The Future of SF₆ for Electric Utilities and the Magnesium Industry

Scott Bartos and Jerome Blackman 2nd International Conference on SF₆ and the Environment San Diego, CA November 21, 2002

Organization

- High GWP Chemicals
- Environmental Impacts
- U.S. Climate Policy
- EPA's Voluntary Partnerships
- Industry Emissions
- New Reduction Opportunities



Heat Trapping Pollutants

- Carbon dioxide, CO₂
- Methane, CH₄
- Nitrous Oxides, NO_X
- Hydrofluorocarbons, HFCs
- **■** Perfluorocarbons, PFCs
- Sulfur Hexafluoride, SF₆



The Greenhouse effect



Some solar radiation is

reflected by the atmosphere and earth's surface
Outgoing solar radiation:
103 Watt per m²

Some of the infrared radiation passes through the atmosphere and is lost in space

Not outgoing infrared radiation: 200 Watt ner m²

GREENHOUSES

Solar radiation passes through the clear atmosphere. Incoming solar radiation: 343 Watt per m² Some of the infrared radiation is absorbed and re-emitted by the greenhouse gas molecules. The direct effect is the warming of the earth's surface and the troposphere.

> Surface gains more heat and infrared radiation is emitted again

Solar energy is absorbed by the earth's surface and warms it...

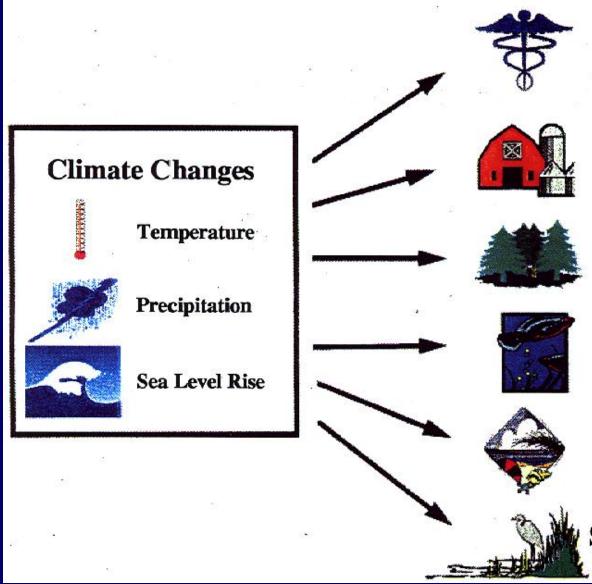
168 Watt per m²

... and is converted into heat causing the emission of longwave (infrared) radiation back to the atmosphere

E A R T H



Potential Impacts



Health Impacts

Weather-related Mortality Infectious Diseases Air Quality-Respiratory Illnesses

Agriculture Impacts

Crop Yields Irrigation Demands

Forest Impacts

Forest composition Geographic range of forests Forest health and productivity

Water Resource Impacts

Water supply Water quality Competition for water

Impacts on Coastal Areas

Erosion of beaches Inundation of coastal lands Additional costs to protect coastal communities

Species and Natural Areas

Loss of habitat and species

Why Worry About SF₆?

| Compound | Atmospheric | Global Warming |
|-----------------|-------------|--------------------------|
| | Lifetime | Potential |
| | (Years) | (100-year time horizon)* |
| CO_2 | 200 | 1 |
| $\mathrm{CH_4}$ | 12 | 21 |
| HFC-134a | 14.6 | 1,300 |
| CF ₄ | 50,000 | 6,500 |
| SF ₆ | 3,200 | 23,900 |

*IPCC 1995



U.S. Climate Change Policy I

- Reduce GHG Intensity by 18% in 2012
 - 2002 = 183 metric tons GHG/\$1 million GDP
 - 2012 = 151 metric tons GHG/\$1 million GDP
- Increased funding
 - FY '03 request \$4.5 billion
 - ↓ \$700 million increase
 - Basic scientific research and technology development

U.S. Climate Change Policy II

- Improve emission reduction registry
 - Improve DOE's 1605(b)
 - accuracy
 - I reliability
 - I verifiability
- Protect and provide credits for reductions
- Additional actions as needed in 2012
- Bilateral agreements

Climate Leaders

- "Umbrella" climate protection program
- Develop long-term comprehensive climate protection strategies
- Set corporate-wide GHG reduction goal
- Track reductions through an EPA-approved GHG inventory protocol



Charter Climate Leaders (Partial List)

- IBM
 - PFCs by 10% and power by 4% by 2005
- Miller Brewing
 - 18% per barrel by 2006
- Bethlehem Steel
 - 12% per ton of steel by 2010
- ST Microelectronics



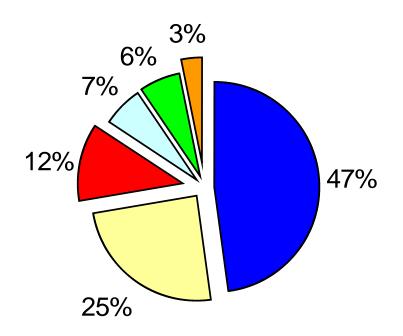
Cornerstone of U.S. Policy

- *Already, agreements with the semiconductor and aluminum industries and others have dramatically cut emissions of . . . the most potent greenhouse gases."
- President George W. Bush

High GWP Industrial Partnerships

- 2% of U.S. total GHG in 2000
 - ODS Substitutes
 - Aluminum Production (PFCs)
 - HCFC-22 Production (HFC-23)
 - Semiconductors (PFCs, HFCs, SF₆)
 - Electric Power Transmission (SF₆)
 - Magnesium Production and Casting (SF₆)

2000 U.S. High GWP Emissions (121.3 MMTCO₂ Eq.)



- ODS Substitutes
- ☐ HCFC-22 Production
- Electric Power Systems
- Aluminum
- Semiconductors
- Magnesium



Growing Industry Participation

- Magnesium Industry
 - 17 U.S. producers and casting companies
 - >80% of U.S. industry emissions
- Electric Power Systems
 - 65 Utilities
 - I >35% of U.S. transmission grid



Pollution Prevention (P²) Approach

- Process Optimizations
 - Gas handling
 - Leak detection
- Alternative chemicals or designs
- Capture/Recycle
- Abatement



Memoranda of Understanding

- EPA's responsibilities:
 - Develop tracking and reporting protocols
 - Evaluate reduction technologies
 - I Global warming effects, toxicity
 - Facilitate information sharing
 - Case studies
 - I Host technical conferences
 - Recognize industry leaders
 - Climate Protection Award

Memoranda of Understanding

- Partner company responsibilities:
 - Commit to reduce emissions
 - Document baseline and annual emissions
 - Explore long-term emissions control options
 - Share information on successful (and not so successful) strategies



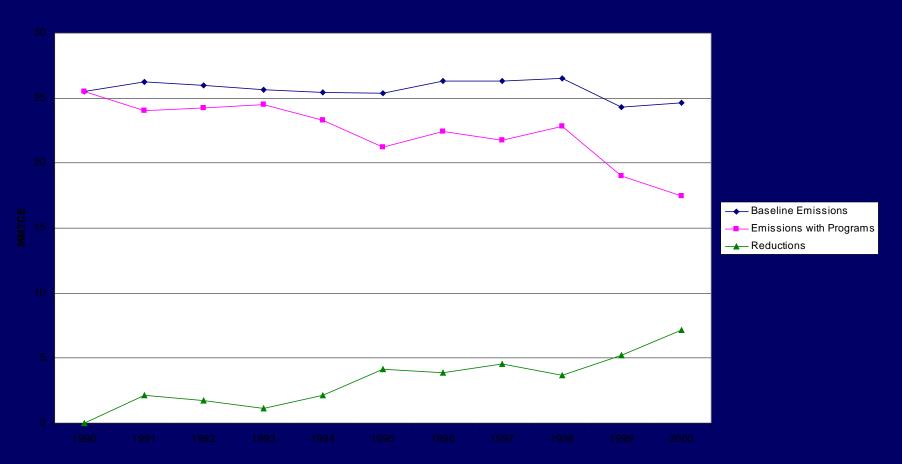
Power of Voluntary Partnerships

- Flexible
- Information-based
 - Can not manage what is not measured
- Cooperative research initiatives
- Explore new approaches to P²
- Involve various industry stakeholders
- Non-regulatory



Results: 1990 - 2000

High-GWP Voluntary Program Emission Reductions 1990-2000



Reduction Opportunities

- Electric PowerSystems
 - Solid State Current Limiter Research
 - Voluntary Agreements with Utilities

- Magnesium
 - Advanced SF₆ leak detection
 - Equipment designs
 - Alternative protective cover gases



Pollution: It's a Small World

