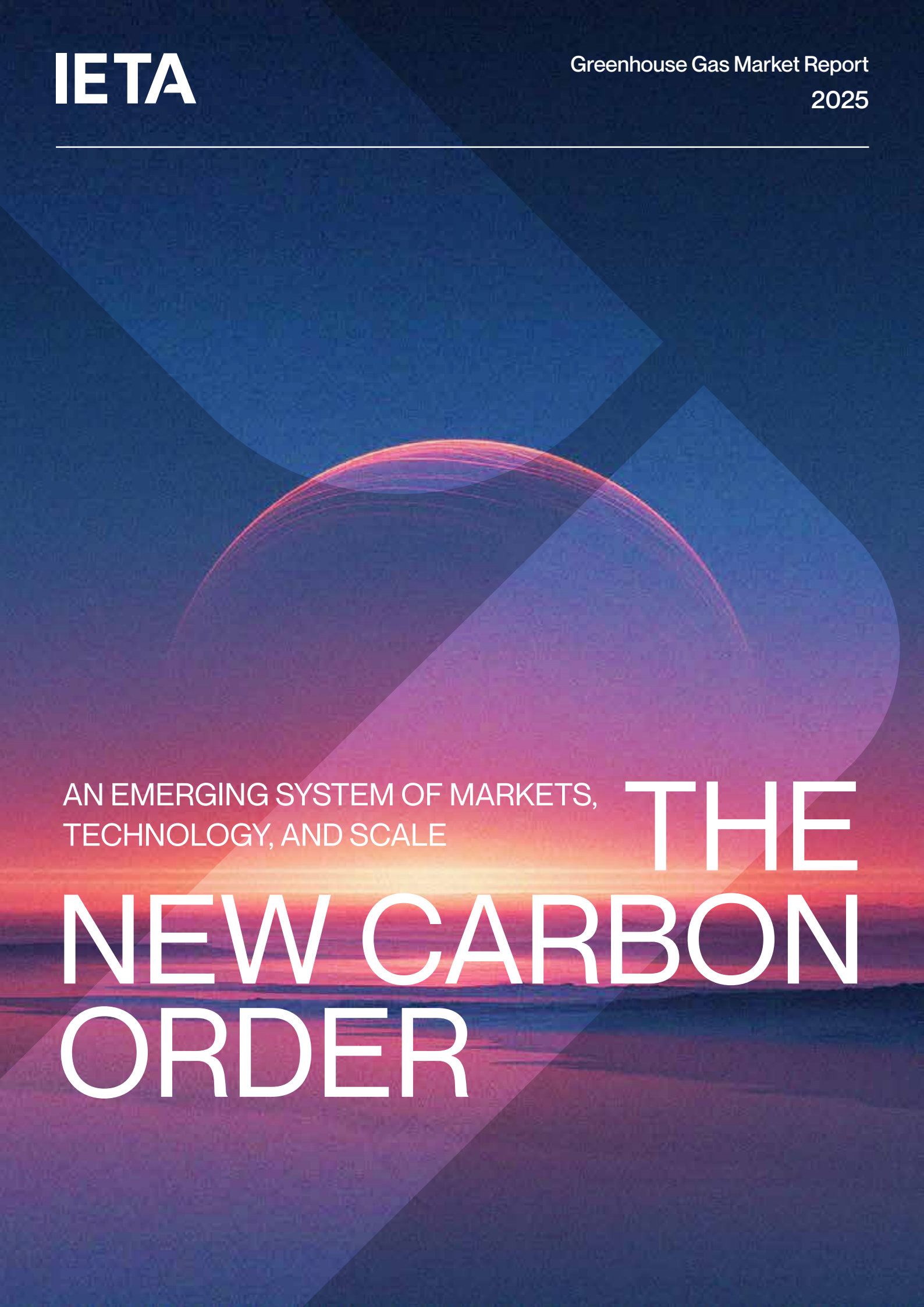
IETA

Greenhouse Gas Market Report
2025



AN EMERGING SYSTEM OF MARKETS, TECHNOLOGY, AND SCALE

THE NEW CARBON ORDER

SINCE 1999 IETA HAS BEEN THE LEADING VOICE OF BUSINESS ON AMBITIOUS MARKET-BASED CLIMATE CHANGE SOLUTIONS AND DRIVING NET ZERO. IETA ADVOCATES FOR TRADING SYSTEMS FOR EMISSIONS REDUCTIONS AND REMOVALS THAT ARE ENVIRONMENTALLY ROBUST, FAIR, OPEN, EFFICIENT, ACCOUNTABLE AND CONSISTENT ACROSS NATIONAL BOUNDARIES. REPRESENTING MORE THAN 300 LEADING INTERNATIONAL ORGANISATIONS, IETA IS A TRUSTED PARTNER IN DEVELOPING INTERNATIONAL POLICIES AND MARKET FRAMEWORKS TO REDUCE GREENHOUSE GAS EMISSIONS AT THE LOWEST COST WHILE BUILDING A CREDIBLE PATH TO NET ZERO EMISSIONS. SEE WWW.IETA.ORG FOR MORE INFORMATION. **THE VIEWS EXPRESSED BY GUEST AUTHORS ARE SOLELY THEIR OWN AND DO NOT CONSTITUTE AN ENDORSEMENT OF THE CONTENT OF THE FULL REPORT.**

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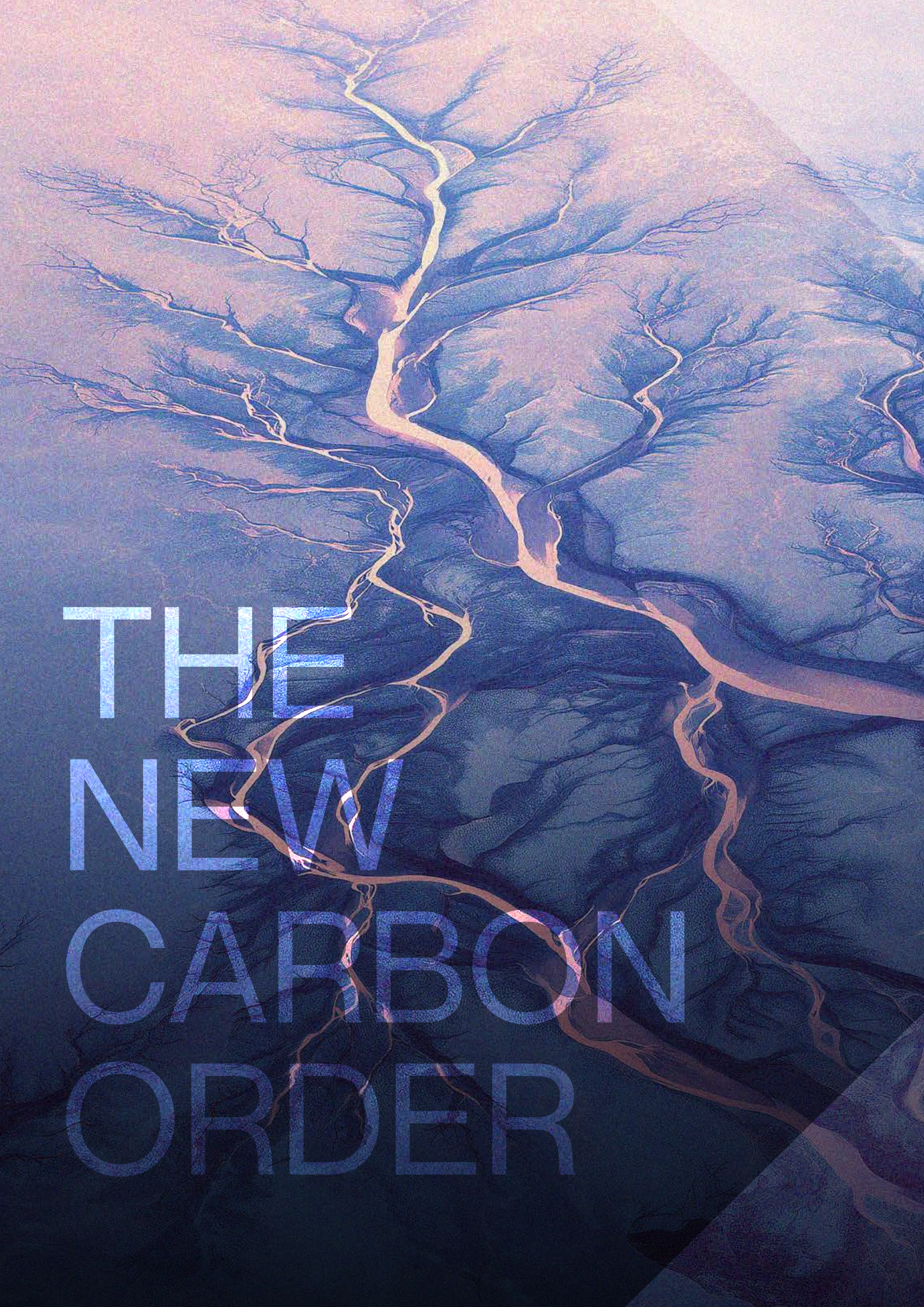
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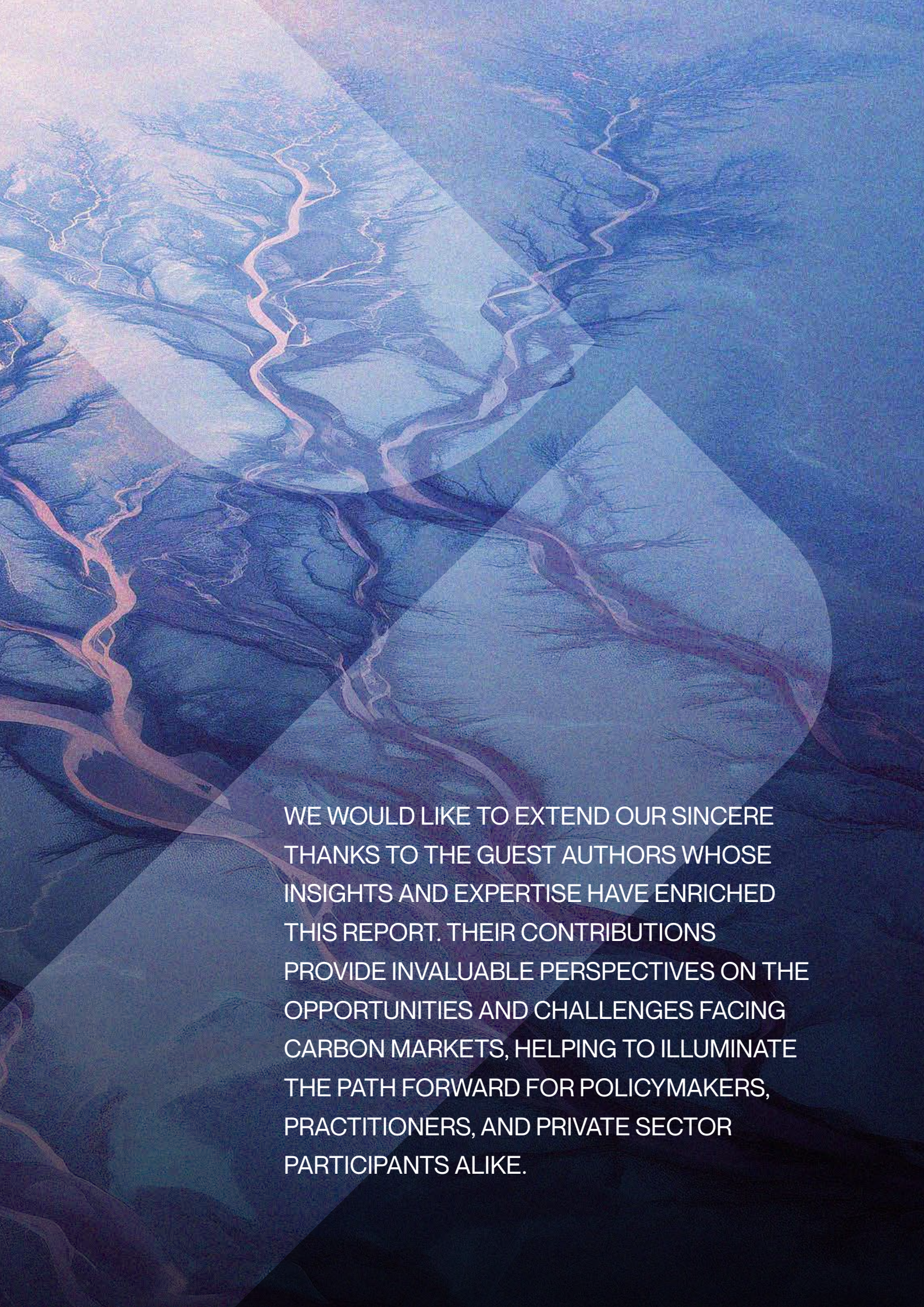
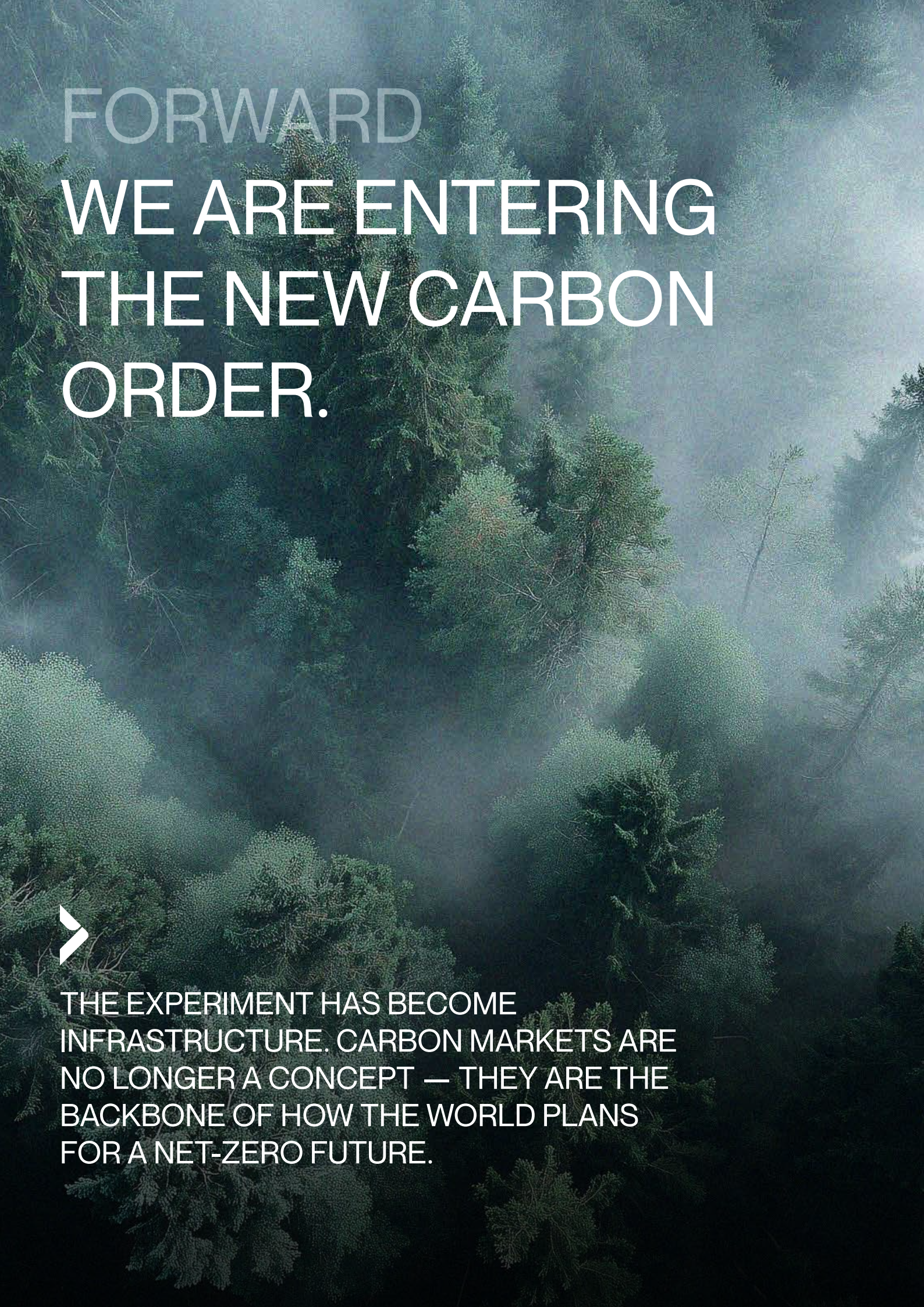


WE WOULD LIKE TO EXTEND OUR SINCERE THANKS TO THE GUEST AUTHORS WHOSE INSIGHTS AND EXPERTISE HAVE ENRICHED THIS REPORT. THEIR CONTRIBUTIONS PROVIDE INVALUABLE PERSPECTIVES ON THE OPPORTUNITIES AND CHALLENGES FACING CARBON MARKETS, HELPING TO ILLUMINATE THE PATH FORWARD FOR POLICYMAKERS, PRACTITIONERS, AND PRIVATE SECTOR PARTICIPANTS ALIKE.



FORWARD

WE ARE ENTERING THE NEW CARBON ORDER.

THE EXPERIMENT HAS BECOME INFRASTRUCTURE. CARBON MARKETS ARE NO LONGER A CONCEPT — THEY ARE THE BACKBONE OF HOW THE WORLD PLANS FOR A NET-ZERO FUTURE.

DIRK FORRISTER, IETA CEO & PRESIDENT

Two decades ago, carbon markets were an untested idea — a bold experiment in turning climate ambition into measurable, verifiable action. The concept was simple but radical: use the power of markets to put a price on carbon, to channel finance into innovation, and to build a bridge between environmental goals and economic growth. Back then, this approach was met with equal parts optimism and scepticism. Could markets really deliver climate outcomes? Could price signals shift behaviour faster than policy alone?

Today, the answer is clear. Carbon markets have become one of the world's most important tools for climate action. They have evolved from isolated policy pilots into a core element of the global economy — guiding investment, shaping regulation, and defining how nations and industries plan for a net-zero future. The experiment has become infrastructure.

Yet as this report explores, we are again at a point of transformation. The foundations are laid — now we must connect and scale them. Around the world, we see a patchwork of systems: compliance markets underpinned by national and regional policies; voluntary markets that continue to innovate and adapt; and emerging mechanisms under Article 6 that promise to link these systems into a shared global framework. The challenge and the opportunity of this moment lie in joining these threads into something coherent — an integrated architecture for the decades ahead.

The New Carbon Order is emerging. It's not a single market or a single design — it's a system of systems, a dynamic ecosystem that brings together governments, companies, and technologies across borders. It is built on a recognition that markets are not static instruments, but living systems that learn, evolve, and respond to new information and ambition.

Technology is the great catalyst of this transformation. A decade ago, the tools to measure, monitor, and verify carbon outcomes were often manual and fragmented. Today, digital infrastructure — from satellite imaging and sensor networks to AI-driven verification and blockchain registries — is redefining what accuracy and transparency mean in carbon markets. Data no longer sits in silos; it flows through connected systems. This digital backbone enables not just better accounting, but a fundamental redesign of how markets operate — faster, more efficient, more open.

But technology alone won't deliver the transformation we need. Progress depends on governance that keeps pace with innovation. As new platforms emerge, we must ensure they connect to a shared foundation: compatible data standards, transparent methodologies, and clear rules for how credits and allowances are created, traded, and retired. The conversation about integrity is now becoming one about functionality — how to build markets that work at global scale while maintaining confidence in their outcomes.

This is where policy leadership and private innovation must meet. Governments design the frameworks, set the caps, and define the rules. Businesses bring capital, creativity, and execution. Civil society, in turn, ensures that outcomes are credible and equitable. The success of carbon markets has always relied on this collaboration — and in this new era, it will be more important than ever.

Consider the landscape we see today. Emissions trading systems are expanding faster than at any point in history. New systems are coming online across Asia, Latin America, and Africa. The EU ETS remains the benchmark for depth and liquidity, while North America's markets demonstrate the power of subnational collaboration. The voluntary market, meanwhile, is undergoing its most significant reset yet — shifting from a fragmented collection of initiatives toward a coordinated framework of standards, methodologies, and digital systems that reflect rising expectations from buyers and the public alike.

At the centre of this transition stands Article 6 of the Paris Agreement — the world's first framework for international carbon cooperation under a common accounting rulebook. It offers the architecture for connecting markets, aligning ambition, and ensuring that each tonne traded represents a real and additional outcome. Implementing Article 6 at scale will require patience, investment, and trust between nations — but it represents the clearest path toward a genuinely global carbon market.

In this report, you will read perspectives from across this emerging landscape — how policymakers are shaping emissions trading systems, to analysts tracking market signals, to innovators building digital verification tools. Together, they paint a picture of a system in motion: growing, learning, converging.

For IETA, this is both a moment of reflection and renewed purpose. Our mission has always been to make markets work for climate. Over the years, we've helped shape the standards and systems that underpin market confidence. We've advocated for policies that reward efficiency, drive investment, and expand participation. But our role today is also about connection — convening governments, businesses, and institutions to align the pieces of this new carbon economy.

Because what lies ahead is not just about expansion, but integration. We need to move from markets that exist to markets that connect. The next phase of growth will depend on interoperability — between registries, standards, and policy frameworks. We need to ensure that data and credits can move across systems as easily as capital does, backed by shared definitions and digital infrastructure.

This is the promise of the New Carbon Order: a world where carbon is accounted for and valued consistently, where technology enables participation, and where markets become a true force for global cooperation.

The journey is far from over. But as this report demonstrates, the direction is clear — from fragmentation to alignment, from ambition to architecture. The task before us is to build it well, and to build it together.

Dirk Forrister
IETA CEO & President

MARKETS WORK WHEN THEY CONNECT. THE FUTURE OF CLIMATE ACTION DEPENDS ON THAT CONNECTION.

CHAPTER 1

A NEW ERA FOR CARBON MARKETS

01

Carbon markets have evolved from experimental policy tools into one of the world's most powerful mechanisms for driving decarbonisation. As national systems mature and new ones emerge, the conversation is shifting – from establishing price signals to integrating markets, linking systems, and aligning with net zero. This chapter sets the scene for this new era: exploring how emissions trading systems (ETSs) are expanding across regions, how voluntary markets are adapting to new governance frameworks, and how these parallel tracks together form the backbone of global climate cooperation.

MARK C. LEWIS, PARTNER & MANAGING DIRECTOR, CLIMATE FINANCE PARTNERS LLC

CARBON MARKETS AT A CROSSROADS: ARTICLE-6 CREDITS THE KEY TO EXPANSION AND INTEGRATION

AS WE APPROACH THE END OF 2025 AND WITH COP-30 NOW IN FULL SWING IN BRAZIL THERE ARE GROUNDS FOR CAUTIOUS OPTIMISM IN TERMS OF THE OUTLOOK FOR GLOBAL CARBON MARKETS HEADING INTO 2026. BUT WITH THE EU NOW POISED FOR INTERNAL TALKS TO DETERMINE ITS 2040 EMISSIONS-REDUCTION TARGET AND THE MODALITIES FOR ACHIEVING IT – THE SO-CALLED TRILOGUE DISCUSSIONS BETWEEN THE COMMISSION, THE COUNCIL, AND THE PARLIAMENT ON ITS 2040 CLIMATE LAW – THE REAL ACTION REGARDING THE OUTLOOK FOR THE EXPANSION AND INTEGRATION OF GLOBAL CARBON MARKETS RIGHT NOW IS IN FACT TAKING PLACE IN BRUSSELS RATHER THAN BELÉM. THIS IS BECAUSE WHAT THE EU ENDS UP DECIDING ON THE ALLOWED USE OF ARTICLE-6 (A6) CREDITS OVER 2031-40 TO ACHIEVE ITS 2040 TARGET WILL BE KEY TO DETERMINING HOW QUICKLY AND HOW BROADLY THE A6 MARKET CAN SCALE AND THEREBY HELP THE WORLD ACHIEVE THE OVERRIDING TARGET OF THE PARIS AGREEMENT.

ARTICLE 6 CREDITS ARE EMERGING AS THE **ONLY INSTRUMENT** CAPABLE OF TRULY LINKING GLOBAL CARBON MARKETS.

In this article, we first review the major developments in global carbon markets over 2024 and 2025, as well as the changing geo-political landscape on climate change and the trend in global emissions, before explaining why A6 credits are so vital to the future expansion and integration of global carbon markets, and why the EU is so crucial to driving the scaling-up of the A6 market. Our conclusion is that the latest signs from Brussels give grounds for cautious optimism regarding the EU's willingness to allow A6 credits to play a meaningful role in achieving its 2040 target, and hence for the prospects for expanding and integrating both project and compliance markets globally over the next two decades and thereby optimizing the contribution of carbon markets to fighting climate change.

TAKING STOCK OF GLOBAL CARBON MARKETS AND GLOBAL EMISSIONS: WHERE ARE WE NOW?

Surveying recent trends across carbon markets, climate policy, and emissions, there are both positive and negative developments to highlight.

On a positive note, 2024 and the first quarter of 2025 saw the amount of global greenhouse-gases subject to a national or regional emissions-trading system (ETS) rise to 23% as of 1 April 2025 from 18% at the end of 2023, driven in large part by China's decision to include heavy industry in its national ETS retrospectively from 1 January 2024.[1] This means that 15Gt out of a total annual 52Gt of GHG emissions in 2024 are now covered by an ETS,[2] comprising 45% and 38% of total global power and industrial emissions respectively.[3] In terms of the Voluntary Carbon Market (VCM), the volume of non-retired credits grew further through the first half of 2025,[4] but at a slower pace, with the new ICVCM and CCP standards starting to change the pattern of both demand and supply for the better[5]

On the other hand, the geo-political headwinds have picked up over the last 12 months, with the US leaving the Paris Agreement for a second time, and, as of 28 October, only 64 of the 195 parties to the Paris Agreement having submitted their updated Nationally Determined Contributions (NDCs) just a week before COP-30, when all parties were actually meant to have submitted these in February.[6] Moreover, the collective level of ambition of the 64 NDCs that were submitted by late October falls well short of the trajectory required to keep the 1.5°C Paris target in view according to the UNFCCC's 2025 NDC Synthesis Report. This is extremely concerning given the ongoing rising trend in global emissions and the latest scientific evidence of dangerous climate tipping points fast approaching.

In terms of the trend in emissions, in 2018 the Intergovernmental Panel on Climate Change (IPCC) published its Special Report on Global Warming of 1.5°C,[7] stating that the world needed to reduce CO2 emissions by 45% by 2030 versus 2010 levels in order to align with the 1.5°C target. Yet instead, 2023 carbon-dioxide emissions of 37.8 Gigatonnes (Gt) in 2023 were already 7% higher than in 2015 when the Paris Agreement was signed, 13% higher than the IPCC base year for that report of 2010, and 61% higher than in 1995, the year of the first COP.[8]

In terms of climate tipping points, we are now approaching some of the inflection points in the biosphere that, if hit, will accelerate warming still further and lead not only to catastrophic but also irreversible climate change. Indeed, in the most up-to-date summary of where we stand on global tipping points, the recent report by the University of Exeter and The Potsdam Institute states that the world has entered a new reality, with global warming soon to exceed 1.5°C, and that we have already reached the tipping point for widespread coral-reef die-offs.[9]

Against this mixed backdrop of the positive albeit incremental expansion of global carbon markets on the one hand, and the grossly inadequate ambition and urgency in the face of the existential risk posed by climate change on the other, how are we to make sense of the outlook for the global carbon market? And what is the best way for policymakers to encourage the faster expansion of and greater integration between markets, standards, and ultimately prices over the next decade?

The answer lies in scaling up the market for Article-6 credits so that in the first instance they can drive greater integration and convergence between the project-based market and compliance markets, but more importantly, and over time, so that they can also drive convergence between different compliance markets all over the world. And as so often, it is the European Union that must lead the way here, both for the noble reason of maintaining its global leadership on climate change but also for the no less important reason of ensuring that its industry can remain competitive as the EU-ETS cap declines sharply over 2031-40.

THE EU AND ARTICLE-6: THE KEY TO EXPANDING AND INTEGRATING GLOBAL CARBON MARKETS

It is hard to overstate how much the EU-ETS still dominates total turnover globally in carbon markets. In 2024, the value of total turnover in the world's compliance markets was approximately $875bn,[10] while turnover of Voluntary Emission Reduction (VER) credits in the VCM was $535m.[11]

Yet turnover in the EU-ETS alone was $740bn, or 85% of the total global turnover. The next largest turnover recorded was in North American markets – the Western Climate Initiative (WCI), the Regional Greenhouse Gas Initiative (RGGI), and Washington State combined – at $92bn, with the UK-ETS in third place at $28bn. Together, the EU, North America, and the UK accounted for 98% of total turnover by value.

Although this partly reflects the much higher prices in the EU-ETS than in other compliance schemes, the EU-ETS was also way out in front in terms of volume: of the total 14.6 Gigatonnes (Gt) traded in global compliance markets in 2024, the EU accounted for 10.5Gt (71%), North American markets for 3Gt (21%), and the UK for 0.6Gt (4%). Again, combining the volumes in these three regions we get to 97% of total compliance volumes traded. Turnover in the VCM in 2024, meanwhile, was just shy of 100 Megatonnes (Mt).

The numbers tell a clear story: the EU-ETS remains by far the largest market globally in terms of value, volume, and liquidity, and while China's market will one day replace it on all these metrics that is probably still at least a decade away.[12] This means that for the next decade the EU will continue to exert a disproportionate influence on the global carbon market, and nowhere will this be more crucial than in what it decides to do regarding the admission of A6 credits into the ETS1, the soon-to-be-established ETS2,[13] and for use against residual emissions not covered by these compliance schemes.

ARTICLE-6 CREDITS: A KEY NEW INSTRUMENT IN THE GLOBAL CARBON MARKET

Article-6 credits are of two main kinds depending on whether they are issued under Article 6.2 or Article 6.4 of the Paris Agreement. The key difference between the two lies in the framework governing the authorization of credits.

Article 6.2 is a bilateral mechanism allowing for flexibility between parties to the Paris Agreement and relying on national administrative frameworks to facilitate trading, with the emissions reductions agreed on a cooperative basis between Parties to the Paris Agreement and based not only on projects but also on climate-finance based and sectoral approaches. The UNFCCC provides guidance to ensure that the transactions comply with rules on transparency, accounting practices and environmental integrity. By contrast, Article 6.4 is a purely project-based mechanism governed by a UNFCCC framework – the Paris Agreement Crediting Mechanism (PACM) – with a centralised body (the Supervisory Board) that validates approved methodologies.

Credits issued under Article 6.2 are known as Article-6.2 Emissions Reductions (A6.2ERs) and are traded either: i) between Parties to the Paris Agreement (i.e. state actor to state actor), whereby a host country sells an A6.2ER to a buying country for meeting its NDC; or ii) between state or private-sector actors in the host country and state or private-sector actors in a third country, whereby the buyer uses the credit either for meeting an NDC (state actors), or for meeting compliance obligations in a national or international compliance scheme (private-sector actors),[14] or for offsetting emissions on a voluntary basis (private-sector actors). When authorized for use with corresponding adjustments, these credits become known as Internationally Traded Mitigation Outcomes (ITMOs).

WITH 85% OF GLOBAL COMPLIANCE-MARKET VALUE, **THE EU'S STANCE ON A6 CREDITS WILL SHAPE CARBON MARKETS FOR THE NEXT DECADE.**

CORRESPONDING ADJUSTMENTS MAKE ARTICLE 6 CREDITS **UNIQUELY PARIS-ALIGNED,** ELIMINATING DOUBLE COUNTING AND INCREASING GLOBAL TRUST.

Credits issued under Article 6.4 are known as Article-6.4 Emissions Reductions (A6.4ERs) or, since COP-29, as Paris Agreement Crediting Mechanism ERs (PACM ERs). As with A6.2ERs, when authorized for transfer A6.4/PACM ERs become ITMOs and can be traded between the same range of actors as A6.2 ERs. The A6.4 crediting process is both more rigorous and more transparent than for A6.2 credits as it is subject to a centralized UN process rather than being negotiated bilaterally. In addition, 2% of all A.6.4/PACM ERs issued are cancelled to ensure a conservative approach to emissions reductions, and 5% of proceeds are set aside for the UN's Adaptation Fund. For all these reasons, PACM ER's look set to become the premier global offset credits once the A6 market ramps up in earnest.

CORRESPONDING ADJUSTMENTS ARE THE USP OF ARTICLE-6 CREDITS

The crucial thing about both A6.2ERs and A6.4/PACM ERs is that they depend upon corresponding adjustments (CAs) for their legitimacy. This means that any country selling either A6.2ERs or A6.4/PACM ERs to third parties will have to make a corresponding adjustment to their own target under the Paris Agreement on a tonne-for-tonne basis such that it may no longer count the emissions reduction represented by the A6 credit towards their own Paris target.

This means A6ERs remove the risk of double counting under the accounting framework of the Paris Agreement. This gives them great value as it means they are inherently part of the global carbon budget for achieving the Paris Agreement's overarching objective of 'holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels.'[15]

The unique nature of A6 credits in representing emissions accounted for under the global carbon budget that underlies the entire Paris Agreement makes them ideal instruments not only for CORSIA but also for inclusion in compliance schemes such as the EU-ETS, UK-ETS, and so forth, and also as premium instruments in the voluntary market for companies that want to demonstrate the strongest possible commitment to climate action.[16]

In turn, this means that they have the potential to turbo-charge the expansion of the global carbon market while also driving convergence between compliance markets and the project-based market on the one hand, and thereby between compliance markets themselves on the other. Given that there is no other instrument that can act as a glue between the world's various carbon markets in this way, how quickly the A6 market scales is crucial to the future health of the global carbon market more generally. And given the EU's importance to the global market overall, what the EU decides regarding the admissibility of A6 credits under its 2040 target will be decisive to how quickly the market scales.

THE CURRENT EU DEBATE OVER A6 CREDITS IN THE EU

There is a very live debate in the EU at the moment regarding the quantity of, kind of, uses for which, and timeframe over which A6 credits will be allowed for enabling the EU to meet its 2040 emissions target, and in particular over the allowed use of A6 credits as compliance units in ETS1 over 2031-40.

Back in July, the EU Commission proposed the allowed use of up to 3% of the EU's 1990 net emissions in the form of A6 credits when it presented its 2040 target for a 90% reduction in EU emissions versus 1990. However, it stipulated that none of these credits would be valid in ETS1,[17] while leaving open the possibility of their use in ETS2 and for other emissions not covered by either ETS1 or ETS2. Moreover, there was ambiguity over whether the proposed 3% was intended to be a cumulative or an annual number, or whether it represented a final number for 2040 towards which the market would scale up in linear fashion from 2036.

In reacting to the Commission's proposal, the EU Council – the voice of the member states – reached a common position on 5 November. The Council's position is aligned with the Commission's 90% emissions-reduction target but it differs from the Commission's proposal on three key points.[18]

First, the Council has proposed increasing the allowed use of A6 credits to 5% of 1990 emissions and has also introduced the idea of a pilot phase over 2031-2035. Allowing the use of more A6 credits from an earlier date would increase the flexibility available to the EU in achieving its 2040 target while at the same time reducing the overall cost. It would also accelerate the ramp-up of supply and hence increase the global effectiveness of Article-6 as an instrument for driving finance and technology transfer to developing countries, and, above all, for driving emissions reductions.

Second, the Council has left open the possibility of allowing the use of A6 credits in ETS1. This is a very positive development as this would provide a safety valve on prices for the EU's industrial companies over 2031-40, a vital consideration when the competitiveness of EU industry is already being crushed by very high power and gas prices relative to other regions of the world.

Third, the Council has allowed for the inclusion of a revision clause in the EU 2040 Climate Law that could see the allowed use of A6 credits increased beyond 5% in future if needed. Again, this seems a sensible proposal given the uncertainty on the cost of decarbonization between now and 2040 when EU industry is already under great competitive pressure.

Meanwhile, the EU Parliament reached its negotiating position in a plenary vote on 13 November, aligning with EU Council on most of the key points including raising the allowed quota of A6 credits to 5% from the 3% originally proposed by the Commission.[19] Unfortunately, however, the Parliament, like the Commission, does not want to allow A6 credits into the ETS1, so this means there will now have to be a negotiation on this point in the forthcoming trilogue discussions.

Given that the EU Council is the most influential of the three constituent bodies of the EU legislative process, we would expect its position on the allowed volume of A6 credits and the purposes for which they may be used to be the one that ultimately prevails. This means we are now looking at three potential demand scenarios for A6 credits over 2031-40 depending on how the 5% figure is ultimately interpreted: i) 235m if the 5% represents a cumulative number over 2031-40; ii) 2.35Gt if it represents an annual number over the 10 years; or iii) 1.3Gt if it is to be scaled in linear fashion from 2031 to 5% by 2040.

This is clearly a very wide range but our reading of the politics and of the need for a pragmatic solution in the face of EU industry's crisis of competitiveness leads us to conclude that an outcome close to the third scenario – 1.3Gt – would be the sensible compromise. The first scenario would be so unambitious as to be almost meaningless in terms of either scaling up A6 or helping EU industry, while the second scenario would almost certainly be a step too far for many policymakers concerned with the need for an ambitious internal EU abatement target.

As such, only the third scenario would balance all of these competing considerations, namely the need to retain a competitive EU industrial base while also ensuring both an ambitious internal EU abatement target and the EU's leadership role in scaling up the A6 market. As a result, that is where we think the EU will ultimately land.

Neither the Commission, the Council, nor the Parliament has specified what kind of A6 credits should be allowed to count towards the 2040 target but given the greater rigour and transparency of A6.4/PACM ERs versus A6.2ERs, we think it likely that A6.4/PACM ERs will become the instrument of choice.[20]

CONCLUSION: TIME TO LET ARTICLE-6 FLOURISH

The world is currently far removed from a Paris-compliant emissions trajectory and the risk of hitting climate tipping points looms ever larger with each year that passes without urgent action to correct course. A6 credits provide a much-needed source of hope in that if the market can scale significantly over the next five years we could have a tool for reducing global emissions while also driving momentum for the expansion and convergence of existing and future national and regional compliance markets.

CORSIA itself will already be a source of significant demand for A6 credits over 2027-35 as the mandatory obligation kicks in,[21] but creating demand within both ETS1 and ETS2 would provide a formal link between the world's largest compliance market and Paris-compliant offsets. In turn, this would pave the way for other compliance schemes to follow suit over time, thereby creating a link between the world's different compliance markets, and hence a pathway towards convergence of standards and prices in carbon markets globally.

In short, the EU Council's proposal offers an optimistic pathway for this to become a virtuous circle, maximizing the impact of carbon markets in reducing emissions and fighting the existential risk of climate change for the benefit of the planet and of future generations.

For all these reasons it is to be hoped that the Council's position on the use A6 credits ultimately prevails. Otherwise, an historic opportunity to scale up the A6 market and to provide a guardrail against excessive costs for EU industry over 2031 will be squandered.

SCALING ARTICLE 6 IS NOW **ESSENTIAL** — NOT ONLY TO EXPAND CARBON MARKETS, BUT TO KEEP CLIMATE GOALS WITHIN REACH.

Mark Lewis *is Partner & Managing Director of Climate Finance Partners LLC and a researcher with over 25 years' experience in energy and climate finance. He previously served as Head of Research and Partner at Andurand Capital, Chief Sustainability Strategist at BNP Paribas Asset Management, and Global Head of Carbon and Energy Research at Deutsche Bank. A former TCFD member and Senior Associate at CISL, Mark's award-winning research and commentary have helped shape the understanding of global carbon and energy markets over the last two decades.*

ANDRES FELIPE OLARTE PENA, CONSULTANT, ICAP

ETS AROUND THE WORLD: CURRENT TRENDS AND FUTURE OUTLOOK

AS CARBON PRICING GAINS GLOBAL TRACTION, ATTENTION TURNS FROM THE THEORY TO THE PRACTICE OF MARKET DESIGN. THE NEXT CONTRIBUTION FROM ICAP PROVIDES A COMPREHENSIVE LOOK AT HOW EMISSIONS TRADING SYSTEMS ARE EVOLVING AROUND THE WORLD — HIGHLIGHTING REGIONAL MOMENTUM, POLICY INNOVATION, AND THE COLLECTIVE PROGRESS TOWARD A CONNECTED GLOBAL CARBON PRICE SIGNAL.

ETSs NOW COVER 23% OF GLOBAL EMISSIONS, MAKING CARBON PRICING A **MAINSTREAM CLIMATE TOOL** ACROSS MAJOR ECONOMIES.

Over the last two decades, emissions trading systems (ETSs) for greenhouse gases have grown from niche policy tools into a cornerstone of climate policy worldwide. In 2025, they operate in nearly every region of the world, and they cover close to a quarter of global greenhouse gas (GHG) emissions.

GLOBAL REACH AND MOMENTUM

Today, 38 ETSs are in force worldwide, covering over 12 billion tonnes of CO2 equivalent, or about 23 percent of global GHG emissions. Jurisdictions operating ETSs account for 58 percent of global GDP and one-third of the global population. Seventeen of the G20 countries already have or are planning to implement ETSs at the national or subnational level, showing how carbon pricing has become mainstream in major economies.

The pipeline is also expanding. Twenty governments are considering or developing ETSs, and key emerging economies such as Brazil, Chile, Colombia, India, Indonesia, Türkiye and Vietnam are driving the next wave of adoption.

LATEST DEVELOPMENTS AND REGIONAL HIGHLIGHTS

In the Asia-Pacific region, change is rapid. India has adopted regulations to establish an intensity-based baseline-and-credit system for energy-intensive industries. China has expanded its national ETS beyond the power sector to include steel, cement, and aluminium, adding around 1,500 companies and about 3 gigatonnes of CO2 equivalent. Indonesia is operating an intensity-based ETS for the power sector and preparing a hybrid “cap-tax-and-trade” model. Türkiye and Vietnam are preparing pilot systems, while Malaysia, the Philippines, and Thailand are actively considering ETSs. South Korea has been operating an ETS for a decade and Japan launched a voluntary ETS in 2023 that is planned to become mandatory from next year.

In Latin America, Brazil has established the legal foundation for a federal ETS. The law is in place, and the government has entered the initial phase of regulation to make the system operational. Chile is preparing a pilot ETS for the energy sector, and Colombia has launched public consultations on draft ETS regulations. Mexico is transitioning its pilot ETS to full operation.

Developed economies are also advancing their emissions trading frameworks. The EU ETS remains the largest ETS in terms of traded value and continues to reform. Under the “Fit for 55” package, it has expanded to maritime transport and a second system ETS for buildings, road transport, and other sectors will be introduced from 2027. The UK has tightened the ETS cap and is consulting on expanding the system to waste and domestic maritime emissions. In North America, Oregon reinstated its ETS after a legal challenge, Colorado launched its system in 2024, New York is developing an economy-wide ETS, and Maryland is actively considering introducing one. California and Quebec are in the process of reforming and strengthening their emissions trading systems, while eyeing linkage with Washington State.

ALLOWANCE PRICES AND REVENUES

Market dynamics shifted in 2024 and 2025. Average allowance prices in the EU ETS and UK ETS were lower in 2024 than in 2023, when they reached record highs. In 2025, prices stabilized at these lower levels. California and Quebec also recorded price declines, while China saw small but steady growth, and Korea and RGGI remained stable.

As a result, auction revenues fell slightly, totaling about USD 70 billion in 2024, down from 2023's record. Since 2008, ETSs have raised around USD 373 billion. Revenues remain a vital policy resource, used to support climate action, vulnerable groups, and innovation. Examples include the EU's upcoming Social Climate Fund and reinvestment programs in California, Québec, and New Zealand. Several new systems are also embedding revenue recycling into their design from the start.

As caps tighten, competitiveness and equity are key. The EU and UK are moving away from free allocation and introducing carbon border adjustment mechanisms (CBAMs) to address carbon leakage. Other countries are considering similar tools. At the same time, governments are using ETS revenues to support households and communities, framing carbon pricing as part of a just transition.

EVOLVING SYSTEM DESIGN

Established systems are reducing free allocation and moving toward auctioning, strengthening price signals and market efficiency. Price stability mechanisms such as floors, ceilings, and reserves are now common practice. Intensity-based systems are also becoming more prominent, particularly in emerging economies.

Offset and crediting mechanisms are widely used. Of the 38 ETSs in force, 24 allow for the use of carbon credits as a compliance option, usually with strict limits and in almost all cases domestic only. Emerging economies such as China, India, Indonesia and Brazil are all planning to incorporate domestic credits in their systems, contributing to a gradual convergence between compliance and voluntary markets, though fragmentation in rules and standards remains.

INTERNATIONAL COOPERATION

As ETSs expand, cooperation is essential to align approaches and avoid market fragmentation. While linking remains an aspiration for many systems, real-life examples are still rare but significant. Currently, the EU and Switzerland, California and Quebec as well as Tokyo and Saitama, operate linked markets. In recent months, there has been renewed interest in linking: Washington State is advancing talks to link with California and Quebec, and the EU and the UK have announced their commitment to exploring the linking of their systems.

Broader forms of cooperation, including technical assistance and information-sharing, remain just as important. ICAP, the Carbon Pricing in the Americas, the Global Carbon Pricing Challenge, the World Bank's Partnership for Market Implementation, and other initiatives provide platforms for government-to-government dialogue and alignment.

LOOKING AHEAD

ETSs are expanding geographically, evolving in design, and becoming more integrated with national climate strategies. They are central to achieving 2030 and 2050 targets. The next phase of ETS development will require addressing key questions, such as how to align caps with net zero, how to integrate removal credits, and how to maintain stability and fairness in increasingly ambitious markets.

The experience of the past two decades shows that ETSs are adaptable. They evolve, learn, improve and scale. From a single market in 2005 to covering almost one quarter of global emissions today, ETSs have proven their value. While they are not a silver bullet, they remain one of the most important and versatile tools to cut emissions cost-effectively, raise revenue, and drive innovation. As more countries join and systems mature, ETSs will remain at the heart of the global climate policy mix.

FROM ONE SYSTEM IN 2005 TO 38 TODAY, **EMISSIONS TRADING HAS EVOLVED** INTO A GLOBAL CORNERSTONE OF CLIMATE POLICY.

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INTERNATIONAL PERSPECTIVES: AMBTION MEETS AFFORDABILITY FOR COMPLIANCE MARKETS AS VOLUNTARY MARKETS FACE RESET

WHILE COMPLIANCE MARKETS CONTINUE TO EXPAND AND MATURE AT A TIME WHEN AMBITION MUST BE BALANCED AGAINST AFFORDABILITY, THE VOLUNTARY MARKET REMAINS THE TESTING GROUND FOR INNOVATION – A PLACE WHERE NEW METHODOLOGIES, TECHNOLOGIES, AND INTEGRITY STANDARDS ARE PILOTED BEFORE BEING SCALED. THE FOLLOWING ANALYSIS FROM JENNIFER MCISAAC AT CLEARBLUE MARKETS EXAMINES HOW MARKETS ARE UNDERGOING A FUNDAMENTAL RESET, SHAPED BY TRANSPARENCY, DATA, AND A RISING BAR FOR QUALITY.

THE VCM IS UNDERGOING A **MAJOR RESET,** WITH CREDIT ISSUANCES HITTING A FIVE-YEAR LOW WHILE RETIREMENTS REACH A FIVE-YEAR HIGH.

The global Voluntary Carbon Market (VCM) is undergoing a reset, marked by increasing market maturity and a shift toward high-quality credits. Credit issuances are tracking for a five-year low in 2025, partly due to project developers delaying issuances to transition to higher-quality methodologies compliant with the Integrity Council for the Voluntary Carbon Market (ICVCM) and the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA).

Retirements are set for a five-year high. Demand for credits approved under the ICVCM's Core Carbon Principles (CCP) already surpassed all previous years, underscoring buyers' preferences. The ICVCM has further fully or conditionally approved Biochar, Improved Forest Management (IFM), Af-forestation and Reforestation (ARR), Efficient Cook-stoves, and Engineered Carbon Dioxide Removal (CDR) methodologies.

The focus on price transparency and the alignment between credit price and integrity is growing. The Calyx–ClearBlue Carbon Price–Integrity Index shows a strengthening correlation between GHG integrity ratings and market values. As of October, Tier 1 (highest rated) credits averaged USD 7.98 per tonne, a 59 percent premium over Tier 3 (lowest rated) credits. Removal-based credits, particularly technological CDR such as biochar, remain highly valued at USD 95–210 per credit, with other technologies such as Direct Air Capture priced much higher, while demand for nature-based removals continues to outpace supply, sustaining premiums over avoidance-based credits.

The market reset is influenced by shifting corporate purchasing strategies and international governance efforts. Corporate buyers (e.g., Shell, Eni, Salesforce) are demonstrating a clear preference for projects regarded as high quality, such as forestry, industrial process emissions reduction, and waste or landfill gas projects. Companies aligned with the Science Based Targets initiative (SBTi) show a strong preference for forestry and blue carbon, which command premium valuations. The Voluntary Carbon Markets Integrity Initiative (VCMI) launched its "Scope 3 Action Code of Practice," requiring companies to use high-quality, CCP-aligned credits as a complement to direct decarbonisation.

A number of carbon tax and emission trading (ETS) schemes globally incorporate project-based credits, with continued convergence of the VCM towards compliance markets anticipated. Global frameworks are influencing and aligning with VCM standards. In 2025, the Article 6.4 Supervisory Body adopted critical standards for baselines and leakage. The European Commission has proposed the inclusion of international credits towards its 2040 climate target, and is also considering domestic CDR. 2025 California legislation calls for new compliance offset protocols, including CDR. CORSIA-eligible Credits are seeing new integrity measures, with Verra and Gold Standard introducing insurance frameworks to mitigate the political risks associated with corresponding adjustments and potential double counting. Concerns persist over adequate credit supply to meet demand. The International Air Transport Association (IATA) has held three procurement events for CORSIA Eligible Emissions Units (EEUs) for three million credits total. Current market prices for CORSIA Phase 1 credits on the Intercontinental Exchange (ICE) are around USD 20.

EMEA

EU ETS prices have appreciated 10 percent in 2025, to EUR 80 per metric tonne, driven by investment funds building long positions, tighter power price correlations and the September com-pliance deadline - the first for the maritime sector. After delays, a deal has emerged for a 2040 EU target 90 percent below 1990 emissions, with inclusion of international credits and biannual reviews. With affordability key, the EU ETS will likely see an easing of the cap trajectory post-2030, to delay the "end game," and inclusion of domestic removals. The launch of the ETS 2 covering road transportation and buildings will be delayed one year to 2028, following 16 member states calling for reforms to the program on concerns over high prices.

UK ETS prices have appreciated 60 percent YTD in 2025, driven by tighter balances and large invest-ment fund positions eyeing a future EU-UK ETS linkage.

UK ETS prices have appreciated 57 percent YTD in 2025, driven by tighter balances and large investment fund positions eyeing a future EU-UK ETS linkage. ICE launched ETS2 futures in May 2025, although market activity remains limited. ETS2 futures have traded within the EUR 1 - 9 premium to EU ETS prices. Meanwhile 16 EU member states have called for reforms to ETS 2 on affordability fears, and political divisions remain sharp. The Commission maintains the 2027 start date.

Otherwise, in response to the EU CBAM, Türkiye is expected to launch a pilot phase ETS in 2026, backed by its first comprehensive climate legislation passed in July 2025.

AMERICAS

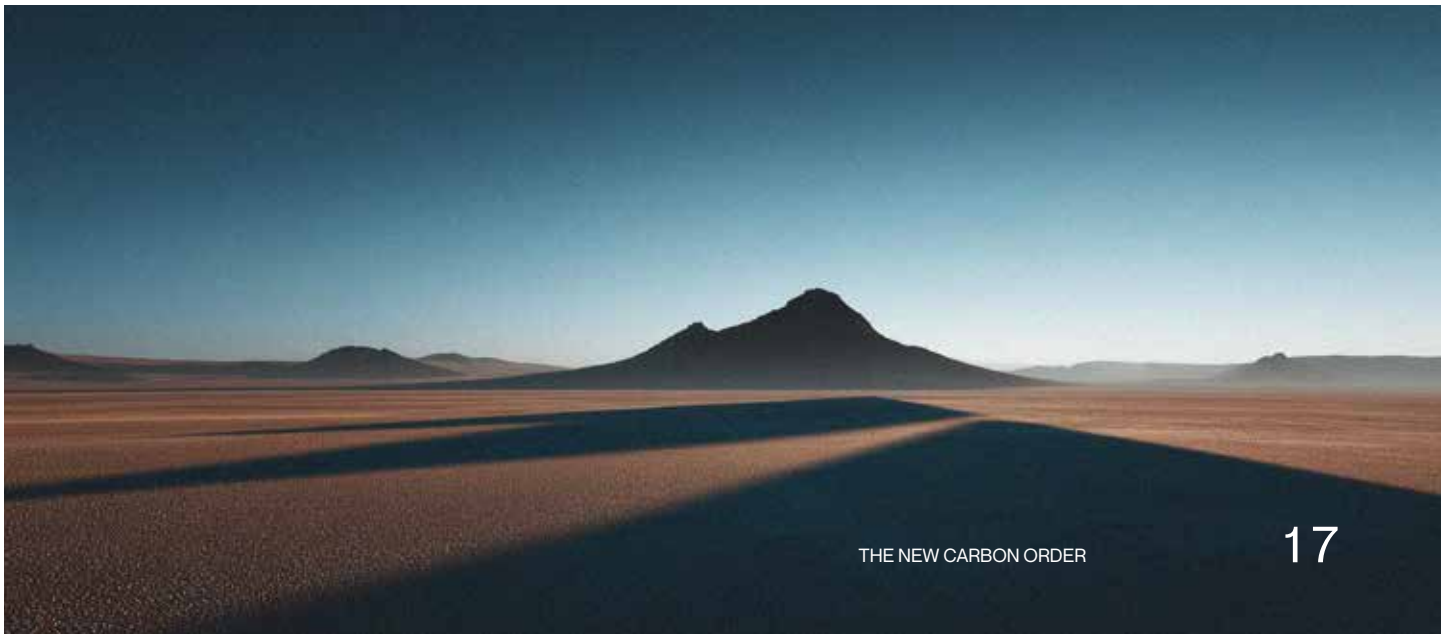
With the second Trump administration, the US again withdrew from the Paris Agreement. President Trump also issued an Executive Order in April 2025 targeting states' climate programs. The "One Big Beautiful Bill" reduced support for renewables and electric vehicles, increasing the burden on state programs.

Allowance pricing in the Western Climate Initiative (WCI) California-Quebec ETS market has fallen around 16 percent in 2025, with the May auction undersubscribed for the first time in five years reflecting policy uncertainty. Buoyed by federal hostility, the California Legislature and Governor Newsom reached an agreement to extend the program through 2045 with 6% offsets usage and rename it as "Cap-and-Invest," emphasizing affordability. Allowance prices moved above USD 30 per metric tonne, as California and Quebec are expected to re-start their regulatory Program Review to finalize program amendments in 2026. Credit prices in California's Low Carbon Fuel Standard (LCFS) are down around 30 percent YTD on delayed implementation of the program reforms, but balances will tighten.

Washington's Cap-and-Invest pricing is about double that of WCI. Legislation in 2025 lowers the program's price ceiling as regulators work towards linkage with WCI in time for Washington's large compliance surrender in November 2027. This timeline is tight, as California and Quebec will complete their Program Review before turning to linkage.

Pricing in the Regional Greenhouse Gas Initiative (RGGI) is up around 7 percent for 2025 and tied to cost containment levels. In response to rising electricity loads and challenges to renewable and offshore wind capacity additions, member states wrapped up their Program Review in July by adopting a model rule that relaxes stringency in the near term and adds a second price ceiling tier. Following a Democrat Governor flip in the 2025 elections, Virginia will look to rejoin RGGI.

TIER 1 CREDITS TRADE 59% ABOVE TIER 3, AND TECHNOLOGICAL CDR SELLS FOR USD 95–210 PER TONNE FOR BIOCHAR WITH DAC MUCH HIGHER



CORPORATE BUYERS ARE SHIFTING DECISIVELY TO HIGH-QUALITY, CCP-ALIGNED CREDITS, SIGNALLING A **NEW ERA OF INTEGRITY-DRIVEN DEMAND.**

In Canada, the 2025 election of Prime Minister Mark Carney led to the repeal of the consumer-facing fuel charge, shifting focus toward harmonizing and strengthening industrial carbon pricing. This re-quires coordination across provincial schemes, with a benchmarking exercise to assess federal equiva-lency scheduled for 2026. Alberta Premier Danielle Smith is proposing to freeze the provincial carbon price at CAD 95 per tonne (the 2025 level), while the federal carbon price is set to increase by CAD 15 per year, reaching CAD 170 by 2030. Credit over-supply and policy uncertainty have driven Alberta TIER prices down by 50 percent, to below CAD 20. With the cancellation of the federal fuel charge and competition with strong US-based biofuels incentives, credit pricing in the Canada Clean Fuel Regulations (CFR) market increased almost 250 percent for the YTD, above CAD 350.

Across Latin America and the Caribbean (LAC), there are 16 operational carbon pricing instruments, most-ly taxes, with seven more under development. Na-tionally, Mexico has committed to launching its ETS in 2026. Brazil continues development of the SBCE (Sistema Brasileiro de Comércio de Emissões) ETS. Chile's NDC upgrade and internal reforms will sharp-en its role. Colombia's proposed tax reforms include a 55 percent increase in the 2026 tax rate to COP 42,600 per metric tonne (~USD 11).

Internationally, 12 countries have advanced regula-tions or signed agreements with buyer countries for ITMOs (Internationally Transferred Mitigation Out-comes) under Article 6. LAC countries are expected to expand Article 6 cooperation frameworks—shifting from bilateral agreements toward ITMO transactions.

APAC

China's Carbon Emission Allowances (CEAs) prices fell below CNY 55 (~USD 8) in October, a two-year low, on speculation of liberal surplus carryover rules, muted industrial demand, and low electricity prices, and in spite of lower China Certified Emission Reduction (CCER) issuances. They rallied to above CNY 65 in November with the release of tightened allocation rules for industry and an increased banking quota. China committed to an economy-wide GHG emission reduction target of 7 to 10 percent from peak levels and is preparing to move towards an EU ETS style absolute cap, plus expand the carbon market to additional sectors.

Australia Carbon Credit Unit (ACCU) pricing is flat this year at around AUD 37 (~USD 24). The re-election of Prime Minister Anthony Albanese in 2025 reinforced climate policy, with a new 2035 NDC announced to reduce emissions by 62 to 70 percent below 2005 levels. New Zealand ETS pricing is down 31 percent YTD, to NZD 44 (~USD 25), but is up from spring lows as the government declined to boost auction volumes and introduced policy changes to limit farmland converted to exotic forest in the ETS. South Korea ETS allowance prices are up 10 percent YTD, to KRW 10,450 (~USD 7). Like Australia (and Canada) elections in 2025 solidified the commitment to climate policy, and there are ongoing efforts to increase ETS market liquidity. A Market Stabilization Mechanism has also been introduced to automatically adjust supply and demand.

India is developing a rate-based ETS and voluntary carbon crediting mechanisms, with eight methodol-ogies approved in 2025. Indonesia's intensity-based ETS for the power sector is transitioning to a hy-brid system incorporating a tax. Japan's voluntary GX-ETS is transitioning to a mandatory program in 2026. Updated rules in Vietnam support a 2025 launch of the pilot ETS. Malaysia, the Philippines and Thailand are also considering emissions trading.

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CHAPTER 2

CONNECTING THE DOTS: CROSSCUTTING MECHANISMS IN A FRAGMENTED MARKET

As carbon markets mature, the boundaries between domestic, regional, and international systems are becoming increasingly interconnected. Mechanisms such as CORSIA, the Carbon Border Adjustment Mechanism (CBAM), and Article 6 of the Paris Agreement now sit at key intersections where policy, trade, and private-sector ambition converge. Each tackles mitigation differently—CORSIA through aviation offsets, CBAM by levelling carbon costs for industry, and Article 6 through international accounting rules—but together they shape investment, corporate strategy, and cross-border climate cooperation. This chapter examines how these frameworks interact, the challenges they expose, and how aligning them can deliver real emissions reductions with economic value.

KAYLEIGH CRABB, POLICY RESEARCHER AT THE PARIS AGREEMENT ARTICLE 6 IMPLEMENTATION PARTNERSHIP (A6IP) CENTER

ARTICLE 6 IMPLEMENTATION: A GLOBAL SNAPSHOT

INTERNATIONAL COOPERATION IS CRUCIAL FOR REALIZING THE POTENTIAL OF CARBON MARKETS. THIS GLOBAL SNAPSHOT FROM THE PARIS AGREEMENT ARTICLE 6 IMPLEMENTATION PARTNERSHIP (A6IP) CENTER HIGHLIGHTS HOW COUNTRIES ARE OPERATIONALIZING THE PARIS AGREEMENT'S MARKET MECHANISMS — AND IDENTIFIES OPPORTUNITIES AND CHALLENGES TO REALIZE FULL IMPLEMENTATION.

ARTICLE 6 IS NOW FULLY OPERATIONAL, MARKING THE TRUE LAUNCH OF INTERNATIONAL CARBON MARKETS UNDER THE PARIS AGREEMENT.

International carbon markets under Article 6 of the Paris Agreement are entering a pivotal phase. At the 29th Conference of the Parties (COP 29) to the United Nations Framework Convention on Climate Change (UNFCCC) in 2024, countries concluded negotiations on Article 6. Rules and guidelines became 'fully operationalized', signaling that the era of international carbon markets under the Paris Agreement is now truly underway.

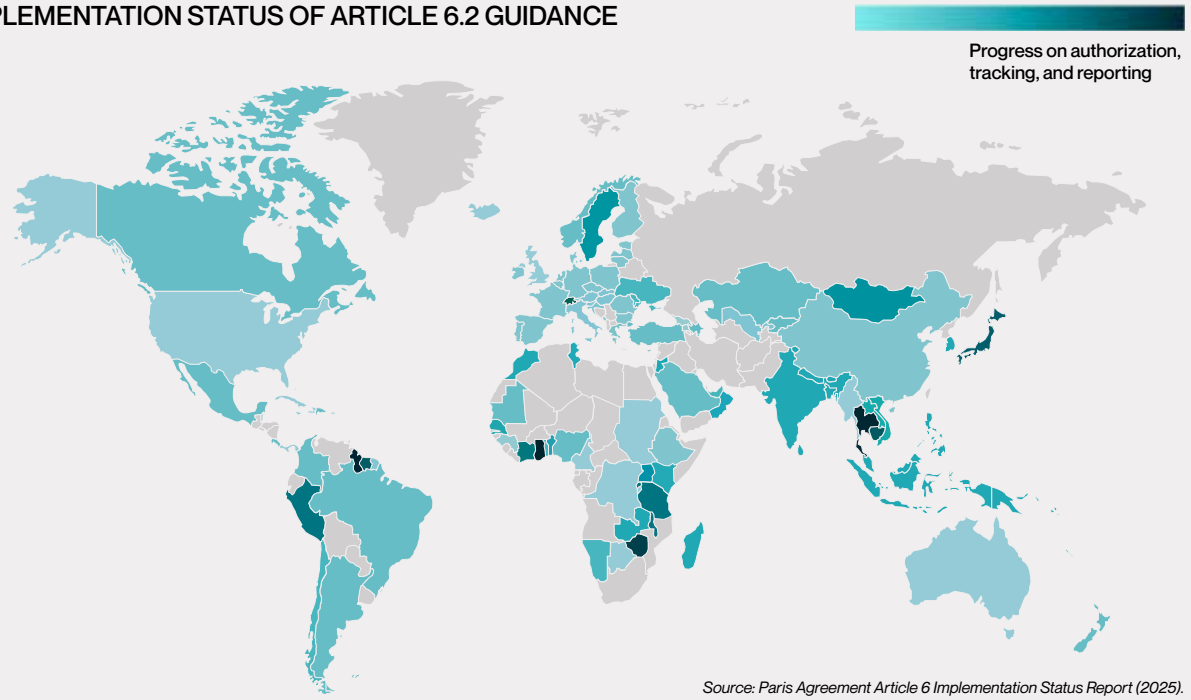
Ahead of COP 30 one year later, the Paris Agreement Article 6 Implementation Partnership (A6IP) Center Center developed the 2025 edition of its Implementation Status Report[22]. The report captures a global snapshot of relevant policy, projects, private sector perspectives, capacity building, national climate goals, and more. The report reveals a dynamic implementation landscape as well as opportunities and challenges for Article 6.

To participate in Article 6, Parties must put in place authorization and tracking arrangements for internationally transferred mitigation outcomes (ITMOs).

- Authorization enables formal approval by the government on the use of ITMOs
- Tracking necessitates a method to record information about ITMOs.

Authorization and tracking arrangements are required under Article 6 and aim to ensure transparency and intended outcomes from international carbon markets. The progress toward development of frameworks, policies, strategies and systems for authorization and tracking can serve as a proxy to assess overall Article 6 implementation status. Of 100 Parties analyzed, 85 are estimated to have authorization and/or tracking arrangements in place, in progress, or under consideration. However, only 13 have both authorization and tracking arrangements in place. High interest coupled with slow progress towards full implementation suggests barriers hindering the development of authorization and tracking arrangements.

IMPLEMENTATION STATUS OF ARTICLE 6.2 GUIDANCE



Source: Paris Agreement Article 6 Implementation Status Report (2025).

The development of institutional arrangements for Article 6 is crucial. However, the legislative process can cause implementation delays and vary widely across Parties. Accordingly, early engagement with core legislative procedures should be prioritized. Parties may collaborate with capacity building organizations or programs to accelerate the development of institutional arrangements. Additionally, Parties may draw from the experience of others that have achieved advanced stages of implementation in order to speed up their internal processes. Knowledge sharing globally, regionally, and among all relevant stakeholders can support efficient development of institutional arrangements.

At the project level, cooperation for Article 6 implementation is growing. Parties have established 99 bilateral cooperation arrangements, which set the stage for projects intended to directly transfer ITMOs from one party to another. Under the Paris Agreement Crediting Mechanism (PACM), 1,041 prior consideration notifications have been submitted to the UNFCCC secretariat and 1,500 Clean Development Mechanism (CDM) activities have requested transition. Of the 1,500 activities have requested transition, 92 have received approval. Simultaneously, projects developed by independent crediting programs are increasingly aligning standards with Article 6 requirements. Nine letters of authorization have been issued for projects under independent crediting programs. A wide range of stakeholders in the private sector, non-profit organizations, government and beyond are engaged with the early phases of project implementation under Article 6.

As various crediting programs and mechanisms are incorporated into projects that intend to use Article 6, it is imperative to ensure high integrity of all ITMOs and avoid fragmented systems. Another pressing concern is that Parties are facing an upcoming deadline to approve transition of requested CDM activities to PACM by the end of this year. Host Parties that wish to provide approval to activities must fulfil the Article 6.4 participation requirements, including by submitting the host Party participation requirements form. The timeline and requirements pose challenges for some Parties. Building readiness for Parties that wish to transition activities to meet participation requirements under PACM is urgent.

The private sector and non-state actors will be key to the implementation of market mechanisms such as Article 6. A strong grasp of the perspectives of key stakeholders is therefore crucial. In a survey of organizations and the private sector, a lack of clear legal rules or frameworks from governments was identified as very challenging by 58 percent of respondents and as moderately challenging by the remaining 42 percent. Alternatively, 83 percent would find clear legal rules or frameworks from governments very helpful. Demand for ITMOs is another key barrier. Fifty-four percent of respondents found lack of demand and price uncertainty as very challenging, while 75 percent replied that more government demand for ITMOs would be very helpful. Although many other challenges and opportunities were identified, the most pressing challenge is tied to institutional arrangements with demand for ITMOs as another top concern.

The private sector is seeking clarity from Parties regarding use of Article 6. The private sector and acquiring Parties may consider direct investments or establishment of capacity building initiatives to support host Parties to develop clear legal frameworks. Acquiring Parties may also reflect on existing policies and ensure there is a clear path forward, including assurances regarding the continuity of established programs in order to build and maintain private sector confidence. Engaging the private sector and all stakeholders can have significant benefits to ensure legislation has its intended impacts.

OF 100 PARTIES ASSESSED, 85 ARE DEVELOPING AUTHORIZATION AND TRACKING SYSTEMS, BUT ONLY 13 HAVE BOTH IN PLACE — SIGNALLING **STRONG INTEREST BUT SLOW IMPLEMENTATION.**

LACK OF CLEAR LEGAL FRAMEWORKS IS THE BIGGEST BARRIER: 58% OF PRIVATE-SECTOR RESPONDENTS FIND IT 'VERY CHALLENGING', WHILE 83 PERCENT SAY CLEAR RULES WOULD BE 'VERY HELPFUL'.

The framing of Article 6 in Parties' national climate goals is another key variable that can impact implementation. In 2025, Parties are to submit their next Nationally Determined Contributions, referred to as NDC 3.0s. These national climate goals outline Parties' commitments to combat climate change, including how Parties intend to use international carbon markets. Article 6 must raise ambition in NDCs and enable the achievement of climate targets that could not be met without contribution from Article 6. As of mid-August, 29 Parties had submitted NDC 3.0s, with 83 percent of Parties either intending to or considering use of Article 6 to achieve their climate targets. While relatively few Parties have submitted NDC 3.0s, a strong recognition of the potential of Article 6 to contribute to climate goals is clear.

Parties interested in engaging with Article 6 for NDC purposes should indicate clearly how Article 6 will be used to achieve NDC goals and contribute to their NDC implementation. For Parties that host projects generating ITMOs under Article 6, specifying which areas of mitigation Article 6 will be contributing to by demarcating conditional targets and associated sectors in the NDC can instil confidence in private sector stakeholders.

This global analysis of Article 6 implementation identifies broad interest and reveals initial steps being taken by policymakers, project developers, and key stakeholders. However, one year after its 'full operationalization', Parties are struggling to put into place the necessary arrangements to implement Article 6. A persistent theme is the need for policy certainty for Article 6 implementation to scale up. As Article 6 offers a market-based approach, clear governance and incentives for private sector participation are critical. The findings suggest that knowledge sharing among market participants and promoting inclusive participation may enable the market to accelerate while avoiding fragmentation and other potential pitfalls. Ensuring clear legislation and a stable policy environment, involving all stakeholders, engaging with capacity building initiatives and providing detailed NDCs are key steps that can transform interest in Article 6 into implementation.

NOTE
For more details on Article 6 implementation and sources, view the Article 6 Implementation Status Report at:

www.a6partnership.org/a6-implementation-status/about

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JACLYN FOSS, HEAD OF BUSINESS DEVELOPMENT – VCM, CFP ENERGY

CORSIA PHASE 1: MARKET FUNCTION, READINESS AND EMERGING PRICE SIGNALS

AS NATIONAL SYSTEMS ESTABLISH THE LEGAL AND TECHNICAL FOUNDATIONS FOR CROSS-BORDER TRADING, THE AVIATION SECTOR OFFERS A LIVE EXAMPLE OF THOSE PRINCIPLES IN ACTION. THE NEXT ARTICLE BY CFP ENERGY EXAMINES CORSIA'S FIRST PHASE – REVEALING HOW COMPLIANCE DEMAND, AUTHORISATION PROCESSES, AND INSURANCE INNOVATIONS ARE SHAPING AN EMERGING GLOBAL MARKET FOR AVIATION OFFSETS.

The Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), established by the International Civil Aviation Organisation (ICAO) under the United Nations framework, entered its first implementation phase in 2024 following a three-year pilot. It aims to stabilise net emissions from international aviation by requiring airlines to offset emissions above 85 percent of 2019 levels through a basket of measures, including greater operational efficiency, scaling up the use of sustainable aviation fuel (SAF), and purchasing eligible carbon credits.

This analysis focuses on the carbon credit component, which underpins CORSIA's market-based mechanism and represents the first operational application of Paris Agreement Article 6 principles at a global, sectoral level.

DEMAND AND MARKET CONTEXT

Updated 2025 models indicate that CORSIA offset demand will exceed earlier projections, driven by faster post-pandemic air traffic recovery and broader state participation. International Air Transport Association's (IATA) revised Sectoral Growth Factor (SGF) forecast[23] (Aug 2025) - which measures the rate of growth in international aviation emissions used to calculate offsetting obligations - estimates Phase 1 demand (runs 2024-2026) between 146-236 million tonnes of CO2, up from 106–137 million tonnes in previous assessments[24] (MSCI, 2024). Airlines now have the confirmed Sectoral Growth Factor (SGF) value for 2024, calculated from verified 2024 emissions, of 0.1594 (15.95%). They are still waiting for consistent compliance guidance and a wider pool of eligible supply before entering long-term contracts. Visibility on SGF values for 2025 and 2026 will continue to shape procurement timing.

CORSIA DEMAND IS RISING FASTER THAN EXPECTED — PHASE 1 REQUIREMENTS COULD REACH **146–236 MILLION TONNES OF CO2.**

Against this backdrop, MSCI's May 2025 analysis[25] supports this higher range (111 and 163 million tonnes of CO2), noting that demand will consolidate toward the end of Phase 1 as airlines align procurement with verified emissions data. Demand remains highly concentrated, with ~70 percent expected from ~20 airlines[26] (World Bank, 2025). Airlines are still developing internal systems to model compliance costs and benchmark pricing, a process constrained by limited eligible supply and scarce price data.

The World Bank (2025) projects that Phase 1 demand could outstrip authorised supply by as much as six to one by 2027, highlighting the risk of tightening conditions as compliance deadlines approach. These projections are beginning to shape market sentiment, with some airlines already planning phased procurement to avoid late-cycle cost escalation.

CARBON OFFSETS MUST ORIGINATE FROM AN ICAO-APPROVED PROGRAMME AND MEET SEVERAL ADDITIONAL CRITERIA

SUPPLY AND AUTHORISATION BOTTLENECKS

To qualify for CORSIA compliance, carbon offsets must originate from an ICAO-approved programme and meet several additional criteria:

- Use an approved methodology under the relevant programme standard;
- Originate from projects started in 2016 or later, with a vintage year of 2021 or later; and
- Receive a Letter of Authorisation (LoA) from the host government confirming their eligibility for use in international aviation compliance.

Eligibility is then finalised through one of two routes:

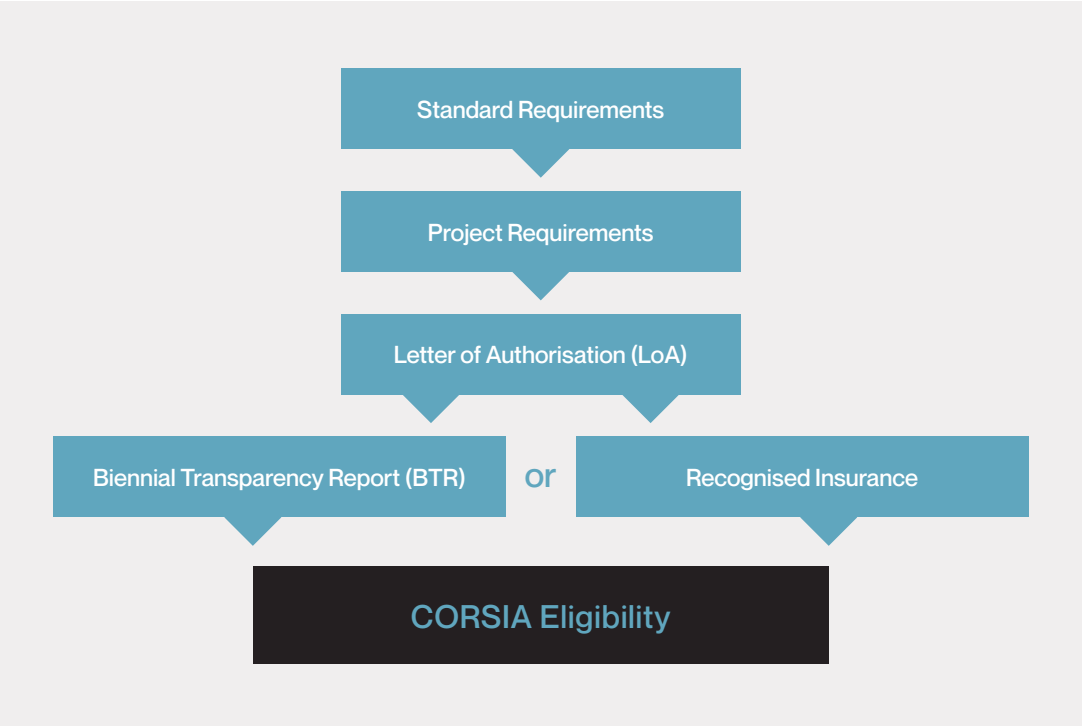
1. A corresponding adjustment (CA), which aligns the host country's nationally determined contribution (NDC) by deducting the exported emission reductions. These CAs must subsequently be reported to the UN through the country's Biennial Transparency Report (BTR), submitted every two years.
2. Insurance coverage from an ICAO-recognised provider, which guarantees the credit's validity if a CA has not yet been recorded, protecting against the risk of non-adjustment.

Slow LoA issuance, uneven Article 6 readiness, and limited registry connectivity between national and programme systems continue to constrain supply and delay progress. Around 20 host countries have LoA frameworks in place, though most are still in early implementation and have yet to issue authorisations (World Bank, 2025).

Recent developments point to gradual but material improvements on the insurance side. In October 2025, Gold Standard approved two additional insurance-backed pathways — CFC Underwriting's CORSIA Guarantee Insurance and Oka's Corresponding Adjustment Protect — while Verra appointed Howden to assess similar products. These products insure against political and regulatory risks, such as a host country failing to issue or uphold a Letter of Authorisation or corresponding adjustment. Together, they expand the mechanisms available to developers for meeting CORSIA's double-counting safeguards and reduce reliance on a single provider.

However, most LoAs still lack the legal clarity and dispute-resolution provisions required for international enforceability, limiting insurability and slowing uptake. (Carbon Pulse, 2025).

As of November 2025, around 17.3 million CORSIA-credits have now been labelled as eligible: approximately 15.8 million from Guyana's ART-TREES Project 102 and a further 1.5 million recently labelled as eligible from a Gold Standard cookstove project in Malawi. Traded volumes remain thin, limited mostly to bilateral transactions between early par-ticipants. The World Bank (2025) and MSCI (2025) estimate that a further 120–150 million credits could enter the pipeline before 2027 if LoA and Article 6 implementation improve, although progress to date has been limited, with only two projects authorised.



This imbalance has become the defining feature of Phase 1. Developers and intermediaries are ready to supply, but without faster and more predictable host-country approvals, issuance cannot keep pace with demand. Nearly two-thirds of the way through the phase, two projects account for all autho-rised volume. Liquidity remains minimal, and price signals reflect policy uncertainty more than under-lying fundamentals. Until authorisation processes become consistent and transparent, supply risk will continue to shape CORSIA's early market dynamics.

PRICE SIGNALS AND COMPLIANCE BENCHMARKS

With only two authorised projects and uneven poli-cy implementation, price discovery in the CORSIA market remains limited, leaving airlines without a clear reference curve for planning and budgeting. This uncertainty poses a particular challenge for operators with tight margins and limited ability to pass through additional costs, complicating procurement planning and long-term cost management. Market data from mid-2025 place CORSIA-eligible credits within a broad range of USD 26–63 per tonne (MSCI, 2025), while QCI's compliance market index shows marginal demand clearing above USD 14 per tonne for aligned credits,[27] indicating an emerging price floor.

Futures markets are beginning to price in higher demand expectations. CORSIA Phase 1 (Dec 2025) contracts reached USD 21.50 in September 2025, their highest level to date, implying that participants expect stronger compliance activity and continued tight sup-ply. For now, open interest remains low (>100,000 tCO2e), showing limited participation despite rising forward prices.

MARKET STRUCTURE AND INTERMEDIATION

CORSIA Phase 1 has highlighted the challenge of turning a global policy framework into a functioning market.

1. **Timing and Market Sequencing**
   Airlines now have the confirmed 2024 SGF value but are still waiting for consistent compliance guidance and a wider pool of eligible supply before entering long-term contracts. Visibility on SGF values for 2025 and 2026 will continue to shape procurement timing. At the same time, project developers and intermediaries need visible de-mand to justify financing and absorbing risk on partially authorised or aligned projects.

2. **Administrative Capacity and Uneven Readiness**
   Operational readiness varies significantly across countries. Some projects initially expected to qualify have faced methodological exclusions or additional verification steps under ICAO-approved standards, lowering issuance and delay-ing market entry for eligible supply. Capacity gaps and competing policy priorities continue to slow LoA issuance and reporting, concentrating supply among a handful of early movers.

3. **Contracting and Risk Allocation Complexity**
   Connecting early-stage supply to future compliance demand remains complex. Some airlines contract directly with developers, but intermediaries remain important for managing delivery and eligibility risk.

A lack of certainty around eligible volumes and compliance rules has led to unclear demand timelines, limiting liquidity and delaying investment as buyers hesitate to commit until greater clarity emerges. This dynamic has prompted creative contracting, including eligibility triggers, replacement clauses, option structures, and the use of insurance. Such mechanisms illustrate what the World Bank (2025) describes as "market learning," where participants adapt through contract design rather than regulation.

SUPPLY BOTTLENECKS, NOT PROJECT AVAILABILITY, ARE DEFINING PHASE 1 — SLOW LOA ISSUANCE AND UNEVEN ARTICLE 6 READINESS ARE HOLDING BACK VOLUME.

THE CHALLENGE FOR CORSIA ISN'T DEMAND BUT **DELIVERY:** AIRLINES ARE PREPARED TO COMPLY, YET ADMINISTRATIVE DELAYS CONTINUE TO CONSTRAIN THE MARKET.

EMERGING LESSON

Insights from CORSIA's initial rollout show that while demand is strong, delivery still depends on the pace of administrative progress. LoA issuance, Article 6 reporting, and registry integration have become the main determinants of what can reach the market.

Recent insurance and BTR-linked safeguards have reduced the risk of reversal or non-adjustment, but procedural uncertainty persists in countries where institutional systems are still taking shape.

Insurance remains a useful bridge for managing political and regulatory risk but cannot substitute for robust host-country legal frameworks and standardised documentation (Carbon Pulse, 2025).

As national Article 6 frameworks evolve, governments are reassessing the administrative and fiscal implications of granting corresponding adjustments. These refinements affect both timing of approvals and the volume of eligible credits entering the system, shaping overall market depth and liquidity in Phase 1.

OUTLOOK AND RECOMMENDATIONS

The immediate challenge for CORSIA lies in execution. The 42nd ICAO Assembly reaffirmed support for the scheme's continuation, with the US committed to Phase 1 and China signalling intent to join Phase 2. Alignment among the world's largest aviation markets reinforces confidence that CORSIA will remain central to international aviation's climate strategy.

The market now stands at a transition point between early implementation and scaled operation. To accelerate progress:

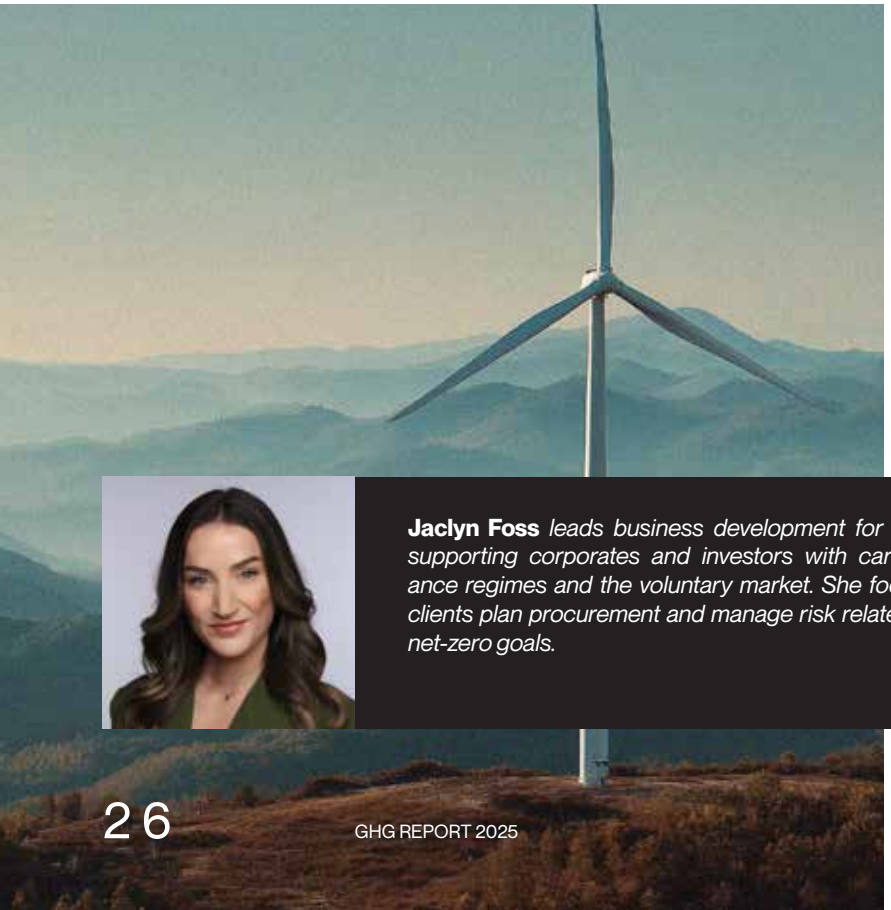
1. **Improve transparency and efficiency in authorisation and accounting**
   Progress hinges on clear information regarding the trajectory of host-country authorisations, corresponding adjustments, and the movement of units through registries. Regular publication of LoA statistics and registry updates would help buyers and intermediaries plan procurement and manage risk more effectively.

2. **Strengthen eligible supply, not just expand pipelines**
   Expanding project numbers alone will not ease supply pressure if historical integrity and authorisation issues persist. Priority should be given to improving Article 6 readiness of existing projects, standardising LoA processes, and ensuring that approved methodologies operate consistently across host countries. This will create depth and credibility, not just volume.

3. **Clarify enforcement and compliance frameworks**
   Most participating states have yet to define pen-alties or deadlines for compliance. Transparent, aligned enforcement, including clear penalties, would strengthen the price signals, help intermediaries structure effective procurement solutions and help airlines plan procurement with confidence.

The challenge for CORSIA is not demand, but delivery. Airlines are preparing to comply, yet supply-side bottlenecks and administrative complexity continue to slow progress. These challenges are common in nascent compliance markets and can be overcome through coordinated action.

Aviation accounts for a growing share of global emissions, and a credible credit mechanism remains essential to managing its transition as longer-term measures such as SAF and efficiency improve-ments scale up. The foundations are sound; what matters now is speed, consistency, and collective commitment to deliver a market that works in prac-tice, not just in policy. What the sector achieves in Phase 1 will set the foundations for Phase 2 (2027–2035), where the same authorisation and adjustment rules will determine whether CORSIA's market can scale with confidence.



Jaclyn Foss *leads business development for CFP Energy's Voluntary Carbon Markets team, supporting corporates and investors with carbon credit strategies across emerging compliance regimes and the voluntary market. She focuses on practical structuring solutions that help clients plan procurement and manage risk related to both compliance exposure and longer-term net-zero goals.*

MAKING CBAM EFFECTIVE: PRACTICAL RECOMMENDATIONS

CORSIA DEMONSTRATES HOW SECTORAL FRAMEWORKS CAN TRANSLATE GLOBAL RULES INTO PRACTICAL MECHANISMS. AT THE SAME TIME, NEW TRADE POLICIES ARE BEGINNING TO ALIGN CARBON COSTS ACROSS BORDERS. IN THE NEXT PIECE, SARAH HAY OF NORSK HYDRO EXPLORES HOW THE EU'S CARBON BORDER ADJUSTMENT MECHANISM (CBAM) SEEKS TO PROTECT INDUSTRIAL COMPETITIVENESS WHILE ACCELERATING REAL DECARBONISATION.

"We will only be successful if we manage to bridge the domains of competitiveness, climate action, and independence."- EU Commissioner for Climate, Net Zero and Clean Growth, Wopke Hoekstra, Extraordinary Meeting of the ENVI Committee, 5 May 2025

The EU's CBAM is a first-of-its-kind climate tool; one that directly links trade with carbon costs. Its core aim is to level the playing field between EU producers, who pay for their emissions under the EU ETS, and importers who may not face equivalent carbon pricing. CBAM also seeks to support global decarbonization by encouraging third countries to adopt and strengthen carbon pricing systems.

However, translating policy into practice is rarely straightforward. Even for seasoned carbon pricing experts, CBAM can feel complex, technical, and opaque.

WHY DOES COMPETITIVENESS MATTER IN A CLIMATE CONTEXT?

Consider this: primary aluminium production in Europe emits less than half the global average.[28] If our plant in Sunndal, Norway was replaced by equivalent production in India or South Africa, global emissions could rise by over 5 million tonnes of CO_2. This alone would cancel out Norway's emissions cuts since 1990.[29] Yet, since 2021, the EU's primary aluminium capacity has shrunk by 50 percent, largely due to the energy crisis in 2022 which put significant cost pressure on European smelters as electricity prices soared, resulting in production cuts and permanent closures.[30]

As an aluminium company, headquartered in Europe and with a global presence, CBAM isn't just a policy headline for us, it's a daily reality. From reporting requirements to market dynamics, the practical implications are already being felt across our value chain.

We support CBAM provided it works as intended. However, as CBAM currently stands, this is not the case for aluminium.

In 2023, we partnered with the consultants, Arkwright, to analyse how CBAM will impact the aluminium industry once fully phased in. The findings were clear: unless key flaws are addressed, CBAM risks undermining its own objectives of protecting European industry competitiveness, rewarding decarbonization and driving real climate impact.

INCENTIVISING REAL DECARBONIZATION, NOT CIRCUMVENTION

To achieve its aims, CBAM must drive genuine decarbonization, not encourage resource shuffling or circumvention.

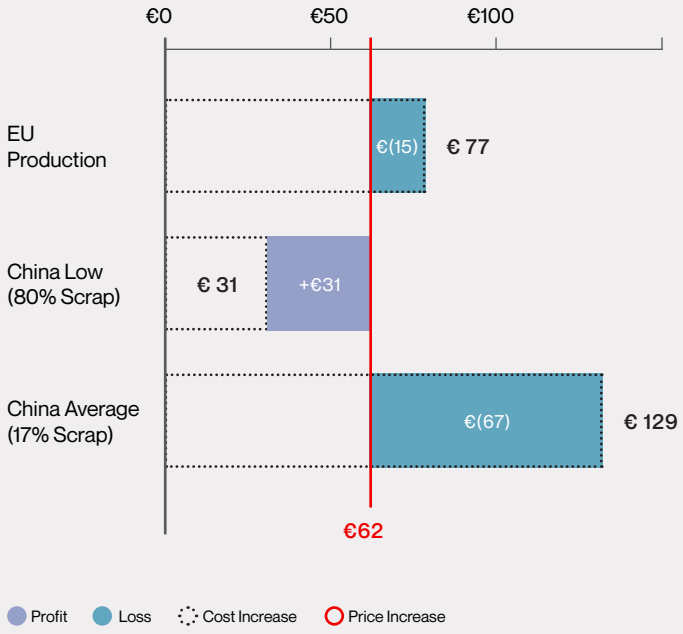
Scrap loophole

One major design flaw for aluminium is that remelted scrap is assigned zero emissions (and, therefore, zero carbon costs) under CBAM. This issue was highlighted in both the Draghi report[31] and the European Steel and Metals Action Plan.[32] Solving it is critical for both European industrial competitiveness and climate objectives.

This loophole gives non-EU producers a significant cost advantage, as they can evade carbon costs under CBAM, while European producers pay carbon costs because of the EU ETS. In the EU, these costs are embedded in the price of aluminium throughout the value chain, including in scrap, which closely tracks the price of primary aluminium.

CBAM LINKS TRADE WITH CARBON COSTS TO PROTECT EU COMPETITIVENESS AND **DRIVE GLOBAL DECARBONIZATION** — BUT CURRENT DESIGN FLAWS UNDERMINE ITS GOALS.

FOR ALUMINUM PRODUCTS (CN 7601[61])



Source: Sandbag, using data from JRC and the European Commission

The scale of the issue is substantial, with aluminium scrap representing a significant share of the global aluminium market. Arkwright's[33] analysis concluded that by 2035, up to 4 million tonnes of aluminium from non-EU/EEA recyclers could enter the EU market due to the scrap loophole, potentially pushing out 35 percent of current EU recycling capacity.

Analysis from Sandbag[34] adds further concern: simply by increasing scrap content in their metal, Chinese aluminium exporters could turn the impact of CBAM from 67 EUR cost to a 31 EUR profit per tonne of aluminium (see figure above).

This loophole could also encourage foreign producers to artificially inflate scrap volume; overproducing, remelting and exporting aluminium scrap to Europe under misleading "carbon-free" claims.

To close this loophole, aluminium scrap must be included in CBAM and assigned the same embedded direct emissions as primary aluminium. This would:

- Align CBAM with the EU ETS
- Create a level playing field
- Reduce fraud risks
- Safeguard European recyclers
- Support climate ambitions

Downstream loophole

Another key flaw is that CBAM's product scope is too limited: most downstream aluminium products, like car wheels, are excluded. This creates a clear risk where EU downstream producers face carbon costs, while foreign producers do not.

Take car wheels: as a result of an increase in input prices due to CBAM, car wheels produced in the EU/EEA will face a carbon cost of ~$240 per tonne aluminium, while imported wheels face zero.[35] Without broader coverage under CBAM, downstream production will shift abroad, undermining EU industry and climate efforts.

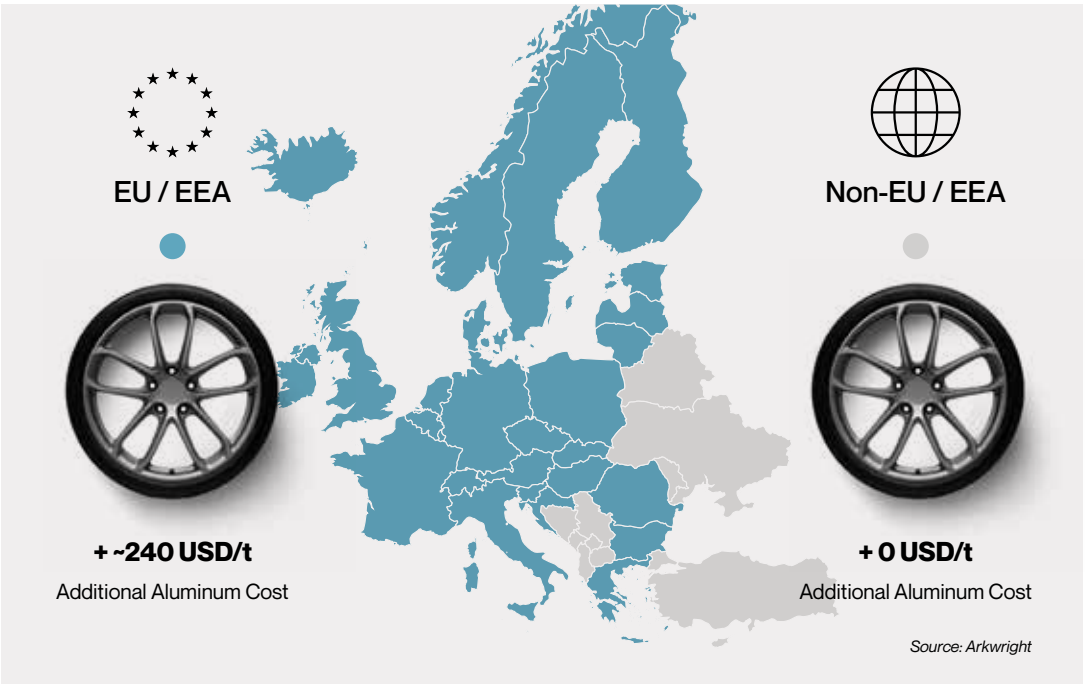
CBAM must expand to include all relevant downstream aluminium products, prioritising those, such as automotive components, building materials and packaging, that:

- have high aluminium value relative to the final price, and
- are highly commoditized

SUPPORTING FAIR COMPETITION, NOT RESOURCE SHUFFLING

Including indirect emissions for aluminium may seem logical, but doing so prematurely could backfire. European producers already face carbon costs in electricity prices, even when using 100 percent renewable energy. That's because European power prices are set by the marginal producer (usually fossil-based) which inflates costs for all. This carbon cost in the power price is unique to Europe.

THE SCRAP LOOPHOLE COULD ALLOW UP TO **4 MILLION TONNES** OF NON-EU ALUMINIUM INTO EUROPE BY 2035, THREATENING 35% OF EU RECYCLING CAPACITY.



THE URGENCY OF ESTABLISHING A STRONG BUSINESS CASE FOR INDUSTRIAL DECARBONISATION HAS NEVER BEEN GREATER.

If CBAM includes indirect emissions before the EU grid is close to decarbonization (and a fossil-based producer no longer sets the electricity price), renewables-based EU producers will be penalized because third-country producers using renewable energy won't face the same carbon cost on import, giving them a competitive edge.

This could lead to resource shuffling with third countries sending renewables-based aluminium to Europe, competitiveness of low-carbon European producers being undermined and likely no net reduction in global emissions.

So, what's the solution?

EU ETS indirect cost compensation must remain in place until:

- the European electricity grid mix is decarbonized and fossil-based power no longer sets electricity prices
- CBAM proves fully effective in delivering carbon leakage protection equivalent to that provided by the ETS indirect cost compensation scheme.

AN EFFECTIVE CBAM IS ESSENTIAL FOR CLIMATE AND COMPETITIVENESS

The urgency of establishing a strong business case for industrial decarbonisation has never been greater. Yet global disparities in climate policy ambition and market mechanisms threaten the competitiveness of European industry.

CBAM, if designed correctly, has the real opportunity to reward decarbonization both in Europe and abroad, whilst protecting European competitiveness. But to achieve this, the design must be fixed and a robust review mechanism implemented to identify and rectify flaws on a regular basis.

Getting CBAM right isn't just a policy detail, it's vital for climate ambition and competitiveness.

Sarah Hay *joined Norsk Hydro in 2022 where she leads work on climate policy. With a focus on carbon pricing, she seeks to drive industrial decarbonisation and policy development in the aluminium sector. Prior to joining Norsk Hydro, she spent a decade working as a global trade consultant at EY, advising international businesses on how to navigate customs, VAT and excise duty complexities in their supply chains. Sarah is the chair of IETA's CBAM Taskforce.*

ANNA GASTMAIER, CLIMATE CHANGE AND DECARBONIZATION, VALE HOLDINGS B.V.

CBAM: CHALLENGES AND OPPORTUNITIES – A VALE PERSPECTIVE

FROM AN INDUSTRIAL VANTAGE POINT, CBAM'S SUCCESS WILL DEPEND ON THE READINESS AND ADAPTABILITY OF GLOBAL SUPPLY CHAINS. THE FOLLOWING CONTRIBUTION FROM ANNA GASTMAIER AT VALE SHARES INSIGHTS FROM A MULTINATIONAL PRODUCER NAVIGATING CBAM'S PRACTICAL REALITIES – FROM DATA SYSTEMS TO GLOBAL ALIGNMENT.

CBAM HAS MADE FLEXIBLE, HIGH-GRANULARITY **GHG ACCOUNTING** ESSENTIAL — PUSHING VALE TO ACCELERATE DATA INTEGRATION AND VALUE CHAIN TRACEABILITY.

As a global mining company headquartered in Brazil and present in 19 countries, Vale operates across diverse regulatory landscapes and is deeply integrated into global value chains. For Vale, the EU CBAM represents a significant shift in how carbon emissions are priced and managed across borders.

THE IMPERATIVE OF ROBUST GHG ACCOUNTING SYSTEMS

One of the most immediate lessons from CBAM's implementation is the critical importance of having a robust GHG accounting system. For Vale, this has meant accelerating the development of internal systems and data lakes capable of tracking emissions across our operations with granularity and accuracy, while evolving value chain data management, as ores and metals are precursors to downstream CBAM goods.

Investing in flexible software and data integration has been essential, since each regulatory framework requires different reporting boundaries, aggregations and GHG emissions sources, while enabling faster responses to regulatory changes and more efficient reporting. This has also enhanced our ability to engage with suppliers and customers on emissions data, fostering transparency and collaboration across the value chain.

TRANSITION PHASE INSIGHTS: COLLABORATION IS KEY

One of the most significant takeaways is the importance of collaboration. For Vale, this has meant understanding its reporting needs, supporting importers and traders by ensuring that the GHG emissions data meet their compliance efforts.

Engaging with industry associations, such as IETA, and the relevant regulatory bodies to clarify methodologies and expectations has also been essential to enhance internal capabilities. This dialogue has been instrumental in identifying gaps in data availability, harmonizing calculation approaches, and engaging in pragmatic timelines that reflect the realities of global operations.

CHALLENGES AND AREAS FOR IMPROVEMENT

Despite the progress made, several challenges remain. In particular, the lack of harmonization between EU requirements and other international frameworks can lead to duplication of efforts and increased compliance costs.

We also see a need for greater recognition of climate efforts undertaken outside the EU. Vale is actively investing in decarbonization and implementing regional strategies to achieve net-zero emissions. A more inclusive, multilateral approach that acknowledges these efforts could strengthen CBAM's effectiveness and enhance the resilience of global value chains.

LOOKING AHEAD: OPPORTUNITIES FOR GLOBAL ALIGNMENT

While CBAM presents challenges, it also offers opportunities. It has catalyzed internal improvements in emissions tracking and reporting, strengthened our engagement with stakeholders, and reinforced the strategic importance of decarbonization.

Looking ahead, it is essential that CBAM evolves to include:

- Recognition of carbon pricing mechanisms and climate efforts outside the EU.
- Provision for consolidated parent company and operator pooling of CBAM certificates, supporting importers in navigating CBAM compliance.
- Further policies are also needed to integrate carbon capture, both geo- and nature-based, to CBAM.

RECOGNISING CLIMATE EFFORTS OUTSIDE THE EU AND **HARMONISING RULES** WOULD STRENGTHEN CBAM AND REDUCE UNNECESSARY COMPLIANCE BURDENS.

CBAM HAS BECOME A CATALYST FOR INTERNAL IMPROVEMENTS — STRENGTHENING EMISSIONS REPORTING, STAKEHOLDER ENGAGEMENT, AND THE STRATEGIC DRIVE TOWARD DECARBONIZATION.

Anna Gastmaier *is a climate policy and environmental specialist advancing decarbonization and regulatory compliance in the mining sector. She leads alignment with evolving climate and trade rules and supports decarbonization strategies across mining value chains. Anna's expertise includes climate-risk assessment, scenario analysis, and global disclosure frameworks such as TCFD, IFRS, and CSRD. She engages with policymakers, industry groups, and investors, represents Vale in global forums, and serves as Chair of the ICMM Decarbonization Working Group.*

CHAPTER 3

BUILDING TRUST IN THE VOLUNTARY CARBON MARKET: INTEGRITY, DATA, AND LEGAL FOUNDATIONS

The voluntary carbon market (VCM) has long been a testing ground for innovation, investment, and corporate climate ambition. It now sits at a pivotal moment, where rising expectations for transparency and quality meet persistent concerns about credibility. This chapter explores how the VCM is working to build trust through clearer legal definitions, stronger governance, and improved data transparency. It highlights growing recognition of carbon credits as tradeable assets with rights and obligations, MSCI's data insights on market trends, and ongoing integrity reforms by ICVCM and VCMI. Ultimately, the chapter considers what the next phase requires: clarity, consistency, and confidence.

LEGAL NATURE OF CARBON CREDITS

INTEGRITY BEGINS WITH DEFINITION. BEFORE CREDITS CAN EARN CONFIDENCE, THEIR LEGAL STATUS MUST BE CLEAR. IN THE NEXT ANALYSIS, MARISA MARTIN AND SARA OISHI OF ARDEN CLIMATE UNPACK THE LEGAL NATURE OF CARBON CREDITS AND WHY CLEAR CLASSIFICATION IS ESSENTIAL FOR MARKET STABILITY AND INVESTMENT.

The legal nature of a carbon credit is critical because it determines how credits can be owned, traded, and used. Whether a carbon credit is treated as a property right, a license, or a contractual claim affects everything from its tax treatment to whether it can be enforced by a court or used as collateral.

For project developers, investors, buyers, and regulators, legal clarity is essential to avoid disputes, ensure proper transfer and retirement of credits, and maintain confidence in the market. Clearly defining the legal status of a carbon credit helps ensure that carbon markets function efficiently, guard against fraud and double counting, and support the scaling of carbon finance.

However, before defining its legal nature, it is important to understand the attributes of a carbon credit.

Typically, a carbon credit represents a quantified and serialized reduction or removal of a volume of carbon dioxide equivalent (CO2e) from the atmosphere, verified by a third party and recorded on a registry.[36] Carbon credits[37] may include:

- Verified carbon credits traded in the voluntary market;
- Internationally Transferred Mitigation Outcomes (ITMOs) under Article 6.2 of the Paris Agreement; and
- Article 6.4 units issued by the Supervisory Body of the Paris Agreement's Crediting Mechanism.

Many jurisdictions have not explicitly defined the legal nature of a carbon credit. In the absence of specific legislation, market practice generally treats carbon credits as a form of property, applying domestic property law principles accordingly.[38] Recognizing carbon credits as property offers market benefits, particularly regarding ownership and transferability.[39] If treated as property, carbon credits typically have the following attributes:

- Rights are created and defined by domestic property law.
- They are enforceable against third parties (proprietary rights).
- They can be transferred to third parties.
- They may be used as collateral (subject to security rights).
- They form part of the owner's estate in the event of insolvency.

carbon credits may fall under different classifications depending on local legal and regulatory frameworks, potentially triggering varying rules around ownership, reporting, foreign investment, or taxation. For example[40]:

- In the United States, carbon credits are often treated as "general intangibles" under the Uniform Commercial Code and as "non-financial commodities" by the Commodity Futures Trading Commission (CFTC) when subject to physical delivery.
- In Australia, Australian Carbon Credit Units (ACCUs) and Safeguard Mechanism Credits are considered financial products under applicable law.
- Elsewhere, particularly where carbon credits are tokenized or recorded on blockchain-based registries, they may be regulated as digital assets.

LEGAL CLARITY IS THE **FOUNDATION** THAT ALLOWS CARBON CREDITS TO BE OWNED, TRADED, ENFORCED, AND TRUSTED.

CARBON CREDITS RISK **INCONSISTENT TREATMENT** ACROSS BORDERS, HIGHER TRANSACTION COSTS, AND STALLED INVESTMENT.

As countries develop legal frameworks to implement Article 6 of the Paris Agreement and support voluntary carbon markets, defining the legal nature of carbon credits will be key to attracting and protecting carbon finance. Without clear legal recognition, market participants may have to rely on judicial interpretation or analogies to existing asset classes, leading to inconsistent treatment, legal uncertainty, and operational confusion.

For instance, consider a cross-border transaction where a private party is seeking to sell project-scale credits from one country to another. In many cases, a critical element making such a transaction possible—or enabling the transaction to take place at a larger, more commercially viable scale—is participation by a lender to provide upfront financing for project development. However, a lender may expect the project developer to pledge the carbon credits generated by the project as collateral to secure the loan. Whether doing so is an option will depend on how the countries in which the seller, buyer, and lender are located treat legal rights over carbon credits. Moreover, the processes by which any available security interests are perfected will similarly depend on multiple jurisdictions' approach to legal rights over carbon credits. To the extent the relevant countries define the legal nature of carbon credits differently, these types of cross-border secured transactions become more complex and more expensive.

As carbon markets grow and take on a more central role in global decarbonization efforts, more countries should take steps to expressly define the legal status of carbon credits. Legal clarity underpins market integrity, supports investment, and facilitates efficient credit transfer and enforcement. While treating carbon credits as property has proven practical in many contexts, divergence between countries (or legislative silence) highlights the need for harmonized legal recognition. Without it, inconsistent treatment across jurisdictions could undermine trust and slow the growth of carbon finance.

Marisa Martin *is a Chambers-ranked lawyer and international expert in climate law and policy, with deep expertise in Article 6 and nature-based solutions.*

Sara Olshi *is a licensed attorney who, with a background spanning law, engineering, and finance, helps clients develop and transact environmental assets.*

GUY TURNER, MANAGING DIRECTOR, MSCI CARBON MARKETS

CARBON CREDIT DEMAND OUTLOOK: VOLUNTARY, SOVEREIGN AND COMPLIANCE PATHWAYS

AS LEGAL FRAMEWORKS EVOLVE, MARKET DEMAND PROVIDES THE OTHER HALF OF THE EQUATION. THE FOLLOWING ANALYSIS FROM MSCI MAPS HOW VOLUNTARY AND COMPLIANCE DEMAND ARE INTERACTING TO SHAPE THE NEXT DECADE OF CARBON CREDIT MARKETS.

CARBON MARKETS ENTER A DEMAND-LED DECADE

Carbon markets are demand-driven systems. The willingness of companies, governments, and sectors to purchase credits—whether for compliance, climate leadership or net zero targets—creates the signals that mobilize investment. Over the past decade, the demand for carbon credits has evolved from a niche offsetting practice into a multi-pillar system spanning voluntary corporate commitments, the aviation sector through CORSIA, government agreements under Article 6, and domestic emissions trading and tax schemes.

Understanding how these channels might grow and interact is central for policymakers, investors, and project developers. Without credible and expanding demand, supply has little incentive to scale. As the world approaches 2030, a milestone for both the Paris Agreement and corporate net zero pledges, forecasting demand across these pillars becomes critical.

Scenario analysis helps map not just the scale but also the composition of demand—compliance versus voluntary, sovereign versus corporate, reductions versus removals—each shaping the flow of capital and the pace of global decarbonisation.

THE DEMAND LANDSCAPE

Before looking ahead, it is important to anchor the discussion in today's baseline. Despite a downturn in the broader market, between 2021 and 2024 annual retirements and cancellations of carbon credits have remained flat at just under 200MtCO2e. And in the first half of 2025 companies retired around 100MtCO2e of credits, the highest first-half total in our data.

The trend toward higher integrity projects is also accelerating. If we look at just credits with an MSCI Carbon Credit Rating of BBB or better, 28Mt of credits were retired in 2024—two and a half times more than in 2021. During the first six months of 2025, credits rated BBB and above accounted for more than 35 percent of retirements, compared to the 25 percent share seen in the previous year.

Looking ahead across scenarios, our analysis suggests total demand could reach between 300 and 1,050 MtCO2e in 2030 and accelerate to 2.3 – 8.2 GtCO2e by mid-century. Our medium scenario sees carbon credit demand increase to 600 MtCO2e in 2030 and over 4.8 GtCO2e by 2050. Regional concentration is striking: North America, Europe, and East Asia already account for more than 85 percent of demand, reflecting both the density of corporate commitments and the presence of strong compliance frameworks. This trend is expected to continue over the next two decades.

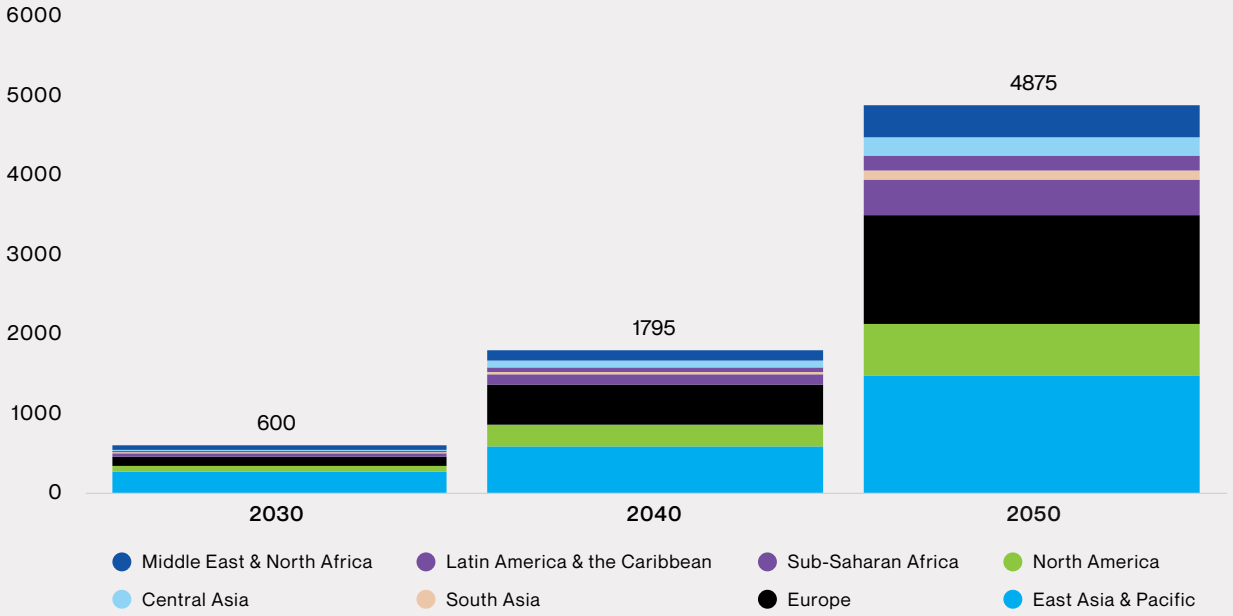
CORPORATE ACTION: THE ENGINE OF DEMAND

Among the different pillars of demand, corporates remain the largest and most dynamic force, continuing to define both the scale and character of the market. Despite reputational challenges and heightened scrutiny, companies still rely on carbon credits as a bridge to net zero.

By 2050, we estimate between 1.8 and 6.5 GtCO2e of demand could come from corporates—60 to 65 percent of which is linked to Science Based Targets initiative (SBTi)-aligned commitments. In the near term, however, demand is more diverse. By 2030, as much as half could be driven by broader carbon neutrality and climate claims outside of strict SBTi alignment. This underlines the variety of motivations shaping engagement with credit markets.

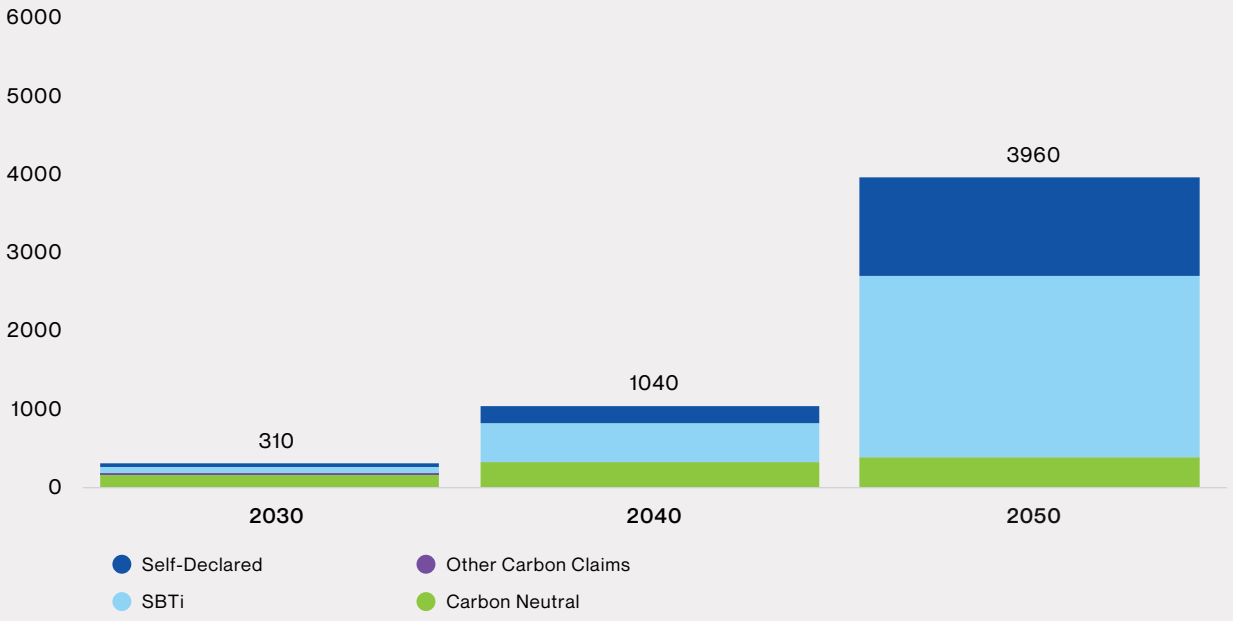
BY 2030, GLOBAL DEMAND FOR CARBON CREDITS COULD RANGE FROM **300 TO 1,050 MTCO2E** — RISING TO AS HIGH AS 8.2 GTCO2E BY 2050.

GLOBAL CARBON CREDIT DEMAND BY REGION IN MTCO2E (MEDIUM SCENARIO)



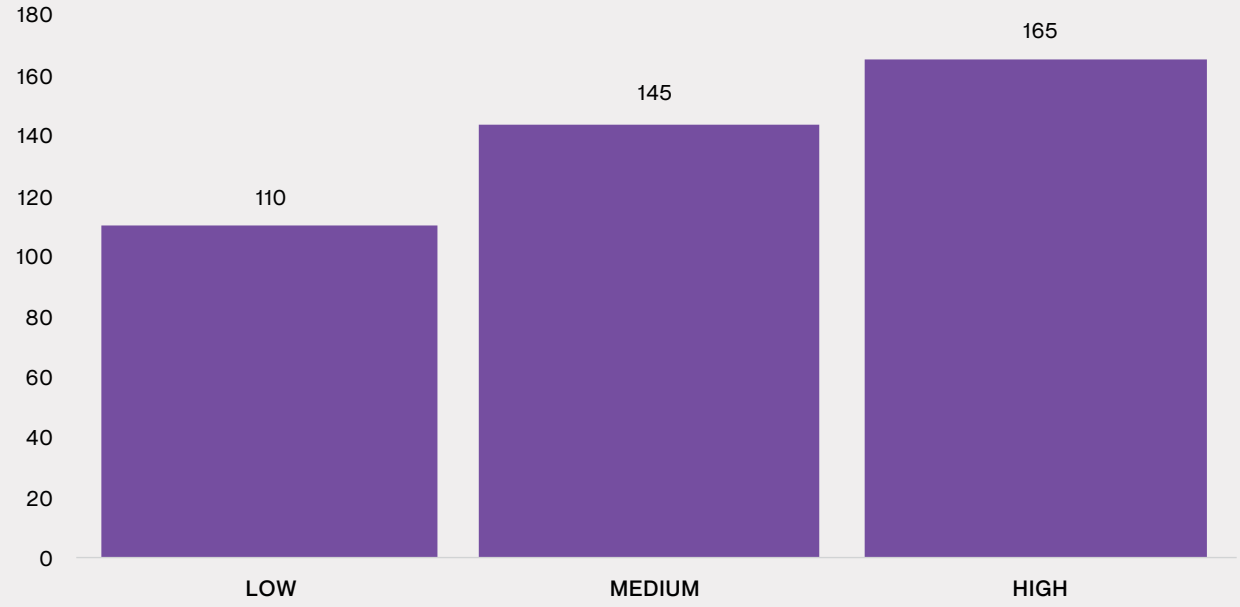
source: MSCI Carbon Markets

VOLUNTARY CORPORATE DEMAND FOR CARBON CREDITS BY TARGET TYPE IN MTCO2E (MEDIUM SCENARIO)



source: MSCI Carbon Markets

TOTAL CORSIA DEMAND FOR PHASE I (2024 – 2026)
HIGH, MEDIUM AND LOW SCENARIOS IN MTCO2E



source: MSCI Carbon Markets

AVIATION: CORSIA TAKES OFF

Beyond the corporate sphere, aviation represents the first global compliance-driven source of credit demand. CORSIA, the Carbon Offsetting and Reduction Scheme for International Aviation, is currently in its voluntary pilot phase before full compliance begins in 2027.

Airlines are expected to retire the bulk of their Phase I obligations in 2026–27, marking the first large-scale demand event under the scheme. Longer term, aviation demand is highly scenario dependent. Airlines may account for nearly a quarter of global demand in 2030, but as demand from other sectors accelerates, particularly from hard to abate sectors, we could see this share fall sharply to less than five percent by 2050. Still, cumulative CORSIA demand could amount to 4.6–7.4 GtCO2e by 2050, with European carriers playing a leading role.

SOVEREIGNS ENTER THE MARKET: ARTICLE 6.2

While airlines prepare for compliance, sovereign actors are beginning to enter as buyers under Article 6.2 of the Paris Agreement. Early movers such as Singapore, Switzerland, Ghana, and Senegal have signed bilateral agreements to trade internationally transferred mitigation outcomes (ITMOs).

Sovereign demand is expected to grow gradually—from 65–100 MtCO2e in 2030 to between 300 and 915 MtCO2ee by 2050. A critical distinction of this pillar is the requirement for corresponding adjustments for nations, ensuring emission reductions are not counted twice against both host country NDCs and buyers' targets. This adds complexity but also credibility to sovereign transactions, positioning Article 6.2 as a key building block for global market integration.

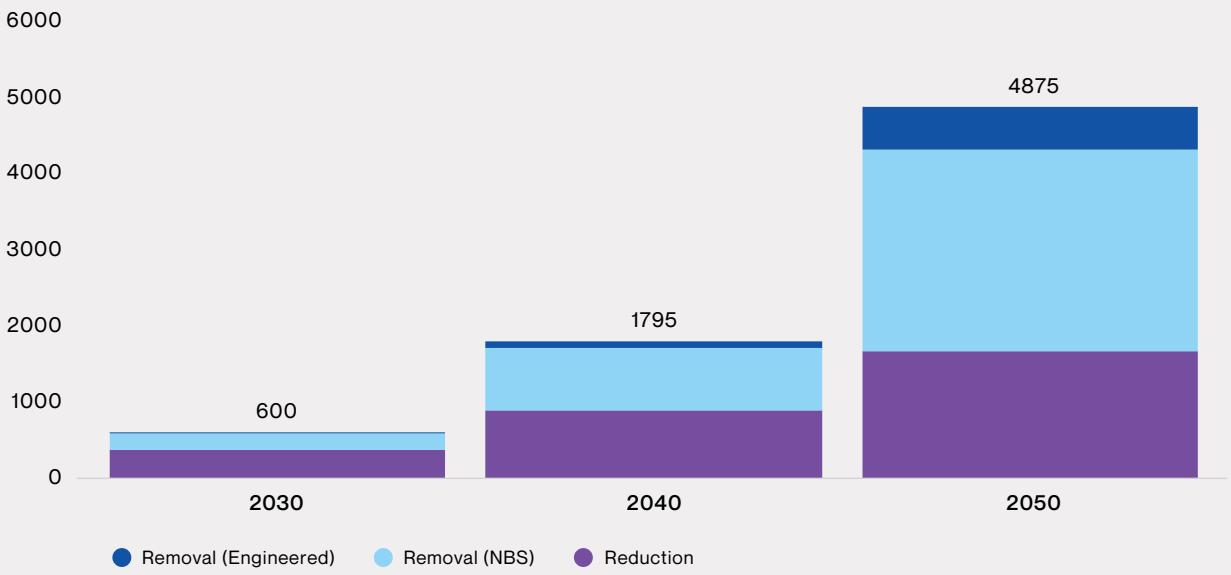
DOMESTIC ETS AND CARBON PRICING

Alongside international cooperation, domestic carbon pricing systems are expanding steadily. There are now 69 trading and tax schemes in operation worldwide, with more in development. Our analysis shows 15 of these schemes allow some use of carbon credits for compliance, increasing fungibility among carbon markets. These range from regional cap-and-trade schemes like the California program, which allows to use up to 4 percent of carbon credits from independent standards or registries to national carbon tax schemes like Chile which permit 100 percent of obligations to be offset.

Based on our modelling, by 2030, compliance demand for credits through domestic systems could range from 14 to 295 MtCO2e, rising to 82–420 MtCO2e by 2050. Although modest compared with corporate demand, these systems play a crucial role. They anchor national climate policy, provide clear signals to industry, and increasingly intersect with international trading frameworks.

BY 2050, COMPANIES COULD ACCOUNT FOR **1.8–6.5 GTCO2E** OF CREDIT USE.

GLOBAL CARBON CREDIT DEMAND SPLIT BY CREDIT TYPE IN MTCO2E (MEDIUM SCENARIO)



source: MSCI Carbon Markets

A MAJOR MARKET SHIFT IS UNDERWAY — **REMOVALS ARE SET TO OVERTAKE REDUCTIONS** BY 2040 AND COULD MAKE UP TWO-THIRDS OF TOTAL DEMAND BY 2050.

FROM REDUCTIONS TO REMOVALS

Across all these channels, the most transformative trend may be the shift in the type of credits demanded. Today, reductions dominate, accounting for roughly 90 percent of retirements. By 2040, removals are projected to surpass reductions, and by 2050 they could represent two-thirds of total demand.

This transition reflects both falling costs for technologies such as direct air capture (DAC) and bioenergy with CCS (BECCS), and tightening requirements in corporate and sovereign net zero pathways. Sectoral patterns will evolve too: aviation and power generation dominate demand in the 2020s, but by 2050, hard-to-abate industries such as materials and fossil fuels are expected to drive credit use.

CONCLUSION: SIGNALS FOR THE NET ZERO TRANSITION

Taken together, these trends illustrate how carbon markets are evolving from fragmented beginnings into a multi-pillar system capable of supporting the global net zero transition. Voluntary corporate action continues to dominate, but compliance through CORSIA, sovereign trading under Article 6.2, and domestic pricing schemes are each adding depth and resilience to demand.

By mid-century, carbon markets could support between 2.3 and 8.2 GtCO2e of annual demand. The composition of that demand—reductions versus removals, voluntary versus compliance, corporate versus sovereign—will determine where capital flows, which technologies scale, and how international cooperation under the Paris Agreement is realized.

The decade ahead will decide whether carbon markets mature into a backbone of climate finance or remain fragmented. Demand will set the course. All our future demand scenarios are based on H1 2026 global credit demand model report.

Guy Turner *leads MSCI Carbon Markets. He previously founded Trove Research, which was acquired by MSCI, to focus on voluntary corporate climate action and the global carbon-credit market. He has over 30 years of experience in climate, sustainability and the energy transition. He spent his first 15 years in consulting, advising companies and governments on a wide range of sustainability issues.*

MARK KENBER, VCMI EXECUTIVE DIRECTOR

CARBON MARKETS: FROM CAUTION TO CONFIDENCE

DEMAND PROJECTIONS ILLUSTRATE THE SCALE OF OPPORTUNITY BUT ALSO HIGHLIGHT THE NEED FOR CONFIDENCE AND CONSISTENCY. THE NEXT ARTICLE BY THE VOLUNTARY CARBON MARKETS INTEGRITY INITIATIVE (VCMI) EXAMINES HOW CLARITY IN RULES AND CORPORATE PARTICIPATION CAN UNLOCK PRIVATE CAPITAL AT SCALE.

Research by Accenture for the Voluntary Carbon Markets Integrity Initiative (VCMI) in early 2025 suggests that companies increasingly recognise the role carbon markets can play in accelerating climate action. Yet investment is constrained by three consistently mentioned barriers.

The first is reputational risk. Concerns about the integrity of carbon-credit projects, and about how firms use those credits, continue to outweigh the benefits of participation. The second is inconsistency. Standards—both regulatory and voluntary—remain fragmented, leaving companies uncertain about what constitutes quality and credible use. The third is financial. With decision-making authority now resting largely with chief financial officers, firms require a clear, defensible business case to justify investment in carbon-credit portfolios.

None of these obstacles is insurmountable. The foundations for a credible market are emerging through efforts to raise quality, establish integrity standards, and build confidence among buyers. The stakes are high: a market valued at $1.4 billion today could grow to between $40 billion and $250 billion by 2050, according to MSCI. Such capital would contribute meaningfully to the $1.3 trillion in annual climate finance agreed at COP29 as necessary by 2035 to fund mitigation, adaptation, and nature restoration.

Mobilising that finance will require clear, consistent, and predictable rules for carbon-credit quality and use. The Integrity Council for the Voluntary Carbon Market (ICVCM) is defining standards for the supply side, while VCMI has set out Foundational Criteria for high-integrity corporate participation: firms must maintain and disclose a greenhouse-gas inventory, adopt and publicly report science-based near-term emission-reduction targets, commit to reaching net zero by 2050, demonstrate progress toward those targets, and ensure that their public policy advocacy aligns with the Paris Agreement.

But meeting these criteria is only the beginning. To move from principles to practice, governments must provide the consistency and policy coherence that companies seek. Only with such clarity can firms engage confidently and at scale, integrating carbon credits into their global operations while maintaining credibility and ambition.

THREE BARRIERS CONTINUE TO CONSTRAIN CORPORATE INVESTMENT: **REPUTATIONAL RISK, INCONSISTENT STANDARDS, AND THE NEED FOR A DEFENSIBLE BUSINESS CASE.**

A $1.4 BILLION MARKET TODAY COULD GROW TO **$40–250 BILLION** BY 2050 — BUT ONLY IF GOVERNMENTS PROVIDE CLEAR, CONSISTENT RULES FOR HIGH-INTEGRITY CREDIT USE.

The Coalition to Grow Carbon Markets, launched at London Climate Action Week in June 2025, aims to do just that. Co-chaired by Kenya, Singapore, and the United Kingdom, with France and Panama as founding members, the coalition brings together ambitious governments committed to advancing climate action through scaling credible business use of high-integrity carbon credits alongside direct decarbonisation. It seeks to harmonise national approaches and catalyse private-sector demand for high-integrity credits. At COP30 the Coalition announced five new members, including Switzerland and Canada, bringing total membership to 10. It also unveiled Shared Principles, endorsed by 11 governments and welcomed by a further four, that will create alignment on critical questions about the role of carbon credits and set the direction of travel for national policy and incentives to drive business use of carbon credits investment.

The world will miss its climate targets unless much more finance flows to projects and businesses that can cut emissions quickly and affordably while boosting growth. Private capital will be essential and high-integrity carbon markets can complement emission-reduction efforts by channelling funds to projects that deliver verifiable climate benefits. The work of the Paris Agreement Crediting Mechanism (PACM), CORSIA and ICVCM and VCMI to set new standards for integrity, ratings agencies professionalising quality assessments, and technology enabling far more rapid and scalable measurement and monitoring of project results, mean the voluntary carbon market is delivering carbon credits that represent credible climate action.

Now, to harness the full potential of carbon markets, governments must offer steadier regulatory ground, and companies must act with transparency and discipline. If they succeed, carbon markets will evolve from peripheral instruments of corporate responsibility into a central pillar of global climate governance—linking ambition, accountability, and capital in the pursuit of net zero.

Mark Kenber, *is Executive Director of VCMI and Head of the Secretariat for the Coalition to Grow Carbon Markets, with nearly three decades of experience in market-based environmental policy and carbon markets. His previous roles include positions at Fundación Natura in Ecuador, WWF's International Climate Change Program, The Climate Group, Mongoose Energy Ltd, and Climate Advisers, and he has served as Climate Change Advisor to the Ecuadorian Government. Mark is also a board member of C:C Brighton.*

AMY MERRILL, CHIEF EXECUTIVE OFFICER OF THE INTEGRITY COUNCIL FOR THE VOLUNTARY CARBON MARKET (ICVCM)

BUILDING INTEGRITY IN THE VOLUNTARY CARBON MARKET: ICVCM'S PROGRESS AND IMPACT

THE INTEGRITY COUNCIL FOR THE VOLUNTARY CARBON MARKET (ICVCM) SETS THE STANDARD FOR HIGH-NTEGRITY SUPPLY, WHEREAS THE VCMI LAYS OUT THE ROADMAP FOR HIGH-INTEGRITY USE OF CREDITS. IN THE FOLLOWING PIECE, THE ICVCM OUTLINES HOW ITS CORE CARBON PRINCIPLES ARE BECOMING THE GLOBAL QUALITY THRESHOLD FOR CARBON CREDIT INTEGRITY

The Integrity Council for the Voluntary Carbon Market (ICVCM) was established in 2021 to bring clarity, trust, and high-integrity standards to the global carbon market ecosystem. At the heart of ICVCM's mission is the development and implementation of the Core Carbon Principles (CCPs)—a rigorous and independent global threshold for carbon credit quality. Through its assessments, stakeholder engagement, and continuous improvement work, the ICVCM is helping build a market that can credibly contribute to climate impact at scale.

PROGRESS ON ASSESSMENTS

As of October 2025, the ICVCM has assessed over 40% of the carbon crediting methodologies in the market, reviewing 57 methodologies and seven carbon crediting programs for adherence to the CCP Assessment Framework. When carbon crediting programs and methodologies are CCP approved, they are subject to ongoing assurance by the ICVCM, ensuring that compliance to the CCPs is maintained over time. So far the Integrity Council has approved specific methodologies within the following project categories: Ozone Depleting Substances (ODS); Landfill Gas (LFG); leak detection and repair; reducing emissions from deforestation and forest degradation in developing countries (REDD+); Jurisdictional REDD+; Afforestation, Reforestation and Revegetation (ARR); Adipic Acid; clean cookstoves; household biodigesters; biochar; Improved Forest Management (IMF); and a range of additional Carbon Dioxide Removal (CDR) methodologies including Carbon Capture and Storage (CCS) and Direct Air Capture (DAC).

Some of the newer CCP-Approved methodologies do not yet have any issued credits. However, there is a large pipeline of both new and existing projects that will issue CCP credits by transitioning to these methodologies in the near future. It is projected that several million tonnes of credits will be issued under these methodologies in the coming years and the percentage of CCP-labelled credits in the market will rise as a result. Over 120 new projects using CCP-Approved methodologies are under development as of 30 June 2025, according to a Climate Focus report.

Project types with methodologies that are still in the ICVCM's assessment pipeline include nature-based solutions like mangrove and wetland restoration, marine and technological carbon dioxide removals, and projects reducing methane emissions from agriculture.

MARKET IMPACTS AND ALIGNMENT

ICVCM's work is raising standards in carbon markets. Carbon crediting programs have made substantive changes to meet CCP requirements, and the label is globally recognized as a mark of quality and credibility. Regulatory bodies are increasingly referencing the CCPs as a valid quality threshold in policy. For example, the French government launched a 'charter' supported by 17 companies, inviting organisations to commit to using carbon credits aligned with Integrity Council standards. The Monetary Authority of Singapore now requires CCP alignment for transition credits. In the UK, the Voluntary Carbon and Nature Markets Consultation proposed CCPs as a minimum baseline for integrity for companies participating in the market.

Additionally, there are several multilateral initiatives coalescing around the CCPs as the global quality threshold for carbon credits. These include bodies such as the UNDP, who have pledged to require the carbon crediting programs it supports to be CCP-Eligible and encourages the development of high-integrity markets in line with the CCPs and CCP Assessment Framework. The UNEP and the World Bank have also pledged similar support.

THE CORE CARBON PRINCIPLES ARE BECOMING THE **GLOBAL BENCHMARK** FOR CREDIT QUALITY — RAISING STANDARDS AND RESHAPING DEMAND ACROSS THE MARKET.

WITH OVER 40% OF METHODOLOGIES ASSESSED AND WIDESPREAD REGULATORY ADOPTION, THE ICVCM IS ESTABLISHING THE **FOUNDATION OF TRUST** THE VOLUNTARY MARKET DEPENDS ON.

This regulatory and policy momentum is mirrored by market actors. For example, the world's largest spot carbon exchange, Xpansiv CBL, launched the first standardised contracts aligned with the CCPs and began trading CCP-labelled credits in July 2024.

The CCPs have had a tangible impact on credit demand and credit pricing since the first CCP labels entered the market. Analysis by Patch finds that CCP-labelled credits are now the most in demand credits on the market, with almost 40% of buyers looking for CCP-labelled credits. Additionally, research by Ecosystem Marketplace finds that CCP-Approval is prompting an increase in demand for quality across the market as buyers prioritise CCP-Approved credits for their purchasing strategies. CCP credits have also achieved a price premium since entering the market. For example, CCP-Approved landfill gas credits saw a price increase of 35% and a 149% increase in trading following approval by the ICVCM in April 2024.

INDIGENOUS PEOPLES AND LOCAL COMMUNITIES

A cornerstone of ICVCM's strategy is ensuring the prioritisation of Indigenous Peoples and Local Communities as key decision makers in the development of high integrity carbon markets. The independent Indigenous Peoples and local communities Engagement Forum, supported by the ICVCM, is a platform for members to engage directly on carbon market governance and standard-setting. Strategic priorities for the Forum include respecting traditional ecological knowledge, supporting Indigenous entrepreneurship in carbon crediting, and embedding customary laws into project design and grievance mechanisms.

The ICVCM's work alongside the Forum enhances the integrity of the market and ensures that carbon finance supports equitable outcomes and community self-strengthening.

LOOKING AHEAD

The ICVCM's goal to deliver a global high-integrity carbon credit quality threshold is further supported by strategic stakeholder engagement and continuous improvement. The ICVCM has established 13 Continuous Improvement Work Programs (CIWPs) that explore how the Integrity Council can refine future versions of the Assessment Framework, as well as broader areas for adaptation and maturation in the carbon market. The CIWPs also identify where and how the broader market can evolve, develop and mature to unlock barriers to scale.

Through rigorous assessments and assurance, stakeholder engagement and inclusive governance, the ICVCM is laying the foundation for carbon markets to deliver real, measurable climate impacts alongside positive sustainable development outcomes.

As the carbon market ecosystem continues to evolve and coalesce around the CCPs as the global threshold for high quality carbon credits, the ICVCM's role as a standard setter is building trust and critical collaboration among integrity initiatives in this space.

Amy Merrill *is the CEO of the ICVCM, the global body setting quality standards for voluntary carbon markets. From 2011 to 2021, she led UNFCCC work on Article 6 of the Paris Agreement, guiding negotiations that produced the COP26 implementation rules. She previously served as senior lawyer for the Kyoto mechanisms and compliance bodies and earlier practiced as a leading climate finance lawyer in London. After UNFCCC, she took senior legal and operational roles in natural capital and at ICVCM. She is a UK-qualified lawyer with over 20 years' experience.*

CARBON MARKETS AT A CROSSROADS: OVERCOMING UNCERTAINTY REQUIRES CLEAR POLICY GUIDANCE

WITH GOVERNANCE AND QUALITY FRAMEWORKS TAKING HOLD, PRIVATE SECTOR ACTORS MUST NAVIGATE HOW TO USE MARKETS EFFECTIVELY AND RESPONSIBLY. THE PERSPECTIVE FROM KEVIN SOUBLY EXPLORES HOW CORPORATE POLICY CLARITY AND HIGH-INTEGRITY USE OF CREDITS CAN RESTORE CONFIDENCE ACROSS BOTH VOLUNTARY AND COMPLIANCE MARKETS.

Carbon markets are at an inflection point in 2025 – a year marked by a complex interplay of geopolitics, economic headwinds, regulatory evolution, and shifting market behaviours. Nonetheless, the voluntary carbon market has demonstrated resilience, while compliance-focused mechanisms have continued to scale.

In fact, 2025 remains on track for record retirement volumes. Market data also shows increasing year-on-year demand for higher-rated credits, including an emerging price premium – proof that even amidst market apprehension, demand signals continue to strengthen and mature.

The ICVCM's Core Carbon Principles have had a supportive effect in reshaping the market's understanding of quality, as has increased use of and coverage by credit ratings agencies. Other innovations, including significant methodological updates, improved MRV technologies, and credit insurance products, provide increased opportunities for market confidence. As a result, buyers are increasingly capable of more sophisticated purchasing decisions.

Corporate climate commitments are evolving, under pressure from both increased regulation and public scrutiny to deliver on grand declarations. So too do corporate sustainability aspirations face a reckoning from economic pressures and political shifts – this is exemplified in the recent disbanding of the Net-Zero Banking Alliance. Recent developments make clear the need for target setting to be underpinned by detailed delivery strategies capable of executing amidst challenging political, economic, and energy security contexts.

Given these pressures and continually increasing physical climate risk, generic offsetting strategies and broad-based marketing claims will need to evolve into more sophisticated and resilient decarbonization strategies, such as those recommended by the updated IETA's Guidelines for High Integrity Use of Carbon Credits.[41] Within these maturing approaches, carbon markets remain a strategically critical decarbonization lever – not only for addressing residual emissions but also as immediately deployable climate action while low-carbon technologies come to market and scale. For investors and users, this requires access to diversified credit portfolios across methodologies.

2025 IS ON TRACK FOR **RECORD CREDIT RETIREMENTS,** WITH DEMAND SIGNALS REWARDING HIGHER-RATED, HIGHER-INTEGRITY CREDITS

NATURE-BASED SOLUTIONS REMAIN ESSENTIAL

As carbon markets and associated decarbonization strategies evolve, the push for higher integrity and stricter quality standards can be misinterpreted as a pivot to technology-based solutions, such as direct air capture, and away from nature-based credits. But such debates between technology and nature are a false choice.

THE BOTTOM LINE IS THAT CARBON MARKETS REPRESENT THE ONLY SCALABLE MECHANISM CURRENTLY AVAILABLE TO CHANNEL PRIVATE SECTOR FINANCE INTO AT-RISK ECOSYSTEMS

Binary arguments favoring tech versus nature overlook the necessity of nature-based approaches, which not only sequester carbon but also deliver key benefits to biodiversity, water security, and Indigenous and local communities. Such arguments also ignore the fact that updated methodologies, improved permanence frameworks, and enhanced co-benefit accounting are enabling a new generation of nature-based credits that are more transparent, durable, and quantifiably impactful. Instead of either or, what's needed is a diversified, all-of-the-above strategy.

The bottom line is that carbon markets represent the only scalable mechanism currently available to channel private sector finance into at-risk ecosystems, the conservation and restoration of which are critical to addressing climate change. Philanthropic and public funding remain insufficient and unreliable, despite frequent pledges. Landscapes the world over face urgent threats and require immediate support.

Pragmatic, science-based approaches are enabling a market environment that incentivizes innovation, investment, and continual improvements over time. And the demand is there - premium pricing, already seen for high-integrity nature-based credits, shows buyers are willing to pay for quality.

POLICY AS A MARKET CATALYST

Even as market reforms and clear demand signals restore trust and drive growth, countervailing systemic risks threaten to undermine progress – including limited market engagement and broader geoeconomic issues. Policy volatility compounds these risks.

Inconsistent regulatory signals from key jurisdictions create uncertainty on the role of carbon credits in corporate disclosures, compliance mechanisms, and climate strategies. Absence of harmonized international standards complicates decisions around eligibility, accounting, and reputational risk. And political changes can rapidly shift carbon pricing, credit use recognition, and climate policy, driving market instability.

Ultimately, clear policy direction and support is required to enable the market to deliver its decarbonization potential.

Well-designed policies to scaling carbon markets and advance the broader energy transition are consistent, clear, and built on foundational principles of demand stimulus, efficient market functions, and supply-side support.

Concerted efforts to do so, such as the recently launched Coalition to Grow Carbon Markets, may deliver the type of guidance and demand signal stimulation needed. To succeed, policies should define practical use-case and marketing claims around the role of credits in corporate disclosures, incentivize strategic use of credits within transition plans, and aim to incorporate credit use in national climate strategies.

National-level operationalization and enforcement of agreements like CORSIA and Article 6 also have immense potential, providing both demand mandates as well as directing investment into high-quality methodology projects. The inverse is also true. Continued uncertainty over methodologies, disparate authorization processes, and overall implementation limits liquidity and risks quickly eroding confidence. This underscores the need for governments to capitalize on this opportunity.

Strong governance and effective risk management enable healthy markets. Supportive policy includes strategically limited interventions that guide and harness carbon markets. These include promoting interoperability among frameworks, such as integrating high quality international verified credits within compliance schemes, working to standardize definitions across jurisdictions, enabling efficient and transparent trading via interoperable registries.

On the supply side, government policy must support new high-integrity credit origination. Other policy measures could include harmonization of Letter of Authorization processes to minimize operational risk, drive collective support for enabling effective Article 6 infrastructure across regions, and investing in robust MRV technologies. De-risking and early-stage finance is also critical, available through blended finance agreements and early-stage financing through tax incentives.

These measures will help scale high-integrity credit generation, break through the supply constraints currently creating a structural bottleneck, and ensure equitable access to carbon finance. Collectively, these measures will provide investment certainty and renew market confidence, enabling the next few years to realize a transformational growth and drive significant climate action even in challenging times.

THE WAY FORWARD

Carbon markets are maturing and poised for scale, yet confidence remains tenuous. Market forces alone won't unlock their full potential; clear, consistent, and internationally aligned policy frameworks are essential. Mechanisms like CORSIA and Article 6 offer powerful pathways to leverage the power of markets to mobilize climate finance, but their impact depends on coordinated implementation and regulatory clarity.

Policymakers must act decisively to provide clarity and harmonization needed to instil trust and incentivize investment. And nature-based solutions must be embraced, not sidelined, provided they meet evolving standards. With policy guidance and support, we may finally unlock the potential carbon markets have long promised. The time for decisive policy and investment is now.

The views expressed in this essay are personal and do not necessarily represent the views of Shell plc or its subsidiaries.

CLEAR, CONSISTENT POLICY IS NOW THE **CRITICAL CATALYST** — WITHOUT IT, MARKET CONFIDENCE, LIQUIDITY, AND THE PATH TO SCALE REMAIN AT RISK.

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PAUL ZAKKOUR, FOUNDING DIRECTOR, CARBON COUNTS / **JEREMY RUBIN,** POLICY ANALYST, IETA

IETA GEOSTORAGE AND CARBON CREDITING HANDBOOK

BEYOND NATURE-BASED AND TRADITIONAL PROJECT CREDITS, ENGINEERED REMOVALS ARE EMERGING AS A CRITICAL COMPONENT OF MARKET MATURITY. THE NEXT PIECE FROM PAUL ZAKKOUR AT CARBON COUNTS INTRODUCES VERSION 2.0 OF IETA'S GEOSTORAGE AND CARBON CREDITING HANDBOOK – A FRAMEWORK FOR INTEGRATING CARBON CAPTURE AND STORAGE INTO CREDIBLE MARKET SYSTEMS.

IETA'S UPDATED GEOSTORAGE AND CARBON CREDITING HANDBOOK SYNTHESIZES **30+ METHODOLOGIES ACROSS 13 STANDARD-SETTERS** — PROVIDING THE **MOST COMPREHENSIVE GUIDE** YET FOR ENGINEERED REMOVALS.

Recognizing the growing role of geological carbon dioxide (CO2) storage (GCS) in achieving net zero, IETA and partners have developed a series of guidance materials to strengthen the integrity and functionality of crediting frameworks for these activities. Building on foundational work that began in 2021, this body of research has evolved in parallel with rapid market and policy developments.

The latest edition – IETA's Handbook for Geostorage and Carbon Crediting (v2.0)[42], released at the 2025 North America Climate Summit – responds directly to this shifting landscape. As jurisdictions including the EU, UK and California explore how to integrate engineered removals into emissions trading systems, the Handbook provides an up-to-date reference for practitioners and policymakers navigating the design of robust, credible approaches to CCS and engineered carbon dioxide removal (eCDR).

The updated Handbook synthesizes more than 30 methodologies and protocols across 13 standard-setters, identifying common approaches and areas of divergence in technical scope, accounting boundaries, and risk management. It also reviews the safeguards and accounting principles that underpin GCS crediting under the Paris Agreement – including MRV requirements, legal and regulatory conditions, and Article 6 provisions.

The below sections briefly summarize key contents and findings contained within the Handbook.

SECTION 1: METHODOLOGIES AND PROTOCOLS: A SYNTHESIS

The current suite of methodologies and protocols covered across the 13 reviewed standard-setters share many design similarities but also contain subtle differences and divergences in approaches. Only minor differences exist across methodological components such as baseline and additionality, and few if any unique issues are posed for GCS technologies in these respects. Conversely, wider differences can be seen in technical scopes and applicability conditions, the spatial and temporal accounting boundaries (including leakage effects), and the approaches taken to manage the risk of carbon reversals, especially over the longer-term. These main differences relate to:

i. The types of GCS activities that may apply the methodology;
ii. The locations in which an eligible GCS project activity may be developed, operated and closed;
iii. The sources of emissions and removals that should be accounted for within the methodological framework; and
iv. The approach to quality assurance and quality control (QA/QC) and the legal, regulatory and technical requirements applied to GCS site development, operation, closure, post-injection and over the longer term.

The table, included in full in the Handbook, depicts this landscape analysis and synthesis across standard-setters.

SECTION 2: SAFEGUARDS FOR CREDITING UNDER ARTICLE 6

Climate mitigation approaches involving enhanced carbon reservoirs present unique risks, impacting upon how they are counted towards climate goals and credited for use in carbon markets. More specifically, risks of GCS include potential impacts on the local environment and human health, and, given the possibility for stored CO2 to leak from a GCS site back to the atmosphere in the future, the site's effectiveness in delivering long-term (permanent) mitigation.

To address these risks, mitigation activities involving GCS call for specific and additional safeguards in methodological design relative to other types of climate mitigation activities. Local populations and ecosystems must be protected from potential adverse environmental effects, while the environmental integrity of climate mitigation accounting and claims must be insulated from the risk of carbon reversal. Drawing upon the Clean Development Mechanism (CDM), safeguarding requirements underpinning the hosting of creditable GCS activities can include:

a. Political support for the technology.
b. Legal and regulatory safeguards to robustly govern GCS sites, including site leaks, which are implementable over the long-term. This includes a three-part legal and regulatory model that covers i) project development; ii) operation, closure and post-injection; and iii) liability.
c. Environmental and social safeguards that require comprehensive and thorough risk and safety assessment, including potential impacts on human health and ecosystems.

While the Handbook contains a deeper analysis of these topics, and assesses how these safeguards are integrated in the current Article 6 Rulebook, a snapshot of the analysis is presented on page 48.

Effective GCS development at scale will need to be underpinned by robust regulatory frameworks and safeguards. With the above acting as a quick overview and snapshot, the Handbook highlights important linkages between methodologies, safeguards and accounting for GCS operations and the origination and trading of credits and other units in the Paris Agreement era.

As discourse around the integration of engineered carbon dioxide removals in compliance carbon markets continue, this Handbook can serve as a resource to enable effective GCS methodological design with robust jurisdictional accounting and reporting underpinnings. Doing so will ensure that these activities necessary to reaching net-zero maintain rigorous environmental and social safeguards and allow for emissions reductions and removals that are efficient, quantifiable and real.

ROBUST SAFEGUARDS, STRONG REGULATORY FRAMEWORKS, AND ARTICLE 6-ALIGNED ACCOUNTING ARE **ESSENTIAL** TO ENSURE GCS DELIVERS **REAL, PERMANENT,** AND **SOCIALLY RESPONSIBLE** CLIMATE MITIGATION.

	Article 6.2 (Cooperative Approaches)	Article 6.4 (PACM)
Political Support	Article 6.2 guidance mandates each participating Party in a cooperative approach to ensure that: "4....(f) Its participation contributes to the implementation of its NDC and long-term low-emission development strategy, if it has submitted one..." Inclusion within NDCs offers an assurance check for host country policy support for the technology. Therefore, any Party wishing to host and credit GCS-based activities under A6.2 must include it in its NDC or LT-LEDS.	The PACM rules, modalities and procedures (RMPs) require that Parties wishing to host PACM activities provide the following notices to the Article 6.4 Supervisory Body (SBM): • Indicate publicly the types of activity that the Party would consider authorizing, and how such activities contribute to the achievement of its NDC, etc., • Approval of PACM activities prior to their registration, • Authorizations for the activity.
Legal and Regulatory Safeguards	Countries hosting GCS activities generating ITMOs must fulfil the requirements of the 2006 IPCC Guidelines, including legal and regulatory considerations therein. Initial Reports shall provide descriptions of how environmental integrity is maintained, including the approach to manage non-permanence and carbon reversal. Countries participating in cooperative approaches should consider how responsibility for remediation in the event of a reversal might be allocated and/or shared with standard setters, projects participants and between buyer and seller Parties.	The RMPs require PACM activities to originate A6.4ERs in line with IPCC Guidance (e.g. Volume 2, Chapter 5 of the 2006 IPCC Guidelines). The 2006 IPCC Guidelines oblige host countries to monitor and report any emissions from CO2 transport and GCS sites, including those resulting from PACM activities, and report any emissions in their national GHG inventories.
Environmental and Social Safeguards	Within its Article 6.2 Initial Report, as well as in Regular Information provided thereafter, Parties must, describe how each cooperative approach will (or is): *"Minimize and, where possible, avoid negative environmental and social impacts and be consistent with its sustainable development objectives." [and] "Be consistent with the sustainable development objectives of the Party, noting national prerogatives."*	The PACM Removals Standard requires participants to apply robust social and environmental safeguards to minimize and, where possible, avoid negative environmental and social impacts of the activity. All projects developed under the PACM must be assessed using the forthcoming A6.4 Sustainable Development Tool (A6.4 SD Tool).

"MINIMIZE AND, WHERE POSSIBLE, AVOID NEGATIVE ENVIRONMENTAL AND SOCIAL IMPACTS AND BE CONSISTENT WITH ITS SUSTAINABLE DEVELOPMENT OBJECTIVES." [AND] "BE CONSISTENT WITH THE SUSTAINABLE DEVELOPMENT OBJECTIVES OF THE PARTY, NOTING NATIONAL PREROGATIVES."

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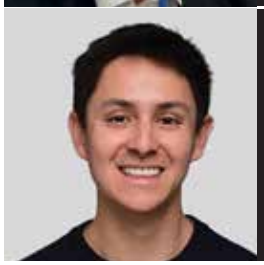

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CHAPTER 4

DIGITAL AND TECHNOLOGY ENABLERS FOR SCALABLE, TRUSTED MARKETS

Digital innovation is reshaping how carbon markets operate, connect, and build trust. As systems shift from fragmented registries to integrated digital infrastructure, the challenge is no longer efficiency alone but ensuring interoperability and integrity at scale. This chapter examines how shared data standards, secure systems, and transparent verification tools form the backbone of a connected market. It explores the role of digital MRV, blockchain-based safeguards, and satellite monitoring in strengthening transaction integrity and transparency. Ultimately, the chapter shows how a trusted digital ecosystem enables carbon markets to scale with credibility, confidence, and measurable climate impact.

IEVA STEPONAVICIUTE, DIRECTOR, STRATEGY & OUTREACH – CLIMATE ACTION DATA TRUST

DATA, SYSTEMS, INTEROPERABILITY: A COMMON LANGUAGE FOR SCALE

INTEROPERABLE INFRASTRUCTURE IS KEY TO SCALING TRUSTED MARKETS. THE CONTRIBUTION FROM IEVA STEPONAVICIUTE AT THE CLIMATE ACTION DATA TRUST OUTLINES HOW DATA STANDARDS ARE BUILDING THE FOUNDATIONS FOR AN INTERCONNECTED, FUTURE-READY CARBON MARKET.

INTEROPERABLE DATA STANDARDS ARE BECOMING THE **BACKBONE OF FUTURE CARBON MARKETS** — ENABLING TRUSTED ACCOUNTING, PREVENTING DOUBLE COUNTING, AND UNLOCKING CROSS-BORDER FINANCE AT SCALE.

COMPARABLE INFORMATION IS KEY TO GROWING A TRUSTED DECENTRALISED MARKET

Data standardization has risen to prominence this year. In this short piece, I will unpack why you should pay attention and where key complementary efforts are heading next.

We are at an interesting inflection point in market development. The policy, legal, and technological systems that have underpinned carbon credit markets for the past few decades are now in flux. New stakeholders have started addressing quality, transparency, and market operations, and regulators are beginning to coordinate efforts. All the while, global mechanisms are moving from negotiation to implementation.

Article 6 negotiations took nearly 10 years to conclude because the underlying questions are complex. Aligning individual projects with corporate, national and global responsibilities is hard work; governments seek sovereignty and oversight, buyers want certainty, and experts debate over principles and quality amid increasing stakeholder scrutiny. The VCM stands on its own, yet independent credits are also used in compliance schemes and bilateral cooperation under Article 6.2. We are simultaneously building systems to manage dwindling carbon budgets, finance NDCs, encourage corporate action, and develop a new asset class – all without a central authority for credit issuance or trades. This is the decentralised, yet interconnected world of the Paris Agreement.

Scaling markets that deliver on global goals requires confidence in credit quality, investability, accounting treatment and double-counting prevention across systems and borders. As more governments, crediting programs and private actors enter the space, unified frameworks for comparing and exchanging information between systems are essential. Common standards for data formats, disclosure, and exchange prevent operational bottlenecks that undermine trust and stall investment. Standardizing key information across the credit lifecycle will reduce inefficiencies, support globally compatible registries and connections between them, and enable transparent accounting and market oversight.

In 2025, these topics were explored in detail in the Data and Systems Interoperability Guidance Note under the World Bank's Carbon Markets Infrastructure Working Group[43], as well as at the ICVCM's CIWP7, UNIDROIT, and the G20's Sustainable Finance Working Group. These efforts have reinforced one another and strengthened the momentum for data standardisation. When an idea emerges in many places at once, it's usually a sign that its time has come.

CAD Trust supports public data infrastructure for carbon markets, enhancing access to key data points from diverse registries, enabling transparent accounting and double-counting checks. A common data model is key for our mission, and we have learnt extensively from the last 3 years of operationalising one. Our public platform now hosts information covering around 90% of credits ever issued, voluntarily shared by 11 programs and governments committed to building trust in this increasingly complex space. This year marked real progress towards global alignment, as we collaborated closely with key efforts addressing complementary gaps to advance toward global common data frameworks across the industry. Below is a summary of key ongoing collaborative efforts and links between them.

COMMON DATA FRAMEWORKS WILL ENABLE INTEROPERABLE INFRASTRUCTURE, CROSS-BORDER FINANCE, AND EASY OVERSIGHT

The Common Carbon Credit Data Model (CCCDM)[44] was developed as an input to the G20 Sustainable Finance Working Group by the Climate Data Steering Committee (CDSC). It proposes a global baseline data structure across the credit lifecycle to enable regulatory oversight and cross-border trades, drawing from existing work – including the CAD Trust and official UNFCCC guidance on Article 6.2 reporting – and extensive feedback from G20 policymakers and market participants through a public consultation. Among its key contributions is a proposed approach to formatting and issuing global unique identifiers modelled after ISINs. The G20 SFWG encouraged the CDSC Secretariat to run 12-18 month pilots with interested partners over 2026[45], potentially around credit registration, the proposed format and issuance of global unique identifiers, and scaling market transactions through standardised post-issuance data.

The Carbon Data Open Protocol (CDOP), started in late 2024, is currently co-chaired by Sylvera, S&P Global, GCMU and RMI and has over 50 members. CDOP is working on an open framework to harmonise approaches to detailed project data along the whole lifecycle. Version 1.0 of the schema integrates over 15 ones in use and addresses pre-issuance – e.g., project details, stakeholders, disclosures - and is now available for testing. It aims to streamline detailed information exchanges where different formats are now a bottleneck, such as project developer communication with investors, insurers, or ratings agencies. CDOP aims to develop detailed guidance for the full credit lifecycle in 2026. It has committed[46] to building on the structure of the CCCDM and integrating the CAD Trust Version 2.0 in the next round of updates.

The CAD Trust Data Model 2.0[47], to be rolled out in the first half of 2026, is our new baseline for harmonising diverse registry data on our platform, enabling its use for auditing of credit labels, Article 6.2 reporting, and automating double-counting checks in the future. It was designed with extensive input from connected and prospective registries and market participants through our governance bodies and bilateral consultations. We have also shared it with other initiatives as a contribution to global data standardisation and sought alignment where possible. As a result, CAD Trust Version 2.0 and the CCCDM v2.0 are largely compatible, with some divergence where we harmonise current registry approaches and the CCCDM introduces practices common in financial markets (e.g., batch-level vs unit-level operations). Next year, we will support registry transition to Version 2.0, expand capacity-building on registry interoperability, and continue collaborating with the CDSC, CDOP, and ISO toward common global guidance.

ISO TC/322 Sustainable Finance Working Group 5, supported by the Singapore Standards Council and the British Standards Institution, has embarked on a proposed standard on Data Model for Carbon Credit Markets, intended to support carbon credit trading and carbon market integration with financial systems. Work started this October, with experts now advancing a Working Draft for publication in early 2027. CAD Trust, CDSC,

AS MORE GOVERNMENTS, CREDITING PROGRAMS, AND PRIVATE ACTORS ENTER THE SYSTEM, **COMMON DATA MODELS AND SHARED FORMATS ARE ESSENTIAL** TO CONNECT REGISTRIES, STREAMLINE OVERSIGHT, AND BUILD MARKET CONFIDENCE.

WITH INITIATIVES LIKE CAD TRUST, CCCDM, AND CDOP ALIGNING, THE MARKET IS MOVING TOWARD A UNIFIED DIGITAL LANGUAGE — A FOUNDATION FOR **TRANSPARENT, DECENTRALISED,** AND **GLOBALLY CONNECTED** CARBON INFRASTRUCTURE.

and CDOP are among the consulted experts, with Evan Kong, our Technical Director, supporting as one of the project leads. Involvement is possible through a National Standards Body and IETA.

The Article 6.2 Crediting Protocol, launched at COP30[48] by Singapore, Verra, and Gold Standard, proposes standard workflows for information exchanges between governments, independent crediting programs (ICPs), and project developers related to ICP credit authorizations for use under Article 6.2. ICPs following the framework will have a coordinated approach to labels and other information necessary to flag these credits in their registries and support governments with Article 6.2 reporting needs.

AS ARTICLE 6 MOVES INTO INPLEMENTATION AND MARKET MATURES, COMMON DATA PRACTICES WILL HELP TRUSTED ACCOUNTING AND UNLOCK FINANCE AT SCALE

Several technical areas offer strong opportunities for cooperation in 2026. Coordinated guidance on label format and implementation is key for tracking credit eligibility for certification schemes or authorizations. It will enable easier cross-referencing, auditing, and automated system connections. Unique identifiers present another major opportunity to mature the market, with CCCDM pilots one way to test out a global approach and national implementation. Global accounting and interlinkages with UN infrastructure will draw increasing attention, as the PACM and International Registries are rolled out, the Biannual Transparency Reports highlight the use of the Agreed Electronic Format, and national registry build out continues. It will also be important to start building bridges to efforts supporting the digitisation of methodologies and asset origination – e.g., the InterWork Alliance - and deployment of dMRV.

Common data practices will save time and reduce friction in financing climate action. Over the next two years, I expect – and will continue supporting – significant progress on technical matters as well as convergence and governance of these data standards. When that happens, we will look back on these countless evenings with data tables as time well spent.

If this vision resonates with you, get involved. Pilot the CCCDM or CDOP, connect your registry to CAD Trust, or explore our open data tools. Share your experiences in the appropriate committees. We have the momentum to shape a common language for the next generation of infrastructure in our markets. Let's use it wisely.

Ieva Steponaviciute *has been building CAD Trust since 2021. She has developed strategy and implemented multi-stakeholder projects in climate policy, carbon markets, marketing, and technology. Informed by a multidisciplinary background and a drive to accelerate the climate transition, she combines analytical thinking, policy and technical knowledge to create new partnerships for the public good.*

JEFFREY BERMAN, HEAD OF BUSINESS DEVELOPMENT FOR REGISTRY SOLUTIONS, XPANSIV

ENSURING TRANSACTION INTEGRITY IN CARBON MARKETS

AS INTEROPERABILITY FRAMEWORKS LIKE THE CLIMATE ACTION DATA TRUST LAY THE GROUNDWORK FOR TRANSPARENT DATA EXCHANGE, CORRESPONDING EFFORTS ARE ENHANCING MARKETPLACE FUNCTIONALITY. THE FOLLOWING ARTICLE FROM XPANSIV EXPLORES HOW DIGITAL EXCHANGE AND PORTFOLIO MANAGEMENT INFRASTRUCTURE ARE BRINGING THIS INTEROPERABILITY TO LIFE – ENABLING TRACEABLE, TRUSTED TRANSACTIONS AT SCALE.

Despite a range of headwinds in recent years, the core premise of the VCM remains as sound as ever: by creating a tradable instrument from an activity that would not have taken place without the program, the market channels vital capital to low-carbon projects while providing emitters with an efficient tool for addressing their emissions.

Though initiatives such as the ICVCM are working to improve the sustainability and transparency of VCM standards and individual methodologies, while the VCMI provides guidance on how corporate buyers can best utilize carbon credits when making voluntary claims, the responsibility of developing the systems and associated operational procedures necessary to implement high-integrity carbon crediting schemes ultimately falls to digital infrastructure providers.

INTEROPERABILITY MEANS NOTHING WITHOUT EXECUTION — SECURE DIGITAL INFRASTRUCTURE ENSURES TRUSTED, TRACEABLE REAL-WORLD MARKET TRANSACTIONS.

DIGITAL INFRASTRUCTURE AND TRANSACTION SECURITY

A unique aspect of environmental commodities is that a piece of digital infrastructure exists at every single point of their lifecycle.

- The registry is central to this ecosystem, where it acts as its single source of truth for a program or standard. Program sponsors use the registry to implement their program's rules and onboard different types of account holders – like project developers or end-buyers. Developers use it to register specific projects, issue credits based on a specific issuance methodology, and transfer credits to end-buyers. End-buyers use the registry to take possession of acquired credits and ultimately retire them to meet voluntary commitments or mandatory obligations.
- Portfolio management applications allow market participants to not only view but fully manage and transact their holdings across multiple registries and programs from a single location, which not only increases the efficiency of day-to-day workflow but also enhances transaction security for users.
- A marketplace, which provides market participants with a forum to transact with counterparties that have been fully vetted, both reducing counterparty risk and improving price transparency of the assets.

There is a lingering fear that intangible commodities like carbon credits pose a contingent financial risk, particularly as there are a lot of new players moving into the market. Ultimately, the digital infrastructure and associated systems powering carbon credit markets must be as secure and robust as what is found in all other financial systems – which is already the case in most other environmental markets, such as those for compliance carbon and Renewable Energy Credits (RECs).

THERE IS A LINGERING FEAR THAT INTANGIBLE COMMODITIES LIKE CARBON CREDITS POSE A CONTINGENT FINANCIAL RISK

UNIVERSAL IDENTIFIERS LIKE UPNS AND EINS ARE BECOMING THE CUSIPS OF ENVIRONMENTAL MARKETS, ENABLING **SEAMLESS, TRUSTED TRANSACTIONS** ACROSS PLATFORMS.

This means prioritizing transaction integrity when developing the multiple systems used to power environmental markets, as well as the associated policies that govern how they are operated. Specifically, this involves utilizing reference data to safely streamline transactions across multiple systems, relying on strong Know-Your-Customer policies to prevent bad actors from accessing systems, and leveraging encumbrance technology to enhance the security of asset and cash transactions.

UNIVERSAL SYMBOLOGY

With an increasing number of participants, platforms, and service providers in carbon markets, developing systems that are interoperable with each other is a paramount concern. Credits issued on one registry may be transacted via one or more portfolio management applications or exchanges, and may even be exported to another registry entirely for retirement. Ensuring that multiple systems can work together is critical for streamlining transactions and ensuring that all transactions – including credit creation, transfers, and retirements – are conducted with the utmost integrity.

But what should interoperability mean in practice? Interoperability does not mean relying on a single technology stack or provider. Individual registries, applications, and exchanges have their own levels of risk, as well as regulatory requirements, and their systems and processes should reflect that. Interoperability should mean working to make interconnection between systems as easy as possible.

Global financial markets have encountered a similar problem and ultimately addressed it with the use of reference data. These are a set of standardized unique identifiers for financial assets that can be used to reference and track those assets across multiple platforms like registries and exchanges. The best example are CUSIPs, a nine-character ID for financial securities that support the clearing and settling of trades, which simplifies and reduces downstream costs of moving financial assets across different systems.

The environmental market version of CUSIPs are Universal Project Numbers (UPNs) and Environmental Instrument Numbers (EINs). They have already been deployed for over a decade to streamline connections between various service providers and data layers, and they can be used by any environmental system or data layer that needs to securely connect to other systems – thereby increasing efficiency and ensuring transaction integrity.

KNOW-YOUR-CUSTOMER POLICIES

Identifying and preventing bad actors from accessing market services and infrastructure is a critical component of ensuring transaction integrity within environmental (as well as other) markets. With that in mind, trust and integrity with respect to all financial platforms and services must begin with robust Know Your Customer (KYC) processes, which refers to the process of assessing the risk associated by entities accessing their systems, and by extension, to stop bad actors from ever entering the system.

Developing a robust KYC program first begins with building an understanding of the unique risks that a population of users (potential or existing) poses to an organization or platform. A registry operator may have concerns related to onboarding project developers that can be trusted to operate high-integrity projects, whereas an exchange may be more concerned with onboarding entities that will be transacting cash on their platform.

Additionally, just as the nature of risk differs between platforms, not all platform users carry the same level of risk. For example, newly established project developers, entities based in jurisdictions that allow opaque ownership structures, and global financial institutions each demand different levels of scrutiny. An organization's specific screenings for customer identification and verification, ownership and control, and sanctions and political exposure can then be adjusted accordingly.

What is critical is that platform operators know where the risk to their systems exists and then implement a KYC program that is informed, nuanced, and built-for-purpose, as this is key to deepening trust, liquidity, and innovation in environmental markets.

CREDIT ENCUMBRANCE

The transaction of a carbon credit from a seller to a buyer inherently involves the transfer of cash from the buyer to the seller. These two transfers must be seamless and simultaneous in order to facilitate same-day (T+0) settlement and protect against the risk that the seller delivers credits but the buyer does not transfer cash.

With this in mind, Xpansiv's CBL Marketplace and Xpansiv Connect portfolio management application (which is used to settle bilateral transactions) leverage encumbrance technology to protect against this risk and ensure that all cash and credit transactions are securely settled between counterparties.

When a credit is posted for sale on our market platforms, the platform will automatically "encumber" the credit, or freeze it in its current account. Once encumbered, a credit cannot be further transferred until the sale is complete or the order cancelled. A buyer will bid on the volumes that it seeks to procure, and when a trade match is made, the seller's volumes will be automatically transferred to buyer's registry account (via an Xpansiv intermediary account to maintain anonymity), and buyer's cash is automatically transferred to seller's bank account (also using an Xpansiv intermediary account). Ultimately, encumbrance technology, especially when combined with robust financial infrastructure and connectivity, protects against double transaction risk and ensures broader transaction security.

ENSURING CONFIDENCE IN CARBON MARKET SYSTEMS

The combination of institutional-grade digital financial infrastructure and robust operational procedures provide market participants – including both buyers and sellers – with assurance in the security of digital platforms that carbon markets rely upon. By regularly adapting and building upon these systems, carbon markets will continue to attract the capital to low-carbon solutions needed to address climate change.

WHAT IS CRITICAL IS THAT PLATFORM OPERATORS KNOW WHERE THE RISK TO THEIR SYSTEMS EXISTS AND THEN IMPLEMENT A KYC PROGRAM

Jeffrey Berman *is the Head of Business Development for Registry Solutions at Xpansiv, where he oversees commercial operations and new project origination for Xpansiv's registry technology business that works with a range of public, private, and non-profit partners in the carbon, renewables, and low-CI fuels sectors. Prior to joining Xpansiv in 2023, he spent 12 years as an environmental and energy market analyst at a number of globally recognized consultancies, where he developed detailed market assessments for, among others, the EU ETS, WCI, RGGI, Korea, CDM/JI, and VCM programs.*

WES GEISENBERGER, VICE PRESIDENT FOR SUSTAINABILITY & ESG, THE HEDERA FOUNDATION

DIGITAL INFRASTRUCTURE FOR CARBON INTEGRITY: BUILDING TRUST AND INTEROPERABILITY IN CLIMATE MARKETS

BUILDING ON THE RISE OF DIGITAL CARBON INFRASTRUCTURE, THE CONTRIBUTION FROM HEDERA LOOKS DEEPER INTO THE DISTRIBUTED SYSTEMS THAT UNDERPIN TRANSPARENCY AND VERIFICATION. AS BLOCKCHAIN TECHNOLOGY MATURES, HEDERA SHOWS HOW DECENTRALISED LEDGERS CAN SAFEGUARD INTEGRITY WHILE SUPPORTING THE LIQUIDITY AND CONNECTIVITY THAT MODERN CARBON MARKETS DEMAND.

WITHOUT INTEROPERABLE DIGITAL PUBLIC INFRASTRUCTURE, CARBON MARKETS WILL REMAIN **FRAGMENTED** AND **UNABLE TO SCALE** WITH INTEGRITY — REAL-TIME, AUDITABLE DATA IS NOW ESSENTIAL.

Carbon markets are evolving rapidly, driven by growing demand for climate finance and expanding regulatory frameworks such as Article 6. Yet despite this momentum, the sector remains constrained by fragmentation, opacity, and inefficiencies. Data is often siloed, methodologies are inconsistently applied, and verification processes rely on static documents and manual registries. These limitations increase transaction costs, erode trust, and slow the flow of capital to legitimate climate impact.

As markets mature, the need for robust digital public infrastructure (DPI) becomes increasingly clear. Effective DPI must support real-time linkage between data, methodologies, and assets, enabling transparency, auditability, and interoperability across diverse stakeholders. Without such infrastructure, carbon markets risk becoming bottlenecked by outdated systems that cannot scale with integrity.

A key challenge lies in connecting environmental data integrity with financial infrastructure. Verified impact data must be traceable and linkable to the economic activities it represents—whether through registries, investment platforms, or national reporting systems. This requires modular, interoperable components that span digital measurement, reporting and verification (MRV), tokenized finance, and asset lifecycle management.

Public ledgers offer new capabilities that address these needs. They enable programmable methodologies that validate project data in real time, end-to-end traceability across verification events, and dynamic comparability across geographies and asset types. These features transform environmental accounting from a static reporting exercise into a real-time integrity network, supporting integration with exchanges, registries, and sustainable finance instruments.

Another emerging opportunity is comparative intelligence: the ability to analyze and compare methodologies in machine-readable form. This allows regulators and standards bodies to assess credibility, identify harmonization opportunities, and move toward differentiated pricing based on co-benefits such as biodiversity or social outcomes. Such visibility is essential for developing genuine market signals of environmental integrity.

HEDERA'S ROLE IN ENABLING DIGITAL INTEGRITY

In response to these challenges, the Hedera Foundation has supported the development of open-source digital public infrastructure designed to meet the evolving needs of carbon and environmental markets. Its flagship platform, the Hedera Guardian, provides a modular suite of tools for digital MRV, registry systems, and programmable integrity. By lowering the cost of digitalization and enabling traceable, auditable claims on a public ledger, Hedera's infrastructure helps bridge the gap between environmental and financial integrity. This approach supports scalable, trustworthy climate finance systems that can adapt to regulatory change while remaining anchored in verifiable impact.

Wes Geisenberger *is the Vice President for Sustainability & ESG at the Hedera Foundation, leading its Sustainable Impact work since its launch in 2021 and advancing Digital Public Infrastructure, including the Hedera Guardian—the world's largest open-source library of digitized environmental methodologies. Before joining Hedera in 2019, Wes spent six years at Oracle developing blockchain, AI, and IoT solutions for public benefit. He holds a degree in Government & International Politics from George Mason University.*

SASSAN SAATCHI, CEO, CO-FOUNDER, CHIEF SCIENTIST, CTREES

BREAKING BARRIERS: THE PIVOTAL ROLE OF EARTH OBSERVATION FOR NATURE-BASED CLIMATE SOLUTIONS

AS DIGITAL SYSTEMS ENHANCE INTEGRITY AND TRACEABILITY ACROSS MARKETS, EARTH OBSERVATION IS DOING THE SAME FOR NATURE. THE NEXT ARTICLE BY CTREES SHOWS HOW SATELLITE AND GEOSPATIAL DATA ARE TRANSFORMING THE WAY WE MEASURE AND VERIFY NATURE-BASED CLIMATE SOLUTIONS — BRINGING TRANSPARENCY AND SCALE TO PROJECTS ON THE GROUND.

Decarbonizing economies is no longer optional—it's a profound moral and strategic imperative. Achieving this requires a comprehensive approach that leverages technological innovation, policy reform, and market mechanisms, while safeguarding and restoring ecosystems.

Nature-based solutions (NBS), especially trees inside and outside forests, are essential in this transition. Trees absorb over 70 percent of land-atmosphere carbon fluxes, reducing emissions from deforestation, land use, and wildfires, while serving as vital carbon sinks through natural recovery and restoration. Beyond climate mitigation, forests support biodiversity, protect communities from climate-related hazards, and strengthen resilience. They are fundamental to advancing both climate action and adaptation, fostering a sustainable and equitable future.

CRITICAL ROLE OF SCIENCE AND TECHNOLOGY IN UNLOCKING THE POTENTIAL OF NBS

Realizing scalable, effective NBS requires deliberate integration of science and technology. Science defines the physical limits and pathways for emission reductions and removals, guiding targeted action. Technology transforms these insights into tangible, practical tools. This is critical for two reasons:

1. Context-Specific Solutions: NBS must be tailored to local geography, ecosystems, history, and socio-political landscapes. No one-size-fits-all approach works.
2. Dynamic Adaptability: As scientific understanding evolves, so too must NBS. Nature's response to shifting climate conditions necessitates adaptable solutions for sustained success.

Accurate, transparent, and scalable carbon monitoring of NBS—long challenged by data gaps—is now revolutionized by earth observation (EO) and remote sensing. EO offers unparalleled spatial and temporal coverage, enabling cost-effective, precise monitoring of land use, deforestation, and biomass. This strengthens policy, enforcement, and market credibility, ensuring NBS deliver reliable MRV data essential for effective climate action.

Key technologies for NBS and GHG market are:

1. Optical Satellite Imagery: Provides high-resolution data on land cover, forest extent, deforestation, reforestation, and land-use changes. Platforms like Landsat, Sentinel-2, and commercial satellites enable detailed mapping of forest health, vegetation dynamics, and habitat classification.
2. Synthetic Aperture Radar (SAR): Penetrates clouds and is useful for monitoring forest structure, biomass, and cover changes in cloud-prone regions such as tropical rainforests. ESA's Sentinel-1 and Biomass, and NASA and ISRO's NISAR are key SAR sources.
3. Lidar (Light Detection and Ranging): Airborne and spaceborne lidar provide precise 3D measurements of canopy height and structure. Airborne Lidar Scanning (ALS) systems are considered the gold-standard for accurate carbon stock assessments and calibration of other sensors.
4. Hyperspectral Imagery: Capture detailed spectral signatures of vegetation leaf characteristics, moisture content, and temperature, enabling assessments of plant health, species composition, and stress detection, which are vital for targeted restoration efforts.
5. Soil Moisture and Land Surface Temperature: Often derived from microwave sensors and thermal infrared sensors, these measurements help assess ecosystem resilience, drought risk, and hydrological status related to NBS.

NATURE-BASED SOLUTIONS ARE INDISPENSABLE — TREES DRIVE **OVER 70%** OF LAND–ATMOSPHERE CARBON FLUXES AND DELIVER CRITICAL CLIMATE, BIODIVERSITY, AND RESILIENCE BENEFITS.

EARTH OBSERVATION IS TRANSFORMING NBS: ADVANCED SATELLITE AND LIDAR SYSTEMS NOW ENABLE **PRECISE, SCALABLE, NEAR–REAL-TIME MONITORING** OF FORESTS AND CARBON STOCKS.

MONITORING DEFORESTATION AND FOREST DEGRADATION

Land use, land-use change, and forestry (LULUCF) accounts for more than 30% of total gross GHG emissions, making accurate monitoring critical for effective climate mitigation. Key sources include deforestation, forest conversion to agriculture—which dominates tropical land use—large-scale logging, degradation from selective logging, harvests for timber and wood products, and wildfires.

Earth observation systems enable continuous tracking of forest cover loss, even in remote or unstable regions. Data from NASA's Landsat since the 1980s, ESA's Sentinel-2 since 2015, and SAR sensors—available routinely since the 1990s—provide global maps of land cover, forest change, and land use attribution. Near-real-time alerts from tools like NASA's Land Change Monitoring System and CTrees' LUCA platform support prompt action, enforcement, and transparent reporting, reducing uncertainties and boosting confidence among market actors, regulators, and the public.

Monitoring forest degradation from activities like logging, wildfires, droughts, and tree mortality remains challenging. High-resolution satellite imagery (< 3 meters resolution), mainly from commercial satellites, is essential for precise attribution. Initiatives like Norway's NICFI program have supported free access to Planet's visual mosaics (2020–2024). Leveraging NICFI data, CTrees' REDD+AI platform uses deep learning to generate the most comprehensive, reliable maps of logging, fire, and road-related degradation in tropical rainforests from 2017–2024. REDD+AI can detect logging activities monthly, providing evidence-based insights vital for reporting project performance and ensuring the integrity of carbon credits.

However, the loss of NICFI Planet data would severely undermine platforms like REDD+AI, as commercial data costs make it almost impossible to provide affordable, publicly accessible data for the community.

MAPPING FOREST BIOMASS CARBON AND CHANGES

Beyond deforestation and degradation, Earth observation (EO) plays a crucial role in accurately quantifying forest biomass carbon stocks, regeneration, and growth—key indicators for assessing carbon sequestration and the effectiveness of management and interventions. Integrating satellite imagery with airborne lidar and ground measurements enables the development of robust models that support precise estimates of forest carbon stocks across local, regional, and national scales. Advanced analytics, including AI and machine learning, process this diverse data to produce high-resolution, spatially explicit metrics of above-ground biomass, net removals, and growth—forming the foundation of emerging carbon accounting standards. This integration ensures that forest-based credits accurately reflect real climate benefits, fostering trust, credibility, and unlocking increased investment in carbon markets.
Historically, large-scale biomass maps were created by combining limited ground data with cloud-free optical imagery in machine learning models. While these regional and global maps effectively capture broad patterns, they often lack the accuracy required for detailed local monitoring of forest carbon. Customized, lidar-based maps — exemplified in standards like VCS Tool VT0005 — remain the gold standard, but until recently, comprehensive, high-resolution EO data was limited.

Recent commitments by NASA and ESA have transformed this landscape. NASA's GEDI (Global Ecosystem Dynamics Investigation), launched in 2018 on the International Space Station, provides global samples of forest height and vertical structure, greatly enhancing biomass mapping accuracy. ESA's Biomass mission, launched in April 2025, is a P-band SAR specially focused on tropical forests, offering annual maps of vertical structure and biomass in the most intact, high-biomass regions.

Complementing these, the NASA-ISRO NISAR platform, launched in July 2025, leverages L-band SAR to monitor biomass loss and recovery worldwide at approximately weekly intervals. NISAR's high-resolution, near-real-time observations enable rapid, accurate detection of deforestation, degradation, and regrowth, supporting REDD+, improved forest management, and other nature-based solutions within carbon markets and policy frameworks.

Collectively, these advanced EO systems are setting a new standard for scalable, precise, and near-real-time forest biomass monitoring—an essential foundation for credible carbon accounting and amplified climate action.

ADVANCING MARKET INTEGRITY WITH STANDARDIZED AND TRANSPARENT DATA

The success of the evolving GHG market depends on standards rooted in reliable, comparable data. Earth observation (EO) underpins these standards, enabling independent verification of emission reductions. Frameworks like VCS and ICVCM increasingly incorporate EO data, boosting credibility, lowering compliance costs, and accelerating project approval. This transparency fosters investor confidence and drives market growth.

Digital MRV systems powered by EO and remote sensing have substantially improved accuracy, scalability, and transparency in forest carbon accounting. When combined with ground validation, they support continuous, credible monitoring—vital for climate policies and market integrity. With advances in technology, like NISAR and Biomass, EO's role in global climate mitigation will only intensify.

OVERCOMING CHALLENGES AND DRIVING INNOVATION

Despite its transformative potential, EO faces hurdles. Data processing and interpretation require specialized expertise, highlighting the need for capacity building. Cloud platforms like Google Earth Engine democratize access, broadening participation. Ensuring data quality and consistency across sensors and resolutions remains critical for market confidence. Continuous innovation—integrating multispectral, hyperspectral, and SAR data—improves accuracy in complex ecosystems like wetlands and mangroves.

Collaboration among governments, research institutions, satellite providers, and NGOs is accelerating EO's integration into market frameworks. Supported by multilateral agencies and philanthropy, these efforts are making EO technologies more accessible and reliable. However, operational sustainability is threatened, as most Earth observation data relies on publicly funded, government-operated platforms. Funding cuts and policy shifts risk undermining these vital assets, threatening the future of nature-based solutions and global carbon markets.

WITHOUT SUSTAINED PUBLIC INVESTMENT, THE **CREDIBILITY** AND **FUTURE** OF NATURE-BASED CARBON MARKETS ARE AT RISK.

Sassan Saatchi, *is CEO, co-founder, and chief scientist at CTrees, as well as a senior research scientist at NASA's Jet Propulsion Laboratory/Caltech and adjunct professor at UCLA's Institute of the Environment and Sustainability. His research activities include land cover classification, biomass and soil moisture estimation in boreal forests, land use and land cover change, forest structure and carbon stock in tropical forests, applications of remote sensing in biodiversity and conservation.*

CHAPTER 5

THE NEW CARBON ACCOUNTING ERA

Carbon accounting is entering a new phase. What once centred on basic measurement is now vital to market confidence, corporate strategy, and environmental integrity. Precision, transparency, and digital integration are reshaping how emissions are tracked and verified across sectors and borders. Governments are strengthening inventories for Paris Agreement reporting, while companies face rising expectations for credible, comparable disclosures. Digital MRV, blockchain, and AI-enabled analytics are accelerating real-time monitoring, despite ongoing challenges with fragmented frameworks. This chapter explores how data integrity, policy alignment, and digital tools are defining the next generation of carbon accounting.

MIKE ZEHETMAYR, CARBON AND NATURE MARKETS LEAD, EY

CARBON MARKETS: STEPS TO CREATE A RECOGNISABLE MARKET AND ASSET CLASS

ACCOUNTING FOR CARBON REQUIRES BOTH PRECISION AND TRUST. IN THE FOLLOWING PIECE, EY EXPLORES HOW ESTABLISHED ASSURANCE PRINCIPLES AND AUDIT-GRADE SYSTEMS CAN STRENGTHEN CONFIDENCE IN EMISSIONS DATA – TURNING CARBON REPORTING FROM A COMPLIANCE EXERCISE INTO A STRATEGIC TOOL FOR VALUE CREATION AND RISK MANAGEMENT.

Accounting for carbon matters because it turns climate action into something finance teams can recognise, measure and manage. The good news is we don't need to invent a new rulebook. Existing accounting frameworks under IFRS and US GAAP already offer relevant guidance for carbon units. CFOs should work with auditors to determine where these criteria are met and when carbon units can be recognised as assets.

What do today's standards allow in practice? Under IFRS, the treatment depends on purpose and facts. Carbon units held for sale may be inventory (IAS 2); units held for use may be intangible assets (IAS 38). For nature-based projects, entities can analogise to IAS 41 at the moment of verification (fair value less costs to sell), which then becomes the cost basis under IAS 2 or IAS 38. Recognition hinges on demonstrable future economic benefits, which in turn depend on a legally enforceable right to the credit and the existence of an exit market.

US GAAP is converging on a comprehensive standard: the FASB is finalising guidance on environmental credits and related obligations and effective for calendar-year companies in 2028 (with early adoption likely). The model distinguishes credits held for sale from those held to settle compliance obligations. Notably, credits acquired to be retired against a voluntary objective or target would be expensed on acquisition under the tentative conclusions.

Timing and evidence matter. Ex-post credits—issued only after a verified environmental benefit—are generally easier to recognise than ex-ante credits, which carry greater performance risk. Project developers often recognise credits on verification, but may capitalise certain costs earlier depending on method and project characteristics; newer or more complex approaches can push recognition later and affect initial measurement.

On the liability side, when policy links "voluntary" and compliance use—e.g., removals permitted to settle regulatory obligations—the accounting can follow established ETS permit and liability models. In short, where a removal becomes an asset to settle a recognised obligation, existing ETS accounting is the reference point.

Of course, accounting sits on legal foundations. Markets operate best when carbon rights are defined as property, with clear title, serialisation to individuate units, and registry infrastructure that supports taking security and tracing ownership. Jurisdictions such as Australia already codify "carbon rights," while others are moving via digital-asset concepts to clarify proprietary treatment of intangible units; clarity over subsurface storage rights for CCUS is also essential.

An "active market" is not just an accounting nicety—it's the backbone of price discovery, liquidity and confidence. Building that market relies on familiar financial plumbing: intermediation, standardised contracts, custody, and risk tools such as insurance. ISDA's work on standard carbon contracts can enhance integrity, while insurance can convert delivery risk into counterparty risk and unlock project finance.

CARBON UNITS CAN ALREADY BE RECOGNISED UNDER EXISTING IFRS AND US GAAP FRAMEWORKS — TURNING CLIMATE ACTION INTO MEASURABLE, **MANAGEABLE FINANCIAL ASSETS.**

CLEAR OWNERSHIP, STANDARDISED DATA, AND ROBUST MARKET INFRASTRUCTURE ARE **ESSENTIAL** FOR CARBON TO MATURE INTO A **TRUSTED** ASSET CLASS CAPABLE OF DRIVING CLIMATE FINANCE **AT SCALE.**

HOW DO WE SCALE FROM HERE?

EY has recently published a White Paper[49] which lays out six areas where market participants, policymakers and standard setters should act.

First, demand clarity: align claims standards so corporates can use high-quality units across all scopes where decarbonisation isn't feasible today; connect voluntary demand to compliance where appropriate, and use policy levers such as ETS integration and contracts for difference to create durable offtake. Linking CCUS programmes and carbon markets can also crowd in private capital.

Second, financial market infrastructure: encourage standardisation of methodologies and verification, publish prices, build indices and benchmarks, develop custody and clearing functions, and support structured products with ratings to broaden participation. These steps improve liquidity, transparency and risk management—the prerequisites of an "active market" accountants can rely on.

Third, accounting: CFOs should work with auditors to recognise carbon units on balance sheets where criteria are met, and ensure credits intended to settle ETS liabilities are recognised and derecognised in line with the relevant standards. This is about using the frameworks we already have, consistently.

Fourth, legal clarity: define initial ownership (including the relationship to land and minerals), specify permissions to sequester and store, and make the property status of carbon units explicit—supported by serialisation in registries to individuate rights.

Fifth, regulation: adopt a phased, principles-based approach that classifies credits clearly, brings market-facing functions within the perimeter, and applies conduct, disclosure and market-abuse rules where activities resemble traditional finance. Coordinate cross-border supervision to deter fraud and manipulation.

Sixth, data and assurance: standardise methodologies, digitise registries, require transparent MRV, and improve reporting so transactions are auditable. High-quality, timely data is the antidote to reputational risk and the key to fungibility—and, by extension, to credible valuation.

Accounting does not build markets on its own, but it does support capital deployment and market confidence. If market participants and governments deliver on these six fronts together, carbon can become a recognisable asset class—priced, traded and reported with the same confidence we expect elsewhere. That is how markets help deliver climate outcomes at scale.

Mike Zehetmayr *leads for EY on Carbon and Nature Markets. Mike has over 30 years of delivering large scale technology change across trading, regulation, compliance and risk management across all the major geographies . In an earlier life Mike was a glaciologist studying the impact of climate change in the Arctic. This experience and understanding of the science and financial market structures, practices and data informs how he helps clients build strategy to support their own sustainability journey.*

ADAM DIAMANT, ARIN KAYE, ELECTRIC POWER RESEARCH INSTITUTE

SCOPE 2 GHG EMISSIONS ACCOUNTING: CHALLENGES TO LOCATION- AND MARKET-BASED ACCOUNTING

AS CORPORATE ACCOUNTING FRAMEWORKS EVOLVE TO INTEGRATE GREENHOUSE GAS (GHG) EMISSIONS DATA INTO MAINSTREAM FINANCE, THE POLICY AND TECHNICAL DIMENSIONS OF MEASUREMENT REMAIN CRITICAL TO ADDRESS. THE FOLLOWING PIECE FROM THE ELECTRIC POWER RESEARCH INSTITUTE (EPRI) DELVES INTO THE SCIENCE AND SYSTEMS BEHIND ACCURATE CARBON ACCOUNTING FOR EMISSIONS ASSOCIATED WITH PURCHASED ELECRICITY.

In recent years, many large companies have made aggressive commitments to reduce their operational greenhouse gas (GHG) emissions and achieve "net-zero" emissions by 2050. These corporate goals often are grounded in guidance on methods to calculate corporate GHG emissions inventories provided by the Greenhouse Gas Protocol (GHGP)[50], which categorizes GHG emissions into "scopes" of direct and indirect emissions.[51] For many companies, the scope 2 emissions associated with the electricity they buy and use is a large source of their total GHG emissions and a key focus of their emissions reduction efforts. Yet, it can be very challenging for these companies to reduce these emissions because they are not under their direct control.

Companies can reduce their scope 2 emissions by reducing their demand for grid-based electricity by making energy efficiency upgrades in their operations or by deploying low-carbon, behind-the-meter distributed generation. But for many companies, there are limits to the extent these actions can decrease their emissions, pushing them to purchase renewable and other carbon-free energy resources that align with existing GHG accounting guidance.

EXISTING STANDARDS PROVIDE A STRONG INCENTIVE FOR COMPANIES TO PROCURE RENEWABLE ENERGY

The existing GHGP scope 2 guidance provides a strong incentive for companies to procure renewables and renewable energy certificate (REC) to reduce their reported scope 2 GHG emissions. The existing "market-based" approach to scope 2 accounting recognizes corporate efforts to invest in renewable energy by allowing companies to report zero GHG emissions (i.e., 0 tCO_2e/MWh consumed) associated with the renewable energy and RECs they procure.

In recent years, a large and growing group of leading sustainability-oriented companies engaged in high-technology, retail, apparel, finance, insurance and manufacturing have pledged to procure enough renewable resources – predominately wind and solar generation – and RECs to equal 100 percent of the megawatt hours (MWh) of electricity they consume annually.[52]

Companies that use the market-based approach also are required to report their "location-based" scope 2 emissions. The location-based method guides companies to report the emission embedded in the electricity consumed at their facilities which often is calculated using a regional grid average emissions factor (EF) or a utility-specific EF if one is available.

GROWING CONTROVERSY AROUND SCOPE 2 MARKET-BASED ACCOUNTING

The distinction between market-based and location-based accounting for purchased electricity has led to confusing and disparate claims about the extent a company may have reduced its use of non-renewable, carbon-emitting power resources. In recent years, there has been growing recognition that buying renewables and RECs to reduce reported scope 2 emissions may lead to inaccurate attribution of GHG emissions. For example, in 2020, Google reported that despite having contracted for 100 percent renewable energy to meet the annual electricity consumption of the company's worldwide data centers, the data centers continued to rely on undifferentiated regional "grid power" to meet a significant portion of their electricity consumption, ranging from 6 to 82 percent depending on its location and corresponding demand profile.[53]

The market-based approach to reducing reported scope 2 emissions is controversial and is a key issue being considered as part of the ongoing multi-year review and revisions of the GHGP. In October 2025, the GHGP published proposed revisions to its

COMPANIES CAN REDUCE THEIR SCOPE 2 EMISSIONS BY REDUCING THEIR DEMAND FOR GRID-BASED ELECTRICITY BY MAKING ENERGY EFFICIENCY UPGRADES IN THEIR OPERATIONS

THE SHIFT FROM ANNUAL RENEWABLE MATCHING TO 24/7 CARBON-FREE ENERGY MARKS A **MAJOR EVOLUTION** IN CORPORATE DECARBONIZATION — AND WILL SHAPE THE GHGP'S NEXT GENERATION OF SCOPE 2 GUIDANCE.

scope 2 location-based and market-based approaches for public comment and expects to publishing final updated guidance in 2027 or 2028. This new guidance will determine how companies may use market-based transactions to reduce their reported scope 2 emissions in the future and could have a dramatic impact on the future of renewable and carbon-free resource deployment.

THE MOVEMENT FROM ANNUAL TO HOURLY MATCHING

One factor differentiating contracted and consumed electricity is that the output profile of contracted renewable resources often does not match a customers' actual hourly load. Many large electricity customers may purchase enough renewables to equal their annual electricity consumption, but they will still receive and consume undifferentiated "grid" power that includes GHG-emitting resources during some hours of the day and year, particularly when contracted renewables do not generate electricity (e.g., when the wind is not blowing).

Additionally, renewables and RECs may be generated in a different geographic region than where the contacted electricity is consumed. In the United States, companies are allowed to acquire and retire RECs created by renewable generation anywhere in the U.S. and claim a zero EF (0 $mtCO_2e$ / MWh) associated with the purchased electricity when they use the market-based accounting method. This locational mismatch is another reason why renewable energy procurement may not translate directly into reduced GHG emissions.

EVOLVING SCOPE 2 GUIDANCE

In response to growing concerns about the potential mismatch between renewable procurement and electricity consumption, a few leading sustainability-oriented technology companies, including Google, Microsoft, Iron Mountain and others, have started to procure carbon-free energy (CFE) that more closely matches their actual hourly electricity load on a 24/7 hourly basis every day of the year (aka 24/7 Carbon-free Energy). This shift from procuring 100 percent renewables annually to procuring hourly-matched CFE marks a potentially important evolution of corporate efforts to promote clean energy and increase deployment of a range of carbon-free generation technologies.

Concerns about the potential need for hourly and geographic matching of CFE and end-use load have also been a focus of the ongoing GHGP review. The recently proposed updates to the GHGP's scope 2 accounting guidance includes proposed updated methods and requirements related to the use of hourly and geographic matching for qualified carbon-free electricity generation resources.

ESTIMATING SCOPE 2 EMISSIONS ASSOCIATED WITH BUYING ELECTRICITY IS CHALLENGING

Companies want to accurately estimate and report the scope 2 emissions associated with the electricity they buy. To do this, a company needs to know how much electricity it consumed (MWhs) in a year and the associated "consumption-based" EF (i.e., tCO2e/MWh) of the electricity they purchased.

Because it is impossible to track electricity generated by specific power to where it is consumed, it is not possible to empirically measure consumption-based EFs. While there are ongoing efforts to develop and make available consumption-based EFs, and a variety of start-up companies[54] and others are focused on doing this, there currently is no widely agreed-upon approach for developing and using consumption-based EFs.[55]

As the conversation around accurate and transparent location- and market-based accounting continues to evolve, it could be beneficial for the GHGP to provide more clear and more standardized guidance related to acceptable methods electric companies can use to calculate consumption-based EFs and provide them to their customers.

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KEVIN BIRN, CARLOS PASCUAL, AND JONTY RUSHFORTH, S&P GLOBAL

THE ROADMAP TO A CARBON DIFFERENTIATED MARKET: TAKING STOCK OF THE CARBON ACCOUNTING DIALOGUE IN 2025

CARBON ACCOUNTING MATTERS IF GOVERNMENTS, INDUSTRY AND CIVIL SOCIETY SEEK TO INCENTIVIZE DECARBONIZATION IN BUSINESS TRANSACTIONS AND ALLOW COMPANIES TO COMPETE ON CARBON. THIS IS THE CONCEPT OF A CARBON DIFFERENTIATED MARKET.

Discussions about product-level carbon accounting accelerated in 2025. There is growing recognition that the world lacks a sufficiently consistent and comparable product-level carbon accounting system. The product focus is essential: it is at this level that companies compete and nations trade. Currently, buyers are unable to obtain consistent information, compare, and trust. Sellers cannot reliably signal and differentiate their products to discerning buyers.

S&P Global Energy has been involved in advancing the principles and instruments for a carbon-differentiated market for over a decade. As activity in this space has picked up, so has our engagement. At CERAWeek, S&P Global Energy convened a private roundtable of leading corporates and financial institutions to take stock of the issues. In March S&P Global Energy published a key report outlining the core elements for a carbon differentiated market to evolve.[56]

Throughout 2025, S&P Global Energy and the International Emissions Trading Association partnered to raise awareness of the importance of the issue. In October, S&P Global Energy announced it would lend its expertise as an independent Knowledge Partner to Carbon Measures, an international consortium of some of the world's largest multinationals that have agreed to collaborate on product-level carbon accounting standards.[57]

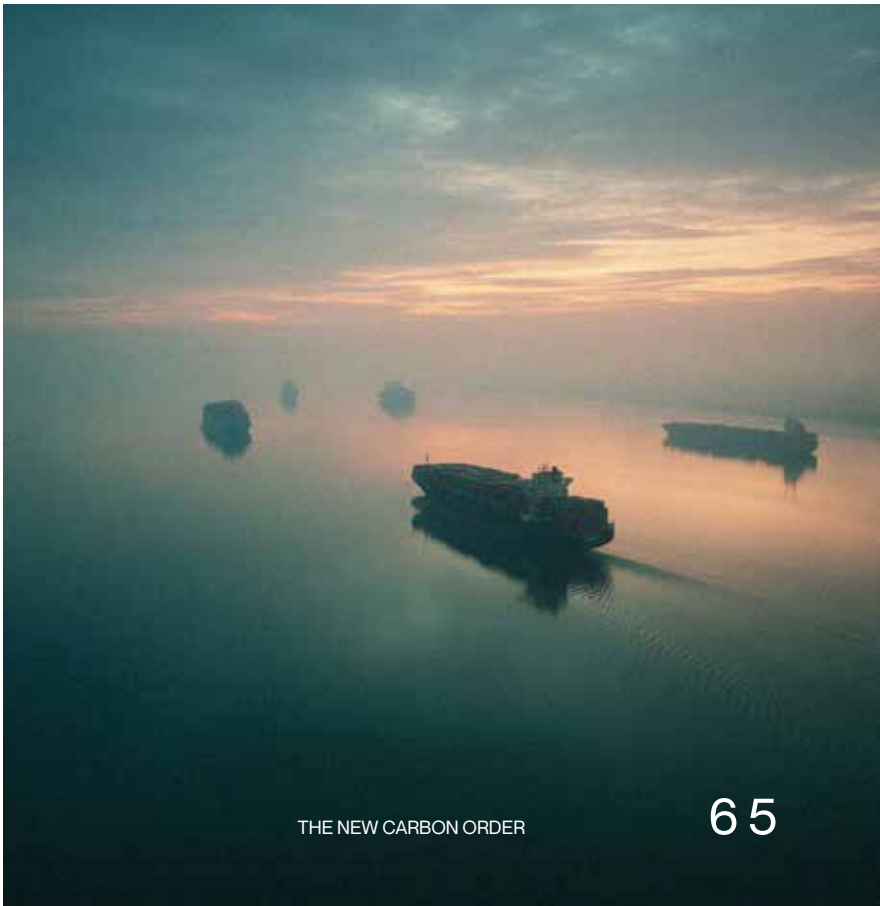
Carbon accounting is important to S&P Global Energy because we are a company focused on bringing transparency to markets through an array of data, analytics, insight, market benchmarks and infrastructure. As long as carbon accounting remains disparate, fragmented and opaque the market will struggle to value lower carbon commodities. This report provides a synthesis of where see progress on carbon accounting, agreement in the market, and differences of opinion.

CARBON ACCOUNTING IS IMPORTANT TO S&P GLOBAL ENERGY BECAUSE WE ARE A COMPANY FOCUSED ON BRINGING TRANSPARENCY TO MARKETS

WHAT IS CARBON ACCOUNTING?

It is important to acknowledge that "carbon accounting" can mean different things to different people. For some it is about how emissions are reported, accounted for and communicated. For others it is about how emissions are estimated, assured and registered through associated market infrastructure—like registries.

For S&P Global Energy, carbon accounting is all these things. Emissions quantification, reporting, assurance and financial style accounting are needed for the market to be able to understand, trust, and incorporate greenhouse gas emissions as an attribute into business decisions.



THERE IS NOW A NEED FOR **LESS FLEXIBILITY** AND **MORE UNIFORMITY** TO ENSURE COMPARABILITY ACROSS PRODUCTS AND SECTORS.

CARBON ACCOUNTING IS EVOLVING

The idea of a 'green' premium—a preferential price for lower carbon products and services—remains elusive. As a result, companies with advantaged lower carbon products cannot be rewarded, and companies that would make investments to reduce their products carbon intensity lack market incentives. Many governments have intervened in the market to create incentives to decarbonize through various carbon pricing regimes. These regulations are typically unique, complex and not linked across regions. But most global emissions remain unregulated, limiting the reach of these markets.

Since 2022, energy priorities have stressed security, competitiveness and affordability, often putting sustainability on the horizon (e.g. the Draghi report).[56] Nations with some form of a price on carbon will eventually face a decision between imposing a price signal that will negatively impact domestic competitiveness or putting in place a carbon tariff on imports from regimes with weaker carbon policies to protect their sectors. If nations adopt different approaches in how they impose their carbon border measures, global trade could be disrupted. This trajectory has the potential to increase compliance costs, complicate trade, and challenge other nations tackling affordability and security.

The situation today is not the result of a lack of guidance, practices, methodologies or standards. Rather, many of the early and most established efforts were designed to be intentionally vague to ensure they were internally consistent over time, and to be applicable across multiple sectors. These approaches helped accelerate corporate reporting and emissions disclosure. Today, however, there is a need for less flexibility and more uniformity, to ensure consistency across similar products within the same sector, and even across different sectors to improve comparability. This would better align capital flows with decarbonization, while helping to protect trade.

WHERE DO WE SEE ALIGNMENT?

Industry consensus is emerging on the need for harmonized product-level carbon accounting to support investment in decarbonization. Governments increasingly recognize that harmonized carbon accounting needs to underpin public policy on decarbonization. Key areas of agreement today, including the shortfalls, include:

- A green premium for lower-carbon products has not emerged. Although there are some anecdotal examples, a green premium has not emerged nor is it likely to emerge based on our current trajectory. This is critical because without a price signal for lower carbon products, companies are unable to monetize advantaged products, and companies who could make investments to improve competitiveness cannot.
- A shared understanding of product-level attributes is critical. A shared understanding of product attributes is fundamental to how companies compete, how nations trade, and the efficient allocation of capital. Information about product attributes—real and perceived—can impact behavior.
- We lack a shared understanding of product-level emissions. Unlike a calorie count on a menu, we simply don't understand emissions of the products we buy. We cannot distinguish high or low carbon. A shared understanding of product attributes would allow companies to bring to market new products with superior low carbon attributes and buyers to distinguish them.
- There is a need for harmonization of product-level carbon accounting. An internationally recognized, harmonized, product-level carbon accounting framework would provide a common basis to communicate carbon as a product attribute and enable more uniform treatment in regulations across nations. This can reduce compliance costs, while protecting trade by ensuring equivalent treatment globally.
- Less flexible, more precise guidance is required. There are four key areas of misalignment that result in most differences today. As shown in Figure 1, these include: System (or Emissions) Boundaries, the treatment of the allocation of emissions to by-products, reporting units, and data quality. These four areas require more specific guidance.
- Coordinated action is need by industry and government. Industry action is critical as it has the skills and technical understanding of heterogenous productions systems around the world required to develop more detailed standards. Government action is critical to communicate acceptability, and develop processes to accept and decide, as absolute consensus is unlikely.

WHERE DO VIEWS DIVERGE?

Despite incredible momentum and acknowledgement of the challenges and importance of harmonization of product level carbon accounting, key challenges remain, principally around how to coordinate and collaborate.

The risk of entrenchments of competing visions of the best process and solution.

The GHG Protocol and ISO Standards are the most cited emissions quantification methodologies. These efforts to standardize emissions reporting were designed to be flexible so that they could be applicable across sectors. The flexibility, however, resulted in small differences in what and how emissions are quantified and reported, even within the same sector. Ultimately, the resulting data is insufficiently consistent to be comparable. To find greater consistency, companies, industry associations, and governments developed their own methodologies and guidance documents which typically, but not always, fit within the confines of the more general leading standards.[57]

These more refined methodologies are often unique and thus inconsistent. They, however, presented a solution for a given company, policy, region, and sector. This has contributed to an expansion of competing approaches. While there is general recognition of the need for harmonization, there is no uniformity on how best to address it. Entrenchment and balkanization of different processes and methodologies is a key challenge to harmonization.

The GHG Protocol is presently undertaking a material review of scope 2 and scope 3 methodology guidance to address consistency and comparability. This effort is more focused on corporate emissions but would have implications for product level guidance.

New initiatives like Carbon Measures, supported by large multinationals, are seeking to coordinate, and accelerate cross-sectoral work to create a more detailed product-level carbon account methodology, while also advancing financial accounting principals into emissions reporting.

Building consensus and finding common ground between competing methodologies across industry is a critical gap that will need to be overcome for the shared goal of harmonization to succeed.

Multiple pathways for government engagement emerging.

At COP30 in Brazil two new initiatives were launched – the Open Coalition on Compliance Carbon Markets and the Coalition to Grow Carbon Markets. Both are voluntary and are government-led. The roles of industry are thus far undefined. The Open Coalition seeks to standardize compliance on carbon markets to allow countries to regulate, price and trade carbon – while remaining flexible across countries. The Coalition to Grow Carbon Markets will also seek to establish unified high-integrity standards for carbon credits.

All these efforts are all working towards more uniformity. Flexibility will remain an issue, particularly among governments that may have specific national prerogatives. How industry insight on technology and costs will feed into government coalitions remains uncertain but will be critical to any viable outcomes. The multiple pathways across governments and between industry and government could lead to greater disparities and risk entrenchment among them that could slow coordination and harmonization.

The potential role of governments following COP30 has now become particularly critical. Until COP30, governments showed increasing awareness, interest and participation in carbon accounting through the G7, G20, and BRIC+ dialogues. The launch of two COP30 initiatives has already drawn volunteers from Brazil, China, the EU, United Kingdom, France, Kenya, Singapore and Panama which will inject new perspectives. The United States is not engaged. Government expectations will be critical to focus industry work and encourage collaboration. Unknown is whether the new Coalitions will recognize existing areas of agreement, incorporate a vast body of corporate knowledge, or seek to chart new directions.

WITHOUT A PRICE SIGNAL FOR LOWER-CARBON PRODUCTS, COMPANIES CANNOT **MONETISE THEIR ADVANTAGE OR JUSTIFY DECARBONISATION INVESTMENTS.**

A HARMONIZATION OF PRODUCT-LEVEL CARBON ACCOUNTING FRAMEWORK COULD PROVIDE CONSISTENT INFORMATION THAT THE MARKET CAN TRUST

CONCLUDING REMARKS

Shared understanding of product attributes is fundamental to how buyers and seller transact. Aside from any political or ideological issues, inconsistencies in carbon accounting have led to incomparability between product-level greenhouse emissions, challenging efforts to make carbon a product attribute that signals value. Emissions information available to markets is not seen as sufficiently credible to be trusted to be transacted upon. A harmonization of product-level carbon accounting framework could provide consistent information that the market can trust to differentiate products based on emissions profile. Companies with superior products could take advantage of this differentiation, and companies that would like to invest to improve their carbon competitiveness would be incented to do so. International interoperability is also critical to protect trade and the global economy.

Industry is converging on the need for harmonization of product-level carbon accounting to give value to low-carbon products, create incentives to invest in carbon competitiveness, and protect trade.

How we organize is where there are differences. There are many expert groups, tracks of analysis, and industry consultations. Now new government coalitions on these issues have merged. They need to be harmonized. Harmonization of carbon accounting is critical to provide clarity to producers, investors, consumers -- and to facilitate growth of carbon markets. Without creating a funnel that drives consensus, we risk further splintering of views that can stall action when time is limited as the climate impacts are already increasing.

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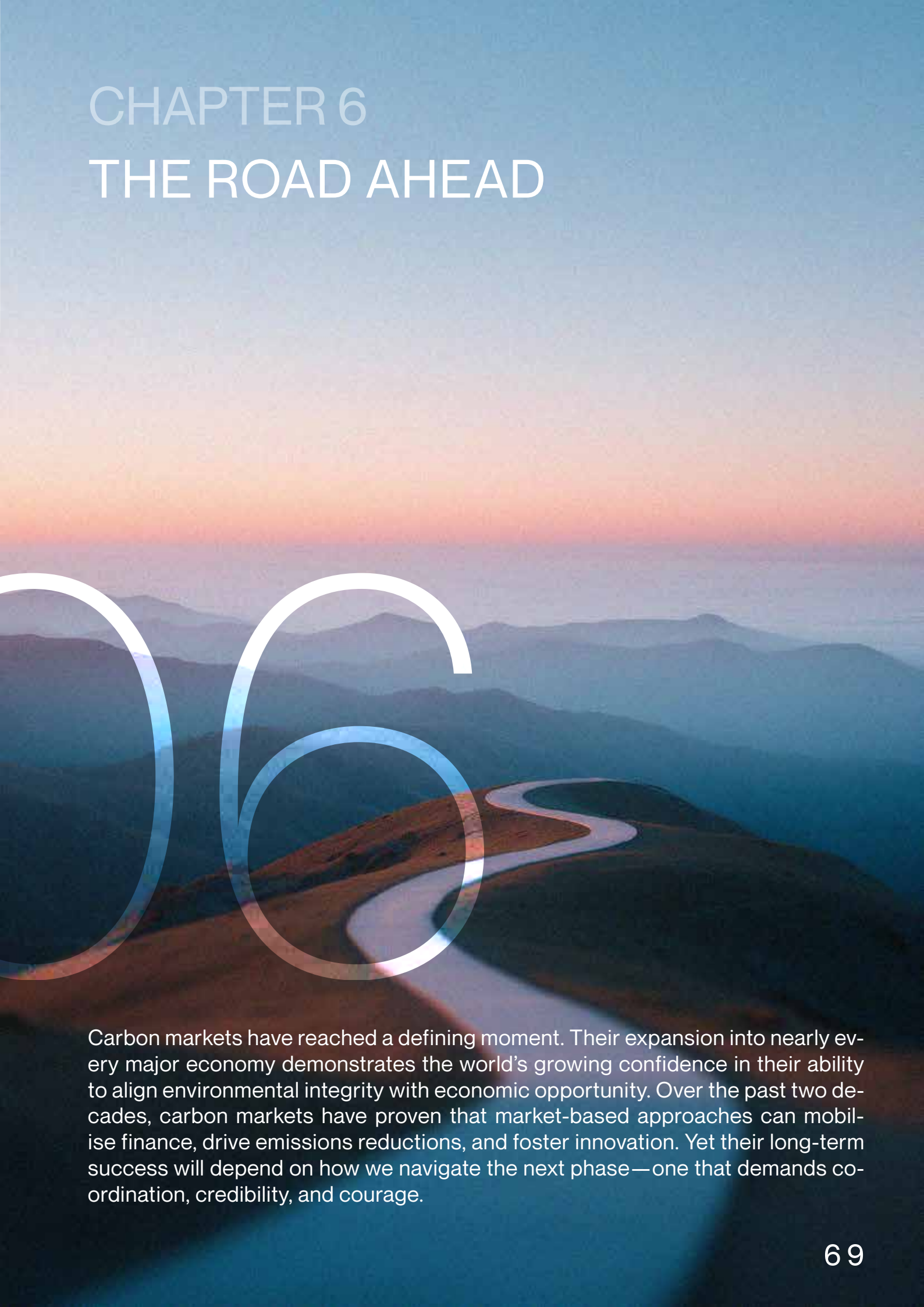
Carlos Pascual, *leads the integration of geopolitics, energy, and markets for S&P Global Commodity Insights. He works with clients globally on addressing the geopolitical challenges of energy transition, security and competitiveness -- and the implications for energy justice. Mr. Pascual also leads the coordination of S&P Global Commodity Insights businesses in Latin America.*

Jonty Rushforthl *works at S&P Global Commodity Insights as the Head of Product & Portfolio, Energy Transition, leading a group that creates and delivers solutions across Energy Transition, both research and infrastructure, including insights, outlooks, registry services and the Meta Registry. Previously, he was a global leader in the pricing team for many years in a range of commodity markets, including Carbon, Energy Transition, Shipping, Chemicals, Agriculture, Gas and Oil, focused on delivering robust price benchmarks and market coverage.*

CHAPTER 6
THE ROAD AHEAD



Carbon markets have reached a defining moment. Their expansion into nearly every major economy demonstrates the world's growing confidence in their ability to align environmental integrity with economic opportunity. Over the past two decades, carbon markets have proven that market-based approaches can mobilise finance, drive emissions reductions, and foster innovation. Yet their long-term success will depend on how we navigate the next phase—one that demands coordination, credibility, and courage.

DIRK FORRISTER, PRESIDENT & CEO, IETA

THE ROAD AHEAD

DELIVERING INTEGRITY AT SCALE WILL DEPEND ON THE INFRASTRUCTURE BENEATH IT. THE CONTRIBUTION FROM IEVA STEPONAVICIUTE AT THE CLIMATE ACTION DATA TRUST OUTLINES HOW DATA INTEROPERABILITY AND OPEN DIGITAL SYSTEMS ARE BUILDING THE FOUNDATIONS FOR A TRANSPARENT, FUTURE-READY CARBON MARKET.

CARBON MARKETS ARE MOVING FROM MANY ISOLATED SYSTEMS TO ONE I**NTERCONNECTED CARBON ARCHITECTURE** — LINKING POLICY, FINANCE, AND TECHNOLOGY TO ACCELERATE DECARBONISATION.

When we look back over the evolution of carbon markets, what stands out is their ability to adapt. From the first pilot trades to today's sophisticated exchanges, every stage of progress has come through learning — through experimentation, feedback, and refinement. The New Carbon Order is the next step in that evolution. It reflects a maturing ecosystem that recognises the need not just for ambition, but for structure — a system that can carry climate action into the next generation of growth.

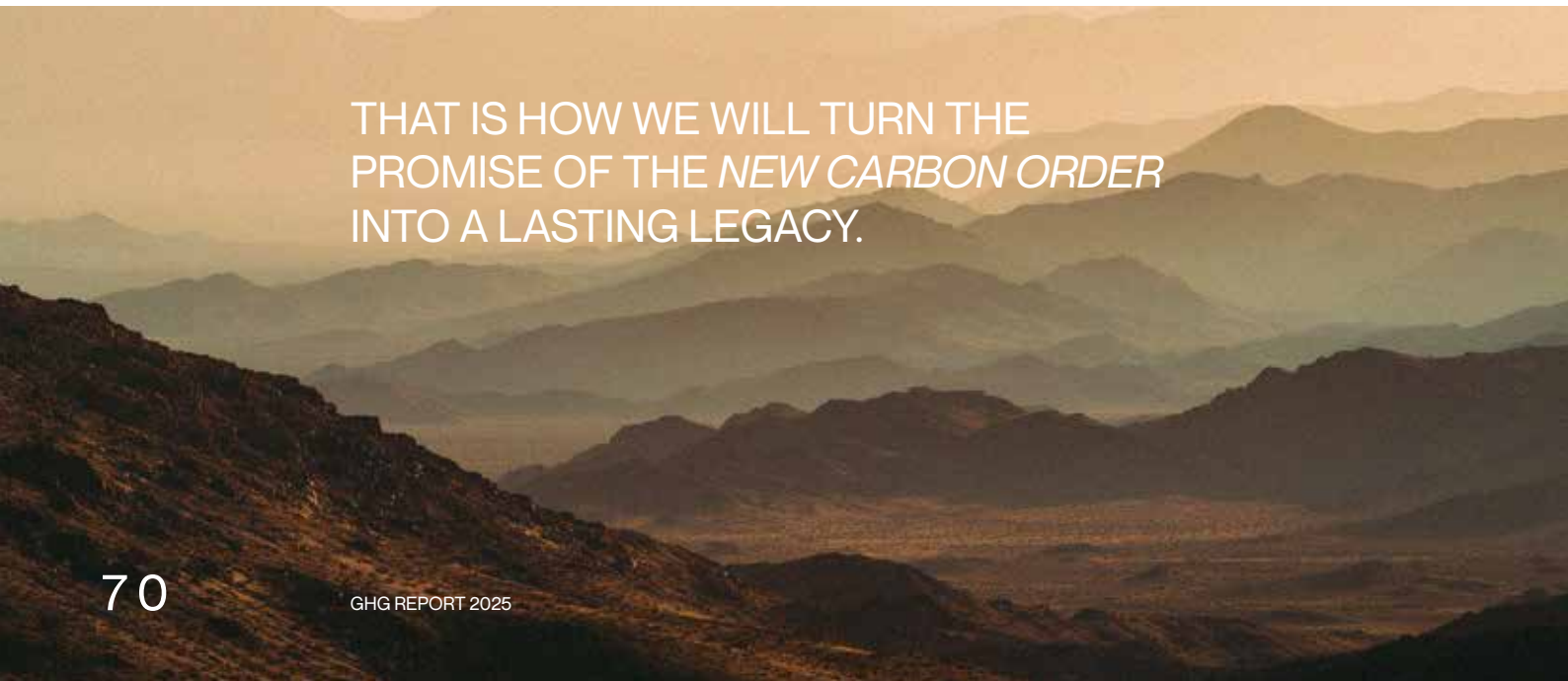
This report has traced the contours of that system. We've seen how compliance markets are expanding and linking, how voluntary markets are resetting around higher standards, and how Article 6 is creating the connective tissue for international trade in emissions outcomes. We've seen technology emerge as the great enabler — transforming verification, registries, and market access. And we've seen a new wave of innovation from the private sector, bringing digital finance, artificial intelligence, and tokenised infrastructure into what was once a policy-driven space.

It's an exciting moment — but also a defining one. For carbon markets to reach their potential, we must make deliberate choices about how they grow and who they serve. Markets can drive efficiency, but they also depend on confidence, coordination, and inclusion. As systems scale up, these principles will determine whether we achieve true transformation or repeat the fragmentation of the past.

The opportunity before us is enormous. Today, around a quarter of global greenhouse gas emissions are covered by an emissions trading system. Within a decade, that could double. Voluntary crediting, once peripheral, is becoming a vital bridge for finance to reach mitigation opportunities that compliance markets can't yet reach. Article 6 mechanisms are creating a common accounting language that allows countries to cooperate under the Paris Agreement without double counting. And digital tools are collapsing transaction costs, making participation possible for smaller actors and emerging economies.

If we succeed in connecting these advances, we will move from a world of many carbon markets to a world of one carbon system — a network that links policy, finance, and technology in service of the same goal: accelerating decarbonisation.

THE NEXT DECADE WILL DETERMINE WHETHER CARBON MARKETS BECOME A BACKBONE OF GLOBAL CLIMATE ACTION OR REPEAT THE FRAGMENTATION OF THE PAST — THE CHOICES WE MAKE NOW WILL **DEFINE THEIR LEGACY.**



TO GET THERE, I SEE FIVE PRIORITIES SHAPING THE DECADE AHEAD.

1. **Build interoperability into the foundations.**

   Every system — whether a registry, a standard, or an exchange — must be able to connect to others. That means open data protocols, common digital identifiers, and clear governance for how units move across jurisdictions. Without interoperability, we risk recreating the same silos we've worked so hard to overcome.

2. **Invest in digital infrastructure.**

   The carbon market of the future will be built on code as much as on policy. Digital MRV, blockchain registries, and automated settlement systems are already proving their worth. But scaling them safely requires investment in cybersecurity, data protection, and global standards that ensure technology serves the public interest.

3. **Align voluntary and compliance markets.**

   The boundary between them is fading. We need a coherent framework where credits, allowances, and Article 6 units can coexist with clear definitions and mutual recognition. Convergence is not about uniformity; it's about compatibility — ensuring that progress in one system strengthens the others.

4. **Unlock investment confidence.**

   Carbon markets are capital markets for climate. Their success depends on predictability — on policy stability, transparent rules, and liquidity. Governments can amplify impact by signalling long-term price trajectories, while the private sector must continue developing financial instruments that make carbon assets investable at scale.

5. **Broaden participation and equity.**

   A truly global carbon market must reflect the full diversity of the world's economies. New entrants in Africa, Latin America, and Asia bring not just new mitigation potential, but new perspectives on design and fairness. Ensuring that these markets have access to technology, finance, and partnerships will determine how inclusive and resilient the global system becomes.

These priorities are not theoretical; they are actionable steps already underway. We see governments building interoperable registries under Article 6. We see developers digitising MRV and using AI to verify projects in near real time. We see financial institutions structuring carbon-linked products that direct capital to mitigation at scale. And we see growing cooperation between standard-setters, regulators, and civil society to align methodologies and definitions.

The lesson of the past two decades is that markets are most powerful when they are connected — across borders, sectors, and systems. Connection is what transforms a series of transactions into a global movement.

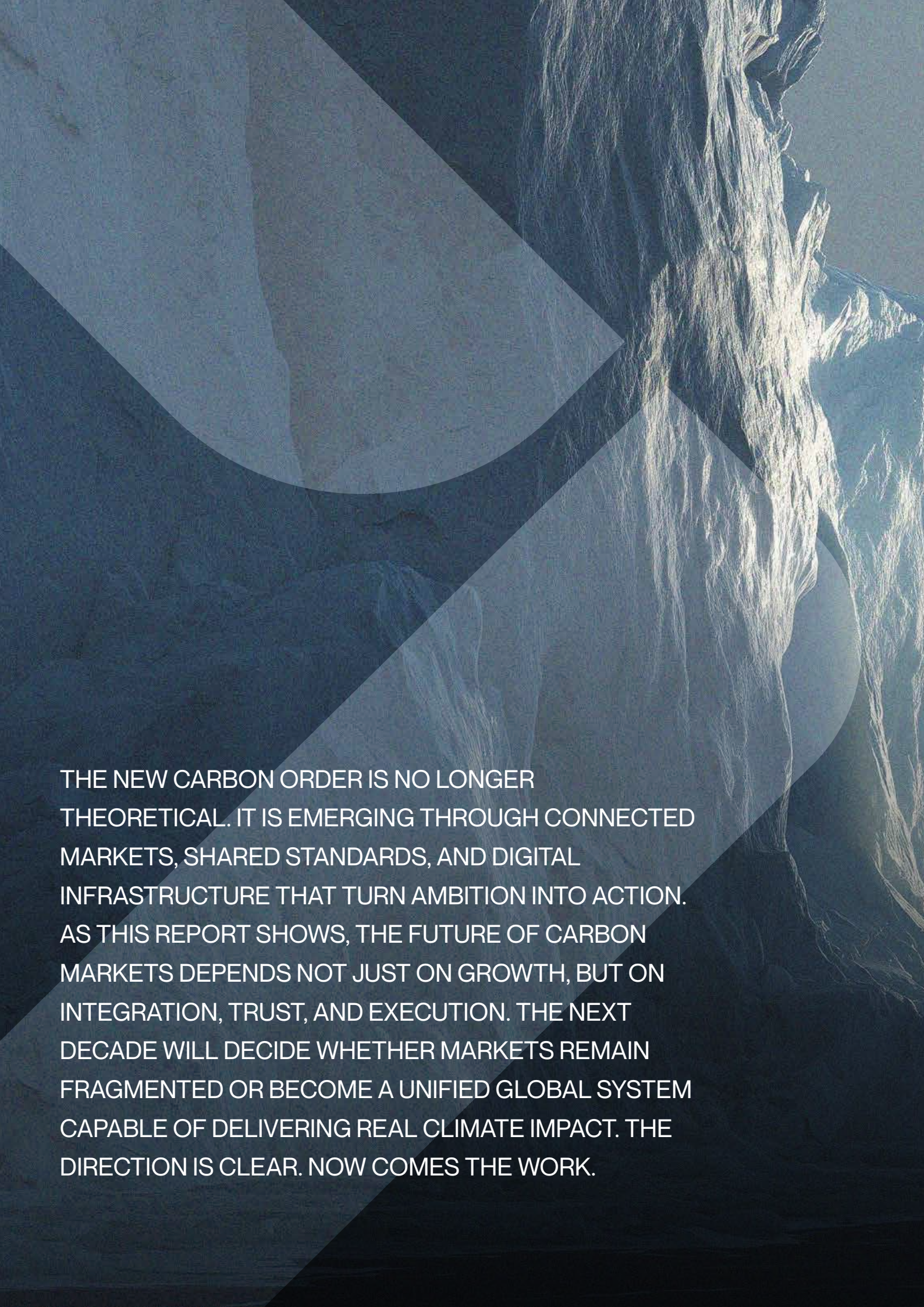
The New Carbon Order is not a fixed endpoint; it is a living process of collaboration. It will continue to evolve as technology advances, as nations raise their ambition, and as new actors join the market. But its direction is unmistakable: toward greater integration, efficiency, and reach.

As IETA celebrates more than twenty five years supporting market development, we remain committed to continued evolution — convening partners, shaping policy, and ensuring that carbon markets deliver real value for climate and the economy alike.

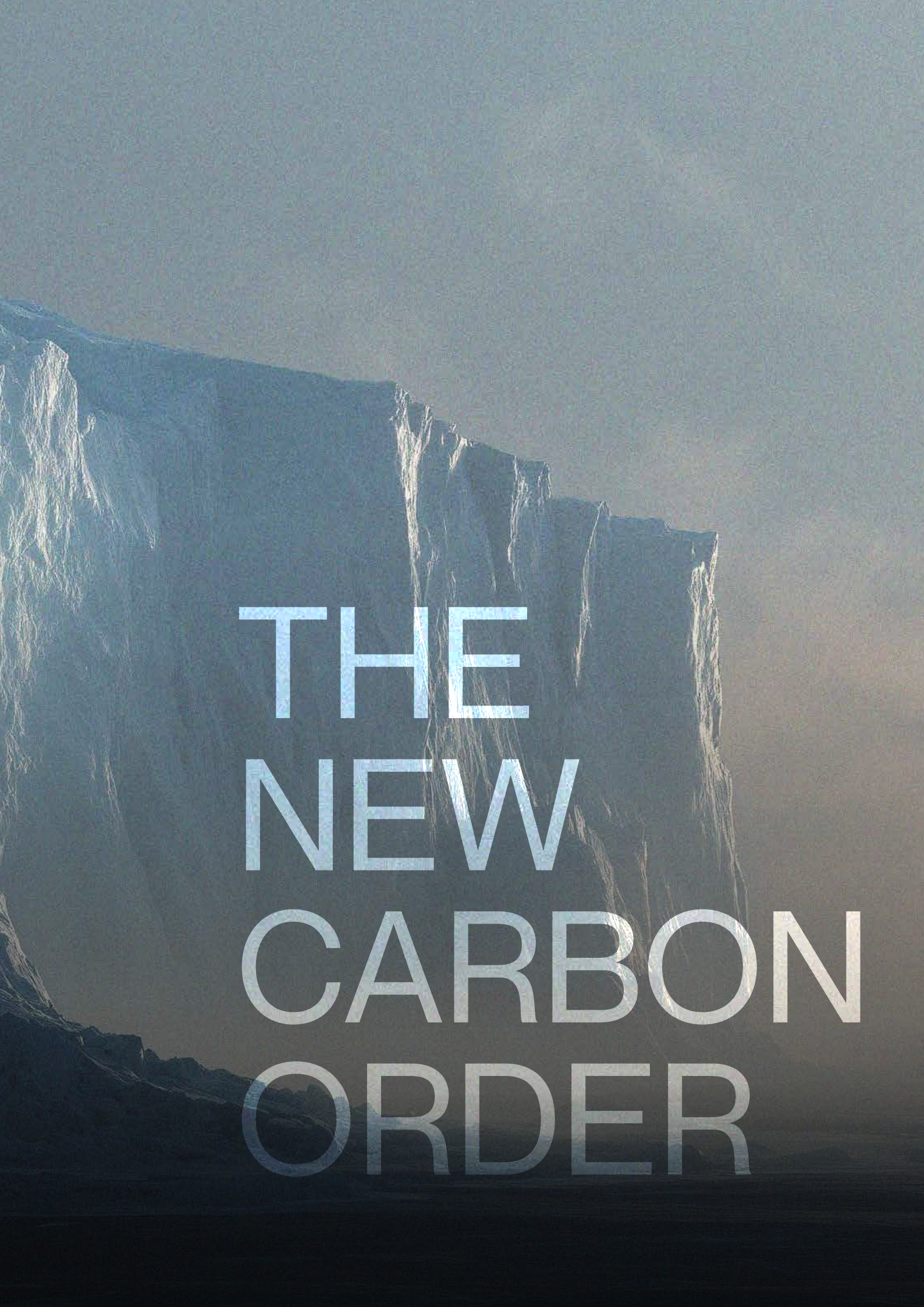
We have the tools, the knowledge, and the momentum to finish what we started. If the last era was about proving the concept of carbon markets, this next one is about perfecting the system. The task ahead is to build confidently — connecting ambition to action, technology to trust, and local innovation to global impact.

That is how we will turn the promise of the ***New Carbon Order*** into a lasting legacy.

THE **NEW CARBON ORDER** DEMANDS INTEROPERABILITY, DIGITAL INFRASTRUCTURE, AND GLOBAL INCLUSION — THE FOUNDATIONS OF A CARBON MARKET THAT CAN SCALE WITH CONFIDENCE AND INTEGRITY.



THE NEW CARBON ORDER IS NO LONGER THEORETICAL. IT IS EMERGING THROUGH CONNECTED MARKETS, SHARED STANDARDS, AND DIGITAL INFRASTRUCTURE THAT TURN AMBITION INTO ACTION. AS THIS REPORT SHOWS, THE FUTURE OF CARBON MARKETS DEPENDS NOT JUST ON GROWTH, BUT ON INTEGRATION, TRUST, AND EXECUTION. THE NEXT DECADE WILL DECIDE WHETHER MARKETS REMAIN FRAGMENTED OR BECOME A UNIFIED GLOBAL SYSTEM CAPABLE OF DELIVERING REAL CLIMATE IMPACT. THE DIRECTION IS CLEAR. NOW COMES THE WORK.


THE
NEW
CARBON
ORDER

ENDNOTES

1. See the World Bank's State and Trends of Carbon Pricing 2025 (p. 21), published 10 June 2025.
2. Ibid, p. 20
3. Ibid, p. 27
4. For the latest trends in the VCM see the World Bank report cited above and the report by Climate Focus, Voluntary Carbon Market First Half 2025 Review and Outlook, published in July.
5. The Integrity Council for the Voluntary Carbon Market (ICVCM) uses 10 Core Carbon Principles (CCPs) to determine whether a given project's credits meet its standards and these are reshaping buyer preferences and hence the project supply pipeline, with reduced demand for older vintages accounting for the further rise in non-retirements. See the ICVCM website for details.
6. See the UNFFCC 's 2025 NDC Synthesis Report, published 28 October 2025. Since then, many more countries have now submitted their updated NDCs in the first two weeks of November –in the run-up to and during COP-30, with the grand total as of 10 November standing at 114 (see the NDC Tracker on the ClimateWatch website).
7. See the IPCC's Special Report on Global Warming of 1.5°C.
8. The emissions figures cited here are taken from Our World in Data.
9. See Global Tipping Points Report 2025, published 13 October 2025.
10. Data from a study by LSEG, as summarized on Carbon Pulse. The original numbers were in €, translated into $ at the average 2024 exchange rate of €/$ = 1.08.
11. See the report 2025 State of the Global Voluntary Carbon Market by Ecosystem Marketplace.
12. In 2024, the total value of the China ETS was $2.8bn, and total volume traded was 275Mt.
13. The EU-ETS (ETS1) was established in 2005 and covers power generation, heavy industry, aviation, and maritime emissions. A second ETS (ETS2) covering heating and road transportation was due to begin in January 2027 but this will likely now be delayed to January 2028 following the EU Council's proposal to this effect (see this Carbon Pulse article from 5 November).
14. For example, the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) already accepts A6.2 ERs as valid units for compliance.
15. See The Paris Agreement, Article 2, Paragraph 1a.
16. The interesting thing about using A6 credits for voluntary offsetting purposes is that such offsetting by definition extends the scope of the Paris Agreement beyond the global carbon budget it is based on. This is because any company using A6 credits with CAs voluntarily is forcing the host country that sold this credit to it to find an alternative tonne to reduce while the company retiring the credit is not itself counting it towards a tonne of emissions covered by the Paris Agreement.
17. The argument most often cited by EU Commission officials and some member-state governments and EU Parliament members for not allowing A6 credits into ETS1 is that allowing offsets from the Clean Development Mechanism and Joint Implementation mechanisms of the Kyoto Protocol into the EU-ETS over 2008-20 resulted in a long period of depressed EUA prices. However, this narrative forgets the impact of the global financial crisis of 2008-09 in plunging the EU into a severe recession, and the periodic Eurozone monetary crises that then ensued over the next couple of years. Moreover, the ETS cap was roughly four times higher over 2008-12 than it will be over 2031-40, such that the comparison is almost meaningless – the fact is without a safety valve on prices over 2031-40 of the kind that a sensible quota of A6 credits could provide, EU industry faces an existential risk to its competitiveness (in this regard see, for example, the recent comments made by Eurofer the trade association for the European steel industry, regarding the risks of much higher EUA prices over 2031-40, as reported by Carbon Pulse on 30 October.) Furthermore, the EU already allows the use of A6 credits for international aviation emissions under the ETS1 – at least on a de facto basis – through the Carbon Offsetting and Reduction Scheme for Aviation (CORSIA), so this further undermines the logic of the Commission in wanting to deny their use by other ETS1 sectors over 2031-40.
18. Again, see the report by Carbon Pulse from 5 November.
19. See the Carbon Pulse article of 13 November.
20. As mentioned above, CORSIA already allows A6.2ERs for compliance but as the supply of A6.4/PACM ERs ramps up over the next few years we would also expect CORSIA buyers to gravitate more towards the A6.4/PACM credits.
21. A July 2025 study by Abatable puts the range of estimates for CORSIA demand over 2027-35 range between 800Mt-1.8Gt.
22. https://a6partnership.org/a6-implementation-status/about
23. https://www.iata.org/contentassets/fb745460050c48089597a3ef1b9fe7a8/iata-corsia-sgf-forecast-august2025.pdf
24. https://www.msci.com/research-and-insights/paper/corsia-costs-and-implications-for-the-airline-industry
25. https://www.msci.com/downloads/web/msci-com/discover-msci/events/event-assets/2025/july/vcm-in-review-2q25-corsia/MSCI%20VCM%20in%20Review%20CORSIA_Slides.pdf
26. https://www.worldbank.org/en/publication/state-and-trends-of-carbon-pricing
27. https://www.qcintel.com/carbon/corsia-prices/
28. European Aluminium, 'Environmental Profile Report for the European Aluminium Industry', November 2024, https://european-aluminium.eu/wp-content/uploads/2024/11/2024-11-07-European-Aluminium-EPR-2024-Executive-Summary.pdf and 'An Action Plan for European Aluminium', January 2025, https://european-aluminium.eu/wp-content/uploads/2025/02/25-01-13-An-Action-Plan-for-European-Aluminium.pdf
29. Norwegian Environmental Agency, 'Greenhouse Gas Emissions 1990-2023, National Inventory Document', 2025, Greenhouse Gas Emissions 1990-2023

30. ERT. (March 2024). Competitiveness of Europe's energy-intensive industries. European Round Table for Industry. Retrieved from ERT website: https://ert.eu/wp-content/uploads/2024/04/ERT-Competitiveness-of-Europes-energy-intensive-industries_March-2024.pdf

31. https://commission.europa.eu/document/download/ec1409c1-d4b4-4882-8bdd-3519f86bbb92_en?filename=The%20future%20of%20European%20competitiveness_%20In-depth%20analysis%20and%20recommendations_0.pdf

32. https://single-market-economy.ec.europa.eu/document/download/7807ca8b-10ce-4ee2-9c11-357afe163190_en?filename=Communication%20-%20Steel%20and%20Metals%20Action%20Plan.pdf

33. https://cdn.prod.website-files.com/61509dd26eb1ae688f25b0d8/67a230ca404fe73dfb28f0c7_January%202025%20-%20Arkwright%20CBAM%20White%20Paper%20-%20Double-page%20version.pdf

34. https://sandbag.be/wp-content/uploads/Sandbag-CBAM-Scrap-Game-2024.pdf

35. Arkwright, 'CBAM – a threat to European Competitiveness? Impact on the EU/EEA Aluminium Industry and Ways to Close Loopholes to Support Climate Action without Sacrificing Competitiveness', 2025, 67a230ca404fe73dfb28f0c7_January 2025 - Arkwright CBAM White Paper - Double-page version.pdf

36. Carbon credits are distinct from allowances issued under government emission trading programs. Allowances are often treated as limited permits to emit or other administrative instruments. They are sometimes expressly defined by statute as not being property, in part to avoid liability in jurisdictions that recognize takings claims.

37. Rights over carbon credits are distinct from carbon rights in the underlying emission reductions and removals. Carbon rights generally originate with the owner of the activity giving rise to the emission reduction or removal or the land on which sequestration is achieved. A project proponent seeking issuance of a carbon credit must demonstrate the rights to the underlying emission reductions and/or removals before the carbon credit can be created.

38. There is an active effort underway by UNIDROIT to provide guidance on the legal nature and effective regulatory oversight of Verified Carbon Credits. The working group has issued principles, one of which notes that rights to carbon credits are based in property law such that they can be the subject of proprietary rights. Yet, these principles are still being refined by UNIDROIT and will need to be implemented by individual countries before they carry legal weight. UNIDROIT Working Group on the Legal Nature of Verified Carbon Credits. 2025. Draft UNIDROIT Principles on the Legal Nature of Verified Carbon Credits. https://www.unidroit.org/wp-content/uploads/2025/04/Study-LXXXVI-W.G.5-Doc.-2-rev.-Draft-Principles.pdf.

39. World Bank, A6IP, GGGI, GIZ, ICVCM, UNDP, UNFCCC, and VCMI. 2025. Country Guidance for Navigating Carbon Markets. Washington, DC: World Bank. https://openknowledge.worldbank.org/server/api/core/bitstreams/5e509041-47b3-479d-83b1-201ec976df99/content.

40. UNCITRAL/UNIDROIT. 2024. Study on the Legal Nature of Verified Carbon Credits Issued by Independent Carbon Standard Setters: Note by the Secretariat. United Nations Commission on International Trade Law. https://documents.un.org/doc/undoc/gen/v24/017/18/pdf/v2401718.pdf.

41. https://www.ieta.org/guidelines-for-high-integrity-use-of-carbon-credits-2-0

42. https://www.ieta.org/geostorage-and-carbon-crediting-2-0

43. https://openknowledge.worldbank.org/entities/publication/2c8fea1a-2b3c-4a66-b473-b200944cd7e1

44. https://www.climatedatasc.org/data-standardization/

45. Pilot EOI form (due 5 Dec) https://forms.office.com/Pages/ResponsePage.aspx?id=in5PNecSb0G8QAass3T1jb0g-Qq9e7NGuL4dNGjR0UVUMDhTNktRSVBIMkdIUUFPWVdEVVFUSUU1QS4u

46. https://www.cdop.info/blog/how-data-standardization-is-ready-to-unlock-carbon-markets

47. https://climateactiondata.org/cad-trust-launches-data-model-version-2-0/

48. https://www.goldstandard.org/publications/article-6.2-crediting-protocol

49. https://library.ey.com/story/carbon-markets-steps-to-create-a-recognisable-market-and-asset-class/page/1

50. https://ghgprotocol.org/ .

51. Scope 1 – direct emissions to the atmosphere by sources a company owns or controls; Scope 2 – indirect emissions from purchased electricity, heat, or steam consumed by the reporting company; Scope 3 – all other "value chain" emissions

52. Examples include high technology (Google, Microsoft) retail (Walmart), apparel (Nike), finance (Citi and Barclays), insurance (Swiss Re), and manufacturing (3M and BMW). See Advancing Corporate Procurement of Zero Carbon Electricity in the United States: Moving from RE100 to ZC100, Columbia University GCEP, December 221, pp. 9. For a list of companies who have taken a pledge to use 100 % RE annually, see https://www.there100.org/ .

53. "24/7 by 2030: Realizing a Carbon-free Future," Google, September 2020, https://www.gstatic.com/gumdrop/sustainability/247-carbon-free-energy.pdf ,accessed April 20, 2022.

54. For example, FlexiDAO, Granular Energy, Kevala, Singularity, and WattTime.

55. For a summary of load-based accounting approaches, see Methods to Account for Greenhouse Gas Emissions Embedded in Wholesale Power Purchases, EPRI, Palo Alto, CA: 2019. 3002015044. https://www.epri.com/research/products/000000003002015044 .

56. Birn, K., Rushforth, J., Kramarz, E., "A roadmap to a carbon differentiated market," March 2025 S&P Global Commodity Insights

57. "Carbon Measures and International Chamber of Commerce, "Launch Technical Expert Panel on Carbon Accounting, " October 2025, www.businesswire.com/news/home/20251027348594/en/Carbon-Measures-and-International-Chamber-of-Commerce-Launch-Technical-Expert-Panel-on-Carbon-Accounting

58. The European Commission, "The Future of European Competitiveness," September 2024, https://commission.europa.eu/topics/competitiveness/draghi-report_en

59. S&P Global Energy makes public their own emissions accounting methodologies: www.spglobal.com/emissions

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