GREENHOUSE GASES and ACCELERATORS
The Impact of Executive Order 13514

prepared for

Accelerator Safety Workshop
Argonne National Laboratory

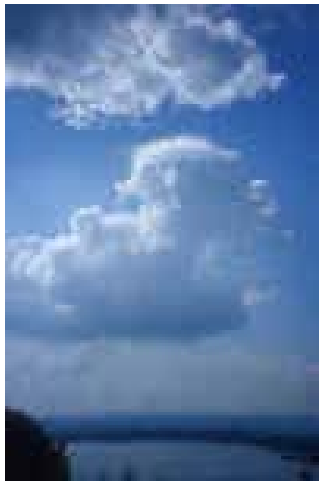
Greg Barrett
Environmental Engineer
September 20, 2011

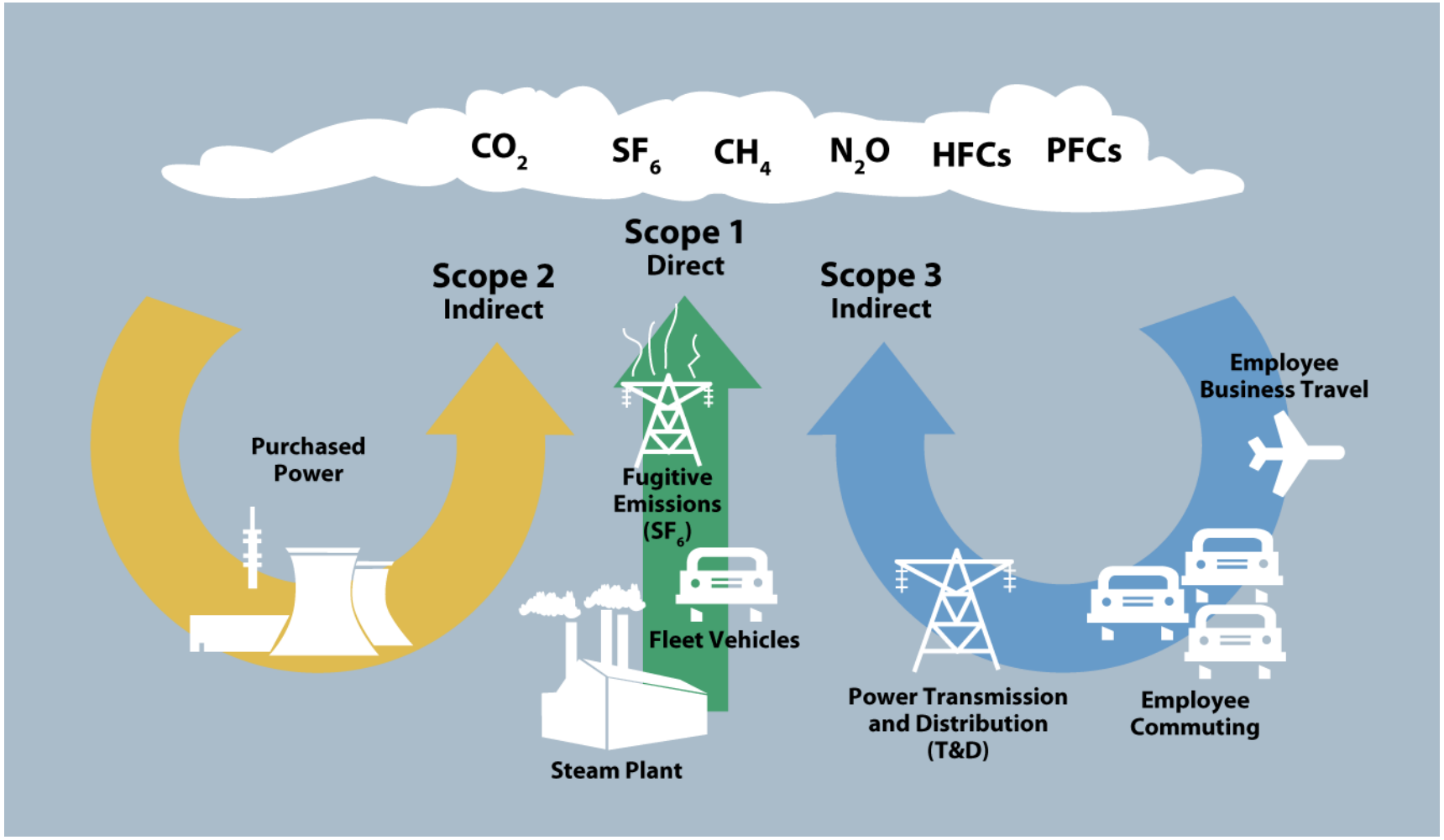
Overview

- E.O. 13514 *Federal Leadership in Environmental, Energy, and Economic Performance*

- Greenhouse Gas (GHG) emission reduction is an overarching performance metric for progress in Federal sustainability

- The DOE *Strategic Sustainability Performance Plan* has established GHG goals:
  1. Scope 1 & 2 GHG Reductions
  2. Scope 3 GHG Reductions
  3. Comprehensive GHG Inventory




CO_2 SF_6 CH_4 N_2O HFCs PFCs
Scope 1
Direct
Scope 2
Indirect
Scope 3
Indirect
Purchased Power
Fugitive Emissions (SF_6)
Fleet Vehicles
Steam Plant
Power Transmission and Distribution (T&D)
Employee Commuting
Employee Business Travel

Scope 1 and 2 GHG Emission Reductions

- DOE commits to a **28%** reduction in Scope 1 & 2 emissions by 2020 calculated from a FY2008 baseline

- To meet this commitment Argonne will focus efforts on:
  - Buildings
    - Reduce facility energy intensity
    - Install and use renewable electricity
    - Install utility meters
  - Fleet
    - Acquire alternative fuel vehicles (AFVs)/electric vehicles (EV)
    - Optimize AFV/EV development and inventory
  - Fugitive Emissions
    - Identify and implement measures to reduce and recapture non-CO_2 GHGs (primarily SF_6 and HFCs)

Reporting on GHG Emissions

- All GHG emissions are expressed as carbon dioxide equivalents (CO_2 e) based upon their global warming potential

GHG	Amount (lb)	CO_2e (lb)	Sources
CO_2	1	1	Fossil fuel combustion
CH_4	1	21	Combustion, landfills
N_2O	1	310	Fossil fuel combustion
HFC-134a	1	1,300	Refrigeration (chillers)
SF_6	1	23,900	Electrical equipment

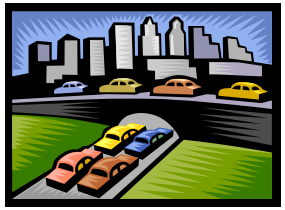
Argonne
Scope 1 and 2 GHG
2008 Baseline

Coal Combustion

22,937 mt CO_2e
(FY10: 15,525)

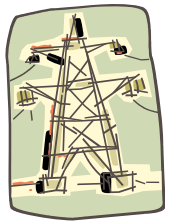
Natural Gas Combustion

36,321 mt CO_2e
(FY10: 43,231)



Fleet Vehicles & Equipment

1,009 mt CO_2e
(FY10: 464)



Purchased Power

186,487 mt CO_2e
(FY10: 196,302)

Fugitive Gas Emissions

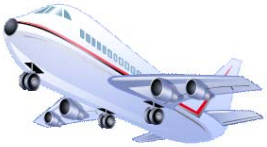
60,040 mt CO_2e
(FY10: 16,278)

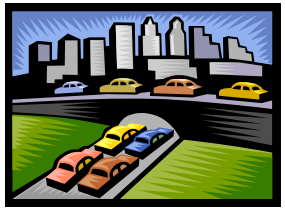
Scope 3 GHG Emission Reductions

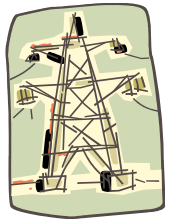
- DOE is committed to a **13%** reduction in Scope 3 emissions by 2020 with FY 2008 as a baseline

- Scope 3 reduction goals will initially focus on:
  - Employee travel (**12%**)
    - Business ground and air travel
    - Employee commuting travel
  - Waste disposal (**12%**)
    - Contracted solid waste
    - Contracted wastewater
  - Transmission and distribution losses from purchased electricity (**16%**)

Argonne Scope 3 GHG 2008 Baseline



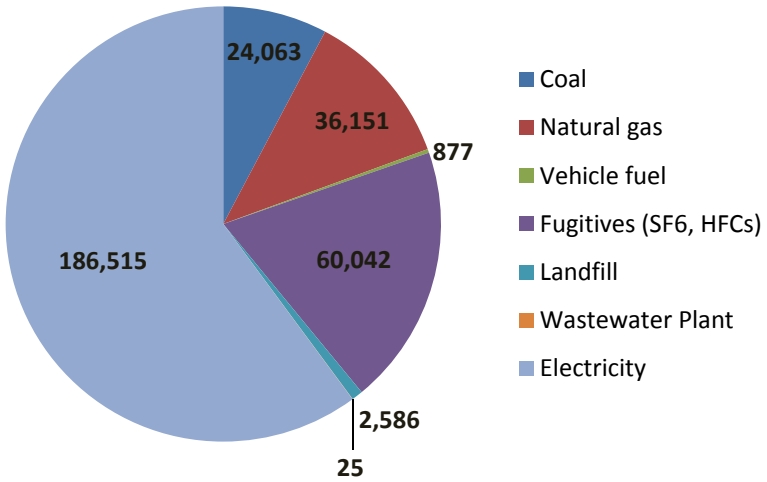




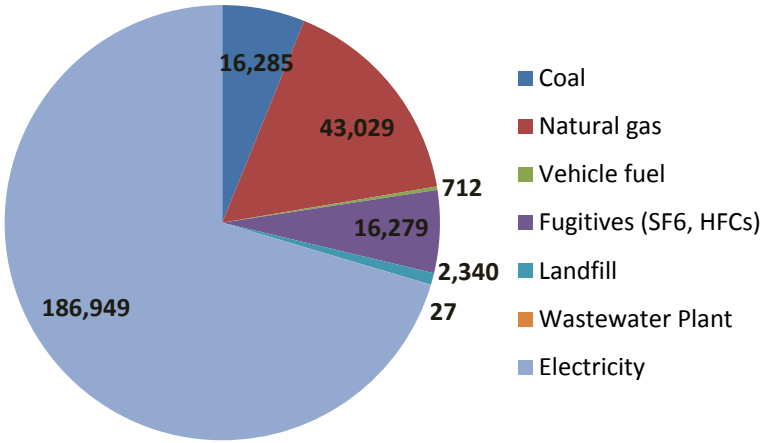
Employee Business Air Travel	Employee Business Ground Travel	Employee Commuting To/From Work	T&D Losses
6,535 mt CO_2e (FY10: 6,179)	512 mt CO_2e (FY10: 399)	11,386 mt CO_2e (FY10: 11,754)	11,521 mt CO_2e (FY10: 12,131)

Argonne National Laboratory Scope 1 and 2 GHG Emissions

2008
310,260 mt CO_2e

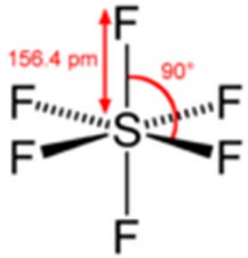


2010
265,621 mt CO_2e



Greenhouse Gases and Accelerators

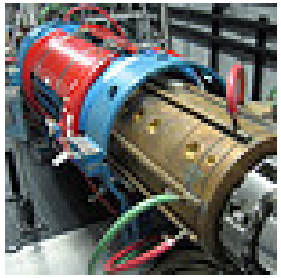
- Accelerator operation impacts Scope 1 (fugitive) emissions if there are uses and losses of sulfur hexafluoride (SF_6)
- Accelerator operation also impacts Scope 2 (indirect) emissions due to the purchase of electricity
- DOE-HQ identified SF_6 emissions as a relatively easy target to approach for effecting GHG emission reductions



Argonne Accelerators and SF_6

- SF_6 is used as an anti-arcing agent in scientific instrumentation
  - **Electron microscopes**
  - **Van de Graaff generators**
  - **Accelerators:**
    - **Advanced Photon Source (APS) – Building 400**
    - **ATLAS – Building 203**
    - **Wakefield Accelerator – Building 366**
    - **LINAC – Building 211**
    - **MSD Accelerator – Building 212**

- SF_6 also used in switchgear in electrical distribution systems
- Amounts of SF_6 used vary widely
  - **a few pounds (APS, electron microscopes, Van de Graaff generators)**
  - **hundreds of pounds (Wakefield, MSD accelerator)**
  - **tons (ATLAS)**



Sulfur Hexafluoride

- Sulfur hexafluoride (SF_6) is a potent GHG (one pound is equivalent to almost 12 tons of CO_2)
- SF_6 is a Scope 1 (fugitive) emission and in December 2009, all DOE sites were required to report on SF_6 purchases in FY2008 (baseline year)
- Argonne reported 7678 pounds of SF_6 purchased, but DOE/HQ calculated this as 5500 pounds of SF_6 emitted (~60,000 mt CO_2e)
- Argonne was categorized as the largest SF_6 emitter in DOE/SC
- Argonne established a Fugitive Emissions Working Group including representatives from all SF_6 facilities

Argonne SF_6 Users Group

- Formed in 2010 consisting of scientific and utility SF_6 users, environmental (air, pollution prevention) and facilities personnel

- Issue: SF_6 had not been regulated under the Clean Air Act so there had been no requirement or incentive to maintain usage records or control emissions

- Two aspects of SF_6 emission reduction needed to be evaluated:
  - **Losses from equipment leaks**
  - **Losses when systems needed to be opened for maintenance or gas replacement (due to degradation)**

SF_6 – Leak Detection/Repair

- In 2010 SF_6 users facilities were visited by a contractor familiar with scientific instrumentation using SF_6
- Using commercial leak detector, facilities were inspected to look for gas leaks
  - **Valves**
  - **Gaskets**
  - **Old fittings**

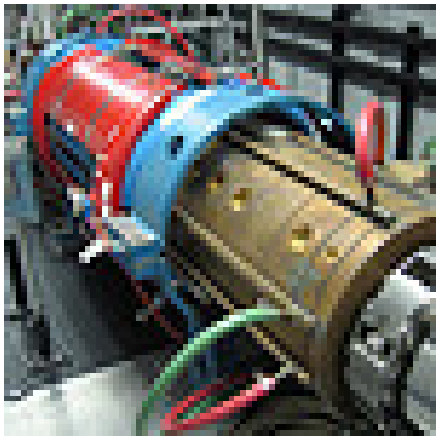
- Leak detection and repair was a relatively low cost approach to reducing SF_6 emissions, but did require investment of time
- Some problems encountered where replacement parts could no longer be obtained due to the age of the equipment

SF_6 – Recovery/Reclamation

- Larger SF_6 emissions resulted from opening instruments for maintenance and repair, or to replace gas
- Two accelerators (ATLAS and MSD - Building 212) had recovery systems due to the large amount of SF_6 used
- Other facilities had to release gas when systems were opened
- Initial assessment was that a portable SF_6 recovery system might provide a solution, but a number of problems were encountered
  - **Capacity**
  - **Availability**
  - **Mobility**

Argonne Wakefield Accelerator (AWA)

- AWA mode of operation required frequent opening of the system
- Hundreds of pounds of SF_6 were being emitted per year
- In 2010 AWA was the largest SF_6 emitter at Argonne, and plans called for facility expansion
- In 2011 a dedicated SF_6 system was designed and ordered for AWA
  - **Would recover virtually all SF_6**
  - **To be installed in September, 2011**
  - **Cost of the system - $77K**



Advanced Photon Source (APS)

- APS had an existing SF_6 recovery system but installation had never been completed
- An upgrade was required to make the system operational
- In 2011 funding ($65K) was provided to upgrade system

SF_6 Scales

- In order to more accurately track SF_6 emissions, usages needed to be more accurately determined
- A typical 115 lb cylinder of SF_6 could contain 0.5 – 1.0 lb of gas when considered “empty”
- Cylinder heels returned to vendor were being categorized as losses
- In 2011, two portable SF_6 cylinder scales were purchased for users to accurately determine how much gas was being used

Status of Portable SF_6 Recovery System

- In July, 2011 a representative from DILO visited Argonne to tour SF_6 users facilities to determine the feasibility of a portable recovery system for multiple users

- A portable system would only be practicable for small SF_6 users
  - **Electron microscopes**
  - **Van de Graaff generators**

- Portable system still being evaluated

Future SF_6 Efforts – Gas Vendors

- Working with gas vendors on gas return/reclamation
- SF_6 can degrade over time with the production of toxic byproducts
- Levels of purity needed by SF_6 users vary
  - **Very high purity (electron microscopes)**
  - **Less stringent purity (Wakefield Accelerator)**
- Still need to develop program with vendors on taking back SF_6

SF_6 Emission Reduction – Argonne and DOE

- DOE-HQ (HS-21) established the Fugitive Emissions Working Group (FEWG) to provide a forum for DOE sites to share strategies, programs, and problems encountered in SF_6 emission reduction

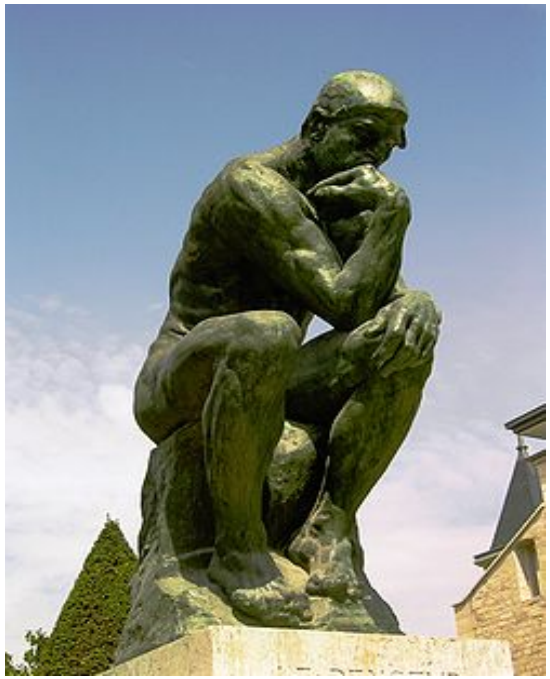
- Argonne has made two presentations (October, 2010 and June, 2011) on its efforts to reduce SF_6 emissions

Argonne NATIONAL LABORATORY

SF_6 Emission Reduction - Summary

- It is a Team Effort
- It takes time
- It takes funding

Questions?



Greg Barrett, Environmental Engineer

Argonne National Laboratory

630-252-2854

gbarrett@anl.gov