Who are we?

Our internationally recognised name is the IEA Greenhouse Gas R&D Programme (IEAGHG). We are a Technology Collaboration Programme (TCP) and are a part of the International Energy Agency’s (IEA’s) Energy Technology Network.

Disclaimer

The IEA Greenhouse Gas R&D Programme (IEAGHG) is organised under the auspices of the International Energy Agency (IEA) but is functionally and legally autonomous. Views, findings and publications of the IEA Greenhouse Gas R&D Programme do not necessarily represent the views or policies of the IEA Secretariat or its individual member countries.
IEAGHG Members
CCS Value Chains

• What is a “Value Chain” for CCS?
  • Broad range of possibilities due to wide range of applications of CCS
    o Power sector
    o Decarbonising industrial sectors
    o Hydrogen and CCS
    o CO2-EOR and other utilization options
  • A range of business models
  • Also Social-economic value
  • IEAGHG looking into better defining and quantifying “value”
Valuing flexibility in CCS power plants (FlexEVAL)

• **Aim:** To investigate the need for flexibility and the value of flexible CCS power plants in the UK energy system

• **Contractor:** Imperial College London

• **IEAGHG Report 2017-09**
System Value

The value of a power technology can be quantified as reduction in total system cost resulting from its deployment.

The System Value (SV)
- accounts for system dynamics (e.g. "cost of intermittency", "associated carbon")
- is not a constant value (like the LCOE, CAPEX, OPEX, etc.)
- is a function of prevalent technologies in the system, demand, emissions target, etc.

\[
\text{START}
\]

Choose base system design
\rightarrow \text{capacity of technology } i: d_o(i)

Solve energy systems model MILP
\rightarrow \text{total system cost}: tsc_o

\[\text{REPEAT FOR } k=1,2,\ldots, n^i, \ n=(\#\Delta d_k + 1)\]

Add capacity of technology \( i \)
\rightarrow \( d_k(i) = d_o(i) + \Delta d_k(i) \)

Solve energy systems model MILP
\rightarrow \text{total system cost}: tsc_k

Receive the Levelised Value of Electricity for technology \( i \)
\rightarrow SV_k(i) = tsc_o - tsc_k
Findings

Flexible CCS power plants:
- provide additional value to the electricity system of the future
- complement intermittent renewable capacity
- facilitate increased intermittent renewable generation
- provide system-wide benefits critical to reducing the cost of the electricity system

Integrating CCS technologies with intermittent renewable capacity:
- is instrumental to reducing the total system cost
- enables both a low-carbon and a low-cost future electricity system.
A carbon tax backstop is enforced by the federal government if provinces do not adopt a price on carbon. The carbon tax is revenue neutral. Funds collected go back to the province to decide how to disburse them.

Canada’s carbon prices begins at a minimum of $10 per tonne in 2019, and increases $10 each year until it hits $50 per tonne in 2022.
Canada’s Carbon Pricing for Coal & Natural Gas

Blue shading: the difference between average intensity of coal power and the allowed limit.

Green shading: the difference between average intensity of NGCC and the allowed limit.

Yellow band: intensity of “old” natural gas and the allowed limit.

Emitters pay the according price.
Industrial carbon capture business models

Key results

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Element Energy identified and assessed business models to incentivise industrial carbon capture

6 promising models address the key requirements from a public and private sector perspective

- Revenue models for industrial carbon capture (ICC) may be based around incentivising CO₂ abatement or low carbon products.
- The key to a successful mechanisms is balancing the private and public sector requirements. For the private sector, a strong and certain revenue model is a key factor; for the public sector it is important to drive cost reductions and implement a simple and transparent policy.
- Globally competitive industry must be protected from the full cost of ICC to maintain competitive position and prevent ‘carbon leakage’.
- Models must consider the revenue mechanism, the funding source, capital and ownership options and risk management measures. Each of the revenue models requires support from a suite of risk management instruments to ensure risks are addressed where possible and allocated to those most able to bear them.
- The scale-up phase of CCS development will require significant support financially and in terms of risk management, but in the roll-out phase the private sector may take on these risks. A model may evolve to account for this.

| Contract for difference: CfD on CO₂ price relative to market CO₂ price (e.g. EU ETS) to provide guarantee of revenue | Cost plus: All properly incurred ICC operational costs are reimbursed through taxpayer funding | Regulated asset base: Public regulation allows costs to be recovered through product prices e.g. of Hydrogen | Tradeable tax credits: CCS tax credits awarded $/tCO₂ to reduce firms tax liability (e.g. 45Q) or trade with other firms. | CCS certificates: Certificates representing tCO₂ abated through CCS, which can be traded and emitters have an obligation. | Low carbon market: End-use regulation e.g. on buildings to create a low carbon market & achieve product premium |
USA

Value created by incentives:

- 45Q
- California Low Carbon Fuel Standard
- CO2-EOR
Norway – Preparing to receive other countries CO₂

- Norway Full Scale Integrated Project

- **London Protocol Export amendment**
  - Provision Application being proposed by Norway and NL to allow countries to apply the 2009 CO₂ export amendment – to avoid waiting for ratification
  - the last international legal barrier to CCS being addressed!
  - 7-11 Oct 2019
IEAGHG work

- Enabling CCS Clusters – IEAGHG Report 2018-01
- Valuing Flexibility in CCS Power Plants – IEAGHG Report 2017-09
- Beyond LCOE: Value of CCS in Grid Scenarios – study underway
- Looking into how to better define and quantify “value”
- Workshop on CCS Value by TOTAL and OGCI on 14-15 October 2019, Paris
Registration still open!

10 keynote presentations
74 technical presentations
115 attendees (to date)
19 countries represented
complimentary site visits

Conference themes:
• Process configurations
• Separation technologies
• Applications
• Modelling
• Cost and environmental assessments
• Demonstration activities

KYOTO, JAPAN, 17-19 SEPTEMBER 2019

https://ieaghg.org/conferences/pccc/2-uncategorised/913-5th-post-combustion-capture-conference
Hosted by Khalifa University; Conference location - ADNEC, Abu Dhabi, UAE
Call for abstracts opens early September 2019

- Deadline to submit an abstract – 7th January 2020
- Early Bird registration opens March 2020
- Draft Technical programme announced online May 2020
- Visit [https://ghgt.info/](https://ghgt.info/) for all conference information and abstract submission
Panel on CCS Value Chain Developments

Global Context - Tim Dixon, IEAGHG

Norway’s Full Scale Integrated Project – Capture Aspects - Bjorn-Erik Haugan, Gassnova

Norway’s Full Scale Integrated Project – Transport and Storage Aspects – Dr Philip Ringrose, Equinor

Hydrogen Energy Supply from Australia to Japan – Mr Katsuya Ishikawa, Kawasaki Heavy Industries

Valuing CCS Flexibility on the Grid – Dr Geoff Bongers, Gamma Energy Technology

Value of CCS-Socio-Economic Impacts - Piera Patrizio, IIASA