



CFA Institute
Research & Policy Center

Global Compliance Carbon Markets: Structure Explained

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Executive Summary

With the rapid development of global compliance carbon markets (CCMs) in recent years, their connection with the investment industry has grown increasingly significant. As the markets evolve, CCMs can offer sustainability-focused investors an effective tool to support their net-zero goals. Furthermore, as an emerging asset class, carbon is becoming a more prominent consideration in the development of investment and trading strategies. Moreover, as CCMs expand coverage to a larger number of companies, firms that previously emitted carbon at no cost now face associated expenses. This shift increases these firms' operating costs, which directly affects investor returns. The expanding scope of carbon markets will affect an increasing number of companies and investors.

This report analyzes the market structure of CCMs in depth. The report offers practical guidance for investment firms and investors that want to engage directly with CCMs and incorporate carbon into their investment strategies—whether to enhance portfolio performance, hedge climate-related risks, or tap into a growing alternative asset class. It also outlines strategies to boost market efficiency and investor access.

The report is structured into four focused sections:

- The first section profiles the major players in global CCMs and unpacks their distinct roles.
- The next section dives into secondary market instruments. Spot trades help regulated companies meet immediate compliance needs, while derivatives support long-term carbon budgeting and cost control—shielding firms from volatile allowance prices. The rise of financial products like the KraneShares Global Carbon Suite and iShares MSCI ACWI Low Carbon Target ETF (CRBN) signals the growing financialization of carbon.

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- The subsequent section analyzes market liquidity. It breaks down key metrics—price volatility, bid-ask spreads, total market volume, open interest, and order book trade volume—to assess the depth of both spot and derivative markets.
- The final main section explores transparency challenges in CCMs, spotlighting issues that hinder market efficiency.

Key Findings

- **Participants:** Global CCMs have various participants. Regulators establish the framework for CCMs and ensure their implementation. Covered entities actively participate in CCMs to meet compliance requirements. Exchanges and central counterparties provide the infrastructure for carbon allowance trading. Institutional investors (investment firms and banks) actively participate in carbon trading and act as financial intermediaries. Although retail investors have limited direct participation options in CCMs, they can still participate indirectly through carbon ETFs and the voluntary carbon market.
- **Instruments:** The secondary market for carbon allowances offers covered entities a range of instruments for carbon budgeting and hedging over various time horizons. EU allowances dominate the spot market, and the China Emission Allowance spot market is rapidly developing. The derivative market offers a wider variety of products. Multiple exchanges provide futures and options linked to CCMs in Europe and North America. In addition, ETFs provide a channel for retail investors to gain exposure to carbon allowances. The development of the secondary market contributes to the efficient pricing and liquidity of carbon allowances.

- Liquidity:** The carbon allowance spot market demonstrates weak liquidity, primarily resulting from the limited availability of spot trading instruments and high entry barriers. Exchange markets, however, provide better liquidity than over-the-counter (OTC) markets. The futures market is dominated by short-term contracts, whereas long-term contracts remain illiquid. This pattern aligns with the typical liquidity distribution observed in most derivative markets. As CCMs continue to develop, the introduction of additional secondary market instruments and an increase in market participants can enhance liquidity.
- Transparency:** Transparency challenges are related to order book transparency, OTC transactions, and the accessibility of underlying data. Order book transparency varies significantly among CCMs. OTC transaction data are difficult to access. Underlying data are not publicly available, and investors often need paid platforms to obtain such data.

Introduction

The global compliance carbon markets (CCMs), a key mechanism for carbon pricing, have developed rapidly in recent years. According to the International Carbon Action Partnership (ICAP 2024), 36 emission trading systems (ETSs) currently operate worldwide, covering approximately 18% of global greenhouse gas emissions (9.9 GtCO₂e). In addition, around one-third of the global population resides in jurisdictions where an ETS is enforced, and together these regions account for 58% of the global GDP.

The connection between CCMs and the investment industry is growing in significance. First, CCMs can support the goals of investors committed to net-zero targets by providing a market-based mechanism to reduce emissions. Second, as carbon pricing mechanisms continue to advance, carbon is progressively emerging as an asset class, gaining traction within asset allocation and investment strategies aided by the growing financialization of carbon. Third, as CCMs expand coverage, more firms will be subject to carbon cost liabilities or reduction obligations, all of which can directly affect operating margins, capital expenditures, and future cash flows. These emission-related compliance costs may alter firm valuations, shift sectoral performance trends, and change portfolio risk exposures, thus influencing investors' return expectations. A comprehensive and accurate understanding of CCMs thus becomes important for the investment industry.

Yang and Preece (2024) provide a detailed overview of the mechanisms, advantages, and disadvantages of CCMs, as well as comparing carbon markets with carbon taxes. Mak (2025) complements that work by offering an introduction to voluntary carbon markets (VCMs). Building on both studies, this report aims to analyze the market structure of global CCMs in depth. A thorough

analysis of market structure is essential for investment professionals to understand the challenges and opportunities of participating in CCMs and integrate them into investment strategies, and the literature has yet to provide sufficient research in this area.

Existing research on CCMs can be categorized into three major groups. The first group either provides an overview of global CCMs (Dumitrescu and Ansotegui 2024; Investcorp 2024) or focuses on specific markets, such as China (Qin 2025), South Korea (Park and Hong 2014), and New Zealand (Tao, Poletti, Wen, and Sheng 2024). The second group addresses specific issues in CCMs and offers policy recommendations (Global Financial Markets Association and Boston Consulting Group 2021), such as regulation (Kachi and Frerk 2013), market functioning (International Organization of Securities Commissions 2023), VCM collaboration (Wetterberg, Ellis, and Schneider 2024), and carbon leakage (Xie and Rousseau 2024). The third group includes regular market status reports published by research institutions (BloombergNEF 2024; ESMA 2024; ICAP 2024; World Bank 2024).

The existing literature on CCMs has three main gaps. First, it focuses on a few specific issues—primarily market and pricing efficiency, trading volume, and trading costs—and often within a single market, such as the EU ETS. Integrating these fragmented studies to gain a full picture can be challenging. The investment industry needs comprehensive and systematic research covering all these aspects to understand market structure-related issues. Second, the existing literature has limited discussions on other critical market structure characteristics and issues, such as the types of participants and available instruments, and it does not adequately address the specific role of financial institutions in CCMs. Third, most existing studies approach the topic from the perspective of enhancing the effectiveness of carbon market mechanisms. Although this angle is undoubtedly important, the literature lacks discussion from the perspective of market access and ease of participation, which is crucial for the investment industry. This study aims to fill these gaps by comprehensively discussing participants, instruments, liquidity, and transparency and covering CCMs globally.

Because the operational mechanisms of carbon markets have been widely covered elsewhere, this report provides only a brief summary. CCMs operate with a regulatory mandate, aiming to control and reduce carbon emissions from companies by establishing a jurisdictional limit on such emissions. At its core, a CCM operates a cap-and-trade system based on carbon allowances. Regulators overseeing the CCM first set a threshold for companies' annual carbon emissions. Companies exceeding this threshold become covered emitters and fall under the CCM's regulation.

After identifying covered emitters, regulators set a cap based on emitters' historical total combined emissions, representing the annual total emission target of the CCM. The cap aims to decrease annually, ideally approaching zero over a given time frame. Regulators then issue an equivalent number of

emission allowances. A carbon allowance legally permits the emission of one metric tonne of carbon dioxide equivalent (tCO₂e) within a calendar year. The covered emitters receive a certain number of free allocated allowances.

If a covered emitter's annual emissions surpass its allocated allowances, it must purchase additional allowances either through auctions or by trading with other covered emitters in the CCM. Conversely, covered emitters with emissions below their allocated allowances can sell their surplus allowances for profit. Covered emitters must match their annual emissions with allowances before the year ends because they must surrender allowances equal to their annual emissions to regulators. Failure to submit sufficient allowances will result in fines. Once companies have submitted, the regulators cancel the allowances, effectively removing them from circulation to prevent reuse. Yang and Preece (2024) and Azlen, Child, and Gostlow (2020) offer in-depth discussions on how CCMs function.

Participants

The primary participants in CCMs include regulators, covered entities, exchanges, institutional investors (investment firms and banks), and retail investors. Each plays a distinct role in the effective operation of CCMs.

Regulators

Compared with VCMs, the defining feature of CCMs is their legal enforceability. Regulators design and implement CCMs based on relevant legislation, aiming to make them an effective tool for achieving reductions in carbon emissions. Overall, regulators are responsible for the following:¹

- Designing the framework of CCMs following relevant laws and regulations
- Defining the details of the operating mechanisms, such as the cap, scope, coverage, and thresholds
- Establishing allowance allocation mechanisms
- Setting the legal and operational frameworks for trading, clearing, and data storage systems²
- Implementing real-time monitoring systems and price stabilization mechanisms to ensure fair and orderly market operations
- Reviewing the framework regularly and adjusting policies when necessary to enhance the efficiency of CCMs.

¹Exhibit A1 in the appendix summarizes the key regulators and their responsibilities across major CCMs worldwide.

²Exchanges and designated market infrastructure providers typically develop and operate these platforms in accordance with those frameworks set by the regulators.

Although the EU ETS was established as the world's first CCM in 2005, most other CCMs were gradually developed after 2010. Consequently, for regulators, the construction and operation of CCMs remain an ongoing process. When formulating policies, regulators must balance multiple factors, including emission reduction outcomes, operational efficiency, short-term business impacts, carbon leakage risks, and long-term planning.³

Many CCMs fulfill these responsibilities by adopting a multi-tiered regulatory model, in which multiple institutions share regulatory functions. In this model, different agencies oversee various aspects of regulation, including the legal framework, registration of covered entities, supervision of trading platforms, and market monitoring and enforcement. China and South Korea use this approach. Regulatory responsibilities can also be divided by sector, as in New Zealand. Other carbon markets, such as those in Switzerland and Germany, adopt a single-tier regulatory model in which a single agency (or a few) assumes all regulatory responsibilities. In summary, the multitier model incorporates distributed accountabilities by authorities with specialized competencies, whereas the single-tier model centralizes regulation and supervision, which can have the benefit of streamlining decision making and implementation.

Covered Entities

Each CCM selects the sector it aims to regulate. Most CCMs cover high-emitting industries, such as power generation and heavy industry, and they extend coverage to the transportation sector to varying degrees.⁴ **Exhibit 1** summarizes the covered sectors in global CCMs. Entities in the covered sectors that exceed the emission threshold set by regulators become covered entities and are subject to the regulation of the CCM.⁵

As CCM coverage expands and thresholds decrease, more sectors and entities will be incorporated. In addition, many CCMs are also open to noncovered entities, as seen in Switzerland, the United Kingdom, Quebec, and the Regional Greenhouse Gas Initiative (RGGI) in the United States. Small and medium-sized noncovered entities can voluntarily participate in CCMs and trade under the same rules and compliance obligations as large covered entities. By voluntarily joining a CCM, these noncovered emitters can begin adapting to relevant regulations and markets early, smoothing out future compliance costs.

On the demand side, covered emitters are the primary buyers of carbon allowances. These emitters must hold sufficient allowances to surrender to the relevant authority to match their emissions for the compliance period.

³Carbon leakage occurs when a company that is facing increased costs because of carbon emission regulations in its original market moves its operations to another market without such regulations.

⁴According to the US Environmental Protection Agency (EPA 2024), the primary sources of greenhouse gas emissions in 2022 were the transport (28%), power (25%), and industry sectors (23%).

⁵Some CCMs, such as California's, apply a single threshold for all covered sectors. Others set different thresholds for covered sectors, as seen in the EU ETS. For a detailed overview of carbon market mechanisms, refer to Yang and Preece (2024).

Exhibit 1. Covered Sectors of Global Compliance Carbon Markets, 2023

Carbon Markets	Covered Sectors							
	Power	Industry	Building	Transport	Maritime	Domestic Aviation	Waste	Forestry
Alberta, Canada								
Australia								
Austria								
British Columbia, Canada								
California, United States								
Canada Federal								
China National								
European Union								
German National								
Indonesia								
Kazakhstan								
Massachusetts, United States								
Mexico								
Montenegro								
New Brunswick, Canada								
New Zealand								
Newfoundland and Labrador, Canada								
Nova Scotia, Canada								
Ontario, Canada								
Quebec, Canada								
Regional Greenhouse Gas Initiative, United States								
Saitama, Japan								

Exhibit 1. Covered Sectors of Global Compliance Carbon Markets, 2023 (continued)

Carbon Markets	Covered Sectors							
	Power	Industry	Building	Transport	Maritime	Domestic Aviation	Waste	Forestry
Saskatchewan, Canada								
South Korea								
Switzerland								
Tokyo, Japan								
United Kingdom								
Washington State, United States								

Notes: According to the US Environmental Protection Agency (EPA 2024), the industry economic sector includes CO₂ emissions from fossil fuel combustion that are also included in the Energy Information Administration's industrial fuel-consuming sector, minus the agricultural use of fuel. Examples include coal mining, the mineral industry, the chemical industry, and the metal industry.

Source: ICAP.

In addition, they typically engage in long-term carbon budgeting to effectively manage their emissions. Covered emitters can also act as suppliers of carbon allowances. Emitters with lower abatement costs can save a portion of their freely allocated allowances and sell them to emitters with higher abatement costs (within the CCM cap-and-trade mechanism) in order to generate additional revenue.

Exchanges and Central Counterparties

Exchanges and central counterparties (CCPs) provide the market infrastructure for centralized trading and clearing among counterparties for carbon allowance auctions and trading. Exchanges facilitate transaction execution, whereas CCPs support posttrade clearing.⁶ These platforms play a key role in supporting the efficient functioning of carbon trading, both in the primary and secondary markets.

In the primary market, most CCMs still distribute allowances primarily through free allocation. Even in CCMs that adopt auctions, which allocate allowances through regular public auctions, a certain proportion of allowances are still distributed for free.⁷ As a result, exchanges and CCPs play a limited role in the primary markets in those CCMs that rely predominantly on free allocation. For CCMs that use a significant auction-based system, however, exchanges and CCPs facilitate the efficient operation of these auctions.

⁶Exhibit A2 in the appendix lists the CCMs that use exchanges.

⁷The "Market Instruments in the Secondary Market" section discusses the impact of allocation methods on price formation.

For the EU ETS, the European Energy Exchange (EEX) conducts daily uniform price auctions with single rounds and sealed bids. The European Commodity Clearing (ECC) serves as the CCP by handling the associated clearing and settlement functions. Germany also conducts national auctions using EEX as the exchange, with transactions cleared by ECC as the CCP. In North America, the Western Climate Initiative (WCI, Inc.), a nonprofit organization managing the auction platform, registry systems, and compliance tracking, functions as an exchange. WCI, Inc. serves CCMs in California, Quebec, and Washington State, providing quarterly auction services.⁸ However, these auctions do not involve a traditional CCP for clearing. Successful bidders transfer payments to a designated settlement bank and then receive the allowances through the state-managed registry system. Other CCMs mainly rely on their regulator-owned registries for allowance auctions and posttrade clearing.

In the secondary market, because carbon market linkages remain limited and allowances cannot be transferred between unlinked markets, allowance trading occurs both on exchanges and through bilateral negotiations or over-the-counter (OTC) trading. Unlike with exchanges, OTC contracts can be customized between the parties to account for their risk management preferences. OTC trading is especially common in emerging and smaller CCMs, where allowance liquidity is relatively low and exchange-based trading is rare. Larger CCMs, such as those in China and South Korea, however, have dedicated exchanges for secondary market trading. In addition, large exchanges, including EEX, Intercontinental Exchange (ICE), ICE Endex, Nasdaq, Chicago Mercantile Exchange (CME), and Nodal Exchange, actively trade allowances from the most mature CCMs. These CCMs include the EU ETS and California's Cap-and-Trade Program, which are commonly cleared by CCPs such as ECC and ICE Clear.⁹ Exchanges and CCPs facilitate the secure and orderly trading of allowances, mitigate counterparty risks, and enhance market liquidity.

Institutional Investors

Institutional investors—investment firms and banks—are actively engaged in all forms of carbon trading, including both auctions in the primary market and exchange and OTC trading in the secondary market. Their trading activity is more intense than that of covered entities.

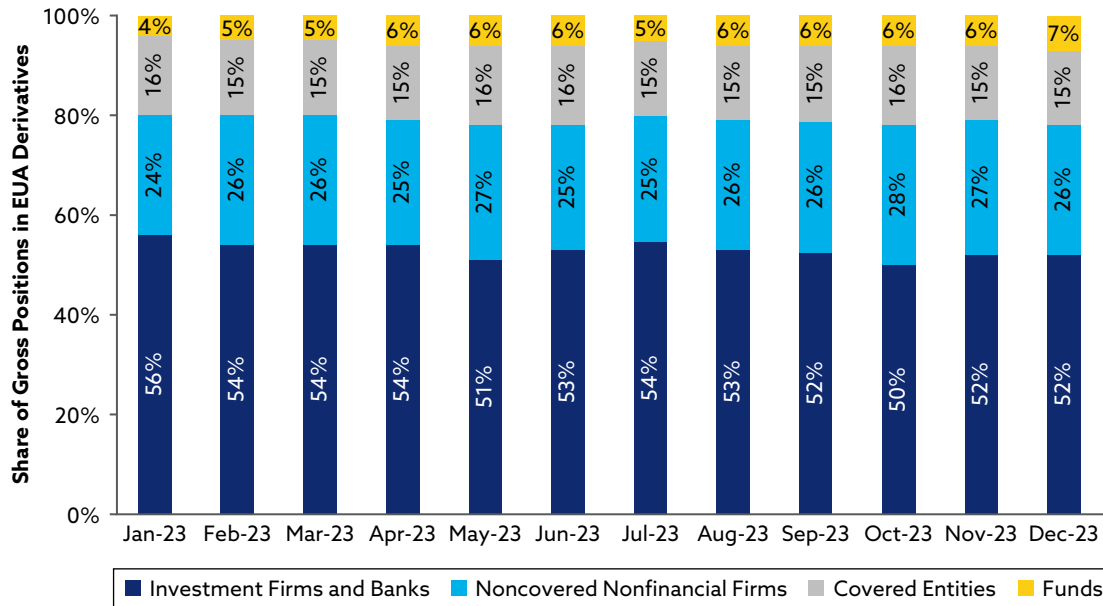
Take the EU Allowance (EUA), the most traded carbon allowance, as an example. According to the European Securities and Markets Authority (ESMA 2024), investment firms, banks, and noncovered nonfinancial firms were the primary participants in the 2023 auction market. The primary market had only 44 active participants,¹⁰ and the top 10 participants acquired 90% of the auctioned EUAs.

⁸The California Cap-and-Trade Program linked with the Quebec Cap-and-Trade System in January 2014. Compliance instruments issued by one market are recognized in both.

⁹The "Market Instruments in the Secondary Market" section explores spot and derivative products in the secondary market.

¹⁰For reference, the EU ETS covered more than 10,000 emitters in 2023.

Exhibit 2. Shares of Gross Positions in EUA Derivatives across Buyers in the Secondary Market, 2023



Source: Data from ESMA (2024).

Among them, four were investment firms or banks (accounting for about 45% of auctioned EUAs), three were noncovered nonfinancial firms (around 35% of auctioned EUAs), and three were covered entities (around 7% of auctioned EUAs).¹¹ Entities not directly subject to the EU ETS purchased 80% of the auctioned EUAs.

A similar pattern also emerged in the secondary market for EUAs. In 2023, investment firms and banks accounted for 56% of the total trading volume (EUR408 billion) across exchange and OTC transactions. Noncovered nonfinancial firms and funds contributed 25% and 12%, respectively. In the OTC market, 48% of transactions occurred among investment firms or banks, and 19% occurred between banks and noncovered nonfinancial firms. In the derivative market, 406 funds held daily positions, compared with 118 investment firms and banks and 206 covered entities and noncovered nonfinancial firms. However, funds held on average much smaller positions compared with investment firms and banks. As shown in **Exhibit 2**, based on their share of gross positions, on average, investment firms and banks held 53% of derivative positions, significantly exceeding noncovered nonfinancial firms (26%), covered entities (15%), and funds (6%) in 2023.

¹¹ESMA (2022, 2024) developed a unique counterparty classification system based on MiFID II to categorize participants in the EU ETS. Investment firms and banks are financial intermediaries that provide liquidity and trading services. Investment funds, either an Undertaking for Collective Investments in Transferable Securities (UCITS) or an alternative investment fund manager, allocate pooled investor capital to carbon assets for return. Noncovered nonfinancial firms are corporates without compliance obligations under the EU ETS and outside the financial sector. They participate in the EU ETS voluntarily.

A key reason behind the active participation of institutional investors in carbon trading is the financial intermediary role that many banks play. According to ESMA (2024), most active buyers in the primary market serve as brokers, purchasing EUAs on behalf of their clients while simultaneously acting as sellers in the secondary market. A trend in the secondary market is that major banks acquire derivatives and sell them to nonfinancial entities. Data from Europe Economics (2023) further confirm this trend from the perspective of covered entities. Among the sampled covered entities, 77% of EUAs were obtained directly from intermediaries, 17% from exchanges (7% through spot trading and 10% through derivatives), 1% through auctions, and around 6% via free allocation. ESMA identified several reasons why covered entities primarily acquire EUAs through financial intermediaries, including the convenience and cost-effectiveness of banks and limited financial market expertise among covered emitters.

Retail Investors

Currently, retail investors have limited ways to participate in CCMs. Most CCMs do not allow individuals to trade carbon allowances directly. Some CCMs theoretically permit retail investor participation, such as those in California, New Zealand, and Switzerland,¹² but in practice, retail investors face several challenges:

- **Primary market/auctions:** To participate in the primary market and auctions, retail investors must register directly with regulators, which typically involves strict and complex requirements, as well as a lengthy approval process. Moreover, the minimum trading unit in the primary market is usually prohibitively high for retail investors (500 tCO₂e to 1,000 tCO₂e).
- **Spot market in the secondary market:** Exchanges often require retail investors to trade through brokers, which typically involve minimum investment requirements and strict qualification criteria for investors.
- **Derivative market in the secondary market:** Derivatives markets involve leverage and margin requirements, which may be complex for retail investors to navigate and also can carry high risks.

Nevertheless, retail investors can still gain indirect exposure to global carbon markets through carbon ETFs or by purchasing carbon credits in VCMs. Carbon ETFs track carbon prices across major CCMs, such as the EU ETS and California's Cap-and-Trade Program. For example, the KraneShares Global Carbon Strategy ETF (KRBN) uses the S&P Global Carbon Credit Index as its benchmark and provides broad global allowance coverage by tracking the most actively traded carbon allowance futures contracts. KRBN launched on 29 July 2020. As of 18 July 2025, it had a net asset value of USD160 million and a closing price of

¹²CCMs that accept retail investor participation include California's Cap-and-Trade Program, the China's National ETS (planned to accept), China's pilot carbon markets (Beijing, Chongqing, and Shenzhen), the Kazakhstan Emissions Trading System, Quebec's Cap-and-Trade System, RGGI, the Switzerland ETS, the UK ETS, Washington's Cap-and-Invest Program, and the New Zealand ETS.

USD29.89 per share. Carbon ETFs offer higher liquidity and lower entry barriers for retail investors relative to directly purchasing carbon allowances.¹³ VCMs are more accessible to retail investors than CCMs are. Individuals can more easily purchase carbon credits to participate in the VCM or offset their carbon footprint.¹⁴ As global CCMs continue to develop, the ways for retail investors to gain exposure to carbon as an asset class and the number of retail products tied to carbon will likely increase, thereby enhancing investor choice, market access, and efficiency.

In summary, global CCMs have various participants. Regulators establish the framework for CCMs and ensure their orderly implementation. Covered entities actively participate in CCMs to meet compliance requirements. Exchanges and central counterparties provide the infrastructure for carbon allowance trading. Institutional investors (investment firms and banks) actively participate in carbon trading and act as financial intermediaries. Although retail investors have limited ways to participate in CCMs directly, they can still gain exposure to carbon indirectly through carbon ETFs and VCMs.

Market Instruments in the Secondary Market

Before introducing instruments used in the secondary market, it is helpful to understand the allocation methods of carbon allowances in the primary market. This background provides insight into the motivations and strategies of secondary market participants.

Regulators typically allocate carbon allowances in the primary market through free allocation, auction, or a combination of both.¹⁵ In the early stages of CCMs, free allocation is often the dominant approach, as seen in China, Kazakhstan, and Mexico. Free allocation helps covered entities transition smoothly toward emission reductions, allowing businesses to avoid a sudden financial burden that could translate into higher consumer costs and also preventing carbon leakage. As CCMs mature, however, the proportion of allowances allocated through auctions gradually increases. The consensus among policymakers is that CCMs should eventually be dominated by auctions to achieve effective carbon pricing and emission reduction goals. Some CCMs, such as those in Austria, Germany, and Massachusetts, have already adopted a 100% auction-based system without free allocation. **Exhibit 3** presents the auction share of the carbon cap in key CCMs in 2023.

Most CCMs currently use a combination of free allocation and auction. In the primary markets, carbon allowance pricing is primarily determined through auctions.¹⁶ For covered emitters, which receive a certain number of allowances

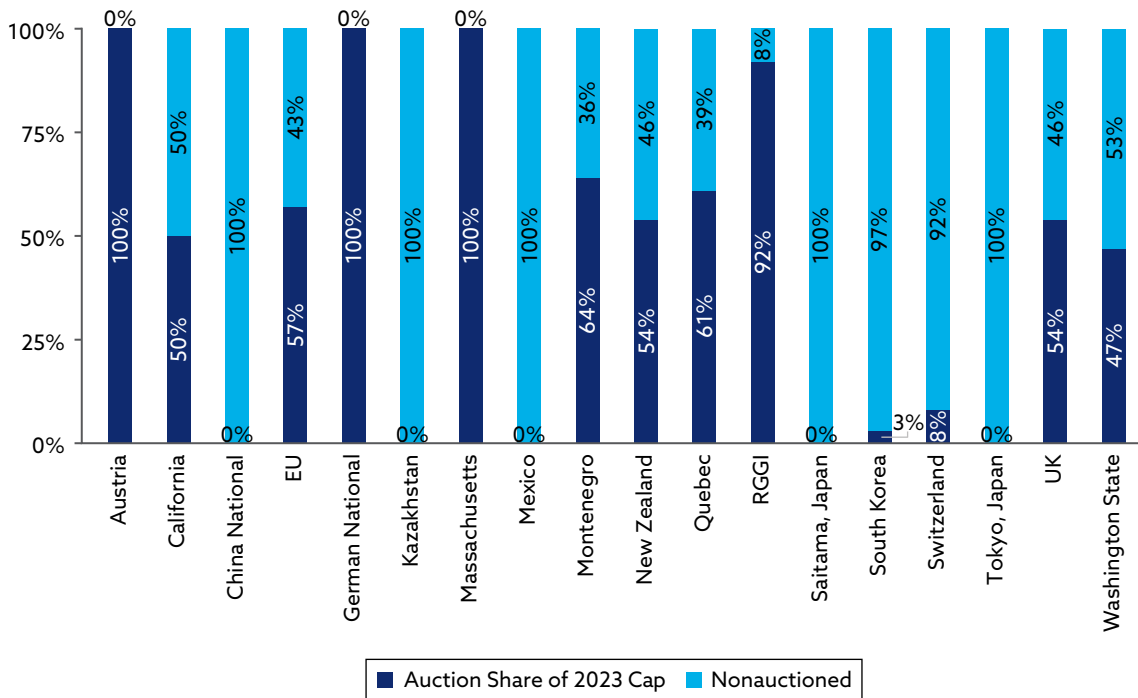
¹³The “Market Instruments in the Secondary Market” section provides some examples of existing carbon ETFs.

¹⁴Mak (2025) provides an overview of VCMs.

¹⁵A few CCMs sell allowances at a fixed price for a certain period, as an alternative form of auction. All of these CCMs, however, plan to eventually transition to auctions.

¹⁶Because auction mechanisms and the primary market are outside the scope of this study, the report does not cover their details.

Exhibit 3. Auction Shares of Carbon Cap in Major CCMs, 2023



Source: ICAP.

for free and can obtain additional allowances through auctions, three factors motivate their participation in the secondary market:

- Purchasing additional allowances in the spot market to meet compliance requirements
- Selling surplus allowances in the spot market to generate extra revenue
- Engaging in the derivative market by buying or selling forwards, futures, and options for long-term compliance planning

In this context, institutional investors often act as counterparties to covered entities, facilitating transactions while seeking investment returns.

This section focuses on allowance trading in the secondary market and discusses three key instruments: spot market instruments, derivatives, and carbon ETFs.

Spot Market Instruments

Currently, there are two CCMs with spot market instruments for carbon allowances: the EU ETS and China's National ETS. The EEX EUA Spot contract is the most traded contract. One EUA corresponds to the emission of 1 tCO₂e. The minimum trading unit is one lot, equivalent to 1,000 EUAs. ECC handles physical

Exhibit 4. EEX EUA Spot Contract Specifications

Feature	EEX EUA Spot
Underlying asset	EU Allowances (EUAs)
Emission allowance	1 EUA = 1 tCO ₂ e
Contract volume	1 lot = 1,000 EUAs
Minimum lot size	1 lot
Minimum tick	EUR0.01 per EUA
Average price (2024)	EUR65.23 per EUA (USD74.49 per EUA)
Trading method	Continuous trading
Fulfillment date	T + 1 for trades before 4:00 p.m. CET
Transfer of EUAs	Participants may transfer EUAs held in escrow to a designated registry account of their choice. The transfer will be completed no later than the next ECC business day.
Sale conditions	All sales must be backed by a sufficient balance of EUAs in the ECC internal delivery account. Before selling, EUAs must be deposited into this account in advance.

Source: EEX.

delivery and settlement, ensuring that delivery occurs on the first business day after the contract's conclusion. **Exhibit 4** summarizes the specifications of the EEX EUA Spot contract.

The spot market for China's National ETS has also developed rapidly since its launch in 2021. The China Emission Allowances (CEAs) are primarily traded on the Shanghai Environment and Energy Exchange, which has four spot instruments: CEAs 2019–2020, CEAs 2021, CEAs 2022, and CEAs 2023. The prices of these four instruments are very close, all around CNY90 per CEA (around USD12.36). Meanwhile, the Shanghai Environment and Energy Exchange provides price information for OTC spot transactions. Derivatives currently are not allowed on CEAs.

Derivatives

Compared with the spot market, derivatives for carbon allowances are more diverse and are available on multiple exchanges. The most representative ones use EUAs, UK Allowances (UKAs), California Carbon Allowances (CCAs), Washington Carbon Allowances (WCAs), and RGGI Carbon Allowances as the underlying asset. The most active exchanges for these derivatives include EEX, ICE, CME, Nasdaq, and Nodal Exchange.

Among these, EUA-related derivatives are the most popular. EEX offers EEX EUA Futures with monthly, quarterly, and yearly expiries. ICE, in addition to ICE EUA Futures, provides ICE EUA Daily Futures with daily expiries and

ICE EUA Mini Futures with a smaller contract size (1/10 of ICE EUA Futures) to accommodate more covered entities and investors.

Both EEX and ICE also offer option contracts on the underlying EUA December futures contract. At expiry, one lot of EUA options is exercised into one lot of EUA futures contracts. EUA options are European style, meaning that they can be exercised only at expiry. In line with standard practice for energy derivatives, both EEX and ICE automatically exercise in-the-money options at expiry.¹⁷

Exhibit 5 summarizes the specifications of EUA options. Despite some minor differences, the contracts offered by EEX and ICE are largely similar. In addition, Nasdaq also offers EUA futures. Similarly, ICE offers UKA futures, UKA daily futures, and UKA options (with UKA futures as the underlying asset).

Exhibit 5. EUA Option Specifications

Feature	EEX EUA Options (Futures Style)	ICE EUA Futures Options (Futures Style Margin)
Underlying contract	EUA December Futures	EUA December Futures
Contract series	EEX lists EUA option contracts for the following maturities: Monthly: current month and the next two calendar months Quarterly: current quarter and the next 11 quarters August: current and next August expiry December: current year and the next 8 December expiries ¹⁸	ICE lists EUA futures option contracts for the following maturities: Quarterly: up to the next 6 quarters August: up to the next 2 August expiries December: up to the next 7 December expiries ¹⁹
Contract size	Depends on the exercised futures position	1,000 EUA (1 lot)

(continued)

¹⁷In-the-money options are options for which exercising them would be profitable. Specifically, for a call option, "in the money" means that the market price of the underlying asset is higher than the strike price. For a put option, it means that the market price is lower than the strike price.

¹⁸For example, as of June 2025, EEX lists EUA options for the following maturities:

- Monthly: current month (June 2025) and next two calendar months (July 2025 and August 2025)
- Quarterly: current quarter (June 2025) and next 11 quarters (September 2025, December 2025, March 2026, June 2026, September 2026, December 2026, March 2027, June 2027, September 2027, December 2027, and March 2028)
- August: current August (2025) and next August (2026)
- December: current December (2025) and the next eight December expiries (2026, 2027, 2028, 2029, 2030, 2031, 2032, 2033)

August options are listed separately because monthly and quarterly contracts do not always include August, despite its importance as a seasonal transition point in energy markets. December options are also separated to enable long-term year-end planning.

¹⁹For example, as of June 2025, ICE lists EUA futures options for the following maturities:

- Quarterly: up to the next six quarters (June 2025, September 2025, December 2025, March 2026, June 2026, and September 2026)
- August: up to the next two August expiries (2025 and 2026)
- December: up to the next seven December expiries (2025, 2026, 2027, 2028, 2029, 2030, and 2031)

Exhibit 5. EUA Option Specifications (*continued*)

Feature	EEX EUA Options (Futures Style)	ICE EUA Futures Options (Futures Style Margin)
Option type	European	European
Fulfillment	Converted to a futures position at the strike price	Converted into EUA futures contracts
Last trading day	Third exchange trading day before the last trading day of the EUA month future	Three UK business days before the expiry of the corresponding futures contract
Exercise procedure	Automatic exercise at 3:00 p.m. if in the money; manual exercise not allowed	Automatic exercise if at least one tick in the money; otherwise at-the-money and out-of-the-money positions expire
Minimum trading size	Not specified	1,000 EUA (1 lot)
Minimum price fluctuation		EUR0.005 per EUA
Tick value		EUR5.00 per lot
Strike price increments		Minimum of five strike prices in EUR0.50 increments
Expiration date		Three UK business days before the futures contract expiry

Sources: EEX and ICE.

CCA-related derivatives are mainly traded on ICE and the Nodal Exchange, with a smaller presence on CME Group. The futures market for CCAs is diverse, consisting of the following types:

- *CCA specific* vintage year X futures: The underlying asset must be CCAs from a specific year X. For example, a CCA Specific Vintage 2025 Future allows the delivery of CCAs only from 2025.
- *CCA* vintage year X futures: The underlying asset can be CCAs from year X or any earlier year. For instance, at the expiry of a CCA Vintage 2025 Future, the seller can deliver CCAs from any year up to 2025.

Compared with specific vintage futures, vintage futures provide greater flexibility for buyers who do not require CCAs from a particular year.²⁰ Both types of futures have contracts for vintage years from 2020 to 2029.

²⁰The emergence of these two types of vintage futures is affected by the California Cap-and-Trade Program's compliance regulation:

- Allowance can be used only in the vintage year or later (e.g., a 2025 CCA can be used only in 2025 or beyond).
- Allowances can be used only within the current compliance period and cannot be carried over to the next one. The previous compliance period was 2021–2023, and the current period is 2024–2026. Therefore, a 2021 CCA can be used only during the 2021–23 period and cannot be used in 2024 or beyond.
- Conditional banking of allowances is permitted, but borrowing future vintages for current use is not allowed.

In addition to these market price-settled futures, two additional futures types settle based on California Air Resources Board (CARB) auction prices:

- *CCA current* auction clearing price futures: At expiry, the contract converts into CCA current vintage futures, with the settlement price based on CARB's respective current auction settlement price. This contract suits covered entities or investors who need to hedge against short-term fluctuations in CARB's recent auction prices.
- *CCA advance* auction clearing price futures: At expiry, the contract converts into CCA specific vintage futures with a vintage three years in advance. The settlement price is based on CARB's advance auction settlement price for future allowances. This contract is designed to hedge against fluctuations in CARB's future auction prices.

Compared with vintage futures, which are based on CCAs' market prices and are influenced by supply and demand, auction clearing price futures are based on auction prices and are affected by CARB's auction mechanisms. Vintage futures have higher liquidity and a larger market than auction clearing price futures. In addition, similar to EUA options, CCA options are also structured with CCA futures as the underlying asset.

The other two major CCMs in North America, RGGI and Washington's Cap-and-Invest Program, have the same types of futures and options as CCAs. These derivatives are also traded on ICE and Nodal Exchange.

ETFs

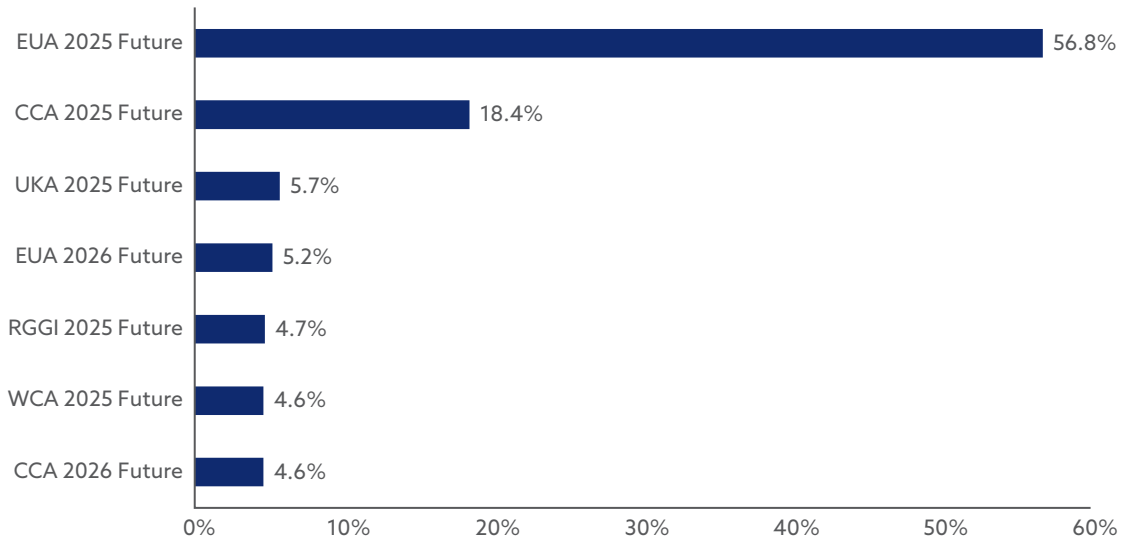
As discussed earlier, retail investors have limited channels to participate directly in carbon allowance trading. ETFs provide retail investors with opportunities to gain direct exposure to carbon allowances or to companies that have low carbon footprints. The most representative ETFs include KraneShares Global Carbon Suite and iShares MSCI ACWI Low Carbon Target ETF.

The KraneShares Global Carbon Suite, managed by Krane Funds Advisors, LLC, includes the Global Carbon Strategy ETF (KRBN), European Carbon Allowance Strategy ETF (KEUA), and California Carbon Allowance Strategy ETF (KCCA). The primary product, KRBN, uses the S&P Global Carbon Credit Index as its benchmark and provides broad global allowance coverage by tracking the most actively traded carbon allowance futures contracts. Currently, KRBN covers EUAs, CCAs, RGGI carbon allowances, UKAs, and WCAs. **Exhibit 6** presents KRBN's futures exposures, with the most traded EUAs and CCAs accounting for 85%.

The iShares MSCI ACWI Low Carbon Target ETF (CRBN), managed by iShares, aims to track the MSCI ACWI Low Carbon Target Index.²¹ This index consists of

²¹The MSCI Low Carbon Index family includes not only the ACWI Low Carbon Target Index but also other low-carbon indexes designed for specific carbon markets, such as the United States, Japan, Europe, emerging markets, Asia, and the United Kingdom. ICE offers multiple futures contracts based on MSCI Low Carbon Indexes, such as the MSCI ACWI NTR Index Future.

Exhibit 6. Composition of Carbon Allowance Futures in KraneShares Global Carbon Strategy ETF



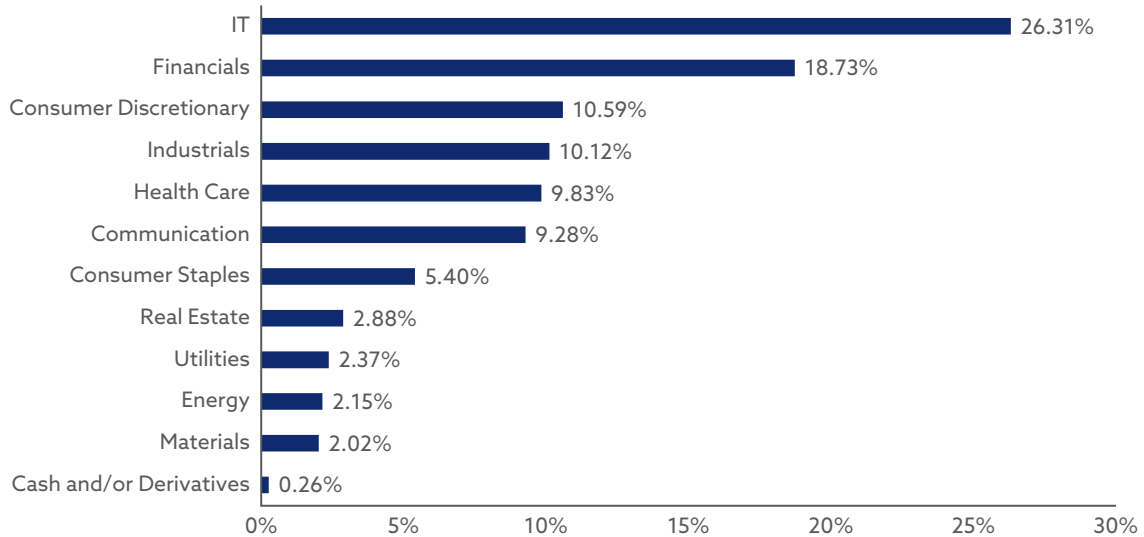
Source: KraneShares, as of 28 February 2025.

large- and mid-capitalization equities from developed and emerging markets, specifically those with a lower carbon footprint compared with the broader market. **Exhibit 7** presents CRBN's sector exposures. CRBN enables investors to gain exposure to a diversified range of global stocks that are less dependent on fossil fuels, while reducing the carbon footprint of an equity portfolio by favoring companies with lower carbon emissions relative to their higher-emitting peers.

Note that KRBN and CRBN use different types of investment strategies. CRBN is a low-carbon equity portfolio that focuses on companies with relatively low carbon emissions, whereas KRBN provides direct exposure to carbon allowances, allowing retail investors to access the carbon asset class. Although several low-carbon equity funds are available to retail investors, very few offer the direct access to carbon allowances that KRBN does. In addition, retail investors may also gain indirect exposure to CCMs through certain types of derivatives on carbon allowances.

Exhibit 8 compares the key attributes of KRBN and CRBN. CRBN, the low-carbon footprint equity portfolio strategy, is larger in net assets and offers better liquidity compared with KRBN, using the carbon allowance portfolio strategy. The direct investment in carbon allowances through KRBN is a more specialized strategy and reflects the underlying costs of futures trading. Therefore, retail investors need to decide whether they are willing to pay for direct exposure to carbon markets or invest through equity-based strategies as an alternative.

Exhibit 7. iShares MSCI ACWI Low Carbon Target ETF Sector Exposure



Source: iShares, as of 28 February 2025.

Exhibit 8. Key Attributes of KRBN and CRBN

	KRBN	CRBN
Net assets of the fund	USD161.71 million	USD1,009.62 million
Exchange	NYSE	NYSE Arca
Benchmark index	S&P Global Carbon Credit Index	MSCI ACWI Low Carbon Target Index
Closing price	USD29.79	USD207.93
Fund inception	29 July 2020	8 December 2014
Distribution frequency	Quarterly	Semiannual
30-day median bid-ask spread	0.84%	0.18%
Expense ratio	0.85%	0.20%

Sources: KraneShares, Yahoo Finance, and iShares, as of 9 June 2025.

In summary, the secondary market for carbon allowances provides covered entities with instruments for carbon budgeting and hedging over different time horizons. EUAs currently dominate the spot market, and the CEA spot market is also developing rapidly. In contrast, the derivative market offers a wider variety of products. Multiple exchanges provide futures and options linked to CCMs in Europe and North America. In addition, ETFs serve as a channel for retail investors to gain exposure to carbon. The development of the secondary market contributes to the efficient pricing and liquidity of carbon allowances.

Liquidity

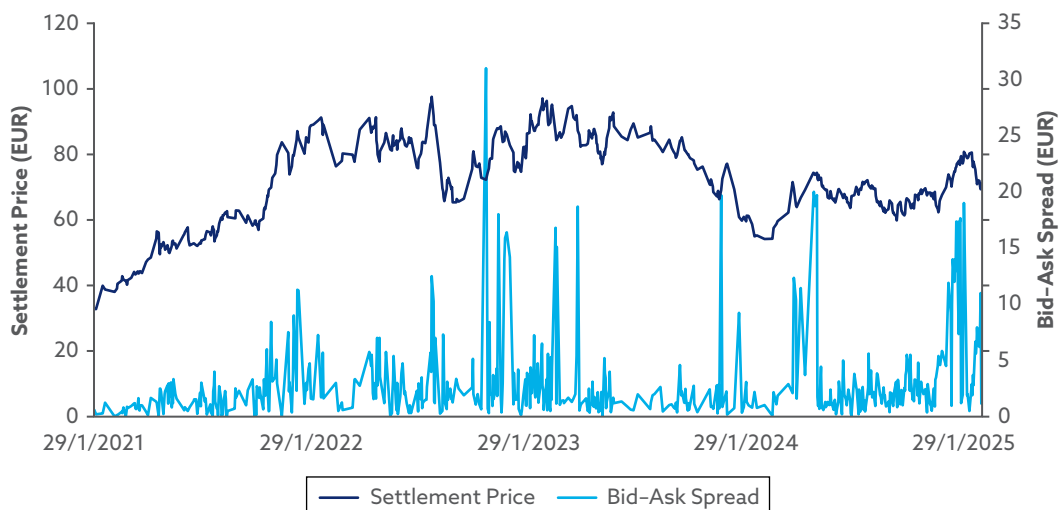
This section assesses the overall liquidity level of carbon allowances in the secondary market.

Spot Market Liquidity

As discussed earlier, the spot market for carbon allowances primarily consists of EUA and CEA spot trading. **Exhibit 9** presents the EEX EUA Spot price and bid-ask spread from January 2021 to February 2025. The EEX EUA Spot price exhibits significant volatility. During the sample period, the average price was EUR71.9, with a standard deviation of 13.0, resulting in a coefficient of variation (CV) of 18% ($13.0/71.9$).²² This high CV suggests that the market is relatively unstable and susceptible to short-term shocks. The bid-ask spread, representing transaction costs, is generally low and stable in highly liquid markets. During the sample period, however, the average bid-ask spread was EUR2.9 per EUA. Moreover, the spread's standard deviation reached 3.8, exceeding its mean and suggesting considerable fluctuations and potentially poor market depth.

The relative bid-ask spread (bid-ask spread/price) standardizes liquidity across different price levels. During the sample period, the average relative bid-ask spread was 4%, with a standard deviation of 5%, indicating that trading conditions are challenging and the market is highly sensitive to external factors. Overall, Exhibit 9 and the supporting data indicate that EUA spot market liquidity is weak, transaction costs are relatively high, and price volatility is significant.

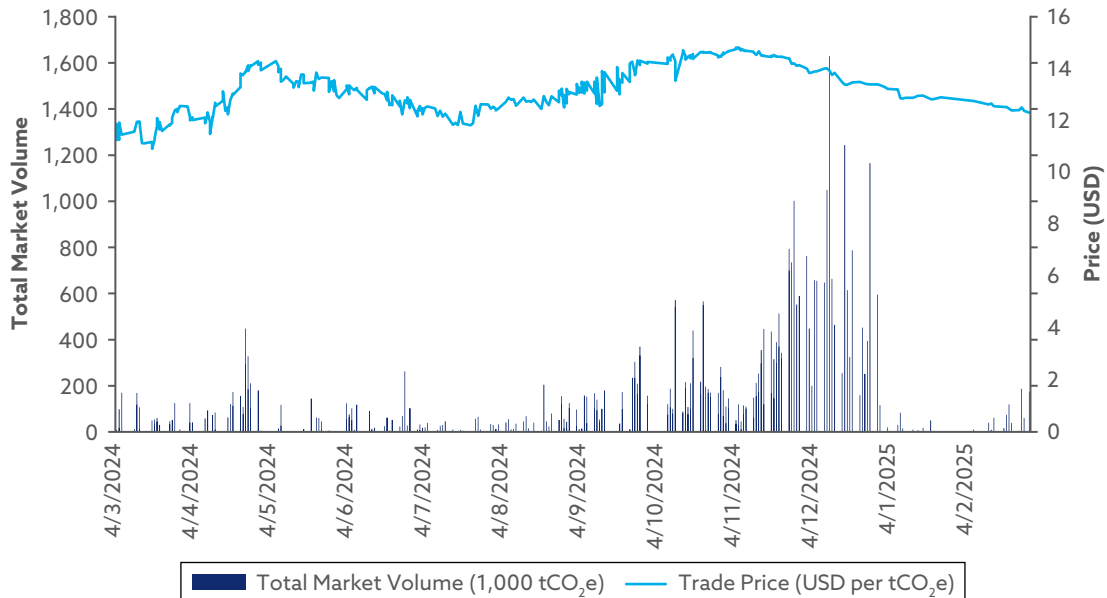
Exhibit 9. EEX EUA Spot Price and Bid-Ask Spread, January 2021–February 2025



Source: London Stock Exchange Group (LSEG).

²²The CV measures the relative dispersion of data by dividing the standard deviation by the mean. It compares the relative variability of different datasets, especially when their means differ. A larger CV suggests greater volatility.

Exhibit 10. CEA Spot Trade Price and Total Market Volume, Shanghai Environment and Energy Exchange, March 2024–February 2025



Source: LSEG.

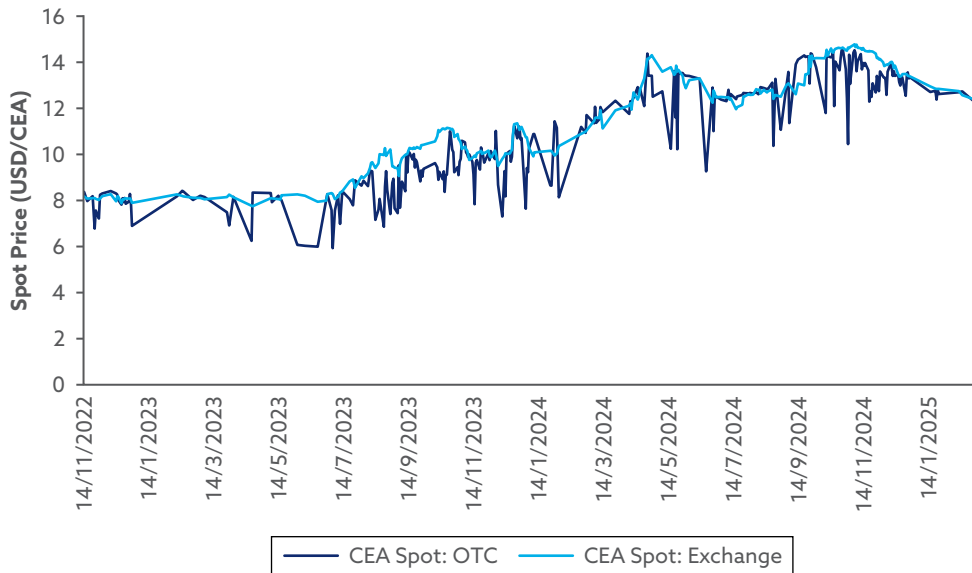
Exhibit 10 presents CEA spot trade prices and total market volume on the Shanghai Environment and Energy Exchange from March 2024 to February 2025.²³ During the sample period, CEA prices remained relatively stable, with an average price of USD13.3 per CEA and a standard deviation of 0.9. The CV of 6.8% indicates a relatively steady market price. Total market volume serves as a measure of trading activity. Exhibit 10 illustrates that trading volume was highly volatile and exhibited seasonal fluctuations (with a significant increase at the end of the year). Although the daily average trading volume was 135,000 tCO₂e, its standard deviation was 208,000, resulting in a CV of 154% and indicating inconsistent market activity and unstable liquidity. Overall, China's National ETS has made progress in stabilizing the carbon price, benefiting from the experience gained through its regional pilot carbon markets.²⁴

Furthermore, because CEAs are entirely allocated for free in the primary market, there is no auction price to influence the secondary market. As the market gradually transitions to auction-based allocation, price volatility may increase. However, the significant fluctuations in trading volume indicate weak overall liquidity in the CEA spot market. This weakness may be partially attributed to the absence of derivatives to enhance liquidity, as well as to the limited number of market participants, primarily driven by compliance requirements.

²³The available data do not support using the same metrics to compare EUA and CEA.

²⁴Note that the sample period for CEA spot prices covers only one year, whereas the EUA spot market data cover four years. During the same time frame, however, the CV of EUA spot prices was 7.1%, higher than the CEA spot CV of 6.9%, suggesting that price fluctuations in the EUA market were slightly more pronounced.

Exhibit 11. CEA Spot Price in Exchange and OTC Markets, November 2022–March 2025



Source: LSEG.

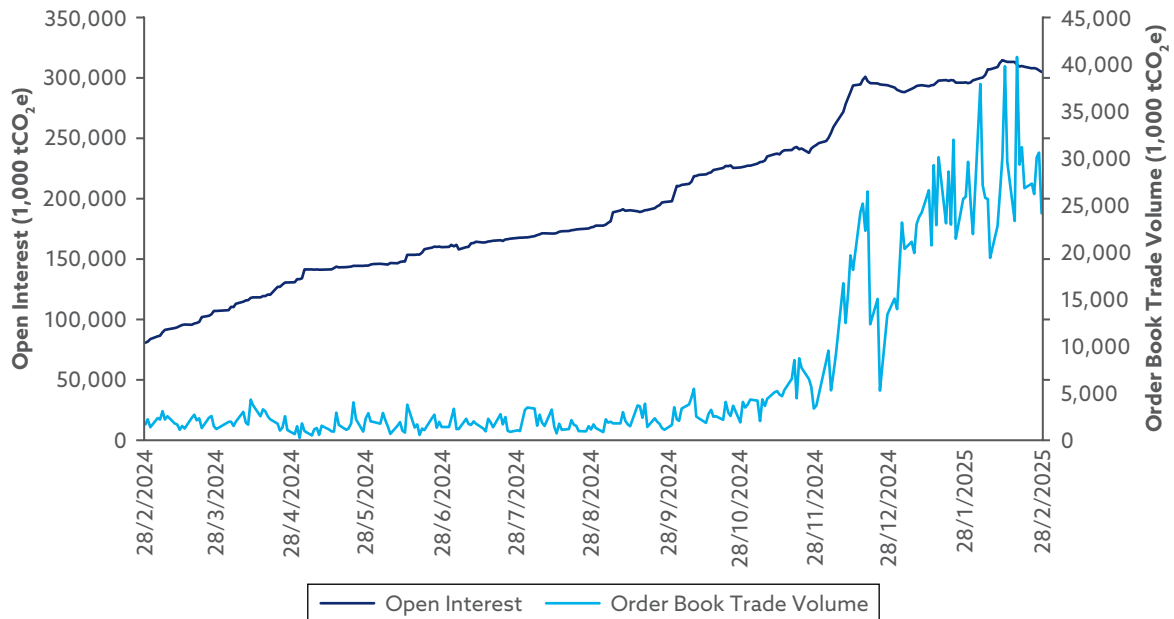
Exhibit 11 compares CEA spot price trends in the exchange and OTC markets from November 2022 to March 2025. Although OTC spot prices tend to track closely with exchange spot prices in the long run, they exhibit significantly greater volatility. The high volatility suggests that the liquidity of the OTC market is weaker than that of the exchange market. The primary reason for this discrepancy is that OTC transactions rely on bilateral negotiations between counterparties, whereas exchange-based transactions typically benefit from a more efficient price discovery mechanism.

Derivative Market Liquidity

This subsection evaluates the liquidity of carbon allowance derivatives by analyzing ICE EUA December Futures, one of the most traded carbon allowance contracts. Specifically, the subsection examines a short-term futures contract (December 2025) and a long-term one (December 2028) using two key indicators: open interest, reflecting long-term liquidity, and order book trade volume, reflecting short-term liquidity.

Exhibit 12 presents ICE EUA December 2025 Futures open interest and order book trade volume from February 2024 to February 2025. Open interest followed a continuous upward trend, increasing to three times its initial level. This dynamic indicates sustained capital inflows, suggesting the contract remains attractive to investors for the long term. Order book trade volume remained relatively low for most of the period but increased substantially as the contract approached its delivery year. This trend suggests that investors prefer

Exhibit 12. ICE EUA December 2025 Futures Open Interest and Order Book Trade Volume, February 2024–February 2025



Source: LSEG.

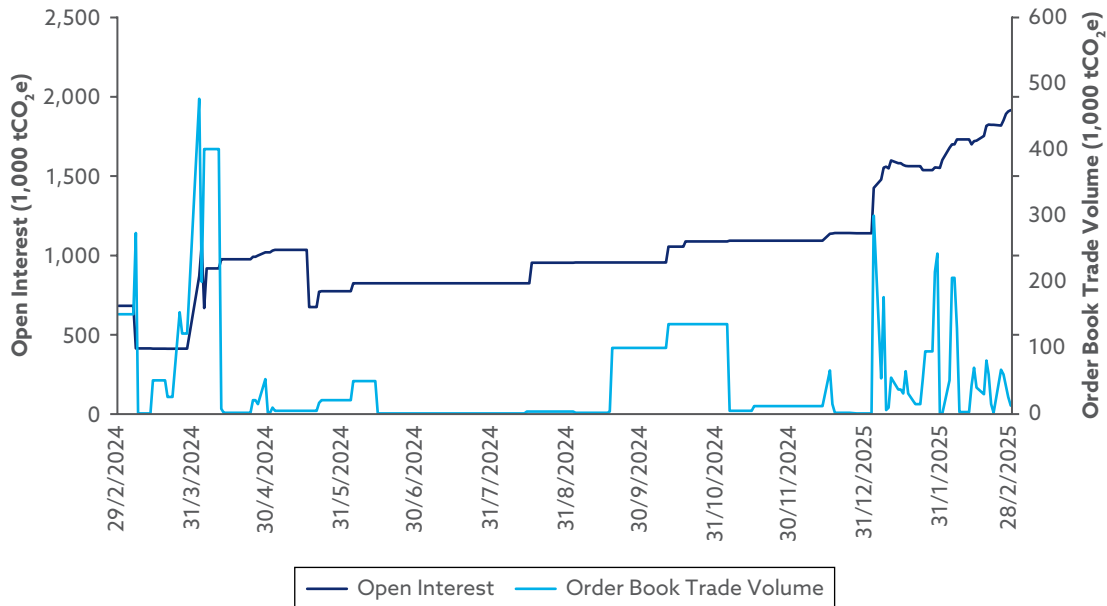
to hold more-liquid futures contracts in the short term. Both open interest and order book trade volume surged significantly in December 2024, reflecting a clear pattern of compliance-driven liquidity cycles. Overall, December 2025 futures exhibit strong liquidity, which improves further as the contract approaches delivery.

Exhibit 13 presents ICE EUA December 2028 Futures open interest and order book trade volume from February 2024 to February 2025.²⁵ Open interest peaked at only 2,000, significantly lower than the December 2025 contract's minimum open interest of 100,000. Open interest remained stagnant for most of the sample period, indicating limited market interest in this contract. This low level of open interest suggests that the long-term futures market for carbon allowances is still in an early stage of development and that covered entities are adopting a cautious approach toward long-term carbon budgeting and hedging because of policy uncertainties. Order book trade volume was sparse and highly volatile during this period, indicating low market activity. Overall, December 2028 futures contracts exhibit weak liquidity.

From the perspective of open interest and order book trade volume, short-term futures contracts (December 2025) demonstrate significantly higher liquidity than long-term contracts (December 2028). Liquidity for December 2025 is expected to increase further as the contract approaches delivery,

²⁵For reference, the longest available futures contract in the market is for 2029.

Exhibit 13. ICE EUA December 2028 Futures Open Interest and Order Book Trade Volume, February 2024–February 2025



Source: LSEG.

while December 2028 and similar long-term futures contracts are likely to remain illiquid in the interim. Policy changes and carbon market reforms may encourage covered entities to engage more in long-term carbon planning, improving the liquidity of long-term contracts.

Based on price volatility, bid-ask spread, and total market volume, the carbon allowance spot market demonstrates weak liquidity, primarily as a result of the limited availability of spot trading instruments and high entry barriers. Exchange markets provide better liquidity than OTC markets. Based on the open interest and order book trade volume, futures market participants prefer short-term contracts, while long-term contracts remain illiquid. This pattern aligns with the typical liquidity distribution observed in most derivative markets. As CCMs continue to develop, the introduction of additional secondary market instruments and an increase in market participants are expected to enhance liquidity.

Transparency

Market transparency plays a crucial role in enhancing the market's liquidity and integrity. A highly transparent market helps reduce information asymmetry, improve market efficiency, and lower transaction costs. Because carbon market derivatives are classified as financial instruments, many jurisdictions impose relatively strict regulatory requirements on them.

For example, derivatives in the EU ETS are regulated under MiFID II, whereas those in the United States are regulated by the Commodity

Futures Trading Commission. In China, because of a more cautious approach toward financial derivatives, the carbon market currently operates primarily as a spot market, with no official derivatives yet. The China Securities Regulatory Commission maintains strict regulatory standards for developing such instruments in the future. In CCMs' secondary markets, however, transparency faces several challenges.

Order Book Transparency

Order book transparency varies significantly among CCMs and even among products within the same CCM. Some products, such as EUA futures, disclose relatively detailed order book data. For most products, however, only partial information (such as closing price, bid, and ask) is disclosed while other critical information (such as volume) is missing. Moreover, updates are typically not in real time and are subject to delays.

One reason for this limited transparency is the high level of diversity among global CCMs, with no unified disclosure mechanism. In addition, CCMs are at different stages of development and subject to different regulatory requirements, and their capabilities in data collection and disclosure may vary. Even within the same CCM, related products (such as EUA futures and options) are often traded on different platforms (such as EEX and ICE), each with different disclosure standards on the type and level of details of the disclosed information. As a result, obtaining comprehensive order book data remains challenging.

OTC Transactions

The liquidity of CCMs' secondary markets is still relatively limited, and the variety of instruments in these markets is still expanding. As a result, many transactions are conducted through the OTC market. Data transparency in OTC transactions is worse than it is for exchange markets, however, making a large portion of CCM trading data difficult to access. Many markets are establishing disclosure regulations for the OTC market (such as the EU's MiFID II/MiFIR reporting) to gradually enhance the transparency of secondary market data, particularly for derivatives and OTC transactions.

Accessibility of Underlying Data

Regulators (e.g., ESMA), exchanges (e.g., EEX and ICE), and market data vendors (e.g., LSEG, ICAP, and MSCI) regularly publish global carbon market status reports based on detailed data. Most of the data presented in these reports are aggregated, however, with little underlying data made publicly available. Investors often need to rely on paid platforms to access such data.

In summary, improving carbon market transparency requires cooperation among regulators, exchange operators, intermediaries, and market data vendors across different CCMs. Greater transparency will ultimately facilitate more efficient carbon pricing and strengthen market integrity.

Conclusion

With the growing development of CCMs in recent years, CCMs and the investment industry have become increasingly connected, a shift marked by greater investor participation in these markets and more products tied to carbon becoming available for trading and investing. A thorough understanding of market structure is essential for investment professionals to be able to participate effectively in CCMs and integrate carbon into investment strategies where appropriate. This report provides an in-depth analysis of the market structure of CCMs and contributes to the current literature in three ways:

- It provides a detailed analysis of the participants in CCMs and their respective roles.
- It introduces instruments in the secondary market, including spot market instruments, derivatives, and ETFs.
- It evaluates the liquidity and transparency of CCMs using multiple indicators.

The study offers practical guidance for the investment industry to engage with CCMs and provides insights for enhancing market efficiency.

Practical Guidance for Investors

- **Liquidity:** Liquidity remains a key challenge in CCMs. Compared with the spot market, which offers limited availability and access, derivative markets are larger, more liquid, and easier to trade in. Within the derivative markets, short-term contracts tend to have higher liquidity than long-term ones. Investors seeking direct exposure to carbon as an asset class may prefer to focus on the derivative markets, as this approach enables more effective trading and risk management, as well as greater flexibility in incorporating carbon into portfolio construction.
- **ETFs:** Retail investors looking to gain direct exposure to carbon can do so through the KRBN ETF or retail derivatives, such as contracts for difference tied to carbon futures contracts. Investors should carefully evaluate costs and liquidity when making investment decisions. These considerations will help determine whether to pursue direct participation in carbon allowances or adopt indirect strategies, such as low-carbon equity portfolios (e.g., CRBN).
- **Transparency:** Market transparency remains limited, and collaboration among stakeholders (investors, regulators, and market infrastructures) is needed to improve transparency and strengthen market functioning. More transparent CCMs will further facilitate investor interest and participation in carbon as an asset class, improving efficiency and price discovery.

Appendix

The appendix presents supplementary exhibits that provide additional details on CCMs to maintain the flow of the main text. **Exhibit A1** summarizes the key regulators and their responsibilities across major CCMs worldwide. **Exhibit A2** lists the CCMs that use exchanges.

Exhibit A1. Regulators of Major Compliance Carbon Markets

Compliance Carbon Markets	Regulators	Responsibilities
Asia		
China National ETS	Ministry of Ecology and Environment (MEE)	Regulatory framework
	Provincial-level MEE subsidiaries	Implementation
	Municipal-level authorities	Managing covered entities
	China Carbon Emissions Registration and Clearing Co., Ltd.	China Emission Allowances (CEAs) registry and clearing platform
	Shanghai Environment and Energy Exchange	CEA trading platform
Kazakhstan ETS	Ministry of Ecology and Natural Resources	Regulatory framework
	JSC Zhasyl Damu	Implementation
	Caspy Commodity Exchange JSC	Secondary market auctions
Korea ETS, South Korea	Ministry of Environment	Regulatory framework
	Ministry of Economy and Finance	Allowance allocation
	Korea Exchange (KRX)	Trading and auctioning platform
	Greenhouse Gas Inventory and Research Center	Registry
	International Carbon Reduction Council	Greenhouse gas reduction projects
Target Setting ETS in Saitama, Japan	Saitama Prefectural Government	Regulatory framework and implementation
Tokyo Cap-and-Trade Program	Tokyo Metropolitan Government	Regulatory framework and implementation

(continued)

Exhibit A1. Regulators of Major Compliance Carbon Markets (*continued*)

Compliance Carbon Markets	Regulators	Responsibilities
Europe		
EU ETS	European Commission	Regulatory framework and EU registry
	Competent authorities of all member states	Implementation
German National ETS	German Federal Ministry for Economic Affairs and Climate Action	Regulatory framework
	German Emissions Trading Authority (DEHSt)	Implementation
Switzerland ETS	Federal Office for the Environment (FOEN)	Implementation
UK ETS	UK ETS Authority	Regulatory framework and implementation
	Environment Agency	UK Emissions Trading Registry
	Scottish Environment Protection Agency	Regulatory compliance enforcement
	Natural Resources Wales	Regulatory compliance enforcement
	Northern Ireland Environment Agency	Regulatory compliance enforcement
	Offshore Petroleum Regulator for Environment and Decommissioning	Regulatory compliance enforcement
North America		
California Cap-and-Trade Program	California Air Resources Board	Regulatory framework and implementation
	Western Climate Initiative, Inc.	Auctions and system registry
Massachusetts Limits on Emissions from Electricity Generators	Executive Office of Energy and Environmental Affairs	Regulatory framework
	Massachusetts Department of Environmental Protection	Implementation
	Potomac Economics	Market monitor
	Enel X	Auctions
	APX	Allowance tracking platform

Exhibit A1. Regulators of Major Compliance Carbon Markets (*continued*)

Compliance Carbon Markets	Regulators	Responsibilities
Mexican ETS	Secretariat of Environment and Natural Resources (SEMARNAT)	Implementation
	ETS Advisory Committee (COCOSCE)	Formal technical forum
Nova Scotia Output-Based Pricing System for Industry, Canada	Nova Scotia Environment and Climate Change	Regulatory framework and implementation
Quebec Cap-and-Trade System	Ministry of the Environment, the Fight against Climate Change, Wildlife and Parks	Implementation
	Western Climate Initiative, Inc.	Auctions and system registry
Regional Greenhouse Gas Initiative (RGGI), United States	Statutory and/or regulatory authority of each RGGI state	Implementation
	Environmental and energy agencies for each RGGI state	Implementation
	RGGI Inc.	Implementation
	Potomac Economics	Market monitor
	Enel X	Auctions
Pacific		
New Zealand ETS	Ministry for the Environment	Regulatory framework
	Environmental Protection Authority	Registry and compliance
	Ministry for Primary Industries	Overseeing the forestry sector
	Climate Change Commission	Independent advice body

Source: ICAP.

Exhibit A2. Global Compliance Carbon Markets with Exchange

Carbon Markets	Primary Markets/Auctions	Secondary Markets/Trading
Asia		
China National	NA; all free allocation	Shanghai Environment and Energy Exchange
Indonesia	NA; all free allocation	IDXCarbon
Kazakhstan	NA; all free allocation	Caspy Commodity Exchange JSC
South Korea	Korea Exchange (KRX)	
Europe		
EU	European Energy Exchange (EEX)	Intercontinental Exchange (ICE), ICE ENDEX, and Nasdaq
Switzerland	Swiss Emissions Trading Registry	OTC
UK	ICE Futures Europe	
North America		
Alberta, Canada	NA; all free allocation	Alberta Emission Performance Credit Registry
California, US	Western Climate Initiative (WCI, Inc.)	ICE, CME Group, and Nodal Exchange
Canada Federal	NA; all free allocation	Credit and Tracking System
Massachusetts	Enel X	Massachusetts Carbon Allowance Registry
Quebec, Canada	WCI, Inc.	ICE, CME Group, and Nodal Exchange
Regional Greenhouse Gas Initiative, US	Enel X	ICE
Washington State, US	WCI, Inc.	ICE and Nodal Exchange
Pacific		
Australia	NA; all free allocation	Australian Carbon Exchange
New Zealand	NZX (New Zealand Exchange) and EEX	OTC

Source: ICAP.

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