Programme Area: Carbon Capture and Storage

Project: Hydrogen Turbines

Title: One Page Summary

Abstract:

The ETI's energy system modelling shows that flexible power generation systems comprising hydrogen generation with CCS, intermediate storage (particularly using salt caverns) and flexible turbines are attractive options for the UK. In the model described here, hydrogen is supplied from coal and biomass fired gasifiers and steam methane reformers, with CO2 captured for storage. This permits the use at high load of capital intensive and relatively inflexible conversion and CCS equipment, filling hydrogen storage when power is not needed, and releasing hydrogen at short notice through turbines when power is at a premium.

Context:

This £300k project, led by global engineering and construction company Amec Foster Wheeler, in collaboration with the BGS, assessed the economics of a range of flexible power generation systems which involve the production of hydrogen (with CCS) from coal, biomass or natural gas, its intermediate storage (e.g. in salt caverns deep underground) and production of power in flexible turbines. The work included mapping of potentially suitable hydrogen storage salt cavern sites in and around the UK and provided the ETI with a flexible economic modelling tool to assess the range of possible options. The ETI's energy system modelling work suggests that systems such as these could provide a valuable contribution to the future energy mix, filling the gap between base load nuclear plant and low carbon power generation.

Programme: Carbon Capture and Storage

Project Name: Hydrogen Storage and Flexible Turbine Systems

Deliverable: CC2009/D2

Contractor: Foster Wheeler Energy Limited

Context

ESME modelling shows that flexible power generation systems comprising hydrogen generation with CCS, intermediate hydrogen storage (particularly using salt caverns) and flexible turbines are attractive components in the UK energy system. In the model, hydrogen is supplied from coal and biomass fired gasifiers and steam methane reformers, with CO_2 captured for storage. This permits the use at high load of capital intensive and relatively inflexible conversion and CCS equipment, filling hydrogen storage when power is not needed, and releasing hydrogen at short notice through turbines when power is at a premium.

Project

The purpose and focus of the Hydrogen Storage and Flexible Turbines Project was:

- To improve our understanding of the economics of flexible power generation systems comprising hydrogen production, storage and flexible turbines;
- To focus on the potential, economics and technical requirements for salt cavern storage and flexible turbines, to confirm or adjust ESME findings.

The project was undertaken by Foster Wheeler Energy Limited (FWEL), with support from British Geological Survey (BGS) to address issues relating to salt cavern storage. The Project was split into five desk-based work packages.

- WP1 – Hydrogen power production (from coal, biomass and gas);
- WP2 – Hydrogen storage in salt caverns;
- WP3 – Supporting studies (e.g. alternatives methods of hydrogen production and power generation; use of hydrogen in the energy system);
- WP4 – Development of a flexible, Excel-based Modelling Tool; and
- WP5 - Identification of a representative system & comparison of a CCGT with CCS.

The first three work packages (WP1, WP2 & WP3) were focussed on data collection and research in order to derive a basis for techno-economic analysis and modelling in WP4. Using the output from the WP4 modelling, a representative system was selected. In WP5, this representative system was compared against a post-combustion CCGT case.

Key Project Findings

The project has provided a firm evidence base for the costs of such systems, for a variety of hydrogen-production technologies and salt cavern types: the Excel spreadsheet model enables a wide range of ‘what if’ scenarios to be investigated. Overall no one technology shows a substantial benefit over others. Initial ESME modelling confirms the importance of such technologies in the UK energy system.

Further Information

Full information on the results of the project is available to ETI Members in the confidential technical report and spreadsheet economic model.