Semiconductor Manufacturers Leading the Way for Climate Protection

Scott C. Bartos Plasma Etch Users Group Meeting San Jose, California March 13, 2002

Organization

#High Global Warming Potential (GWP) Chemicals
#Policy Approaches
#FPD Industry Emissions
#Technology Transfer Opportunities
#Next Steps





Sources: Okanagan university college in Canada, Department of geography, University of Oxford, school of geography; United States Environmental Protection Agency (EPA), Washington; Climate change 1995, The science of climate change, contribution of working group 1 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge university press, 1996.

Heat Trapping Pollutants

#Carbon dioxide, CO₂
#Methane, CH₄
%Nitrous Oxides, NO_X
#Hydrofluorocarbons, HFCs
#Perfluorocarbons, PFCs
#Sulfur Hexafluoride, SF₆



Chemical Characteristics

Compound	Atmospheric	Global Warming
	Lifetime	Potential
	(Years)	(100-year time horizon)*
CO_2	200	1
CH_4	12	21
NF ₃	740	10,800
CF ₄	50,000	6,500
C_2F_6	10,000	9,200
SF ₆	3,200	23,900

*IPCC 1995 and 2001



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

High GWP Industrial Sources

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





Kyoto Protocol Review

#Requires:

☑ Ratification by ≥ 55 Parties to the Conference
☑ Annex I countries accounting for ≥ 55 % CO₂ emissions in 1990

#Current Status*:

- Ratification by 105 Parties
- \triangle Annex I emissions = 43.9 % of 1990 CO₂

*UNFCCC - Feb. 24, 2003



How Might Kyoto Enter Force?

%Russian Federation = 17.4 %
%Switzerland = 0.3 %
%Liechtenstein = 0.0 %
%Monaco = 0.0 %
%Australia = 2.1 %
%USA = 36.1 %



U.S. Climate Change Policy I

#Reduce GHG Intensity by 18% in 2012 $\simeq 2002 = 183$ metric tons GHG/\$1 million GDP $\simeq 2012 = 151$ 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 **⊠**reliability **⊠verifiability #**Protect and provide credits for reductions **#**Additional actions as needed in 2012 **#**Bilateral agreements



Cornerstone of U.S. Policy

#President George W. Bush



Semiconductor Industry Leading the Way

**Partnerships in U.S., Japan, E.U., Taiwan, and Korea
**Global industry coordination via WSC
**Emission reduction goal
**10% below 1995 baseline by 2010
**Suppliers play critical role



Pollution Prevention (P²) Approach

Process Optimizations I End point detection Alternative chemicals $\#NF_3$, c-C₄F₈ # Capture/Recycle # Abatement



Power of Voluntary Partnerships

#Flexible and quickly initiated
Develop emissions reporting protocols
Can not manage what is not measured
#Cooperative research initiatives
#Host technical conferences
#Educated voice in government



Flat Panel Displays

Strain Film Transistor (TFT) LCDs
Scomputer monitors
○ Video monitors
○ Cell phones
○ Personal digital assistants (PDAs)
○ Digital cameras



Rapid FPD Industry Growth

******NF₃, CF₄, C₂F₆, and SF₆
Chemical Vapor Deposition
Plasma Etching ******45% CAGR since 1998 ******25% CAGR projected to 2007



Estimated PFC Use (1995 - 2005)



Comparison of PFC Emissions from TFT-LCD and Semiconductor Manufacture, 1995 - 2005



Progress to Date

 ₩ World LCD Industry Cooperation Committee - July 2001
 ☑ Identified need to control PFC emissions
 ₩ AKT supplies Remote CleanTM for PECVD
 ☑ >99% NF₃ utilization



Reduction Opportunities

#Transfer proven technologies Process optimizations △Alternative chemicals \mathbb{I} c-C₄F₈ alternative to C₂F₆ △Capture and reuse Abatement **⊠**Catalytic thermal **⊠**Plasma



Next Steps for FPD Industry

Coordinate with national governments
Measure and report emissions
Explore technology options
Open lines of communication with semiconductor equipment suppliers
Do not reinvent the wheel
Set an aggressive emission reduction goal



Next Steps for Semiconductor Partnership %Support plasma abatement study at Texas A&M %Complete data guality assurance guidelines

#Compile report on strategies for small/medium
fabs

#Investigate:

Cylinder heel handling practices

☑ PFC heat transfer fluids

 $\square N_2 O$ emissions: 100 year GWP = 310

Study impact of foundry fab business on WSC goal attainment

