Technology Collaboration Programme



Status of CCUS

Tim Dixon General Manager IEAGHG

IEA-OVP workshop on Facilitating Nigeria's Energy Transition through CCUS Development

10 September 2021

www.ieaghg.org



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





Carbon Capture & Storage (CCS) value chain





CO₂ Geological Storage to Scale: Aquistore (Canada)





CO₂ Storage Trapping Mechanisms (IPCC 2005)



Oil & Gas Reservoirs: EOR with CO₂ Storage





- Data rich (lots of wells, seismic)
- Objective: produce more oil (CO₂ storage secondary, but also occurs)

SACROC (Texas) CO2-EOR since 1972, over 150 Mt CO2 injected
Now an ISO standard for storage through CO2-EOR (ISO 27916:2019)









COMMERCIAL CCS FACILITIES IN DEVELOPMENT

OPERATION SUSPENDED

PILOT & DEMONSTRATION FACILITIES IN OPERATION & DEVELOPMENT

PILOT & DEMONSTRATION
 FACILITIES COMPLETED

Commercial-scale Application of CCS









Sleipner 1Mt/y CO₂

WeyburnIn-Salah2.5 Mt/y CO21.2 Mt/y CO2

Snohvit 0.7Mt/y CO2





160km sub sea pipeline



US DOE RCSP Phase III: Development Phase



2013 Port Arthur Project

- H2 Plant SMR operated by Air Products in Texas, USA
 - Consists of 2 Trains of SMR
- Retrofit capture Vacuum Swing Adsorption (VSA)
- Operational 2013
- 1mt CO2 pa to EOR



2014 Worlds first integrated coal fired power plant with CCS

- SaskPower's Boundary Dam Coal PS, Saskatchewan, Canada
- 110MWe Retrofit
- Shell/Cansolv Post combustion capture technology.
- EOR, and storage at Aquistore
- Started operation October 2014
- 2016 International CCS Knowledge Centre







2015



Quest, Shell, Canada H₂ Refining Retrofit amine absorption capture 1Mt CO2 pa to DSF storage



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THE SHELL QUEST CARBON CAPTURE AND STORAGE PROJECT

Lula, Petrobras, Brazil

Offshore gas separation and CO2-EOR FPSO Deep: 2000m water depth, 3000m beneath seabed





2016



Tomakomai, Japan

- Capture from hydrogen production unit in existing refinery
- Injection started spring 2016, rate ~100kt pa
- Onshore wells, deviated 3600m to offshore storage at 1200m
- Act for the Prevention of Marine Pollution and Maritime Disasters (amended 2007 to reflect London Protocol amendment). Permit issued by Min Env Mar 2016
- MMV plan included Marine Environmental Survey:- Regular (annual); Precautionary; Contingency
- Achieved target of 300kt in November 2019. Injection ceased, MMV continues.





2017

Petra Nova, NRG Parish, USA



- Refit of existing coal fired unit
- Operational Jan 2017
- MHI amine based PCC technology
- 250 MW slip stream, 90% capture
- 1.6Mt pa CO₂ for EOR

ADM's Illinois Industrial CCS Project



- 1Mt pa CO2 to DSF
- Operational April 2017
- Bioethanol = BioCCS

2019 - Gorgon CO₂ Injection Project

- Largest commercialscale injection project
- Operated by Chevron, off the coast of Western Australia
- CO₂ from Gorgon and Jansz-lo gas fields
 - Separated from natural gas stream prior to processing
- Injection into Dupuy Formation (2km beneath Barrow Island)



Image c/o https://www.dmp.wa.gov.au/Petroleum/Gorgon-CO2-injection-project-1600.aspx

- 3.4–4 million tonnes CO₂ /yr to be injected
- Expected 100 Mt total will be injected over project lifetime (40 yrs)

2020 - Alberta Carbon Trunk Line (ACTL)



Images courtesy of www.actl.ca

- World's newest integrated, large-scale CCUS system
- Central Alberta, Canada
- Consortium of partners
 & government support
- 240km pipeline
- Captures industrial CO₂ & delivers to mature oil & gas reservoirs for EOR & permanent storage

- CO₂ sources:
 - Sturgeon Refinery
 - Redwater Fertilizer Facility
- Fully operational in June 2020
- 1.8 Mt CO₂ /yr expected to be stored in Phase 1
- At full capacity, 14.6 Mt of CO₂ /yr can be transported



Northern Lights: a nucleus for further growth





Full-scale capture from Cement and WtE plant in Norway (Longship project)

and potentially many other sources across Europe

Ship transport to onshore hub and pipeline to offshore storage

- Construction underway ٠
- **Operational 2024** •

Other developments include



Hydrogen and CCUS – new projects being developed include

- Australia-Japan Hydrogen Energy Supply Chain from coal
- Equinor H2H Saltend (UK) from natural gas
- HyNet (UK)

Direct Air Capture and CCS (DACCS)

- Pilot scale projects in Canada, USA, Switzerland, Iceland
- New collaborations include:
 - Northern Lights and ClimeWorks (Norway)
 - Pale Blue Dot and Carbon Engineering (UK)
 - Corporate Carbon Advisory (Australia)
 - California LCFS credits for DACCS

CCS-specific Regulations

International



United Nations Framework Convention on Climate Change Clean Development Mechanism Modalities and Procedures for CCS (2011)



London Protocol

CCS amendments to allow and regulate offshore CO2 storage (2006, 2009, 2019)



ISO TC-265 – standards on Capture Performance, Pipeline Transport, Geological Storage, Storage in EOR, Vocabulary

National

IEA CCS Model Regulatory Framework (2010) - to

assist development of national regulations

USA EPA : Storage 2010 and GHG 2010

EU CCS : Directive 2009 and ETS Directive 2009 Australia, Japan, Canada Third party verifiers eg DNV All based on IPCC GHG Guidelines (2006)

Geologic CO₂ Storage - Safe By Design

- 1. Site Characterization
- 2. Risk Assessment Modeling identifies potential outcomes
- 3. Project Design to minimize potential risk
- 4. Permitting requires high level of assurance
- 5. Monitoring Plan

<u>Deep Subsurface – Verification</u> Behavior conforms to predictions

Shallow Subsurface - Assurance No unwanted outcomes to environment





Nigeria and IEAGHG



- Nigeria paper to London Protocol 2016
- "Report on the International Workshop on Offshore CO2 Storage (Austin, Texas, United States, 19 to 21 April 2016) "Submitted by Nigeria (LC38/6 2016)
- COP22 (2016) CCS Side-event "Opportunities for Africa in Carbon Capture and Storage (CCS)"
- CCS opportunities in Nigeria Felicia Mogo, NIMASA



MARRAKECH COP22 CMP12 UN CLIMATE CHANGE CONFERENCE 2016

IEAGHG CCS Summer Schools

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