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Monitoring technology programs for offshore CCS

'The state of the art'

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As part of the Bifrost CCS Project, a major focus for DTU Offshore, we survey the monitoring technologies deployed for offshore CCS programs globally. Offshore CCS projects worldwide differ from each other in several key ways that affect monitoring program design. Storage reservoirs may be sited in open saline aquifers at shallow and intermediate depths (1000-2500 m), such as Sleipner (Norway) and Gorgon (Australia), or alternatively in deeper depleted gas fields (2500-4000 m) with existing infrastructure from hydrocarbon production, such as Porthos (Netherlands). Projects also vary by their business model. Some are pilot projects with significant academic and governmental research and development (R&D) efforts in their MMV plans, such as Sleipner, Tomakomai (Japan) and K12B (Netherlands). A second set of projects are 'paired' with existing hydrocarbon production and have comprehensive monitoring programs that reflect the cash flow available to them, such as Snøhvit (Norway) and Gorgon. A third set of projects that has emerged in recent years aims to demonstrate the viability of CCS as a stand-alone business, such as Porthos and Northern Lights (Norway). These stand-alone projects have leaner business models and simpler MMV plans. A discernable trend is for modern MMV plans to be leaner than plans proposed 10 or 15 years ago, reflecting the change in financial drivers and an increased focus on cost. Additionally, there are some country specific trends with for example MMV plans in the Netherlands paying more attention to induced seismicity as compared to projects in the neighboring UK North Sea which focus more on environmental and seabed monitoring. Hence geology, history of the storage site, economics, and socio-political risk perceptions all appear to play a role in MMV planning for CCS. Fibre optic-based sensing is perhaps the most promising up-and-coming monitoring technology, enabling low-cost measurements of multiple data types, potentially along the same fibre, including seismic signals through Distributed Acoustic Sensing (DAS), temperature and CO2 concentrations. We also foresee that 'big data' and machine learning will play a key role in reducing cost of long term monitoring. We also expect seabed monitoring to become increasingly important in the future as a key pillar in securing authority approvals and public acceptance for large-scale offshore CCS projects.