Multiscale whole systems modelling and analysis for CO_2 capture, transport and storage

Research Councils' Energy Programme
Natural Environment Research Council, Sustainable Use of Natural Resources Theme
and Engineering and Physical Sciences Research Council

Consortium 2: Whole systems analysis of carbon capture, transport and storage

Project team

Imperial College London

Department of Earth Science and Engineering

Prof. Sevket Durucan, Dr Anna Korre, Dr Ji-Quan Shi, Dr Zhenggang Nie

Department of Chemical Engineering and Chemical Technology

Prof Nilay Shah, Dr Peter Spelt, Dr Niall Mac Dowell

University of Cranfield School of Engineering

Dr Meihong Wang, Prof. John E Oakey, Dr Hoi Yeung

University of Sussex School of Business Management & Economics

Dr Jim Watson, Dr Lee Mark Stapleton

British Geological Survey Edinburgh

Dr Martin Smith, Mr Martyn Quinn

Collaborating organisations: Scottish Power, National Grid, Environment Agency, IEA GHG R&D Programme, Vattenfall, Shell, PSE ltd

Imperial College London

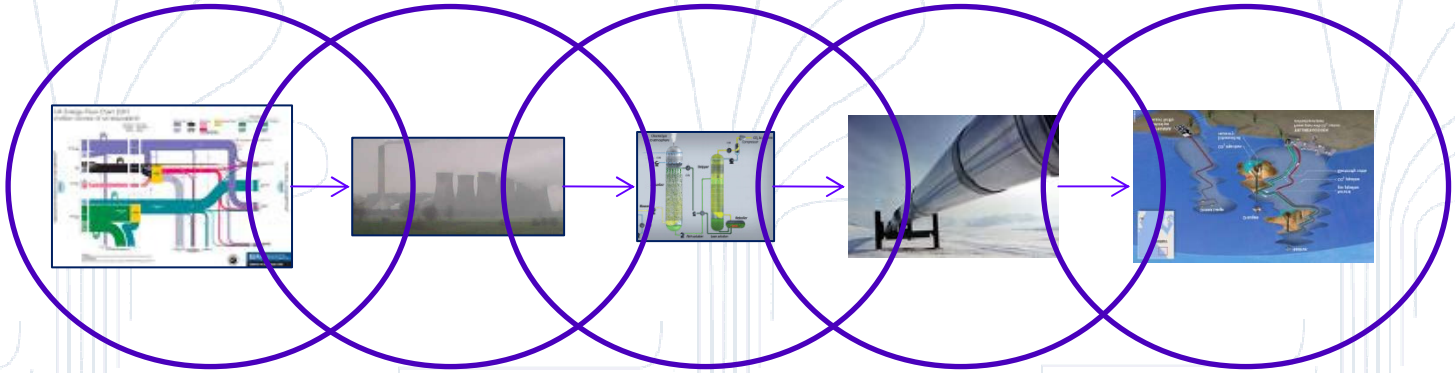
Cranfield UNIVERSITY

US University of Sussex

BGS 1835

Project objectives

The principal objectives of the project are to develop a systems modelling framework relevant to CCS in the UK and apply this to perform a range of analyses which quantify a series of environmental, economic and safety-related metrics.



Key outputs and important benefits

New methodologies and practical solutions for the design and analysis of future CCS systems. This will be achieved through the development of a modular and multiscale modelling framework that can used to evaluate the whole CCS value chain system performance in any given region.

The generation of insights into the important interactions affecting system design and operation. The key effects that propagate between components of the whole system will be identified.

The quantification of the performance (in terms of metrics including economics, environmental impacts, safety and operability) of the CCS systems relevant to the UK. This will be of benefit both to system operators and society at large and help in the public acceptance debate.

Technology themes and workpackages

Technology themes

UK Energy System assessment
Sussex, J Watson

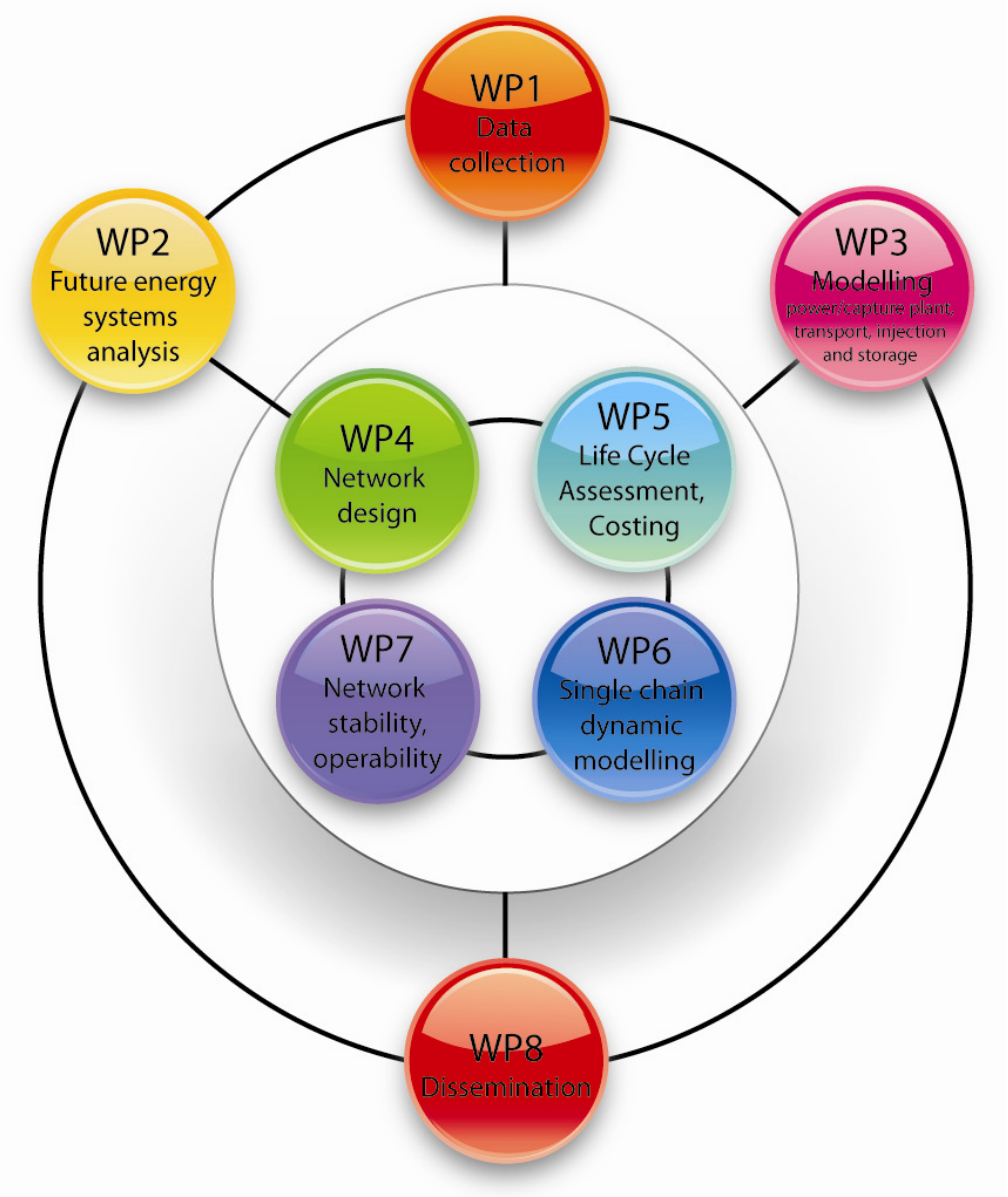
Power plant model
Cranfield, M. Wang

Capture plant model
Cranfield, J Oakey

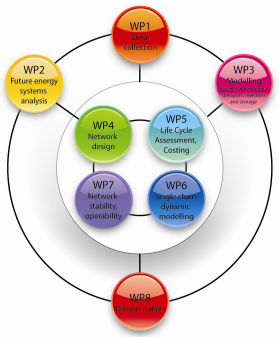
Transport model
Imperial, P Spelt

Injection and storage model
Earth system model
BGS, Martyn Quinn
Storage reservoir
Imperial, JQ Shi

Integrated assessment
Dynamic space time integration
Imperial, Nilay Shah
Life cycle assessment
Imperial, A. Korre
Economic analysis
Sussex, J Watson



Research plan



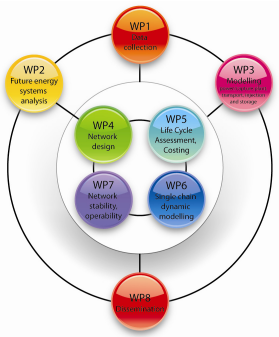
WP1 Data collection – major CO_2 sources and potential storage sites

Study the Firth of Forth region, link up with the existing UK programmes (e.g. the ETI assessment of UK CO_2 storage capacity and with other relevant studies).

WP2 Analysis of future energy systems integrated with CCS. Will use existing scenarios for the UK energy system to 2050 to examine the implications for the role of carbon capture plants and the wider CCS system.

WP3 Modelling– component models This workpackage underpins all the activities in this project. It will either identify and modularise existing models of unit processes (e.g. amine-based carbon capture; pipeline models) or develop fit-for-purpose models (e.g. injection and storage) for the each system component.

Research plan

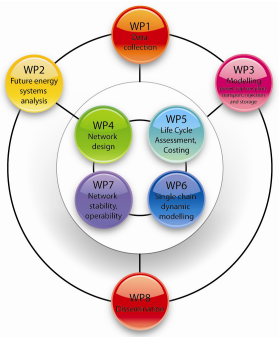


WP4 Network design Develop a stochastic multi-period design model to produce a time-phased solution over which sources to include in the network, the degree of capture for each source, the network structure joining the sources and storage sites, the flows in the system and network capacities.

WP5 LCA and integrated assessment build a generic integrated life cycle assessment and life cycle cost model coupled at the component unit process level and perform assessment for the designs generated in WP4 and informed by the component models of WP3.

WP6 Single chain dynamics Study the behaviour of integrated source-sink CCS systems by combining the component models developed in WP3 in a dynamic model. This will be used to perform simulations against a number of transient scenarios.

Research plan



WP7 Network stability and operability analysis Extend and use the dynamic analysis methods of WP6 to analyse the networks designed in WP4 aiming to understand how different scenarios involving independent transient operation of the individual point sources in the network affect the overall network dynamics, stability and operability.

WP8 Final dissemination of the developed approach and results to the UK and international stakeholders and to the wider community, with a view to improving understanding of whole system performance and its key determinants.

The models and approach to be developed will be validated using real CCS case study data from the Firth of Forth Region.

Further information:

Professor Sevket Durucan
Imperial College London
Department of Earth Science and Engineering
Royal School of Mines, Prince Consort Road,
London SW7 2AZ, UK
Tel.: +44 (0)20 75947354

s.durucan@imperial.ac.uk

Imperial College London

Cranfield UNIVERSITY

US University of Sussex

BGS 1835