



A review of developments in carbon dioxide storage

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HIGHLIGHTS

- Current state of developments in carbon dioxide storage is reviewed.
- The main carbon dioxide storage options and challenges are presented.
- Public acceptance of CO₂ storage play a central role in technology deployment.
- Major carbon dioxide storage projects are summarised.
- Future outlook for carbon dioxide storage is suggested.

ARTICLE INFO

Keywords:

Carbon capture and storage
Geologic CO₂ storage
CO₂ storage reservoir
CO₂ storage projects

ABSTRACT

Carbon capture and storage (CCS) has been identified as an urgent, strategic and essential approach to reduce anthropogenic CO₂ emissions, and mitigate the severe consequences of climate change. CO₂ storage is the last step in the CCS chain and can be implemented mainly through oceanic and underground geological sequestration, and mineral carbonation. This review paper aims to provide state-of-the-art developments in CO₂ storage. The review initially discussed the potential options for CO₂ storage by highlighting the present status, current challenges and uncertainties associated with further deployment of established approaches (such as storage in saline aquifers and depleted oil and gas reservoirs) and feasibility demonstration of relatively newer storage concepts (such as hydrate storage and CO₂-based enhanced geothermal systems). The second part of the review outlined the critical criteria that are necessary for storage site selection, including geological, geothermal, geohazards, hydrodynamic, basin maturity, and economic, societal and environmental factors. In the third section, the focus was on identification of CO₂ behaviour within the reservoir during and after injection, namely injection-induced seismicity, potential leakage pathways, and long-term containment complexities associated with CO₂-brine-rock interaction. In addition, a detailed review on storage capacity estimation methods based on different geological media and trapping mechanisms was provided. Finally, an overview of major CO₂ storage projects, including their overall outcomes, were outlined. This review indicates that although CO₂ storage is a technically proven strategy, the discussed challenges need to be addressed in order to accelerate the deployment of the technology. In addition, beside the necessity of techno-economic aspects, public acceptance of CO₂ storage plays a central role in technology deployment, and the current ethical mechanisms need to be further improved.

Abbreviations: ACTL, Alberta Carbon Trunk Line; API, American Petroleum Institute; ARI, Advanced Resources International; CAS, Chinese Academy of Sciences; CBM, Coal Bed Methane; CCS, Carbon Capture and Storage; CCSU, Carbon Capture Storage and Utilisation; CO₂CRC, The Cooperative Research Centre for Greenhouse Gas Technologies; CSLF, The Carbon Sequestration Leadership Forum; DOE, Department of Energy; DoReMi, Derivative of Refractive Microtremor; ECBM, Enhanced Coal Bed Methane recovery; EGS, Enhanced Geothermal System; EOR, Enhanced Oil Recovery; EPRI, Electric Power Research Institute; FEP, Features, Events and Processes; GHG, Greenhouse Gas; HCPV, Hydrocarbon Pore Volume; IMO, International Maritime Organisation; InSAR, Interferometric Synthetic Aperture Radar; IPCC, Intergovernmental Panel on Climate Change; LNG, Liquefied Natural Gas; MIT, Massachusetts Institute of Technology; MoU, Memorandum of Understanding; MRCSP, Midwest Regional Carbon Sequestration Partnership; MVA, Monitoring, Verification and Accounting; NETL, National Energy Technology Laboratory; OBPP, Otway Basin Pilot Project; OGCM, Ocean General Circulation Model; OGIP, Original Gas in Place; OOIP, Original Oil in Place; OSPAR, Oslo Paris; PCOR, Plains CO₂ Reduction Partnership; PFTs, Perfluorocarbon tracer compounds; PTRC, Petroleum Technology Research Centre; SECARB, Southeast Regional Carbon Sequestration Partnership; SEM, Scanning Electron Microscope; SSEB, Southern States Energy Board; SWP, The Southwest Regional Partnership; TRL, Technology Readiness Level; UKCCSRC, UK Carbon Capture and Storage Research Centre; US-DOE, United States Department of Energy; USGS, United States Geological Survey; VSP, Vertical Seismic Profile; XRD, X-ray Diffraction

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<http://dx.doi.org/10.1016/j.apenergy.2017.09.015>

Received 7 December 2016; Received in revised form 14 August 2017; Accepted 8 September 2017

Available online 21 September 2017

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