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CARBON CREDIT MARKETS

There are many who still do not believe that global warming is a problem at all. And it's no wonder: because they are the targets of a massive and well-organized campaign of disinformation lavishly funded by polluters who are determined to prevent any action to reduce the greenhouse gas[1] *emissions that cause global warming out of a fear that their profits might be affected if they had to stop dumping so much pollution into the atmosphere.*[2]

—Al Gore

Introduction

Since the late 1970s, trading rights have been used to control pollution. Under emissions trading programs, parties who could not cut their emissions below the allowed amount had to buy rights from parties who had. Emissions trading was introduced under the Kyoto Protocol on December 11, 1997 to reduce greenhouse gases in the atmosphere because global warming was increasingly becoming a severe problem. For help in understanding emissions trading terminology in greater detail in this note, a glossary is provided in **Appendix A**. Below are the topics that will be discussed in detail:

- Emissions trading approaches
- Regulatory framework (Kyoto Protocol) and two key mechanisms of carbon credit creation
  - Clean development mechanism (CDM)
  - Joint implementation (JI)

[1] Greenhouse gases (GHGs) are the gases present in the earth's atmosphere (e.g., water vapor, carbon dioxide, methane, etc.) that warm near-surface global temperatures through the greenhouse effect.

[2] http://www.woopidoo.com/business_quotes/global-warming.htm, (accessed October 24, 2008).

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- Carbon credit creation and trade (in such markets as OTC and organized exchanges such as the Chicago Climate Exchange)
- Carbon market investors (carbon funds) and established carbon indices
- Recent developments in U.S. carbon markets such as the Regional Greenhouse Gas Initiative and the Western Climate Initiative
- Investment considerations and factors affecting pricing in carbon markets

Suppose there are two firms, X and Y that are polluting the atmosphere in a country/economy. If the country wants to decrease its overall level of pollution, it can mandate that *both* firms reduce the amount of pollutants they emit into the atmosphere. It's easy in theory, but in reality the cost of emissions reduction might differ markedly for these two firms. Firm X might be able to reduce its emissions at a much lower cost than firm Y. The difference in this cost of emissions reduction creates a market opportunity: the firms could reduce the same amount of total emissions at a lower cost if firm X reduces more than what it has to and sells its extra reduction units (amount of emissions reduced over its required level) to firm Y at a cost lower than the cost of emissions reduction for firm Y. Firm X will gain because of the difference between the cost of emissions reduction for firm X and firm Y. Firm Y will also gain for the same reason.[3] This simple principle is the basis of emissions trading.

The United States implemented the emissions-trading program for the first time in 1976 under the Clean Air Act. Generic mono-nitrogen oxides (NO_x) and sulfur-dioxide (SO_2) trading programs were introduced, based on cap-and-trade, to combat acid rain and ozone depletion. Under this act, existing sources of pollution (firms) were encouraged to reduce their emissions below the legal requirements (the cap) set by the regulatory body. They were awarded *emissions reduction units,* credits that could be traded or transferred internally to other sources.

In the following sections, common forms of emissions trading and their various components are examined. The dynamics of the emissions market and the role of the different players in the market will also be investigated.

Emissions Trading Approaches

There are three basic approaches of emissions trading: cap-and-trade, baseline-and-credit, and offset.

[3] For example, if the cost for firm X is $20 per unit and $30 for firm Y, then X can sell the extra units at $25 to Y; X pockets the difference ($20–$25), and Y also reduces its costs of emissions reduction from $30 per unit to $25, so it also profits from the trade.

Cap-and-trade

Under this program, regulatory bodies establish a cap on the aggregate level of emissions permitted in a jurisdiction called an *emissions cap*. The participants in the program receive credits distributed (sometimes given, sometimes purchased through auction) by the regulatory authorities, which correspond to the amount of pollution (defined as the number of tons of pollutants in a year) that they are expected/allowed to emit within one year. If they exceed the cap, they have to buy credits from other participants who have excess credits (i.e., they have polluted less than their allowance). Hence, total pollution is limited to a total amount (cap) and trading allows for an efficient allocation of pollution as those participants who can reduce emissions in a cost-effective way will do so and benefit from trading with those who cannot.

A simple example explains this concept. There are two power plants. Plant A emits 100 tons of CO_2, and plant B emits 200 tons of CO_2, so emissions total is 300 tons. Then the regulatory authorities put the cap at 210 tons of CO_2 in total (30% reduction). As a result, both plants have to decrease pollution by 30%. Plant A can emit only 70 tons of CO_2, and plant B can emit only 140 tons of CO_2. The cost of reduction of one ton of CO_2 for plant A is \$20 (for the first 30 units of emissions) and \$50 for plant B (for the first 60 units). If plants A and B reduce pollution *separately*, the total cost to reduce emissions to 210 tons in the aggregate will be \$3600 [(\$20 × 30) + (\$50 × 60)].

Under a cap-and-trade system, each plant seeks out the most cost-effective way to reduce emissions. Initially, plant A is able to reduce its emissions at a lower cost than plant B, so it can sell permits to plant B; however, the more plant A reduces its emissions, the more expensive it becomes to make further cuts. Eventually, both plants reach a point where their costs to reduce an additional ton of pollution are equal. In this scenario, suppose that plant A could reduce 60 tons of CO_2 at \$20, and plant B could reduce 30 tons at \$50, implying that the total cost to reduce total emissions to 210 tons would be \$2700 [(\$20 × 60) + (\$50 × 30)]. Therefore, cap-and-trade reduces the overall cost of emissions reduction. Plant A can then sell its extra 30 units to plant B at a cost between \$20 and \$50 and profit from this extra emissions reduction. Plant B also benefits, as the cost of reducing its emissions would now be lower than \$50 for part of its emissions.

The design of a cap-and-trade program could affect the ability of renewable energy to actually reduce CO_2 emissions in a given system. Existing renewable-energy generation must be accounted for when calculating the cap level (or through the gradual retirement of carbon allowances) in order to reduce overall CO_2 emissions levels. For example, if a new wind farm offsets some coal-fired-power production and this wind-generation capacity is not accounted for in the cap, the coal-fired plant could sell some allowances (no longer needed because wind would have replaced a portion of its production) to another coal plant, and this coal plant could raise CO_2 emissions.

Two major concerns surrounding the entire emissions-credit marketplace are *validity* and *lifespan*. Because credits are paperless commodities that electronically represent a physical

substance (e.g., CO_2), they are vulnerable to misrepresentation and fraud, so numerous verification organizations must certify that credits serve their purpose as a carbon credit or offset (UNFCCC, Gold Standard, etc.). Additionally, credit registries such as Climate Exchange track the lifespan of outstanding credits so that retired credits are not resold; otherwise, a given credit could potentially be resold numerous times, negating its emissions-reduction benefit.

In July 2008, the Offset Quality Initiative (OQI) released an influential white paper[4] detailing policy recommendations for the design of a greenhouse-gases (GHG) offset program in U.S. cap-and-trade schemes. The offset design principles and recommendations of OQI for cap-and-trade programs include the following:

1. Environmental integrity—ensure offsets achieve real, measurable GHG emissions reductions;
2. Additionality—ensure offsets are above and beyond what reductions would have been anyway (i.e., require additional effort from the entity);
3. Coverage—programs should cover all six GHG classes and multiple industries;
4. Geographic—programs should not restrict geographic source of offset;
5. Crediting—establish reasonable, conservative crediting periods; and
6. A system of links—programs should be designed to be compatible with other, integral offset regimes.

Although verifications and registries are helping to combat fraudulent carbon trading, retirement policies differ in each market, and these risks remain a major threat to both the price of carbon and the legitimacy of the entire emissions-trading concept.

Baseline-and-credit

Under this program, the regulator assigns an emissions output baseline for all polluters, then compares expected and actual emissions. Polluters who emit below their baseline level receive credits, while polluters who emit above their baseline levels must purchase credits. These credits can then be traded.

Suppose a coal-fired power plant emits 100 grams of CO_2 for every kilowatt of electricity it produces and that it expects to produce 100,000 kilowatts of electricity in the first year (i.e., 10,000 kilograms [10 tons] of CO_2 total emission for the year). If actual plant emissions are only 9,000 kilogram (9 tons) of CO_2, the plant will get 1 credit (1 credit = 1 ton of CO_2 = 1000 kilograms of CO_2). The following year, the plant expects to produce 200,000 kilowatts of electricity and emit 20 tons of CO_2 (20,000 kilograms of CO_2). If the plant actually emits only 19.5 tons of CO_2, then the plant will get 0.5 credits.

[4] Offset Quality Initiative (July 2008), "Ensuring Offset Quality: Integrating High Quality Greenhouse Gas Offsets into Cap-and-Trade Policy," white paper.

Thus, in the baseline-and-credit system, the baseline level of emissions is fixed (i.e., there is an *implicit* cap, equal to the total of the baseline emissions). In contrast, in the cap-and-trade system there is an *explicit* cap at the aggregate level. The number of credits awarded or needed depends on the difference between the expected and actual levels of emission. Theoretically, cap-and-trade and baseline-and-credit are equivalent systems, if the implicit cap in the baseline-and-credit system is fixed and equal to the fixed cap in the cap-and-trade system; however, the implicit cap can vary with the level of aggregate output, which would make the two plans very different.[5] There are also some institutional differences in the two systems. In the baseline-and-credit system, credits are often given on a project-by-project basis rather than based on firm-wide emissions. Also, credits must be certified and registered before they can be traded, and credits are not tradable until the actual emissions reduction has occurred and been verified.[6]

Offset

A *carbon offset* is another type of commodity that represents the *reduction* of one metric ton of carbon-dioxide equivalent (CO_2) by a qualifying carbon-reduction project. The offset may or may not represent the actual reduction of CO_2 emissions. In theory, an offset represents an activity that prevents or compensates for (offsets) the emission of one ton of actual CO_2. Examples of offset projects include renewable-power generation, energy efficiency projects, and forestry and industrial-waste remediation. There are a variety of governing bodies and certifications that attempt to ensure offsets are real and accounted for properly.

A *renewable energy certificate* (REC) can be a type of carbon offset but is a different commodity altogether. A REC represents a claim that one megawatt-hour (MWh) of electricity was produced using an approved renewable energy resource. RECs can be converted into carbon offsets, usually by proving the renewable energy generated is actually offsetting an equivalent amount of carbon-based electricity production that would have been produced elsewhere on the grid (e.g., one MWh of power created in a hydroelectric dam that reduces demand for one MWh that would be otherwise generated from burning coal). In this case, RECs measured in MWhs are converted to tons of CO_2 equivalent (CO_2e).

Below we describe milestone activities that led to the development of emissions trading for greenhouse gases.

[5] A recent academic paper that constructs a computerized experiment of the two systems finds supporting evidence of the theoretical prediction that aggregate output and emissions are inefficiently high under a baseline-and-credit trading plan compared to a corresponding cap-and-trading plan (N. Buckley, S. Mestelman, and R. A. Muller, "Baseline-and-Credit Emission Permit Trading: Experimental Evidence under Variable Output Capacity," (2005) working paper, McMaster University).

[6] Buckley et al.

Kyoto Protocol

More than a decade ago, most countries joined an international treaty, the United Nations Framework Convention on Climate Change (UNFCCC) to consider the alternative steps needed to reduce global warming. A number of nations approved a treaty, the Kyoto Protocol adopted in Kyoto, Japan, on December 11, 1997. It set binding targets for 37 industrialized countries and the European Union to reduce greenhouse gas (GHG) emissions. Under the Kyoto Protocol, some countries agreed to collectively reduce emissions by 5% below 1990 levels for the years 2008–12. These countries have to meet their targets by taking steps internally (i.e., by reducing their emissions total), and the Kyoto Protocol offered them additional means of meeting their targets via three market-based mechanisms.

- Emissions trading (also called carbon market)
- Clean development mechanism (CDM)
- Joint implementation (JI)

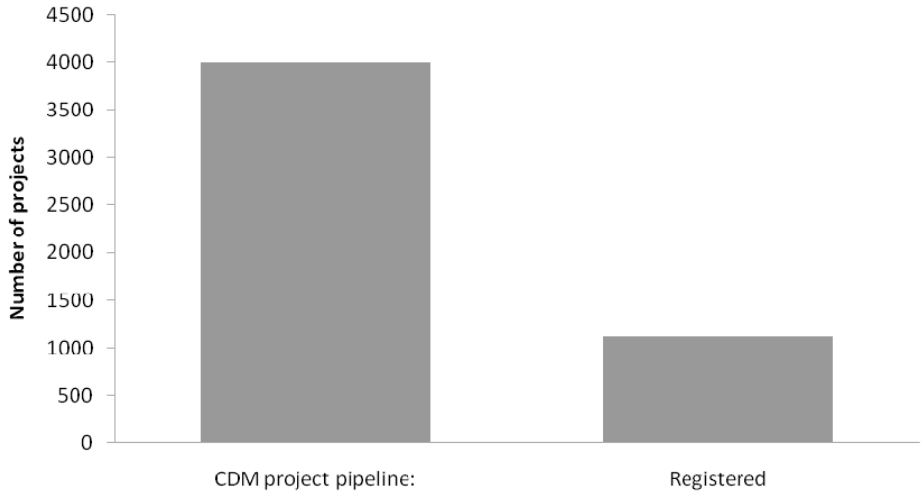
Industrialized countries involved in the Kyoto Protocol were identified as Annex I countries (**Appendix A**). Annex I countries accepted specific targets to reduce their emissions assigned by the Kyoto Protocol. These targets were expressed as levels of allowed emissions or *assigned amounts* during the 2008–12 commitment period. The allowed emissions were divided into *assigned amount units* (AAUs) and assigned to each country, which could only emit up to its total AAU level. A similar trade can occur between countries who emit less and those who emit more than the predetermined targets. Each unit or credit of AAU is one ton of CO_2. The market considers each unit emission reduction—or one ton of CO_2—as a new commodity. Two different methods of production of carbon credits are the clean development mechanism (CDM) and the joint implementation (JI).

Clean Development Mechanism

CDM is a mechanism under which *industrialized* countries (Annex I) can meet their emissions-reduction commitments by implementing emissions-reduction projects in *developing* countries. Such projects can earn certified-emissions-reduction credits (CERs), with each equivalent to one ton of CO_2 that can be counted toward meeting Kyoto targets. For example, in a developing country, a rural electrification project that uses solar panels, or a project that provides installation of more energy-efficient boilers potentially could qualify.

As of July 23, 2008, 1,128 projects were registered by the CDM executive board as CDM projects (**Figure 1**). These projects reduced greenhouse gas emissions by an estimated 220-million tons of CO_2 equivalent per year. In the pipeline until the end of 2012 are about 4,000 projects that will produce more than 2.5 billion tons of (CO_2e) reductions (**Figure 1**).

Figure 1. Statistics of CDM projects.

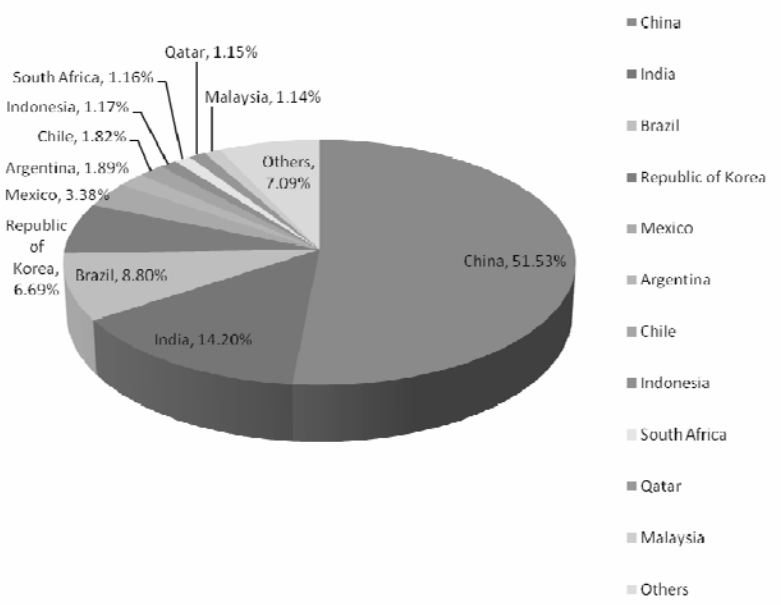


Data source: http://cdm.unfccc.int/Statistics/index.html.

Registration of CERs

Nearly 75% of all the projects being registered are in China, India, and Brazil. The following pie chart (**Figure 2**) shows the share of CDM projects in different developing countries.

Figure 2. Breakdown of CDM projects across developing countries.



Data source: http://cdm.unfccc.int/Statistics/index.html.

Joint Implementation

JI is one more mechanism that allows an Annex I country that must reduce emissions to earn *emissions-reduction units* (ERUs) equivalent to one ton of CO_2 by establishing an emissions-reduction project in another Annex I country. The country where the emissions-reduction project is set up benefits from both the investment and the knowledge transfer.

Creation of CER Credits

As shown in **Figure 3**, CER credits can be created by individual firms that need emissions credits or by firms such as EcoSecurities PLC[7] Group that specialize in creating and subsequently selling emissions credits. CER creation starts when a firm sponsors a project, such as an emissions-reduction project in a developing country, and submits it to that country for approval, upon which the firm provides a project-design document with details, guidelines, and analysis. Consideration is given, among other things, to the net reduction in emissions and to the net present value (NPV) of the project. If the project passes from an economic standpoint, then it is registered with the CDM executive board.

The executive board reviews the project and passes it on for validation by the Designated Operational Identity (DOE)—a third-party verification and validation company, accredited by the United Nations Framework Convention on Climate Change (UNFCCC)—and approval by the Designated National Authority (DNA)—an agency identified by the CDM Kyoto Protocol process in the host country. The entire process of identification, verification, and approval takes approximately six to ten months. Finally, the project is registered as a CDM project. Following this, verification and certification occurs every one to three years, and CERs are issued.

Figure 3. The CER creation process.

		Example
1	**Project identification**	Reduction of methane from mine in China
2	**Host country approval**	China approves the project
3	**Project design**	Benefits to society NPV etc. calculations Implementation planning
4	**Validation**	DOE validates the project document
5	**Registration**	Project is registered with UN CDM Executive board
6	**Issue CERs**	CERs are issued and compared with original project documents
7	**Verification and certification**	CDM executive board verifies the CER

Data source: http://64.233.169.104/search?q=cache:lIOgML0rl-AJ:siteresources.worldbank.org/INTRUSSIANFEDERATION/Resources/Fortis_eng.ppt+cdm+project+fortis&hl=en&ct=clnk&cd=1&gl=us and case writer.

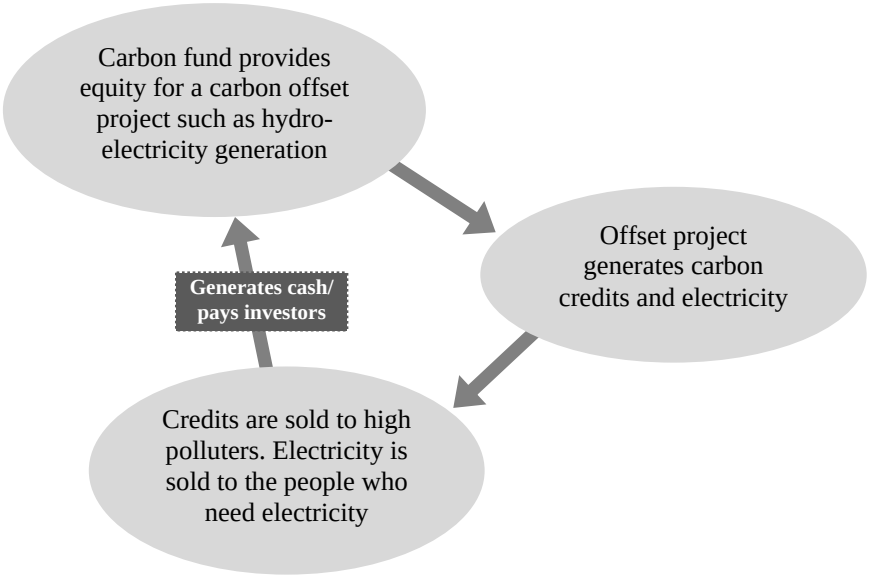
[7] See http://www.ecosecurities.com.

As they have become increasingly important in offsetting emissions, these carbon credits, commonly called *carbon assets*, have attracted many firms who are active in carbon-procurement.

Carbon-Procurement Vehicles

Carbon-procurement vehicles, normally referred to as *carbon funds*, are pools of public or private capital reserved to secure carbon credits through alternative mechanisms under the Kyoto Protocol. These assets (credits) can be used for compliance (when a company needs to buy credits to offset its emissions) or for capital gains (when a company buys and sells credits as part of a trading strategy). Of the many players in the carbon-finance area, the more active have divisions devoted to investing in projects to secure credits either for their own use or for capital gains. Also, firms such as EcoSecurities develop projects and sell acquired credits to clients directly through organized exchanges and OTC markets. **Figure 4** shows the role of carbon funds in the carbon markets.

Figure 4. The role of carbon funds in the carbon markets.



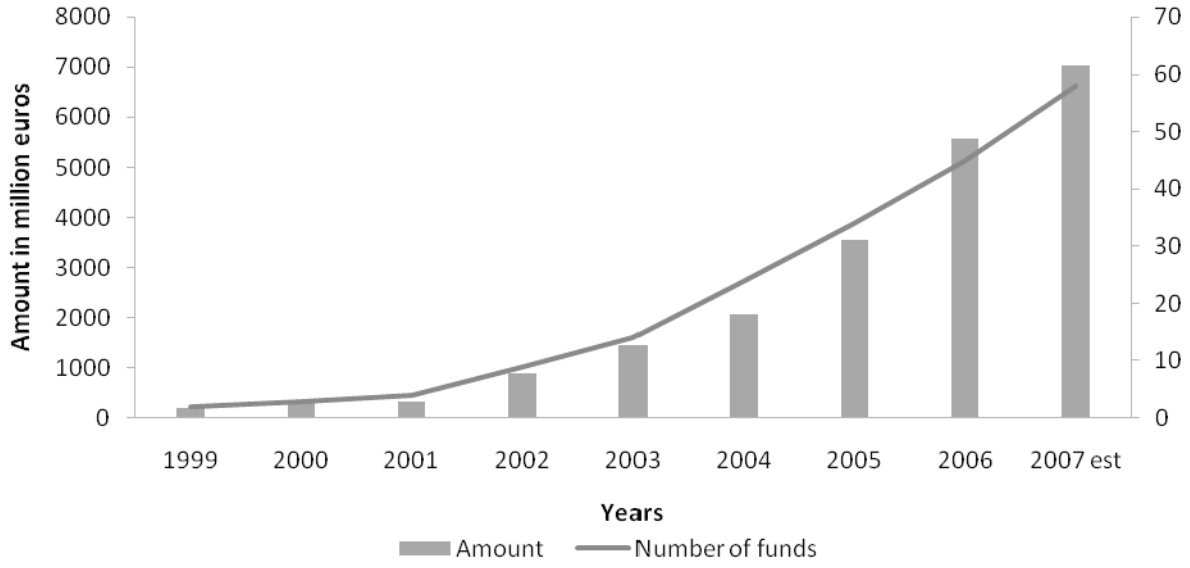
Source: Created by case writer.

Carbon Funds

Examples of carbon funds include the European Carbon Fund and the World Bank Fund. The European Carbon Fund is a carbon fund for capital gains launched jointly in 2005 by the Caisse des Dépôts and Fortis Bank, to be managed by Natixis Environment & Infrastructures. The fund has secured EUR142.7 million in capital from 14 large financial institutions. It invests in CDM and JI projects eligible under the European Union Linking Directive Process through the use of future contracts with project developers.

The World Bank created a prototype fund in 1999 to create carbon assets. This fund used many innovative methods to create and secure carbon credits. Projects generally included clean power (renewables), clean transport (biofuels), and clean water (desalination, treatment, efficiency solutions). Since 2003, more than 10 funds have been created annually, and since 2004, more than 1 billion euros have been added to the total capital pool each year. By October 2007, there were approximately 58 funds in the sector. **Figure 5** shows the evolution of carbon funds.

Figure 5. Evolution of carbon funds.



Data source: http://www.caissedesdepots.fr/IMG/pdf_07-11_Mission_Climat_Research_Report_12_Carbon_Investment_ Funds-2.pdf.

CER Trading

From the time carbon trading was initiated in Europe, trading volumes and underlying asset values have grown considerably. The global carbon market has already jumped from EUR9

billion in 2005 to EUR23 billion in 2006 and is expected to be worth EUR100 billion by 2020.[8] If the United States ratifies the Kyoto Protocol, the carbon market potentially could reach EUR2.1 trillion in 2020.[9] There are two main mechanisms for trading these credits: the over-the-counter (OTC) market and organized exchanges.

OTC market

The OTC market is nearly 72% of the entire CER trading market.[10] There are a few alternative ways to participate in the OTC emissions-trading market, which includes bilateral transactions (trades transacted through brokers) and allowances purchased in the annual allowance auction. Bilateral trading is a relationship-based approach and is used by investors who have extensive contacts in emissions markets. These investors are providing liquidity to the market. Emission traders interested only in facilitating trades can act as brokers. The annual allowance auction was started by the Chicago Board of Trade under the Clean Air Act.

Organized exchanges

Currently, there are several exchanges around the world facilitating emissions trading, including the Chicago Climate Exchange (CCX) (**Table 1**) and the Europe Climate Exchange (ECX). The commodity traded at CCX is the CFI contract, each of which represents 100 metric tons of CO_2 equivalents. CFI contracts are composed of ECX allowances and offsets. ECX allowances are issued to emitting members in accordance with their emission baselines and the CCX emission-reduction schedule. Liquidity in the CCX market is generally created by GHG-emitting CCX members signing a commitment to cap annual emissions of various GHGs at a given level. Members whose emissions fall below the cap level earn surplus credits, which can then be held (*banked*) or traded. Members who fail to meet cap levels in a given year must purchase CFIs to account for the excess pollution emitted. During Phase I (launched in 2003), each member committed to reducing emissions by 1% annually below an established baseline from 2003 through 2006. In Phase II (launched in 2006), all members had to reduce emissions by 6% below their baselines by 2010. As of August 2008, CCX had traded 541,294 CFIs, representing a 237% volume growth compared to same period in 2007.

The *allowance-based* credits comprise the vast majority of the traded CFI volume on CCX; however, CCX also permits *offset-based* credits generated from qualifying emissions-reduction projects such as renewable energy generation and carbon sequestration. Offset-based credits are only permitted to be used to account for up to 4.5% of a member's emission-reduction efforts to meet its cap.

[8] http://www.carbon-financeonline.com/index.cfm?section=global&action=view&id=10841.
[9] http://findarticles.com/p/articles/mi_m0EIN/is_2008_May_22/ai_n25450757.
[10] http://www.carboncreditworld.net/emission.html.

CCX currently has nearly 300 members across multiple membership categories. In addition to the aforementioned GHG emitters, offset project providers and those looking to offset personal or corporate emissions, CCX offers the *Liquidity Provider* membership to "entities or individuals who trade on the CCX for purposes other than complying with CCX's emissions-reduction schedule." This membership opens the door for outside investors interested in trading CCX CFIs.

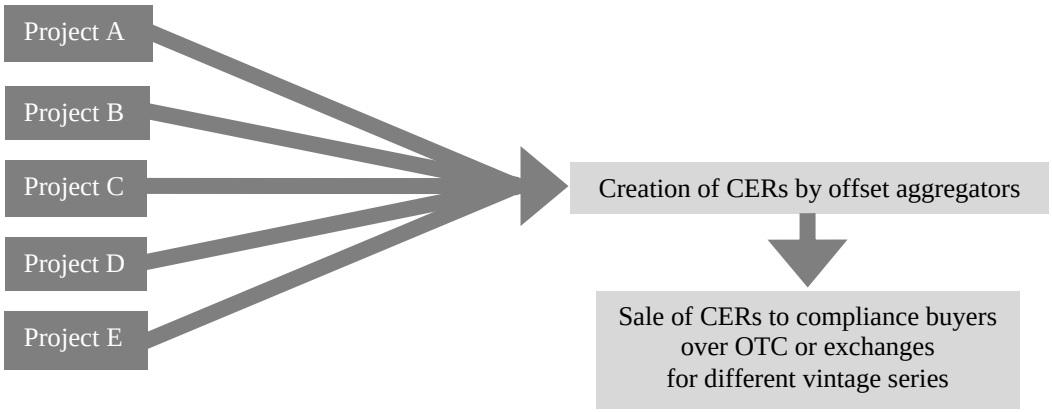
Table 1. Sample of a contract traded on CCX.

Product type	Cash product
Contract size	100 metric tons
Quotation	U.S. dollars
Minimum tick increment	$.05 per ton = $5.00 per contract
Symbol	CFI
Trading hours	8:30 a.m.–2:00 p.m. Central Standard Time
Products offered	Vintages for 2003–10
Transaction methods	Transaction participation eligibility is limited to CCX members who qualify as eligible commercial entities. CCX offers an Internet-based, electronic trading system for submission of bids and offers for anonymous, cleared agreements executed on price and time priority.
Deliverable instrument	CCX carbon financial instrument
Delivery process	All transactions are delivered through the CCX clearing system and held by the CCX registry on the trade day. Earlier dated vintages may be delivered against later vintage trades. Transactions (with exception of bilateral agreements) are cleared on trade day. Full-contract-value settlement occurs on the next business day. CCX substitutes as a counter party to all transactions and guarantees performances until settlement is completed.
Closing price	For each vintage, the closing price will be based on the following criteria: 1. The last transaction executed on the trading platform during a trading session. 2. If at the close the best bid is above the last trade price or the best offer is below the last trade price, then the closing price will be the best bid/best offer price. 3. If no trades occur in the trading session, the closing price is the previous day's closing price unless the best bid is above the previous day's closing price, or the best offer is below the previous day's closing price; then the closing price will be the best bid/best offer price.
Price limits	20% up and down from the previous trading day's last traded price

Data source: CCX and case writer.

The members at the exchange are firms who need CERs, offset aggregators, and offset providers (e.g., Rolls-Royce and American Electric Power). Offset aggregators are those who aggregate the portfolio of offsetting projects in different parts of the world and trade them (e.g., Carbon Farmers LLC, Carbon Green LLC, and EcoSecurities). The process of the creation and sale of CERs by offset aggregators is shown in **Figure 6**.

Figure 6. Process of CER creation by offset aggregators.



Source: Created by case writer.

Customized CER contracts can be sold on the OTC market, but standardized contracts can be traded on an exchange for different vintages (the year from which the contracts can be used for offsetting).

The prices of CER contracts have fluctuated significantly as shown in **Figure 7**. Because the market is not mature, and there is significant uncertainty related to its future (i.e., the future of the Kyoto agreement), there is significant volatility in CER prices.

Figure 7. Price series for 2003 vintage CER contracts (in dollars).

Data source: http://www.chicagoclimatex.com/market/data/summary.jsf.

Many investment banks and financial institutions have entered the carbon market to profit from its increasing size, and some of them have launched carbon indices to track the performance of the carbon market.

Carbon Indices

Carbon indices are important to asset managers, private banks, and institutional investors alike seeking a comprehensive benchmark for the rapidly growing carbon-emissions markets. Several institutions have launched different indices (e.g., Barclays Capital launched Barclays Capital Global Carbon Index [BGCI] in 2007). The BGCI tracks the performance of carbon credits associated with the world's most liquid greenhouse-gas credit schemes. The performance of the BGCI index is shown in **Figure 8**. Merrill Lynch launched the MLCX Global CO_2 Emissions Index. The weightings of the new MLCX Global CO_2 Emissions Index are based on the liquidity of the underlying assets.

On August 28, 2008, the Dow Jones Indices and CCX launched the Dow Jones/CCX European Carbon Index and the Dow Jones/CCX Certified Emissions Reduction (CER) Index. The indexes measure the synthetic spot prices for futures of European Union Allowances (EUAs) and CERs, respectively, both traded on the European Carbon Exchange (ECX). The development of these indexes suggests an increased interest in carbon as an asset class; they also add to the transparency of the carbon market. Additionally, this also opens the door for future ETF products derived from these indexes.

Figure 8. The performance of BGCI (in dollars).

Data source: https://ecommerce.barcap.com/indices/.

Recent Developments

Regional Greenhouse Gas Initiative

The Regional Greenhouse Gas Initiative (RGGI) is the first mandatory cap-and-trade system in the United States and is designed to reduce greenhouse-gas emissions stemming from the power-generation sector in 10 mid-Atlantic and northeastern U.S. states. RGGI became fully operational on January 1, 2009 and aims to reduce 10% of the CO_2 emitted in power generation by 2018. The 10% target is designed to be reached gradually in phases that allow generators to plan in order to avoid drastic consumer electricity price surges. RGGI allowances are primarily distributed through quarterly auctions in each participating state, and RGGI uses auction proceeds to develop clean-energy technology. Each power generator is required to hold allowances covering its CO_2 emissions. Outstanding allowances can be bought and sold through RGGI's Budget Trading Program, which allows power generators to trade allowances issued in any of the 10 states.

On September 29, 2008, RGGI held the first carbon-credit auction in the United States and sold all 12.5-million permits for $3.07 a ton. The relatively low price was anticipated because the RGGI cap of 188-million tons of carbon per year was actually higher than the 2007 emissions level.

Western Climate Initiative

Western Climate Initiative (WCI) is a group launched in 2007 that includes 11 western U.S. states and Canadian provinces. On September 23, 2008, WCI announced a cap-and-trade structure designed to cover 90% of the region's emissions and reduce GHG emissions by 15% from the 2005 level by 2020.

The WCI partners will begin reporting emissions in 2011. The first phase of the cap-and-trade program will begin on January 1, 2012. The second phase will begin in 2015, when the program is expanded to include transport fuels and residential, commercial, and industrial fuels not covered in the first phase. The second phase is more comprehensive than any major cap-and-trade program currently in existence.

The WCI will establish allowance budgets for each member (state or province) consistent with the size of the member's 2020 reduction goal. Unlike RGGI, which auctions in total, WCI members are only required to auction 10% of allowances per year (gradually increasing to 25%) and can choose to give away any of the 90% remaining. Although this flexibility is likely designed to ease the financial burden on WCI-regulated companies, this auction structure introduces additional price risk to WCI allowances.

Future Cap-and-Trade Landscape

In October 2007, the House Committee on Energy and Commerce released a white paper stating that the United States should reduce GHG emissions between 60% and 80% by 2050 and that the central program of a mandatory, economy-wide GHG reduction program should be a cap-and-trade program.

During the week of June 2, 2008, the Lieberman-Warner Climate Security Act became the first GHG cap-and-trade bill to reach the Senate floor via regular order. The bill was rejected, yet it is clear that emissions reduction is a hot issue, and the U.S. political climate is warming rapidly to the notion of a mandatory, economy-wide cap-and-trade system.

Investment considerations

In April 2008, the Pew Center on Global Climate Change released a study of different model scenarios of the economic impact related to the Lieberman-Warner Bill. Although long-term, large-scale modeling is clearly filled with uncertainty, the findings are interesting and particularly relevant in examining the future of carbon-market asset prices.

- The more offsets included in a program, the lower the costs. The availability of offsets is the most important driver of carbon-allowance pricing in many model scenarios. The Lieberman-Warner Bill currently calls for a 30% offset allowance. When the EPA conducted a sensitivity analysis of the size of the offset allowance, the results were dramatic. For example, a 15% offset allowance increased the price of carbon allowances 34% compared to the Lieberman-Warner Bill baseline. When the scenario was modeled with 0% offsets, the price of carbon allowances rose 93%.
- Flexibility in the timing of GHG reductions through such approaches as banking and borrowing keeps costs down over time because companies have additional flexibility in planning to meet requirements. Banking increases allowance prices in the short term because holders tend to hoard in anticipation of higher future prices.
- Some sectors provide greater opportunities for reductions than others in the short term. In the near term, it appears that the “lowest hanging fruit” is the electric-power-generation sector and the switch from coal to natural gas. As carbon allowances are expanded to additional sectors (industrial manufacturing, etc.), all else being equal, demand for credits and prices will increase.

Risks

Although investing in emissions credits is increasingly popular as new markets and controls are established, carbon markets do have unique risks that may not be present in more mainstream commodity markets. The following processes involve carbon-market-specific risks:

- Creating new credits in different cap-and-trade markets;

- Getting administrative and regulatory approval of qualifying emissions-reduction projects;
- Obtaining accurate verification of new emissions-credits/multiple validation projects; and
- Determining that a carbon offset project would not have been completed without purchase of offset (additionality).

There are many factors that could potentially affect the price of carbon credits (including the uncertainty surrounding the Kyoto Protocol); **Table 2** provides an abbreviated list of some important factors and the rationale behind their impact.

Investment in carbon markets is currently facing significant uncertainty risk, yet the potential emergence of a mandatory federal cap-and-trade scheme in the United States has generated strong interest in the asset class. After better standards and oversight are established, new investment vehicles and liquidity will pave the way for investor participation in these emerging financial markets.

Table 2. Potential factors affecting carbon prices.

Risk Factor	Effect on Emissions Credit Prices	Rationale
Higher price of fossil fuels	Up	Higher oil prices correspond with higher natural gas prices; electricity providers substitute coal for natural gas as fuel.
Lower cap level	Up	Emitters are forced to constrain emissions; increased demand for credits.
Banking	Short term: up	Participants are allowed to carry credits forward to future years; decreases supply of credits in market.
	Long term: down	Participants can hold credits for future obligations rather than initiating expensive carbon-reduction projects in a given year.
Allowance of offset credits in cap-and-trade schemes	Down	Increases supply of potential qualifying credits; offset project credits are likely less expensive than scheme-specific credits.
Allowance of REC in cap-and-trade	Down	Increases supply of potential qualifying credits; offset project credits are likely less expensive than scheme-specific credits
Retirement of credits	Up	Retiring (cancelling) “redeemed” emissions credits means that they cannot be reused, so the supply of credits is reduced in a given emissions-reduction program.

Appendix A

Glossary

Annex I countries
Developed countries that under the Kyoto Protocol have accepted greenhouse-gas-emissions reduction obligations and must submit to an annual greenhouse-gas inventory.

Assigned Amount Unit
Allowances issued to Annex I countries, which have a cap on their emissions under the Kyoto Protocol. Each AAU grants the country the right to emit one ton of greenhouse gases during a commitment period.

Baseline
Under a business-as-usual scenario, emissions are forecasted. This is also called a baseline scenario.

Certified Emission Reduction
Carbon credits that arise from Clean Development Mechanism projects, with one CER awarded for a reduction in greenhouse gas emissions equivalent in impact to one ton of carbon dioxide.

Clean Development Mechanism
An arrangement under the Kyoto Protocol allowing industrialized countries (Annex I countries) with a greenhouse gas reduction commitment to invest in projects that reduce emissions in developing countries (non-Annex I countries) as an alternative to more expensive emission reductions in their own countries.

Designated Operational Entity
A legal entity accredited by the CDM Executive Board to carry out the validation, verification, and/or certification of CDM projects.

Emission Reduction Unit
Carbon credits arising from Joint Implementation projects, with one ERU awarded for a reduction in greenhouse gas emissions equivalent in impact to one ton of carbon dioxide.

European Union Emissions Trading Scheme
The EU Emissions Trading Scheme commenced on January 1, 2005, creating the world's first multicountry emissions-trading system and the largest scheme ever implemented. The EU ETS runs in three phases: 2005–07 (Phase I), 2008–12 (Phase II), and 2013–20 (Phase III).

Appendix A (continued)

Kyoto Protocol
The agreement reached in Kyoto, Japan, in 1997, committing developed countries and countries making the transition to a market economy (Annex I countries) to achieve quantified targets for decreasing their emissions of greenhouse gases.

Non-Annex I Countries
These are developing countries that have no greenhouse-gas emission-reduction obligations under Kyoto but who may participate in the Clean Development Mechanism.

United Nations Framework Convention on Climate Change
The UNFCCC sets an overall framework for international efforts to fight against climate change. Its main objective is "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic (man-made) interference with the climate system." It was established 1992 at the Rio Earth Summit.

Vintage
An offset's vintage refers to the year in which the carbon reduction takes place.

Appendix B

Examples of carbon offset caselets

1. http://www.ecosecurities.com/Assets/3018/CaseStudy_Cuyamapa.pdf.
2. http://www.ecosecurities.com/Assets/3016/CaseStudy_Irani.pdf.
3. http://www.ecosecurities.com/Assets/3181/casestudy_san%20jacinto.pdf.
4. http://www.ecosecurities.com/Assets/3180/casestudy_aguascalientes.pdf.