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Royal Academy of Engineering

The London Register of Subsurface CO_2 Storage

Annual Report 2025

Overview

We report the annual amounts of CO_2 stored underground by projects globally over the period 1996 – 2024. We describe the methods used to compile this data and provide an overview of the project below. For the full Register, comprising a spreadsheet of the data with detailed information about the sources and quantification protocols used by the projects, please visit the project website at https://imperialcollegelondon.github.io/The-London-Register-of-Subsurface-CO2-Storage/

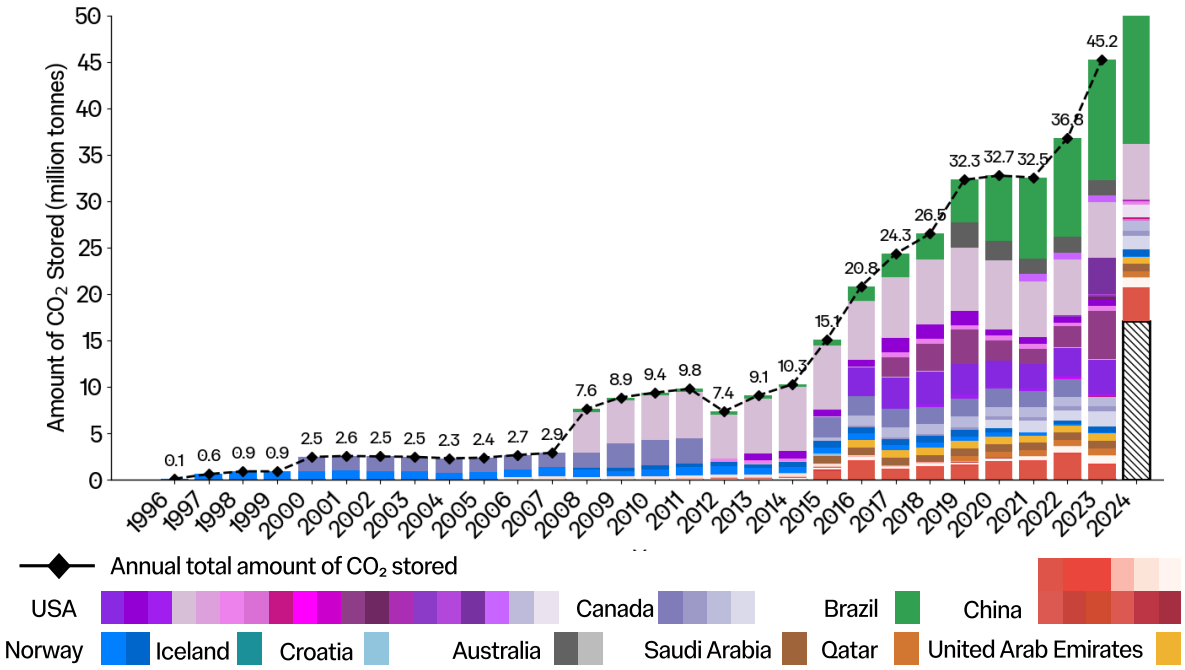

Figure 1. Annual amounts of CO_2 stored with colouring by continent, country, and individual project. See Appendix 1 for the individual project legend. The hashed grey in the bar for 2024 represents the amount of CO_2 stored in 2023 by projects where data has not yet been published

Amounts of CO_2 stored since 1996

From 0.1 million tonnes in 1996, the amount of CO_2 stored globally increased to a record 45.2 million tonnes in 2023 (Figure 1). This represents an average annual growth of 17.1% since 1996. Inclusive of 2024, a total of 384.6 million tonnes has been stored. Three distinct phases of growth can be observed

1. Pioneering Phase (1996–2007, 3 Projects): Annual storage amounts were less than 3 million tonnes of CO_2 per year, driven by the Sleipner project in Norway, which began in 1996 at a rate of about 0.8 million tonnes per year, and the Weyburn-Midale project in Canada, operational from 2000 at a rate of about 1.6 million tonnes per year. China's Zhongyuan oilfield began operations in 2006 with a rate of about 0.3 million tonnes per year, marking an early expansion beyond North America and Europe. The annual average growth rate of injection during this period was 21.6%, albeit with most of the growth taking place in the first year.
2. North American Expansion (2008–2015, 18 Projects): New projects boosted annual amounts to the range of 7–15 million tonnes of CO_2 per year. This corresponds with an annual average growth in injection rate of 6.2 % over this period. The total injection rate increase was dominated by projects in North America, and this also brought the prominence of geological storage combined with oil recovery. The Santos Basin Pre-Salt oilfield in Brazil joined the

Zhongyuan project in China in marking the initiation of a broader international deployment of CO_2 storage.

3. Global Scaling (2016–2023, 36 Projects): Large-scale deployments and new market entrants increased injection rates to 45.2 million tonnes per year with an annual average growth in injection rate of 9.8 % during this period. This phase featured a large increase in project numbers and a marked global spread, with activity ramping up in China and new large-scale projects launching in Australia, the United Arab Emirates, Saudi Arabia, and Qatar. The growing deployment in Asia, the Middle East, and South America represented an international expansion of industrial scale CO_2 storage.

Amounts of CO_2 stored in 2023

In 2023, the most recent year with complete data, there were 35 projects reporting and an aggregate reported global storage amount of 45.2 million tonnes of CO_2 (Figure 2). The total amount of stored CO_2 increased by 8.4 million tonnes from 2022, marking one of the highest single-year increases on record.

Leading the increase were projects based in the United States, contributing an additional 8.1 million tonnes. This growth was driven by both newly initiated projects and increased injection rates at existing facilities. The newly launched Seminole San Andres Unit emerged as the largest single contributor, accounting for a 3.9 million tonne increase. Other newly launched projects in the U.S.A. included the Camrick Unit, Petra Nova West Ranch, the Seminole East Field, the Blue Flint CO_2 Storage Project, and the Barnett RDC Well No. 1.

There was also considerable growth in Brazil. Expansion at Petrobras's Santos Basin Pre-Salt Oil field added 2.4 million tonnes rising from 10.6 million tonnes in 2022 to 13.0 million tonnes in 2023. As a result, CO_2 storage at the Santos Basin made up 33% of the global total for 2023.

Growth continued in Norway with an increase in injection from 0.5 million tonnes in 2022 to 0.8 million tonnes due to increases in storage rates at both Sleipner and Snohvit.

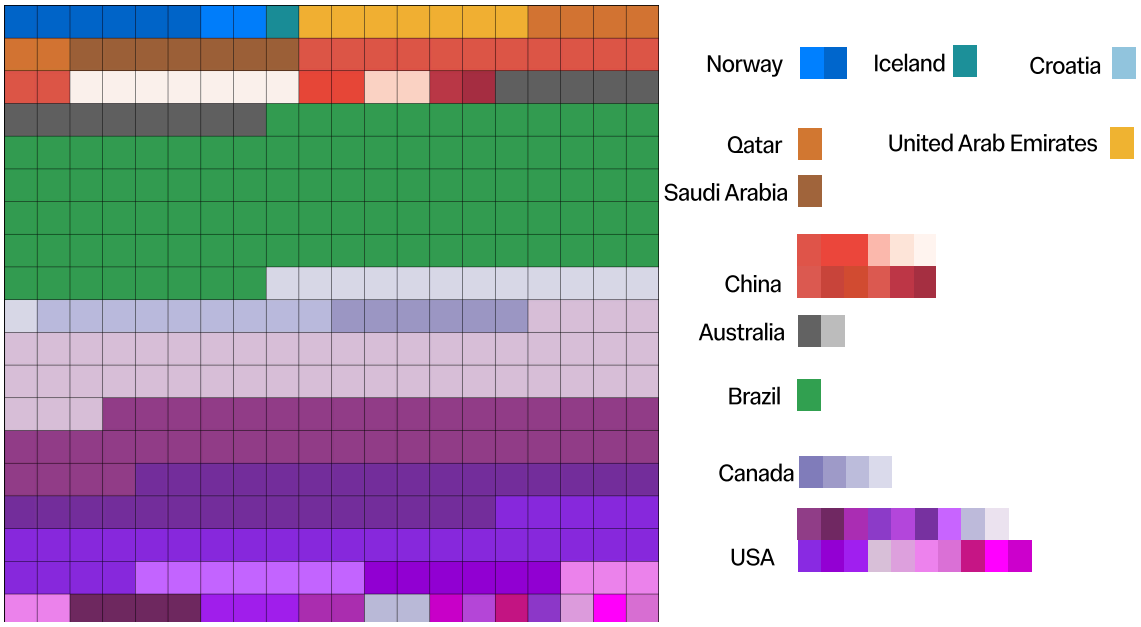

Figure 2. A waffle Plot of 2023 CO_2 Storage by country and project. The chart is a 20 ×19 grid with each block representing about 100,000 tonnes of CO_2 injected. The individual project legend is provided in Appendix 1.

However, we cannot report growth in all regions. In Canada, one major facility, Weyburn-Midale, has not yet reported injection data for 2023. This contributes to an apparent decline of 2.0 million tonnes which may change after data becomes available. Storage rates declined in China by 1.0 million tonnes, primarily due to a decline at the Jilin oilfield.

Incomplete Reporting on Amounts of CO_2 Stored in 2024

At the time of publication there were 22 projects reporting data from 2024 with an aggregated storage amount of 33.2 million tonnes. The data is currently incomplete and there is a particularly large gap in information from projects in the USA that was previously available through the EPA Greenhouse Gas Reporting Programme. This data will be back revised for the 2026 Annual Report.

Reporting for 2024 from the USA includes 6.0 million tonnes from Shute Creek and 1.4 million tonnes from the DGC Beulah Broom Creek project. Smaller amounts come from the Illinois Industrial Carbon Capture and Sequestration Project, accounting for 0.3 million tonnes, while Barnett RDC Well No. 1, the Blue Flint CO_2 Storage Project, and Red Trail Energy each storing approximately 0.2 million tonnes.

In Canada there is reporting for 3.1 million tonnes of CO_2 stored in 2024. This amount decreased slightly by 0.1 million tonnes from 2023, primarily because of a slight decline from the Alberta Carbon Trunk Line (ACTL) project.

In Brazil, the Santos Basin Pre-Salt Oil Field project continues as one of the leading contributors to the global aggregate. In 2024, 14.2 million tonnes of CO_2 were injected, a 1.2 million tonne increase from 2023. As a result, CO_2 storage at the Santos Basin project accounted for nearly half of the global reported storage for 2024.

Storage operations in China recorded a total of 4.7 million tonnes, with the Jilin Oilfield contributing 3.5 million tonnes of this figure. This marks an increase from the 2.0 million tonnes among all of China's projects reported in 2023.

The majority of Middle Eastern facilities maintained steady operations. Both Saudi Arabia and the United Arab Emirates reported unchanged levels at 0.8 million tonnes each. There was a small decrease in the storage rate in Qatar, from around 0.7 to 0.6 million tonnes.

At Sleipner and Snohvit, offshore Norway, storage rates remain the same as the previous year, with a total storage of 0.8 million tonnes in the year.

Methods

The London Register of Subsurface CO_2 Storage compiles reported amounts of CO_2 stored geologically. We summarise the methods used to compile this data here. Full details of data sources and reporting protocols can be found on the downloadable spreadsheet at the project website https://imperialcollegelondon.github.io/The-London-Register-of-Subsurface-CO2-Storage/.

- Data sources: The data in this report is compiled from publicly reported sources, including project-level disclosures, government databases, industry reports, environmental assessments, and data directly from project operators by response to a survey. The full register may be downloaded in spreadsheet form from the project website.
- Data processing: In many cases, multiple sources of data exist for a project in a given year, and these are included in the full database. For global injection rate calculations, and locations in this report and on our website where we provide single values for projects in a year, we have prioritised primary sources (e.g., operator responses to a survey) over secondary reporting. For some projects, only cumulative amounts of stored CO_2 is reported following several years of

activity. In these cases, we report the average value for the years of the reporting period. The specific data that are used and instances of averaging are shown in the Register spreadsheet.

- Definitions of storage: We accept definitions of storage as reported by projects, and these are usually governed by adherence to independent standards and regulations including those set forth by Ipieca, the Global Reporting Initiative (GRI), the Sustainability Accounting Standards Board (SASB), the Hong Kong Stock Exchange ESG Reporting Guide (HKEX-ESG), and the U.S. Environmental Protection Agency Greenhouse Gas Reporting Programme. Standards under which projects are reporting CO_2 storage are provided in the Register spreadsheet. We also provide links to some of the more commonly used standards in Appendix 2.
- Assurance and Quality: An independent assurance evaluation of the data has been carried out by DNV. A summary is provided in Appendix 3. The detailed outcome and recommendations can be found in a separate report issued to Imperial College London that will be available on the website.

About the London Register of Subsurface CO_2 Storage

This is a centralised register of annual rates of CO_2 stored underground from operational projects worldwide. This initiative, funded by the UK Royal Academy of Engineering and supported by a consortium of stakeholders from academia, industry, and government, obtains data directly from operators and from publicly available information, providing a standardised register of the annual amounts of stored CO_2. Please contact us with any questions or interest in the project.

This report should be cited as:

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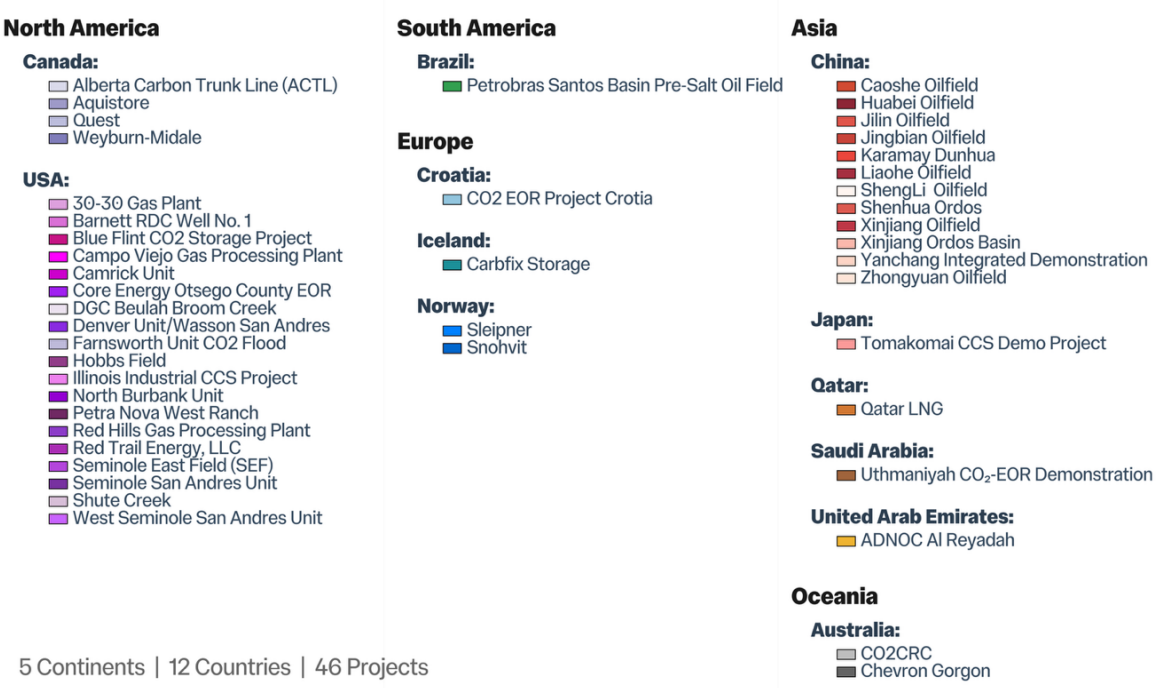
Appendix 1: Project Legend for Figure 1 and Figure 2



Appendix 2: Links to Reporting Frameworks and Standards Used by CO_2 Storage Projects in the Register

- EPA Greenhouse Gas Reporting Program Subpart RR – Geologic Sequestration of Carbon Dioxide: https://www.epa.gov/ghgreporting/subpart-rr-geologic-sequestration-carbon-dioxide
- GRI: https://www.globalreporting.org/how-to-use-the-gri-standards/gri-standards-english-language/
- HKEX-ESG standards KPIs: https://www.hkex.com.hk/-/media/hkex-market/listing/rules-and-guidance/environmental-social-and-governance/exchanges-guidance-materials-on-esg/app2_envirokpis
- Ipieca CCE-3: https://www.ipieca.org/resources/sustainability-reporting-guidance
- SASB Standards EM-EP: https://sasb.ifrs.org/standards/

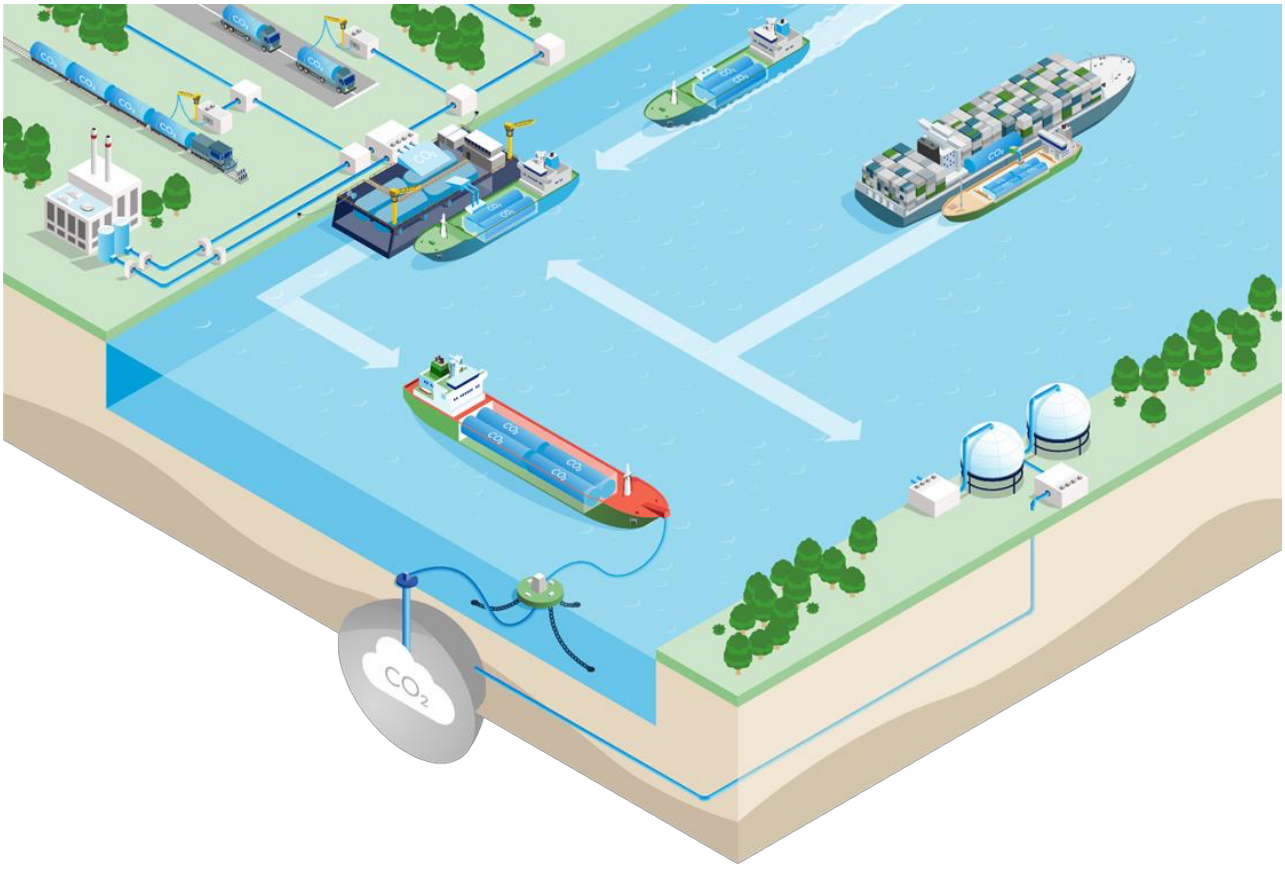
Appendix 3: Data Assurance Summary appended from the following page

LONDON REGISTER OF SUBSURFACE CO2 STORAGE

Data assurance summary

Imperial College London Ltd.

Report no.: 10591504-01, Rev. 0
Document no.: 2788367
Date: 2025-11-12



Project name:	London Register of Subsurface CO2 Storage	DNV Services UK Limited Energy Systems Digital Energy 5th Floor Vivo Building Vivo Building 30 Stamford Street SE1 9LQ London United Kingdom
Report title:	Data assurance summary	
Customer:	Imperial College London Ltd., Exhibition Road Sherfield Building SW7 2AZ London United Kingdom	
Customer contact:	Xiaowei Gao	
Date of issue:	2025-11-12	
Project no.:	10591504	
Organisation unit:	Digital Energy	
Report no.:	10591504-01, Rev. 0	
Document no.:	2788367	

Prepared by:	Verified by:	Approved by:
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Rev. no.	Date	Reason for issue	Prepared by	Verified by	Approved by
0	2025-11-12	First issue	D Simpson	A Daoud	G Faiz

1 ASSURANCE SUMMARY

The London Register of Subsurface CO_2 Storage (hereafter 'the register') compiles project-level global CO_2 storage data from operational CCS projects on an annual basis. Storage data is sought for many purposes by the scientific community, policy makers, technology providers, and the public. Such purposes include tracking industry progress, project performance and global trends; informing insight, investment and policy decisions; therefore access to trustworthy data is valuable.

Most operating storage projects report their storage rates publicly; however, these sources vary widely in format, publication type, and reporting methods. This leads to challenges in accessing and analysing global data; hence the register seeks to alleviate access and usability challenges by presenting a consolidated source of global data.

DNV have reviewed the register against prioritised data quality principles which embody the objectives and value of this dataset. This review has been carried out based on DNV-RP-0497 "Assurance of data quality management" /1/. This document provides a summary of the initial assurance review; the detailed outcome and recommendations can be found in a separate report issued to Imperial College London.

1.1 Assurance process

Data assurance provides confidence that data meets a specific need, and that its requirements have been or will be achieved. DNV have been carrying out an assurance review of the register to evaluate the extent to which it fulfils its requirements and make recommendations for enhancement.

DNV's Digital Trust services provide assurance for technologies through our recommended practices, which give a framework for deriving confidence in data and digital solutions where a specific standard does not exist. These allow confidence to be derived in complexity and uncertainty, being rooted in international standards and best practices.

Assurance evaluation of the register has been guided by DNV-RP-0497, which provides a systematic approach and governance framework to evaluate and enhance data quality. A range of assurance activities have been or are being carried out. These activities take into consideration the stage of the programme, the ambitions of the register, and the level of assurance. They include:

- Evaluating the impact of the reporting standards used by the projects and quoted in the register.
- Interviewing members of the register team to establish data gathering and processing steps.
- Clarifying and confirming the format and presentation of data in the register, and associated management processes.
- Review of a sample of projects' data to evaluate the data lineage and clarity of presentation in the register.

1.2 Value in consolidated storage data

DNV's Energy Transition Outlook (ETO) /2/ predicts that carbon capture and storage capacity will quadruple by 2030, and by 2050 will have grown to capture 1,600 $MtCO_2/yr$, or 6% of global CO_2 emissions. While the ETO predicts an increase to 16% of global emissions captured and stored by 2060, these predictions represent a significant shortfall relative to what is required for any net-zero outcome by mid-century. CCS is a critical component is our transition to net zero: the IEA's "Net Zero Emissions by 2050 Scenario" /3/ requires 6,040 $MtCO_2/yr$ capture and storage by 2050 representing 8% of cumulative emissions reduction.

For the deployment of CCS there is a need for clear strategy, policy alignment, investment, and global coordination: all of which are built upon a bedrock of quality data. With more CCS projects coming into operation there is a need for transparent reporting of project performance, particularly to understand the impact of CCS as a climate change mitigation tool. As well as this, trust in reported volumes of CO_2 storage is critical when considering commercial

implications associated with compliance and voluntary carbon markets, subsidy support schemes and tax credits. The efforts of the London Register of Subsurface CO_2 storage in seeking to provide a consolidated view of global storage data is an important contribution to this critical foundation.

1.3 Key requirements

The primary objective of the register is to target comprehensive coverage of operational CO_2 storage projects worldwide and to maintain sufficient transparency to foster trust and encourage use. DNV convened a collaborative workshop with the register team, the outputs of which were used to clarify and strengthen these fundamental aims and requirements.

The following **principles** summarise the core values and ambitions of the register:

1. The data is sufficiently comprehensive, aiming to cover all major operational subsurface CO_2 storage projects globally.
2. The data is sufficiently well documented and structured so that target users can utilise it easily, and without additional support.
3. The data sources and processing methodology are sufficiently well documented to inspire trust in the broad community; and enable understanding of limitations for individual use cases.
4. The data reflects the truest available representation of injection rates for each project.

1.4 Assurance evaluation

Based on our initial assurance assessment, the register is well aligned with the core principles identified above and has made good initial steps in fulfilling its key data quality requirements. A detailed assessment is ongoing at the time of publication, whose outcomes and recommendations for enhancement and scalability will be delivered to the register team in a separate report.

For data to have impact it must be trusted. Trust in data reflects the data sources, gathering and transformation processes, presentation format, and means of access. DNV's Energy Transition Outlook "CCS to 2050" report /4/ states:

"a consistent approach to reporting operational performance and transparency regarding the data could offer significant benefits to the CCS industry. Such data could enable more accurate quantification of CO_2 avoided and provide the basis for bench-marking and performance improvements"

In order for the register to be impactful it is critical that all stakeholders contribute to maximise the quality of data, in line with the key principles outlined in section 1.3.

2 ABOUT DNV

DNV is an independent assurance and risk management provider, operating in more than 100 countries, with the purpose of safeguarding life, property, and the environment. As a trusted voice for many of the world's most successful organizations, we help seize opportunities and tackle the risks arising from global transformations. We use our broad experience and deep expertise to advance safety and sustainable performance, set industry standards, and inspire and invent solutions.

We provide assurance to the entire energy value chain through our advisory, monitoring, verification, and certification services. As the world's leading resource of independent energy experts and technical advisors, we help industries and governments to navigate the many complex, interrelated transitions taking place globally and regionally, in the energy industry. We are committed to realizing the goals of the Paris Agreement, and support our customers to transition faster to a deeply decarbonized energy system.

3 REFERENCES

/1/ DNV-RP-0497 Assurance of data quality management; October 2023

/2/ DNV (2025), Energy Transition Outlook 2025

/3/ IEA (2023). Net Zero Roadmap: A Global Pathway to Keep the 1.5 °C Goal in Reach. IEA, Paris. https://www.iea.org/reports/net-zero-roadmap-aglobal-pathway-to-keep-the-15-0c-goal-in-reach

/4/ DNV (2025). Energy Transition Outlook "CCS to 2050"