STEMM-CCS: Strategies for Environmental Monitoring of Marine Carbon Capture and Storage

Sub-Seabed CO_2 Storage

Carbon dioxide Capture and Storage (CCS) has been identified as an important mitigation strategy to reduce anthropogenic carbon dioxide (CO_2) emissions and thereby combat the rising levels of atmospheric CO_2 responsible for global climate change and ocean acidification. CCS is seen as a key contribution to reducing anthropogenic greenhouse gas emissions by 80-95% by 2050 and keeping global temperature increases below 2°C. For most European nations offshore storage of CO_2 in depleted oil and gas reservoirs and saline aquifers is the option of choice.

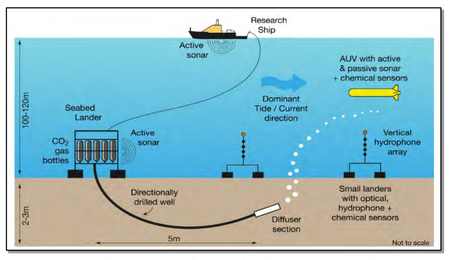
The STEMM-CCS project will deliver <u>new insights</u>, <u>guidelines for best practice</u>, and <u>tools</u> for all phases of the CO_2 storage cycle at offshore CCS sites. The key objectives of the project are:

- To produce new tools and techniques for environmental monitoring as well as CO_2 emission monitoring, quantification and assessment
- To generate new knowledge of the reservoir overburden by direct investigation of natural geological and manmade features
- To deliver the first CCS demonstration project level implementation of an ecological baseline, incorporating geochemical and biological variability
- To promote knowledge transfer to industrial and regulatory stakeholders and local and international communities

Workpackages

WP1 - Technical Logistics and Equipment

A central part of STEMM-CCS is a controlled release of CO_2 into sub-seabed sediments. WP1 will coordinate and develop the technical logistics to deliver this demonstration.



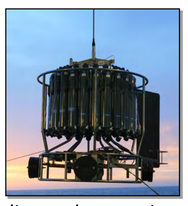
Schematic diagram of the shallow sub-surface release of CO_2 gas in sediments.

<u>Objectives</u>:

- **Coordinate the production, delivery and deployment of equipment to the demonstration site and coordinate the management of the test site**
- **Design, develop, manufacture and deploy a seabed drill and CO_2 delivery system to release CO_2 at < 5 m beneath the sediment water interface**
- **Deliver a current recording mooring and integrate sensors and functionality into the seabed lander**

WP2 - Baseline Studies for CCS sites

WP2 will deliver best practice methodologies and tools for baseline environmental monitoring relevant to offshore CCS.



CTD sampling and measuring system to determine the geochemical baseline in the water column (image courtesy A. Lichtschlag).

<u>Objectives</u>:

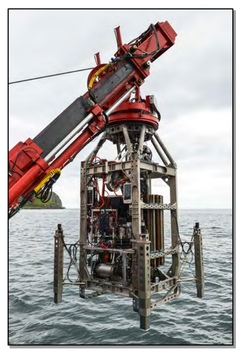
- **Design and implement an effective environmental baseline survey**
- **Identify appropriate biological and chemical indices of impact, suitable for industrial-scale application above CCS sites**
- **Use modelling approaches to extend spatially and temporally limited field observation data to support a comprehensive environmental baseline**

WP3 - Leakage Pathways through the Overburden

WP3 will use new geophysical techniques, sediment imaging techniques and direct sampling to determine the efficiency of fluid pathways in the shallow sub-surface. This will focus on anomalies in seismic data ('chimney structures'), common in many sedimentary basins which are generally believed to be the result of hydro-fracturing and fluid migration.

<u>Objectives</u>:

- **Determine the efficiency of leakage pathways for CO_2 transfer**
- **Determine the CO_2 permeability of chimney structures**
- **Determine how long chimney structures remain open for CO_2 transfer**
- **Determine the physical properties of chimney structures**



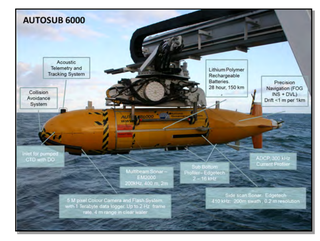
BGS British Geological Survey RD2 Rock Drill that will be used during WP3 to determine the permeability of chimney structures (image courtesy BGS).

WP4 - Leakage Detection, Localisation and Quantification

WP4 will focus on simultaneous calibration of various techniques for detecting and quantifying CO_2 released in the sub-seafloor experiment in the North Sea (WP1).

<u>Objectives</u>:

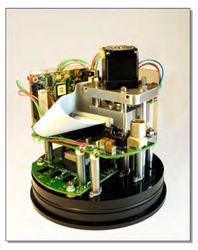
- **Detect, locate and quantify CO_2 leakage from the controlled sub-seabed CO_2 release experiment**
- **Assess the utility of artificial and natural tracers of CO_2 in the marine environment**
- **Develop effective methodologies for quantification of CO_2 fluxes across the seabed and dispersion in the water column**
- **Develop coupled and nested model systems to assess CO_2 and tracer dispersion in sediments and the water column for a range of leakage scenarios**



The AUV Autosub 6000 equipped with sensors for detecting shallow fluid flow (image courtesy NOC Southampton).

WP5 - Emerging Technology

WP5 will address capability gaps in the instrumentation, sensors, observational systems and techniques required to reduce the cost and uncertainty in measurement of the environment at proposed and operational CCS sites.



pH sensor developed at the National Oceanography Centre (image courtesy OTE, NOC Southampton).

<u>Objectives</u>:

- **Develop new technologies and optimise methods to locate, detect and quantify CO_2 leakage**
- **Develop new technologies and techniques for measurement of biological and chemical parameters, including natural variability**
- **Reduce the cost of data collection by developing new technologies and techniques**
- **Assimilate measurement and model information to produce a decision support tool to guide mitigation and remediation action**
- **Develop automated low-cost seabed imaging and mapping technologies and techniques for baseline and impact assessments**

WP6 - International Collaboration

STEMM-CCS has the potential to export knowledge and products to many international stakeholders and WP6 will collaborate with, and benefit from, the many research and development initiatives and associated observations underway outside the EU.

<u>Objectives</u>:

- **Capitalise on collaborative interactions with international research and development to maximise the impact of STEMM-CCS**
- **Maximise the exposure and dissemination of project outputs to an international audience of CCS stakeholders including industry, regulators, governments and researchers**

WP7 - Knowledge Sharing

WP7 will share the knowledge gained and the methods proposed in WPs 2, 3, 4 and 5 with a range of appropriate stakeholders and other interest groups through a variety of approaches.

<u>Objectives</u>:

- **Ensuring that accurate information about CO_2 storage is available by providing clear and accessible communications designed for specific audiences**
- **Facilitating interaction between project scientists and stakeholders**
- **Establish a comprehensive training programme for the community of postgraduate and postdoctoral researchers involved in the project, and industry and regulatory stakeholders**

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