Carbon Trading
an overview of financial instruments
designed to combat climate change

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Carbon Dioxide

Intercepts infrared waves going into space
Gasoline is 85.5% carbon

1 gallon of conventional gasoline becomes
172 cubic feet / 4.87 cubic meters of CO\(_2\)
Humans add about 25 billion tonne carbon dioxide to the atmosphere each year.
Greenland is melting

NY Times June 8, 2004
The oceans have absorbed about 30 times more heat than the atmosphere since 1955.
Vostok Ice Core CO₂ Concentration and Temperature Variation Record

Source: Barnola, et.al.; Petit et.al. (PAGES / IGBP)

Climate Change Post-2100: What are the Implications of Continued Greenhouse Gas Buildup?
Man came out of his cave at the time earth entered the ‘present interglacial’ (Holocene) and flourished only after the 120,000 year winter was over.
Globally, temperatures are projected to rise an additional 2 – 5°C in the 21st Century.
CO2 is linked with geologic periods. In other words, if we travel to $4 \times \text{CO2}$, which some speculate we may later this century, we would travel across several geologic time zones.
Yikes, Climate Change!

What to do?

- Nothing
- Adapt
- Engage
Man invents the Kyoto Protocol!

The Kyoto Protocol (KP) sets legally binding emissions targets for a basket of six greenhouse gases (GHG) for Annex I countries.

Together, they must reduce their emissions by 5.2% below 1990 levels over the commitment period 2008-2012.

The Protocol will became effective when it was ratified by 55 parties whose CO2 emissions represent 55% of the total from Annex I Parties in the year 1990.
### Table 4.3 Key information on approved JI projects

<table>
<thead>
<tr>
<th>Host Country</th>
<th>Program</th>
<th>Project Type</th>
<th>Project Description</th>
<th>Greenhouse gas reduction [tCO₂-eq]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Czech Republic</td>
<td>ERUPT</td>
<td>Biomass portfolio</td>
<td>28 biomass projects.</td>
<td>1,200.000</td>
</tr>
<tr>
<td>Hungary</td>
<td>ERUPT</td>
<td>Biomass</td>
<td>90 MW fuel switch coal to biomass.</td>
<td>710.000</td>
</tr>
<tr>
<td>Latvia</td>
<td>PCF</td>
<td>waste management</td>
<td>Methane capture.</td>
<td>368.101</td>
</tr>
<tr>
<td>Poland</td>
<td>PCF</td>
<td>Geothermal</td>
<td>Replace coal for district heating.</td>
<td>364.553</td>
</tr>
<tr>
<td>Poland</td>
<td>PCF</td>
<td>Biomass</td>
<td>Use of biomass waste.</td>
<td>190.630</td>
</tr>
<tr>
<td>Poland</td>
<td>ERUPT</td>
<td>Wind energy</td>
<td>60MW new capacity.</td>
<td>583.500</td>
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<tr>
<td>Romania</td>
<td>PCF</td>
<td>Afforestation</td>
<td>6,728 ha of public land.</td>
<td>1,018.000</td>
</tr>
<tr>
<td>Romania</td>
<td>ERUPT</td>
<td>Hydro</td>
<td>55MW.</td>
<td>612.631</td>
</tr>
<tr>
<td>Romania</td>
<td>ERUPT</td>
<td>Co-generation</td>
<td>26 MWe CHP.</td>
<td>1,536.140</td>
</tr>
<tr>
<td>Romania</td>
<td>ERUPT</td>
<td>Energy efficiency</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slovakia</td>
<td>ERUPT</td>
<td>Waste management</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 4.2 Key information on approved CDM projects

<table>
<thead>
<tr>
<th>Country</th>
<th>Program</th>
<th>Type</th>
<th>Description</th>
<th>Greenhouse gas reduction [tCO₂-eq]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bolivia</td>
<td>CERUPT</td>
<td>Energy efficiency</td>
<td>Efficient gas plant.</td>
<td>319.392</td>
</tr>
<tr>
<td>Brazil</td>
<td>PCF</td>
<td>Sinks &amp; fuel switch</td>
<td>Charcoal from mono-culture plantation used in stead of coal.</td>
<td>12,041.356</td>
</tr>
<tr>
<td>Brazil</td>
<td>CERUPT</td>
<td>Biomass</td>
<td>Retrofit CHP bagasse sugar mill; 15 MW.</td>
<td>259.506</td>
</tr>
<tr>
<td>Brazil</td>
<td>CERUPT</td>
<td>Gas capture</td>
<td>Landfill gas recovery.</td>
<td>700.000</td>
</tr>
<tr>
<td>Brazil</td>
<td>NCDF, Japan</td>
<td>Fuel switch</td>
<td>Charcoal based steel production.</td>
<td>21,000.000</td>
</tr>
<tr>
<td>Brazil</td>
<td>NCDF</td>
<td>Gas capture</td>
<td>Combustion and flaring credits.</td>
<td>11,800.000</td>
</tr>
<tr>
<td>Brazil</td>
<td>VEGA</td>
<td>Gas capture</td>
<td>8MW power from landfill gas.</td>
<td>5,208.344</td>
</tr>
<tr>
<td>Chile</td>
<td>PCF</td>
<td>Hydro</td>
<td>26 MW run-of-river.</td>
<td>2,812.000</td>
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<tr>
<td>China</td>
<td>CERUPT</td>
<td>Wind energy</td>
<td>30.6 MW new capacity.</td>
<td>600.248</td>
</tr>
<tr>
<td>Colombia</td>
<td>PCF</td>
<td>Wind energy</td>
<td>19.5 MW new capacity.</td>
<td>1,168.000</td>
</tr>
<tr>
<td>Costa Rica</td>
<td>PCF</td>
<td>Wind energy</td>
<td>9.6 MW new capacity.</td>
<td>327.000</td>
</tr>
<tr>
<td>Costa Rica</td>
<td>PCF</td>
<td>Wind energy</td>
<td>8.4 MW new capacity.</td>
<td>300.000</td>
</tr>
<tr>
<td>Costa Rica</td>
<td>PCF</td>
<td>Wind energy</td>
<td>25 MW new capacity.</td>
<td>204.000</td>
</tr>
<tr>
<td>Costa Rica</td>
<td>CERUPT</td>
<td>Hydro</td>
<td>7.5 MW new capacity.</td>
<td>184.360</td>
</tr>
</tbody>
</table>
Result: Glide Trajectory

BAU

~ 29%
## Project 0032: Methane capture and combustion from swine manure treatment for Peralillo

<table>
<thead>
<tr>
<th>Project title</th>
<th>Methane capture and combustion from swine manure treatment for Peralillo</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| **Host Parties** | Chile:  
|                |      [approval](#) (371 KB) [authorization](#) (371 KB)  
|                | Authorized Participants: Agricola Super Limitada  
|                |  
|                | Japan:  
|                |      [approval](#) (250 KB) [authorization](#) (250 KB)  
|                | Authorized Participants: The Tokyo Electric Power Company, Incorporated  
|                |  
|                | Canada:  
|                |      [approval](#) (167 KB) [authorization](#) (167 KB)  
|                | Authorized Participants: TransAlta Corporation  
| **Activity Sector** | Waste handling and disposal / Agriculture  
| **Activity Scale** | LARGE  
| **Methodologies Used** | AM0006 - GHG emission reductions from manure management systems  
| **Amount of Reductions** | 78,867 metric tonnes CO2 equivalent per annum  
| **Fee level** | USD 15,000  
| **Validation Report** |  
|                |  
|                |  
|                | Other documents (descriptions provided by the DOE)  
|                |   
|                | [Explanation of taking due account of comments](#) (69 KB)  
|                | [List of documents](#) (68 KB)  
|                | [List of interviewed persons](#) (69 KB)  
|                | [Modalities of communication](#) (340 KB)  
| **Public availability information** | The validation report will be published on the CDM website with the request for registration.  
|                |  
|                | [Compilation of all comments received](#) (69 KB)  
| **Requests for Issuance and related documentation** |  
|                |  
|                |  
|                |  
|                |  

What is a Cap-and-Trade Program?

- A “cap” is placed on emissions from “covered sources”
- Covered sources must surrender “credits” equal to emissions in the compliance period
  - A “credit” can either be an “allowance” or an “offset”
    - Allowances – allocated to covered sources
    - Offsets – come from projects in uncovered sectors (i.e. outside the “cap”)
- Covered sources can design their own compliance strategy:
  - Reduce emissions to the cap
  - Reduce below cap and sell unused allowances to others
  - Purchase allowances and/or offsets and emit above the cap
- Emitters and other project developers can create offset credits to be used, banked or traded on an exchange
Cost Minimization With Trading

Abatement Cost: $100/ton
Reduction: 5 tons

Abatement Cost: $80/ton
Reduction: 7 tons

Abatement Cost: $120/ton
Reduction: 3 tons

Potential transfer of 2 allowances for $80-$120 each

Cost: $500

Cost: $560 minus $160 - $240 = $320 - $400
(vs. $400 fixed)

Cost: $360 plus $160 - $240 = $520 - $600
(vs. $600 fixed)
What Is A “Carbon Credit”?

A carbon credit is:

- A tradable commodity
- With an independent market value
- Created pursuant to legal requirements
- In a voluntary or mandatory market
- From projects in non-covered sectors
- That represents a reduction, avoidance or sequestration of 1 ton of CO2 or equivalent greenhouse gas (GHG)
Legal Components

✓ Real (represents actual emissions reductions)
✓ Measurable (capable of accurate measuring & monitoring)
✓ **Additional** (based on a realistic baseline)
✓ Permanent (account for reversals during commitment period)
✓ Verified (by independent, registry-approved verifier)
✓ Enforceable (clear, unambiguous ownership)
✓ Unique (no double counting)
✓ Transparent & Address Leakage (does not lead to an increase in emissions outside of the project’s boundary)
Carbon Offset Projects: Typical Project Cycle

1. Identify Project
2. Assess Project Feasibility
3. Prepare Project Design Document (PDD)
4. Validation
5. Implementation
6. Registration
7. Issuance
8. Verification & Certification
9. Emission Reduction Purchasing Agreement (ERPA)
10. Delivery
11. Spot Sale
12. Forward Sale
13. Option
14. Trading
15. Identify Buyer
Carbon Offset Standards/Registries

- Climate Action Reserve (CAR) - http://www.climateactionreserve.org
- Clean Development Mechanism (CDM) - http://cdm.unfccc.int/index.html
- Voluntary Carbon Standard (VCS) - http://www.v-c-s.org/
- American Carbon Registry (ACR) - http://www.americancarbonregistry.org/
- Chicago Climate Exchange (CCX) - http://www.chicagoclimatex.com/
Trading and Sourcing Basics

- Credits can be purchased/sold through an exchange such as the Chicago Climate Exchange, or “over-the-counter”.
  - Over-the-Counter Transactions (2009) – 63% of Volume
  - Exchange Transactions (2009) – 37% of Volume
  - CAR Credits (aka Climate Reserve Tonnes, or CRTs)
    - 37% of volume in 2009
    - 65% of market value in 2009

- Trading vs. Retirement
  - Credits can be traded without being “retired”. Only the retirement of credits allows the holder to claim the carbon reduction.
Mandatory, Voluntary & Pre-Compliance Markets

- **Voluntary Markets** – 35% in 2009
  - Companies purchase carbon offsets to reduce or neutralize their greenhouse gas emissions for various reasons.

- **Pre-Compliance Markets** – 65% in 2009
  - Buyers purchase credits with the hopes that they can be used for compliance purposes in a future cap-and-trade program.

- **Mandatory Markets** – 0% in 2009
  - Regulated entities purchase offsets credits to meet their compliance obligations.
    - Distinction between “offsets” and “allowances”
### Size and Value of US Offset Market in 2009

<table>
<thead>
<tr>
<th></th>
<th>Volumes (Mt CO2e)</th>
<th>Value ($M)</th>
<th>Price/Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Exchange Based</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CCX CFIs</td>
<td>6.4</td>
<td>$5.8</td>
<td>$.90</td>
</tr>
<tr>
<td>CAR</td>
<td>0.8</td>
<td>$4.0</td>
<td>$5</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>7.2</td>
<td>$9.8</td>
<td>$1.36</td>
</tr>
<tr>
<td><strong>OTC Transactions</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAR</td>
<td>7.2</td>
<td>$48.2</td>
<td>$6.70</td>
</tr>
<tr>
<td>VCS</td>
<td>2.1</td>
<td>$9.7</td>
<td>$4.60</td>
</tr>
<tr>
<td>ACR</td>
<td>1.8</td>
<td>$3.5</td>
<td>$1.95</td>
</tr>
<tr>
<td>Other</td>
<td>1.1</td>
<td>$2.4</td>
<td>$2.20</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>12.2</td>
<td>$63.8</td>
<td>$5.20</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>19.4</strong></td>
<td><strong>$73.6</strong></td>
<td><strong>$3.80</strong></td>
</tr>
</tbody>
</table>

**Source:** Point Carbon Research – US Offset Markets in 2010: The Road Not Yet Taken. March 1, 2010
Carbon Finance

- 10% Carbon Finance
- 30 – 50% Equity
- 40 – 60% Debt

Added Project Economic Viability
Where Does Bioenergy Fit In?

- **Methane Reductions** – 49% of supply in 2009
  - Livestock (manure management)
  - Landfills (landfill gas collection)
  - Organic waste digestion

- **Energy Production**
  - Biomass/biogas combustion

- **Transportation**
  - Fuel switching (biofuels)
Hedging: Carbon Credits vs. RECs

- A carbon credit represents the reduction, avoidance, or sequestration of 1 ton of CO2e of GHG

- A Renewable Energy Credit (REC) represents proof that 1 MWh of electricity was generated from an eligible renewable energy resource.

- Both are tradable commodities

- A REC *may* be considered convertible…
  - Represents the amount of GHG displaced from using 1 MWh of energy
  - Greater GHG reductions when grid is supplied by high-carbon fossil fuels
  - Elements like additionality must still be met
Current Regulatory Environment

- **International**
  - Kyoto / EU ETS

- **Federal**
  - EPA Reporting Rule
  - SEC Guidance
  - House/Senate Bills

- **State**
  - Assembly Bill 32 (California)

- **Regional**
  - Regional Greenhouse Gas Initiative
  - Western Climate Initiative
Int. Mechanisms for Reducing GHGs

Kyoto Mechanisms

- Emissions Trading Scheme (ETS)
- Clean Development Mechanism (CDM)
  - Allows industrialized countries with reduction commitments to invest in projects that reduce emissions in developing countries.
- Joint Implementation (JI)
  - Allows annex I countries with reduction commitments to invest in projects that reduce emissions in other annex I countries.

Current Prices
- Allowances (EAUs) - $15.24
- Offsets (CERs) - $13.03
Federal Legislation & Regulations

- Environmental Protection Agency (EPA)
  - Facilities emitting > 25,000 tons CO2e must submit annual reports to the EPA
  - Covers 85% of U.S. GHG emissions
  - Emissions data will inform future policy decisions
  - Utilities to be regulated in 2011 if comprehensive legislation is not passed by congress
All publicly traded companies must disclose “material” risks resulting from climate change, including:

- Impact of legislation and regulation
- Impact of international accords
- Indirect consequences of regulation or business trends
- Physical impacts of climate change
Federal Legislation & Regulations

- **House Bill: Waxman-Markey – Passed 06/26/2009**
  - Overlays EPA’s jurisdiction under Clean Air Act
  - Covered Sources - > 25,000 tons CO2e/year
  - Caps gradually escalate:
    - 2012: 3% below 2005 level
    - 2020: 17% below 2005 level
    - 2030: 42% below 2005 level in 2020
    - 2050: 83% below 2005 level in 2050
  - Offsets
    - 2 billion offsets useable per year
    - Domestic and International Project Types
    - Methodologies to be developed by EPA & USDA
Federal Legislation & Regulations

- Senate Bill: Kerry-Lieberman – Released 05/12/2010
  - Also overlays EPA’s jurisdiction under Clean Air Act
  - Covered Sources - > 25,000 tons CO2e/year
  - Caps gradually escalate:
    - 2013: 4.75% below 2005 level
    - 2020: 17% below 2005 level
    - 2030: 42% below 2005 level in 2020
    - 2050: 83% below 2005 level in 2050
  - Similar cost containment provisions
  - Price Forecasts???
    - PointCarbon projects carbon would avg. $31/ton btwn. 2013 - 2020
State Legislation

- Assembly Bill 32 (California)
  - Broad-based cap-and-trade program
    - Electricity, Industry, Transportation Fuels, Natural Gas
  - Rulemaking currently in progress
  - Caps gradually escalate:
    - 2020: Reduce to 1990 levels (28% below BAU)
    - 2050: Reduce 80% below 1990 levels
  - Offsets are being considered on a sector-by-sector basis
    - Climate Action Reserve is a state-sanctioned offset program
Regional Greenhouse Gas Initiative (RGGI)

- 10 states & 53 million people
- 8th largest emitter in the world
- Caps gradually escalate
  - Stabilize thru 2015
  - Reduce 10% by 2018
- Allowance Price - $1.90
- Offsets:
  - 5 Project types accepted
  - Allowance price too low for offsets
Western Climate Initiative (WCI)

- 11 participants plus 13 “observers”
  - Participants – 7 states and 4 Canadian provinces
  - Observers – 6 states, 1 province and 6 Mexican states

- Multi-dimensional approach, including
  - Cap and Trade
  - Low carbon fuel standards
  - Renewable Portfolio Standard (RPS)

- Expects mandatory programs to start 2012
-Nice meeting all of you!

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Toward Climate Stability™