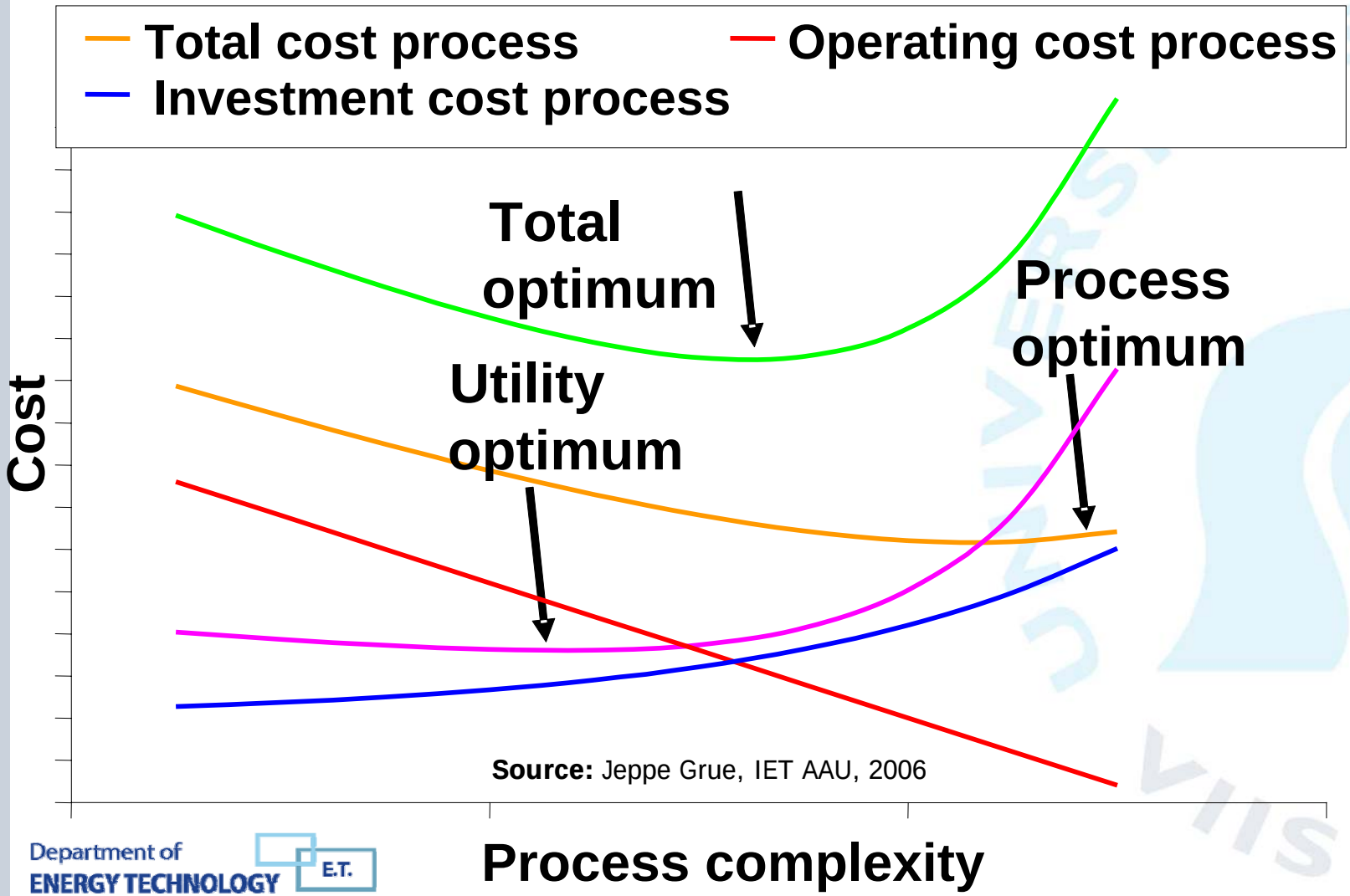
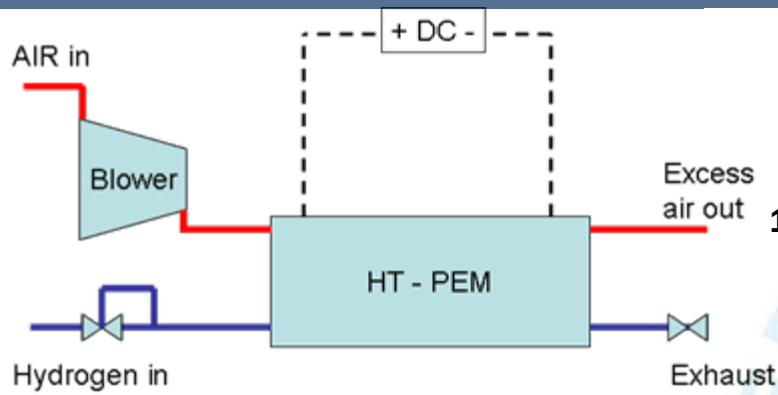
Source: Jeppe Grue, IET AAU, 2006

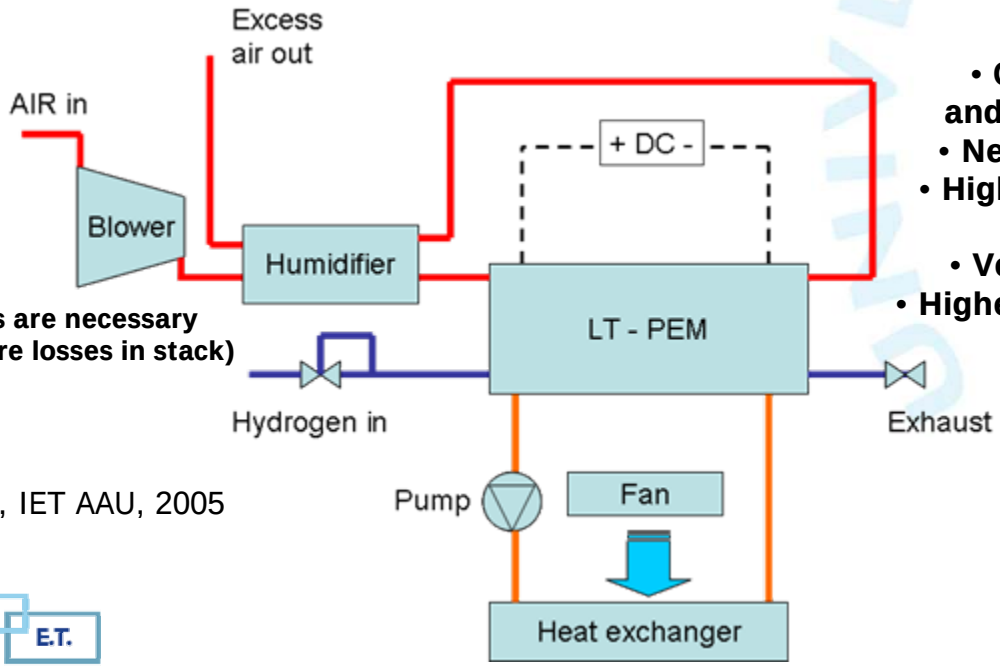
Optimisation of the entire process



LTPEM vs. HTPEM (fueled w. H2)



- **Very simple system**
- **Cooling system can be simplified**
- **High CO tolerance (up to 1 % by volume ~ 10000ppm)**
- **Excess heat could be utilized directly in a reforming system**



(Often compressors are necessary due to internal pressure losses in stack)

- **Complicated heat and water management**
- **Need of humidifier(s)**
- **High air stoichiometries not allowable**
- **Very sensitive to CO**
- **Higher power density from stack**

Source: Mads Bang, IET AAU, 2005

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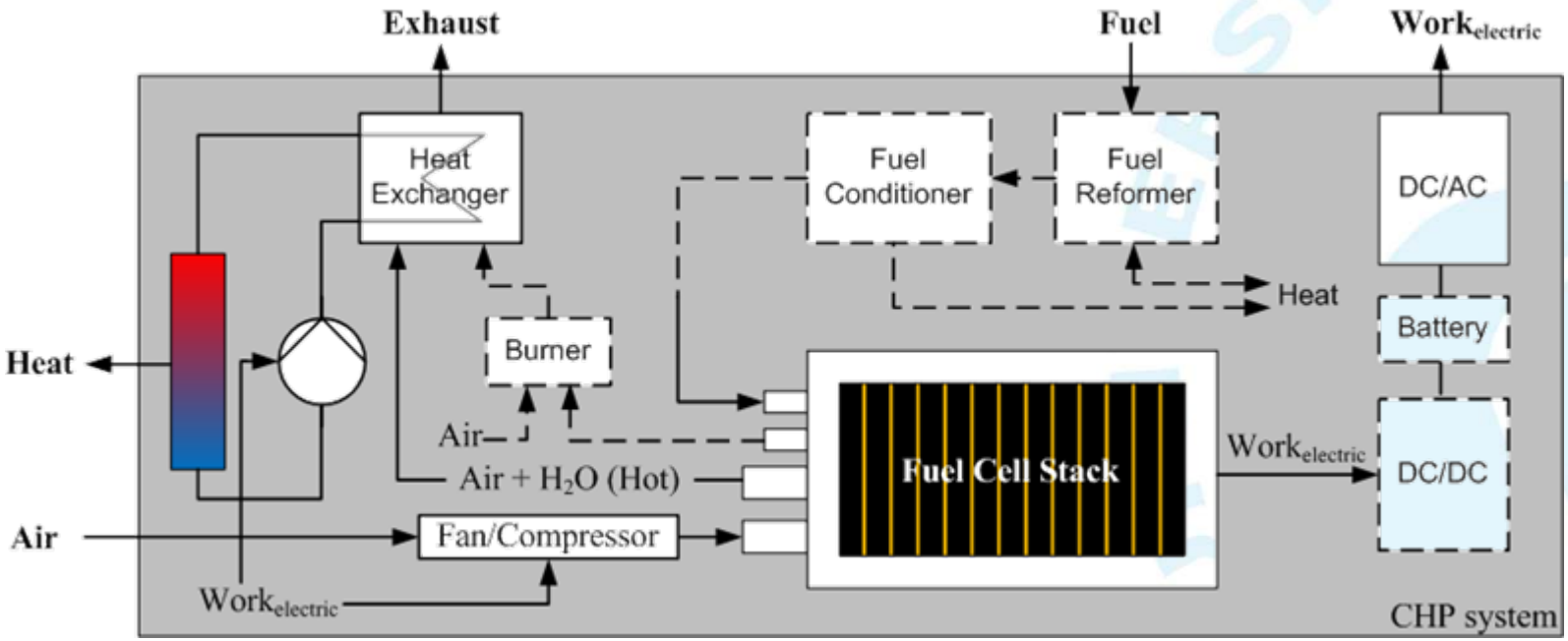
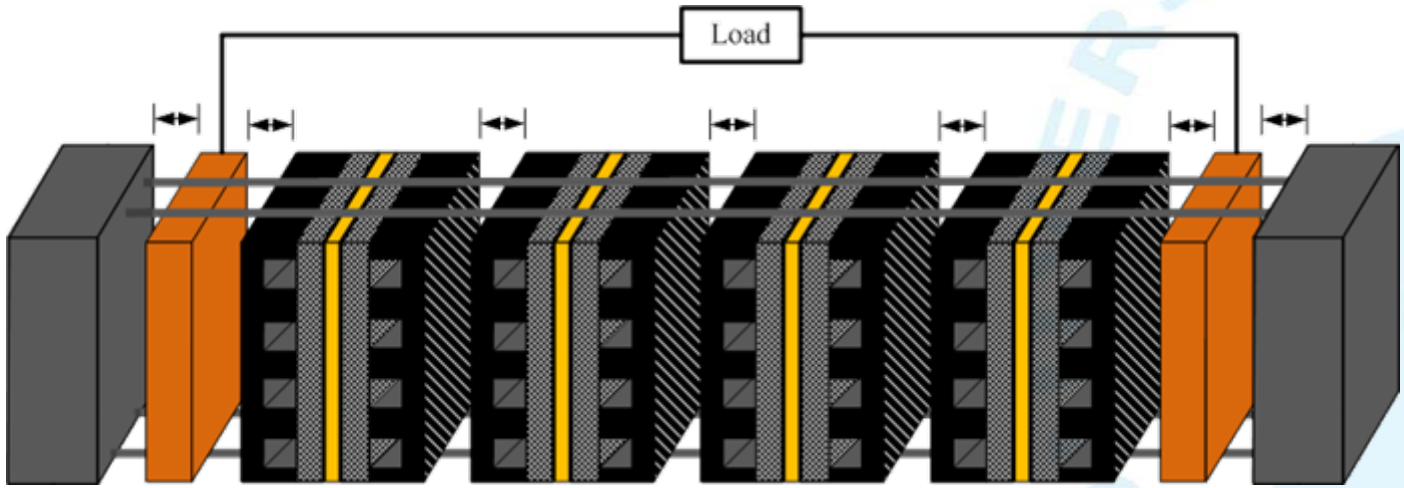
HTPEM system with reforming:



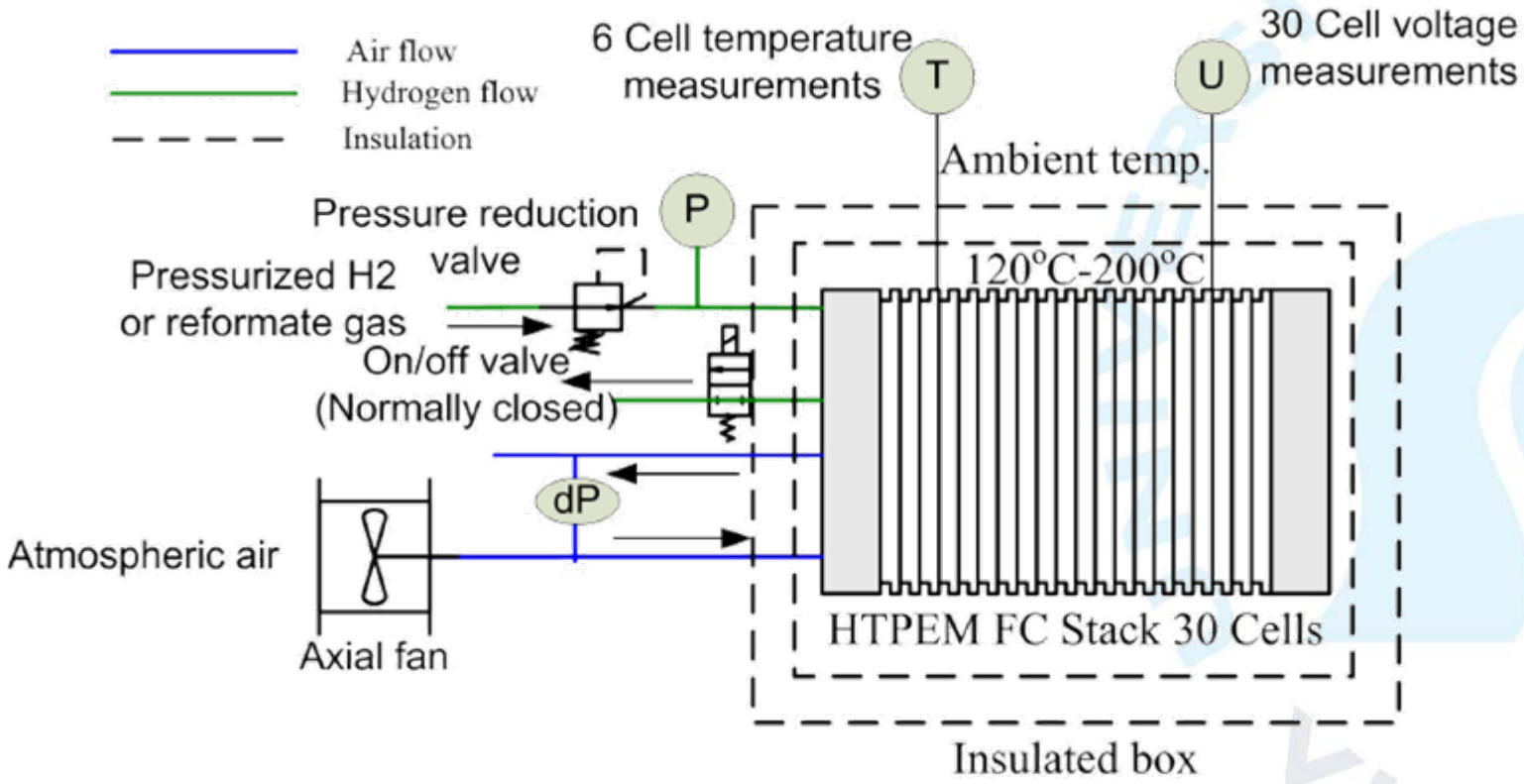
Source: Peder Lund Rasmussen, IET AAU, 2009

Stack interconnection



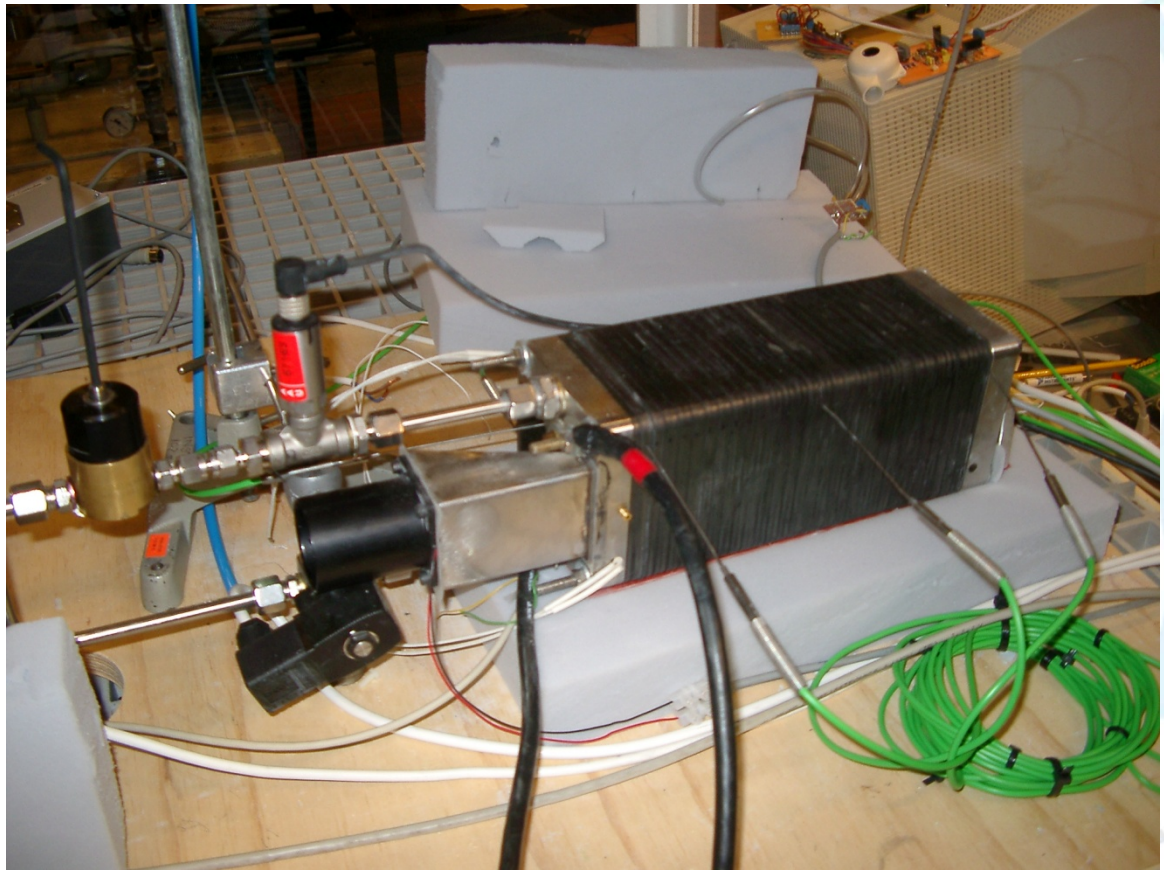
Source: Peder Lund Rasmussen, IET AAU, 2008

Worlds simplest stack including BOP!



Source: Søren Juhl Andreasen, IET AAU, 2008

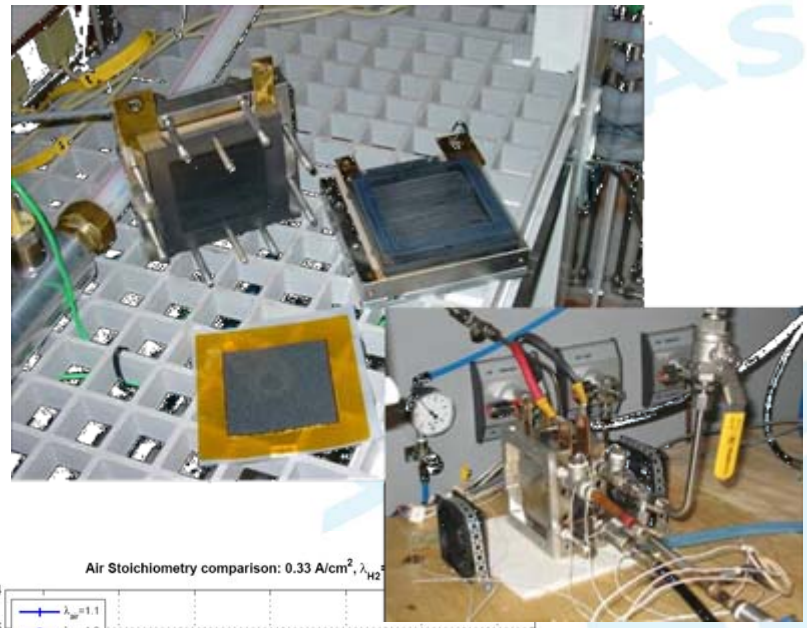
First HTPEM-stack developed at AAU:

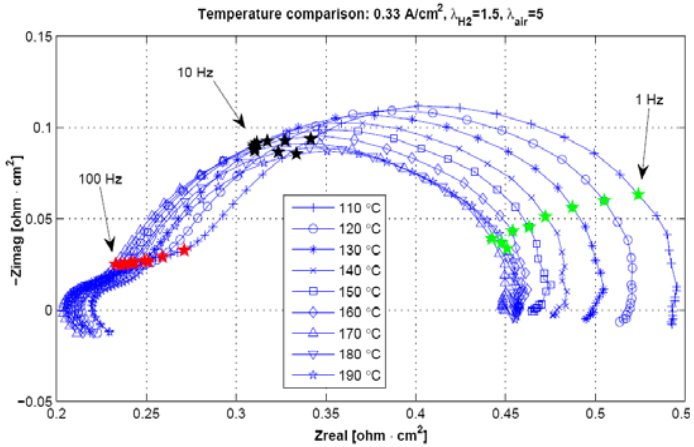


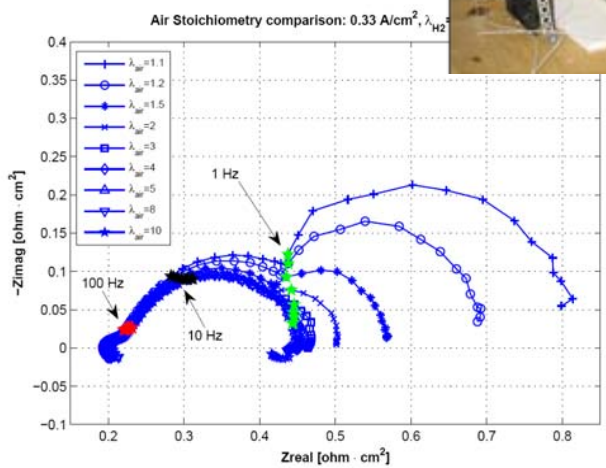
HT-PEMFC cells, stacks and systems

Research activities

- Detailed durability studies
- Optimization of operating cond.
- Advanced measurements
  - Impedance spectroscopy
  - In-situ thermo sensors
  - Flow, gas composition







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Source: Jesper Lebæk, Erhvervsforsker, TI & IET AAU, 2009

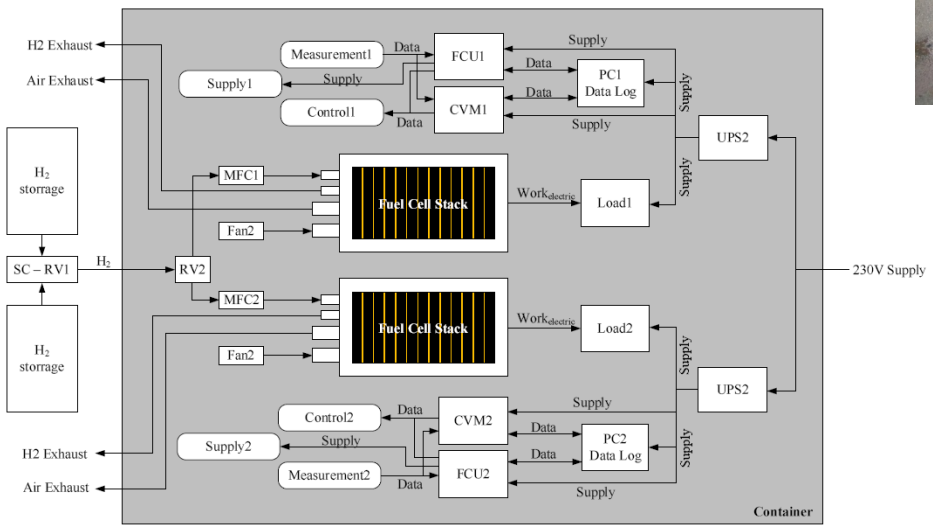
Stack degradation tests

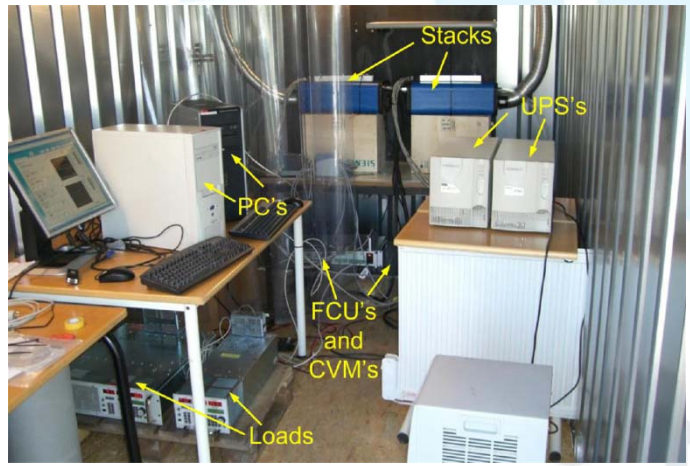
Isolated test facility

- Continuous hydrogen supply
- Uninterruptible power

Investigated parameters

- Temperature
- Operating point





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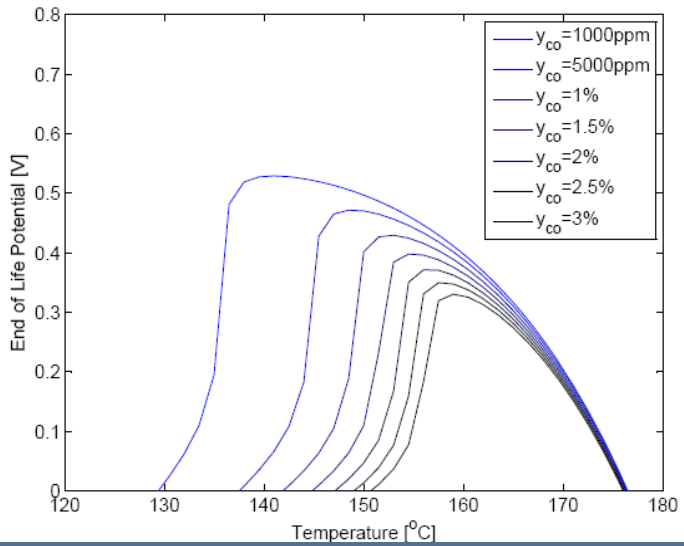
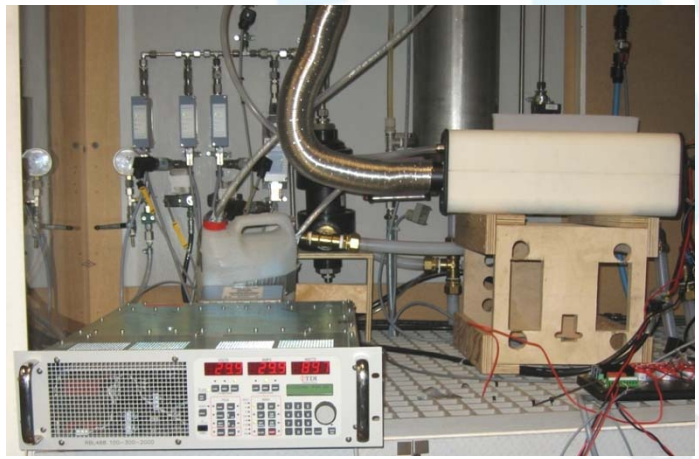
Stack test facility

Stack performance-/degradation tests

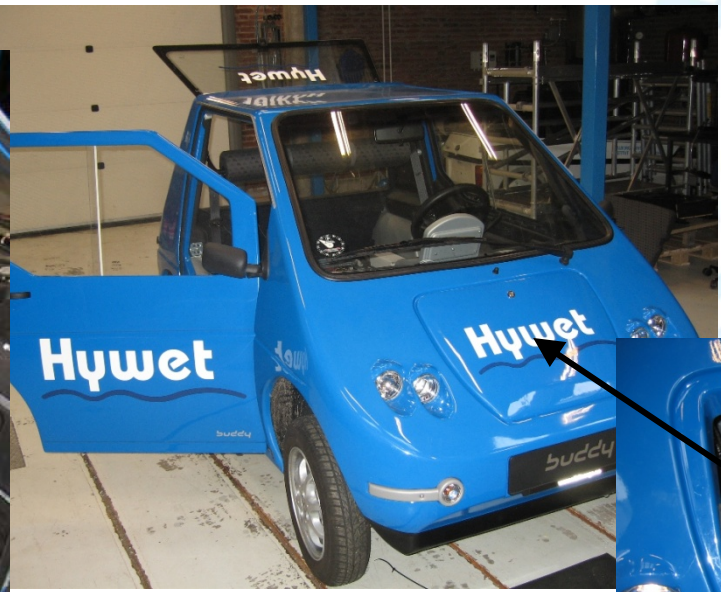
- Hydrogen and synthesis gas operation
  - H_2, CO_2, CO, N_2, H_2O (steam reformering, ATR, CPO)
  - Anode stoichiometry
- Optimum operational temperature
  - Theoretical description of main degradation mechanisms
  - CO tolerance vs. degradation (Pt agglomeration+carbon corrosion)

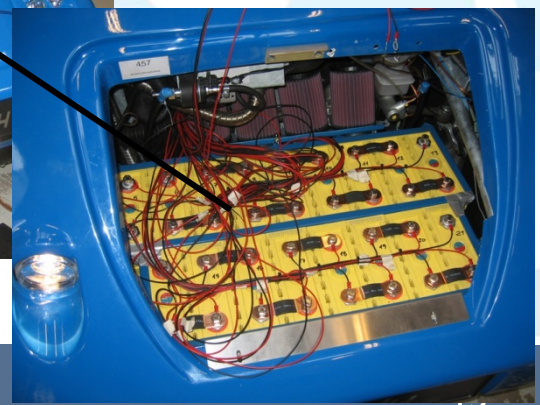




HTPEM hydrogen system

- Integration in a battery/fuel cell hybrid system
  - 4 kW HT-PEMFC
  - 11 kWh Li-Ion batteries
  - 13 kW electric drive system
- 80 km/h and approx. 160 km range

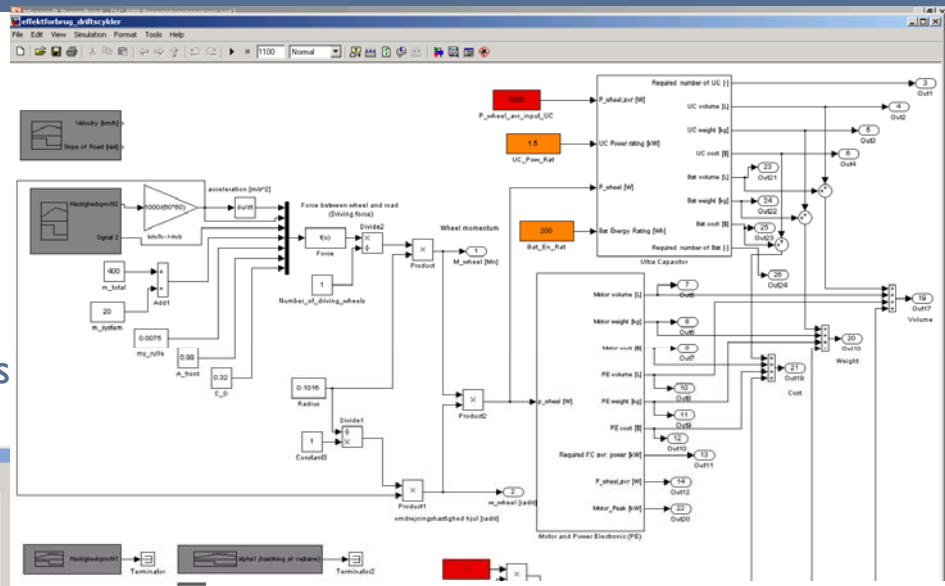


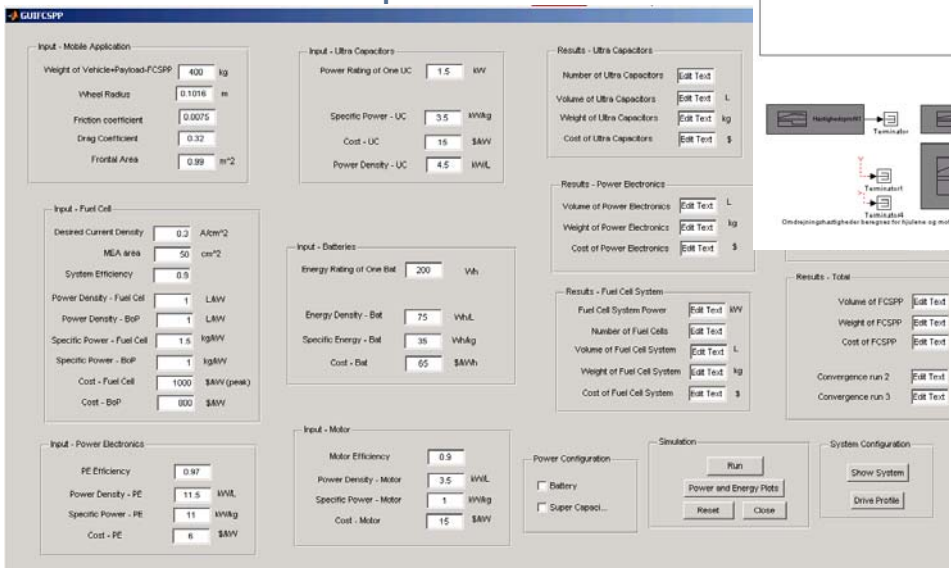


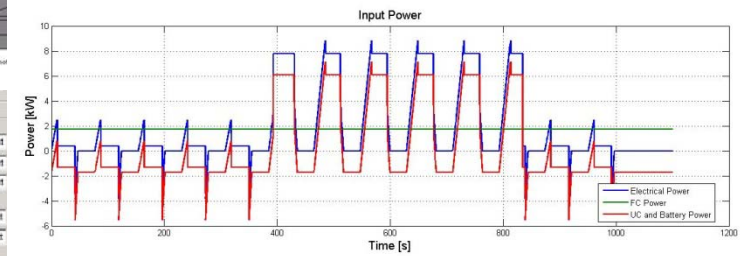
Simulation of hybrid vehicles

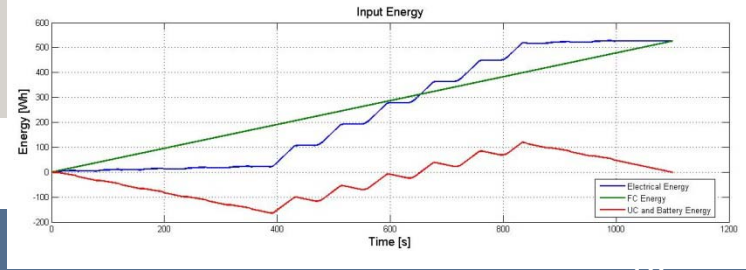
Design of system configuration
Sizing of main components

- Battery
- Supercaps
- Fuel cell system
- Dynamic response and limitations of each component









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Thank you for your attention!