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PRIMER ON CLIMATE TECH: THE URGENCY OF ACTION & WHY CLIMATE TECHNOLOGY MATTERS NOW

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> If you're younger than 60, you have a good chance of witnessing the radical destablisation of life on earth—massive crop failures, apocalyptic fires, imploding economies, epic flooding, hundreds of millions of refugees fleeing regions made uninhabitable by extreme heat or permanent drought. If you're under 30, you're all but guaranteed to witness it.
> – Jonathan Franzen, The New Yorker, 8th Sep 2019.

Introduction

Climate change is one of the most formidable challenges confronting us today. With each passing year, its severity becomes more pronounced, as underscored by the findings of the UN Environmental Program (UNEP) and the Copernicus Climate Change Service (C3S). 2023 witnessed unprecedented climatic extremes, with the Intergovernmental Panel on Climate Change (IPCC) reporting yet another sobering message: Global Greenhouse Gas (GHG) emissions had surged, breaching emissions targets for the year[1].

Record-breaking conditions, including the hottest month on record and daily global temperature averages exceeding pre-industrial levels by over 2°C, characterised the year. In all, 2023 emerged as the warmest year ever recorded. Based on data tracing back to the year 1850, daily average temperatures exceeded 1°C above pre-industrial levels. [2]

Daily global temperature increase above pre-industrial level (1850-1900) in 2023

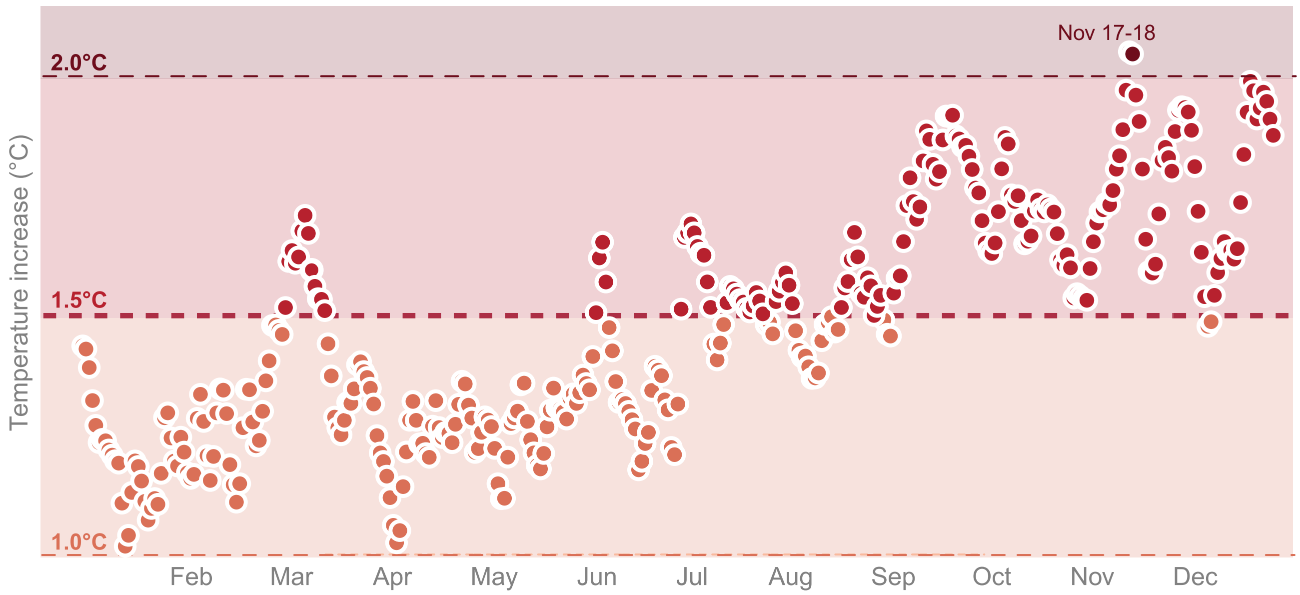

Figure 1: Daily global surface air temperature increases relative to the average, 1850-1900
(Source: European Centre for Medium-Range Weather Forecasts)

These findings underscore the urgent need for decisive action. The escalating trajectory of global temperatures threatens to exacerbate existing environmental challenges—endangering ecosystems, geopolitics, economies, and communities[3] on an unseen scale.

Over 71% of global greenhouse gas emissions come from four key sectors: energy, transportation, industry, and agriculture (fig. 2). To reduce GHG emissions, technological innovation has never been more pivotal. From revolutionising energy generation to enhancing manufacturing, agriculture and transportation systems, technological advancements offer promising solutions to mitigate and potentially reverse the impacts of climate change. Particularly, the evolution of climate tech, a class of technology tailored to slow climate change, has come to the fore.

GHG Emissions By Sector, 2020

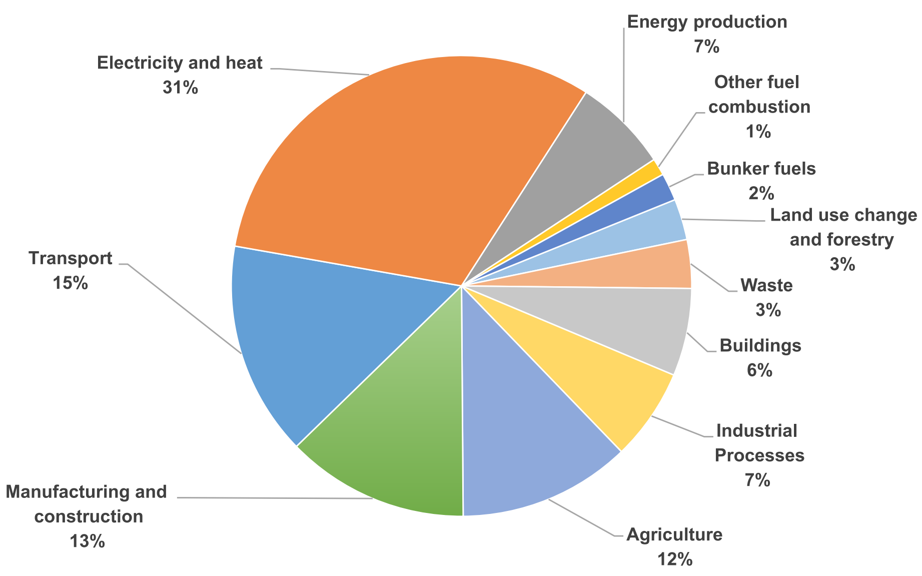

Figure 2: Greenhouse Gas Emission by sector in 2020[4] (Source: Our World in Data)

Chapter I: The unfolding story of climate tech innovation

Understanding the landscape and assessing the gaps

Scaling climate technology poses many unique challenges that necessitate innovative solutions and collaborative efforts. The interdisciplinary nature of addressing climate change means that climate tech ventures need to consider numerous complexities, ranging from navigating regulatory landscapes to securing adequate funding and overcoming technological barriers. These challenges encompass economic, technical and policy dimensions, requiring a multifaceted approach.

In the upcoming section, we use the Hype Cycle framework to assess the transformation of climate tech across time. This framework illustrates the trajectory of climate tech solutions, and allows us to systematically break down these challenges across different phases of development.

Innovation Trigger

- **Sentiment (Low):** Interest primarily from scientists and a handful of entrepreneurs
- **Technical (High):** At the POC stage or lab scale experienment
- **Regulatory (Low):** No significant policy or regulatory interventions at this stage
- **Funding (Low):** VCs & specialised investors recognise early opportunities but limited capital
- **Risk (High):** Unproven tech with high rates of failure

Peak of Inflated Expectations

- **Sentiment (High):** Inflated valuation frenzy of speculation driven by FOMO, overhyped through communications and media channels
- **Technical (High):** Minor technical advancement
- **Regulatory (High):** Some regulatory interest at this stage
- **Funding (High):** A surge of funding driven by enthusiasm, optimism and speculation
- **Risk (High):** Tech still unproven but hyped up

Trough of Disillusionment

- **Sentiment (Low):** Tech winter, enthusiasm wanes as technology fails to meet optimistic expectations
- **Technical (Med):** Some improvement, but challenges and setbacks lead to reassessment of feasibility
- **Regulatory (Low):** No significant regulatory interventions at this stage
- **Funding (Low):** Low funding availability as investor lose capital and confidence. Most companies die off
- **Risk (Med):** Most underdeveloped tech goes extinct, leaving viable options

Slope of Enlightenment

- **Sentiment (Med):** Investments made in the earlier stages begin to yield tangible results
- **Technical (Low):** Advancement and refinements in tech based on lessons learned
- **Regulatory (High):** Supportive regulatory interventions and policies to encourage development
- **Funding (Med):** Firms reinvest cautiously and funding increases gradually
- **Risk (Med):** Viable business models are further developed alongside the tech

Plateau of Productivity

- **Sentiment (High):** Tech is sufficiently mature, gaining widespread acceptance and adoption
- **Technical (Low):** Reaches a maturity with established standards. Cost of tech continues to fall with improvements to production
- **Regulatory (High):** Supportive policies and subsidies to drive adoption and intergration
- **Funding (High):** Stable funding environment with continued investment for innovation and scalability
- **Risk (Low):** Mainstream adoption

Figure 3: Phases of the Hype Cycle (Source: Gartner)

A history on climate tech

Clean Tech 1.0 emerged in the late 1990s, driven by escalating environmental worries and a recognition of the unsustainable nature of conventional fossil fuels. Its genesis can be attributed to the oil crises of the 1970s, which underscored the vulnerabilities associated with dependence on fossil fuels for energy.

In the 1980s and 1990s, catalysed by a mounting understanding of pollution and climate alterations, governmental bodies and industrial sectors embarked on the search for alternative energy reservoirs and cleaner technologies.

In this period, Clean Tech 1.0 primarily focused on renewable energy sources such as solar and wind. The development of these technologies was often driven by government incentives, research grants, and environmental regulations aimed at reducing pollution and mitigating climate change.

In the early 2000s, venture capital played a role in advancing Clean Tech 1.0[5], with a surge of investment in clean energy startups and innovative technologies. VC firms began to see the potential for lucrative returns in the clean tech sector, leading to a flurry of investments in solar, wind, biofuels, and energy efficiency companies. However, there were challenges and setbacks, including long technology development cycles, high R&D costs, and intermittent government support. This led to a decline in funding and interest in this sector fell significantly.

Maturing technologies arising from Clean Tech 1.0

Clean Tech 1.0 laid the foundation for climate tech today. It accelerated the development and production of technologies like cheaper solar panels and wind turbine, efficient heat pumps, and low carbon biofuels. Today, more renewable energy powers the grid, and homes and buildings have switched to heat pumps for heating and cooling, biofuels, powers vehicles, and industrial processes.

A key inflection point is fast approaching. The Levelized Cost of Electricity (LCOE) for utility-scale PV solar and wind power has plummeted by up to 90%, making them competitive with fossil fuels in many regions[6]. This shift is driven by advancements in technology efficiency, manufacturing costs, economies of scale, and supportive government policies. On the tech innovation Hype Cycle (fig. 3), these technologies are at the plateau of productivity phase and are now considered mainstream.

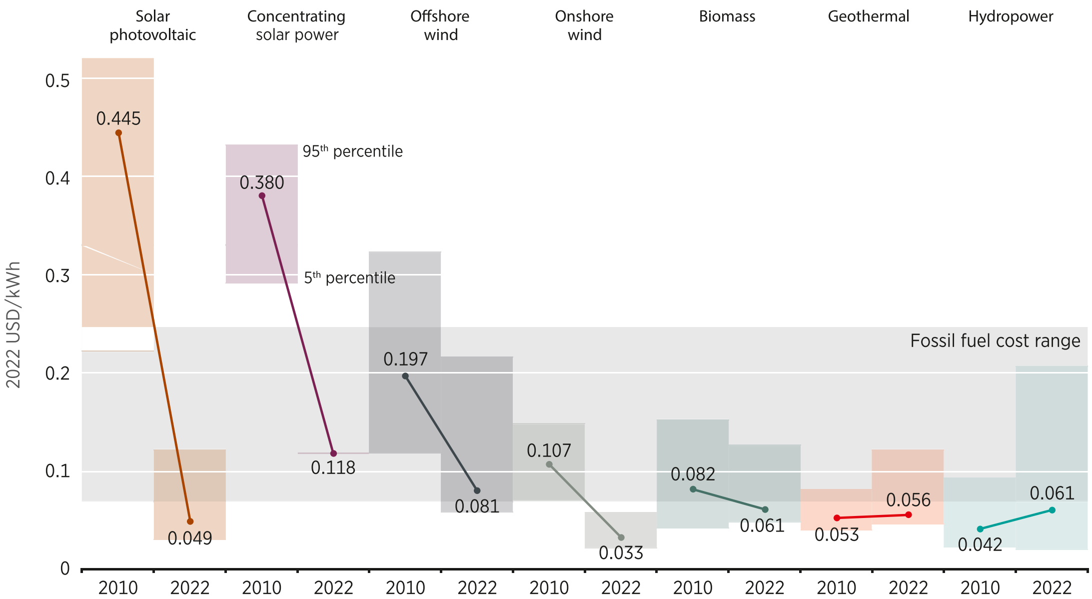

Figure 4: Global LCOE from newly commissioned utility-scale renewable power technologies, 2021 and 2022 (Source: International Renewable Energy Agency)

While renewable sources like solar and wind are gaining mainstream appeal, scaling them to meet global demands takes time. While this remains the goal, transition fuels that boast a lower carbon footprint than traditional fossil fuels, like ammonia co-firing in coal-fired power plants[7], can serve as a stopgap solution.

Emerging technologies for advance decarbonisation

The present era of Climate Tech 2.0 builds upon the foundation of Clean Tech 1.0[8]. It tackles a broader range of climate challenges across sectors, expanding to transportation, agriculture, and carbon capture. This holistic approach recognises that climate change demands solutions beyond clean(er) energy generation. A series of interconnected climate technologies are in development to build on and enhance the decarbonisation effect.

A network of 12 technologies is required to achieve climate goals

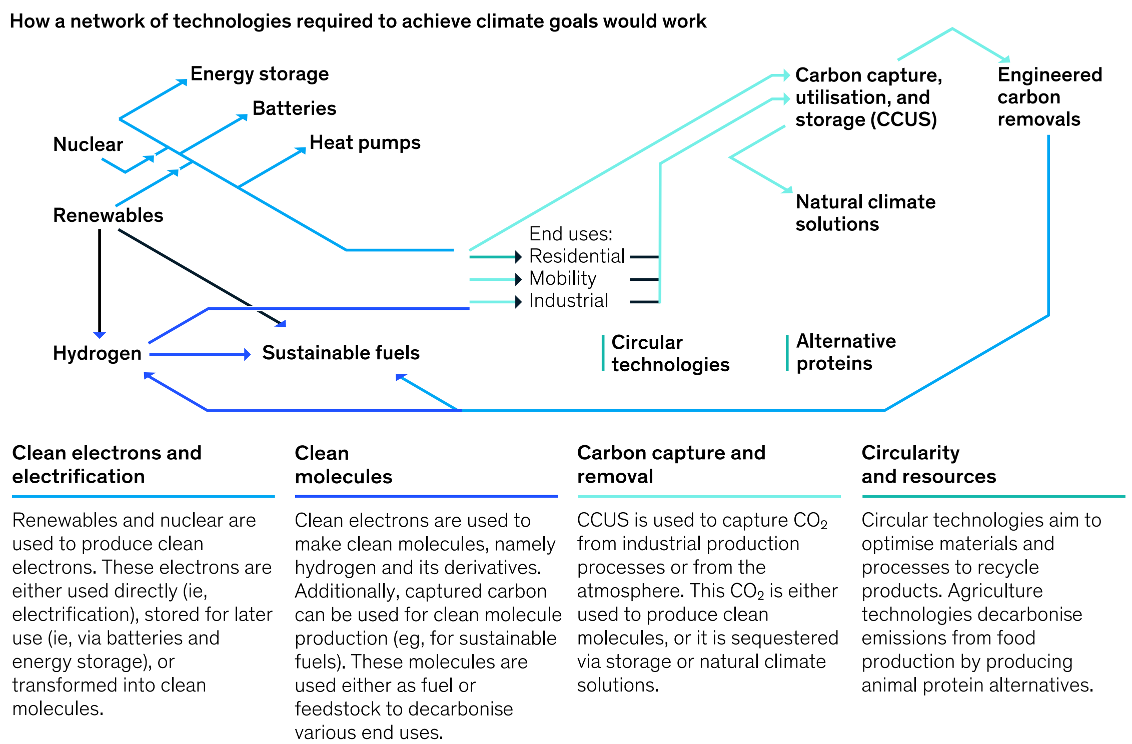

Figure 5: How a network of technologies required to achieve climate goals would work[9] (Source: McKinsey & Company)

Advancements in areas like energy generation, energy storage, sustainable fuels and carbon removal are crucial for integrating renewables into the grid and managing emissions from existing industries. With greater investment flowing in, Climate Tech 2.0 signifies a more comprehensive and promising approach to combating climate change. Below, we dive deeper into some of the notable innovations in Climate Tech 2.0.

Next gen nuclear reactors

As of 2023, the world relies on approximately 440 operational nuclear reactors across 33 countries, which contributes around 10% of global electricity generation[10]. However, with an average age nearing 32 years, these reactors are overdue for modernisation.

Generation IV (Gen IV) nuclear reactors were developed as a response to the imperative for safer, more efficient, and sustainable nuclear energy. These small modular reactors (SMR) represent the next phase in nuclear technology[11]. Gen IV reactors incorporate advanced designs and fuels to address longstanding concerns, including the utilisation of spent nuclear fuel, better control systems and a reduction in waste volume. Despite accidents in Chernobyl and Fukushima[13], the nuclear industry maintains a strong safety record, with ongoing research to enhance that safety.

Clean energy generation from nuclear is crucial for producing green hydrogen. A case in point is the Japanese government, which intends to achieve this by 2028, in line with global interest in nuclear energy as a complement to renewables. If successful, this initiative could provide enough green hydrogen to power 200,000 fuel cell vehicles annually[14].

Gen IV reactors incorporate advanced designs and fuels to address longstanding concerns

Gen IV technology has attracted the interest of influential investors such as Breakthrough Energy Ventures[15]. However, it is crucial to recognise that despite the attention and investment, Gen IV reactors are still in their nascent stages. As evidenced by the ascending trajectory of the Innovation Trigger phase on the Hype Cycle, significant progress has been made, but commercialisation remains a challenge that demands further research, resources and collaboration across industries and governments to overcome technical hurdles and regulatory barriers.

Nuclear fusion and the future of energy

Since the 1930s, scientists and engineers have endeavoured to replicate and use nuclear fusion for power generation. The rationale behind this effort lies in the potential of nuclear fusion to offer near limitless, clean, and cheap energy. Fusion has the capacity to produce four times more energy per kilogram of fuel compared to fission in nuclear power plants and nearly four million times more energy than conventional oil or coal combustion[16].

The pursuit of practical nuclear fusion has led to the development of various experimental fusion reactors and research initiatives worldwide. Among these is the International Thermonuclear Experimental Reactor (ITER), the most ambitious and well-funded fusion project involving 35 nations. ITER aims to demonstrate the feasibility of sustained fusion reactions at a scale large enough to produce significant net energy output[17].

Fusion has the capacity to produce four times more energy per kilogram of fuel compared to fission in nuclear power plants

Emerging from initial public projects, privately financed initiatives have gained momentum[18]. This trend is driven, in part, by advancements in enabling technologies that have piqued the interest of private investors. Presently, there are only 33 startups in the fusion energy space[19], with incumbent energy companies such as Chevron and ENI and notable long-term sovereign wealth funds including the Kuwait Investment Authority, Khazanah Nasional, and Temasek supporting these startups. The technology is currently ascending the Hype Cycle in the Innovation Trigger phase, indicating growing anticipation and potential for significant advancements in the future.

The electric vehicles (EV) race

On the road to decarbonise transportation, batteries, fuel cells and hybrids are the frontrunners. Batteries (BEV) and hybrids (PHEV) currently dominate the EV market, particularly for passenger cars. Their declining cost, increasing range, and expanding charging infrastructure make them a compelling choice for consumers.

However, for heavy-duty commercial vehicles, fuel cells (FCEVs) have an edge. The weight and long charging time required by batteries hinder range. Meanwhile, FCEVs offer fast refuelling, much like ICE vehicles, a major advantage for commercial applications. Their potential for longer range with larger hydrogen tanks makes them attractive for heavy-duty applications.

But FCEVs face similar early hurdles to batteries. The refuelling infrastructure is limited and widespread adoption hinges on the development of infrastructure.

EVs are on the road to becoming mainstream as the technology has proven to be commercially viable and is in the Plateau of Productivity phase of the Hype Cycle. It is important to acknowledge that the manufacturing of EV batteries involves complex processes, and some companies are still grappling with this complexity, leading to incidents of battery fires.

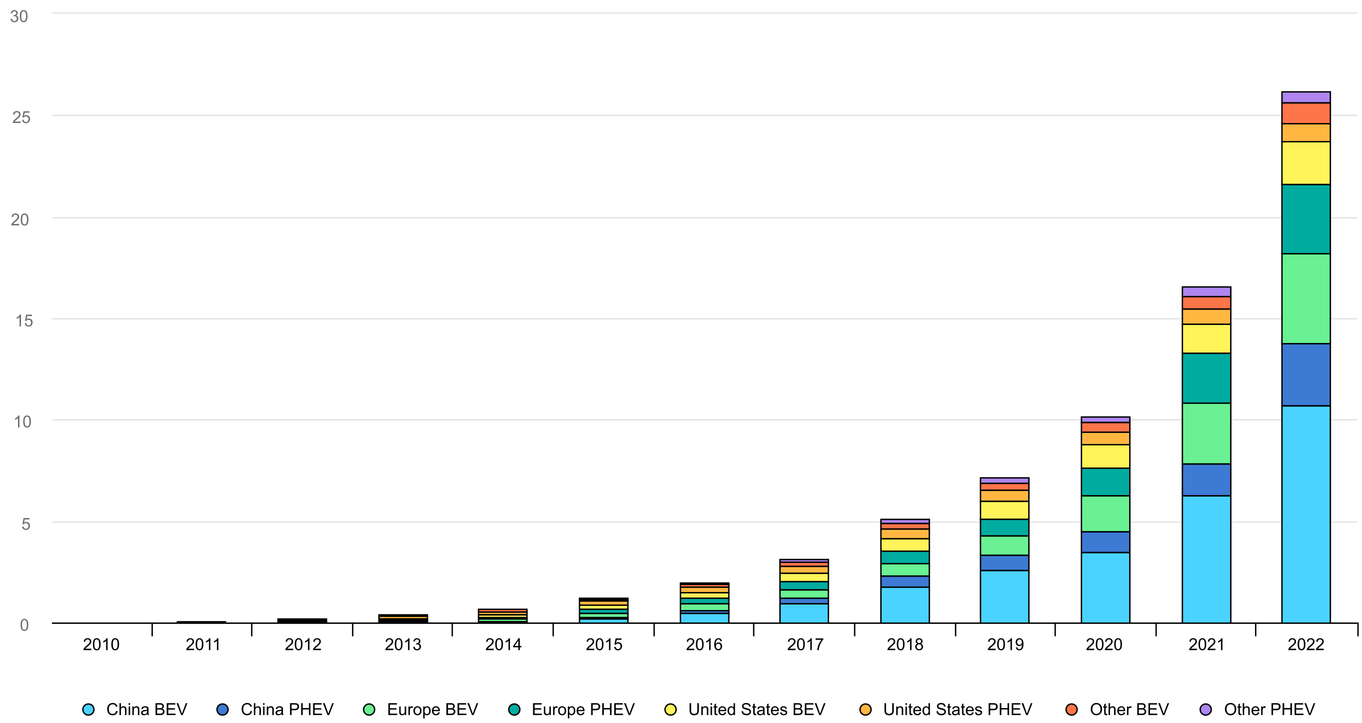

Figure 6: Global electric car stock in selected regions, 2010-2022 (Source: International Energy Agency)

Sustainable aviation fuels take off

Sustainable aviation fuels (SAF) are taking flight as an under-utilised tool to decarbonise air travel. SAF is a liquid fuel alternative used in commercial aviation, which can reduce CO2 emissions by up to 80%[20]. It is typically produced from feedstock sources but can also be produced synthetically.

While still in its early stages, the SAF market is experiencing remarkable growth. According to the International Air Transport Association (IATA), SAF output has increased 5x in just three years, with airlines consuming all available supply in 2022[21]. SAF is extremely versatile, integrating into any conventional aircraft without requiring technical alterations. Having already fuelled over 250,000 flights globally[22], it is today blended with existing fuels, but could replace conventional fuels entirely.

Sustainable aviation fuel output increases, but volumes still low

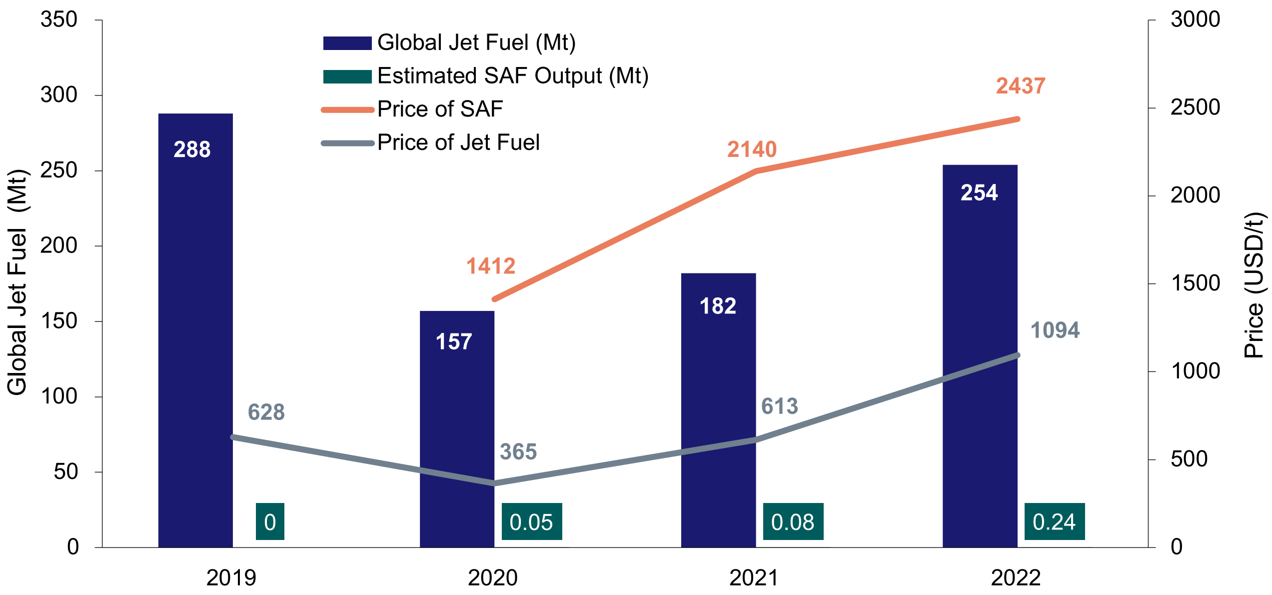

Figure 7: Sustainable aviation fuel volumes, 2019-2022[23] (Source: S&P Global Commodity Insights, IATA Sustainability & Economics)

By 2030, the EU is expected to demand 46 million tonnes of aviation fuel, with a target of 5% SAF blend, necessitating approximately 2.3 million tonnes of SAF[23]. However, the current SAF production capacity within the EU represents only 10% of projected demand at 0.24 million tonnes. The industry is poised for growth, with existing producers planning significant capacity expansions and new market entrants anticipated to bolster production. Optimising existing biofuel facilities could potentially bridge the capacity shortfall.

Reversing climate change with capture and removal

While aggressively cutting emissions remains a goal, the persistent rise in atmospheric CO2 call for a bolder approach and the need for effective carbon capture and removal solutions. These technologies aim to capture CO2 emissions from various sources, including power plants, industrial facilities, and directly from the atmosphere, to either store them underground or for use in enhanced oil recovery or the production of synthetic fuels. These technologies encompass two primary approaches: Direct Air Capture (DAC) and Carbon Capture, Utilisation, and Storage (CCUS).

Direct Air Capture: DAC focuses on removing carbon dioxide directly from the air with the use of specialised equipment and chemical processes. Like many new technologies, DAC is prohibitively expensive today, costing about $1,100 - $2,200/tCO2[24], with a large portion of the cost going into capture materials and energy usage. However, there is a growing market for DAC offsets, with buyers—particularly those with low carbon footprints and in high margin sectors like tech and finance[25]—willing to pay premium prices. Recent years have seen increased investment in DAC companies and projects, reflecting growing recognition of its potential[26] (fig. 8).

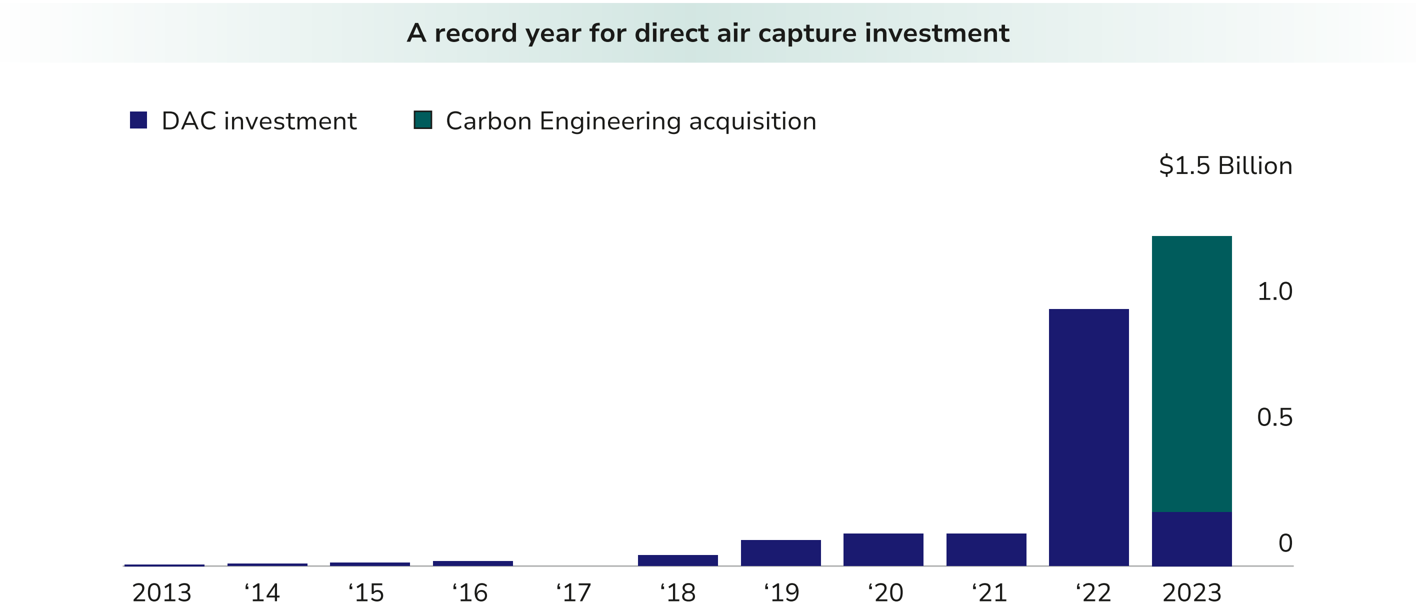

Figure 8: DAC Investment, 2013-2023 (Source: BloombergNEF)

Carbon Capture, Utilisation, and Storage: CCUS encompasses the capture of CO2 emissions from industrial sources, followed by sequestration in an underground storage site or utilisation in industrial processes. Ahead of DAC in technological maturity, CCUS has seen significant growth, with around 40 operational commercial facilities and over 500 projects in development across the CCUS value chain[26].

But challenges persist, including concerns over the use of CCUS for Enhanced Oil Recovery[27], which some argue perpetuates reliance on fossil fuels. Moreover, public apprehension regarding potential leakage from storage sites underscore the importance of transparency throughout the CCUS process to ensure adoption of the technology's effectiveness and safety.

Nevertheless, CCUS technology is promising, with growing momentum and increasing recognition of its potential role in mitigating GHG emissions. As governments and businesses intensify their efforts to address climate change, CCUS is particularly crucial for decarbonising hard-to-abate sectors such as heavy industry and power generation. With advancements in technology, policy support, and investment, the deployment of CCUS is expected to expand significantly in the coming years (See Figure 9).

Evolution of the CO2 capture project pipeline, 2010-Q2 2023

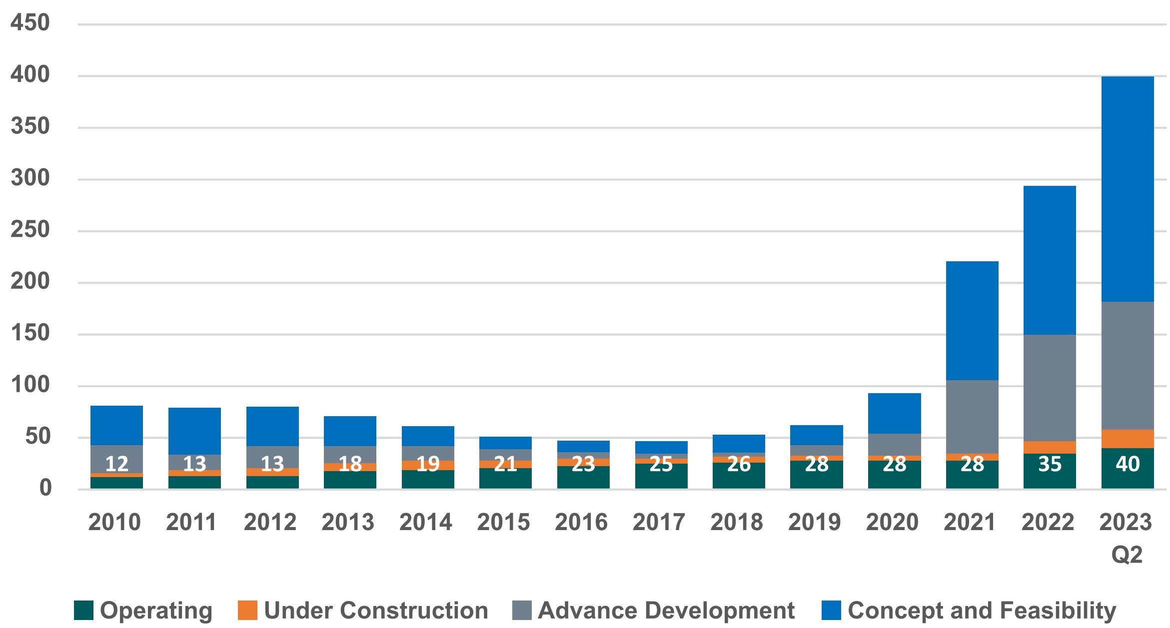

Figure 9: Evolution of CO2 capture project pipeline, 2010-Q2 2023[28] (Source: International Energy Agency)

A summary: Climate technology, today

Currently, climate techs are progressing through various stages of the Hype Cycle. While advancements like nuclear SMR, nuclear fusion, DAC, CCUS, and Climate FinTech are predominantly in the Innovation Trigger and Peak Expectations phases, some of the earlier Clean Tech 1.0 solutions (e.g. Solar PVs) are already transitioning towards the Slope of Enlightenment and Plateau of Productivity.

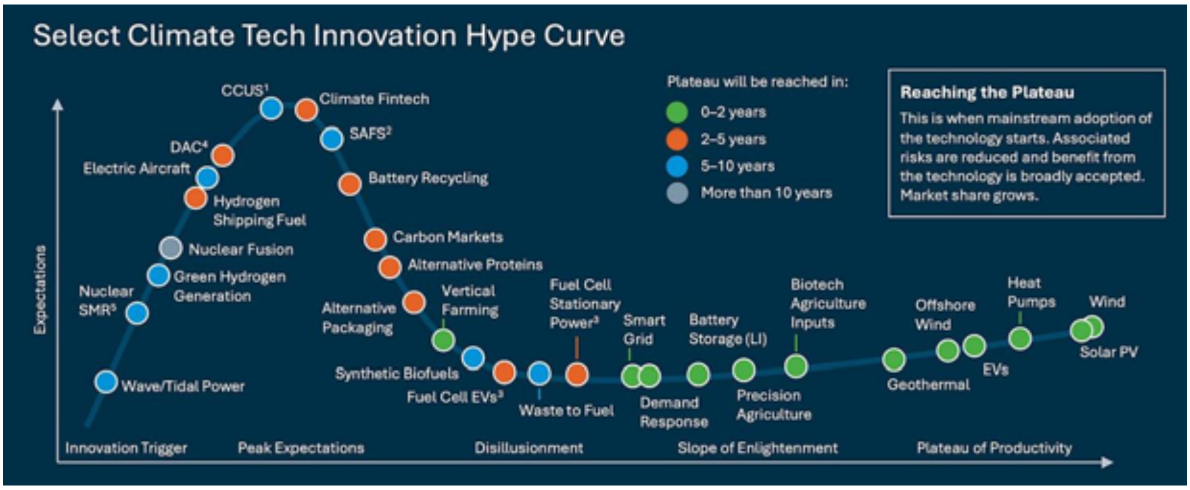

Figure 10: Climate tech innovation Hype Cycle[29] (Source: Silicon Valley Bank)

Once a technology passes the Trough of Disillusionment, it often marks the onset of exponential change, characterised by a gradual, then sudden shift. By this stage, the technology has become reliable and can be standardised, allowing for the establishment of a learning curve. Capital allocators, having become familiar with the technology, perceive reduced risk, and increase funding through many different forms of financing. Enabling policies also plays a crucial role in influencing the level of growth and adoption[30].

An exemplary convergence of technology, finance, and policies is observed in the mobility sector, particularly in the case of EVs. With the technology's reliability established, institutional investors are providing capital to EV manufacturers. Additionally, policies such as purchase subsidies and tax credits directly stimulate consumer demand for EVs[31], leading to increased production volumes. This surge in demand enables battery manufacturers to achieve economies of scale, thereby reducing costs per unit (fig. 11).

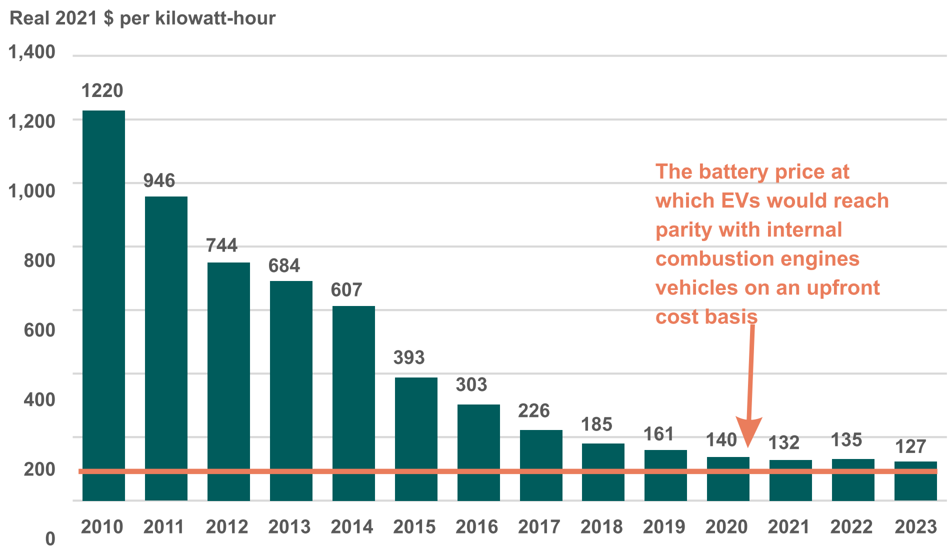

Figure 11: Cost of batteries $ per kWh, 2010-2023 (Source: BloombergNEF)

Chapter II: Finance the driving force for development, deployment and decarbonisation

A proven lever for decarbonisation

Finance plays a pivotal role in driving climate tech forward. Traditionally, it has provided funding for research, development, deployment, and scaling of climate tech solutions. By extension, FinTech is emerging as a key facilitator and climate solution.

The scale of investment needed is substantial, with capital spending on physical assets for the net zero transition projected to reach approximately $275 trillion between 2021 and 2050, averaging $9.2 trillion per year. This is a significant increase from previous levels, potentially rising by as much as $3.5 trillion annually[32]. To meet this challenge, a diversified financing landscape is crucial. Four types of financing play key roles: sustainable finance, transition finance, blended finance, and patient capital.

The intersection of climate and finance: Carbon markets

A specialised type of financial market designed to reduce GHG emissions by putting a price on carbon emissions. It operates through the buying and selling of carbon credits, which represents the right to emit a certain amount CO2e. Participants, such as companies or countries, are allocated or purchase these credits, and they can trade them among each other. The overall goal is to create a financial incentive for businesses to reduce their emissions, either by investing in cleaner technologies or by implementing more sustainable practices and technologies.

Carbon is now tracked and traded like any other commodity[33].

Sustainable Finance

Sustainable finance integrates environmental, social, and governance (ESG) factors into financial decisions to create long-term value while addressing global sustainability challenges. It prioritises investments that generate positive environmental impacts alongside financial returns and encourages responsible investment and transparency. This includes funding businesses to tackle climate change, promote social equity, or conserve the environment.

FinTech application:

FinTech platforms can aggregate and analyse data from various sources, such as utility bills, supply chain records and ERP data to provide a more comprehensive picture of a company's environmental footprint. This data can then be used to set clear sustainability targets and track progress over time, making it easier for lenders to evaluate the eligibility of borrowers for green or sustainability-linked loans.

Transition Finance

Transition finance focuses on bridging the gap between high carbon industries implementing low carbon solutions. It provides financial tools and investments to help these industries adopt new and cleaner technologies[34]. This can involve funding for renewable energy projects, carbon capture efforts, or green business model development. It recognises that simply shutting down these industries overnight is impractical.

Coal to Clean Credit Initiative (CCCI):

Designed to accelerate the retirement of coal-fired power plants, CCCI created a unique type of carbon credit known as the Coal to Clean Credit. These credits monetise the emissions reductions achieved by retiring a coal plant early, providing financial incenti-ves for power plant owners.

FinTech application[35]:

A platform facilitating the issuance and trading of CCCI credits generated by the retirement projects can ensure secure transparent transactions and adherence to relevant standards. The platform leverages its data analytics capabilities to assess the environmental impact of these projects and verify the emissions reductions achieved, which is crucial for the integrity of the credits.

Blended Finance

Blended finance refers to the strategic use of public and private capital to finance sustainable development projects or initiatives by combining concessional (or subsidised) capital from public sources with commercial capital. It aims to leverage the strengths and resources of both public and private sectors to address market gaps, reduce risks, and mobilise additional funding for sustainable development projects that might otherwise be considered too risky or financially unviable by private investors alone.

By blending different types of capital and risk-sharing mechanisms, blended finance seeks to maximise the impact and scale of investments in areas such as infrastructure, renewable energy, healthcare, education, and small and medium-sized enterprises (SMEs) in developing countries or underserved communities.

FinTech application:

The biggest obstacle to financing sustainable development projects via blended finance is the lack of a platform connecting private investors with projects[36]. Notably, a platform called Convergence was built to address the intermediary gap in sustainable development financing. The platform offers:

- A global membership base that connects investors with project developers
- Flow and networking features facilitate deal discovery and knowledge sharing among experts
- Data and intelligence resources to empower informed investment decisions

While Convergence does not directly manage deals or due diligence, it provides the tools and connections to address those needs indirectly. The focus on data collection and methodologies can also contribute to a future impact data repository.

Patient Capital

Patient capital refers to investment capital that is willing to accept high risk for long periods in exchange for breakthrough innovation, unlike traditional investors who tend to seek short-term returns.

Patient capital providers, such as impact investors, philanthropic organisations, or sovereign wealth fund, understand that climate solutions often take time to mature. They are willing to invest despite longer payback periods, providing crucial funding to fuel early-stage research, development, and deployment of climate tech solutions.

FinTech application:

Temasek collaborated with BlackRock to establish Decarbonisation Partners, a venture capital firm specifically targeting investments that propel decarbonisation efforts. Launched in 2022, Decarbonisation Partners plays a crucial role in connecting innovative climate solutions with necessary funding. Decarbonisation Partners spearheaded the Series A funding round for Carbon Direct, providing the latter with the capital needed to significantly expand their science-backed carbon management platform[37].

FinTech Challenges in the Climate Space

Integrating environmental considerations into financial decision-making is crucial for combating climate change. The FinTech industry is rapidly evolving to address this need through novel tools and strategies. While FinTech holds immense promise, significant challenges impede its full potential in the climate space.

These include:

Data deficiencies: Climate FinTech relies heavily on robust data to assess environmental risks, measure the impact of sustainable investments, and track progress towards goals. Unfortunately, high-quality climate data is often scarce or inconsistent, making it difficult to get a clear picture.

Evolving regulatory landscape: Since climate FinTech is a relatively new field, the regulatory landscape is still evolving. Unclear or constantly changing regulations can stifle innovation and make it difficult for companies to develop and launch new financial products or services focused on sustainability.

Integration challenges: Currently, there is no single source of truth for ESG data. This lack of uniformity makes it challenging to compare different investment options and identify credible sustainable practices. FinTech solutions often need to integrate data from various sources, which can be complex and time consuming. In addition, fragmented data creates opportunities for greenwashing, where companies exaggerate their sustainability efforts.

Scaling solutions: Many innovative climate FinTech solutions are still in their early stages. These ventures need to overcome challenges associated with scaling their operations to reach a wider audience and achieve a significant impact.

Chapter III: Data and digital infrastructure for enablement

The role of sustainability reporting

Sustainability reporting is the practice of disclosing a company's ESG performance. It consists of carbon accounting and materiality, its workforce, and the communities it operates within. Reporting provides a clear picture of a company's progress towards sustainability. This transparency allows stakeholders, like investors, customers, and regulators, to assess a company's commitment to ESG practices and reduce the risk of controversies.

Global sustainability reporting rates (1993–2022)

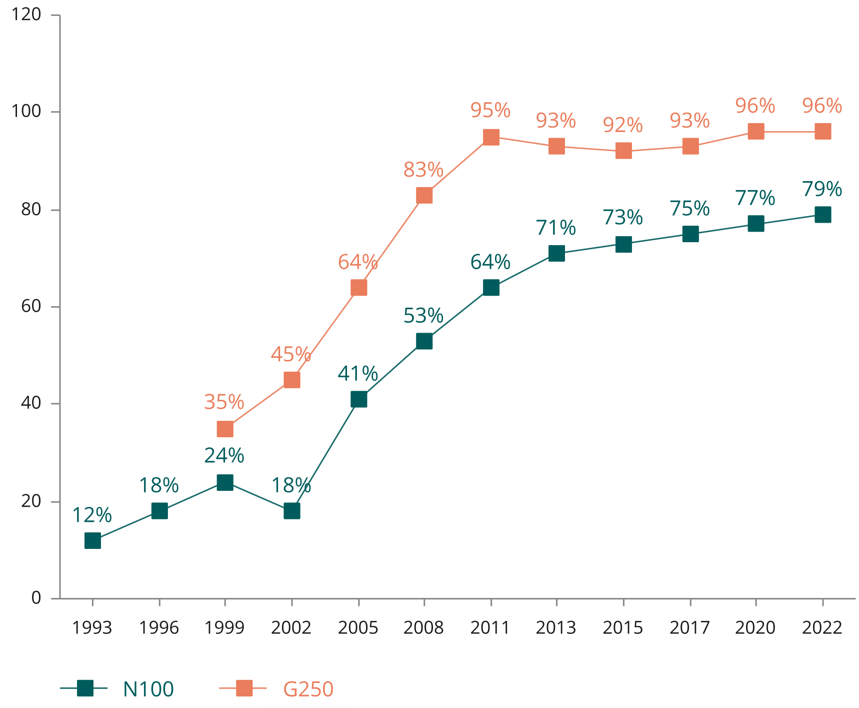

Figure 12: Global sustainability reporting rates, 1993-2022 (Source: KPMG)

Carbon Accounting Methodologies

Carbon accounting, also known as GHG accounting, is a crucial framework for measuring and tracking greenhouse gas emissions generated by organisations, activities, or products. It focuses primarily on quantifying GHG, expressed in CO2 equivalents (CO2e), to allow for a standardised comparison.

Why is carbon accounting important?

- **Understanding impact:** By quantifying emissions, organisations can identify areas for improvement and track progress.
- **Decision-making:** Accurate data informs better decision-making on reducing emissions, investing in technologies, and aligning with climate strategies.
- **Transparency and accountability:** Enables companies to report their emissions transparently, fostering accountability to stakeholders and investors focused on ESG factors.
- **Policy development:** Governments use carbon accounting data to design effective policies and regulations aimed at mitigating climate change.

The three scopes of carbon accounting

The GHG Protocol, a widely used international standard, defines three scopes to categorise emissions:

Scope 1	Direct emissions from a company's owned or controlled sources, such as fuel combustion in facilities, vehicle emissions from company-owned fleets, and industrial processes.
Scope 2	Indirect emissions from purchased electricity, heat, or cooling.
Scope 3	Other indirect emissions that occur throughout the entire supply chain. Generally, the most challenging to quantify and a significant contributor to overall footprint.

How is carbon accounting done?

There are several methodologies for calculating emissions, depending on the specific needs. They typically involve:

- **Data collection:** Gathering data on activities that generate emissions, such as energy consumption, fuel use, travel data, and material purchases etc.
- **Emission factors:** Using established conversion factors (emission factors) to translate this activity data into CO2e emissions. These factors are available from various approved sources.
- **Calculations:** Applying formulas to estimate the total emissions based on the collected data and emission factors

Beyond Carbon-Focussed Reporting

Recently, reporting has expanded beyond a company's carbon emissions alone. Stakeholders now seek greater transparency, especially regarding a company's social performance, which examines its effects on its employees and the communities in which it operates. This covers a wide array of issues, including:

- **Labour practices and employee well-being:** Initiatives to support employee well-being, such as work-life balance programmes, mental health initiatives, and training and development opportunities.

- **Diversity and inclusion:** Commitment to fostering a diverse workforce that reflects the communities it serves and promoting equal opportunities for all employees.
- **Human rights considerations:** This evaluates a company's commitment to upholding human rights throughout its operations and supply chain.
- **Governance:** Governance performance is emerging as a focal point, evaluating a company's internal practices and decision-making procedures. It underscores the importance of transparency, accountability, and responsible leadership.

Regulatory Standards and Global Convergence

In response to the increasing demand for transparent and standardised sustainability reporting, the IFRS Foundation has taken a significant step by establishing the International Sustainability Standards Board (ISSB). Positioned alongside the established financial reporting standards of IFRS, the ISSB is poised to become a central framework for sustainability reporting.

This convergence effort involves the integration of major global sustainability disclosure frameworks into the ISSB framework. By consolidating diverse standards and guidelines, the ISSB aims to streamline ESG reporting processes, enhance and harmonise data quality, and provide investors with clearer insights into long-term value creation.

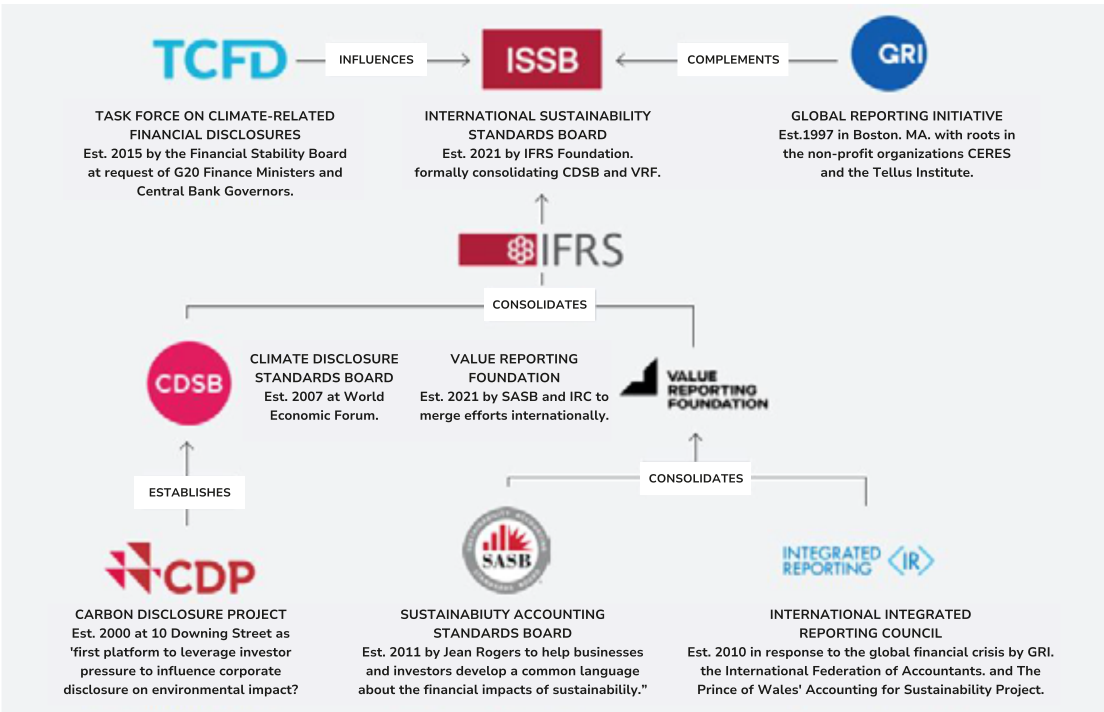

Figure 13: Consolidation of the ESG ecosystem[38] (Source: Harvard Law)

Moreover, the ISSB's inaugural sustainability standards, which took effect on January 1, 2024, marks a significant milestone in the journey towards comprehensive and standardised sustainability reporting. These standards represent a concerted effort to integrate sustainability considerations into mainstream financial reporting, facilitating informed ESG investment decisions and promoting greater accountability and transparency.

Challenges to Reporting

Effectively integrating ESG considerations into sustainability reporting poses significant challenges for companies. While issues such as capability, capacity, and resource allocation are important, the primary hurdle lies in obtaining accurate and reliable data.

Standardisation and harmonisation

Proliferation of sustainability reporting frameworks and standards has resulted in a fragmented landscape, making it challenging to choose the most appropriate framework for reporting needs[39].

Data quality and availability

Ensuring the accuracy, reliability, and completeness of ESG data poses a significant challenge[40]. Issues such as data gaps, inconsistencies, and inaccuracies can undermine the credibility of sustainability reporting efforts.

Data connectivity and interoperability

Data comes from various sources, including company reports, government databases, and sustainability ratings agencies. Each source might have different formats and structures, hindering seamless data exchange and integration.

Manual collection processes

Many companies do not yet have an ESG data collection infrastructure in place, making it challenging to integrate and reconcile data from multiple ESG solution providers[41]. Meanwhile, even companies with an ESG data collection infrastructure may not offer open connection that allows easy access to their ESG data.

Scope 3 and the Supply Chain

Scope 3 emissions often make up the largest proportion of a company's carbon emissions. Unlike Scopes 1 and 2, which focus on direct emissions from a company's own operations and purchased energy, Scope 3 delves into the indirect emissions that occur throughout the entire supply chain. This can encompass a vast network of suppliers, partners, and activities beyond the company's direct control.

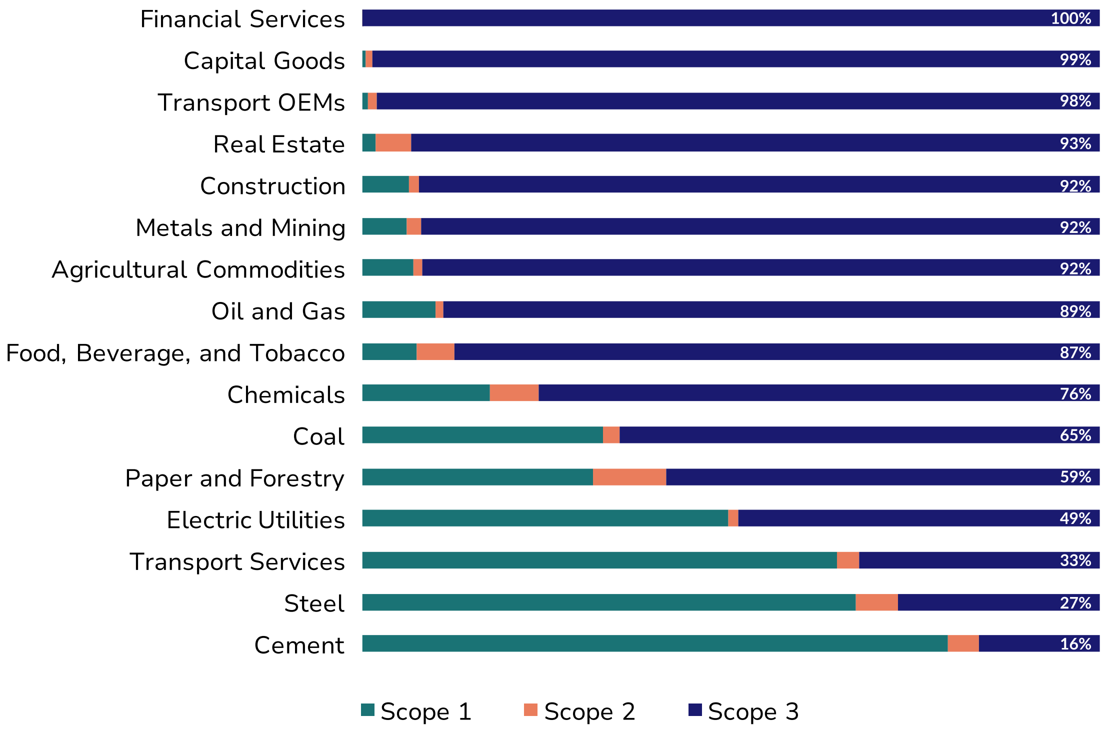

Figure 14: Proportion of Scope 3 emissions across industries[42] (Source: Milken Institute)

Why is Scope 3 important?

- **Transparency and accountability:** Investors and regulators are increasingly demanding transparency about a company's entire carbon footprint. Regulatory developments mandating Scope 3 reporting include CSRD, EUDR, and CSDDD.
- **Risk management:** Often, the greatest impact of a company is within its supply chain. Managing Scope 3 emissions is a strategic risk management practice, particularly since most unintentional greenwashing practices typically come from the supply chain[43].
- **Efficiency opportunities:** Mapping Scope 3 emissions can reveal hidden inefficiencies and opportunities for collaboration with suppliers to reduce their environmental impact, leading to cost savings and a more sustainable supply chain.

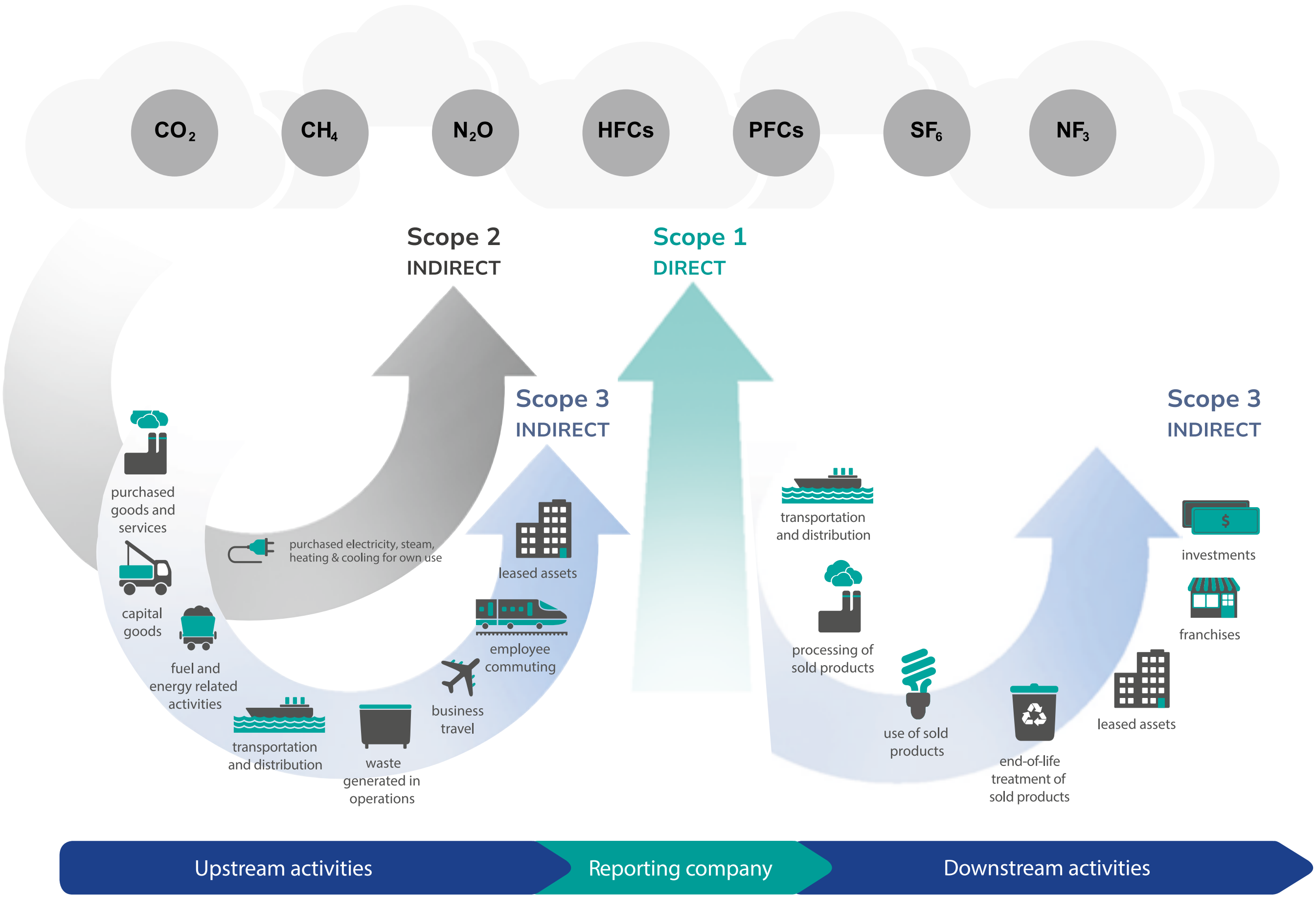

Figure 15: Overview of GHG protocol scopes & emissions across the value chain. (Source: Greenhouse Gas Protocol)

Challenges of reporting Scope 3 emissions:

- **Complexity:** Mapping and quantifying emissions across a complex supply chain with numerous actors can be challenging due to limited data availability and inconsistency in reporting practices[44].
- **Collaboration:** Majority of the companies in the supply chain are made up of SMEs that lack the capabilities and resources to provide the necessary data which necessitates engagement, capacity building, and potentially financial incentives[45].
- **Standardisation:** A lack of standardised methodologies can make comparisons between companies difficult. However, the GHG Protocol and ISSB are working to improve consistency.

Strategies for addressing Scope 3 emissions:

Despite the challenges, companies can take some of the following steps to address Scope 3 emissions:

- **Mapping the supply chain:** Identify key suppliers and understand their sustainability practices.
- **Data collection and collaboration:** Work with suppliers to gather data and encourage better reporting practices. As of today, data is estimated based on several methodologies that may create uncertainty[46].

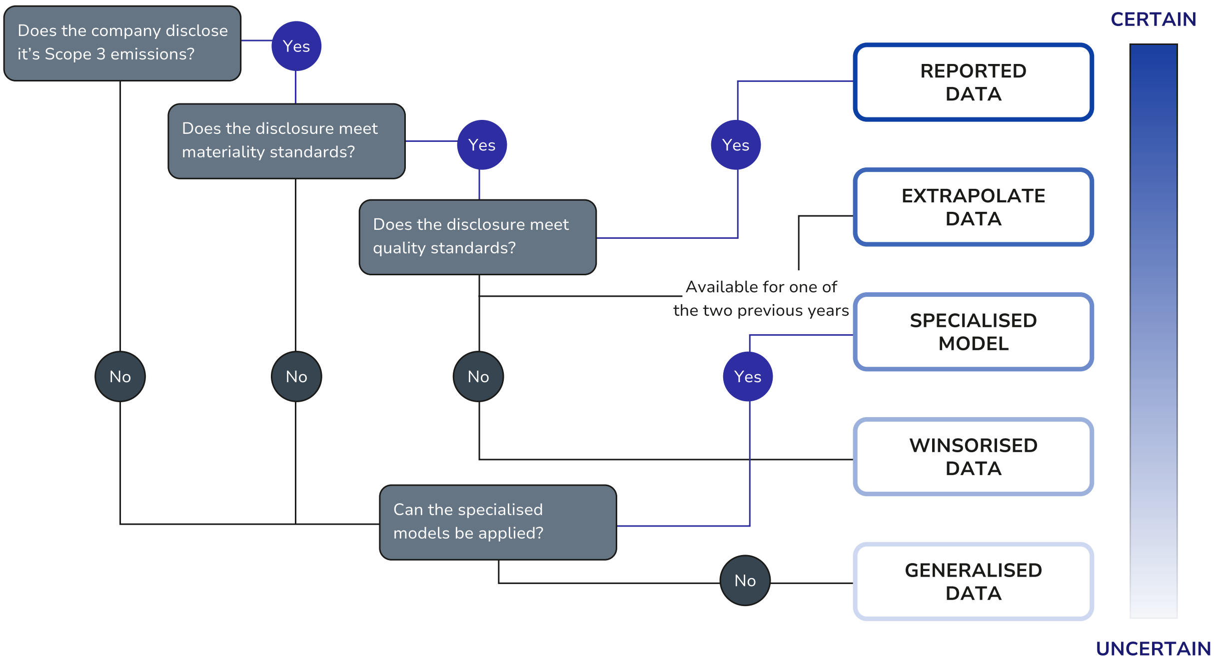

Figure 16: Data and estimates selection hierarchy (Source: FTSE Russell)

Chapter IV: FinTech opportunities in climate

By leveraging innovative solutions, financial institutions can address key challenges in accelerating the adoption and scaling of climate tech. These opportunities span across various sectors including banking, lending, payments, wealth management, insurance, and investment marketplaces. Climate FinTech has the potential to unlock new sources of capital, streamline processes, improve risk management, and empower individuals and businesses to make more informed and sustainable financial decisions.

FINTECH OPPORTUNITIES

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FinTech opportunities can be categorised into four key areas of the value creation cycle (fig. 17). At the outset, FinTech serves as a data conduit, facilitating the flow of ESG data. Subsequently, it enables services aimed at productivity enhancement, followed by product innovation. Finally, it culminates in cross-pollination, where new ways of thinking and ideas go beyond point challenges. At each stage, the value generated by climate FinTech increases, and the cycle repeats.

Data Conduit

- Ingestion: Integration of data beyond traditional financial data sources, including ESG disclosures, sensors, IoT devices, satellites, social media, and databases.
- Enrichment: Cleaning, standardisation, blending and aggregation of data multiple sources to contextualise data.

Productivity Enhancement

- Insights: Advanced analytics using AI to analyse vast datasets, uncovering both opportunities and challenges.
- Verification: Immutable green credentials for transparent and traceable business activities or products, verified through robust authentication processes.
- Decision Making: Analyse vast datasets to automate assessments for risk management, investments, or sustainable business activities.

Product Innovation

- Financial Markets: Products that incentivises and facilitates the development and adoption and sustainable solutions.
- Real World Applications: Integrate technologies in innovative ways, tailored for finance, corporate, and climate FinTech applications.

Cross Pollination

- Systemic Solutions: Beyond point solutions, aiming to transform entire systems e.g. sustainability infrastructure or tech stack.
- Interconnected Ecosystem: Unifying a fragmented landscape of problems and solutions through marketplaces.
- Policy & Regulation: Enhance global connectivity for the seamless exchange of data, knowledge, and innovative ideas, fostering harmonisation across transformative mechanisms.

Figure 17: FinTech value creation cycle (Source: Gprnt.ai)

Exploring the use of adjacent technologies

Blockchain. The core strengths of blockchain—transparency and immutability—translate to secure, verifiable records for ESG data. This empowers companies to meticulously track their environmental footprint, source materials ethically, and provide trusted and verifiable credentials. Stakeholders like investors and consumers gain access to this verifiable information, fostering trust and enabling informed decisions.

FinTech application:

Trusted credentials serve as digital passports, verifying the identity and qualifications of participants like independent auditors. Sustainable palm oil solution provider Musim Mas and MUFG Bank collaborated on a proof-of-concept to trial Web3 application in establishing a verified deforestation-free value chain with independent smallholders in Kalimantan, Indonesia. This initiative holds promise as a platform for managing data and verifying the sustainability credentials of smallholders, potentially meeting regulatory requirements like the EU Deforestation-free Regulation (EUDR) for traceability and verified deforestation-free palm oil.

Artificial Intelligence. AI has the widest opportunity for application, with use cases ranging from optimising current processes to generating new and unique insights. This empowers businesses to make data-driven decisions that contribute to real sustainability gains.

FinTech use case:

NovA! is a platform designed for financial institutions to assess borrowers and issue Sustainability Linked Loans (SLLs) in the real estate sector[47]. It aims to address challenges in the SLL market, including a lack of comprehensive environmental data, inconsistencies in ESG scoring, and a lack of industry guidelines for sustainability targets. It uses a proprietary AI engine called the Autonomous Documentation Insights Engine to analyse a borrower's disclosure documents and monitors that against selected Sustainability Performance Targets to provide a comprehensive insight on borrowers.

Chapter V: Future state of climate tech

The urgency of addressing climate change necessitates a concerted effort from a multifaceted group of stakeholders, including climate tech innovators, FinTechs, potential adopters of these technologies, and financiers. These groups can accelerate the development, adoption, and affordability of climate technologies.

To drive the development of Climate Tech, we have identified the following focus areas:

- **Trial and deployment mechanisms:** Creating mechanisms for adopters to easily trial and deploy proven climate tech solutions is crucial. This could involve pilot programs, subsidies, or tax breaks that incentivise adoption.
- **Embracing esoteric technologies:** There are many promising climate technologies that may seem complex or unfamiliar initially. FinTechs can help by providing financial instruments and risk assessment tools that encourage experimentation with these potentially game-changing solutions.
- **Scaling for affordability:** As production capacity increases, climate tech solutions should become more affordable. This will make them easier to deploy on a wider scale. FinTechs can help by developing innovative financing solutions that make these technologies accessible to a broader range of adopters.
- **Attracting public and private finance:** Large-scale investment is needed to fund the development and deployment of climate technologies. As acts such as the Inflation Reduction Act[48] and the EU's Green Deal[49] come into play, the deployment of these technologies will ramp up.
- **Supporting talent development:** A skilled workforce is essential for the success of climate tech. Initiatives to support talent development, such as training programs and educational pathways, can ensure there are qualified individuals to design, implement, and maintain these technologies.

2024: A year of unknowns

2024 has become a pivotal year for environmental action, largely shaped by the outcomes of numerous global elections. Victories for candidates prioritising strong climate policies could lead to a surge in regulations and incentives for sustainable practices[50]. This, in turn, could unlock a wave of green investments from businesses and individuals eager to capitalise on the new landscape.

Conversely, entrenched political resistance threatens to impede progress, risking the continued subsidies of fossil fuel and hindering the momentum[51]. Investor confidence in funding environmentally friendly projects may waver amidst ongoing backlash against ESG considerations[52], a trend particularly notable in certain quarters of the US political spectrum and the EU with regards for energy security.

In navigating these challenges, the imperative for sustained, large-scale government support cannot be overstated. Initiatives such as the Inflation Reduction Act (IRA) and the EU Green Deal serve as vital pillars in bolstering the foundation for sustainable development, providing the necessary frameworks and resources to drive meaningful progress towards a greener, more resilient future.

To access more reports, scan the QR code below:

REFERENCES

FUTUREMATTERS™ CENTRE OF EXCELLENCE

1 United Nations Environment Programme, Broken Record Temperatures hit new highs, yet world fails to cut emissions (again)

2 2023 is the hottest year on record, with global temperatures close to the 1.5°C limit, Copernicus, 9th January 2024 https://climate.copernicus.eu/copernicus-2023-hottest-year-record.

3 When mitigating climate risks, companies should look at their most valuable asset, World Economic Forum, 8 Jan 2024 https://www.weforum.org/agenda/2024/01/when-mitigating-climate-risks-companies-should-look-at-their-most-valuable-asset/

4 Hannah Ritchie, Pablo Rosado and Max Roser (2020) - "Emissions by sector: where do greenhouse gases come from?" Published online at OurWorldInData.org, https://ourworldindata.org/emissions-by-sector

5 https://www.cambridgeassociates.com/insight/climate-techs-evolution/

6 IRENA (2023), Renewable power generation costs in 2022, International Renewable Energy Agency, Abu Dhabi

7 Mitsubishi Heavy Industries Technical Review Vol. 59 No. 4 (December 2022)

8 https://www.bvp.com/atlas/eight-lessons-from-the-first-climate-tech-boom-and-bust

9 What would it take to scale critical climate technologies?, McKinsey & Company, December 2023

10 Plans For New Reactors Worldwide, World Nuclear Association https://world-nuclear.org/information-library/current-and-future-generation/plans-for-new-reactors-worldwide.aspx

11 Small reactors, big ambitions, is this the future of nuclear energy?, World Economic Forum, 21st Nov 2022 https://www.weforum.org/agenda/2022/11/small-reactors-big-ambitions-is-this-the-future-of-nuclear-energy/

12 3 Advanced Reactor Systems to Watch by 2030, US Department of Energy, 12 Apr 2021, https://www.energy.gov/ne/articles/3-advanced-reactor-systems-watch-2030

13 Japan Plans to Dump Fukushima Wastewater Into a Pacific With a Toxic Nuclear History, TIME, 6 Feb 2023 https://time.com/6250415/fukushima-nuclear-waste-pacific-islands/

14 Japan eyes hydrogen production using next-gen nuclear reactor, Nikkei, 4 Apr 2024, https://asia.nikkei.com/Business/Energy/Japan-eyes-hydrogen-production-using-next-gen-nuclear-reactor

15 Gates Notes, 5 May 2023, https://www.gatesnotes.com/Wyoming-TerraPower

16 What is Nuclear Fusion?, International Atomic Energy Agency, 3rd Aug 2023, https://www.iaea.org/newscenter/news/what-is-nuclear-fusion

17 What is ITER, ITER, https://www.iter.org/proj/inafewlines

18 Will fusion energy help decarbonize the power system?, Mckinsey & Company, 12 Oct 2021, https://www.mckinsey.com/industries/electric-power-and-natural-gas/our-insights/will-fusion-energy-help-decarbonize-the-power-system

19 Nuclear fusion startups, Dealroom, 7 Jun 2023, https://app.dealroom.co/lists/25184

20 Developing Sustainable Aviation Fuel (SAF), International Air Transport Association, https://www.iata.org/en/programs/environment/sustainable-aviation-fuels/

21 "Sustainable aviation fuel output increases, but volumes still low", Chart of the Week, International Air Transport Association, Sep 2023

22 How sustainable aviation fuels can tackle aviation's carbon footprint, World Economic Forum, 5 Jan 2023, https://www.weforum.org/agenda/2023/01/sustainable-aviation-fuels-carbon-footprint-davos23

23 Sustainable Aviation Fuels (SAF) in Europe: Navigating Towards a Greener Future, European Comission, https://alternative-fuels-observatory.ec.europa.eu/transport-mode/aviation/general-information-and-context

24 Occidental's Big Buy May Change Course of $150 Billion Market, Bloomberg NEF, 28 Aug 2023, https://about.bnef.com/blog/occidentals-big-buy-may-change-course-of-150-billion-market/

25 Low-carbon tech: can direct air capture rise to the challenge?, Wood Mackenzie, 18 Jan 2024, https://www.woodmac.com/news/the-edge/can-direct-air-capture-rise-to-challenge/

26 Tracking Clean Energy Progress 2023, IEA, Jul 2023, https://www.iea.org/reports/tracking-clean-energy-progress-2023

27 Carbon Dioxide Market Research, S&P Global, Jan 2021

28 Carbon Capture, Utilisation and Storage, IEA, 2023, https://www.iea.org/energy-system/carbon-capture-utilisation-and-storage

29 The Future of Climate Tech: A look at technologies driving a sustainable future, Silicon Valley Bank, June 2023.

30 Technological learning and policy together can advance clean energy, Yale Climate Connections, 4 Nov 2022, https://yaleclimateconnections.org/2022/11/technological-learning-and-policy-together-can-advance-clean-energy/

31 The Effect of Early Electric Vehicle Subsidies on the Automobile Market, Xi Wu, Jing Gong, Brad N. Greenwood, Yiping Song, 13 Oct 2022

32 The net-zero transition: What it would cost, what it could bring, Mckinsey & Company, Jan 2022

33 Emissions Trading, United Nations Climate Change, accessed 10 Apr 2024, https://unfccc.int/process/the-kyoto-protocol/mechanisms/emissions-trading

34 Why transition finance is essential, HSBC, 29 Jun 2020, https://www.hsbc.com/news-and-views/views/hsbc-views/why-transition-finance-is-essential

35 "Getting Transition Finance Right", Ravi Menon, Monetary Authority of Singapore, COP28, 3 December 2023

36 Blended finance: How setting up a financial intermediary can accelerate sustainable development, World Economic Forum, 3 Apr 2023, https://www.weforum.org/agenda/2023/04/blended-finance-financial-intermediation-can-accelerate-sustainable-development/

37 Carbon Direct raises $60 million to expand science-backed end-to-end carbon management, Carbon Direct, 24 Aug 2022, https://www.carbon-direct.com/insights/carbon-direct-raises-60-million-to-expand-science-backed-end-to-end-carbon-management

38 The Rise of International ESG Disclosure Standards, Harvard Law, 29 Jun 2023, https://corpgov.law.harvard.edu/2023/06/29/the-rise-of-international-esg-disclosure-standards/

39 ESG Investing: Practices, Progress and Challenges, OECD, Sep 2020

40 Future Readiness of Small and Mid-Sized Companies: A Year On, World Economic Forum, Nov 2022

41 ESG Data – Why is it so difficult?, Owl ESG, 9 May 2023, https://owlesg.com/2023/05/09/esg-data-why-is-this-so-difficult/

42 How Technology Can Accelerate Sustainable Finance, Milken Institute, Nov 2022

43 Procurement leaders feel 'best guess' Scope 3 reporting puts them at risk of unintentional greenwashing, CSO Futures, 15 Jan 2024, https://www.csofutures.com/news/procurement-leaders-feel-best-guess-scope-3-reporting-puts-them-at-risk-of-unintentional-greenwashing/

44 Overcoming Challenges in Understanding and Quantifying Scope 3 Emissions for Large Enterprises, Terrascope, 13 Feb 2023, https://www.terrascope.com/blog/overcoming-challenges-in-understanding-and-quantifying-scope-3-emissions-for-large-enterprises

45 ESG for SMEs: future proofing supply chains, ICAEW, 8 Sep 2023, https://www.icaew.com/insights/viewpoints-on-the-news/2023/sep-2023/esg-for-smes-future-proofing-supply-chains

46 FTSE Russell, Scope for improvement: Solving the Scope 3 conundrum, Jan 2024

47 NovA! A whitepaper on accelerating sustainability with AI, Monetary Authority of Singapore, Nov 2023

48 The United States' Inflation Reduction Act, introduced in 2022, is designed to boost clean energy, among other tenets. (Inflation Reduction Act Guidebook, The White House, https://www.whitehouse.gov/cleanenergy/inflation-reduction-act-guidebook/)

49 The European Green Deal commits to transforming the EU into a "modern, resource-efficient and competitive economy, ensuring no net emissions of GHG by 2050, economic growth decoupled from resource use, and no person and no place left behind". (The European Green Deal, European Commission, https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en)

50 ESG and the Energy Transition Are on the Ballot, Jefferies, 5 Feb 2024, https://insights.jefferies.com/sustainability-and-culture/esg-and-the-energy-transition-are-on-the-ballot

51 Fossil Fuel Subsidies Surged to Record $7 Trillion, IMF, 24 Aug 2023, https://www.imf.org/en/Blogs/Articles/2023/08/24/fossil-fuel-subsidies-surged-to-record-7-trillion

52 Could far-right voters spark a backlash on the EU's Green Deal?, EuroNews, 22 Mar 2024, https://www.euronews.com/business/2024/03/22/could-far-right-voters-spark-a-backlash-on-the-eus-green-deal