Panel on International CCS Value Chain Developments

29th August 2019

NETL CCUS Review Meeting

Pittsburgh, USA

Technology Collaboration Programme by iea

International CCS Value Chain Developments Global Context

Tim Dixon, General Manager, IEAGHG

29th August 2019

NETL CCUS Review Meeting

Pittsburgh, USA

Technology Collaboration Programme
by IEA

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

Southern Company

Chevron

Institut Teknologi Bandung 1920

Total

J-POWER

CIAB

ExxonMobil

Instituto de Investigaciones Electricas

Evaluating technology options to mitigate greenhouse gas emissions

ieaghg

EPRI

Jülich Forschungszentrum

Doosan Doosan Babcock

equinor

SOTACARBO Sustainable Energy Research Centre

BR Petrobras

جامعة خليفة Khalifa University

JGC

Powering. Reliable. Future. RWE

CCS Value Chains

- What is a "Value Chain" for CCS?
  - Broad range of possibilities due to wide range of applications of CCS
    - Power sector
    - Decarbonising industrial sectors
    - Hydrogen and CCS
    - 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.

START

Choose base system design
→ capacity of technology i: $d_o(i)$

Solve energy systems model MILP
→ total system cost: tsc_o

REPEAT FOR k=1,2,…,n^i , n=($\#\Delta d_k +1$)

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

Solve energy systems model MILP
→ total system cost: tsc_k

Receive the Levelised Value of Electricity for technology i
→ $SV_k(i) = tsc_o - tsc_k$

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.

Canada’s Carbon Pricing Backstop

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.

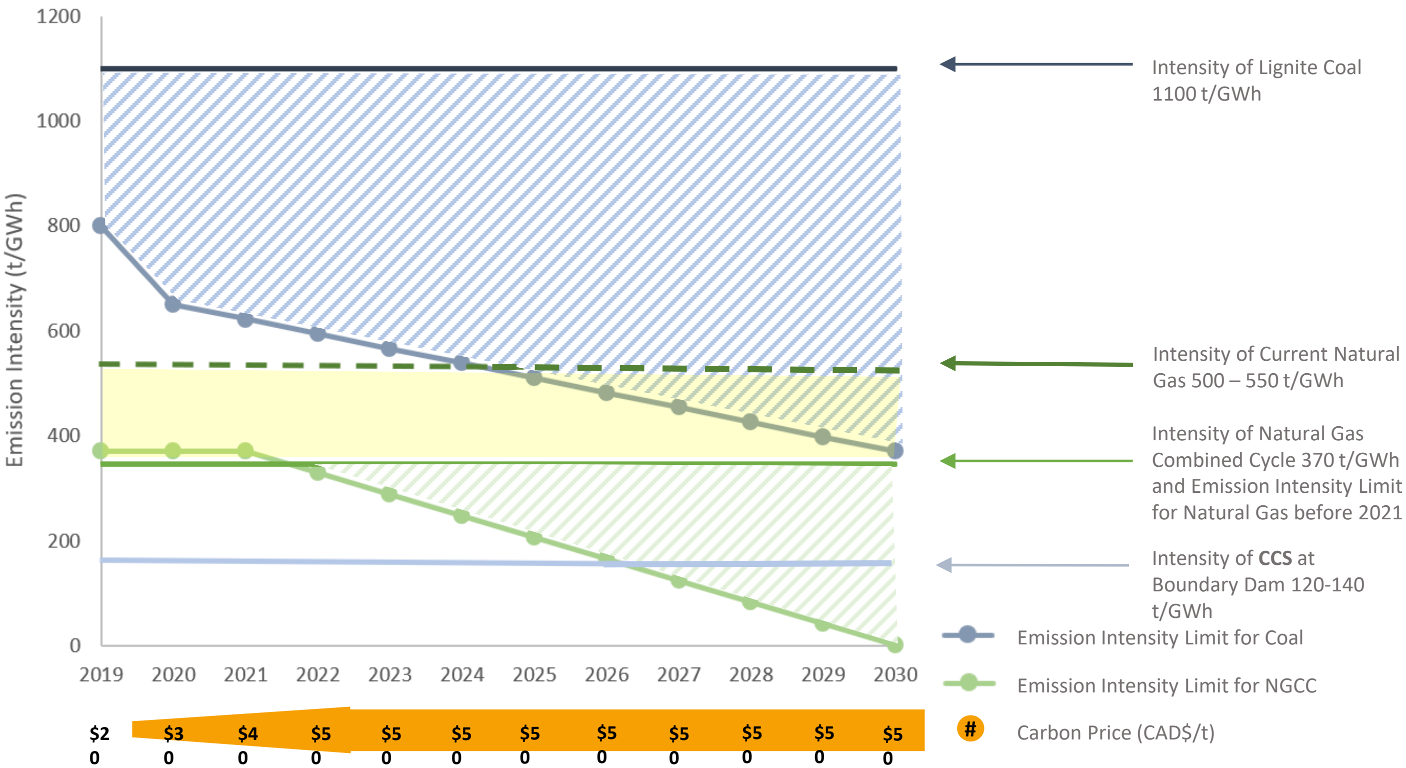
Canada’s carbon prices begins at a minimum of

$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

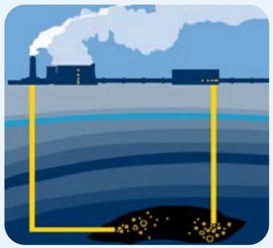


Blue shading: the difference between average intensity of coal power and the allowed limit.

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

elementenergy

Emrah.Durusut@element-energy.co.uk
antonia.mattos@element-energy.co.uk

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 CO_2 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 CO_2 price relative to market CO_2 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 $/t$CO_2$ to reduce firms tax liability (e.g. 45Q) or trade with other firms.	**CCS certificates:** Certificates representing tCO_2 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 CO_2

- Norway Full Scale Integrated Project
- **London Protocol Export amendment**
  - Provision Application being proposed by Norway and NL to allow countries to apply the 2009 CO_2 export amendment – to avoid waiting for ratification
  - the last international legal barrier to CCS being addressed!
  - 7-11 Oct 2019

IEAGHG work

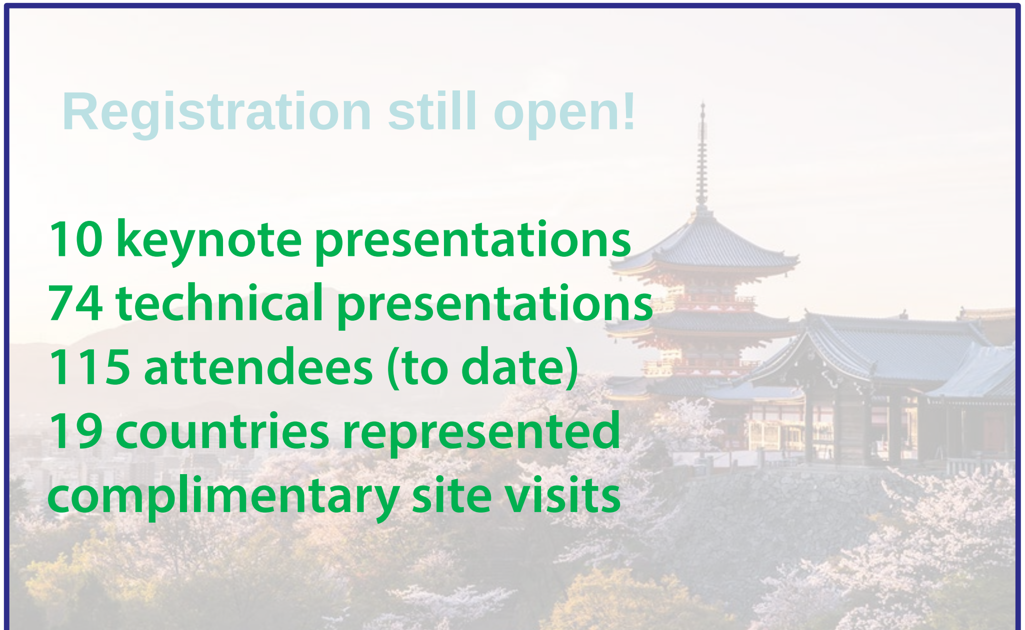
- Enabling CCS Clusters – IEAGHG Report 2018-01
- Valuing Flexibility in CCS Power Plants – IEAGHG Report 2017-09

- 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

Evaluating technology options to mitigate greenhouse gas emissions

pccc-5

Post Combustion Capture Conference



Conference themes:

- Process configurations
- Separation technologies
- Applications
- Modelling
- Cost and environmental assessments
- Demonstration activities

KYOTO, JAPAN, 17-19 SEPTEMBER 2019

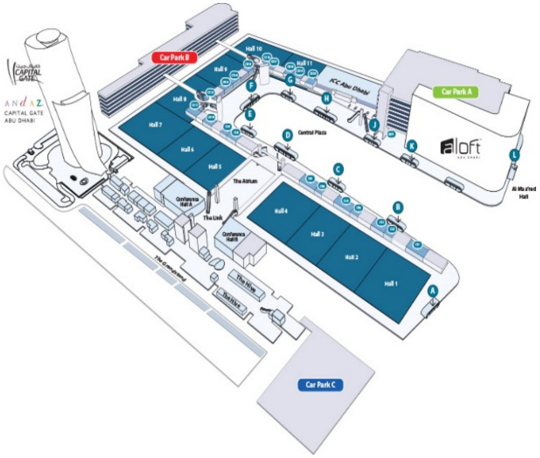
https://ieaghg.org/conferences/pccc/2-uncategorised/913-5th-post-combustion-capture-conference

ghgt-15 5th to 8th October 2020

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/ 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