GENEVA ASSOCIATION

Expediting Sectoral Decarbonisation

Strategic implications for the insurance industry

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Foreword

The transition to a low-carbon economy is unfolding under unpredictable conditions, amid geopolitical crisis, economic pressure and polarised climate-change debate. Governments are rebalancing priorities – placing greater weight on energy security, affordability, and competitiveness, alongside decarbonisation. While this does not lessen the urgency of climate action, it does change the path to progress, with important implications for risk management and the insurance sector.

This report examines how decarbonisation is advancing across emissions-intensive sectors – oil & gas, aviation, steel, cement & concrete, data centres and buildings – and the role insurers play in enabling these transitions. While sustained investment in areas such as operational efficiency and waste management is moving the transition forward, large, complex projects to adopt emerging, low-carbon energy technologies are also accelerating. These projects introduce new technical, financial, liability and regulatory risks. As a result, conventional approaches to underwriting and risk transfer are being challenged.

Our analysis points to four conditions that will shape insurability at scale: stable, coherent policy environments; closer collaboration between project developers, investors, insurers and governments; integrating climate resilience in decarbonisation plans; and credible carbon markets. Where these conditions are absent, the gap between the needed pace and scale of transition and the availability of insurance cover can hinder progress.

Insurers are stepping forward as risk carriers and partners to shape resilient, investable low-carbon systems. This requires developing a whole new set of capabilities: targeted R&D efforts, innovative risk-sharing schemes, multidisciplinary teams, fresh-talent acquisition, and strategic cross-sectoral partnerships. Insurers are moving with enthusiasm and determination to put these capabilities in place.

Jad Ariss
Managing Director

Executive summary

Re/insurers play a critical role in expediting energy transition and deep carbonisation and enhancing energy resilience.

Against a backdrop of increasingly polarised climate politics, governments are refocusing transition strategies on energy security, industrial competitiveness, and secure access to critical and rare earth minerals. Decarbonisation policy support, while varying by jurisdiction, is increasingly directed toward nuclear energy, carbon capture, utilisation, and storage (CCUS), renewables combined with long-duration energy storage (LDES), smart grids, and carbon-linked trade measures.

Geopolitical shocks to oil and gas supply, such as the 2026 conflict in the Middle East and the closure of the Strait of Hormuz, reinforce that energy security and the energy transition are inseparable. Energy resilience could be enhanced with diversified domestic clean energy production, supported by storage, distribution, and energy efficiency. At the same time, such tensions could also disrupt critical minerals and supply chains, highlighting the importance of building robust clean energy supply chains.

Economic sectors such as energy (e.g. oil and gas), transportation (e.g. aviation, shipping, and trucking), industrial production (steel, cement, aluminium, and chemicals), data centres and buildings account for a significant portion of greenhouse gas (GHG) emissions. Beyond being energy intensive, a range of other shared characteristics also explains both their high emissions and the difficulty in reducing them. For example, such sectors require continuous and reliable power, operate long-duration assets, and have system dependence and infrastructure constraints. Although challenges persist, private-sector decarbonisation is progressing; the key question is how to scale and accelerate this progress while ensuring lasting resilience.

Five global developments are paving the way for sectoral decarbonisation:

First, new partnerships are securing access to critical and rare earth minerals through co-investment, offtake agreements, and frameworks such as the US–Australia Critical Minerals Agreement. Second, global investment in technologies for production of zero- and low-carbon energy has continued to grow, reaching a record USD 2.3 trillion in 2025, up 8% year-on-year, despite geopolitical and trade headwinds. Third, public-private sector collaborations are accelerating the deployment of nascent climate technologies for deep decarbonisation, including CCUS hubs (e.g. Northern Lights), green hydrogen gigaprojects (e.g. NEOM) and small modular reactors (SMRs). Fourth, carbon-credit markets are maturing, with tighter integrity standards and growing demand for high-quality, technology-based removal credits, to mobilise early demand for and investments in low-carbon technologies. Fifth, private-sector industry-specific platforms are enabling coordinated actions to expedite scaling of decarbonisation and resilience solutions for sectors such as oil and gas, cement and concrete, steel, and buildings.

Sector-specific decarbonisation is well underway within the private sector, using a portfolio approach combining various strategies, deployed with differing priorities and over different time horizons.

These include energy and operational efficiencies and alterations, electrification, reliance on fossil fuels combined with CCUS, an energy mix combining a range of low- or zero-carbon energy production options, waste management and circularity, supply-chain management, and utilising carbon-credit markets or similar sector-specific schemes to mobilise capital.

The implementation of sector-specific decarbonisation strategies depends on the development and deployment of a wide range of technologies and approaches, exposing companies to new risks, which need to be assessed and managed. This provides insights on the evolving needs of each sector for insurance products and services, to implement their respective priorities.

Interviews and roundtables with leading experts across six industries (oil and gas, data centres, aviation, steel, cement and concrete, and buildings) have revealed that sectors are advancing decarbonisation but at different speeds and levels of ambition. For each, concrete short-, medium-, and long-term priorities, aligned with respective decarbonisation strategies, have been identified, offering valuable insights into where investments are being focused today and how these are expected to evolve over time.

While some approaches, focusing on areas such as operational and energy efficiency, will lead to evolutionary changes, others such as shifting the energy mix for deep decarbonisation have the potential to lead to transformative changes in the core business models in these sectors. As companies confront associated challenges and emerging risks, the implementation of these strategies will also shape evolving, sector-specific needs for insurance products and services.

There are four noteworthy common challenges experienced across these sectors in implementing projects for deep decarbonisation, which key stakeholders – including re/insurers – could work together to tackle.

1. **Integrating climate resilience in decarbonisation strategies is an emerging concern across sectors.** This is not only to protect assets, operations, and workforce, but also to re-prioritise decarbonisation strategies to mitigate credit risks related to potentially stranded assets. Preventive approaches are needed to protect new low-carbon assets, operations, and supply chains.

2. **There is a need for clear and stable public policy and regulatory frameworks.** Across sectors, unclear, fragmented, and misaligned public policy and regulatory frameworks remain a core bottleneck to decarbonisation and resilience. Gaps in risk-based land management and zoning – and the slow adoption and enforcement of updated building codes, as well as permitting and liability regimes – increase transition and liability risks, constraining insurability, risk sharing, and subsequently investments.

3. **New cross-sectoral collaborations and process reforms are needed with profound implications for industry, governments, re/insurers, and investors.** Deep decarbonisation increasingly depends on complex, capital-intensive projects spanning multiple sectors, jurisdictions, and value chains, creating new risks and coordination challenges. Six transformative approaches are needed:

   i. Adopting a project life-cycle view for the mapping of untested risks, stakeholder roles and liabilities, contractual agreements, and risk-mitigation measures would allow re/insurers to assess cascading risks and exposures. For example, a project life-cycle approach within CCUS projects would include design, construction, and operations across sequestration, transportation, storage, and closure stages.

   ii. Stronger coordination among energy, environmental, financial, and insurance regulators to align policy, liability, and capital regimes would provide greater certainty for developing effective risk sharing and project financing.

   iii. Reforming project-finance processes to enable early engagement of re/insurers' risk engineers to help improve project design and mitigation measures would enhance insurability and bankability for project developers and lenders.

   iv. Embedding climate resilience into technology choices, project siting, and asset design would reduce long-term operational, credit, and stranded-asset risks for asset owners and investors alike.

   v. Expediting the development of emerging technologies' supply chains, involving a complex network of suppliers, manufacturers, developers, and service providers, would accelerate the scaled deployment of such technologies.

   vi. Adopting and implementing a systems-based approach to developing standards and codes of practice are critical to project replication and scaling. This should address all aspects such as risk identification, mitigation, allocation, contracts, supply chains, data transparency, safety, compliance, and decommissioning.

4. **Mobilising private-sector investment requires expediting the development of credible and certified technology-based carbon credits and sector-specific carbon-reduction schemes.** Divergent methodologies, accounting rules, and credibility criteria create uncertainty for all stakeholders. Convergence on standards, monitoring, reporting, and verification (MRV) practices and governance frameworks are needed.

Sector-specific decarbonisation priorities and requirements, as well as their common challenges, have strategic implications for the insurance industry.

Accelerating sectoral decarbonisation needs a wide range of new technologies to be developed, scaled, and adopted by a wide range of stakeholders, within and across many sectors, affecting business models over the coming years. The insurance industry can play a key role in supporting sectors through this transition.

The implementation of sectoral decarbonisation strategies exposes companies to a wide range of emerging risks, such as technology, construction, supply-chain, product liability, stranded-asset, regulatory, and long-tail environmental liability risks. While each sector's approach and needs for insurance and financing services varies, common threads across their decarbonisation strategies have implications for the insurance industry and investors. This will have profound implications for re/insurers and the dynamics of insurance markets.

By assessing sectoral decarbonisation priorities over the short, medium, and long term across various sectors, re/insurers can proactively identify emerging areas of expertise and technical knowledge they need to build and support sectoral transitions. This approach enables them to develop tailored risk management strategies and offer insurance products and services that facilitate sectoral transformations.

The scale up of capital-intensive, pre-commercial technologies for the production of clean or low-carbon energy and the development of robust supply chains presents a clear growth opportunity, positioning re/insurers not only as risk carriers, but also as strategic risk advisors, enablers of investments, and partners for setting standards. As investors, re/insurers can leverage blended finance, guarantees, and innovative risk-sharing structures to crowd in private capital and improve risk-adjusted returns.

Re/insurers can capture these opportunities through:

- Sustained investment in research and development (R&D) in emerging technologies for sectoral decarbonisation, advanced risk analytics, and forward-looking, location-specific modelling of physical and transition risks;

- Organisational restructuring, enabling multidisciplinary cross-functional teams engaging early with clients.

- An evolution from transactional underwriting to a more strategic and integrated approach in delivering innovative risk engineering, risk-sharing, and risk-transfer solutions.

- Deeper cross-sectoral partnerships to co-develop risk-mitigation and risk-sharing solutions, expediting the deployment and adoption of pre-commercialised technologies for clean or low-carbon energy production.

- Supporting the development of standards for project replication and exploration of ways to address uninsurable development through other means, such as public-private partnerships or even the government as the insurer of the last resort.

- A renewed focus on attracting and retaining talent aligned with sectoral needs and priorities.

Finally, collaboration among regulatory bodies overseeing insurance and other sectors is required to develop liability regimes. Capital requirements that could lead to viable risk-sharing models among the stakeholders, particularly to expedite the scaled deployment and adoption of emerging technologies for deep decarbonisation, are also needed.

1 Introduction

Introduction

The path to a low-carbon economy is changing as governments rebalance priorities, with important implications for risk management and the insurance sector.

Against a backdrop of increasingly polarised political debates, recent policy and regulatory developments have refocused national transition priorities towards energy security,[1] industrial competitiveness,[2] and access to robust supply chains.[3] For example, in the US, the 2025 One Big Beautiful Bill Act marks a pivot away from broad-based wind, solar, and electric vehicle (EV) incentives[4] towards targeted, longer-term support for CCUS,[5] nuclear and geothermal energy,[6,7] energy infrastructure, as well as robust access to critical materials.[8] Japan's 7th Strategic Energy Plan, approved by the Japanese Cabinet in February 2025, elevates nuclear and renewables as core pillars of decarbonisation and energy security, while China and Australia continue backing renewables combined with energy storage.[9,10] EU regulations continue to prioritise rapid wind and solar expansion, grid upgrades, and energy storage, keeping nuclear and green hydrogen as complementary rather than core decarbonisation drivers.[11,12,13] Importantly, the EU Carbon Border Adjustment Mechanism (CBAM) enters into full force in 2026, embedding carbon costs into trade, strengthening incentives for low-carbon steel, cement, aluminium, and hydrogen.[14] Country-specific measures, such as increasing flight taxes and green subsidies in France, are also being implemented.[15]

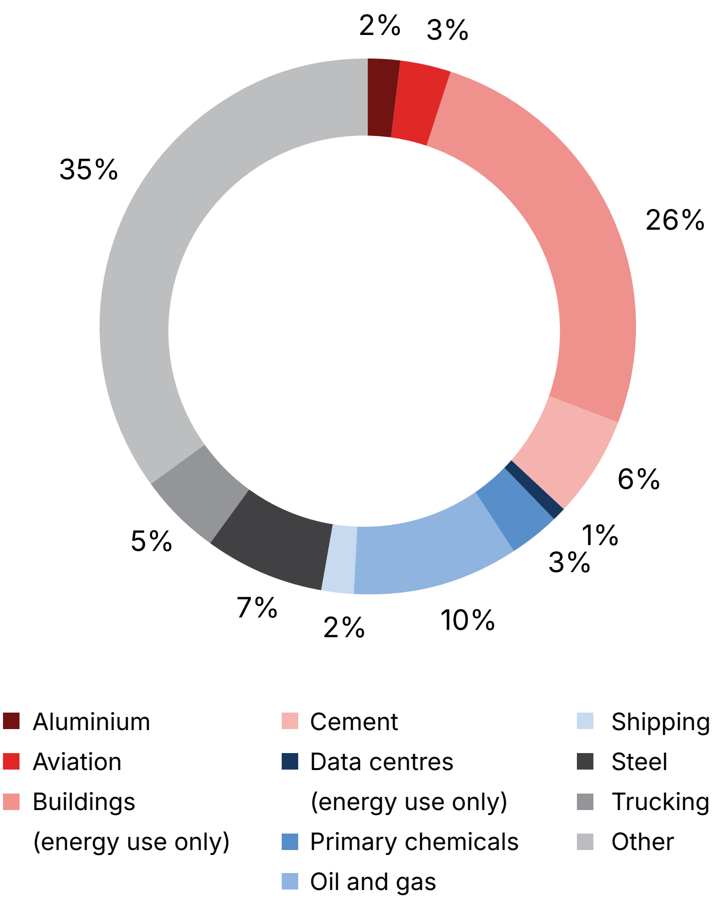
Beyond climate policies, geopolitical tensions such as the 2026 Iran conflict could affect major energy-transit corridors, such as the Strait of Hormuz, underscoring persistent vulnerabilities in global energy security and supply chains. These international tensions demonstrate how energy security and the energy transition are fundamentally interconnected. Diversified domestic clean and low-carbon energy systems, supported by robust storage, distribution, and energy efficiency, enhance resilience to external shocks. Geopolitical disruptions can also impede progress by constraining access to critical minerals, materials, shipping routes, and key project inputs, reinforcing the critical need to build clean energy supply-chain resilience.

1 Morenne 2025.
2 IEA 2025a.
3 BloombergNEF 2025a; Carbon Capture Coalition 2025.
4 BloombergNEF 2025a.
5 In this report, carbon capture and storage (CCS) and carbon capture, utilisation, and storage (CCUS) are used as related but distinct terms. Specifically, CCS refers to projects that capture carbon dioxide (CO_2) emissions from industrial or energy sources and permanently store them, typically in geological formations. CCUS includes an additional utilisation step, in which captured CO_2 may be used in applications such as the production of building materials (e.g. concrete), synthetic fuels (e.g. sustainable aviation fuel), plastics, or fertilizers. In some cases, a portion of the utilised CO_2 may also be permanently stored. Not all projects include the utilisation.
6 The US is fast-tracking 11 small modular reactors with USD 900 million in investments. US Department of Energy 2025.
7 Morenne 2025; Carbon Capture Coalition 2025.
8 IEA 2025a.
9 IEA 2025a; Millard et al. 2025.
10 IEA 2025b; Reuters 2025; Atchison 2024.
11 As one of the primary EU decarbonisation regulatory levers, the European Green Deal establishes a 2050 climate neutrality target and 55% emissions reduction by 2030. The European Green Deal 2019.
12 The Renewable Energy Directive operationalises the Green Deal through a 42.5% renewable electricity target and deployment mechanisms. The Renewable Energy Directive 2023.
13 The EU Energy Efficiency Directive reduces overall energy demand through the aim of accelerating building retrofits and industrial efficiency measures. EU Energy Efficiency Directive 2023.
14 The EU CBAM places a carbon fee on high-emission imports, aligning foreign goods' costs with EU emissions standards. It reshapes supply chains in sectors like cement, steel, and aluminium by requiring importers to track and offset embedded emissions. OECD 2025.
15 Gill 2025.

1.1 Greenhouse gas emissions and sectoral-decarbonisation challenges

Despite increasing private sector initiatives and investments, speeding up scaled decarbonisation of economic sectors with inherently high greenhouse gas (GHG) emissions remains a key challenge. Sectors spanning industrial production (steel, cement and concrete, aluminium, and primary chemicals), energy (oil and gas), and transport (aviation, shipping, and trucking), together account for approximately 40% of global Scope 1 and 2[16] greenhouse gas emissions (see Figure 1).[17] The energy use of buildings accounts for a further 26% of global GHG emissions.[18] The rapid expansion of large-scale data centres, driven by digitalisation, cloud computing, and expectations of rising demand for artificial intelligence (AI), is sharply increasing their electricity use (see Box 1). While data centres currently account for about 1% of global energy-related emissions, even conservative projections suggest this could nearly double by 2030 if current trends continue.[19]

FIGURE 1: GLOBAL GHG EMISSIONS (SCOPE 1 AND 2) BY SECTOR



Note: In this chart, the 26% attributed to buildings refers solely to global GHG emissions from operational energy use (e.g. heating, cooling electricity) and does not represent the sector's full life-cycle emissions, including embodied carbon in materials and construction. Similarly, the 1% attributed to data centres reflects emissions from operational energy consumption only, and excludes embodied emissions, upstream supply-chain impacts, and end-of-life considerations.

Source: Geneva Association, based on World Economic Forum 2024, 2025, and IEA 2024[20]

16 Scope 1 emissions include direct GHG emissions that occur from sources that are owned or controlled by the company. Scope 2 emissions include GHG emissions from the generation of purchased electricity consumed by the company. The Greenhouse Gas Protocol 2004.
17 World Economic Forum 2024.
18 IEA 2024a.
19 S&P Global 2024.
20 World Economic Forum 2024; World Economic Forum 2025; IEA 2024a.

Box 1: Growth of data centres and their GHG emissions

Major cloud-infrastructure companies, known as hyperscalers,[21] are spearheading the massive expansion of data centres. For example,

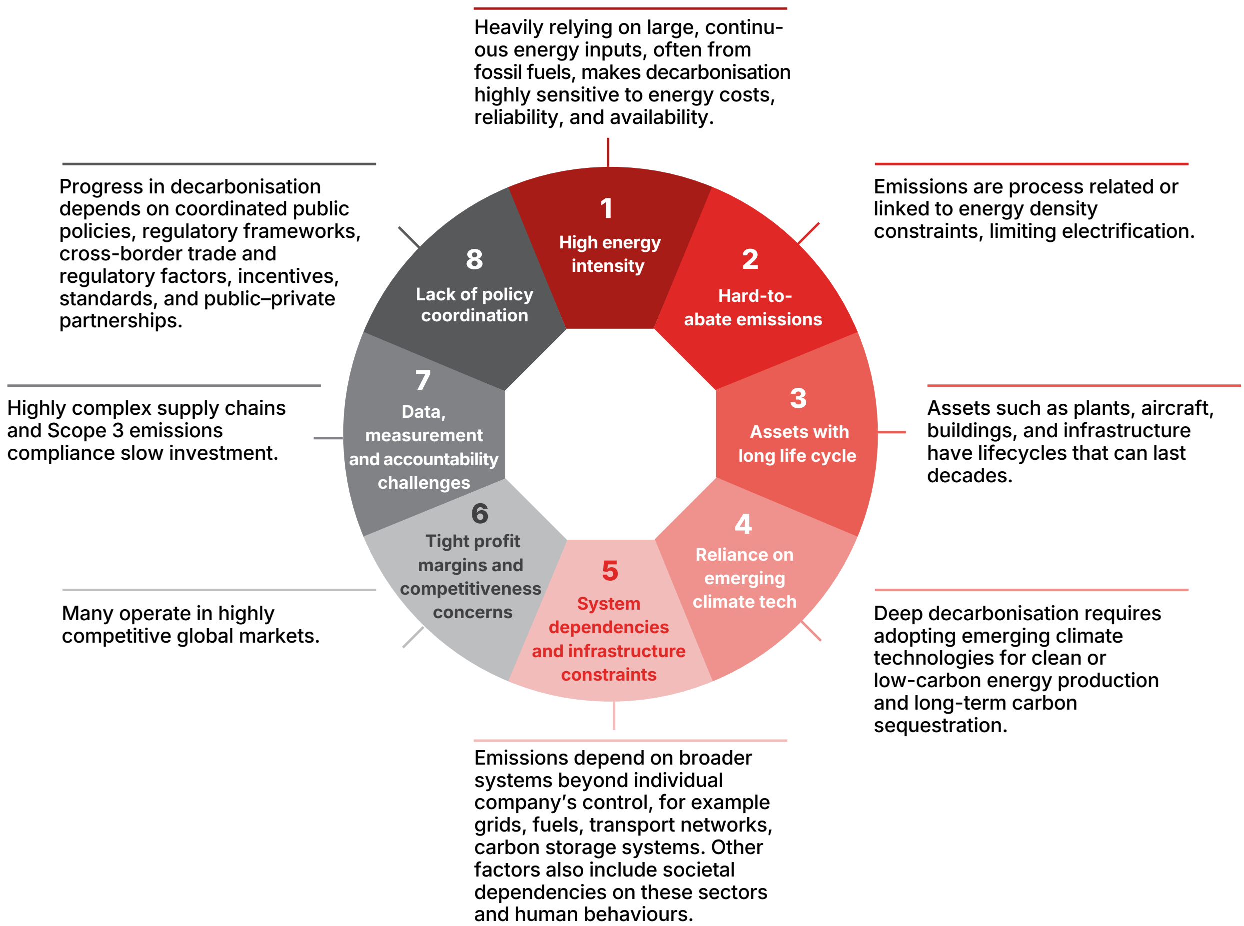
- US: The dominant overall market, with in excess of USD 74 billion in construction investment in 2024.
- China: Expanding capacity at pace, with installed IT load projected to double by 2030.
- Europe: Experiencing an annual increase of 43% in its data project pipeline, led by the core Frankfurt-London-Amsterdam-Paris-Dublin (FLAPD) axis.

Data centres require highly reliable, 24/7 power, with industry standards limiting unplanned downtime to about 5 minutes per year (99.9% uptime). In 2024, they accounted for roughly 1.5% of global electricity demand, growing at about 12% annually over the past five years. They also depend on continuous cooling, as high temperatures lead to performance losses, equipment failure, and outages.

Source: Geneva Association, based on various sources[22]

Several common characteristics explain both the large GHG emissions of these sectors and the challenges to reduce them (see Figure 2).

FIGURE 2: FACTORS CONTRIBUTING TO SECTORS' HIGH GHG EMISSIONS AND CHALLENGES WITH REDUCING THEM



Source: Geneva Association

21 Hyperscalers are large cloud-providing companies operating vast computing platforms designed to scale rapidly (Amazon Web Services, Microsoft, Google, Meta, Apple, Alibaba, etc).

22 Allianz 2025a; IEA 2025c; Water Unite 2025.

1.2 Global developments for sectoral decarbonisation

Several promising developments are paving the way for sectoral decarbonisation:

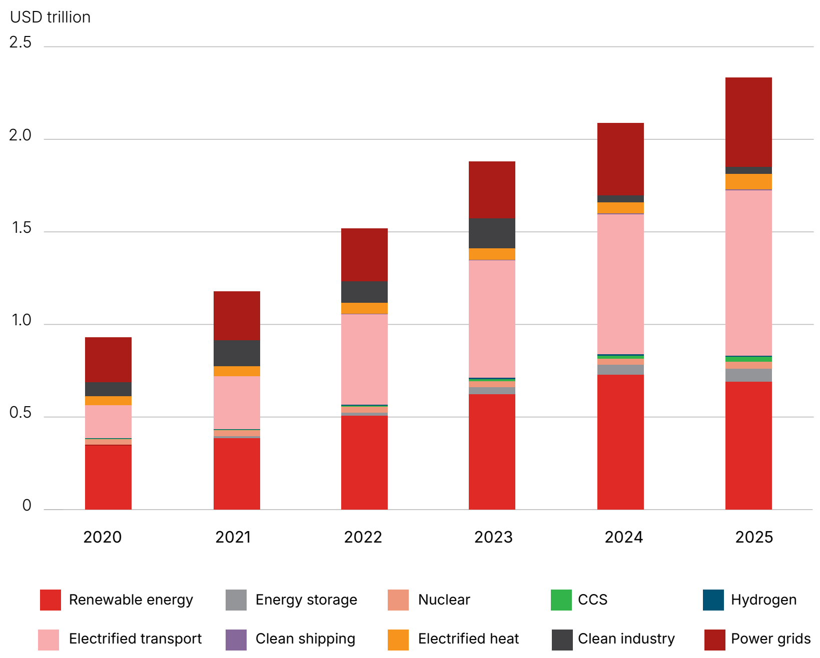
1. **Public-private partnerships and bilateral cooperation initiatives aim to secure access to critical and rare earth minerals.**

   Building on recent national critical material strategies,[23,24,25,26] collaboration between industries and governments is advancing across the critical and rare earth minerals value chain,[27] through targeted policy alignment, risk-sharing mechanisms, and joint investments.[28] Governments are de-risking mining and processing by offering public co-investments, loan guarantees, offtake agreements, and price floors that improve bankability for early-stage and first-of-a-kind projects, while streamlining permitting and coordinated infrastructure support in remote regions.[29] Industrial policy, fiscal incentives, and partnerships with trusted allies are helping to build domestic and allied supply chains, through strategic agreements and bilateral frameworks, such as the US-Australia Critical Minerals Framework Agreement.[30] Innovation, recycling, and circularity are being mobilised via joint research and development (R&D) funding and through public–private initiatives to recover materials from end-of-life products.[31]

2. **Global investments in climate technologies for low-carbon energy production are on the rise, with some nuances.**

   Global investments in clean or low-carbon energy production reached a record USD 2.3 trillion in 2025 (see Figure 3), up 8% year-on-year, despite geopolitical and trade headwinds.[32] Notably, both

FIGURE 3: GLOBAL ENERGY TRANSITION INVESTMENT BY SECTOR, 2020–2025



Source: BloombergNEF 2026[33]

23 Geneva Association 2024a; Geneva Association 2024b.
24 Government of Australia 2023; European Commission 2023b; Government of UK 2022.
25 Government of Canada 2023; US Department of Energy 2021; The White House 2022a; The White House 2022b.
26 Government of Brazil 2021; Government of India 2019; Government of Japan 2020.
27 Core battery and electrification materials include lithium, nickel, cobalt, manganese, and both natural and synthetic graphite. Rare earth elements, specifically neodymium, praseodymium, dysprosium, and terbium, are critical for permanent magnets used in wind turbines, and electric vehicle motors. Energy, power, and grid infrastructure rely heavily on copper, aluminium, silicon, and silver. Clean hydrogen and fuel cell technologies depend on platinum, iridium, palladium, and ruthenium, while nuclear and other advanced energy systems require uranium, zirconium, and hafnium.
28 IEA 2025d.
29 IEA 2025d.
30 Government of Australia 2025.
31 For example, the Nevada Tech Hub was awarded USD 15.5 million in funding across 17 projects aimed to strengthen Nevada's position in the national lithium battery and critical materials supply chain. Demuth 2025.
32 BloombergNEF 2026.
33 BloombergNEF 2026.

public and private investors continued to scale-up funding.[34,35] Low-carbon energy supply investments exceeded fossil fuels for the second consecutive year.[36] In 2025, electrified transport-led investments (USD 893 billion), followed by renewables (USD 690 billion), were the most significant investment categories.[37]

3. **Cross-sectoral public-private collaborations are being forged to expedite scaled deployment of nascent climate technologies, essential for the energy transition.**

Public- and private-sector initiatives are underway through regulatory harmonisation and public-private partnerships to expedite scaled deployment of the next wave of climate technologies needed for changing the energy mix and enabling deep decarbonisation, such as CCUS,[38] green hydrogen,[39,40] long-duration energy storage (LDES),[41] and small modular nuclear reactors (SMRs).[42]

4. **Carbon-credit markets are advancing, but with many nuances**

Carbon markets are systems where carbon credits are bought and sold, each credit representing a unit of GHG emissions reduced or removed by a project.[43] Project developers earn income by selling these credits to finance projects that cut emissions, for example through energy efficiency improvements, forest conservation, wetland restoration, and carbon-removal technologies that would otherwise struggle to secure funding. Companies buying these credits use them to help meet climate regulatory requirements, alongside other efforts to cut their own emissions (Box 2).

Over the last few years, rules for GHG reduction claims associated with carbon credits have tightened with rising demand for more robust accounting.[44] New integrity frameworks are pushing for stricter criteria in areas such as permanence of carbon removal and prevention of double counting, which is raising expectations of project quality across the market.[45] Over recent years, the market has moved from large volumes of cheap, lower-quality credits toward fewer but higher-integrity units.[46]

Box 2: Mechanisms for generating certified credits

Typically, there are four steps in the generation of certified carbon credits: 1) a baseline is established reflecting how much CO_2 would be released if the project did not happen; 2) project implementation; 3) measurement of avoided emissions; and 4) verification and issuance of certified credits, whereby an independent auditor certifies reductions based on standards established by standard-setting bodies (e.g. Gold Standard Verified Emission Reductions or Verra's Verified Carbon Units).

These standards provide detailed rules on how projects must quantify, report, and verify their impact.

There are two main types of markets: 1) compliance markets, created by governments where companies buy credits to meet certain regulations, such as emissions trading systems; and 2) voluntary markets, where companies and individuals buy credits to meet their own climate or net zero targets.

Source: Geneva Association, based on various sources[47]

34 Allianz 2025b.
35 Liu 2025.
36 BloombergNEF 2025b.
37 Regionally, Asia Pacific led with 47% of global investment, with China remaining the largest market despite a slowdown in renewables. Investment continued to grow in the EU (+18%), India (+15%), and the US (+3.5%). BloombergNEF 2026.
38 These include projects such as the Norwegian government and industry collaboration on Northern Lights and government funding and industry consortia enabling hubs such as Orthos and Carbon Connect Delta. Pathway Alliance 2024.
39 The NEOM Green Hydrogen Project in Saudi Arabia is a public-private industrial scale deployment integrating large-scale renewable energy with green hydrogen/ammonia production. NEOM 2026.
40 Other future giga-projects are following in the wake of the NEOM investment, such as the Pudimadaka Green Hydrogen Hub in India. Pudimadaka 2026.
41 These technologies are essential to help enhance the utilisation of renewables. They feature proposed pumped hydro projects such as the Earba Storage Project. Gilkes Energy 2026.
42 US-UK pact was signed to speed reactor approvals and advance broader nuclear technology cooperation, including SMRs; a wide range of public-private partnerships with SMR developers are underway. The Chemical Engineer 2025.
43 Typically, each credit unit is equivalent to 1 tonne CO_2 avoided.
44 For example, through the EU CBAM. South Pole 2025.
45 For example, integrity frameworks include those established by the Integrity Council for the Voluntary Carbon Market (ICVCM), the Paris Agreement Crediting Mechanism (PACM), and Article 6 of the UN Paris Agreement.
46 Low-quality carbon credits common examples include avoided-deforestation (REDD+) credits with inflated baselines, industrial gas destruction credits, such as HFC-23 that created perverse incentives, and temporary soil or forestry sequestration credits with high reversal risks. OECD 2024.
47 UNDP 2025; MSCI 2022; World Bank 2025.

5. Sectoral collaborations are being forged to expedite decarbonisation

Sector-specific platforms are enabling intra- and cross-industry collaborations to accelerate the development, scaling, and financing of practical decarbonisation and climate resilience solutions. Table 1 highlights examples of such platforms in oil and gas, steel, cement and concrete, buildings, data centres, and aviation, which are the target sectors for this study.

TABLE 1: EXAMPLES OF SECTORAL PLATFORMS FOCUSED ON DECARBONISATION AND RESILIENCE SOLUTIONS

Organisation	Members and sector coverage
Oil and Gas Climate Initiative (OGCI)	• 12 major companies • Around 26% of global oil and gas production • Oil and Gas Decarbonisation Charter, with over 55 signatories accounting for 50% of production
International Petroleum Industry Environmental Conservation Association (IPIECA)	• 43 companies, 29 associations • Around 60% of global production
Net Zero Innovation Hub for Data Centres	• European data centre operators and suppliers
Climate Neutral Data Centre Pact	• 43 operators and 22 associations
Mission Possible Partnership (MPP)	• Members are companies from industrial sectors, with this project engaging experts from the aviation sector
World Steel Association (worldsteel)	• Producers, associations and research institutes. • Around 85% of global production
Global Cement and Concrete Association (GCCA)	• 49 companies, 31 associations • Around 80% of industry volume outside of China
World Green Building Council	• More than 85 national Green Building Councils and 50,000 private members • Around 60% of global building stock

Source: Geneva Association

1.3 About this report

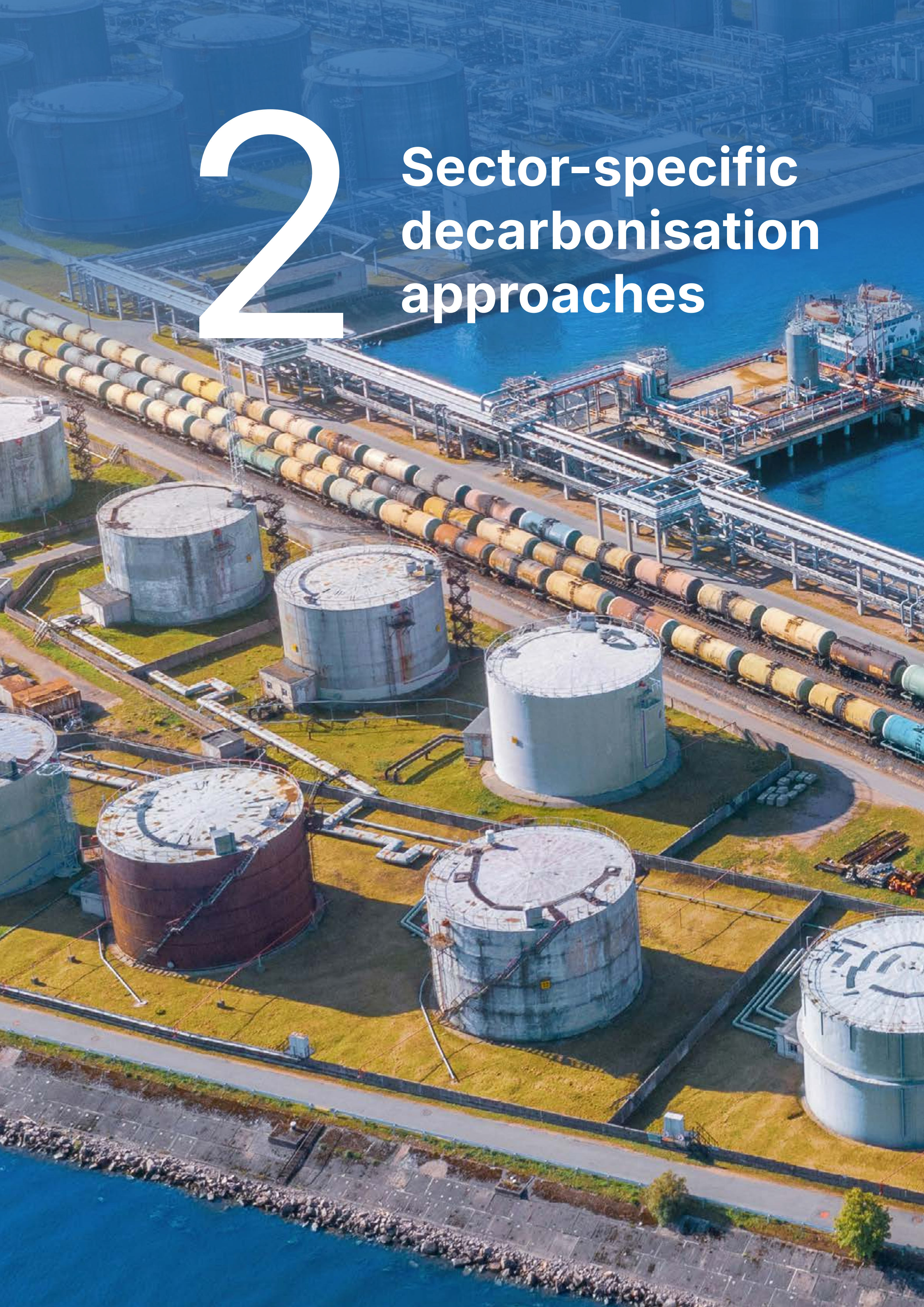
Focusing on six key sectors (oil and gas, steel, cement and concrete, aviation, data centres, and buildings), this report explores sectors' receptivity, strategies, and priorities for business decarbonisation; the associated challenges and opportunities; and ways in which the insurance industry could support commercial clients to enable and expedite their decarbonisation plans. The objectives of this study are to:

1. Present the latest trends and more concrete insights on sector-specific, short-, medium- and long-term decarbonisation priorities.
2. Examine sectors' perspectives on the impacts of physical climate risk on their core business, particularly in the context of incorporating robust climate resilience in their decarbonisation business models.
3. Identify common challenges among sectors for expediting more resilient, deep decarbonisation and how these can be overcome.
4. Explore overall strategic implications for the insurance industry.

The research methodology has involved:

- An in-depth literature review.
- Interviews and roundtable discussions with leading international experts from the six sectors, in collaboration with the sectoral platforms highlighted in Table 1.
- Four roundtables with the project advisory committee, comprised of leading experts from Geneva Association member companies, listed in the acknowledgements.

Section 2 examines sector-specific decarbonisation strategies and priorities, providing insights on current and future areas of focus and related emerging risks. Section 3 examines common challenges among sectors to expedite deep decarbonisation strategies, also taking into account the impacts of slow-changing climatic trends and the intensification of extreme weather. Section 4 takes a deeper dive into future strategic implications for the insurance industry.



2 Sector-specific decarbonisation approaches

Sector-specific decarbonisation approaches

FIGURE 4: PORTFOLIO OF STRATEGIES USED FOR SECTORAL CORE BUSINESS DECARBONISATION

1. Operations

Energy efficiency
Energy efficiency is focused on reducing the amount of energy required to deliver the same output through better design, equipment, controls, and digital optimisation.

Operational efficiency
Operational efficiency addresses improving how assets and systems are run by reducing losses, downtime, and waste through better maintenance, scheduling, automation, and data-driven operations.

2. Electrification

Electrification replaces fossil-fuel-based technologies and processes (e.g. internal combustion engines, gas boilers) with electric alternatives such as electric vehicles, electric furnaces, or heat pumps, ideally powered by low-carbon electricity.

3. Fossil fuels with CCUS

This uses fossil fuels where alternatives are limited, while capturing, transporting, and storing or utilising CO_2 to significantly reduce net emissions.

5. Waste management and circularity

This aims to reduce emissions by minimising waste generation, increasing reuse and recycling, recovering energy or materials, and lowering the need for emissions-intensive primary production.

6. Supply-chain management

This addresses Scope 3 emissions by engaging suppliers, redesigning procurement, improving logistics, increasing transparency, and shifting to lower-carbon inputs and partners.

Source: Geneva Association

Sectoral decarbonisation follows a portfolio approach involving a combination of seven strategies (see Figure 4). These include operations, electrification, combining fossil fuels with CCUS, evolving energy mix with low- or zero-carbon energy production options, waste management and circularity,[48] supply-chain management, and the use of carbon credits or similar schemes to mobilise upfront investments in decarbonisation solutions.

Process and product alteration/innovation

Operational process alteration considers changing production methods or inputs to lower-carbon alternatives (e.g. new materials, redesigned process, or chemistry changes) to reduce inherent emissions.

4. Energy mix

Renewables with storage (e.g. LDES)

This involves the deployment of renewables (solar, wind, hydropower), supported by short- and long-duration energy storage, to ensure reliability, flexibility, and low-carbon power.

Adoption of new climate technologies for energy production

This involves the adoption of new technologies such as SMRs, hydrogen, industrial geothermal, and SAF and integrating these emerging low- or zero-carbon energy options to supply heat, power, or feedstocks where conventional renewables or electrification alone are insufficient.

7. Carbon-credit markets

Carbon-credit markets and other mechanisms such as sector-specific 'book and claim' models are being developed to complement direct decarbonisation by enabling near-term climate action, mobilising capital for investing in high-impact mitigation technologies, supporting innovation, scale up, and transition pathways to decarbonise core operations.

48 Circular solutions could include factors such as increased utilisation rates, service life extension, reuse, and remanufacturing. It has been estimated that doubling global circularity in the next 10 years, could cut GHGs by 39%. Circle Economy 2021.

Examples of sectoral activities and their impacts for the implementation of various decarbonisation strategies are highlighted in Table 2.

TABLE 2: EXAMPLES OF ACTIVITIES AND THEIR IMPACTS IN THE IMPLEMENTATION OF DECARBONISATION STRATEGIES

Strategies		Oil and gas[49]	Data centres[50,51]
1. Operations	**Energy efficiency**	• Waste-heat recovery and digital tools to reduce energy use	• Approximately 5.5% improvement over 10 years via facility redesigns with cooling enhancements
	Operational efficiency	• Limit methane leakage and flaring in extraction	• Dynamic load management and predictive maintenance using digital tools
	Process or product alteration/innovation	• Deployment of vapour-recovery solutions and satellite monitoring to prevent methane leakage	• Improving cooling technologies to reduce GHG emissions by 15% and water use by 50%
2. Electrification		• Electrification from upstream (more developed) to downstream operations	
3. Fossil fuels with CCUS		• Operates over 90% of global CCUS capacity • 50 Mt CO_2 of CCUS capacity at gas-fired power plants is currently in the pipeline	• Collaborations with CCUS stakeholders (e.g. Google and Broadwing Energy Centre)

49 World Economic Forum 2024.
50 IEA 2024b; IEA 2025c; IEA 2025e.
51 Data Centre Magazine 2025; Uptime Institute 2024; Garcia 2026.
52 The aviation sector's fragmented supply chain (e.g. lack of universal access to SAF at all airports), and long-asset life cycles, are among the challenges hindering the speed of decarbonisation. World Economic Forum 2024.
53 Miller 2023, World Economic Forum 2024, Mission Possible Partnership 2023.
54 World Economic Forum 2023; Climeworks 2024; International Civil Aviation Organization 2025.
55 Global crude steel production totals around 1.9 billion tonnes per year, with China alone accounting for a majority share of approximately 53-54% of global output while the remaining production is distributed among countries such as India, Japan, the US, Russia, South Korea, Germany, Turkey, Brazil, and Iran. World Steel Association 2025.
56 Over 80% of total output is concentrated in developing economies and characterised by capital-intensive, locally-bound production. China is by far the largest cement producer, accounting for roughly 47–51% of global output, followed by India at about 9–10%. Other major producers include Vietnam, the United States, Turkiye, Iran, Brazil, Indonesia, Russia, and South Korea. Global Cement 2025.
57 GCCA 2022; GCCA 2025a; GCCA 2025b.
58 IEA 2021; Swedish Environmental Research Institute 2025; McKinsey 2025.
59 IEA 2022; IEA 2023.
60 Global Alliance for Buildings and Construction 2025; Climate Action Tracker 2022.
61 Imperial College London 2020.
62 Key ingredient in cement production.

Aviation[52,53,54]	Steel[55]	Cement and concrete[56,57,58]	Buildings[59,60]
• The rollout and use of sustainable aviation fuel (SAF) have started • New aircraft/engine technologies to raise fuel efficiency 30–40% (2050)	• Increased emissions from blast furnaces of 0.6% (2019–2023). Use of electric arc furnaces (EAFs) expected to reverse this	• Modern production led to 25% efficiency gains since 1990 • Use of high-efficiency kilns with waste heat recovery and the substitution of raw materials	• Insulation improvements are being outpaced by floor area growth
• Rerouting 1–2% of contrail-prone flights to cut emissions by 50–60% with minimal fuel impacts[61]	• Improved logistics and raw-material transport	• Logistics and process-control improvements (cutting emissions by 20% between 1990 and 2020), with a further 20% reduction expected by 2030	• Deployment of smart systems to automate heating/cooling and lighting
• Aircraft weight reduction, electric taxiing, aerodynamic improvements, and engine washes are being explored	• Hydrogen-based production	• Clinker[62] substitution to cut production emissions by 9% by 2050	• Wider adoption of heat pumps
	• Electric arc furnaces: 43% of production in 2023; wider expansion expected	• Electrification and renewables supply around 8% of 2050 energy mix	• Electrification to deliver around 50% of emission reductions by 2050
• Airlines investing in carbon-removal firms to offset operational emissions	• CCUS to deliver around 13% emission cuts by 2050, subject to infrastructure development	• CCUS to deliver approximately 30% emission cuts by 2050, subject to infrastructure development	

Strategies		Oil and gas[49]	Data centres[50,51]
4. Energy mix	**Renewables with storage**	• Renewables supply less than 1% of electricity in 2025; further expansion planned	• Renewables supply 27% of electricity in 2025 • 50% of demand growth is met by renewables with battery storage
	Adoption of new climate technologies for energy production	• Green hydrogen and zero-emission fuels production is at the prototype stage	• Exploring and investing in innovative, clean, on-site power-generation technologies (see Annex 1)
5. Waste management and circularity			
6. Supply-chain management			
7. Carbon-credit markets and related instruments			• In 2025, a coalition of hyperscalers committed USD 1 billion to permanent carbon-removal credits by 2030

Discussions with leading experts from sectoral platforms (see Table 1) have identified clear short-, medium-, and long-term priorities across the six target sectors, aligned with the seven decarbonisation strategies, thereby clarifying key areas of focus for each sector (see Annex 1). Specifically, each sector requires the deployment and adoption of a wide range of new technologies and approaches with varying complexities to implement its respective decarbonisation strategy.

This transition introduces complex operational, technological, and financial challenges that expose companies to emerging risks requiring careful assessment and management, driving evolving demand for new insurance products and services. While many of these new technologies and activities that are focused on areas such as operational and energy efficiency will lead to evolutionary changes in their core business, others – such as scaling up CCUS and shifting the energy mix for deep decarbonisation – have the potential to lead to transformative changes, significantly impacting their needs for new insurance products and services.[64]

63 CORSIA is the first global market-based climate scheme applied to an entire sector. Designed by the International Civil Aviation Organization (ICAO), it aims to limit the growth of international aviation's CO_2 emissions using ICAO-approved carbon credits. It applies only to international flights among participating countries, with temporary exemptions for some states and small operators until 2027.

64 Notably CCUS is currently considered to be in a scaling stage; while many technologies (such as SMRs, industrial geothermal, green hydrogen, renewables combined with LDES), remain at the demonstration and early deployment stages. They come with a myriad of technological, market, financing, supply-chain, and policy and regulatory risks that need to be addressed, taking into consideration the project life cycle. Geneva Association 2024b.

Aviation[52,53,54]	Steel[55]	Cement and concrete[56,57,58]	Buildings[59,60]
	• The industry is increasingly dependent on low-carbon electricity from renewables and hydrogen	• Solar and wind use remains in early stages	• Renewables currently meet 17% of energy demand
• Less than 1% of energy consumption from low-emissions fuels • Less than 1% of SAF infrastructure currently exists • Electric and hydrogen aircraft	• Biomass inputs (biochar) to replace fossil carbon without major process changes	• Bioenergy to reduce emissions 9% by 2050	
	• Scrap use can lower emissions by 75–90%	• Recovery of minerals from unrecyclable waste	• Circular-economy strategies to cut construction emissions by 13%
	• Access to scrap	• Expansion of bioenergy infrastructure	
• The Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) requires airlines to offset emissions above 85% of 2019 levels, with expansions expected after 2027[63]	• Chain-of-custody and product carbon accounting standards (e.g. worldsteel) support credible emissions tracking across complex steel supply chains	• The book-and-claim model creates tradable Environmental Attribute Certificates (EACs) from verified emissions reductions, decoupling benefits from physical supply chains to drive demand, finance projects, and enhance bankability for low-carbon cement	

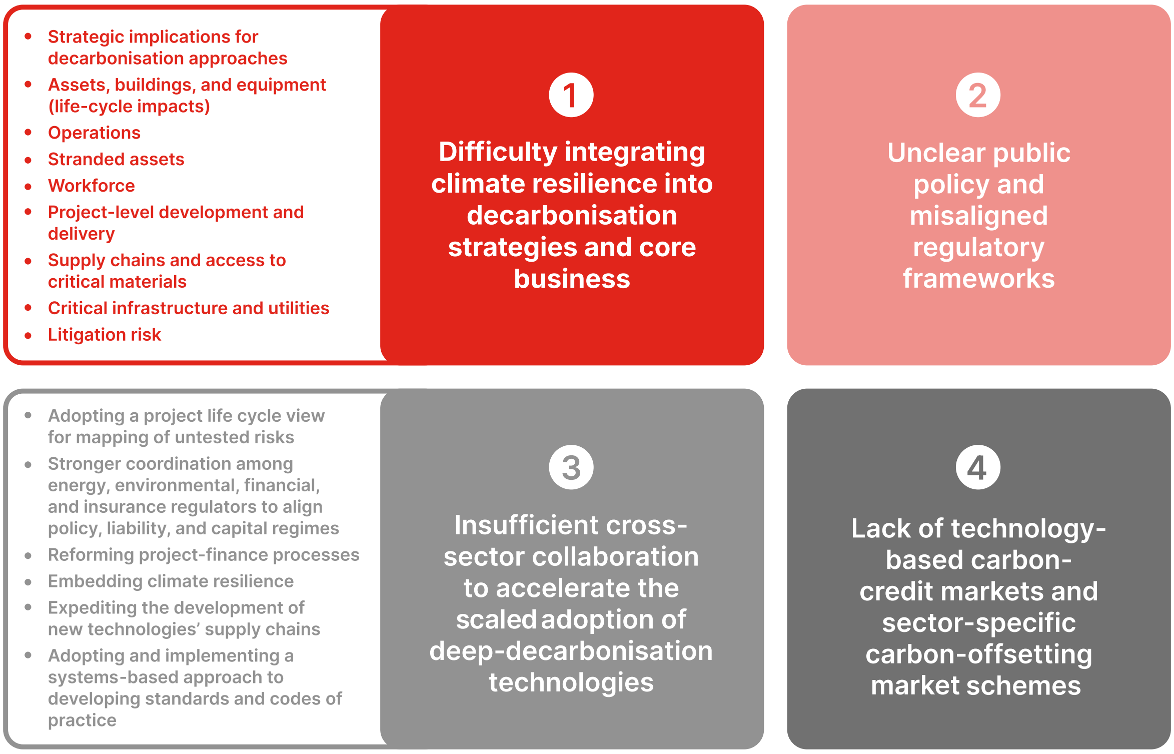
3 Common decarbonisation challenges among sectors

Common decarbonisation challenges among sectors

Four conditions will shape the insurability of decarbonisation projects: stable policy environments; new cross-sectoral collaborations; integrating climate resilience in strategies; and credible carbon markets.

Sectoral interviews revealed four common challenges hindering sectoral decarbonisation efforts (see Figure 5).

FIGURE 5: COMMON SECTORAL CHALLENGES HINDERING THE IMPLEMENTATION OF DECARBONISATION STRATEGIES



Source: Geneva Association, based on interviews with sectoral experts

3.1 Difficulty integrating climate resilience into core business and decarbonisation strategies

Discussions with representatives from the six sectors and further research confirm rising concerns with the impacts of the intensification of extreme weather events[65] and slow-changing climatic trends[66] on their core business and

65 For example, floods, wildfires, tropical cyclones, and convective storms.
66 For example, rising temperatures, water scarcity, and sea-level rise.

their decarbonisation strategies. For example, as billions of dollars in public and private funding are being invested to accelerate the commercial deployment of climate technologies and related infrastructure systems, choices around where and how to build new assets and operations will be critical to ensure their resilience and insurability over their full life cycle. These issues are highlighted in Table 3.

TABLE 3: COMMON SECTORAL CONCERNS ASSOCIATED WITH INTENSIFICATION OF EXTREME WEATHER AND SLOW-CHANGING CLIMATIC TRENDS AND IMPLICATIONS

Common concerns	Implications
1. **Strategic implications for decarbonisation strategies**	Climate resilience considerations may require re-prioritising decarbonisation strategies; for example, favouring resilient, modular, and distributed assets, and operations over exposed, centralised, or water-intensive options. These considerations would affect sectoral decisions on where and how to build new assets and operations, taking into account the insurability of those assets throughout their life cycle.[67] For sectors such as cement and concrete, scaling up alternative and recycled raw materials in the production of concrete and cement is a significant challenge in realising the industry's decarbonisation roadmap. Constraints related to the slow development and adoption of building standards, and to customer acceptance of alternative decarbonised raw materials, could have significant impacts on the cement industry's decarbonisation strategy.[68]
2. **Assets, buildings, and equipment (life-cycle impacts)**	Damage to and destruction of existing assets,[69] rising maintenance, retrofit, and relocation costs[70]
3. **Operations**	Disruption of operations through shutdowns, efficiency losses, safety constraints, outages, and water stress[71] which can permanently alter site-design assumptions[72]
4. **Stranded assets**	Assets becoming unusable or uninsurable, increasing stranded-assets and credit risks[73]
5. **Workforce**	Injury, illness and mental-health impacts, reduced productivity and labour availability, and increased health insurance and compensation costs[74,75]
6. **Project-level development and delivery**	Construction and maintenance delays, driving cost overruns, permitting challenges, and uncertainty around schedules and performance[76]
7. **Supply chains and access to critical materials**	Damage to infrastructure and operational delays[77] with mining of critical minerals as well as supply-chain disruptions[78]
8. **Critical infrastructure and utilities**	Delayed repair of power, transport and digital infrastructure, causing prolonged business interruptions, affecting supply chains, workforce access, and service delivery[79]
9. **Litigation risk**	Rising exposure to climate-related litigation, including alleged impacts from physical-damage claims, failure-to-adapt allegations, disclosure and fiduciary-duty cases, and liability for service interruptions, creating growing legal, financial, and reputational risks[80,81]

Source: Geneva Association, based on interviews with sectoral experts and various sources

67 Kaminsky 2023; Norton Rose Fullbright 2023; Rider 2023.
68 Queensland Government 2024; Swiss Re 2023.
69 Smolaks 2016; Aragon and Schreiber 2024.
70 Anderson 2023; Dong et al. 2022; Husseini 2017.
71 UNEP FI 2023a, 2023b, 2024.
72 Copley 2022; IATA 2020; Warder 2024.
73 Ellison 2022; Global Witness 2025; World Economic Forum 2018.
74 Geneva Association 2024c; US Occupational Safety and Health Administration 2024.
75 Holcim 2023; Minoretti et al 2024; N and Xu 2024.
76 Bromfield 2023; Marsh 2023; Roads & Bridges 2005.
77 DiChristopher 2017; Drewry 2025; Tandon 2024.
78 Commodity News 2024.
79 Geneva Association 2019; Uptime Institute 2018; Rosen 2023.
80 Geneva Association 2021; Kaminski 2022.
81 Sabin Center for Climate Change Law 2018, 2019, 2020, 2024.

Implications for re/insurers: P&C re/insurers could invest in developing forward-looking stochastic climate risk assessment tools and provide risk advisory services to help sectoral clients' prioritisation of retrofit investments and development of phased, cost-effective plans for existing assets and operations. In addition, these services could support decarbonisation investments, for example, with site selection, asset design, and incorporation of risk-mitigation measures for new assets and operations. Through underwriting incentives, re/insurers can also promote resilient design and adaptive technologies, reducing disruptions, preserving long-term insurability, and lowering stranded asset risks. Re/insurers could also support supply-chain resilience by mapping supplier concentration and exposure to extreme weather and slow-changing climatic trends. They can pre-assess alternative suppliers and logistics routes through risk engineering.

3.2 Unclear public policy and misaligned regulatory frameworks

Discussions with sectoral representatives emphasised that the lack of clear, coherent, and well-aligned public policy and regulatory frameworks remains a critical bottleneck to accelerating sectoral decarbonisation. For example, in the buildings sector, risk-based land-use planning and zoning, alongside updated and enforceable building codes for low-carbon and climate-resilient buildings are essential to enabling green, resilient buildings, and reducing transition and liability risks.[82] Re/insurers could work with governments to develop green and resilience incentives, leverage government rebates as well as achieve a shared understanding of hazards, identify regions facing insurance affordability pressures, and prioritise high-impact resilience and green-building investments. In parallel, market uptake and scaled use of low-carbon concrete and alternative binders in construction depend on the timely development and enforcement of building standards that allow for the safe use of these new materials.

3.3 Insufficient cross-sectoral collaboration

A key challenge highlighted in the interviews is the urgency to accelerate their deep decarbonisation,[83] which relies on companies gaining access to commercial-scale technologies like CCUS and production of low- or zero-carbon energy. Experiences from these sectors have revealed that as industrial projects scale, they become increasingly complex, involving multiple stakeholders with diverse roles, risk exposures, liabilities, and regulatory requirements. These projects could span jurisdictions with differing policy and regulatory regimes and rely on underdeveloped supply chains. This further amplifies the need for more coordinated risk identification and risk management to reduce risks for all stakeholders and enable scaled upfront investments. This is illustrated for CCS[84] clusters in the EU in Box 3.

Geneva Association research and a recent multi-stakeholder R&D initiative[85] have indicated that early engagement among project owners and developers from economic sectors, engineering, procurement, and construction (EPCs) firms, re/insurers (particularly risk-engineering teams), investors, sector-specific policymakers, and regulators could deliver significant benefits, including:

1. Improved data availability, knowledge sharing, and transparency.
2. More integrated and holistic approach to mapping risks, taking into consideration the project value chain[86] and cascading effects.
3. Earlier identification and alignment of risk-mitigation measures across stakeholders.
4. Development of risk-sharing mechanisms that help unlock financing.
5. Identification of gaps in risk-transfer and financing solutions.
6. Design of public-policy and regulatory frameworks that support scalable deployment.

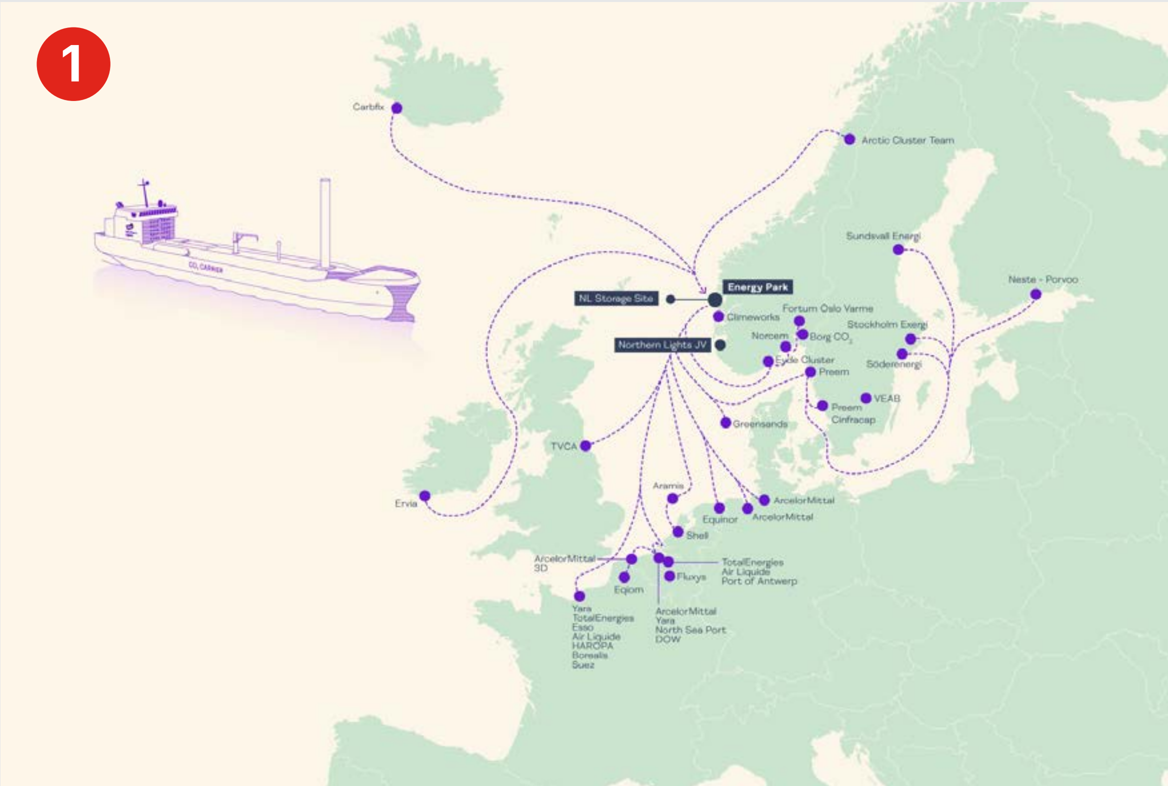
Together, these outcomes would strengthen project bankability, enhance insurability, and accelerate the responsible scaling of complex projects.

82 Geneva Association 2025.
83 Deep-decarbonisation technologies refer to CCUS and the wide range of emerging technologies for changing the energy mix, enabling significant GHG-emission reduction.
84 These carbon capture storage industrial clusters do not have an explicit utilisation component.
85 Geneva Association 2024b and a cross-sectoral strategic R&D initiative engaging the Geneva Association, the OGCI and Clean Energy Ministerial CCUS Initiative, bringing together oil and gas companies, insurers, and governments, is undertaking an in-depth assessment of risks and risk-mitigation solutions across the full value chain, including capture, transport, storage, and closure, and explore opportunities for enhancing insurability of these projects for scaling.
86 A project value chain is a network-based system of interdependent organisations that collectively create value across a project's life cycle, from concept and financing to construction and operation, monitoring and maintenance, and eventually project closure. Unlike traditional firm-centric value chains, project value chains rely on coordinated risk-sharing, aligned incentives, and multi-stakeholder collaboration.

Box 3: Europe's CCS clusters

In Europe, industrial clusters are developed around a single, shared carbon capture, transportation, and storage infrastructure to manage and reduce their combined GHG emissions. A complex ecosystem of stakeholders, with different roles and liabilities, enables capture, transportation, utilisation, storage, and closure. The interconnectedness of stakeholders is illustrated in three cases in Figure 6 including: HyNet in Northwest England and North Wales; Aramis in the Netherlands; and Northern Lights in Norway. Importantly, a single incident in a critical part of the system, for example, a major event on an offshore platform that forces a prolonged halt in CO_2 injection would stop CO_2 transport to the storage site and effectively block the entire system. This could trigger losses related to property damage and/or business interruption for the offshore operator, pipeline companies, and each emitter unable to send CO_2 to storage. These accumulated losses, together with others, such as lost revenue from the inability to claim carbon credits, need to be considered as part of the total insured exposure. Interconnectivity and risk accumulation are major concerns in large industrial clusters.

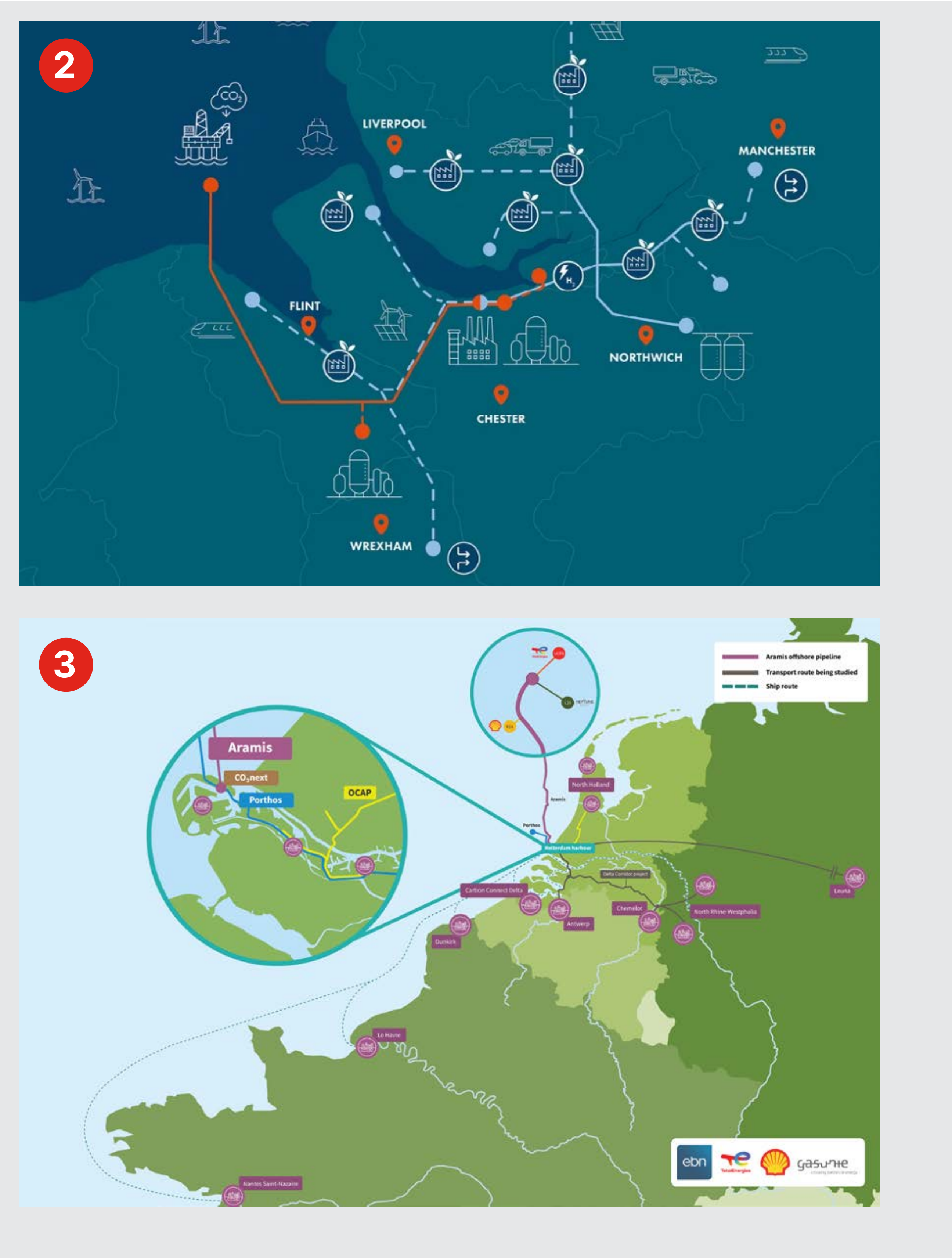
FIGURE 6: CCS CLUSTERS – HYNET, ARAMIS AND NORTHERN LIGHTS



1. Northern Lights – an open and flexible CCS infrastructure that aims to transport CO_2 by ship from capture sites across Europe (purple dots) to a terminal in Norway for intermediate storage, before transporting it for permanent storage in a reservoir under the seabed (operational 2025).

2. HyNet – a project in the North West of England that combines a low-carbon hydrogen transportation and storage network (blue lines and dots) to supply energy-intensive industrial gas users and a pipeline to capture up to 95% of emissions from industrial processes (orange lines and dots) and to be piped to a permanent storage in Liverpool Bay (expected to be operational by 2028).

3. Aramis – CCS infrastructure that will enable connections to several European clusters (purple dots), transporting CO_2 through pipelines, ships and barges, collected at a hub in the Netherlands, transported by an off-shore pipeline at sea and injected and stored below the seabed (expected to be operational by 2028).



Source: Geneva Association, based on various sources[87]

87 Northern Lights 2022; WSP 2022; CCUS Alliance 2023.

TABLE 4: SIX TRANSFORMATIVE APPROACHES TO EXPEDITE SECTORAL ADOPTION OF EMERGING TECHNOLOGIES FOR DEEP DECARBONISATION, WITH IMPLICATIONS FOR KEY STAKEHOLDERS AND THE INSURANCE INDUSTRY

	Why is this needed?
1. **Adopting a project-life-cycle approach for the mapping of untested risks, stakeholder roles and liabilities, contractual agreements, and risk mitigation measures would enable better coordination of risk mitigation, risk-sharing, and reduce overall risk from early stages.** For example, with CCUS projects, this could include design, construction, execution and monitoring of sequestration, transportation and storage, and final closure stages.	• Complex, multi-stakeholder projects create interlinked technical, contractual and liability risks. Failure in any segment can trigger cascading effects and complex liability scenarios. • Cross-border projects face divergent policy and regulatory regimes and increasing legal uncertainty.
2. **Strengthened cross-sectoral coordination among policymakers and regulators (e.g. energy, environment, finance and insurance) is needed to align regulations and liability regimes and enable effective risk-sharing models.**	• Public policy and regulation directly determine insurability, project economics, and long-term risk-sharing. • Project stakeholders operate under different regulatory and capital regimes, creating misaligned liabilities. • Sector-specific regulatory silos limit scalable deployment of emerging technologies.
3. **Reforming project-finance processes would improve site selection and project design by embedding risk mitigation to enhance insurability and financing from the early stages.**	• Re/insurers are typically engaged too late, after sites and designs are fixed. • Early risk-engineering input helps anticipate emerging and known risks, improve design and mitigation, reducing costly surprises and shortening insurance due diligence timelines.
4. **Embedding climate resilience as a core requirement in plans, project design, and investment decisions for new assets would enhance insurability and reduce stranded-asset and credit risks over the asset life cycle.**	• Site selection often prioritises cost and infrastructure, underestimating future climate risk. • Forward-looking scenario analysis can reveal extreme weather and chronic climate risks that affect long-term asset viability.

What does it mean for key stakeholders?	What are the implications for the insurance industry?
• Clearer allocation of roles, responsibilities, and liabilities across project owners, developers, financiers, governments, and re/insurers. • Improved coordination supports more effective risk mitigation, smoother operations, and bankable project structures.	• Shift from transactional underwriting toward integrated, multi-line products and services. • Earlier engagement of re/insurers' risk-engineering and underwriting teams to assess insurability and shape mitigation strategies. • Proactive dialogue with policymakers to reflect insurability considerations in emerging regulatory frameworks. • New partnerships and distribution models enabling re/insurers to engage pre-commercialisation alongside developers, investors, and governments.
• Regulatory alignment clarifies liability allocation and capital treatment across sectors. • Coordinated frameworks reduce uncertainty for project developers, investors, re/insurers and governments.	• Cross-sector policy and regulatory collaboration could establish viable liability regimes, solvency treatment, and long-term risk-sharing structures, particularly for emerging technologies with extended liability tails.
• Project owners/developers and their EPCs, by engaging the risk engineers of re/insurers from an early stage gain better-designed projects, and more insurable assets. • Earlier risk visibility supports faster financing and smoother project execution.	• Investment in top risk-engineering talent, advanced assessment tools and dedicated early-stage resources. • Strategic, R&D-oriented engagement with developers, supporting new technology markets and strengthening long-term insurability beyond transactional underwriting. • Direct access of re/insurers' risk-engineering teams in pre-commercialisation stages remains a challenge.
• Project developers can rethink technology and siting choices as extreme-weather and slow-changing climatic-trend risks evolve. • More resilient options may include distributed systems, modular designs, and redundancy and backup systems, while large hubs and exposed supply chains may become less viable.	• The early involvement of re/insurers' risk engineers at feasibility and pre-site selection stages helps guide siting, design, and integration of resilience measures.

5. **Accelerating the development of emerging technologies' supply chains involving a network of suppliers, manufacturers, developers, and service providers that design, produce, and deliver components and subcomponents of novel technologies, would expedite scaled deployment.**	• Traditionally, uncoordinated supply-chain development has delayed market readiness and increased project risk, slowing the scaling of emerging technologies.
6. **Adopting and implementing a systems-based approach to developing standards and codes of practice is critical to project replication and scaling. This should address all aspects such as risk identification, mitigation, allocation, contracts, supply chains, data transparency, safety, compliance, and decommissioning.**	• Fragmented or missing standards undermine insurability and financing. • Developing robust standards requires broad cross-sectoral collaboration.

Source: Geneva Association, based on interviews with sectoral experts

The experiences of sectors engaged in the development and deployment of deep decarbonisation technologies are also pointing to the need for transformative cross-sectoral approaches to help expedite scaled deployment for market adoption. These are highlighted in Table 4.

3.4 Limited tech-driven carbon markets and sector-specific offset schemes

The development of credible and certified, technology-based carbon credits is essential to mobilise private-sector investments in decarbonisation projects. While technology-based carbon credits, such as those related to engineered carbon removals and CCUS, are attracting growing interest, scaling remains constrained by the high costs and limited supply of such technologies, concerns with the long-term durability of carbon-storage systems, as well as the need to further develop high-quality monitoring, reporting and verification (MRV) practices, and certification systems.[90,91,92]

Furthermore, a range of sector-specific carbon offsetting and reduction schemes are emerging based on similar principles, but often with differing methodologies, boundaries, and accounting assumptions, such as CORSIA in aviation and the book-and-claim model for cement (as highlighted in Table 2). These are being developed by industry and third parties to mobilise early demand for, and investments in low-carbon production. While these schemes are beyond the scope of this report, discussions with sectoral representatives indicate a consensus or common approach to these systems does not currently exist. Greater alignment and convergence across industries and sectors on definitions, accounting principles, and credibility criteria would help avoid fragmentation, reduce the risk of double counting or greenwashing, and improve confidence for re/insurers, investors, and regulators assessing these mechanisms.

Re/insurers could support this process by providing risk assurance and due diligence on integrity, MRV, permanence, and long-term liability risks; offering guarantees and parametric solutions to enable early demand and financing; and engaging with standard-setting bodies to support convergence and governance.[93]

88 Offshore Energies UK 2025.
89 The Association of Property Insurers, a subsidiary of the GDV. VdS 2014.
90 AIM Carbon 2025.
91 South Pole 2025.
92 There are high-quality, non-technology-based credits that are also attracting premium pricing. Engineered removals typically have a higher price because they cost more to develop, as opposed to them carrying a cost premium due to quality. World Bank 2025.
93 Carbon Offset Guide 2025.

• Early collaboration among project developers, engineering, procurement and construction companies (EPCs), manufacturers, suppliers, re/insurers and public authorities would help accelerate supply-chain maturity and reduce bottlenecks and uncertainties.	• Mapping and monitoring critical supply-chain risks early. • Embedding risk-engineering standards for suppliers and components. • Offering risk-sharing solutions for delays, failures and performance risks. • Supporting data, transparency and standards to improve insurability and scale.
• Shared standards improve risk clarity, efficiency and bankability. • Industry-led initiatives, such as LOGIC in the UK offshore sector, have demonstrated how governance and collaboration can support scalable deployment.[88]	• Engage early to shape and co-develop standards and codes of practice. • Use early project involvement to build expertise and stakeholder trust. • Collaborate with standard-setting bodies to improve replicability and insurability of emerging technologies. • Launch standardisation efforts by engaging key stakeholders, as in offshore wind initiatives led by the German Insurance Association (GDV) and the German Offshore Wind Energy Foundation.[89]

4 Strategic implications for re/insurers

Strategic implications for re/insurers

Exploring the decarbonisation priorities of different sectors reveals emerging risks and helps re/insurers anticipate future insurance needs.

Sectoral decarbonisation is underway within the private sector, as different sectors, with varying levels of application, use a portfolio approach to enable transition within their core business (see Figure 4). As described in this report, a deeper dive into the short-, medium-, and long-term priorities of each target sector allows re/insurers to anticipate evolving needs for insurance-related products and services to support expediting decarbonisation strategies. As sectors implement these strategies, they need to assess and manage a wide range of emerging risks such as technology, construction, supply-chain, product liability, stranded-asset, regulatory, and long-tail environmental liability risks.

While each sector's approach and needs for insurance and financing services vary, there are common characteristics across their decarbonisation strategies, with implications for the insurance industry and investors. For example, achieving deep decarbonisation through low- and zero-carbon energy sources, and ensuring access to robust, credible carbon-credit markets and other sector-specific financial mechanisms, all require strong intra- and inter-sectoral collaborations.

At a time of mounting cost pressures and intensifying competition, re/insurers face strategic choices about how to proactively support clients through early engagement in the transition. Geopolitical shocks and resulting energy instability heighten the need for resilient decarbonisation and energy systems. Re/insurers can help embed resilience into the design, development, and financing of clean energy systems and supply chains – reducing exposure to external shocks while accelerating the energy transition.

The expertise of re/insurers could be significantly leveraged if they directly engage with project owners and governments to co-assess risks and co-develop risk-sharing solutions. Building climate resilience is another critical common concern, particularly as companies and sectors invest massively in new assets, operations, and infrastructure systems. At the same time, advancing deep decarbonisation will require close collaboration among re/insurers and a broad set of stakeholders, as no single organisation can address these shared challenges alone. This carries important strategic implications for the evolving dynamics of insurance markets.

Re/insurers are critical enablers of their corporate clients' decarbonisation journeys. The scaling and broad adoption of many emerging technologies have profound implications for re/insurers, with each with distinct technical, operational, regulatory, and liability profiles:

1. **Medium- and long-term strategic opportunities:** The implementation of concrete sectoral decarbonisation plans and accelerating scale up of capital-intensive, pre-commercial climate technologies for deep decarbonisation represents a growth opportunity for re/insurers. The latter requires finding efficient pathways to engage directly, through their risk-engineering experts with project owners, investors, and governments from pre-commercialisation stages. As these technologies move from pilot to commercial deployment, they generate demand for advanced risk engineering, innovative risk-sharing structures, and new risk-transfer solutions that can help unlock private capital and improve bankability. Re/insurers are increasingly positioned not merely as risk carriers, but as critical enablers of investments and risk-management partners supporting the development of various standards for project replication.

2. **Research and development:** The energy transition underscores the necessity of investing in targeted R&D, as well as building internal technical capabilities to support commercial clients. With the steady emergence of new technologies across various sectors, they face a diverse set of risks related to technical performance, market adoption, resource

constraints, and liability frameworks. These challenges require the implementation of advanced analytical methods and comprehensive risk-mitigation strategies needing new expertise. Traditional risk-transfer structures may also be ill-suited to these contexts, creating the need for new risk-sharing solutions.

Insurability itself is becoming more tightly coupled with climate resilience. Intensifying extreme weather and slow-onset climatic shifts already affect where assets can be built, how long they remain economically and operationally viable, and whether they can remain insurable over their life cycle. This also calls for the development of forward-looking, location-specific modelling of both physical and transition risks.

3. **Organisational structure and governance:** From an organisational perspective, clients point to the need for re/insurers to transition internal institutional and business-line silos towards a more integrated governance framework, enabling early involvement of multidisciplinary teams across various business units, with corporate clients during project design and development. These teams may engage experts from various functions such as risk engineering, underwriting, as well as legal.

4. **Strategic cross-sectoral partnerships:** Partnerships could be forged through early and sustained collaboration with project developers, financiers, technology providers, and governments. This is becoming critical to mapping risks upfront, innovating risk-sharing models and risk-transfer solutions, and supporting the development of policies and regulatory and liability regimes. However, mechanisms for such early direct engagement need to be developed.

   Furthermore, the ability to engage multi-disciplinary teams with standard-setting bodies, manufacturers, and suppliers, could help expedite the development of standards spanning early risk identification, risk mitigation, risk allocation and risk sharing, contracts and processes, supply-chain collaboration, data transparency, safety and regulatory compliance, and decommissioning.

5. **Talent acquisition and retention:** Building internal capacity to engage proactively with corporate clients and other stakeholders may challenge re/insurers' ability to acquire and retain talent. For example, demand for risk engineers and cross-disciplinary experts is rising sharply, reflecting the complexities and the wide range of new technologies that need to be scaled and adopted by various sectors. Competition for such talent is intensifying, requiring re/insurers to rethink recruitment, training, strategic engagement with universities and technical institutions, as well as long-term knowledge-retention strategies.

6. **Development of new products and services:** Investments in new products and services is essential for strategic positioning. Engaging early with project developers in different sectors could lead to access to high-resolution risk data for assessing cascading risks, insurability, and capital mobilisation. Forward-looking stochastic climate models are needed for assisting corporate clients in prioritising retrofit investments for current assets and investments in new assets. Re/insurers are increasingly acting as risk advisors and conveners, not merely as underwriters. Risk-engineering services are no longer ancillary; they are central to re/insurers' strategic positioning. System-level, long-duration risks are driving the need for bespoke, integrated risk sharing, and risk-transfer solutions.

7. **Evolving market dynamics:** These sectors seek to interact directly with re/insurers; however, opportunities for such engagement appear to be limited. Supporting corporate clients' deep decarbonisation requires a shift from transactional underwriting to a more strategic delivery of innovative risk engineering, risk-sharing, and risk-transfer solutions. This calls for new distribution models that enable re/insurers' risk-engineering teams to work directly with project owners, investors, and other stakeholders at the project level from early stages.

8. **Investment strategies:** Today, re/insurers' investment in deep-decarbonisation projects remains limited due to high capital requirements, uncertain technology pathways, unstable policy frameworks, regulatory constraints, and fiduciary obligations. Innovative risk-sharing arrangements, blended finance, and government-backed guarantees can improve risk-adjusted returns and help crowd in private capital from highly regulated institutional investors such as re/insurers and pension funds.

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Annex 1: Sector-specific decarbonisation priorities in the short, medium and long term

Sectors	Short term (0–5 years)	Medium term (5–10 years)
Oil and gas	1. **Operations** • Energy/operational efficiencies • Operational changes (reduce flaring) 2. **Electrification of facilities** 3. **CCUS scaling** 4. **Energy mix** • Renewables	1. **Energy mix** • Hydrogen • Geothermal • Biofuels (e.g. ethanol) 2. **Producing low-carbon fuels for other industries (SAF)**
Data centres	1. **Operations** • Hardware to fit more power in less space • Energy efficiency and minimum performance standards • Improving cooling water use efficiency 2. **Energy mix (priorities vary by region)** • EU: Solar, hydro, and wind with battery storage • US: Natural gas with CCUS, nuclear, and negotiating with grid providers (migrating to other states due to power saturation)	1. **Energy mix** • EU: SMRs (first-of-a-kind pilots beyond 2032) and scaling CCUS • US: Natural gas and CCS, restoring legacy nuclear plants and SMRs (could be delayed by cheaper natural gas)
Aviation	1. **Operations** • Aircraft efficiency • Aligning passenger demand with capacity • Rerouting contrail-prone international flights 2. **Energy mix** • Scale up SAF	1. **Energy mix** • Scale up eSAF[96] • Synthetic kerosene[97] 2. **Carbon-credit markets** • Expansion of the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)
Steel	1. **Operational alteration** • Expanded use of electric arc furnaces (supplied by low-carbon energy), subject to scrap availability 2. **Waste management and circularity** • Increasing use of scrap in production	1. **Operational alteration** • Transforming traditional blast furnace into a low-carbon process (sizeable capital expenditure and research needed)

94 Significant investments are driven by both decarbonisation needs and growing energy demands, investments to power data centres are rising globally, including investments in various emerging technologies. Microsoft (2022, 2024), Amazon (2024), Google (2025).
95 Global CCS Institute 2025.
96 Electro-sustainable aviation fuel, a synthetic jet fuel produced using renewables.
97 Synthetic kerosene is a fuel produced from hydrocarbons derived from renewable resources.

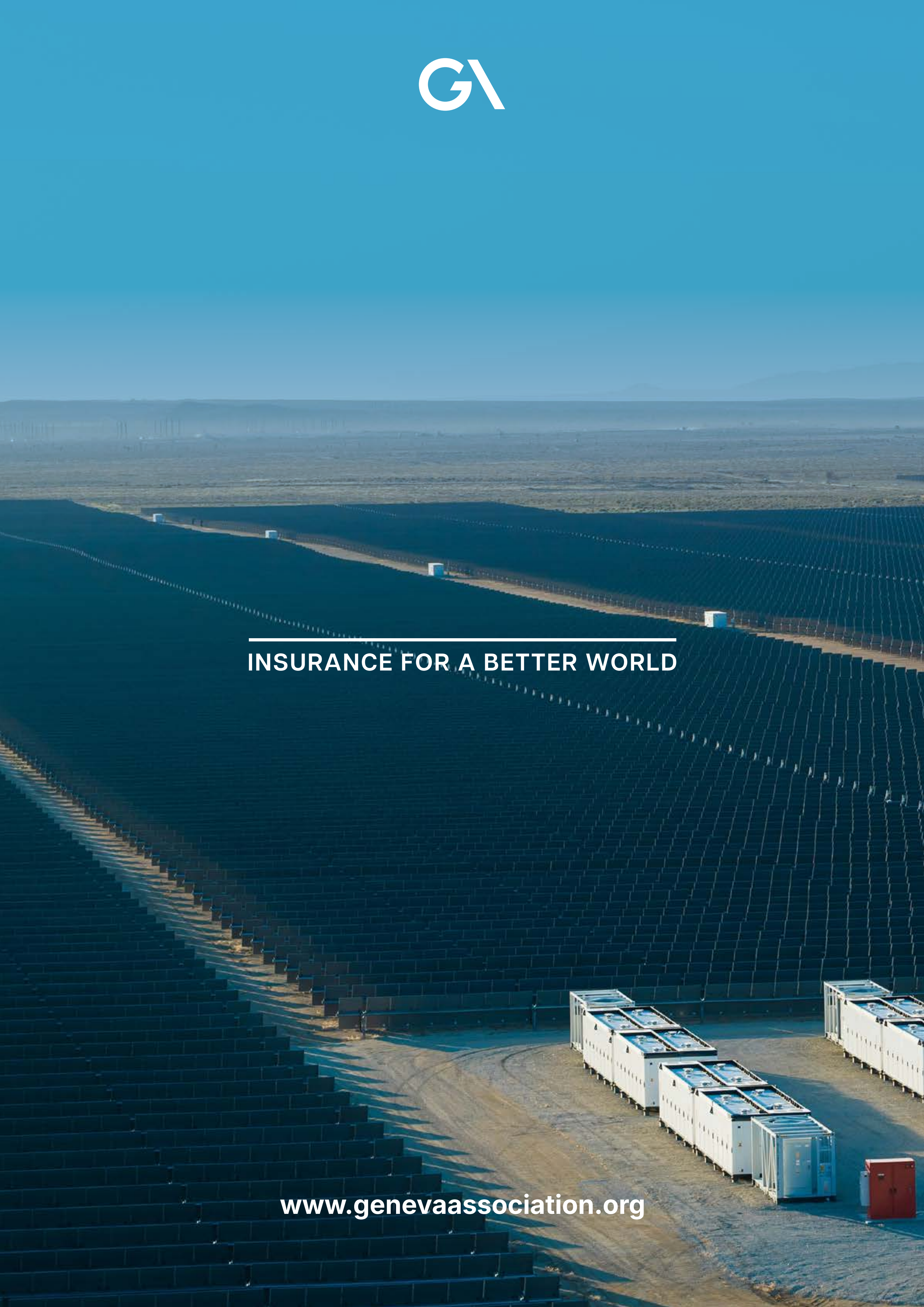
Long term (more than 10 years)	Other considerations
	1. Nature-based solutions 2. Internal carbon pricing
1. **Energy mix**[94] • EU: • SMRs, hydrogen, renewables with LDES • Partnerships with oil and gas for supplying power together with local CCS hubs[95] • US: Natural gas, CCUS and SMRs	1. Industrial geothermal for cooling
1. **Process alterations** • New aircraft: electric (short flights), hydrogen-powered (medium flights) • Infrastructure and supply-chain development for new aircraft	Market makers for SAF would secure long-term fixed-price deals with producers and offer flexible short-term sales to airlines, absorbing price/volume risks to boost liquidity and confidence.
1. **Fossil fuels with CCUS** 2. **Energy mix** • Use of green hydrogen 3. **Supply-chain management** • Shift from global iron ore trade to production and trade of low-carbon (green) iron made near low-cost renewables	1. SMRs being discussed (where nuclear-friendly regulations exist) 2. Renewable energy with scaled deployment of LDES

Sectors		Short term (0–5 years)	Medium term (5–10 years)
Cement		1. **Operational efficiency** • Efficiency in design and construction • Efficiency in concrete production	
Cement		2. **Process alterations** • Clinker[98] substitution to lower-emission alternatives (e.g. fly ash)	2. **Process alterations** • Alternative substitutes for clinker • Scaling-up the use of other alternative raw materials for production
Cement		3. **Fossil fuels with CCUS** • Collaborations to scale CCUS via policy, technology and infrastructure • CCUS commercial-scale deployment post-2030 with increased infrastructure development • Full-scale CCUS deployment	
Cement		4. **Energy mix** • Scale-up grid decarbonisation (e.g. through renewables) in both cement and concrete production	
Buildings	Commercial and industrial	**Developed countries:** 1. **Process alteration** • Mainstream life-cycle approach to greening 2. **Energy mix** • Improving electrification **Developing countries:** 1. **Operational efficiency** • Improvements in energy/water efficiency and cooling 2. **Process alteration** • Partnerships for green building materials	**Developed countries:** 1. **Process alteration** • Further expansion of life-cycle approach **Developing countries:** 1. **Process alteration** • Use of sustainable materials for rapid floorspace growth 2. **Supply-chain management** • Improving stakeholder engagement
Buildings	Residential	**Developed countries:** 1. **Energy efficiency** • Increased consumer demand for green buildings and heating/cooling systems **Developing countries:** 1. **Process alteration** • Balancing consumer priorities for resilience, greening, and energy poverty	**Developed countries:** 1. **Process alteration** • Incentives for resilience • Life-cycle/community approach mainstreamed • Building codes for decarbonisation and resilience. 2. **Energy mix** • Increase electrification over gas use **Developing countries:** 1. **Process alteration** • Policy, regulatory, and financial-system reforms to enable behaviour change

Source: Geneva Association, based on interviews and roundtables held by the GA with representatives from the World Steel Association, Mission Possible Partnership, the Climate Neutral Data Centre Pact, GCCA, and World Green Building Council

98 Key ingredient for cement

Long term (more than 10 years)	Other considerations
	Recarbonation (hardened concrete absorbing CO_2 naturally) is often overlooked in emissions accounting, potentially offsetting up to 20% of cement-production CO_2 **Book-and-claim model** creates tradable Environmental Attribute Certificates (EACs) from verified emissions reductions, decoupling benefits from physical supply chains to drive demand, finance projects, and enhance bankability for low-carbon cement
2. **Process alterations** • Alternatives to Portland clinker cement (2050) • Introducing kiln electrification (2040)	
N/A	
N/A	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