

Simulating impacts of flexibility on CCS Chains with gCCS

Laurence Robinson – E.ON New Build & Technology Ltd.
APGTF – London – 12th February 2014

Contents

- ETI System modelling toolkit project
- gCCS capabilities
- Analysis of a dynamic case study
- Summary

Energy Technologies Institute (ETI)

Public-private partnership between global industries and the UK Government set up with the objectives of

- ensuring clean, secure and affordable energy supplies are available to power everyday living and business
- reducing greenhouse gas emissions to tackle the effects of climate change

The ETI makes targeted investments in key technologies that will help the UK meet its legally binding 2050 targets

ETI members

Corporate



Public institutions

Technology Strategy Board
Driving Innovation



BIS | Department for Business
Innovation & Skills



e-on

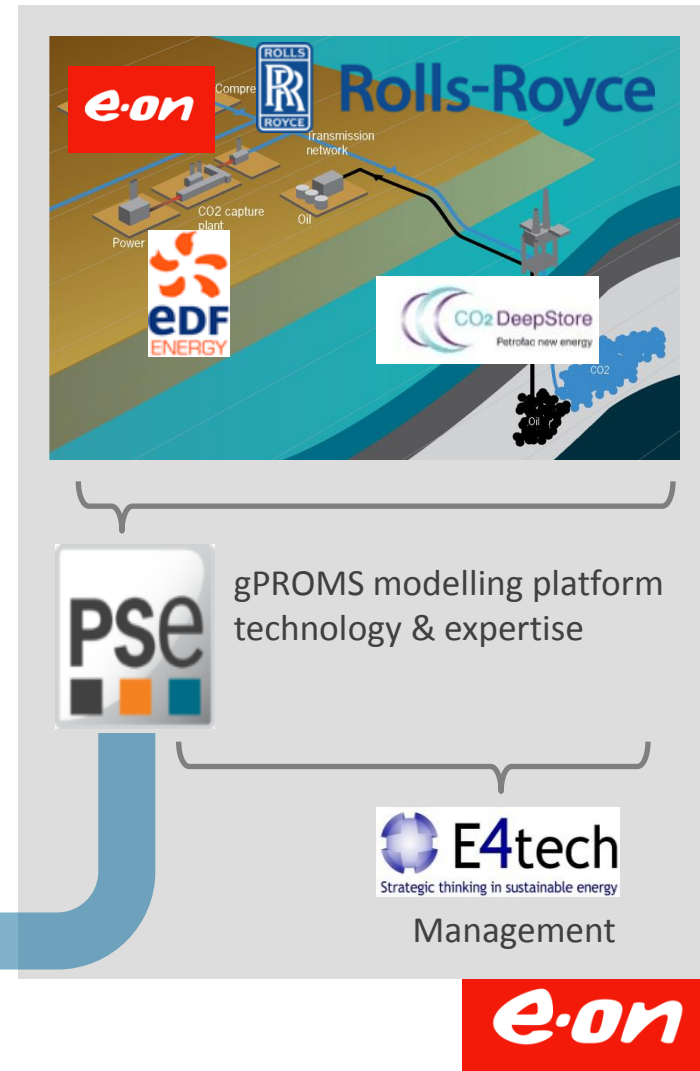
System-wide modelling: high-level requirements

CCS System Modelling Tool-kit Project

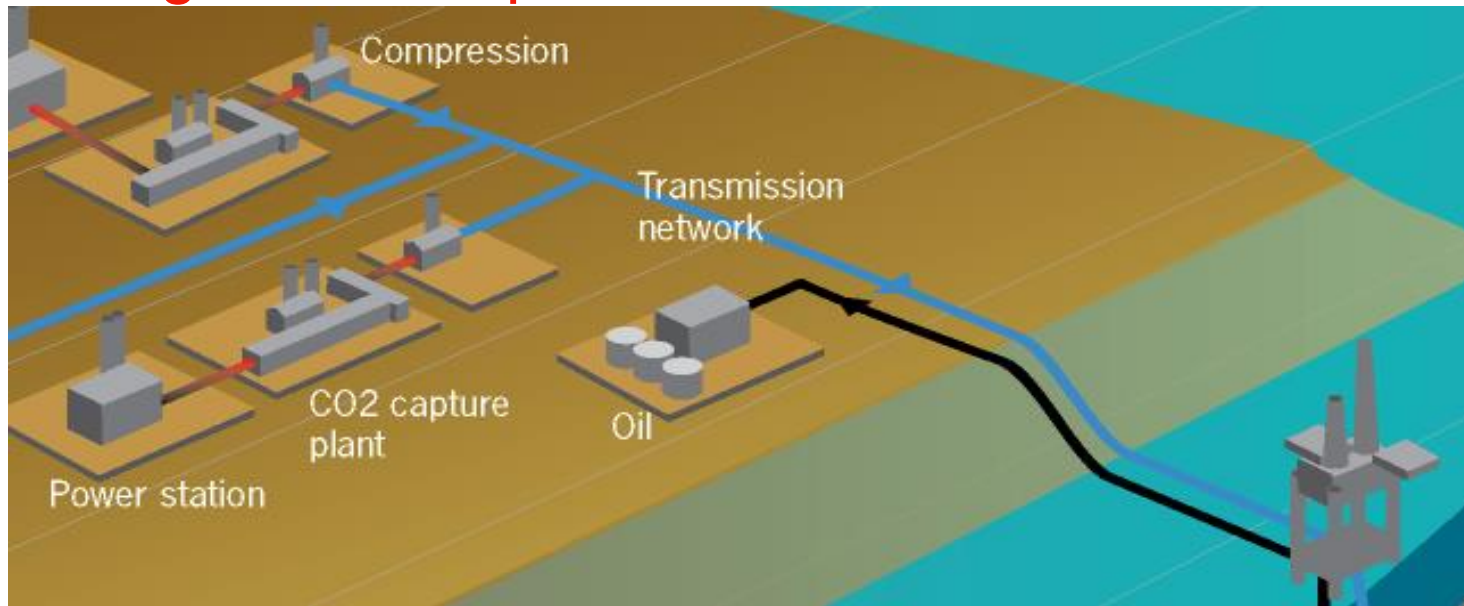
- Energy Technologies Institute (ETI) commissioned £3m (\$5m) project
- E.ON, EDF, Rolls-Royce, Petrofac/CO2DeepStore, PSE, E4tech
- September 2011- Spring 2014

→ Create a commercially available product

- built on PSE's gPROMS platform
- High-fidelity system-wide CCS modelling
- Toolbox and ecosystem



Modelling Toolkit Capabilities



Power Plant

- PF Coal
- CCGT
- IGCC
- Oxyfuel

CO2 capture

- Amine scrubbing
- WGS & Selexol
- Cryogenic CO2 separation

Compression

- Multistage Compression
- Water Drying

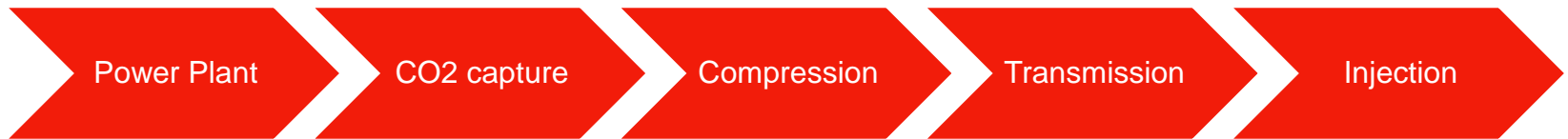
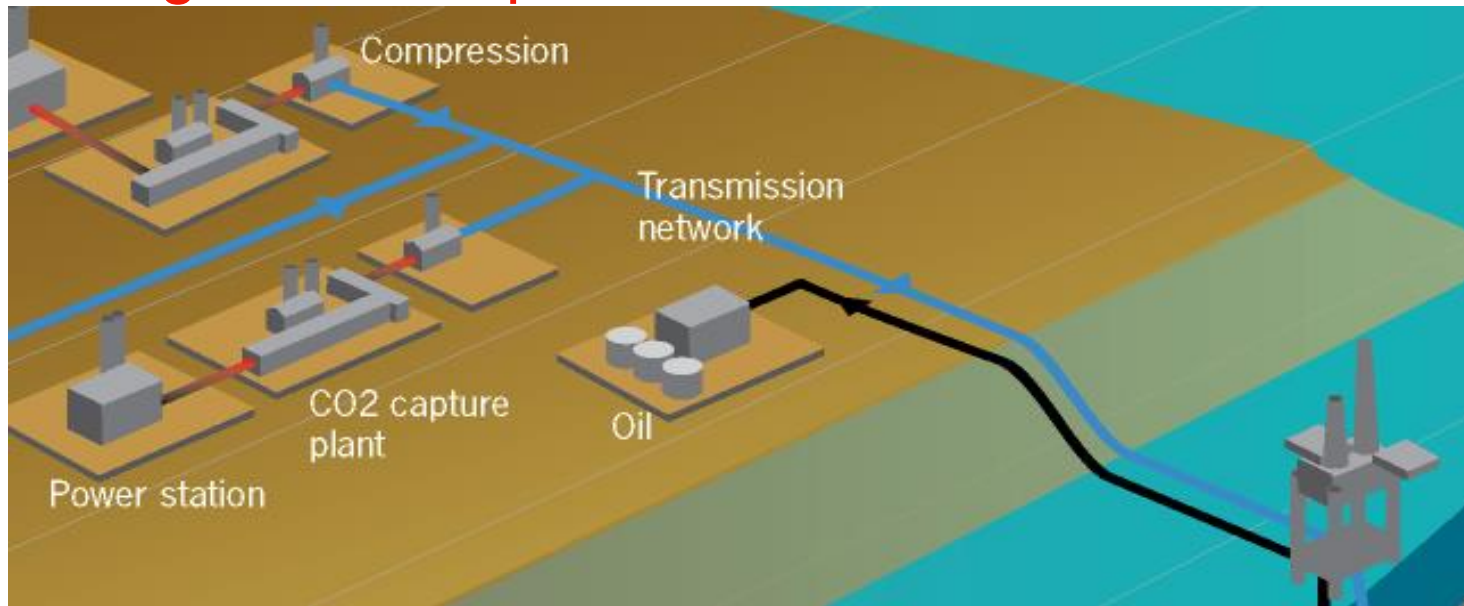
Transmission

- Gas Phase
- Dense Phase

Injection

- Gas field
- Saline aquifers

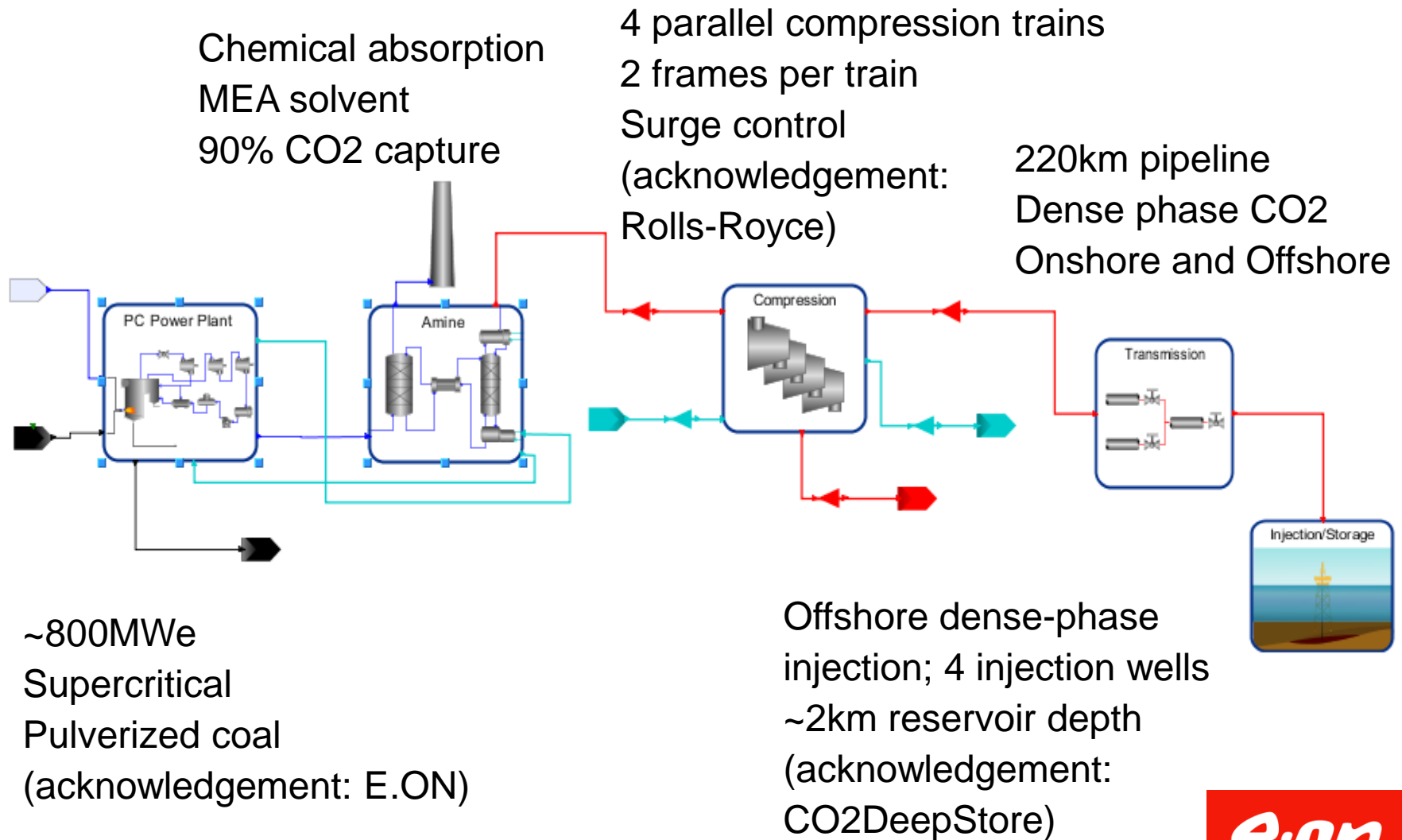
Modelling Toolkit Capabilities



Steady State	Medium	High	Medium – High	High	Medium
Dynamic	Low	High	Low	High	Low

Case Study: dynamic analysis

System overview

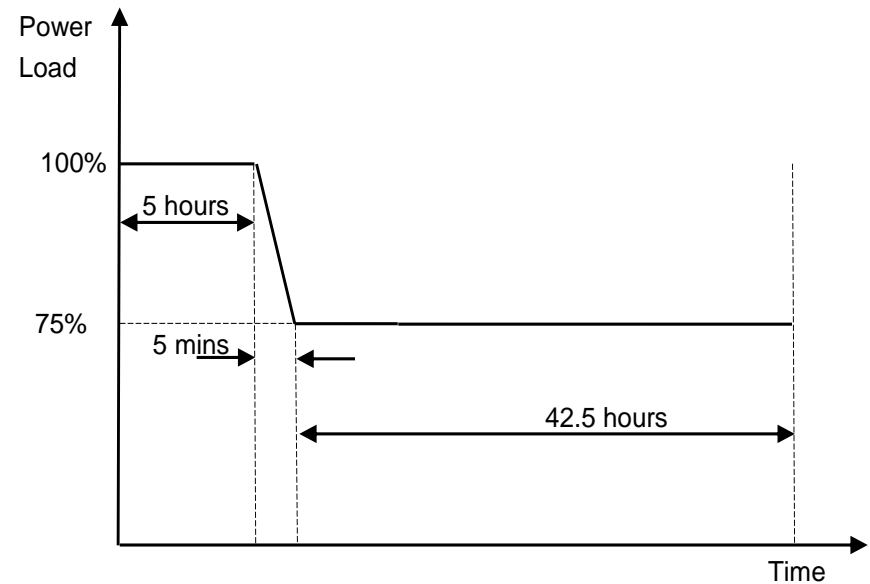
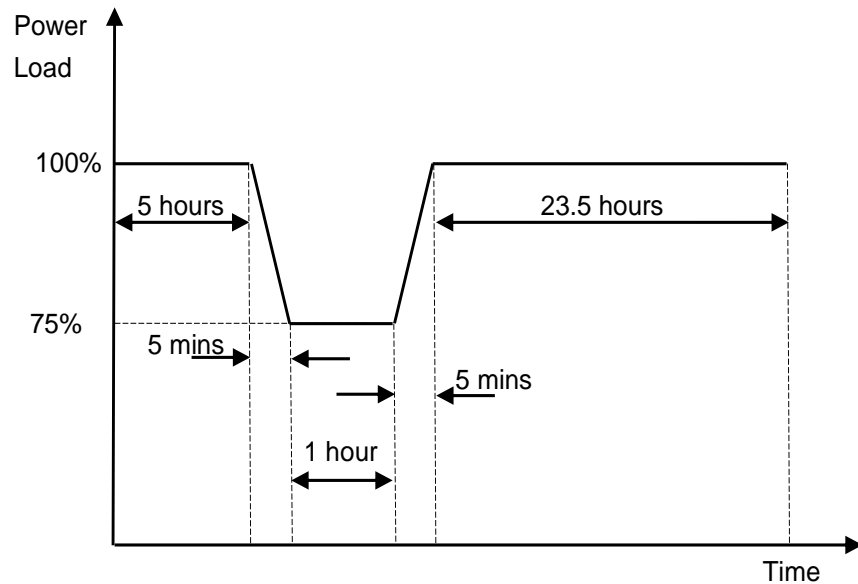


Dynamic analysis

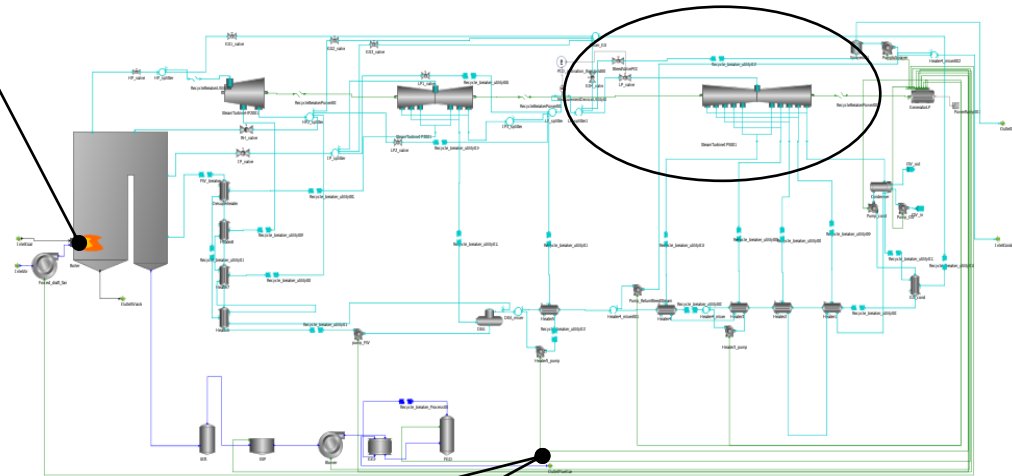
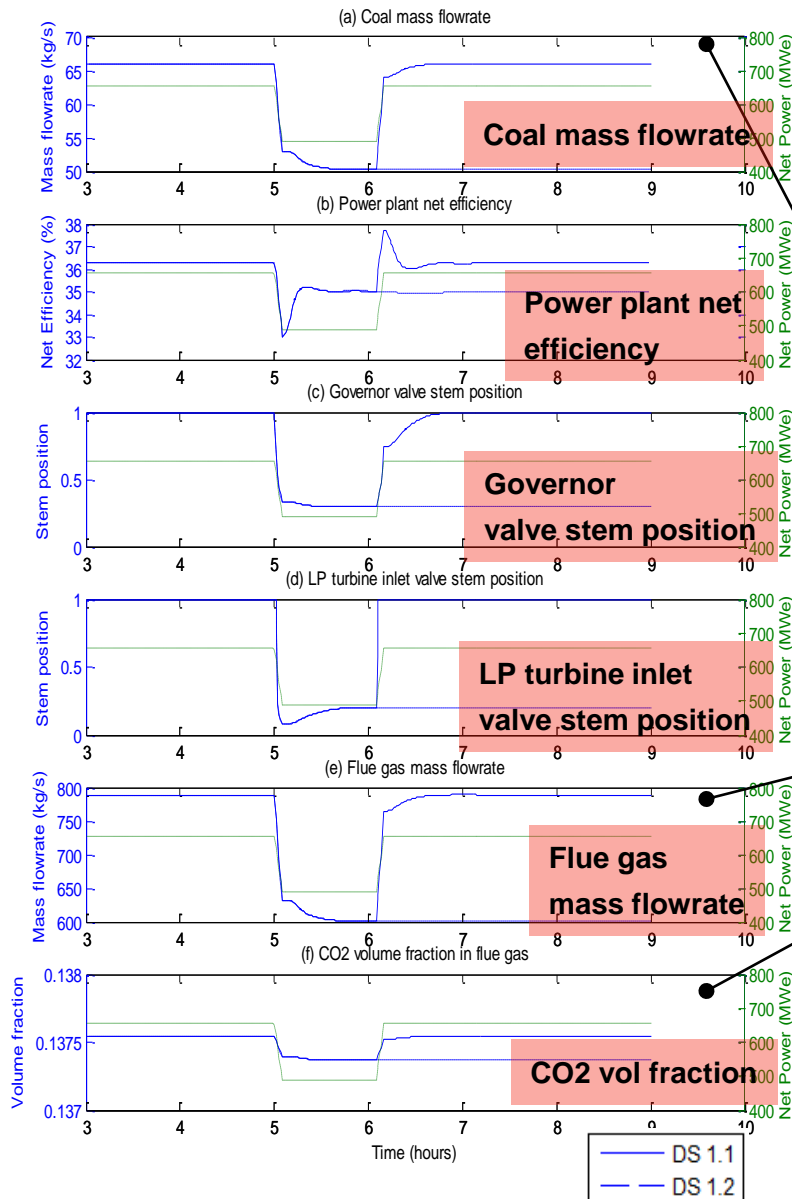
Scheduled changes in power plant load

Scenario DS1.1

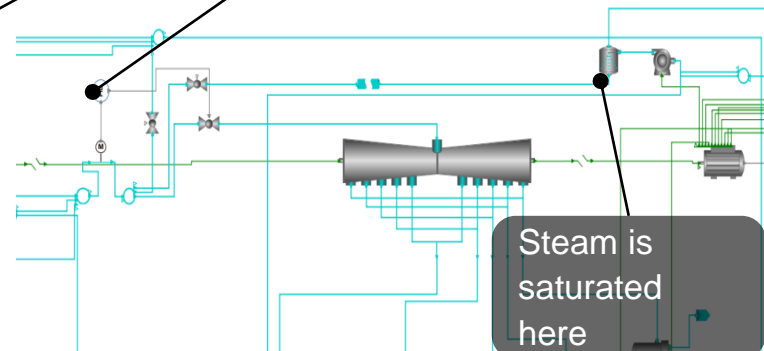
Scenario DS1.2



Dynamic analysis - Power plant

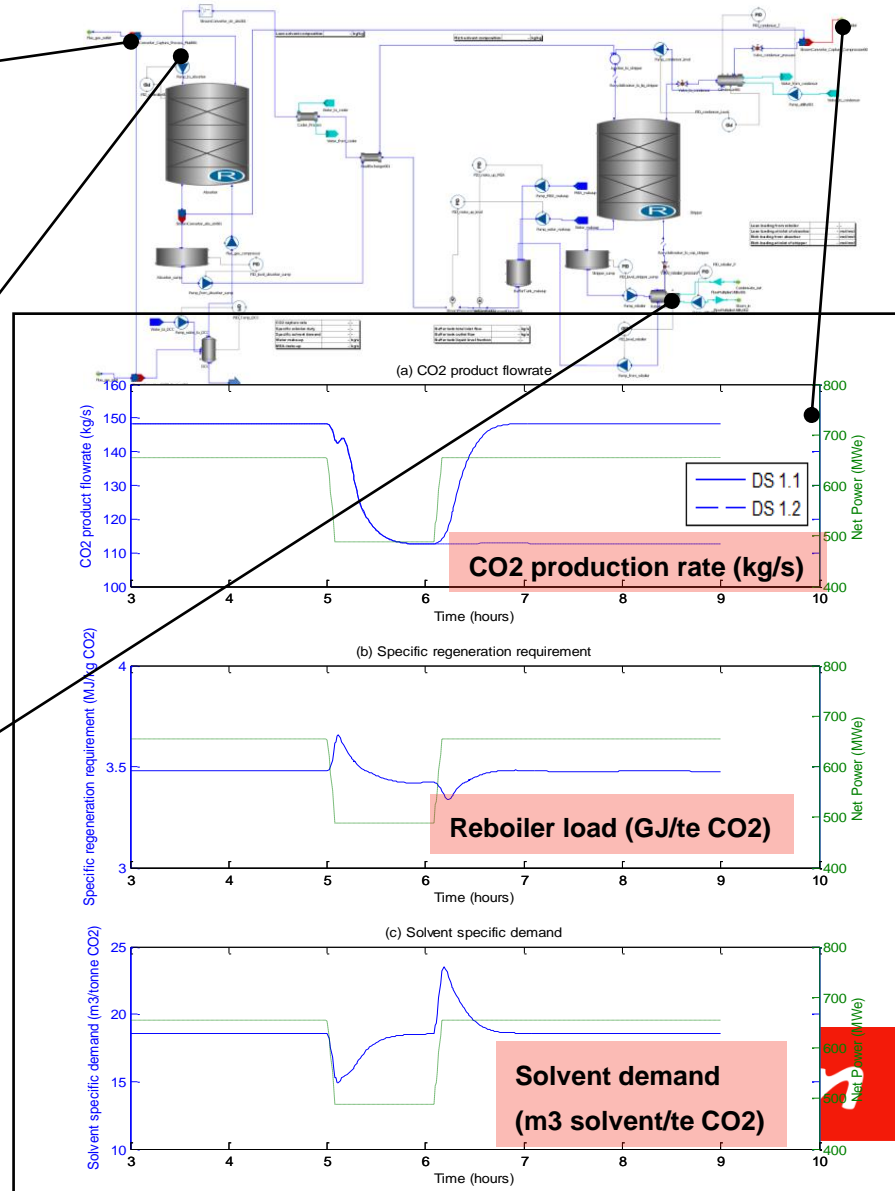
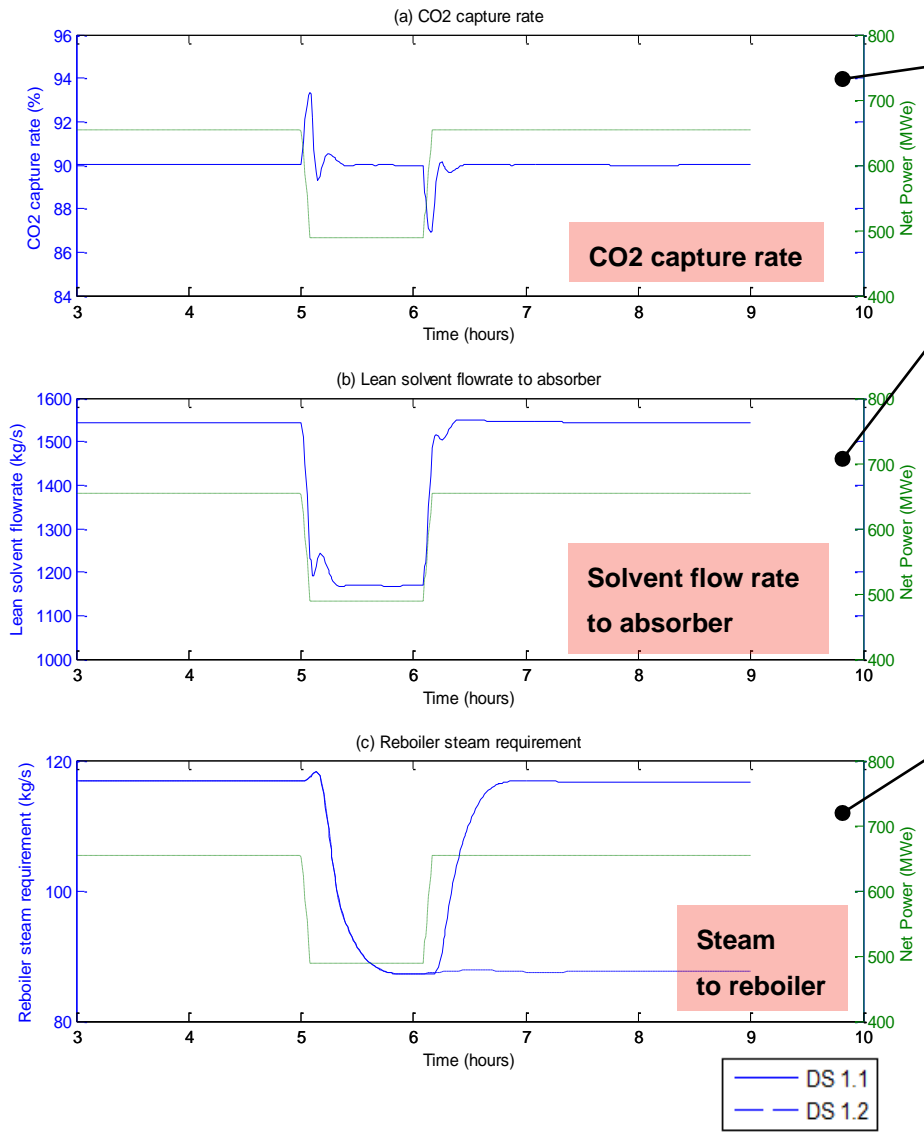


Controller maintains steam to reboiler >3.5bar

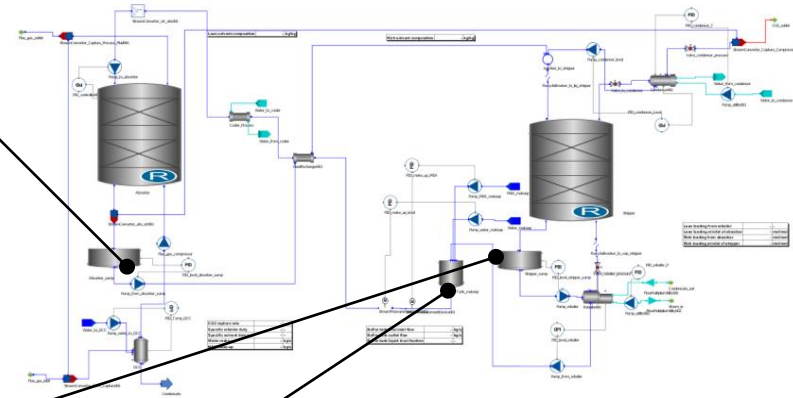
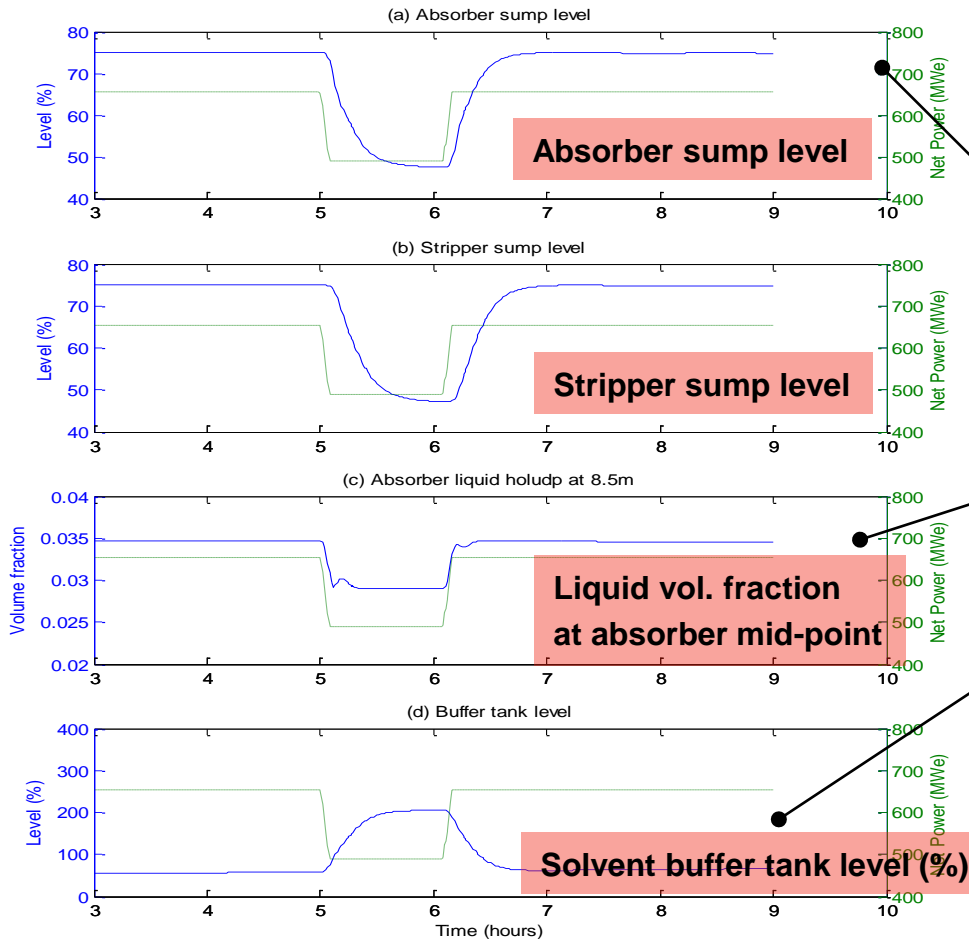


Steam is saturated here

Dynamic analysis - CO₂ capture plant

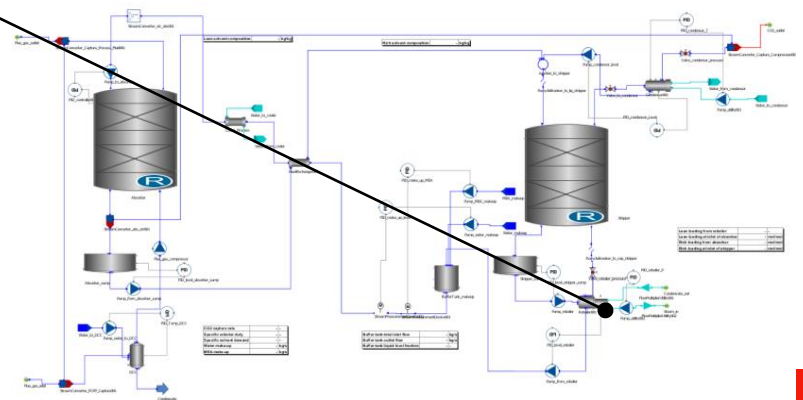
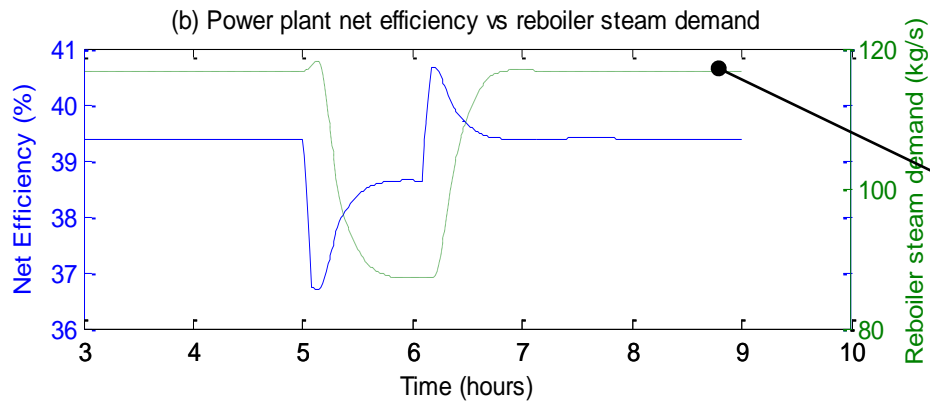
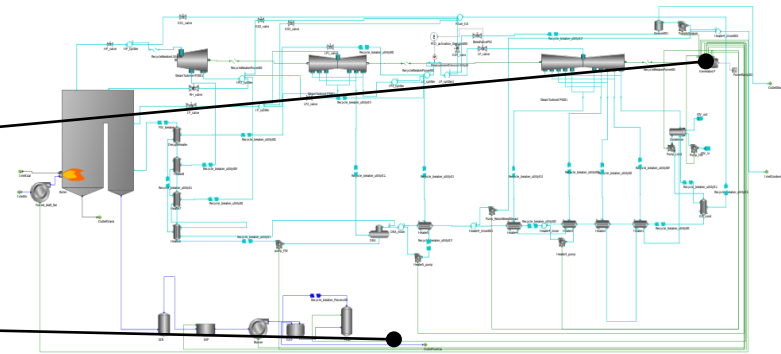
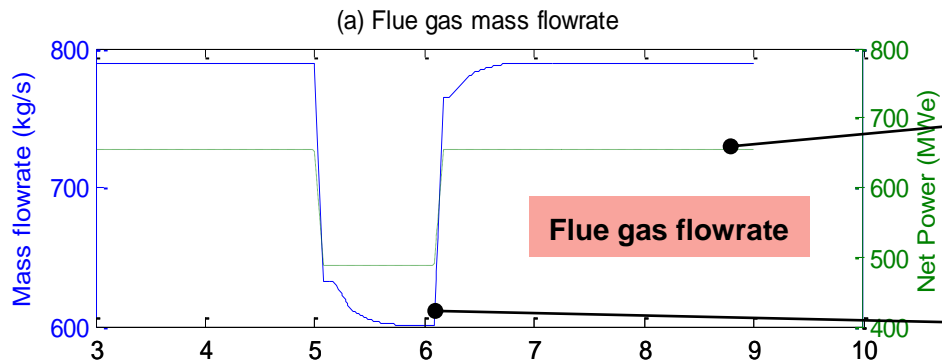


Dynamic analysis - CO₂ capture plant



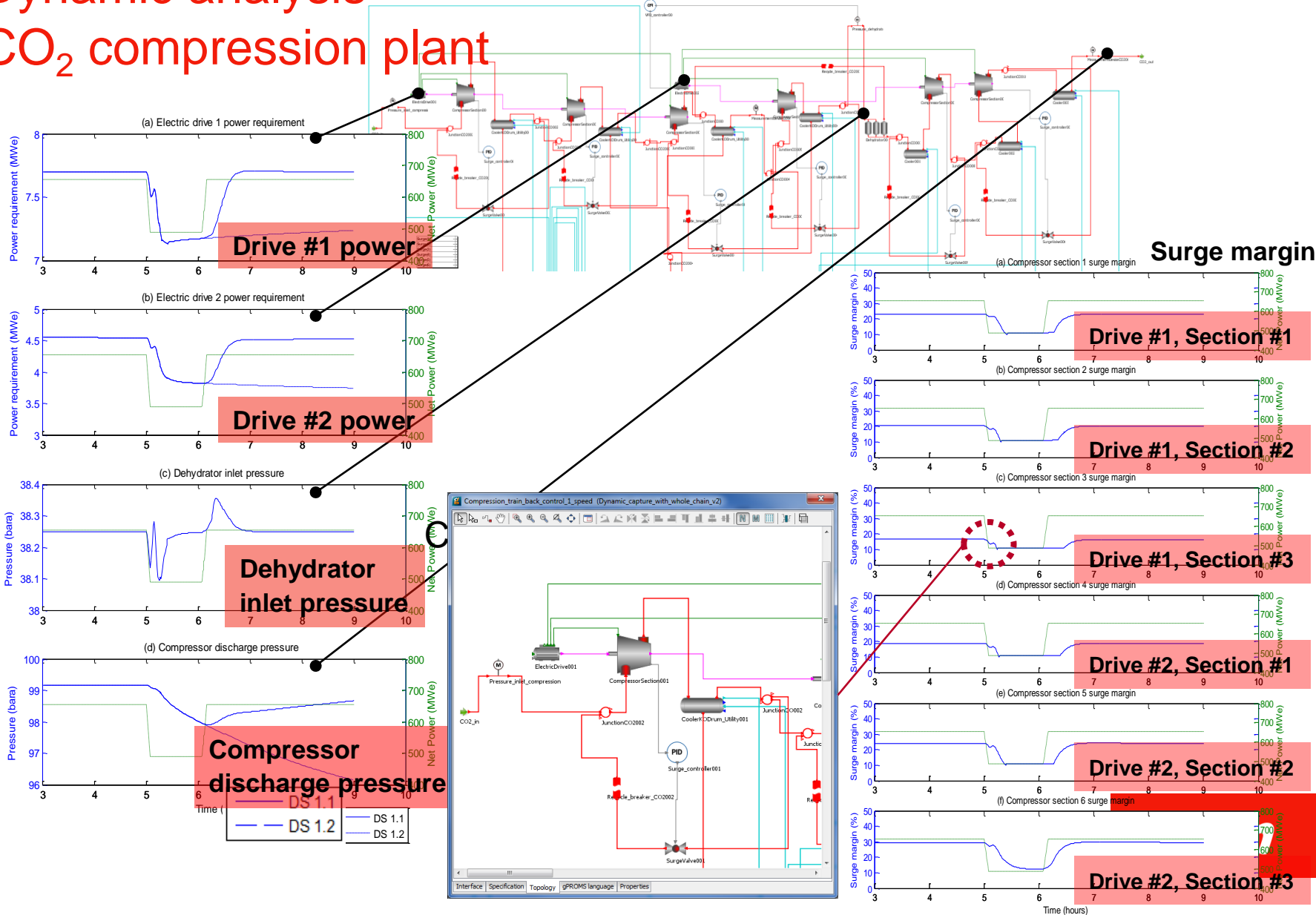
Dynamic analysis

Power/CO₂ capture two-way coupling



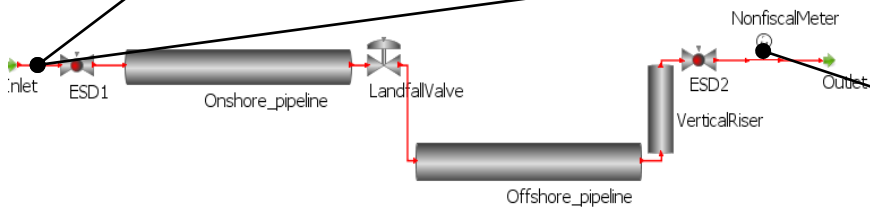
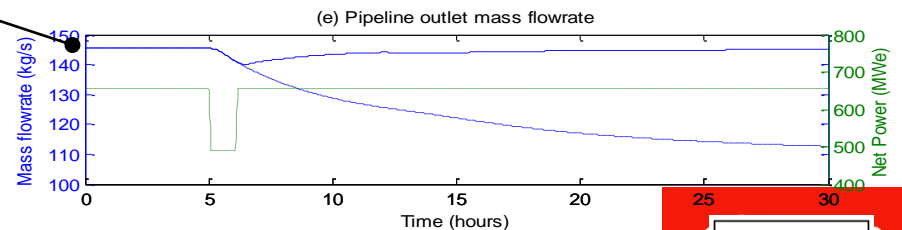
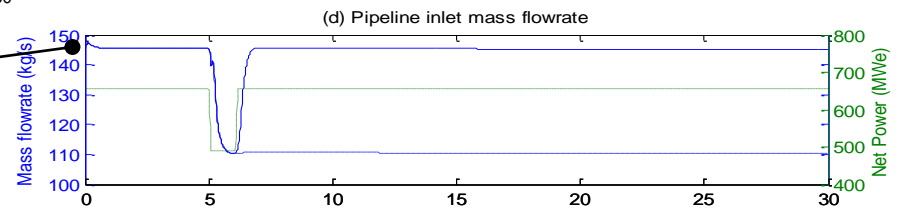
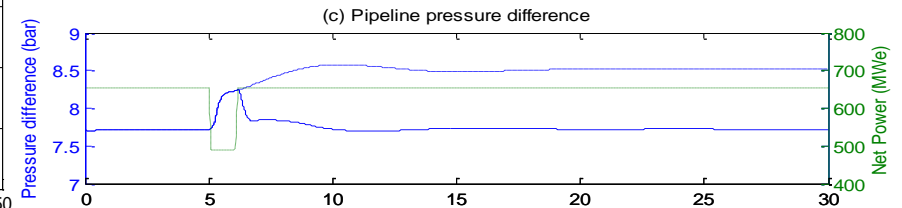
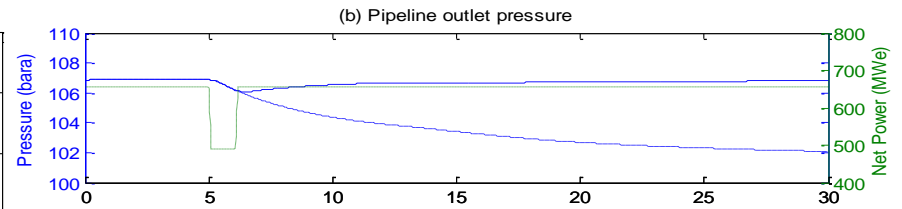
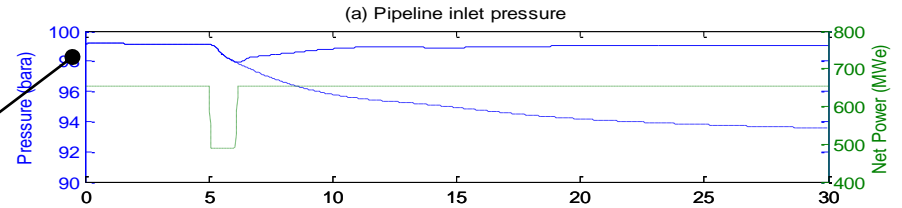
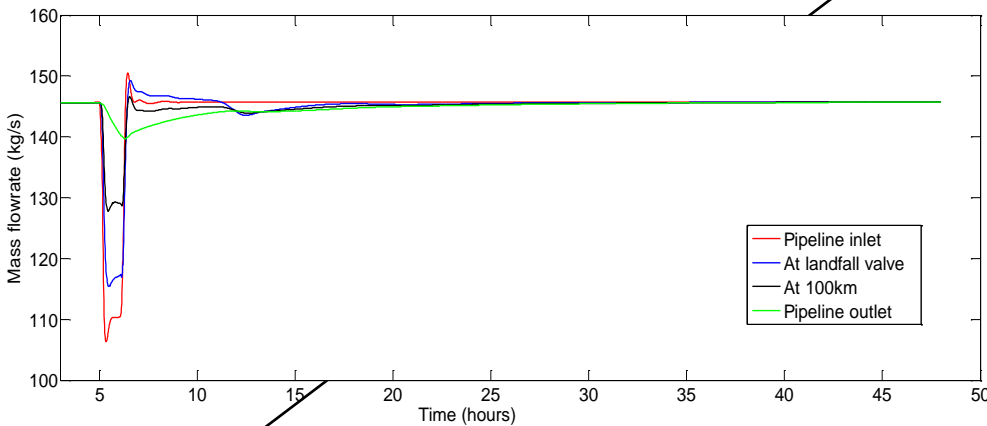
**Power plant net efficiency
vs. reboiler steam demand**

Dynamic analysis CO₂ compression plant



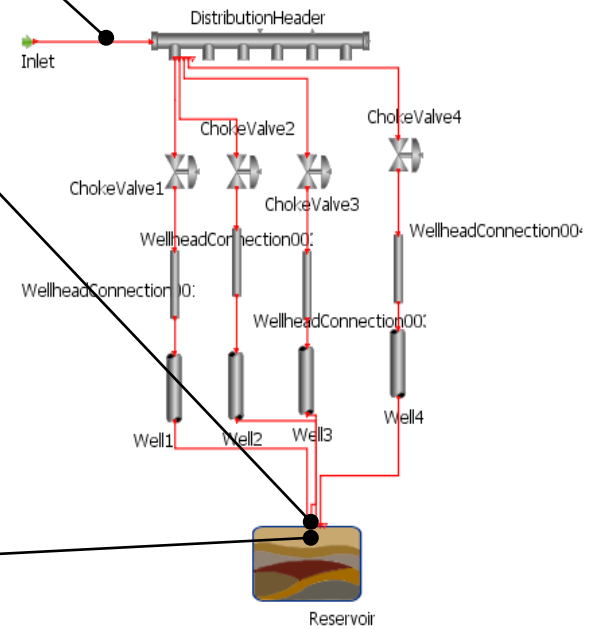
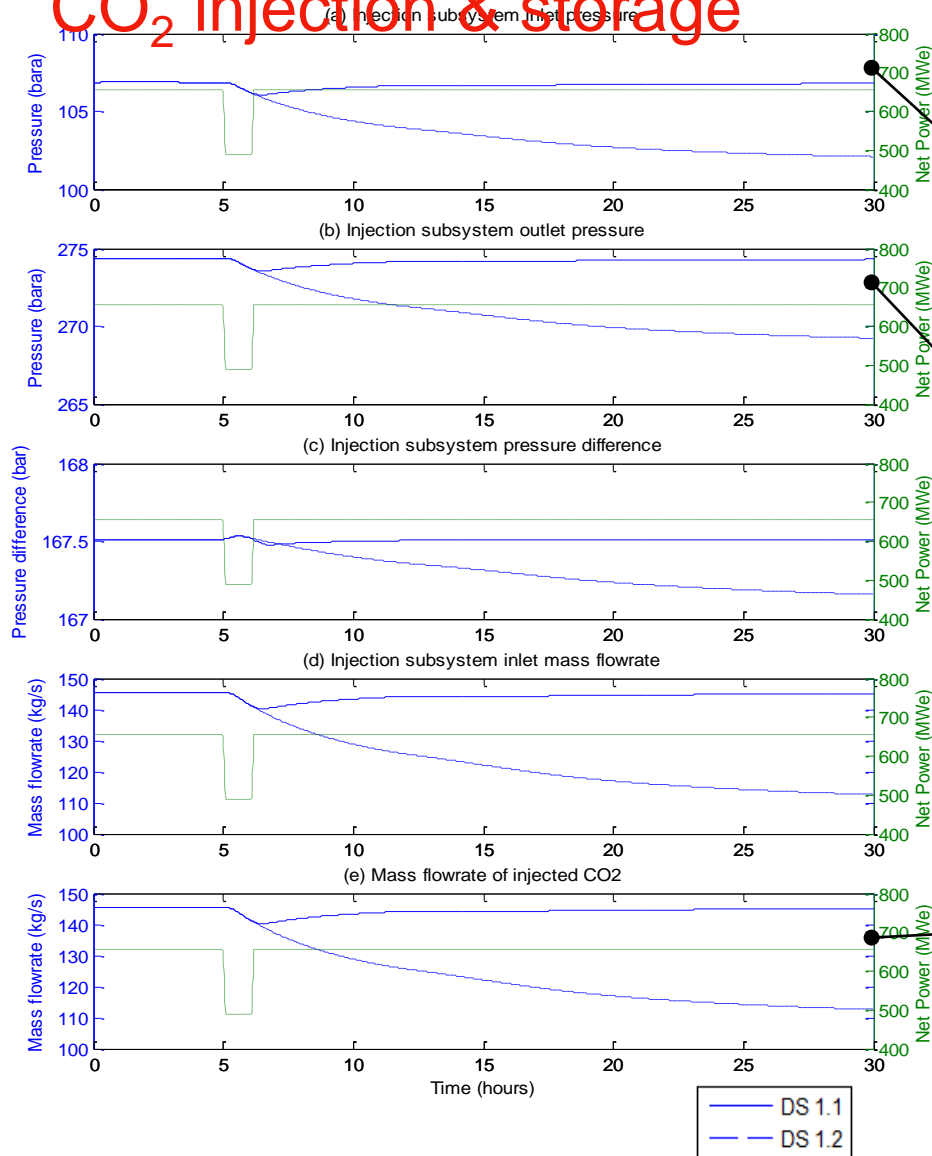
Dynamic analysis CO₂ transmission pipelines

- Buffer potential for flexible operation



Dynamic analysis

CO₂ injection & storage



Summary

- Dynamic modelling of CCS chains is a key tool in understanding the impacts of flexible operation on the CCS chain
- This will allow us to develop safe operating controls and procedures and optimise performance
- Dynamic modelling can identify potential opportunities CCS could provide in terms of increasing power plant flexibility e.g. buffer storage, intermittent capture.