Operability of power plants with CCS

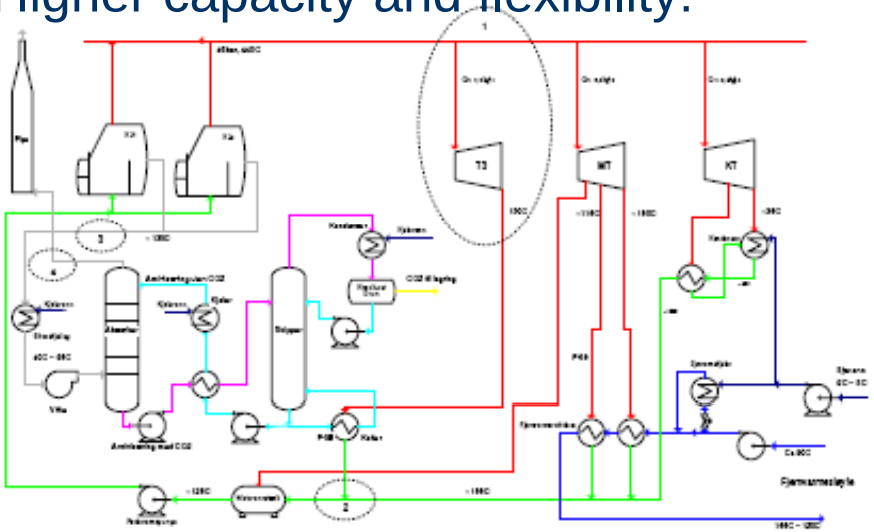
Earlier and ongoing projects at NTNU Department of engineering cybernetics and SINTEF applied cybernetics

Prof. Bjarne A.Foss, NTNU
Ph.D. student Lei Zhao, NTNU
Finn Are Michelsen, SINTEF ICT

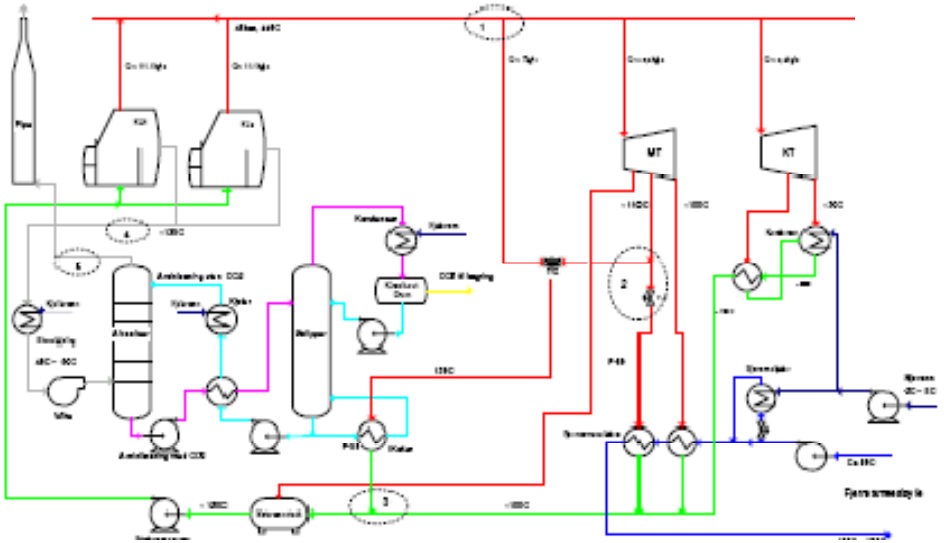
Workshop on operating flexibility of CCS plants, Imperial College London Nov.11.-12.

Carbon capture at the coal-fired power plant in Longyearbyen (Svalbard)

Higher capacity and flexibility:



Minimum investment:

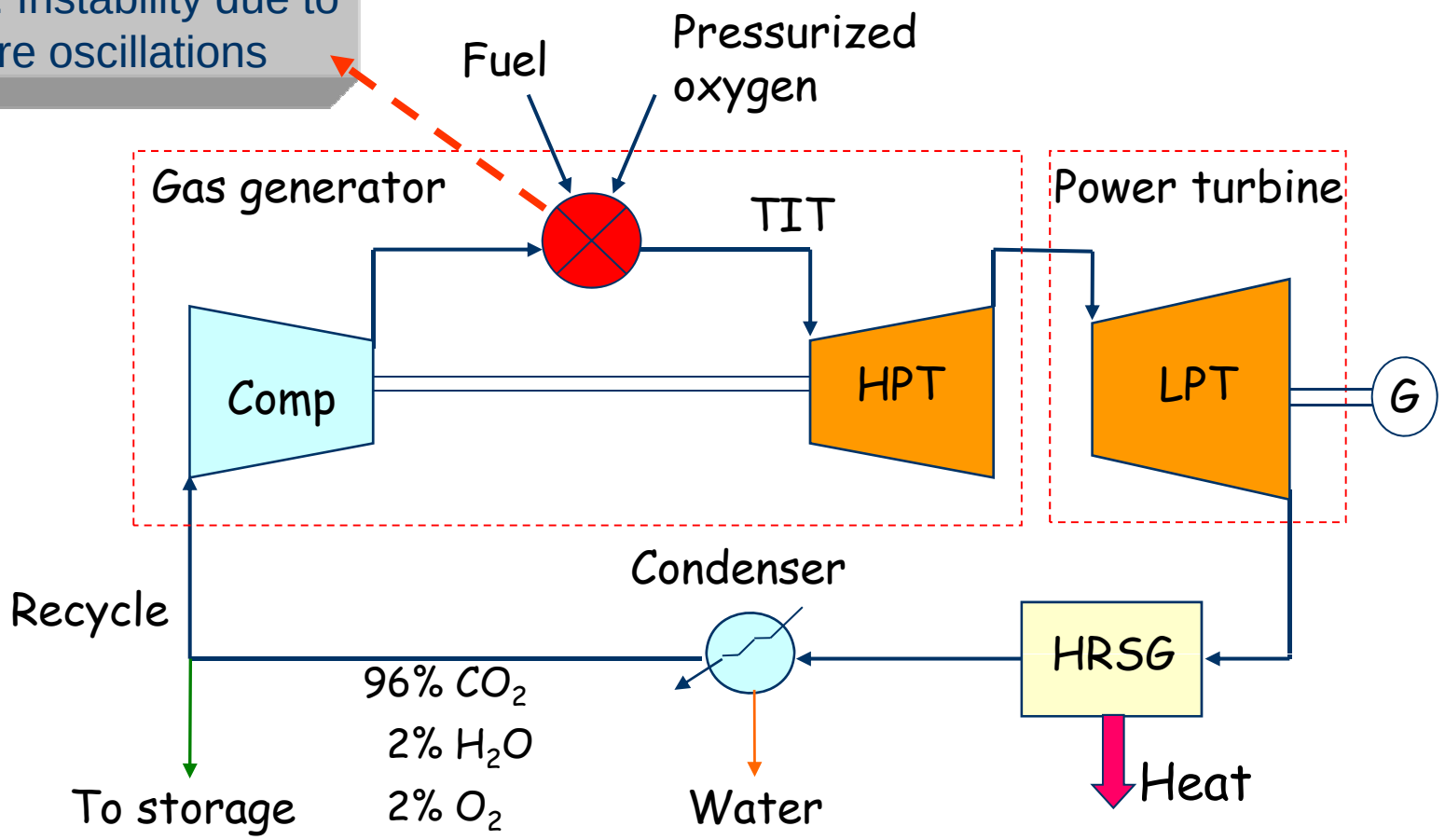


CO_2 capture 85-95%
Small reduction of efficiency

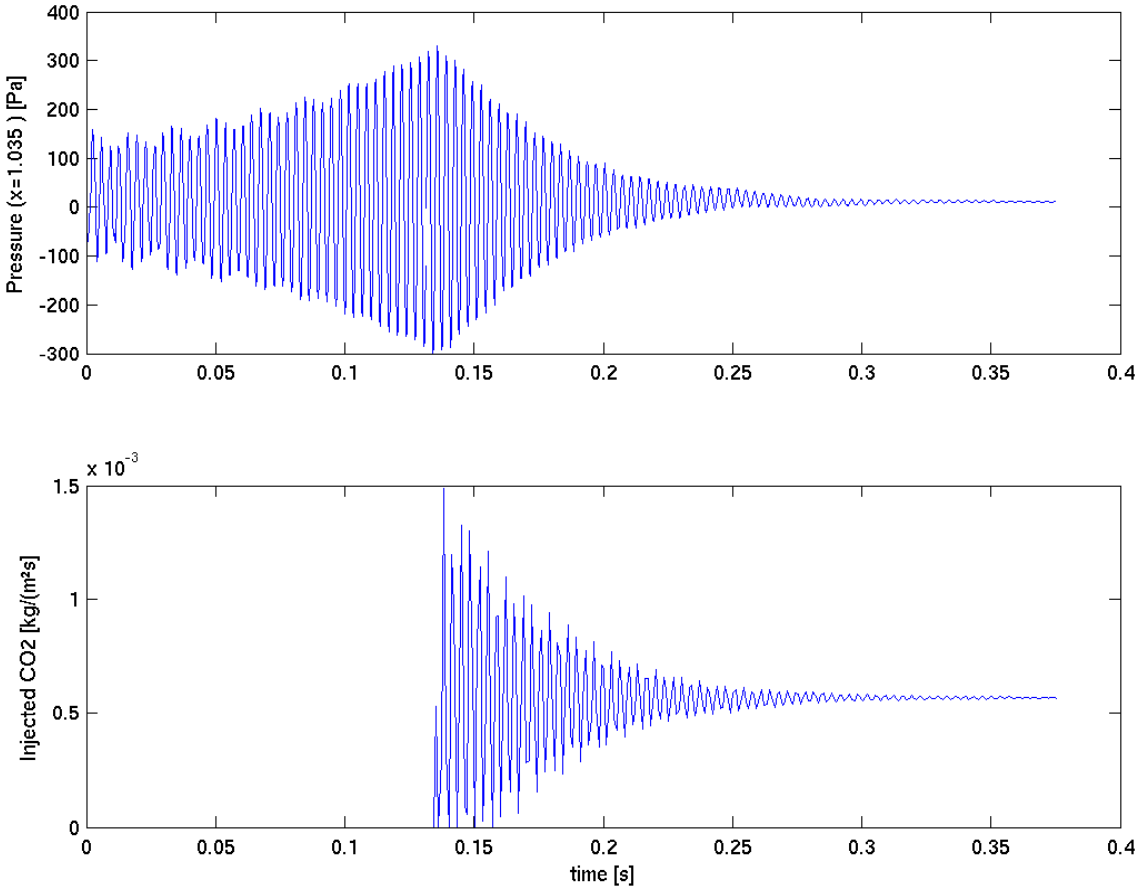
- Master project, Atle Storaker (B.A.Foss)
- Two post-combustion solutions (amine absorption columns) which are integrated with the existing power plant
- Completion July 2008
- In collaboration with professor H. Svendsen, NTNU

Active control of instabilities in oxy-fuel combustion

Challenge: Instability due to HF pressure oscillations

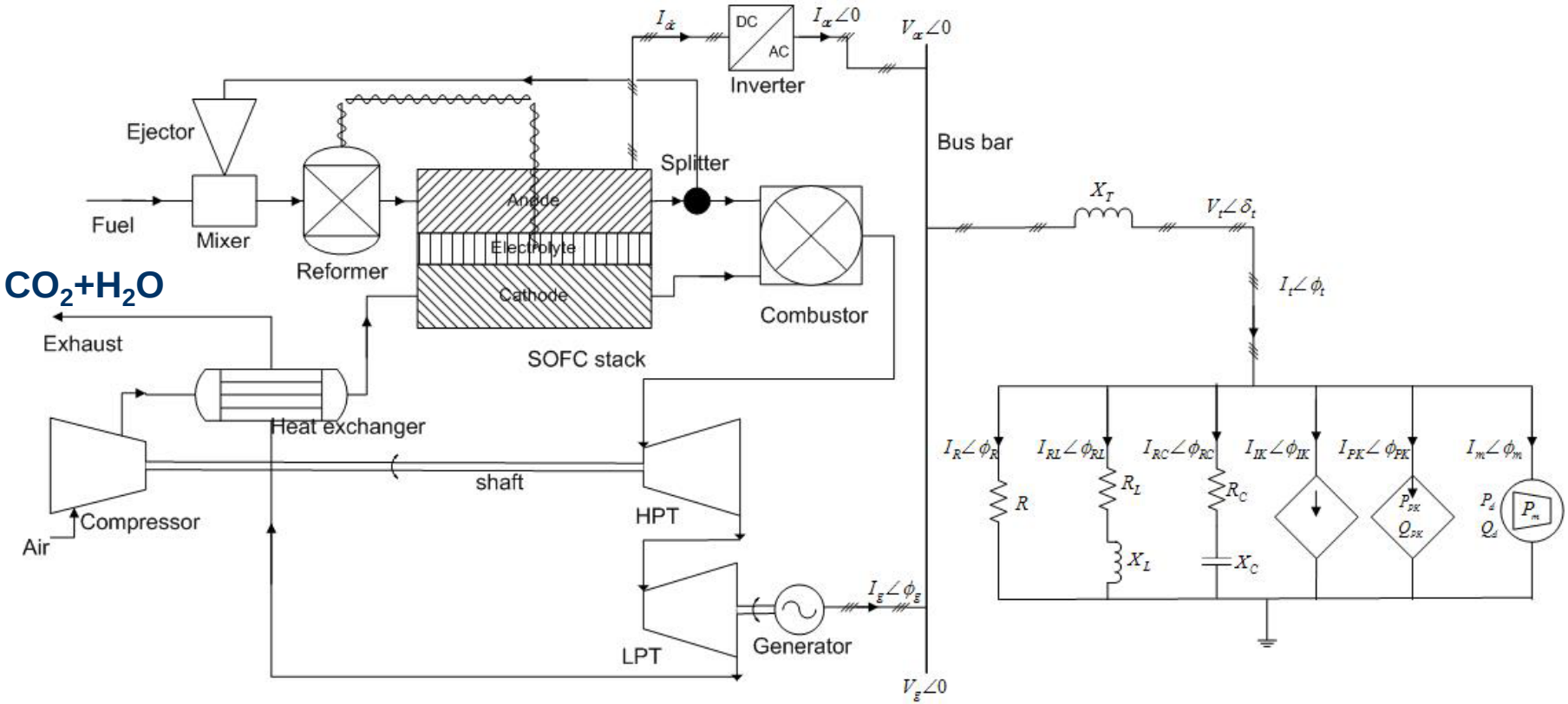


Solution: Injection of CO_2 at the right position in front on the flame



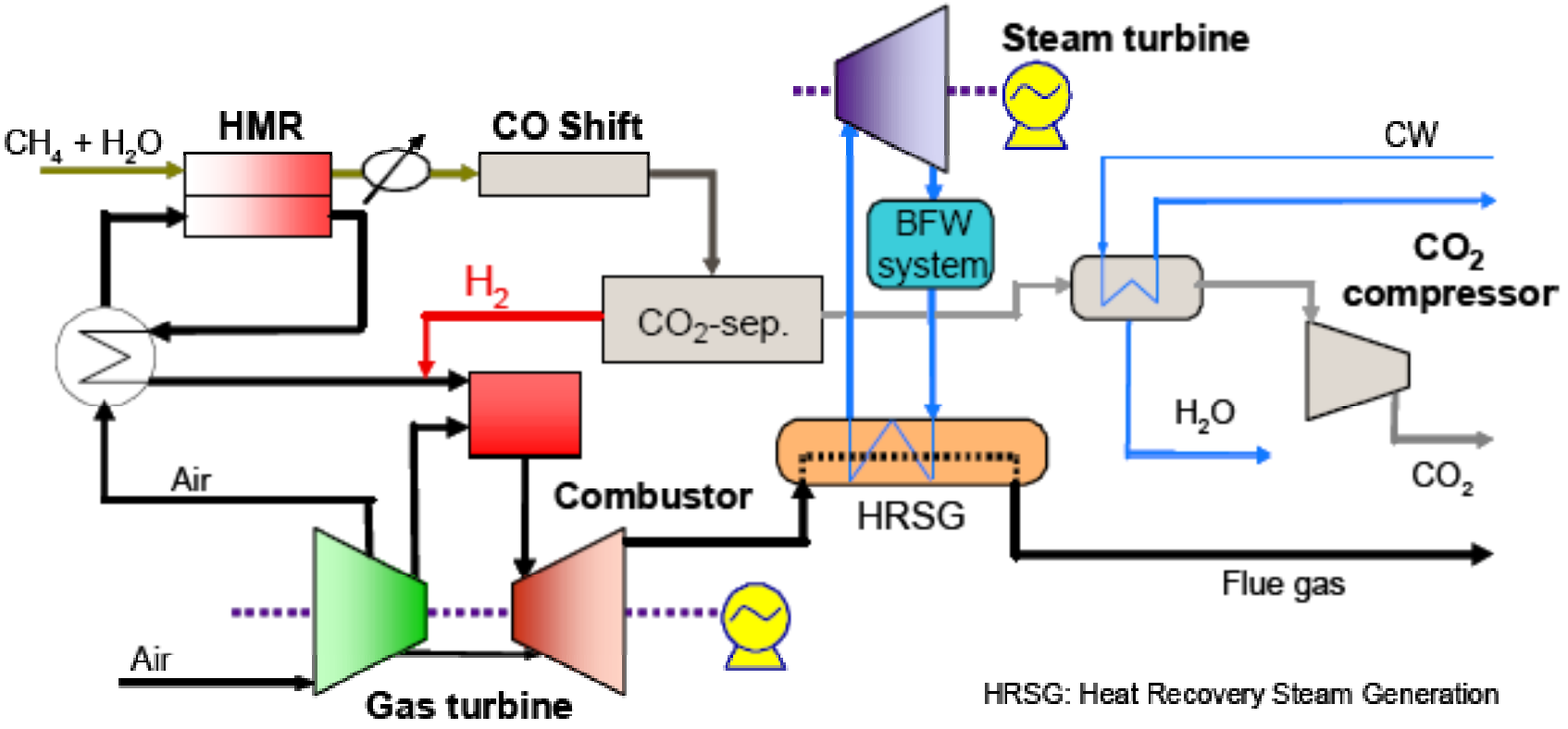
- PhD project, Dagfinn Snarheim (B.A.Foss)
- New low-order dynamic model suitable for control design
- Robust active controller for damping combustions instabilities
- Enabler for active control as a design option for combustion systems
- Completion September 2009
- In collaboration with Dr. Nils E. Haugen, SINTEF and professor Ghoniem, MIT

Control relevant modelling and nonlinear state estimation applied to SOFC-GT systems



- PhD project, Rambabu Kandepu (B.A.Foss)
- New low-order dynamic model suitable for control design
- Control structures for improved transient performance
- New algorithm for online estimation for model-based control
- Completed December 2007
- In collaboration with professor Biao Huang, Univ. of Alberta

Control relevant modelling and control of a HMR reactor system in a pre-combustion carbon capture gas power cycle



- PhD project, Lei Zhao (B.A.Foss)
- New dynamic model suitable for control design
- Control structures for improved transient performance (optimizing operation during startup, shutdown, load changes and disturbances)
- Consideration of CO_2 emission, utility rate of methane, net power output and transition time for load changes etc.
- To be completed in 2011
- In collaboration with professor O. Bolland and H. Svendsen, NTNU and F. A. Michelsen, SINTEF ICT

Common (cybernetic) approach

- Control relevant model
- The impact of process design decisions (sizes, locations,..) on operability, control, process efficiency and carbon capture (and vice versa), e.g.:
  - Active control for stabilization
  - Location of sensors (what to control?) and actuators
  - How easy is the process to control?
- The model for control design can also be used to evaluate more detailed design of process units:
  - Analyse sensitivity from design parameters to controllability
  - Identify critical parameters, e.g. heat exchanger, compressor and turbine sizing.

A systematic procedure for **integrated process and control design** can improve both design and operation. This area should be further explored.