

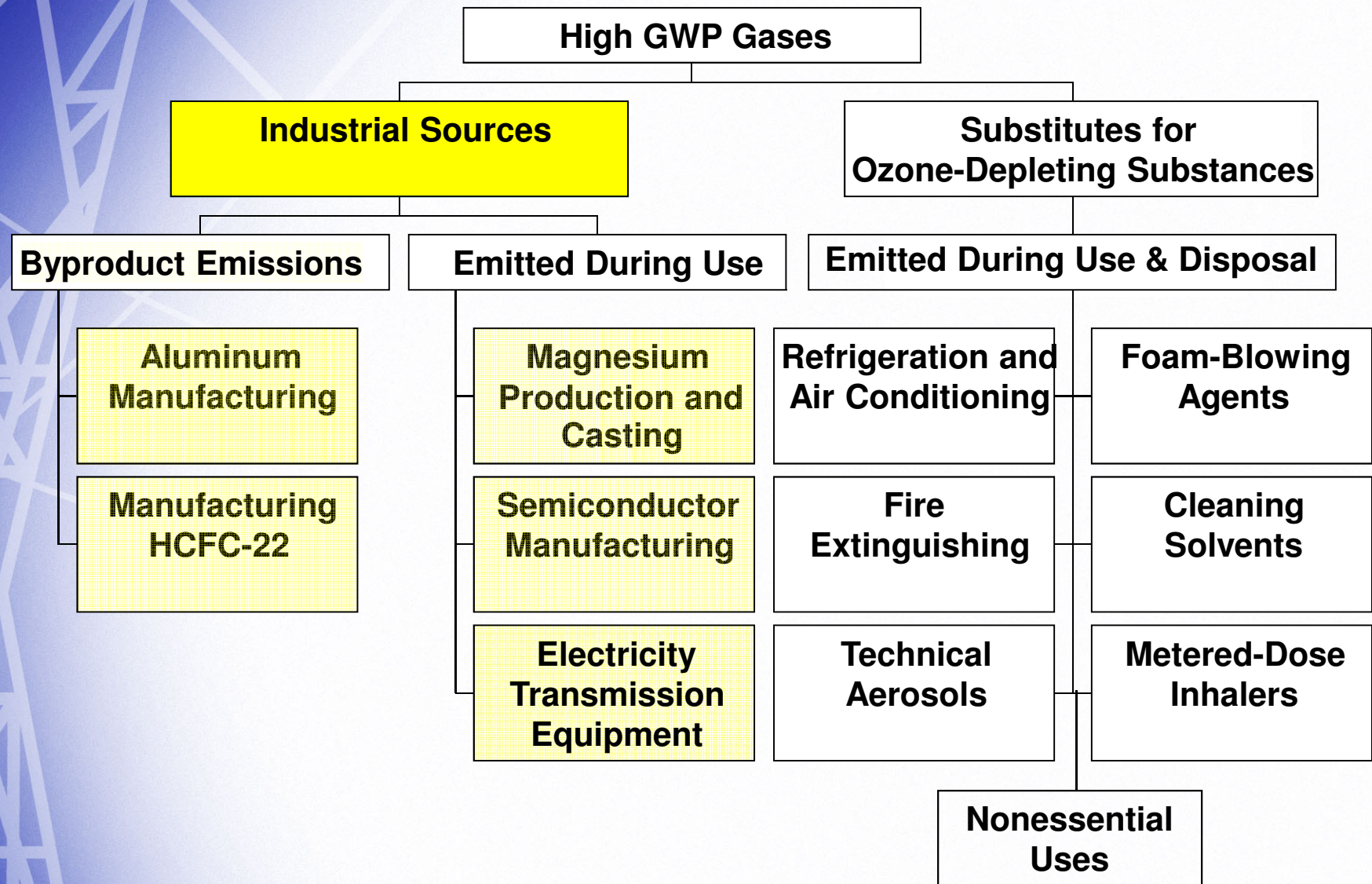
EPA's SF₆ Emission Reduction Partnership for Electric Power Systems

June 4, 2012

Sally Rand
Program Manager
Climate Change Division
Office of Air and Radiation



Fluorinated Gases Emissions



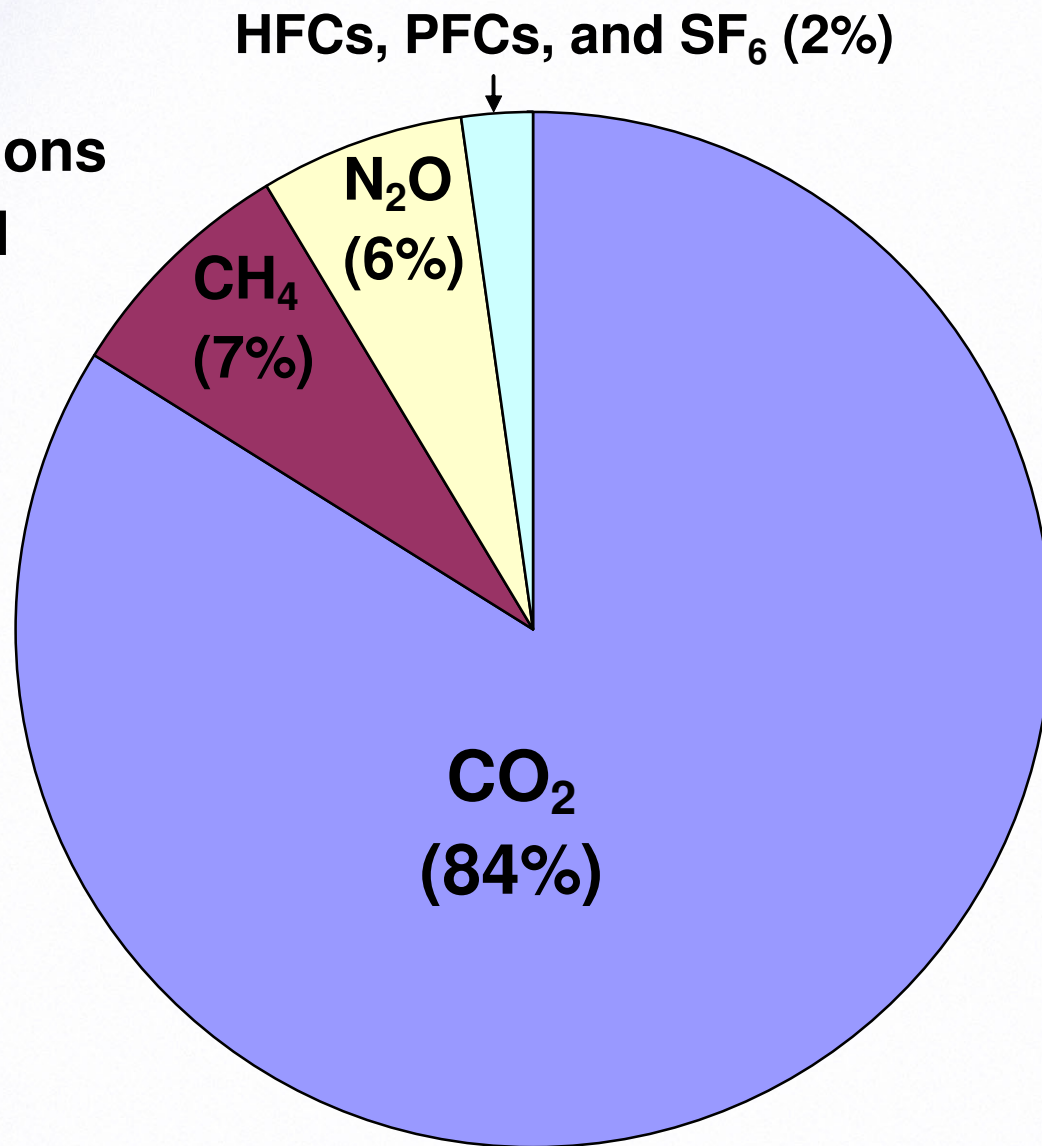
How Do FGHGs Compare to Other Greenhouse Gases?

Compound	Atmospheric Life (Years)	Global Warming Potential (100-year time horizon)
CO ₂	—	1
CH ₄	12	21
HFC-134a	14.6	1,300
CF ₄	50,000	6,500
HFC-23	264	11,700
SF₆	3,200	23,900

Source: Second Assessment Report values as reported in IPCC, 2007.

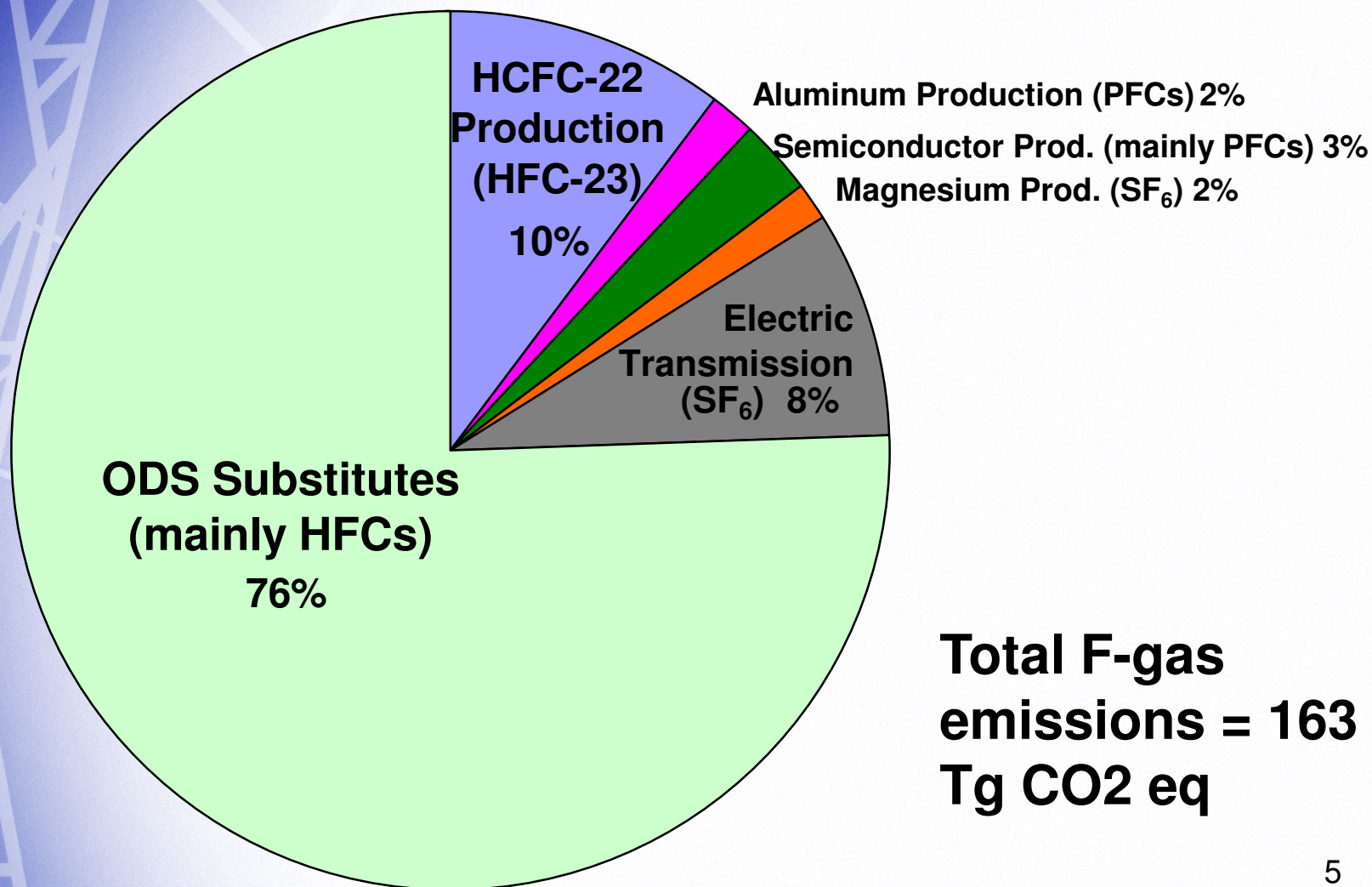
U.S. GHG Emissions (2010)

**Total U.S. Emissions
= 7260 Tg CO₂-eq**



1 Tg = 1 million
metric tons

U.S. Emissions of FGHGs



Trends: Summary

- Emissions of HFCs, PFCs, and SF₆ from “industrial sources” (HCFC-22, aluminum, magnesium, electric power systems, semiconductors)
 - Have fallen by over 55% since 2000
 - Primarily due to reductions in emission rates
- Low FGHG emission rates technically feasible in these “industrial sources”

EPA Voluntary Emission Reduction Partnerships For PFCs, SF₆ and HFC-23

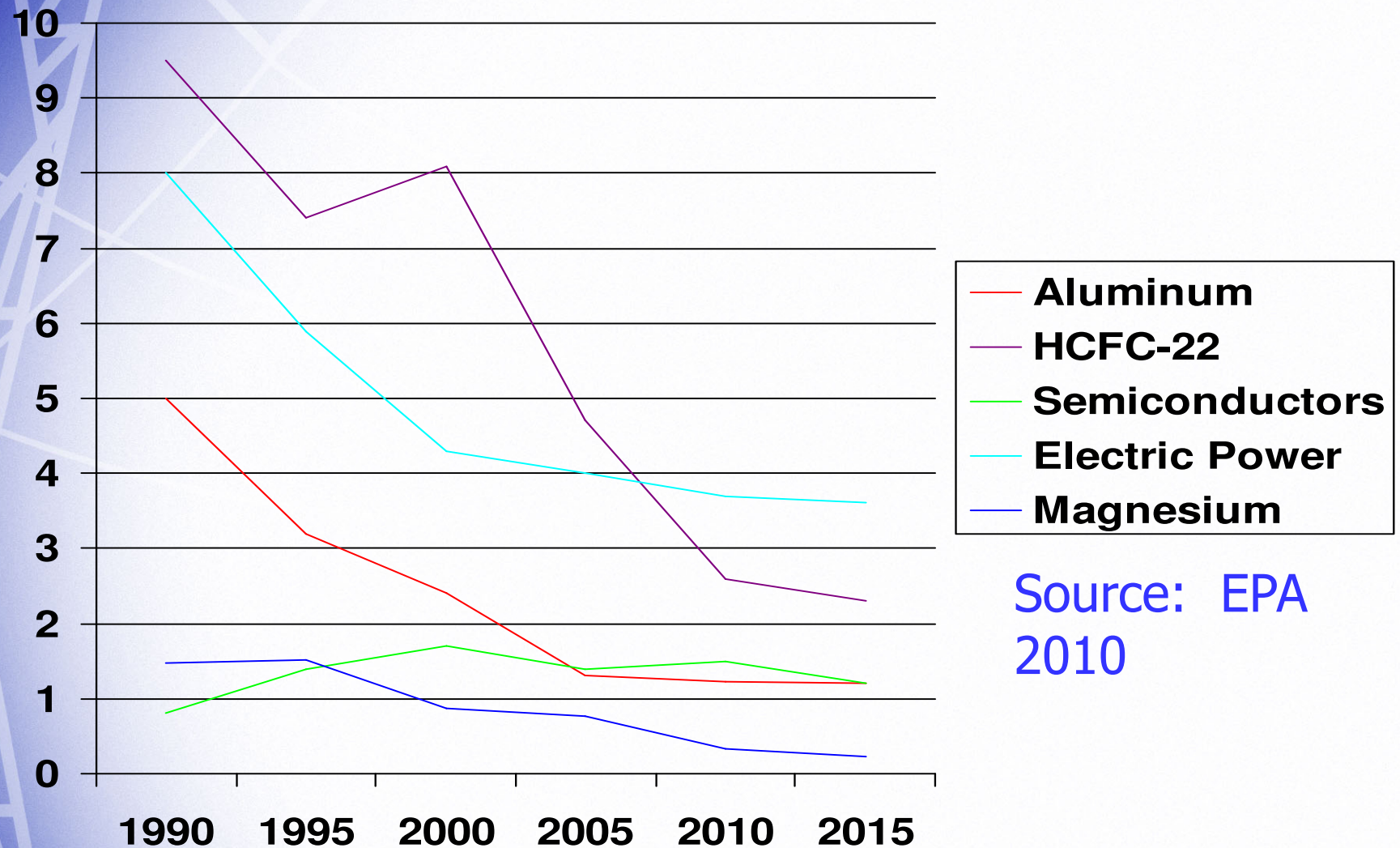
- Collaborative, voluntary agreements between EPA and companies
- Designed to cost-effectively reduce emissions
- Partners are encouraged to implement practices that are economically and technically feasible
- Each partnership has resulted in:
 - Well defined inventory methods
 - Advancing emission reduction knowledge and methods
 - Overall cost savings - improved efficiency and sector-wide collaboration
 - Motivation for climate protection

Emission Reduction Pathways

Very low emissions technically feasible in all sectors

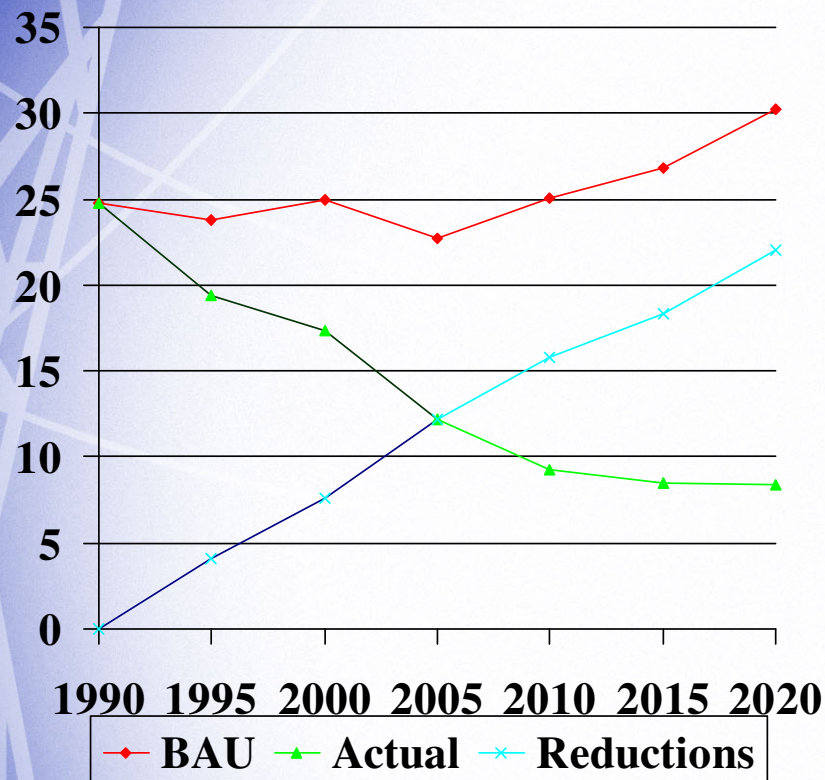
- PFCs from Primary Aluminum
 - Process optimization, automation of AE termination
- HFC-23 from HCFC-22
 - Process optimization, thermal abatement
- SF₆ from Magnesium
 - Substitutes: SO₂, HFC-134a, Novec™
- SF₆ from Electric Power Equipment
 - Best practices, replace old equipment
- FGHGs from Electronics – SC, FPD, thin-film PV
 - Abatement, process optimization, more efficient chemicals

Sector Trends: Emissions (MtCeq)



Source: EPA
2010

U.S. High GWP Partnerships (MtCO₂eq)



Avoid BAU growth

- Significant progress
- Global leadership
- Established methods for MRV
- Reductions in absence of regulatory

Voluntary Inventory Methods

- Industry participants in EPA emission reduction partnerships (“partners”) monitor and submit annual emissions estimates
- Estimates based on EPA/IPCC methods.
 - EPA very active in IPCC inventory method development
- EPA checks partner estimates and use them to estimate total U.S. emissions
 - Don’t require 3rd party verification

Partners Develop Estimates

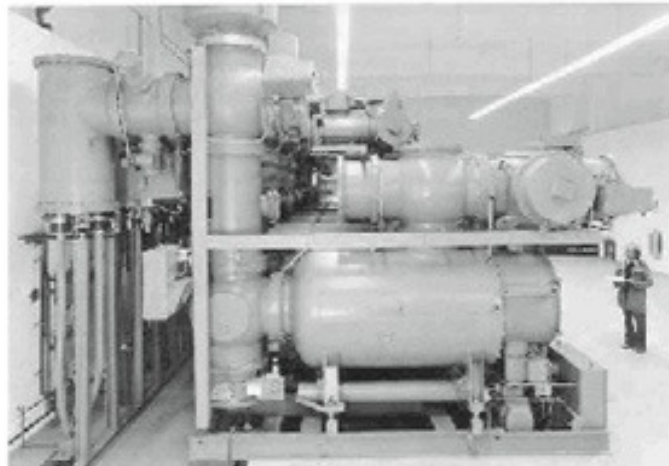
Industry	Method (IPCC GPG Tier)
Aluminum	Al production x anode effect minutes x slope (Tier 2/3)
HCFC-22	Direct measurement of HFC-23 in process stream (Tier 2)
Semiconductors	PFCs fed into process x emission factors (Tier 2)
Magnesium	Track SF ₆ used (Tier 2)
Electrical Equipment	Track SF ₆ used; amount not otherwise accounted for is assumed to be emitted (Tier 3)

QA/QC

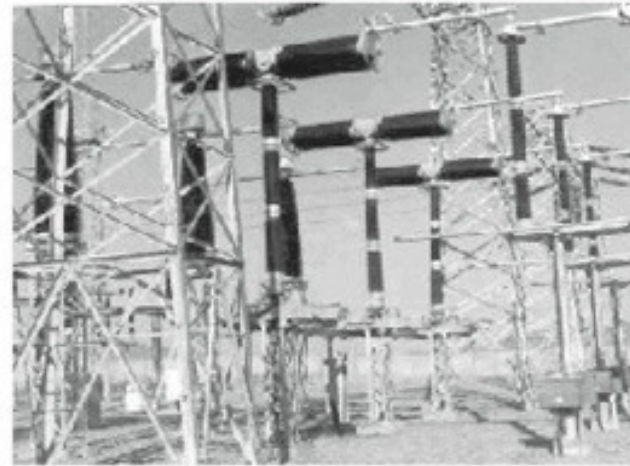
- Reports checked for math, consistency over time and across firms (as appropriate), documentation.
- Reports kept by third parties (HCFC-22, semiconductor, magnesium production) are periodically audited by EPA
 - Reports by semiconductor manufacturers audited annually.
 - 1995 and 2007 HCFC-22 audits involved site visits and plant-specific assessments of measurement accuracy, precision, and QA/QC, verification of emission estimates, and estimates of uncertainty.
- EPA sponsors measurement studies to validate methods and verify emission factors

Sulfur Hexafluoride (SF₆)

- A gaseous dielectric used in high voltage electrical equipment as an insulator and/or arc quenching medium
- Emissions from electric power systems caused primarily by:
 1. Leakage from gas handling practices
 2. Leakage from SF₆-containing equipment including installation, use and decommissioning



33 kV Indoor Type (GIS)



Outdoor Type (AIS)



Dead tank breaker (courtesy ABB)



Live tank breaker (Courtesy BHEL)

Why Care About SF₆?

1. SF₆ is the most potent greenhouse gas

- Global warming potential (GWP) of 23,900
(1 pound of SF₆ = 23,900 pounds (11 metric tons) of CO₂)

2. SF₆ is a very persistent greenhouse gas

- Atmospheric lifetime of 3,200 years
- Accumulates in the earth's atmosphere for centuries

3. Lost SF₆ gas = Increased operating expense

- Cost of SF₆ gas ranges from US\$6 to \$9/lb
- Leakage means diminished transmission efficiency and increased maintenance expenses

SF₆ Emission Reduction Partnership for Electric Power Systems

- **Voluntary** agreement between EPA and the electric power industry designed to **cost-effectively** reduce SF₆ emissions from electrical transmission operations
- Began in 1999 with 49 Charter Partners
- Has grown to 82 U.S. Partner Utilities
- Approximately 48% of total U.S. grid (estimated)





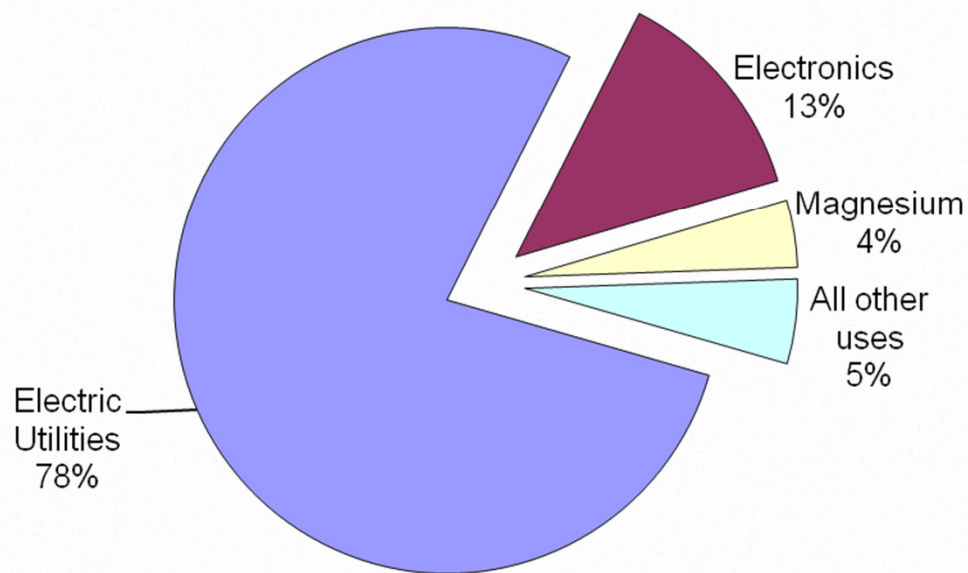
Electric Utility's Partner Responsibilities

- Sign the Memorandum of Understanding
 - Establish senior management commitment
- Develop and distribute an SF₆ handling strategy
 - Identify expected activities and scope of implementation
- Establish an SF₆ Emissions Rate/Reduction Goal
 - Goals may be changed and annually updated to reflect ongoing performance
- Report annual SF₆ emissions and reductions
 - Document emission reduction activities undertaken
 - Use standardized mass-balance reporting method

Sulfur Hexafluoride (SF₆)

In U.S. electric power industry is the primary user of SF₆

Breakdown of Total SF₆ Sales by Industry: 2008



Total 2008 Sales: 6,438 metric tons

Carbon Price – an illustration

	100-year GWP	Atmospheric life (years)	Additional Cost of 1 lb at CO ₂ Price			
			\$5	\$10	\$25	\$50
CO ₂	1	~120	5	\$10	\$25	\$50
SF ₆	23,900	3,200	\$54	\$108	\$271	\$542



Opportunities to Reduce SF₆ Emissions

- Track SF₆ Inventory
- Detect Leaks with Laser Leak Detection Equipment
- Repair and Replace Leaking Equipment
- Train Employees
- Recycle SF₆

SF₆ Emissions Reporting Protocol

Change in Inventory (SF ₆ contained in cylinders, <u>not</u> electrical equipment)	Inventory (in cylinders, <u>not</u> equipment)
	1. Beginning of Year
	2. End of Year
	A. Change in Inventory (1 - 2)
Purchases/ Acquisitions of SF ₆	3. SF ₆ purchased from producers or distributors in cylinders
	4. SF ₆ provided by equipment manufacturers with/inside equipment
	5. SF ₆ returned to the site after off-site recycling
	B. Total Purchases/Acquisitions (3+4+5)
Sales/ Disbursements of SF ₆	6. Sales of SF ₆ to other entities, including gas left in equipment that is sold
	7. Returns of SF ₆ to supplier
	8. SF ₆ sent to destruction facilities
	9. SF ₆ sent off-site for recycling
	C. Total Sales / Disbursements (6+7+8+9)
Change in Nameplate Capacity	10. Total nameplate capacity (proper full charge) of <u>new</u> equipment
	11. Total nameplate capacity (proper full charge) of <u>retired</u> or <u>sold</u> equipment
	D. Change in Capacity (10 - 11)

- Mass-balance
- User-friendly, automated process
- Simplified approach to submitting emissions data to EPA
- Accessible from the Partnership website
- Labor intensive
- Accuracy?

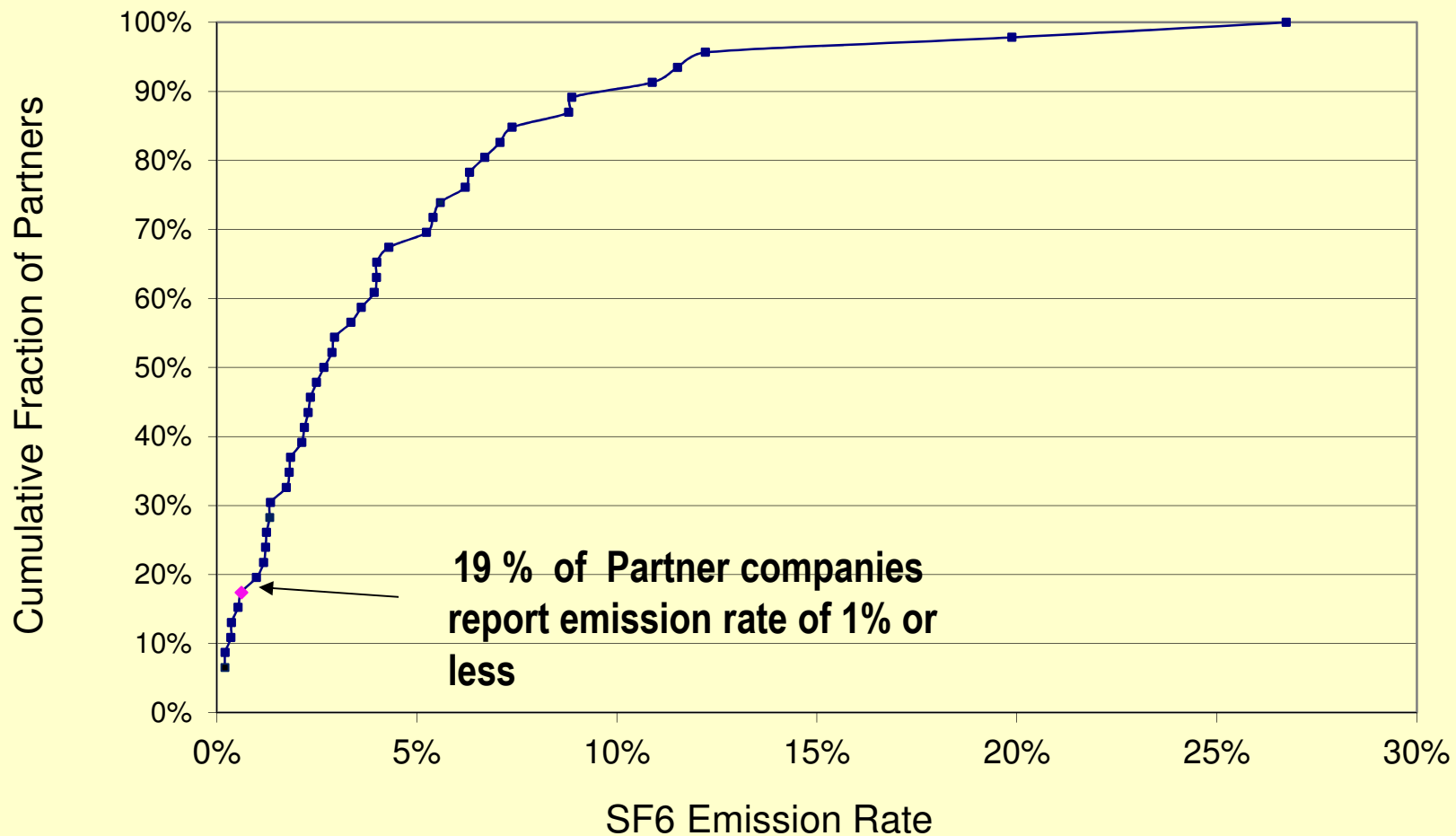
Electric Power Systems

- Reporting facilities (partners) represent over 80% of emissions since 1999.
- Partners track SF₆ use; all assumed to be emitted (Tier 2).
- Missing partner data is interpolated or extrapolated.
 - Extrapolated activity held constant; extrapolated emission rates assumed to follow partnership trends.
- Emissions of non-partners are estimated using net transmission miles and emission factors based on historical partner rates or expert judgment.

Partnership Benefits: Resources from EPA

- Bi-annual Conferences
 - April 2012 Atlanta, GA
- Technology Session Webcasts
 - Topics include: Estimating emissions, tracking inventory, monitoring equipment, detection and repair methods
- Benchmark Reports
 - Track progress and compare performance
- Research and Resources
 - Service Directory
 - Conference Proceedings
 - Technical studies (e.g., Leak Study)
 - Annual Reports
 - Partner Case Studies

2010 SF6 Emission Rates



What All Countries Should Do

- Develop an inventory of SF₆ use and emissions with direct reporting
 - SF₆ Partnership methodology – Tier 2 or higher
- Train personnel on proper handling and benefits of reducing SF₆ emissions
 - Saves money!
- Develop strategy to reduce emissions
 - Avoid irreversible climate impact



F-GHG Reductions Contribute to Early Climate Protection

- Compelling need to act
 - High grow sectors
 - Irreversible impacts on climate
- Opportunity to act
 - Technically feasible, cost-effective reductions available now
- Evaluate compliance assistance
 - Complementary policies and measures can accelerate reductions



Thank you

Sally Rand
rand.sally@epa.gov
(202) 343-9739

www.epa.gov/electricpower-sf6