GLOBAL CCS INSTITUTE

PERSPECTIVE

INSURANCE FOR CARBON CAPTURE AND STORAGE – STATE OF THE MARKET

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1. INTRODUCTION

One of the key considerations to scale up CCS project deployment to the levels required to meet the Paris climate goals is access to project finance. Until recently, this was not available to CCS projects. The first commercial CCS project to successfully access project finance is the Northern Endurance Partnership in the United Kingdom (UK), which is constructing a CO_2 transport and storage network to support NetZero Teesside Power and other projects in the UK's East Coast Cluster (Societe Generale, 2024). Accessing finance requires developers to prove the economic viability of their CCS projects and an acceptable level of risk mitigation to meet lenders' requirements. Risks around long-term containment of stored CO_2, project data availability to appropriately assess risks, and the bankability of projects are amongst the many considerations for financiers.

As projects commence operations and more governments implement CCS regulatory frameworks, project developers and capital providers gain greater certainty, especially around risk management and the permanence of CO_2 storage. The insurance industry is also acknowledging that the small risk remaining around CO_2 storage could be managed by the growing commercial risk management sector. Several innovative insurance products have come to market covering, among others, the reversal of carbon credits and loss of tax credits in the event of CO_2 leakage.

This paper summarises the current landscape and recent developments in carbon insurance, key remaining challenges for insurers and financiers, and the outlook for this market.

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2. EVOLUTION OF RISK ASSESSMENT FRAMEWORKS AND INSURANCE PRODUCTS FOR CCS

The development of risk management solutions for CCS projects is paramount for successful large-scale deployment. Along the CCS value chain, capture, pipeline transport, liquefaction and compression fall comfortably within known risk profiles of energy, marine and construction underwriters (Howden, 2025). Although industrial activities such as waste disposal and oil and gas production pose similar, or even higher risks, the long-term nature and large volumes of CO_2 that need to be permanently stored present unique risks that have concerned insurers since the first deployment of the technology. Concerns have been raised that the risk of CO_2 leakage has far-reaching implications, including damage to the environment[1], human health and safety, revenue losses, and loss of carbon credits and tax incentives.

The insurance industry is increasingly comfortable with insuring the risks posed by CO_2 storage projects, as evidenced by the growing number of insurance providers offering products or publishing interest in developing insurance products for CO_2 storage projects. The insurance industry has supported deployment through the development of refined approaches to project risk assessment, new insurance strategies and innovative products.

Risk assessment frameworks

In recent years, various frameworks have been developed to assess risks and insurability conditions of climate technologies, such as the US Department of Energy's Technology Readiness Level and Adoption Readiness Level (ARL) frameworks[2] and the Geneva Association's Climate Change Risk Assessment Framework, developed by the Geneva Association Task Force in 2021 (The Geneva Association, 2021). These risk assessment frameworks are widely used by the insurance industry to perform project risk assessments for insurance purposes.

In 2024, the Geneva Association (GA) released a series of reports aiming to examine the commercialisation landscape for climate technologies and explore the role of insurance solutions to accelerate project market readiness. Recognising the critical role that available and affordable insurance could play in bringing projects to market, the GA proposed to add a new key risk element to the ARL framework – ''Insurability and Availability of Affordable Insurance'. This new risk element includes, among others, 'the development and availability of a full range of insurance solutions to meet financing and market needs' (Golnaraghi M, 2024).

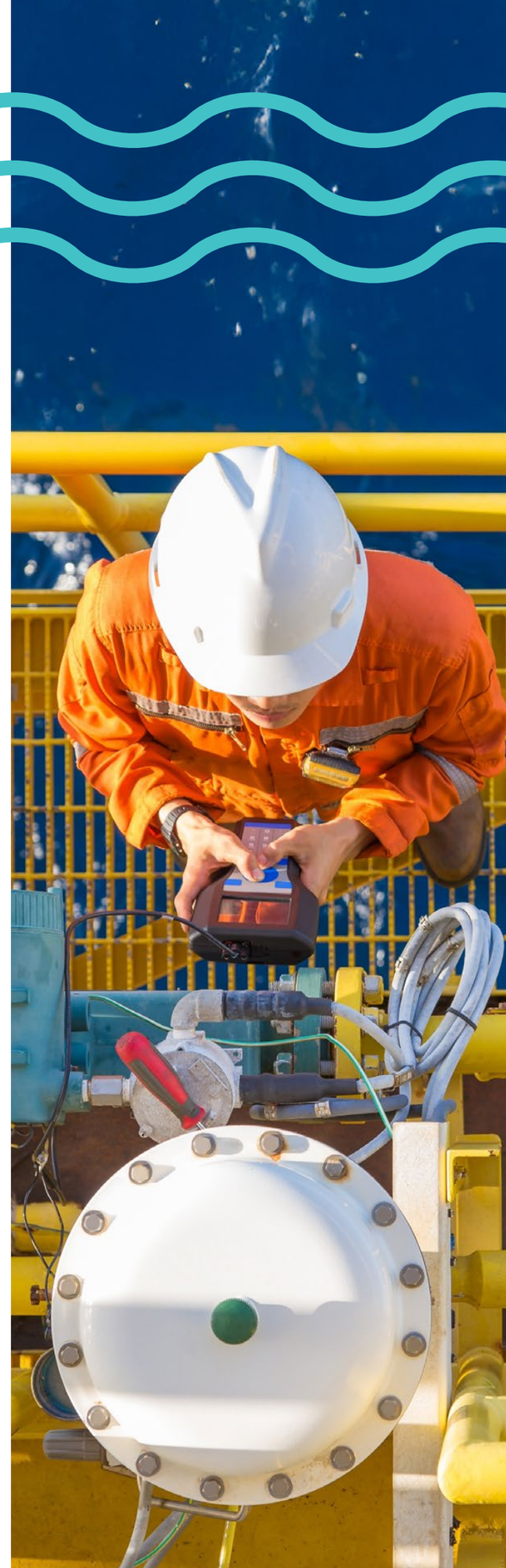
The GA has also developed a novel Insurability Readiness Framework (IRF) to help view climate tech project risks through an insurance lens. The IRF presents seven insurance-relevant risk categories, and how they relate to risks identified in the ARL framework. For each of these categories, the IRF identifies key issues to consider by project developers and insurers/reinsurers when framing risks in the assessment of insurability (Golnaraghi M, 2024). The IRF could play a significant role in accelerating insurance conversations between project developers and insurers, which may ultimately lead to greater project bankability.

Insurance products

The past five years have seen the emergence of several insurance products in the commercial market, providing coverage for aspects of CO_2 storage projects. In 2024, the IEAGHG published a list of insurance firms that offer or have published interest in developing CO_2 storage insurance products (IEAGHG, 2024). Among these products, of particular interest is the emergence of:

- Products that provide coverage for a project's financial performance, for example, business interruption as a result of CO_2 leakage to the atmosphere. This includes cover for damage to the environment, human health and property, financial risk to the project, and regulatory compliance risk.
- Products that provide protection against loss of previously generated carbon credits. The World Bank's risk insurance arm, for example, is set to extend guarantees to cover risks associated with reversal, non-delivery and quality of carbon credits (Financial Times, 2024).
- Specialist products, tailored to specific project needs. AON's specialist CCUS insurance product for CO_2 transportation and storage projects, launched in May 2024, aligns with the project's local regulatory regime, covers both onshore and offshore projects, addresses potential issues with reservoir integrity (including loss of revenue) and provides indemnity for lost tax credits or requirements to purchase carbon credits associated with a leak of CO_2 from the storage facility (AON, 2024). Marsh has released a similar product, tailored to the project's risk profile and aligned with the project location's regulatory and financing requirements (Marsh, nd).

The availability of commercial insurance largely depends on data that can support a quantitative assessment of the losses that are likely to occur in the future. Unavailability of reliable data, or risks that are difficult to quantify, may render certain risks uninsurable or prohibitively expensive to insure.



[1] Environmental damage includes hazards to groundwater, terrestrial and marine ecosystems, and induced seismicity (Ingelson A, Kleffner A and Nielson N, 2023).

[2] The Adoption Readiness Level (ARL) framework was developed to allow climate technology stakeholders to assess the market readiness of emerging climate technologies. Launched by the US Department of Energy (DoE) in 2022, it introduced 17 types of risk that hinder the market readiness of climate technologies.

3. KEY RISKS FACING CCS PROJECTS, AND POTENTIAL INSURANCE SOLUTIONS

Certain technical, financial and regulatory risks around CO_2 storage projects still remain. These risks can impact project viability, safety, and long-term liability, resulting in challenges to accessing project finance. Key risks and innovative insurance solutions under development to mitigate these risks are discussed below.

Return on investment

Stable and reliable income streams (long-term offtake agreements) and acceptable returns over a reasonable timeframe are key to investors in infrastructure projects. CO_2 storage projects are no exception. Income streams and returns for these projects greatly depend on government subsidies and tax incentives, carbon pricing, technology efficiency, demand for storage, and whether projects can earn revenues through the generation of carbon credits. Uncertainty around any of these issues, combined with the long payback period for CO_2 storage projects could mean the return on investment may not be high enough to justify the investment (WTW, 2025).

One solution to this problem may be to wrap long-term contracts with industrial emitters with a form of long-term credit insurance default – a concept that is often used for energy projects. This could lower the project's cost of capital. Another solution to improve a project's expected rate of return is a surety-provided deferred equity facility, whereby equity providers can delay their funding until later in the project (Howden, 2025).

Project cost

In jurisdictions with carbon pricing – whether a carbon tax or emissions trading system (ETS) –the cost of CO_2 storage currently remains higher or marginally lower than the carbon price, making large-scale deployment and bankability of projects non-viable from a cost perspective. Upfront capital costs can be substantial, and given the long development time for storage projects (up to 10 years), changes in legal and regulatory requirements for projects during this period could occur, which may result in cost increases even before operations commence.

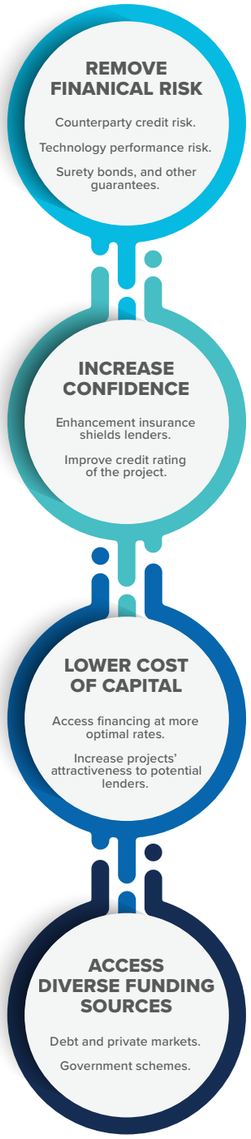


Figure 1 – How insurance can decrease the cost of capital and increase returns. Source: Howden (adapted).

Delays in regulatory processes

Project development could be significantly interrupted if there are delays in obtaining the necessary permits and licenses. WTW notes insurers may minimise the impact of delays and speed up the finance process by issuing provisional insurance, or make it conditional upon the permitting process being completed.

Leakage risk

Leakage of CO_2 from storage sites has several associated risks, including environmental damage, human and health damage, economic loss, and regulatory non-compliance. It has the potential to cause substantial legal and financial liability, both during operations and, where applicable, during the post-closure care and maintenance period. Several forms of liability may be borne, including civil, administrative/regulatory, and carbon credit reversal liabilities. Even where storage sites are transferred to a competent authority at closure, there may be instances where the operator could still be held liable for regulatory non-compliance[3].

Enhanced monitoring technologies and simulation models have improved understanding of CO_2 plume behaviour in subsurface environments (Shi J et al., 2014). Coupled with increasingly robust regulatory frameworks and oversight around site characterisation, continuous monitoring, and verification protocols, this has contributed to a greater ability to manage this risk. Several commercial projects have also demonstrated stable and effective containment over many years (e.g., Sleipner in Norway, Boundary Dam in Canada, Gorgon in Australia). This data contributes to the growing confidence that the risk of leakage is well understood and can be managed, evidenced by insurers starting to offer leakage risk insurance. Due to the long period of "permanent" storage, leakage risk can, however, not be completely eliminated.

For insurability, it is imperative that the risk assessment, monitoring, and management strategies for a CCS project be robust, including the assessment of suitability of geologic formations (permeability and solubility) to achieve storage permanence. There are several key issues that pose a challenge for CO_2 storage project insurability:

- CO_2 leakage could occur at any point along the CCS value chain. This could result in no or a reduced volume of the CO_2 being delivered to the storage facility. The risk of non-delivery and leakage while in transit is challenging to insure, as there are several factors impacting transport of CO_2, including multi-modal transport arrangements, phase changes and pressure fluctuations in different transport modes, and cross-border variances in standards and regulatory requirements (WTW, 2025). An increased focus on projects that include cross-border transport of CO_2 will necessitate the expansion of existing insurance solutions to cover risks across the full value chain that straddles jurisdictions. In 2024, Marsh launched a new insurance solution specifically designed for the transport and storage of CO_2. The solution introduces a non-damage trigger for accidental leakage of CO_2, providing indemnification for the cost of corrective measures, associated business interruption, and the cost of carbon credit acquisition for CO_2 leaked as applicable to the project's geography. It also covers operators' financial security obligations. This indemnity is available across the value chain, whether the leakage occurs from onshore facilities, pipeline, ship or from the storage complex (Marsh, 2024).

- Business Interruption and consequential loss to the emitter from an incident at the CO_2 storage site or transport infrastructure are risks that would fall into the grey zone, i.e., not in either of the upstream or downstream insurers' appetite. This could be mitigated by project participants clearly defining contractual responsibilities between them, where each is responsible for their own losses. Where CCS developers do not have balance sheets large enough to support their indemnity obligations in the event of a recapture event, insurance is increasingly being utilised to provide balance sheet protection for developer counterparties. An alternative could be a government support package similar to the UK's, which separately indemnifies each party (WTW, 2025). This principle would also apply in reverse, where the transporter or storage operator loses revenue as a result of an incident at the capture plant that results in non-delivery of CO_2. This could be addressed via a take-or-pay agreement that mandates a fixed charge be payable regardless of throughput (WTW, 2025).

- The long-term nature of post-closure liabilities is not aligned with typical periods of coverage. Although leakage risk in the long term is understood by the insurance industry to be minimal, insurance, aside from environmental impairment liability insurance, is rarely set out for the expected period of permanent

[3] In the US, for example, operators may remain liable under tort or other remedies, or under Statutes including, but not limited to Clean Air Act, 42 U.S.C. An operator/owner may always be subject to an order the regulator deems necessary to protect the health of persons under section 1431 of the Safe Drinking Water Act after site closure if there is fluid migration that causes or threatens imminent and substantial endangerment to an Underground Source of Drinking Water (Great Plains Institute and Environmental Defense Fund, 2024).

ALTHOUGH THE LEAKAGE RISK IN THE LONG TERM IS UNDERSTOOD TO BE MINIMAL, INSURANCE, ASIDE FROM ENVIRONMENTAL IMPAIRMENT LIABILITY INSURANCE, IS RARELY SET OUT FOR THE EXPECTED PERIOD OF PERMANENT STORAGE IN GEOLOGIC FORMATIONS.

storage in geologic formations. In several jurisdictions, regulations make provision for the transfer of responsibility for stored CO_2 from the facility operator to the government at closure or after a period of post-closure care and maintenance by the facility operator. Until the transfer of responsibility for the storage site has occurred, operators remain liable for any incidents and must continue to provide financial security to the government. The financial security must be sufficient to cover any environmental, health, and property damage claims, remediation, and reclamation costs – assessed based on the best available information at the time. Third-party liability insurance can play a significant role in providing the required financial security (Ingelson A, Kleffner A and Nielson N, 2023).

Technology risk

To be insurable, ideally, technology needs to be proven, i.e., evidence must exist of a minimum of one year of successful operation (WTW, 2025). WTW notes that although much of the technology in the CCS value chain is existing, established technology, new technology deployed for plume modelling and CO_2 monitoring is more nascent and of greater concern to insurers. At present, existing technologies are not able to track subsurface metrics such as fracture gradients, well injectivity, permeability, pressures, and plume migration with absolute certainty (Howden, 2025). Insurers need to be convinced that for any event involving CO_2 leakage, the quantity of CO_2 leaked can be accurately measured as this will determine the size of the insurance recovery (WTW, 2025). Where accurate measurement is not possible, leaked quantities might have to be estimated, and damages could extend beyond the recapture of credits to also include environmental impacts.

For tax insurance specifically, insurers need enough information and documentation to support the insurability of a specific technology. For example, in the US, in the case of insuring recapture of 45Q tax credits that result from CO_2 leakage, there needs to be sufficient analysis around the underground storage formation, and the risks of leaks, vetted by a third party.

Asset condition risk

The condition of pipeline and storage assets is a key concern for insurers, especially in cases where former oil and gas facilities are repurposed for the transport and storage of CO_2. The combination of CO_2, moisture, and other impurities creates corrosive compounds that could be detrimental to carbon steel (Howden, 2025). It should be noted, though, that asset condition is overseen by regulators, and they may require upgrades to address these risks.

Unforeseeable risks

Unknown operational risk

Although the number of CCS projects has increased exponentially in the past decade, the number of commercial operational facilities is still less than 10% of total projects in the pipeline (50 out of 628 projects globally) (Global CCS Institute, 2024). The limited availability of data from operational CO_2 storage projects and, as noted by WTW, the small number of experienced CO_2 storage operators remain a concern for capital providers, as these may increase operational risk.

Political risk

The political landscape and consequently the approach adopted to incentivising decarbonisation technologies may change from time to time. In the eventuality that incentives such as tax credits are made available for CCS and then subsequently terminated, insurance policies will not cover the loss of future tax credits (WTW, 2025).

Carbon price volatility

In jurisdictions with ETSs, carbon prices are set by the market and fluctuate o n a c ontinuous b asis. T his makes quantifying the risk of reversal challenging, and insurers' liability potentially limitless. One solution is for clients to choose a fixed carbon price or to apply a price cap (WTW, 2025). Note, in jurisdictions where the carbon price is set through legislation or other policy mechanisms, this may not be an issue, unless the carbon price is revoked.

4. NOVEL APPROACHES TO INSURING CCS

In-kind insurance

Significant investment in CO_2 removals and avoidance technologies is needed to reach net zero by 2050. The carbon market is set to quadruple by 2050, reaching US$1-2 trillion. As with all other mature markets, insurance is set to be the stabilising factor and investment enabler in the carbon credit market (CarbonPool, 2024).

Several carbon credit registries maintain buffer pools, requiring project developers to allocate a percentage of all credits issued to their buffer pools as a means to protect against reversal risk. There are several disadvantages to this approach that could leave buyers of credits exposed:

- Different risk profiles are not accounted for, leading to high dependency risk on a small number of projects.
- Buffer pools are an unregulated insurance mechanism, lacking regulatory backing for catastrophic events.
- Buffer pools are typically calculated using qualitative assessments, and not actuarial modelling or customised risk selection methods.

CarbonPool[4], a Swiss-based start-up, has developed a world-first solution – in-kind insurance – through which unexpectedly lost carbon credits are replaced with the same or better-quality credits, sourced from their own balance sheet, and representing measurable, verifiable, additional and permanent projects. CarbonPool effectively sources credible credits for its clients in a market where these are difficult to find, especially under time pressure. Insurance is provided in the event of carbon shortfalls, carbon credit reversal, and unintended emissions. In 2023, the company closed the largest European climate finance seed round of CHF10.5 million (US$12 million) and believes that paying out in carbon credits instead of cash will shift the market towards well-regulated, high-quality credits.

Carbon tax insurance

Tax insurance is increasingly utilised to protect the financial interests of project participants if their treatment of tax credits is challenged by the tax authorities.

For example, risks that are insured under WTW's tax insurance products include leakage, suitability of carbon capture equipment, structuring and transfers of tax credits, and use of applicable standards in the construction and maintenance of facilities.

These products protect claimants and buyers of tax credits in the following ways:

- Provision of indemnities between emitters, pipeline operators and storage facility operators related to tax credit claims.
- Protection to claimants against future loss and repayment of the tax credit, in the event of disqualification or reversal, bankruptcy mergers or acquisitions.
- Coverage of applicable penalties and interest on repayment of tax credits.
- Coverage of applicable costs to defend against disqualification and reversal of credits.
- Coverage of taxes incurred on receipt of an insurance payout, to make the taxpayer whole.
- Protection to buyers of tax credits against potential future loss of the tax credit purchased.

Insurance of financial interests in a project could provide the necessary assurance to financiers to unlock project financing (Willis Towers Watson, 2023).

Another insurer that has demonstrated the value of 45Q tax insurance is Atlantic Global Risk (AGR). AGR provided insurance to a US Midwestern CCS project that relied heavily on the 45Q tax credit for project viability, resulting in a significant risk of credit loss due to the project developer's guarantee obligations. The insurance solution, finalised in 2024, covers a broad range of issues that could jeopardise the tax credit, with a coverage period of 10 years – a significant portion of the 12-year tax crediting period. The policy has a significant liability limit of US$785 million (George, 2024).

[4] CarbonPool's insurance license is currently underway in Switzerland. The company has recently joined the United Nations Environment Programme's Forum for Insurance Transition to Net Zero (FIT), a structured dialogue and multistakeholder platform led and convened by the United Nations to support the scaling up of voluntary climate action by the insurance industry (CarbonPool, 2023).

5. OUTLOOK FOR THE CCS INSURANCE MARKET

The insurance industry is actively adapting to the rapidly expanding CCS landscape, evidenced by the recent increase in specialised products to cover some of the unique risks of CCS. Our research indicates that insurers are optimistic about the role insurance can play in derisking CCS projects effectively to provide the necessary comfort around these projects to regulators, the public and capital providers.

As confidence grows around management of the unique risks of CCS, industry reports and discussions indicate that insurers are poised to provide solutions to critical insurance gaps and support the large-scale deployment of CCS globally.

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