Programme Area: Carbon Capture and Storage

Project: System Modelling Tool Kit

Title: gCCS - a commercial system modelling environment for whole-chain CCS applications

Abstract:

gCCS is the commercial system modelling environment for whole-chain CCS applications that has been developed through the ETI's CCS System Modelling Took-Kit Project and is now commercially available from PSE. gCCS operates like many standard process flowsheeting tools, but unlike these it contains high-fidelity models of all major CCS operations. In addition, powerful modelling and solution capabilities mean that it can be used for detailed steady-state and dynamic simulation and ptimisation across large sections of CCS networks.

Context:

The two-and-a-half year, £3m project launched in September 2011 created a modelling tool-kit capable of simulating the operation of all aspects of the CCS chain, from capture and transport to storage to support the future design, operation and roll-out of cost effective CCS systems in the UK. It involved modelling technology provider Process Systems Enterprise (PSE), energy consultancy E4tech, and industrial partners EDF Energy, E.ON, Rolls-Royce and CO2DeepStore, who expected to be involved in capturing, compressing, transporting and storing CO2 in the future. The project has resulted in a commercial product (gCCS) built on PSE's gPROMS modelling platform. The tool-kit will be used to support the initial conceptual design and eventual detailed design and operation of CCS systems by helping to identify and understand system-wide operational issues such as the effects of power station ramp-up or ramp-down on downstream storage operation, or the effect of downstream disturbances on power generation.

Carbon Capture and Storage

gCCS - a commercial system modelling environment for whole-chain CCS applications

by Process Systems Enterprise Limited
from an Energy Technologies Institute project

gCCS - End to end high-fidelity whole chain systems modelling

gCCS is the commercial system modelling environment for whole-chain CCS applications that has been developed through the ETI's CCS System Modelling Took-Kit Project and is now commercially available from PSE

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CCS Systems Modelling Tool-kit

The Project

This £3m project has developed the gCCS toolkit which will support the future design, operation and roll-out of cost effective CCS systems in the UK

In September 2011 The Energy Technologies Institute (ETI) commissioned and funded the Systems Modelling Tool-Kit project which focused on:

- Supporting the future design, operation and roll-out of cost effective CCS systems in the UK
- Creating a modelling tool-kit capable of simulating the operation of all aspects of the CCS chain
- Supporting initial conceptual design and the eventual detailed design and operation of CCS systems

This collaborative project has resulted in a modelling tool-kit capable of simulating the operation of all aspects of the CCS chain, from capture and transport to storage.

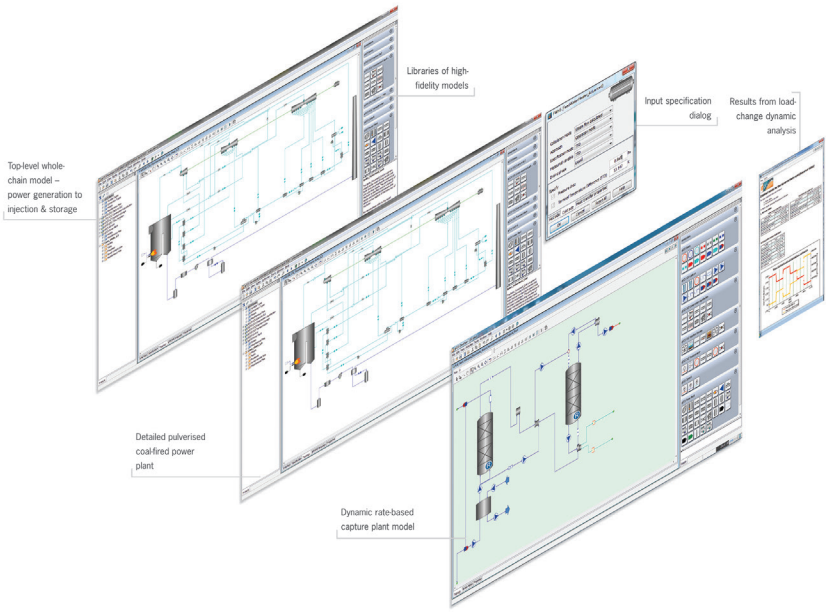
It involved modelling technology provider Process Systems Enterprise (PSE), energy consultancy E4tech, and industrial partners EDF Energy, E.ON, Rolls-Royce and CO_2DeepStore, who expect to be involved in capturing, compressing, transporting and storing CO_2 in the future. The project has now resulted in the commercial product gCCS, marketed and supported by PSE.

What is gCCS?

The Product

gCCS operates like many standard process flowsheeting tools, but unlike these it contains high-fidelity models of all major CCS operations. In addition, powerful modelling and solution capabilities mean that it can be used for detailed steady-state and dynamic simulation and optimisation across large sections of CCS networks.

The diagram below shows a ‘drill-down’ view from a whole CCS chain model (left) into into pulverised coal power station and amine capture plant models (centre and right) used for analysis of flexible operation.



Major Features

Powerful solution capabilities, allowing simultaneous analysis of large sections of the CCS network

gCCS is built on PSE's gPROMS advanced process modelling platform, and inherits many of the platform's powerful capabilities.

Key features are:

- High-fidelity models from power generation through capture, compression and transmission to injection with multicomponent streams, equilibrium and rate-based phase modelling
- Rigorous gSAFT physical properties specially formulated for CCS
- Intuitive drag & drop flowsheeting environment
- Steady-state and dynamic simulation within the same environment
- Powerful solution capabilities, allowing simultaneous analysis of large sections of CCS networks with numerous recycles
- Optimisation – including mixed-integer and dynamic optimisation – capabilities, allowing economic optimisation with numerous decision variables
- Custom modelling capabilities, allowing easy creation of new process models
- Execution on multiple Windows and Linux platforms.

gCCS Scope at a glance

Power generation

- Conventional generation – pulverised coal
- Conventional generation – CCGT
- New generation – Oxyfuel
- New generation – IGCC

Capture

- Physical & chemical solvent-based pre-and post-combustion capture
- To be extended in the future

Compression & transmission

- Compressors
- Onshore and subsea pipelines
- Instrumentation

Injection and storage

- Distribution headers & choke valves
- Well
- Simplified reservoir models

Utilities

- Standard process models (heat exchanger, valves, etc.)
- Control models

Physical properties

- Standard VLE physical properties
- Steam properties
- gSAFT advanced thermodynamics

Application and Benefits

gCCS can optimise design or operation decisions based on an economic objective function

Some typical applications of gCCS are to:

- Investigate the flexible operation of a post-combustion capture plant attached to a coal-fired power station
- Optimise the integration between the power plant and capture plant
- Design optimal compression trains for flexible service
- Investigate the effects of upstream or downstream changes in operation (for example, injection trip)
- Screen and rank economic alternatives
- Optimise design or operation decisions based on an economic objective function.

Benefits

- Easy exploration of the complex decision space
- Better, faster and safer design and operating decision based on accurate quantification

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