
RGGI Inc.



**REPORT ON THE SECONDARY MARKET
FOR RGGI CO₂ ALLOWANCES: FOURTH QUARTER 2016**

Prepared for:

RGGI, Inc., on behalf of the RGGI Participating States

Prepared By:

**POTOMAC
ECONOMICS**

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The Regional Greenhouse Gas Initiative (RGGI) is a cooperative effort of Northeast and Mid-Atlantic states to reduce emissions of carbon dioxide (CO₂) from the power sector.

RGGI, Inc. is a non-profit corporation created to provide technical and administrative services to the states participating in the Regional Greenhouse Gas Initiative.

A. INTRODUCTION AND SUMMARY

The primary market for RGGI CO₂ allowances consists mainly of the auctions where allowances are initially sold. Once a CO₂ allowance is purchased in the primary market, it can then be resold in the secondary market. The secondary market for RGGI CO₂ allowances comprises the trading of physical allowances and financial derivatives, such as futures and options contracts.

The secondary market is important for several reasons. First, it gives firms an ability to obtain CO₂ allowances at any time during the three months between the RGGI auctions. Second, it provides firms a way to protect themselves against the potential volatility of future auction clearing prices. Third, it provides price signals that assist firms in making investment decisions in markets affected by the cost of RGGI compliance.

This report provides a summary of activity in the secondary market in the fourth quarter of 2016 and discusses the results of our market power screens. Several patterns have emerged in this period in the secondary market:

- CO₂ Allowance Prices – CO₂ allowance futures prices averaged \$4.11, down 12 percent from the previous quarter and 42 percent from the fourth quarter of 2015.
 - ✓ Prices were initially stable, holding near \$4.65 throughout October. Volatility increased in November when transaction prices ranged between \$4.00 and \$4.70. After Auction 34 cleared at \$3.55 in early December, prices in the secondary market generally ranged between \$3.40 and \$4.00 through the remainder of the quarter.
- Secondary Market Activity – Options trading volumes fell from the third quarter, while the volume of allowance transfers and futures trading rose sharply.
 - ✓ The volume of trading of RGGI futures was 78.6 million CO₂ allowances in the fourth quarter of 2016, up nearly 200 percent from the previous quarter.
 - ✓ The total volume of CO₂ allowance transfers between unaffiliated firms was 55.4 million, up nearly 600 percent from the previous quarter. It is typical for volumes to increase each December as result of the delivery of futures and the expiration of options contracts.
- CO₂ Allowance Holdings – At the end of the fourth quarter of 2016:
 - ✓ There were 234 million CO₂ allowances in circulation.
 - ✓ Compliance-oriented entities held approximately 142 million of the allowances in circulation (61 percent).

- ✓ Approximately 144 million of the allowances in circulation (62 percent) are believed to be held for compliance purposes.

We evaluate information on the holdings of CO₂ allowances and allowance derivatives as well as the demand for allowances to identify firms that may have acquired a position that raises competitive concerns. In the current study period, we find no evidence of anticompetitive conduct.

B. BACKGROUND

The secondary market for RGGI CO₂ allowances comprises the trading of physical allowances and financial derivatives, such as futures, forward, and option contracts. A physical allowance trade occurs when the parties to the transaction register the transfer of ownership in RGGI's CO₂ Allowance Tracking System ("COATS"). Financial derivatives include any contracts whereby parties agree to exchange funds and/or allowances at some future date, depending in many cases on factors such as the price of allowances at some future date. Many financial derivatives eventually result in the transfer of physical CO₂ allowances (i.e., the transfer is registered in COATS), but this may occur months or years after the parties enter into a financial transaction. These include the following types of transactions:

- *Futures* – Under these contracts, two parties agree to exchange a fixed number of CO₂ allowances of a certain vintage year at a particular price at a specific point in the future (called the "delivery month"). At the end of the delivery month, the contracted number of CO₂ allowances must be physically transferred to the buyer's account in the COATS registry and funds must be transferred to the seller. The vintage year refers to the compliance year of the CO₂ allowance that is to be transferred. One standard futures contract equals 1,000 RGGI allowances.¹
- *Forwards* – These are like futures contracts, but a forward contract typically requires that all financial settlement occur at expiration.
- *Call Options* – Call options give the purchaser the option to buy a fixed number of CO₂ allowances of a certain vintage year at a particular strike price at any time prior to the expiration date. For example, suppose a firm holds a call option with \$5 strike price, and December 2015 expiration date. If the price of the corresponding forward contract rose to \$5.75, the firm could exercise the option to buy CO₂ allowances at \$5 and immediately sell them at \$5.75. Alternatively, if the price of the forward contract stayed below \$5, the firm would let the option expire without exercising it. One standard options contract can be exercised for 1,000 RGGI allowances.

¹ More precisely, a futures contract requires parties with an open interest to post financial assurance in an account with the exchange until the contract reaches expiration. The exchange continually withdraws and deposits funds according to changes in the prices of the contracts in which the party has interest. For example, if a firm buys a contract for 1,000 allowances at \$3.50/allowance, the purchasing firm (firm with a long position) must put \$3,500 in an account (or whatever share of the entire liability the exchange requires). If the futures price declines to \$3/allowance, the exchange transfers \$500 from the account of a firm with a long position to the account of a firm with a short position (firm that sold a contract), and the firm with a long position is only required to keep \$3,000 in the account. At the end of the delivery month, allowances are exchanged for funds according to the closing price on the last day of the month.

- *Put Options* – Put options are similar to call options but they give the purchaser the option to *sell* a certain number of CO₂ allowances of a particular vintage year at a specified strike price any time prior to the expiration date.

Futures, forward, and option contracts allow firms to manage risks associated with unforeseen swings in commodity prices. Futures and forwards allow firms to lock-in the prices of future purchases or sales. Options allow firms to limit their exposure to price volatility. Call options protect the purchaser if the price of the commodity increases, while put options protect the purchaser if the price of the commodity decreases. Although options provide less certainty than futures and forwards, they usually require less financial security, making them more attractive to some firms.

The terms of futures, forward, and option contracts vary in the degree to which they are standardized. “Exchange-traded” contracts typically have the most standardized provisions, while the term “over-the-counter” (“OTC”) is applied to contracts with less standardized provisions. However, OTC contracts, once entered into, are often settled through a clearinghouse in order to protect the parties from the risk that the counterparty defaults.

The amount of *open interest* is the net amount of futures, forwards, or options that have been traded for a contract with a particular set of specifications (i.e., vintage year, delivery month, etc.), but have not reached the time of delivery, expired, or been exercised. For example, if Firm A sells 100 contracts of a particular type to Firm B, Firm A will have a short position of 100 contracts, Firm B will have a long position of 100 contracts, and the total open interest for the particular type of contract will be 100 contracts. Hence, the total open interest can be determined by summing across all of the long positions of market participants or by summing across all of the short positions.

The volatility of a CO₂ allowance refers to the expected standard deviation of the distribution of allowance prices one year in the future. For example, if the expected value of the price one year in the future is \$1 and the option-implied volatility is 25 percent, this implies that the probability that the price will be within 25 percent of \$1 (i.e., between \$0.75 and \$1.25) is 68.2 percent assuming that the price is distributed log-normally. Option-implied volatility refers to volatility

estimates that are derived by analyzing the price and other terms of an option contract compared with the price of CO₂ allowances.

Compliance entities and their affiliates includes firms that are believed to: (i) have a parent-subsidiary relationship with a compliance entity, (ii) be subsidiaries of a parent company that has a large interest in a compliance entity, (iii) have substantial control over the operation of a budget source and/or responsibility for acquiring RGGI allowances to satisfy its compliance obligations.

Compliance-oriented entities include compliance entities that appear to acquire and hold allowances primarily to satisfy their compliance obligations.

The number of allowances that are believed to be *held for compliance purposes* includes 100 percent of the allowances held by compliance-oriented entities and a portion of allowances held by other compliance entities (i.e., compliance entities that are not included in the compliance-oriented category).

C. SUMMARY OF PRICES

This section summarizes prices in the secondary market for RGGI CO₂ allowances in the fourth quarter of 2016. Figure 1 summarizes transaction prices in the secondary market for CO₂ allowances, including the prices of allowance transfers registered in COATS² and the prices of futures contract trades on the Intercontinental Exchange (“ICE”). Figure 2 summarizes the option-implied (i.e., expected) volatility of RGGI CO₂ allowance prices based on an analysis of the trading of options contracts.³ Key observations regarding RGGI CO₂ allowance prices:

- Futures prices averaged \$4.11, down more than 12 percent from the previous quarter and 42 percent from the fourth quarter of 2015. Prices held near \$4.80 in October, dipped to near \$4.00 in early November before modest recovery by the end of the month, and fell to a band between \$3.40 and \$4.00 in December following Auction 34.
- The prices of ICE futures were generally consistent with COATS transfer prices, although the prices of both became volatile in November and December.
- The clearing price in Auction 34, held on December 7, was \$3.55. This was down significantly from Auction 33 in September 2016, which cleared at \$4.54.
- Option trading was down sharply from recent quarters. Just five option trades were recorded on ICE in the fourth quarter, down from 23 in the third quarter.

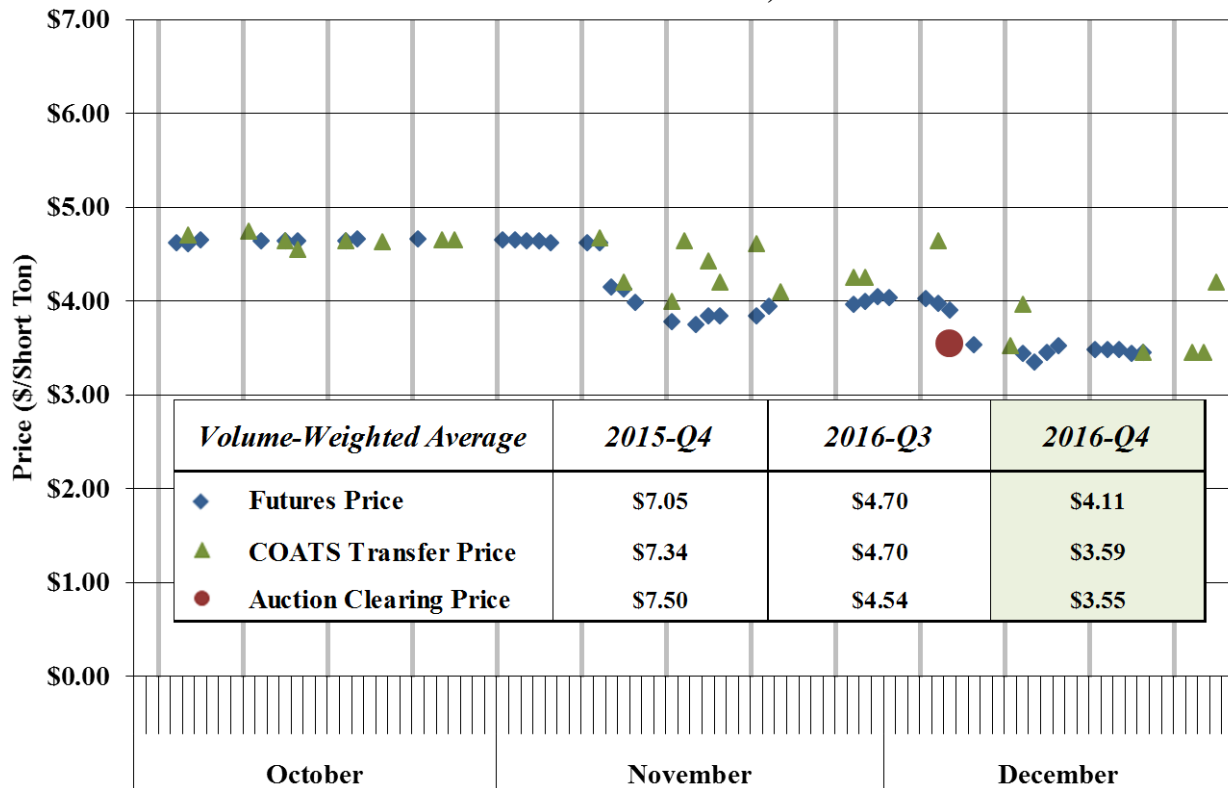
Prices of CO₂ Allowances and Allowance Derivatives

Figure 1 summarizes prices in the secondary market during the period. The blue diamonds show the price of ICE futures on days with trading volume. The green triangles show the volume-weighted average prices of physical deliveries registered in COATS on days with transactions when the price was recorded (“COATS transactions”). The red circle shows the clearing price of the CO₂ allowances that were sold in RGGI Auction 34, which was held on December 7. Figure 1 also shows volume-weighted average prices for each category in the fourth quarter of 2016 compared to the previous quarter and the fourth quarter of the previous year. Volume-weighted average prices for the first, second, and third control period CO₂ allowances are shown together.

² Parties are required to report the transaction price if there is an underlying financial transaction related to the transfer of allowances between accounts.

³ The option-implied volatility of a CO₂ allowance refers to the expected standard deviation of the distribution of allowance prices one year in the future.

**Figure 1: Prices in the Secondary Market for RGGI CO₂ Allowances⁴
October 1 to December 31, 2016**



Key observations regarding CO₂ allowance prices:

- The average price of CO₂ allowance transfers in COATS during the fourth quarter of 2016 was \$3.59, approximately 24 percent lower than in the previous quarter and 51 percent lower than the fourth quarter of 2015.
- The prices of ICE futures trades were generally consistent with COATS transfer prices throughout the fourth quarter. The average futures price of \$4.11 was 12 percent lower than the average price in the previous quarter and 42 percent lower than in the fourth quarter of 2015.
- The clearing price in Auction 34 was \$3.55, which was consistent with secondary market prices leading up to, and after, the auction. The auction clearing price dropped nearly \$1 from Auction 33 (which was held in September 2016).

⁴ Sources: Auction clearing prices are available at www.rggi.org/market/co2_auctions/results, ICE futures prices are available at www.theice.com, and the prices of physical deliveries are based on information in COATS. Futures prices are shown for the prompt month contract settlement price even if the volume traded was for another contract.

Prices of Options for CO₂ Allowances

The clearing prices of option contracts provide insight about how the market expects the price of the underlying commodity to move in the future. The price of an option depends on two factors: (i) the expected value of the underlying commodity relative to the strike price of the option, and (ii) the expected volatility of the underlying commodity over the period before the expiration date. When call option price decreases coincide with put option price increases, it signals a decrease in the expected price of the underlying commodity. Conversely, when call option prices and put option prices move in the same direction, it signals a change in the expected volatility of the underlying commodity price.

Key observations regarding the pricing of options for CO₂ allowances in the fourth quarter of 2016:

- Five option trades (three put options and two call options) were recorded on ICE during the fourth quarter of 2016, down from 23 trades in the previous quarter.
- The strike prices of the put options ranged from \$3.75 to \$4.00, while the call options were sold with strike prices of \$6.00 and \$6.50. These strike prices provide some indication of the market's expectations for the potential range of variation in allowance prices.

Volatility of CO₂ Allowance Prices

Market-based emissions reduction programs such as RGGI are designed to give firms efficient incentives to reduce or offset emissions. In the short-term, high-emitting generators will operate less frequently in favor of low-emitting generators. In the long-term, the market will affect the decisions of firms to develop offset projects, retire older inefficient generation, and perform maintenance that increases fuel efficiency and lowers carbon-intensity. Predictable CO₂ allowance prices decrease the risks associated with making long-term investments in reducing CO₂ emissions. Since CO₂ allowance prices can be volatile, the availability of futures and options contracts allows firms to protect themselves from the risks of such investments.

Expected price volatility is affected by elements of the RGGI program that promote allowance price stability. Potential upward price movements are limited by the Cost Containment Reserve ("CCR"), which allows for the sale of a fixed number of allowances in addition to the cap if the

auction clearing price reaches the CCR Trigger Price.⁵ Potential downward price movements are limited by the Reserve Price, which currently prevents allowances from being sold in the auction at a price below \$2.10 (and is indexed to inflation).

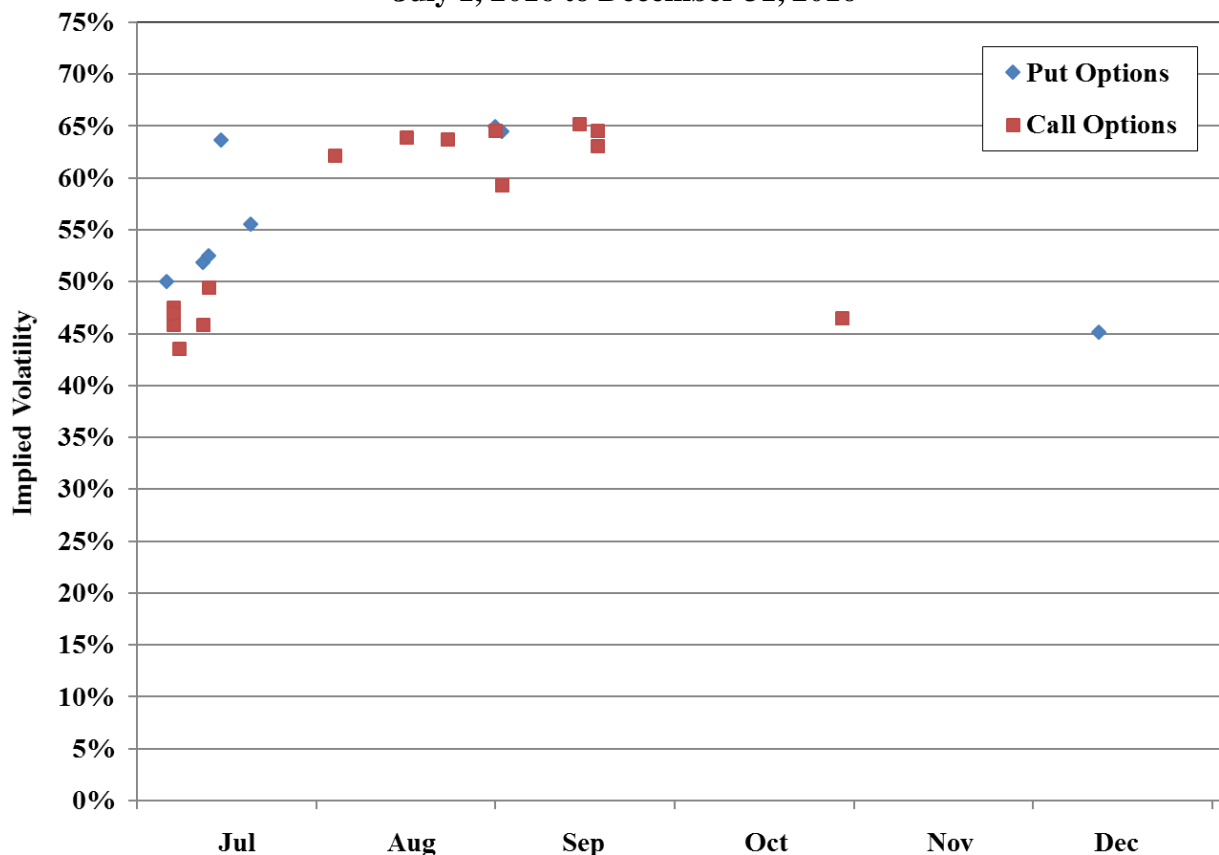
One measure of the volatility of CO₂ allowance prices is known as option-implied volatility, which measures the volatility that is implied by the trading of option contracts for CO₂ allowances. If a firm perceives that CO₂ allowance prices are volatile, the firm may be willing to pay a high price for an option contract that protects it from unforeseen allowance price fluctuations. Likewise, if a firm perceives that CO₂ allowance prices are relatively stable, the firm will be willing to pay relatively little for the same option contract.

The following scatter plot reports the option-implied (i.e., expected) volatility of RGGI CO₂ allowance futures contracts, which can be inferred from the trading of options contracts over the last six months.⁶ The vertical axis shows the option-implied (expected) volatility of CO₂ allowance futures prices, and the horizontal axis shows the trade date. The figure excludes contracts if the trade date is less than 90 days prior to the expiration date. Excluding these contracts reduces variations in implied volatility that are driven by short-term issues such as the timing of the trades within a particular quarter (i.e. around the time of each quarterly auction).

⁵ From 2015 to 2020, the annual withdrawal limit is ten million allowances. Ten million CCR allowances were released in Auction 29 held in September 2015. The CCR Trigger price for 2015 was \$6.00, rose to \$8.00 in 2016, will rise to \$10.00 in 2017, and will rise 2.5 percent in each year through 2020.

⁶ Black's model for valuing futures options is used to estimate the option-implied volatilities of RGGI allowance futures prices.

**Figure 2: Option-Implied Volatility of CO₂ Allowance Futures Prices
July 1, 2016 to December 31, 2016**



Observations regarding the option-implied volatility of CO₂ allowance prices:

- In the third quarter of 2016, implied volatility ranged between 44 and 65 percent.
- In the fourth quarter of 2016, implied volatility ranged between 45 and 47 percent, although the number of trades was much lower in the fourth quarter.
- Overall, option-implied volatility levels averaged 45.8 percent in the fourth quarter of 2016. Option-implied volatility varied over the last two quarters, and future price signals should become clear in the first quarter of 2017.

D. VOLUMES AND OPEN INTEREST

This section evaluates the volume of COATS transactions (i.e., transfers of CO₂ allowances between unaffiliated parties as recorded in COATS) as well as the volume of trading and the level of open interest in exchange-traded futures and options. Figure 3 examines the volumes of transactions recorded in COATS and of futures trading. Figure 4 summarizes the level of open interest in exchange-traded RGGI futures and option contracts. Figure 5 evaluates the concentration of firms with open interest in exchange-traded RGGI futures and option contracts.

Key observations regarding trading volumes and open interest in the fourth quarter of 2016:

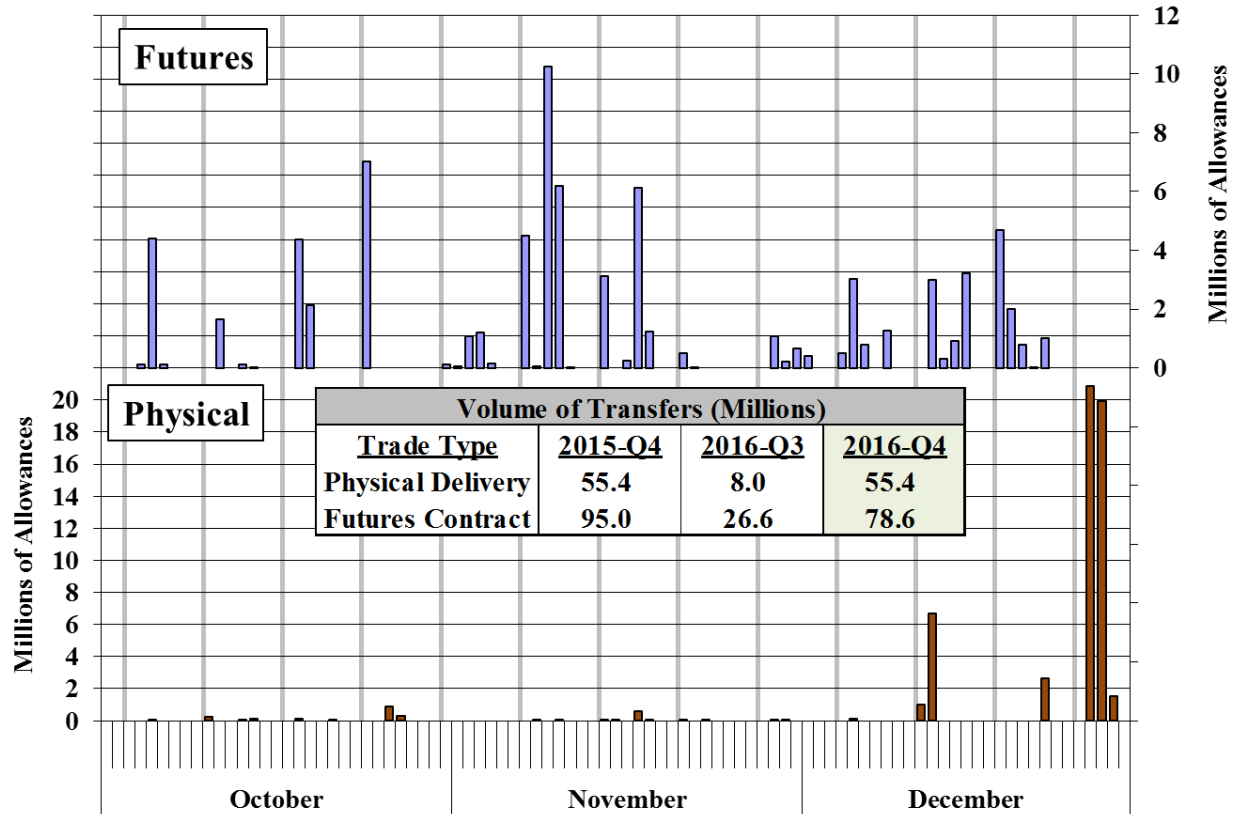
- Secondary market activity was typical for the fourth quarter of the calendar year when a large share of the open futures and options contracts are settled.
 - ✓ The volume of CO₂ allowance transfers between unaffiliated firms was 55.4 million, up nearly 600 percent from the previous quarter, and almost exactly equal to the fourth quarter of 2015.
 - ✓ Open interest in RGGI futures rose steadily from nearly 75 million allowances at the end of the third quarter of 2016 to over 90 million allowances in mid-December before nearly half of all futures contracts reached their closing date. Open interest in futures closed the fourth quarter at 48 million.
- The total trading volume of RGGI futures was 78.6 million CO₂ allowances in the fourth quarter of 2016, up nearly 200 percent from the previous quarter. However, this was down 17 percent from the fourth quarter of 2015, indicating a reduction in secondary market activity from last year.
- At the end of the fourth quarter of 2016:
 - ✓ There were 234 million CO₂ allowances in circulation.
 - ✓ Compliance-oriented entities held approximately 142 million of the allowances in circulation (61 percent).
 - ✓ Approximately 144 million of the allowances in circulation (62 percent) are believed to be held for compliance purposes.

Volume of CO₂ Allowance Transfers, Futures, and Options

Figure 3 summarizes the volume of transfers of CO₂ allowances between the COATS accounts of unaffiliated firms and the volume of trading of RGGI futures listed on ICE. The figure also shows the volume of transfers in the fourth quarter of 2016 compared to the previous quarter and

to the fourth quarter of 2015.⁷ The volume of futures trading and transfers of CO₂ allowances for each control period are shown together because all CO₂ allowances are essentially interchangeable for compliance purposes.

**Figure 3: Volume of CO₂ Allowance Transfers Between Unaffiliated Parties⁸
October 1 to December 31, 2016**



Key observations regarding the volume of transfers of CO₂ allowances in COATS between unaffiliated firms:

- The total volume of CO₂ allowance transfers between unaffiliated firms was 55.4 million, up nearly 600 percent from the previous quarter and almost exactly equal to the fourth quarter of 2015.

Key observations regarding the volume of trading of RGGI futures and options contracts:

⁷ Firms are categorized as affiliated based on available information. As a result, calculations provided in previous reports may be inconsistent with results in this report when new information becomes available.

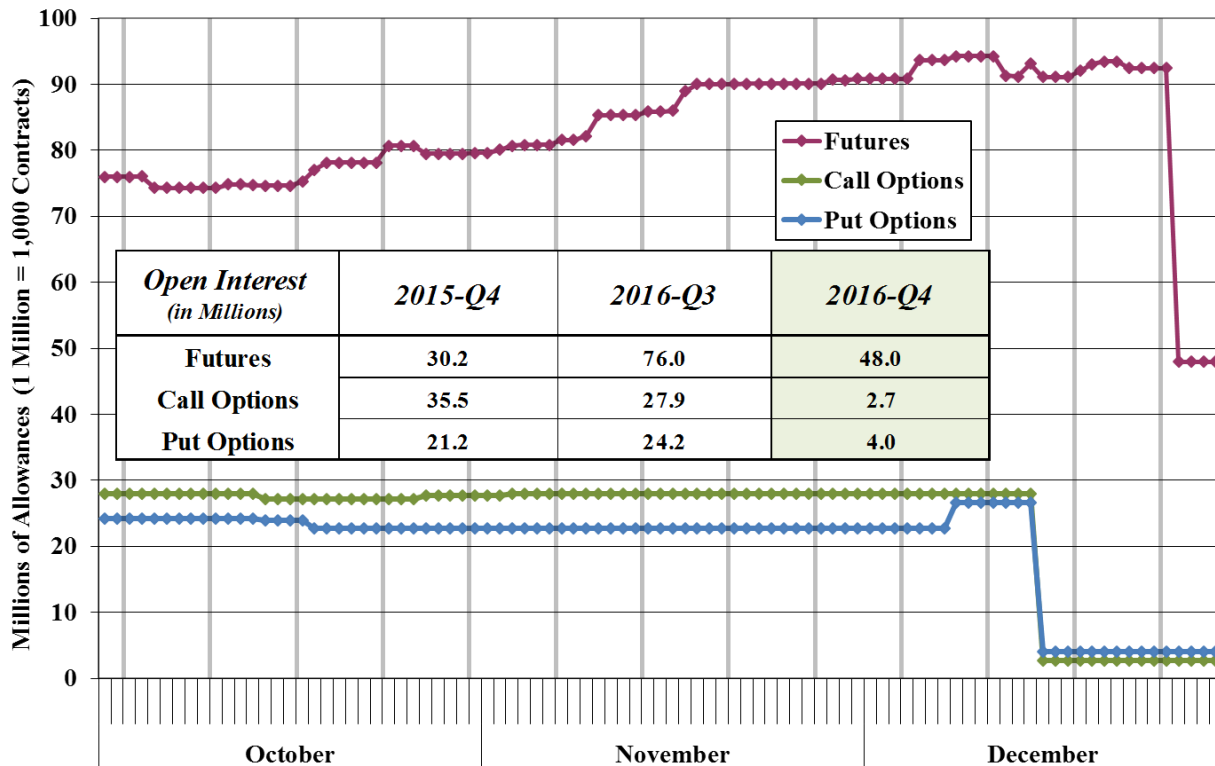
⁸ Source: CO₂ allowance transfers are based on information in COATS.

- The total volume of RGGI futures listed on ICE was 78.6 million CO₂ allowances in the fourth quarter of 2016, up nearly 200 percent from the previous quarter. However, this was down 17 percent from the fourth quarter of 2015.
- Approximately 52 percent of the futures trading volume listed on ICE during the fourth quarter of 2016 was for contracts that settled during the quarter. An additional 35 percent of the volume of trading was for contracts that will settle in December 2017.
- The total volume of options traded in the fourth quarter of 2016 was nearly 7 million CO₂ allowances, which was an increase from the previous quarter.

Open Interest in Exchange-Traded RGGI Futures and Options

Figure 4 summarizes the level of open interest in exchange-traded futures and options listed on the ICE during the fourth quarter of 2016. The red line shows the level of open interest in futures contracts. The green line shows the level of open interest in call options. The blue line shows the level of open interest in put options.

**Figure 4: Open Interest in RGGI Futures and Options
October 1 to December 31, 2016**



Key observations regarding the level of open interest in RGGI futures and options:

- The total open interest in RGGI futures rose steadily from nearly 75 million allowances at the end of the third quarter of 2016 to over 90 million allowances in mid-December before nearly half of all futures contracts reached their closing date. Open interest in futures closed the fourth quarter at 48 million.
- The open interest in RGGI call options decreased 91 percent from 27.9 million at the end of the third quarter of 2016 to 2.7 million in mid-December. Open interest in call options remained at this level to close out the fourth quarter.
- The open interest in RGGI put options decreased similarly to the call options, dropping by 83 percent from the beginning to the end the fourth quarter of 2016.
- Overall, the level of open interest across RGGI options products dropped considerably compared to previous quarters, although the decrease in futures is comparable to previous fourth quarters.

Concentration of Open Interest

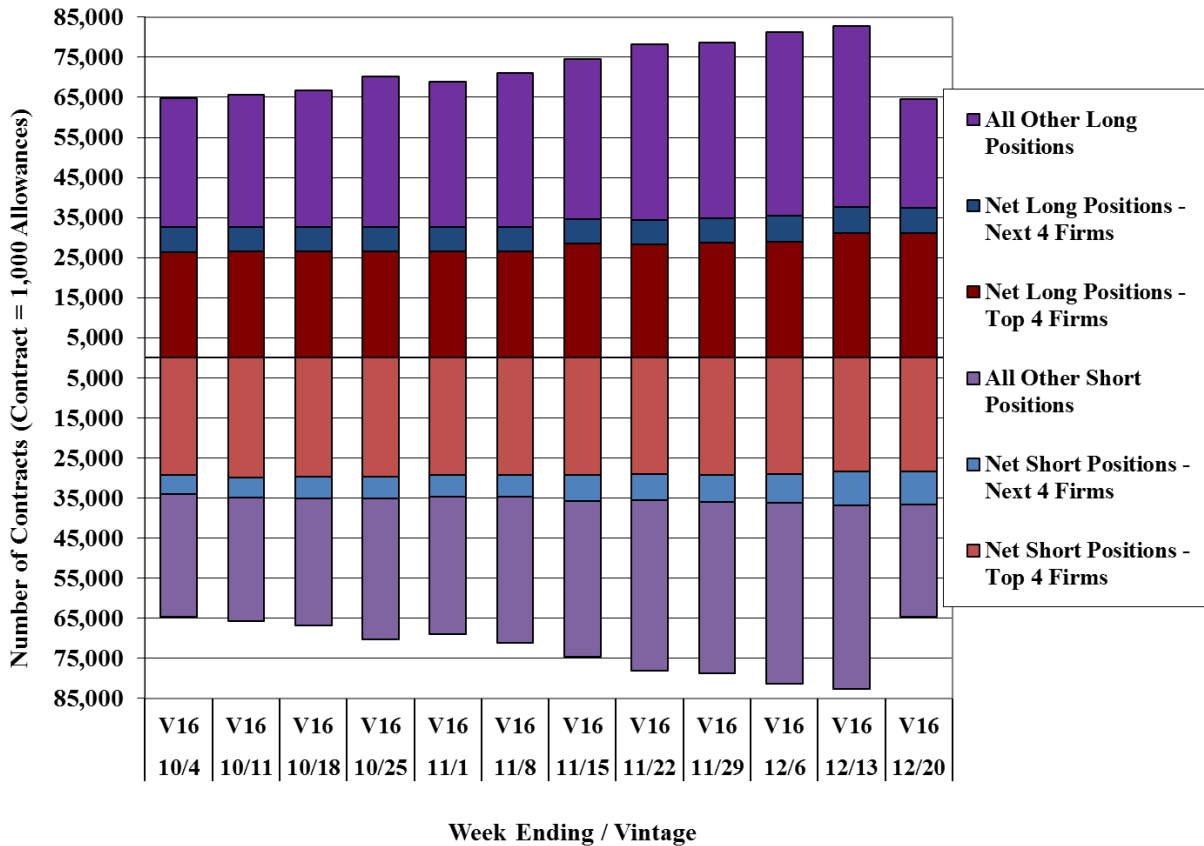
Additional information about the trading of futures, forwards, and options is available in the weekly Commitments of Traders (“COT”) reports, which are published by the Commodity Futures Trading Commission (“CFTC”)^{9,10} for each week when greater than 20 firms have reportable positions in a particular product.

Figure 5 summarizes the concentration of open interest in 2016 vintage ICE futures and options contracts. The figure reports the net long positions in three categories: (i) the four firms with the largest long positions (see “Top 4 Firms”), (ii) the four firms with the largest long positions not including the Top 4 (see “Next 4 Firms”), and (iii) all other long positions. The figure also reports the net short positions in three categories: (i) the four firms with the largest short positions (see “Top 4 Firms”), (ii) the four firms with the largest short positions not including the Top 4 (see “Next 4 Firms”), and (iii) all other short positions.

⁹ Each day, firms with an open interest of 25 contracts or more are required to report their positions to the CFTC. The CFTC categorizes each firm as Commercial if it engages in trading primarily to supply its own need for allowances or Non-Commercial if it trades for another purpose. Hence, compliance entities are generally designated as Commercial and other entities are frequently designated as Non-Commercial. Each Tuesday, the CFTC issues the COT report, which is a summary of the long and short positions of participants in the market.

¹⁰ The CFTC does not publish information from the COT reports for weeks when fewer than 20 firms have reportable positions in a given product, which is why no information is shown for any vintage contract other than 2016 (each vintage is reported separately).

**Figure 5: Concentration of Open Interest in CCFE Futures and Options¹¹
October 1 to December 31, 2016**



Observations regarding the concentration of open interest:

- Many firms have open interest in RGGI CO₂ allowance futures and options, although a small number of firms account for large shares of the net long and short positions in 2016 vintage contracts.
 - ✓ The “Top Four” Firms accounted for an average of 39 percent of the total net long positions for the weeks shown during the quarter, while 47 percent of the total net long positions were held by eight firms.
 - ✓ The “Top Four” Firms accounted for an average of 40 percent of the total net short positions for the weeks shown during the quarter, while 49 percent of the total net short positions were held by eight firms.

¹¹ Source: The CFTC’s Commitment of Traders reports which are available at [“www.cftc.gov/MarketReports/CommitmentsofTraders/HistoricalCompressed/index.htm”](http://www.cftc.gov/MarketReports/CommitmentsofTraders/HistoricalCompressed/index.htm).

- ✓ These results suggest that many firms have significant spreading positions (i.e., combinations of long and short positions of equal magnitude with different expiration dates).
- The CFTC does not publish firm-level information on open interest, although the information they publish provides an indication of the upper limits of the net long and net short positions of individual firms. Combined with firm-specific information about CO₂ allowance holdings from COATS, the information on open interest that is published by the CFTC is useful for evaluating the potential for a firm to hoard RGGI CO₂ allowances, which is discussed further in Section E.

E. DISCUSSION OF MARKET MONITORING

As the RGGI Market Monitor, we monitor trading in the secondary CO₂ allowance market in order to identify anticompetitive conduct. Additionally, the Commodity Futures Trading Commission (“CFTC”) evaluates trading in the secondary CO₂ allowance market consistent with its role as the regulator of derivative markets in the U.S. This section discusses two types of anti-competitive conduct for which we monitor. As in previous reports on the secondary market, we find no evidence of anti-competitive conduct.

In any commodity market, one potential concern is that a firm could hoard a substantial share of the supply of a commodity to influence prices or to prevent a competitor from obtaining CO₂ allowances. Hence, we screen information on the holdings of CO₂ allowances and allowance-derivatives and the demand for allowances to identify firms that might acquire a position that raises competitive concerns. The ability of an individual firm to hoard is limited by the substantial private bank of CO₂ allowances that has been accumulated and also by the market rules, particularly the auction rules that limit the amount of allowances that can be purchased by a single party or group of affiliated parties in a single offering to 25 percent.

Another potential concern is that a firm expecting to purchase CO₂ allowances in the auction might sell a large number of futures contracts in an effort to push the price of the contracts below the competitive level. Such a firm might profit from buying a large number of CO₂ allowances in the auction at a discount if the bidding in the auction were influenced by the depressed futures price. For this to be a profitable strategy, the firm would need to be able to substantially depress the futures price with a relatively small amount of sales—an amount smaller than the amount of CO₂ allowances it planned to buy in the auction. The best protection against this strategy is a market where other firms respond by making additional purchases. Firms that are looking for an opportunity to reduce their short positions or to purchase CO₂ allowances for their future compliance needs help limit the effectiveness of a strategy to depress prices below the competitive level. Nevertheless, the CFTC has access to confidential transaction data, which allows it to monitor for evidence of manipulative conduct.