

SEMICONDUCTORS AND PFCs: VOLUNTARY DOES THE TRICK

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Montreal 12/05

OVERVIEW

- Use of PFCs in semiconductor industry
- Semiconductor industry and climate change policy
- World Semiconductor Council and US EPA agreements
- PFC emissions reduction progress – industry and Intel
- Status of PFCs in Europe

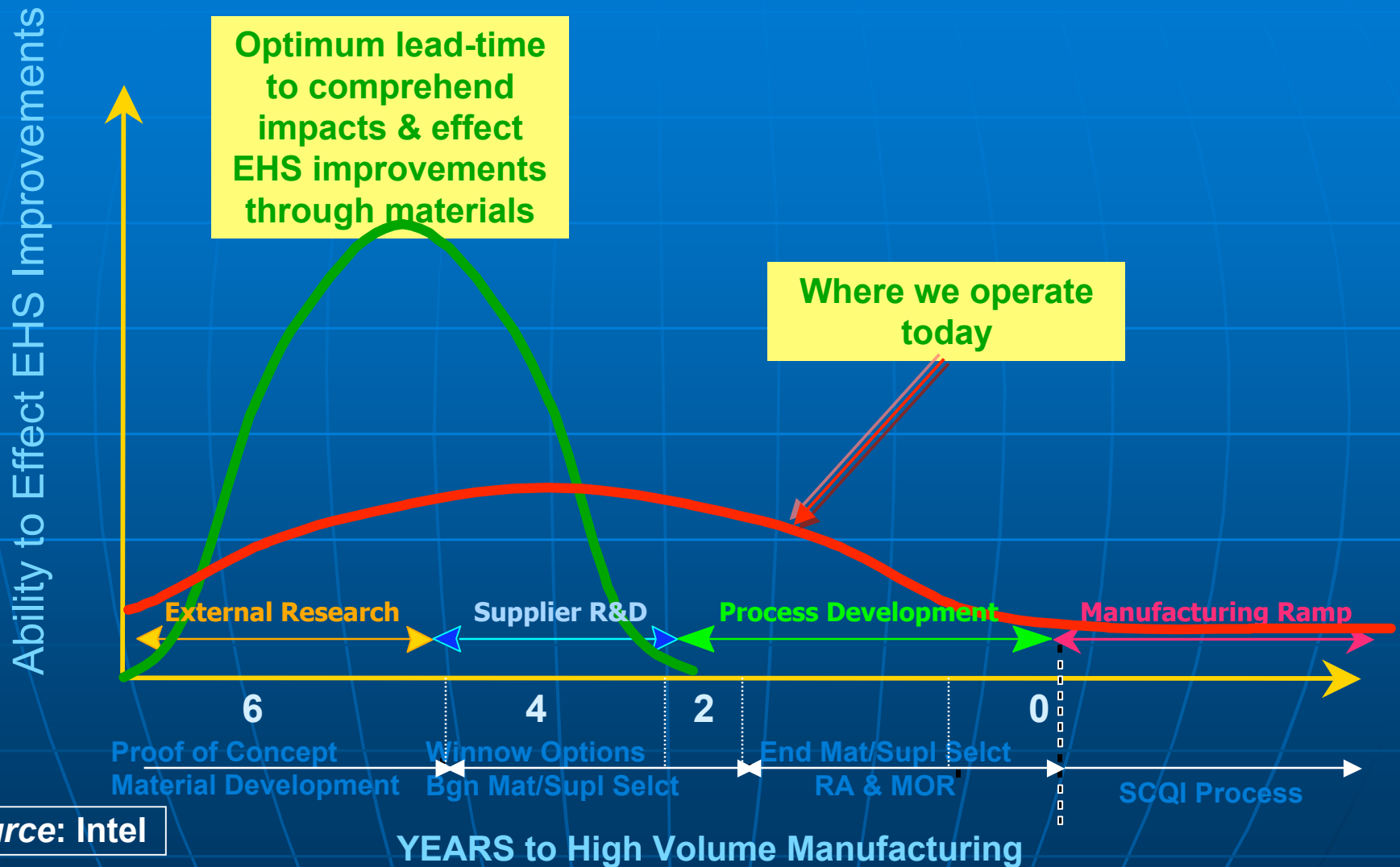
PFCs IN SEMICONDUCTOR INDUSTRY

- Perfluorocompounds (PFCs) are critical in semiconductor manufacturing
 - Fluoride ion highly effective in etching silicon
 - Stable nature of PFCs allows great precision in etch rate – precision is key in semiconductor manufacturing
 - They are non-toxic and therefore safe to use
- No reliable, “drop in” substitute for PFCs in s/c industry
 - 1998 timeframe: substitution challenge very daunting
- Semiconductor industry supported “basket of gases” approach to high –GWP gases in Kyoto Protocol

S/C INDUSTRY PROACTIVE ON CLIMATE CHANGE

- 1996: SIA signs PFC MOU with US EPA
 - First industry to voluntarily address GW emissions
 - “Endeavor to reduce normalized PFC emissions” from ‘95 levels
- 1998: World Semiconductor Council agreement signed among SIA, KSIA, EECA, EIAJ
 - Hard target -- reduce PFCs to 10% below 1995 levels by 2010
 - This is an ABSOLUTE emissions reduction commitment in a rapidly-growing industry; normalized reductions much greater
 - Six PFCs included: CF₄, CHF₃, C₂F₆, C₃F₈, NF₃, SF₆
- Under 1998 WSC agreement, SIA signed MOU with US EPA in 2000; focus of industry is on:
 - Chemical substitution with <GWP gases
 - More complete destruction of PFCs in process
 - Point-of-use abatement (e.g., thermal oxidation)

Materials/EHS Intersect Model



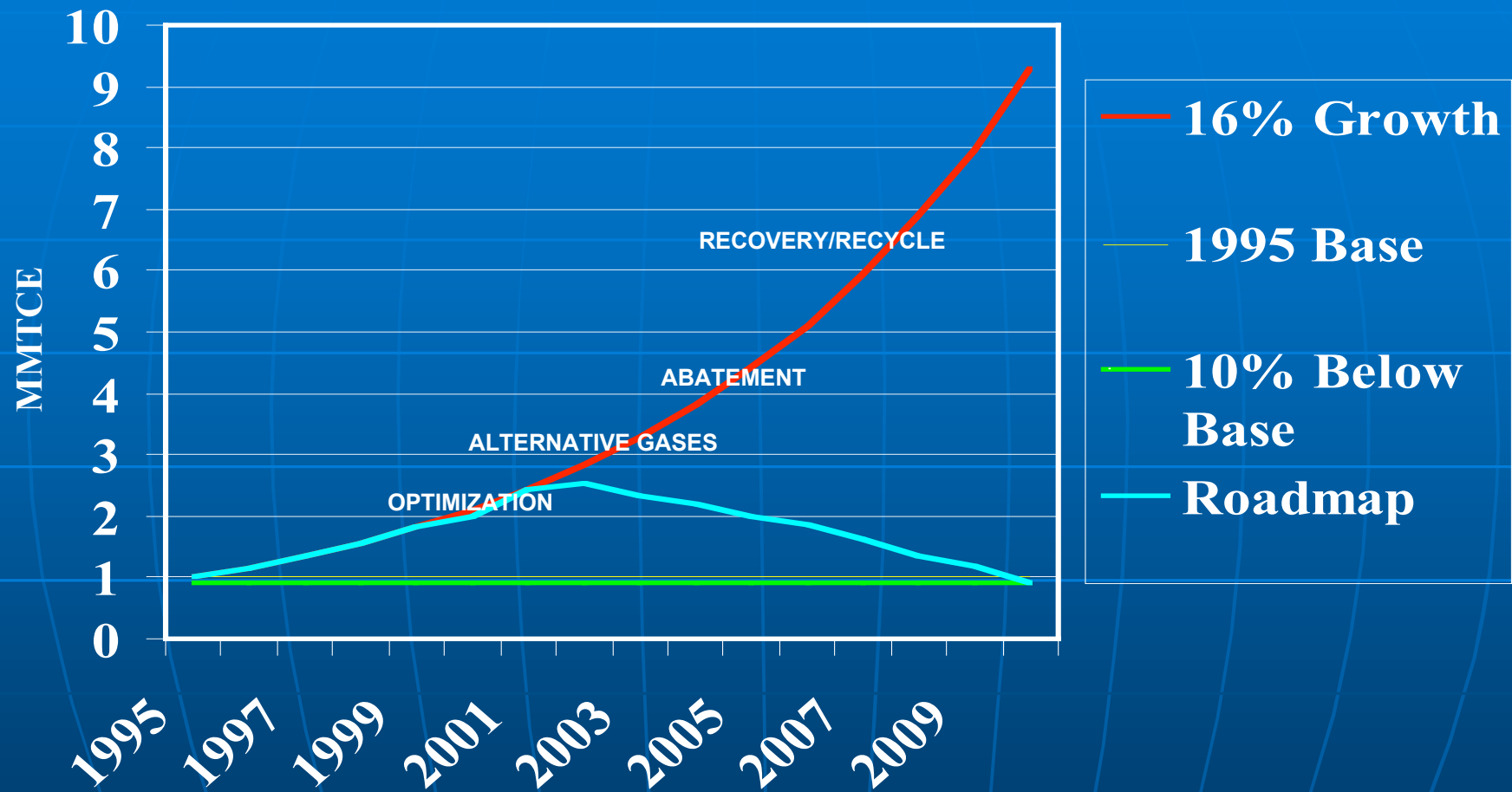
WHY THE 1998 AGREEMENT?

- Strong interest expressed by US EPA in taking the next step beyond 1996 MOU – set a quantitative target
- Increased focus on high-GWP gases in European Union
 - Member State policy discussion
 - Brussels discussions re implementing Kyoto obligations under European Climate Change Programme (ECCP)
- Fear of a potential ban/phase-out of *uses* versus requirement to reduce *emissions*
- We asked ourselves – how do we get out in front of this issue and prevent collision between EU regulatory actions and our PFC dependency?
- Further concern PFCs would get swept up in push against HFCs

INTEL AND WSC AGREEMENT

- Intel played leading role in conceiving what became global WSC agreement
- Senior management supportive of a proactive, “get ahead of the game” strategy, with the proviso that:
 - The rest of industry sign on to ensure both an effective effort (from climate perspective) and a level playing field within industry

REDUCTION STRATEGY

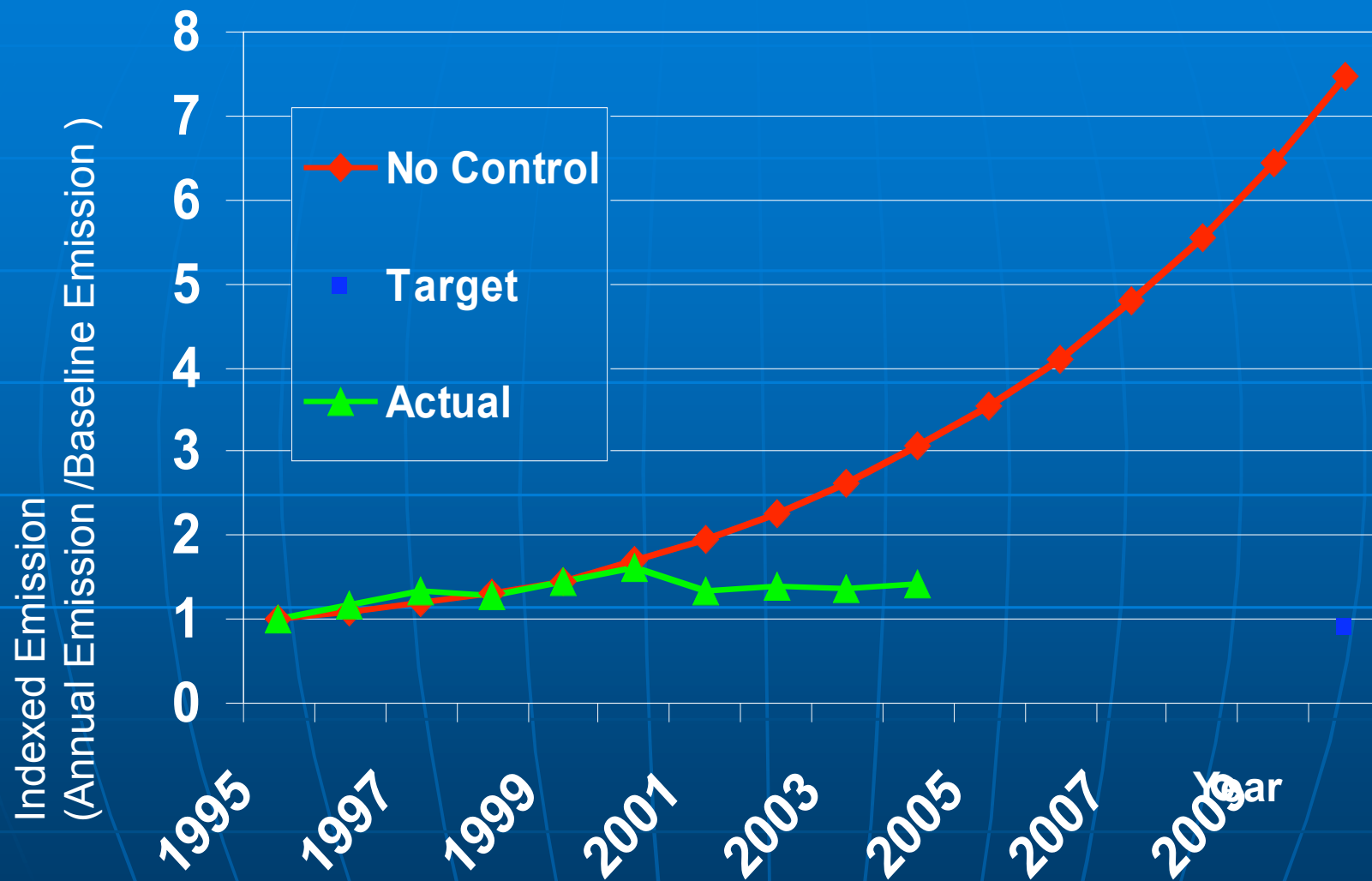


Typical Reduction Roadmap Based on
1 MMTCE Baseline

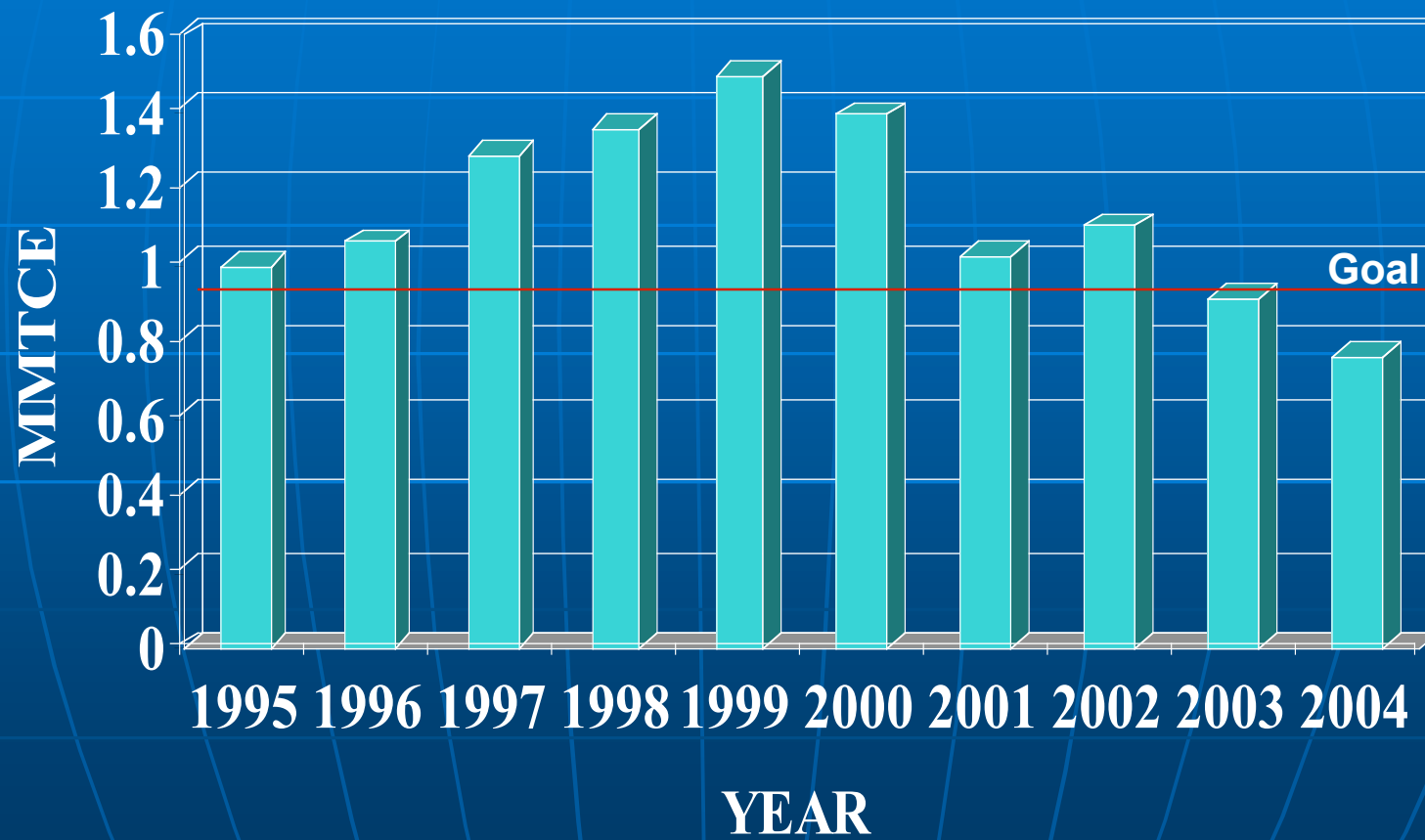
PROGRESS

- Global and US industry both making good progress towards commitments
- Absolute reductions accomplished despite strong growth in semiconductor sector

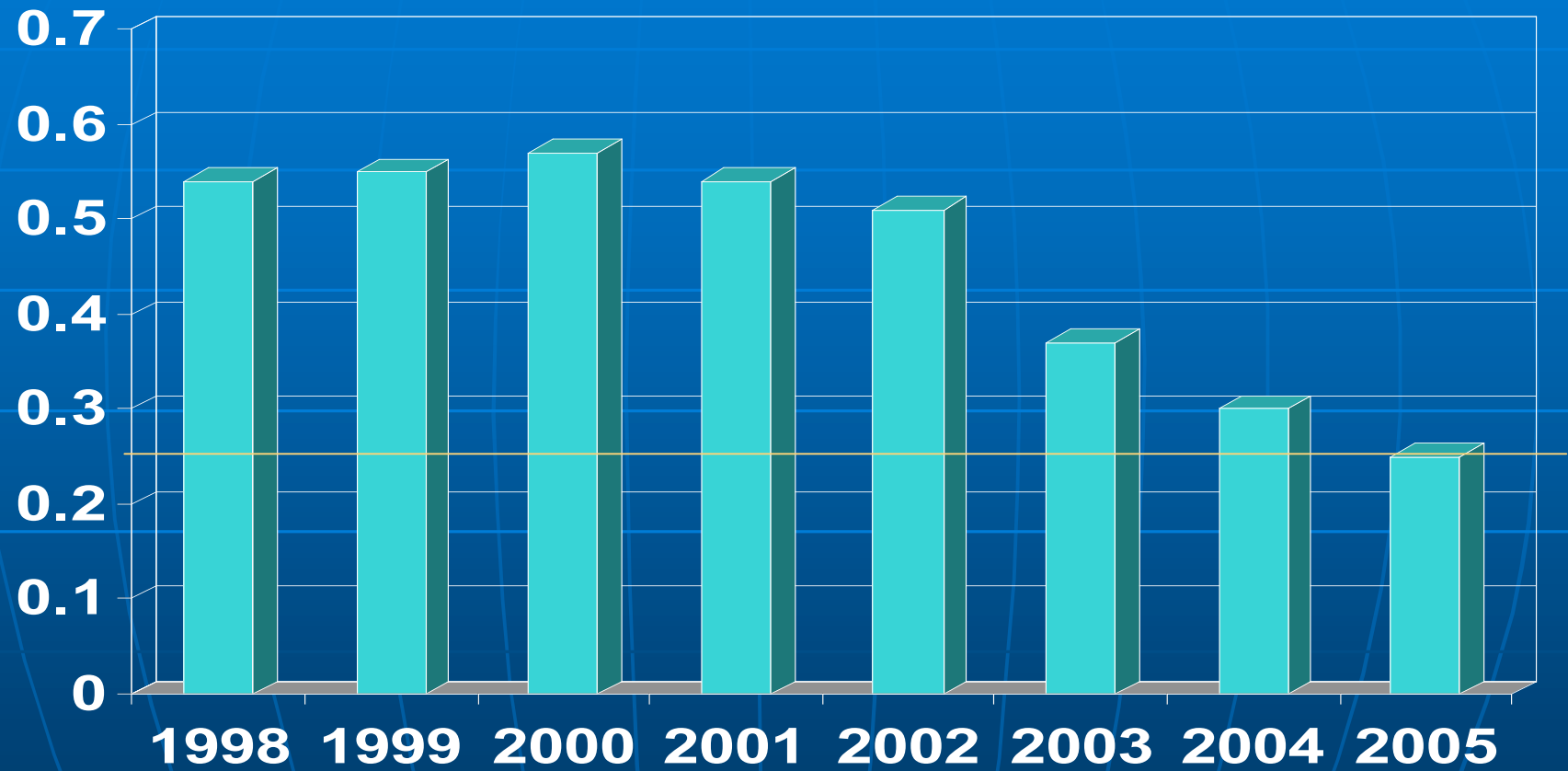
WSC INDEXED PFC EMISSIONS



SIA Partners PFC Emissions



INTEL PROGRESS



1995 Baseline =
0.25 MMTCE

STORY BEHIND THE PROGRESS

- Since 1998, Intel's production has increased by **2X**
- Nonetheless, we have reduce our PFC emissions by:
 - **50%** on absolute basis
 - **>90%** on normalized basis
- Absolute and normalized reductions in PFC emissions achieved through a variety of means:
 - Chemical substitution
 - Lower GWP materials
 - Materials more completely consumed in process
 - Recovery/recycling
 - Process optimization
 - End-of-pipe treatment (least-used option)

STATUS OF PFCs IN EUROPE

- European Climate Change Programme, endorsed by EU Member States, acknowledged PFC voluntary commitment as way forward for semiconductor industry
- Second Reading of F-gas Regulation in European Parliament just completed, semiconductor voluntary commitment intact
 - But change in legal base means Member States could introduce stricter national measures
 - Regulation to enter into force in Q1'06
- PFCs could be in scope of ECCP 2 and the revision of Emissions Trading rules 2008+

CONCLUSIONS

- Lack of substitutes can create climate regulatory vulnerability for entire industries
- Chemical bans can wreak havoc on semiconductor technology roadmaps
- Progressive industries can work together to forge voluntary programs that work
- Close working relationship with government key
- Global initiatives are best – both for climate and for industry competitiveness
- We are delivering on our commitments!