Overview

Categories Within Business and Industry Sector

- Cement
- Oil and Gas Systems
- Refineries
- Waste
- Semiconductor Industry
- High-GWP
- Other
Overview

- Emissions Within Sector
- Sector Profile
- Current Regulatory Status
- Potential Reduction Strategies
1990 Inventory by Subsector [119 MMTCO$_2$E total]

- Refineries: 28%
- Other: 45%
- Waste: 8%
- Cement: 7%
- Oil & Gas Systems: 12%
- Semiconductor: <0.5%
- High-GWP: <0.1%
2004 Inventory by Subsector [125 MMTCO$_2$E total]

- Refineries: 28%
- Other: 32%
- Semiconductors: 11%
- High-GWP: 11%
- Oil & Gas Systems: 12%
- Waste: 8%
- Cement: 8%
2020 Projections by Subsector [165 MMTCO$_2$E total]

- Refineries: 22%
- Oil & Gas High-GWP Systems: 27%
- Semiconductor: 1%
- Other: 29%
- Waste: 7%
- Cement: 6%
- Oil & Gas Systems: 8%
Overall Sector Profile

- Cement
  - 11 facilities
  - Employs approximately 2,300 people
  - Various locations in CA

- Oil and Gas Systems
  - 50,000 oil and 1,000 gas wells
  - Employs approximately 7,000 people
  - Mostly located in Central Valley and Southern California, including off-shore drillings
Overall Sector Profile

- **Refineries**
  - 21 facilities
  - Employs over 17,000 people
  - Located mostly in SF Bay Area and LA Area

- **Waste** (Landfills, Waste Water, and Composting)
  - 367 Municipal Solid Waste landfills
  - Approximately 300 composting facilities statewide
  - Employs approximately 40,000 people
  - Operating in most counties
  - Generated 85 million tons / Land-filled 42 million tons/ Diverted 43 million tons (2005)
Overall Sector Profile

- Semiconductor Industry
  - Numerous facilities
  - Located throughout CA
  - Employs approximately 9,000 people
Existing Controls

• Cement
  – No explicit controls for greenhouse gases
  – Baghouses and electrostatic precipitators to control particulate matter emissions
  – Cogeneration unit at one facility regulated by a district regulation
  – ARB staff coordinating development of Early Action Measures and Scoping Plan Measures

• Oil and Gas Systems
  – District rules reduce criteria pollutants and methane emissions
Existing Controls

• Refineries
  – Air district rules reduce criteria pollutants, methane emissions reduced as a co-benefit
    • Fugitive emission rules
    • Storage tank rules
    • Cogeneration unit at facilities regulated by district permits
    • Increased energy efficiency--co-benefit of regulatory requirements
Existing Controls

• Waste
  – Methane emission controls for safety and water quality (CCR Title 27)
  – Landfills
    • Federal New Source Performance Standards/Emission Guidelines and National Emission Standards for Hazardous Air Pollutants
    • Local Air District Rules
  – Composting
    • Composting in SCAQMD and SJV requires enclosures or other mitigation measures for VOC and PM
Existing Controls

- Semiconductor Industry
  - South Coast, Antelope Valley, Bay Area, Placer and Ventura County Districts limit VOCs
  - National Emission Standards for Hazardous Air Pollutants
  - Memorandum of Understanding between U.S. EPA and over 20 national companies
    - Reduce PFC emissions to 10% below 1995 level by 2010
Potential Controls: Early Action Concepts

- Cement
  - Blended Cements: Limestone and supplementary cementitious materials (SCMs)—to be developed in collaboration with CalTrans and other affected parties
    - Blending with limestone
    - Blending with SCMs – fly ash, slag, and pozzolan
  - Alternative fuels and improved energy efficiency
    - Require preheater/precalcer heat recovery system
    - Raw material preparation
    - Clinker production
    - Emission reduction potentials and cost impacts - to be determined
Potential Controls: Early Action Concepts

• Oil and Gas Systems
  – Reduce fugitive methane emissions
    • Install cost-effective technologies
    • Improve management practices
  – Emission reduction potential of 1.0 MMTCO$_2$E
  – Scheduled for adoption in 2010

• Refineries
  – No Early Actions
Potential Controls: Early Action Concepts

• Waste
  – Landfill Methane Capture (Discrete Early Action Measure)
    • Original proposal from CIWMB – would require adoption by ARB
    • Requires controls at uncontrolled landfills
    • Surface monitoring standards
    • Gas collection and control system standards
    • Monitoring, recordkeeping, and reporting requirements
  – Composting (Early Action Measure)
    • Requirements for enclosures and other mitigation measures may increase GHG emissions
    • VOC/PM mitigation measures may limit ability to process greenwaste
Potential Controls: Early Action Concepts

• Semiconductor Industry
  – Reduce PFC emissions
  – Emissions reduction potential of 0.5 MMTCO$_2$E
  – Scheduled for adoption in 2008
Potential Emission Reduction Measures

- Cement
  - Analysis of control strategies beyond those for Early Action measures pending
- Oil and Gas Systems
  - $\text{CO}_2$ reductions associated with combustion activities
    - Consider energy efficiency measures
    - Evaluate potential for recycling of waste gases
Potential Emission Reduction Measures

• Refineries
  – “Bottom-up” approach: Refinery specific evaluation
    • Permit reviewing (Cooperating w/ the Districts, CEC, and U.S. EPA)
    • Working to identify the major emission sources
    • Evaluating fuel production and consumption, electricity and steam usage
    • Evaluating process efficiencies within each facility
  – “Top-down” approach: Reviewing refinery modeling for GHG
    • Evaluating modeling work being performed by the oil industry
Potential Emission Reduction Measures

- Waste
  - Composting
    - Net reduction in GHG emissions if greenwaste is composted and applied as a soil amendment vs. landfill
  - Commercial recycling programs
    - Requires commercial sector to increase collection of recyclable materials
  - Waste technology demonstration, assessment, and development
    - Demonstrate viability of commercial scale waste technologies currently used in Europe (including waste conversion and biogas-to-fuel technologies)
  - Expand awareness of AB 1969
    - AB 1969 requires purchase specified amounts of renewable energy
    - CPUC/CIWMB funding to expand awareness to qualifying landfill gas facilities
Potential Emission Reduction Measures

- Semiconductor Industry
  - Process Optimization
    - Reduces the amount of PFCs used
  - Alternative Chemistries
    - Substitute gases for hexafluoroethane \((\text{C}_2\text{F}_6)\) in the chamber cleaning process
  - Emissions Abatement
    - Commercially available technologies
    - Performance of abatement systems varies
  - Recovery/Recycling
    - More costly or require more maintenance than other measures
    - Recovered compounds contain more impurities than virgin chemicals
Summary

• Maximum feasible and cost effective technologies to be analyzed
• Strategy dependent upon industry
  – Increases in energy efficiency
  – Process modification
  – Product reformulation
  – New technologies
• These industries will also be evaluated for possible inclusion in a cap and trade system
• Some industries could become sources for offsets
High-Global Warming Potential Sources

Whitney Leeman
California Air Resources Board

December 14, 2007
Overview

• What Are High-Global Warming Potential (GWP) Greenhouse Gases (GHGs)?
  – HFCs, PFCs, SF$_6$
    • Kyoto Protocol Gases
      – Emissions Control Varies by Country, Market System
        (Clean Development Mechanism, Voluntary Carbon
        Market)
  – Class I and II Ozone Depleting Substances (ODSs): CFCs, HCFCs, Halons, et al.
    • Montreal Protocol Gases
      – New Production, Imports, Exports Controlled; Emissions
        Not Controlled
  – Other High-GWP GHGs
    • NF$_3$, HFEs, PFPEs
    • Controlled Neither by Montreal Nor Kyoto Protocols
Overview

• How are High-GWP GHGs Accounted for under AB 32?
  – Kyoto Gases are Directly Included in 1990 Baseline and 2020 Target
  – Several non-Kyoto gases with climate impact are not in baseline but are being evaluated for mitigation
Overview

• High-GWP GHG “Sector” End-Use Categories
  – Mobile Sources
    • Motor Vehicle Air Conditioning (MVAC) Systems
  – Stationary Sources
    • Refrigeration and Air Conditioning (RAC), Foams, Fire Extinguishing, Solvent Cleaning, Industrial Applications, Electrical Transmission
  – Consumer Products
    • Propellants
• USEPA Vintaging Model (VM) Estimates
  – VM Between IPCC Tier 2 and Tier 3 Inventory Development Approaches; VM is a Bottom-Up Model, but is Also Compared with Top Down Data
  – National Estimates Distributed from US to CA Based on Population Fraction

• Verification Based on Ambient Monitoring
  – Mt. Wilson Study, NOAA, MLD Network, Walnut Grove Study, AGAGE Network, Mobile Monitoring

• California-Specific Inventory Development
  – Numerous Inventory Studies and Surveys Underway for Stationary, Mobile, and Consumer Product High-GWP GHG Sources

• SCAQMD Rule 1415: ODS Leak Rate Data
  – Leak Rates for Large, Stationary RAC Systems Available from SCAQMD Rule 1415 Data
CA High-GWP GHG Emissions

*Note: 3.5 MMT CO2E in 1990 represents all Kyoto gases, mostly SF₆
Major CA High-GWP GHG Emissions Sources

- Largest Sources Known From USEPA, IPCC/TEAP

2006 Emissions (MMT CO$_2$E)

- HFCs
- ODSs

- Domestic Refrigeration
- Commercial & Transport Refrigeration
- Industrial Process Refrigeration/Cold Storage
- Mobile Air Conditioning
- Large Commercial AC (chillers)
- Small Commercial AC
- Residential AC
- Fire Extinguishing
- Foams
CA High-GWP GHG Banks

Note: Bank Estimates Exceed Total CO2E Estimates in 2004
Major CA High-GWP GHG Bank Sources

- Largest Sources Known From USEPA, IPCC/TEAP

2006 Banks (MMT CO$_2$E)
Existing Controls

- Existing Controls
  - HFCs Subject to “No Venting” Only
    - AB 1493 Will Reduce HFC-134a Emissions from MVACs
  - ODSs Have Some Sales, Record-Keeping, Technician/Handler, and Emissions Restrictions
    - Section 608 and 609 of CAAA and SCAQMD Rule 1415
  - ARB Regulates ODP of Consumer Products
Emission Reduction Approaches

• Existing Systems: Emissions and Bank Management
  – Extend Sections 608 – 609 of CAAA and Rule 1415 to All High-GWP GHGs
  – New EOL Rules and Enforcement of Existing Rules
  – Capture/Recycling/Destruction Where Applicable
  – Voluntary or Mandatory ODS Destruction

• Existing and New Systems
  – Deposit and Return
    • Increased Leak Repair and Equipment Turnover, EOL Stewardship
Emission Reduction Approaches

• New Production: High-GWP GHGs and Equipment
  – Improved Containment
  – Lower-GWP Substitutes
  – NIK Technologies/Lower Charge Systems
  – Improved Energy Efficiency (LCCP Considerations)
  – Deposit and Return
    • EOL Stewardship
## Board-Approved Related Early Actions

<table>
<thead>
<tr>
<th>EA ID</th>
<th>SECTOR</th>
<th>STRATEGY NAME</th>
<th>2020 Reduction, MMTCO2E</th>
<th>2020 Cost Estimates, MTCO2E</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>Consumer Products</td>
<td>Reduction of high GWP GHGs used in consumer products</td>
<td>0.25</td>
<td>$4-$5/MTCO2E</td>
</tr>
<tr>
<td>16</td>
<td>Mobile</td>
<td>Reduction of HFC-134a from DIY MVAC servicing</td>
<td>1</td>
<td>TBD</td>
</tr>
<tr>
<td>23</td>
<td>Stationary</td>
<td>SF₆ reductions from the non-electric sector</td>
<td>0.1</td>
<td>TBD</td>
</tr>
<tr>
<td>28</td>
<td>Mobile</td>
<td>Ban of HFC release from MVAC service / dismantling</td>
<td>0.1</td>
<td>TBD</td>
</tr>
<tr>
<td>30</td>
<td>Mobile</td>
<td>Add AC leak tightness test and repair to Smog Check</td>
<td>0.45</td>
<td>TBD</td>
</tr>
<tr>
<td>32</td>
<td>Stationary</td>
<td>Specifications for commercial refrigeration</td>
<td>4.7</td>
<td>$10-$20/MTCO2E</td>
</tr>
<tr>
<td>34</td>
<td>Mobile</td>
<td>Requirement of low-GWP GHGs for new MVACs</td>
<td>2.5</td>
<td>TBD</td>
</tr>
<tr>
<td>36</td>
<td>Stationary</td>
<td>Reduction of SF₆ in electricity generation</td>
<td>TBD</td>
<td>TBD</td>
</tr>
<tr>
<td>37</td>
<td>Stationary</td>
<td>High GWP refrigerant tracking, reporting, and recovery program</td>
<td>1.25 - 12+</td>
<td>TBD</td>
</tr>
<tr>
<td>38</td>
<td>Stationary</td>
<td>Foam recovery/destruction program</td>
<td>0.9 - ?</td>
<td>$6.5/TCO2E for automated; $48/MTCO2E for manual</td>
</tr>
<tr>
<td>39</td>
<td>Stationary</td>
<td>Alternative suppressants in fire protection systems</td>
<td>0.1</td>
<td>$40/MTCO2E</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td></td>
<td></td>
<td><strong>11 - 23+</strong></td>
<td><strong>$4 - $48</strong></td>
</tr>
</tbody>
</table>
Activities Underway

• Continuing to Move Forward with Analyses, Working with Stakeholder Groups (2/08 Workshop)

• Research Projects Underway
  – MVAC Indirect, Direct, and EOL Emissions Studies
  – Inventory Development
    • All End-Use Categories (non-1493 MVACs, RAC, Foam, Solvent, Propellant, Electrical Transmission, and Fire Extinguishing/Chemical Stockpile Inventories)
  – LCA of High-GWP GHG Destruction
Summary

• High-GWP GHG “Sector” Contains a Diverse Array of Chemicals and End-Use Categories
• Control Strategies Include High-GWP GHG Emission and Bank Management (Especially HFCs and ODSs)
• Good Potential for Cost-Effective Emission Reductions
• Potential to Include as Source of Offsets will be evaluated
Contact Information

Waste:
Richard Boyd, Manager
Process Evaluation Section
916-322-8285
rboyd@arb.ca.gov

Cement:
Todd Wong, Manager
Technical Assessment Section
916-324-8031
twong@arb.ca.gov
Contact Information

Oil and Gas Systems:
Terrel Ferreira, Manager
Greenhouse Gas Measures Section
916-445-3526
tferreir@arb.ca.gov

Semiconductor Industry:
Terrel Ferreira, Manager
Greenhouse Gas Measures Section
916-445-3526
tferreir@arb.ca.gov
Contact Information

Refineries:
John Courtis, Manager
Alternative Fuels Section
916-323-2661
jcourtis@arb.ca.gov

High GWP:
Whitney Leeman
916-327-9480
wleeman@arb.ca.gov