world semiconductor council
worldwide cooperation in semiconductors

The Semiconductor Industry Contribution to Saving Energy and Protecting the Global Environment

The World Semiconductor Council Chairman , 2008

Frank Huang, Ph.D.

May 2008

Tokyo, Japan

Contents

- Introduction of World Semiconductor Council
- Semiconductor Market
- Energy Saving Activity & Contribution
  - Green Fab (Manufacture)
  - Green Products (Semiconductor products)
  - Contribution Through Green End-Products
  - Contribution for Green Society
- Corporate Social Responsibility
- Technology Roadmap
- Summary

INTRODUCTION OF THE WORLD SEMICONDUCTOR COUNCIL

A unique organization for world semiconductor industry's healthy growth

World Semiconductor Council (WSC)

- **Established in 1997.**
- **WSC now composed of CHINA, CHINESE TAIPEI, EUROPE, JAPAN, KOREA and U.S.**
- **Annual report to governments / authorities.**
- **Member companies cover more than 95% of WW production.**

Purpose and Basic Principles

- Purpose
  - Promote cooperative semiconductor industry activities
  - Expand international cooperation in the semiconductor sector in order to facilitate the healthy growth of the industry from a long-term, global perspective

- Basic Principles
  - Voluntary participation
  - Fairness
  - Respect for market principles
  - Consistency with WTO rules and domestic laws

WSC promotes…

- Trade rules
- Intellectual Property
- Environmental protection
- Safety & Health
- Technology

12th annual meeting in Taipei

- May 22, 2008
  - Chaired by Dr. Frank Huang
- 24CEOs from each association discussed the issues of …
  - Anti Counterfeiting,
  - Trade rules for new products,
  - Climate Change,
  - Contribution of energy saving etc.
- Joint Statement was issued

WSC received a Climate Protection Award

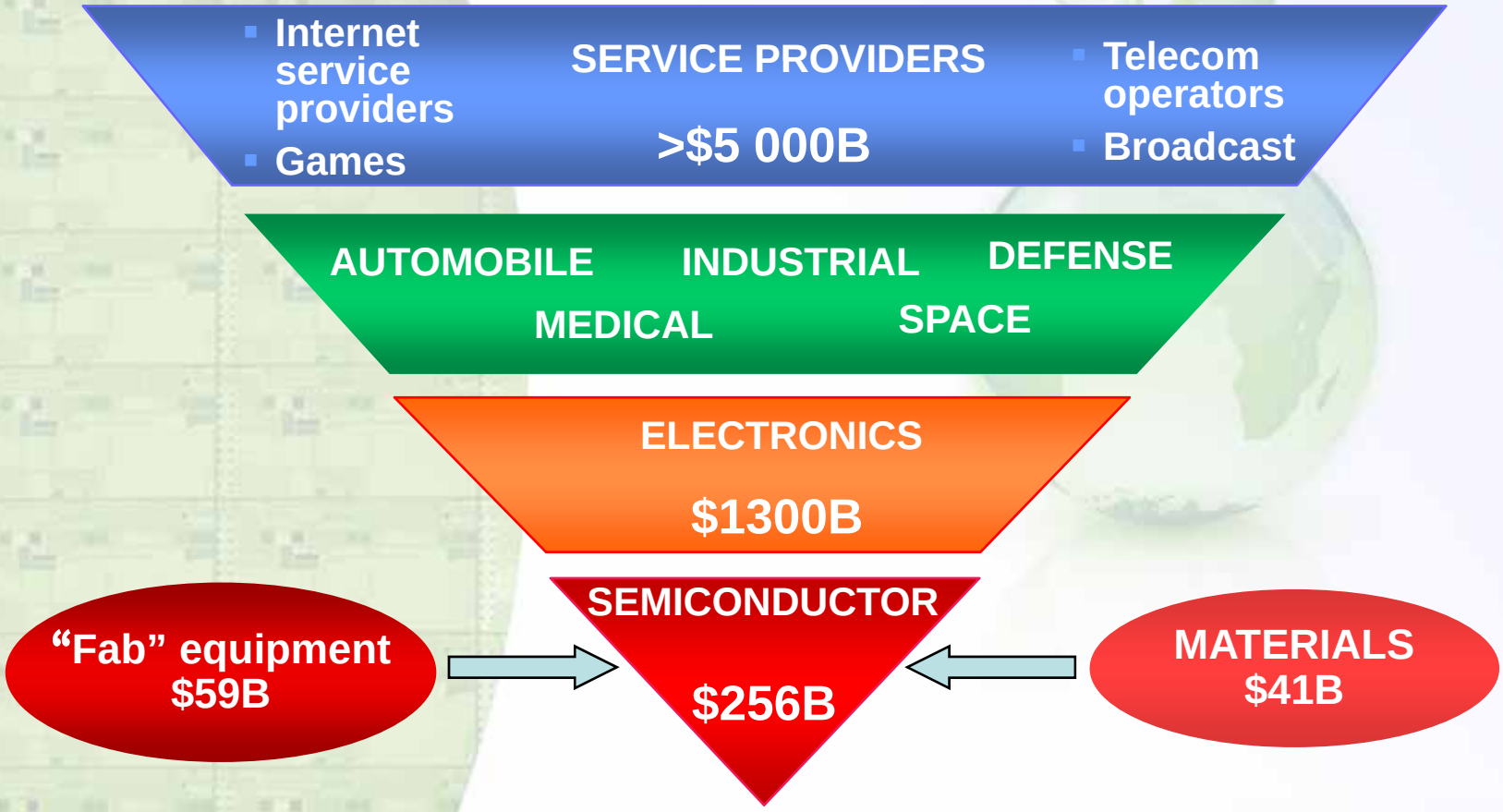
- In 1998 the World Semiconductor Council received the U.S. Environmental Protection Agency's Climate Protection Award.
- The award was for setting a goal to reduce global PFC emissions by 10 % below 1995 levels by 2010 and laying out a strategy to do so.

SEMICONDUCTOR MARKET

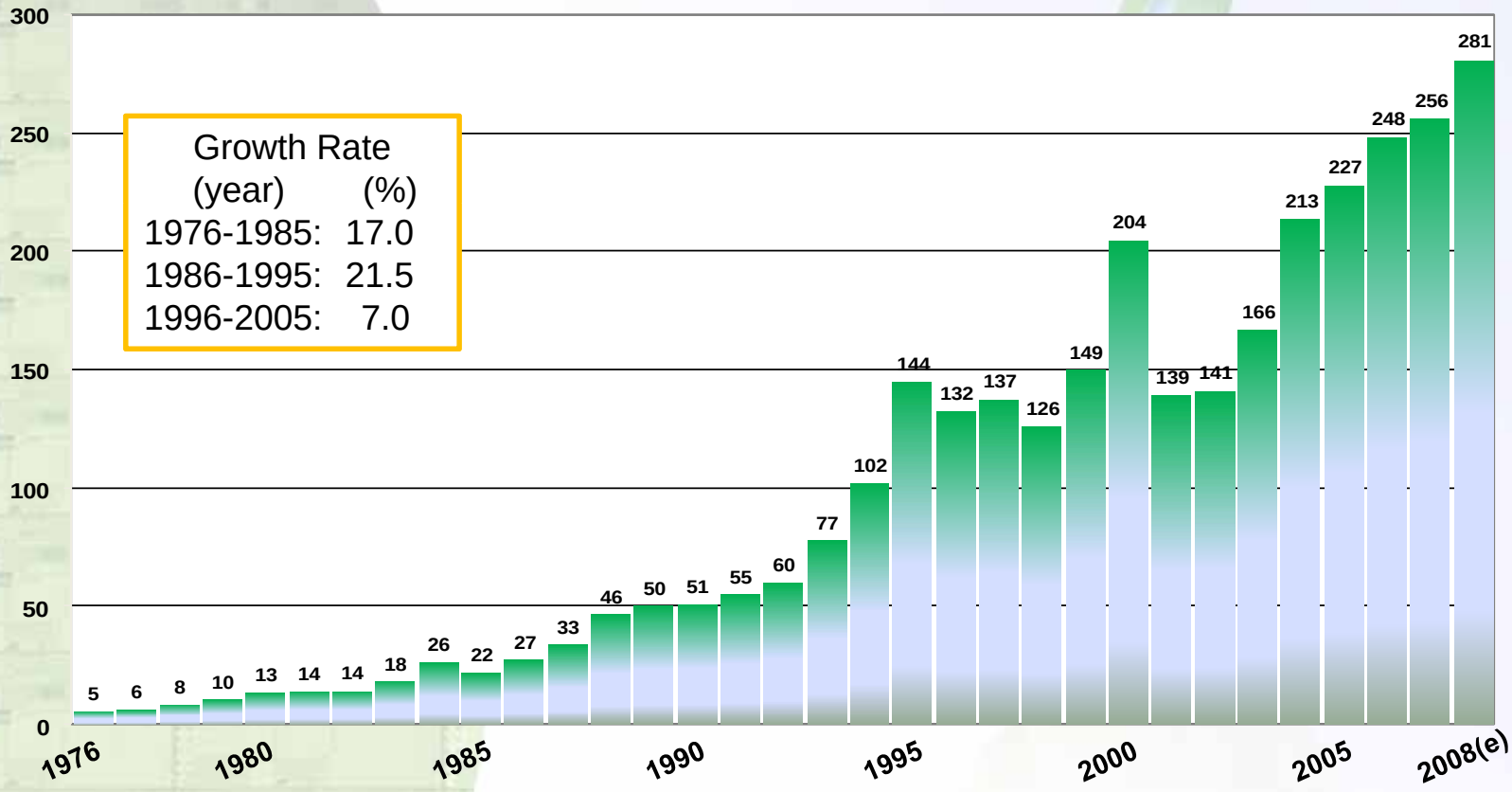
Growing and sustaining most of other industries

Semiconductor as “enabling” industry

Economic impact of the semiconductor industry on key downstream sectors-2007



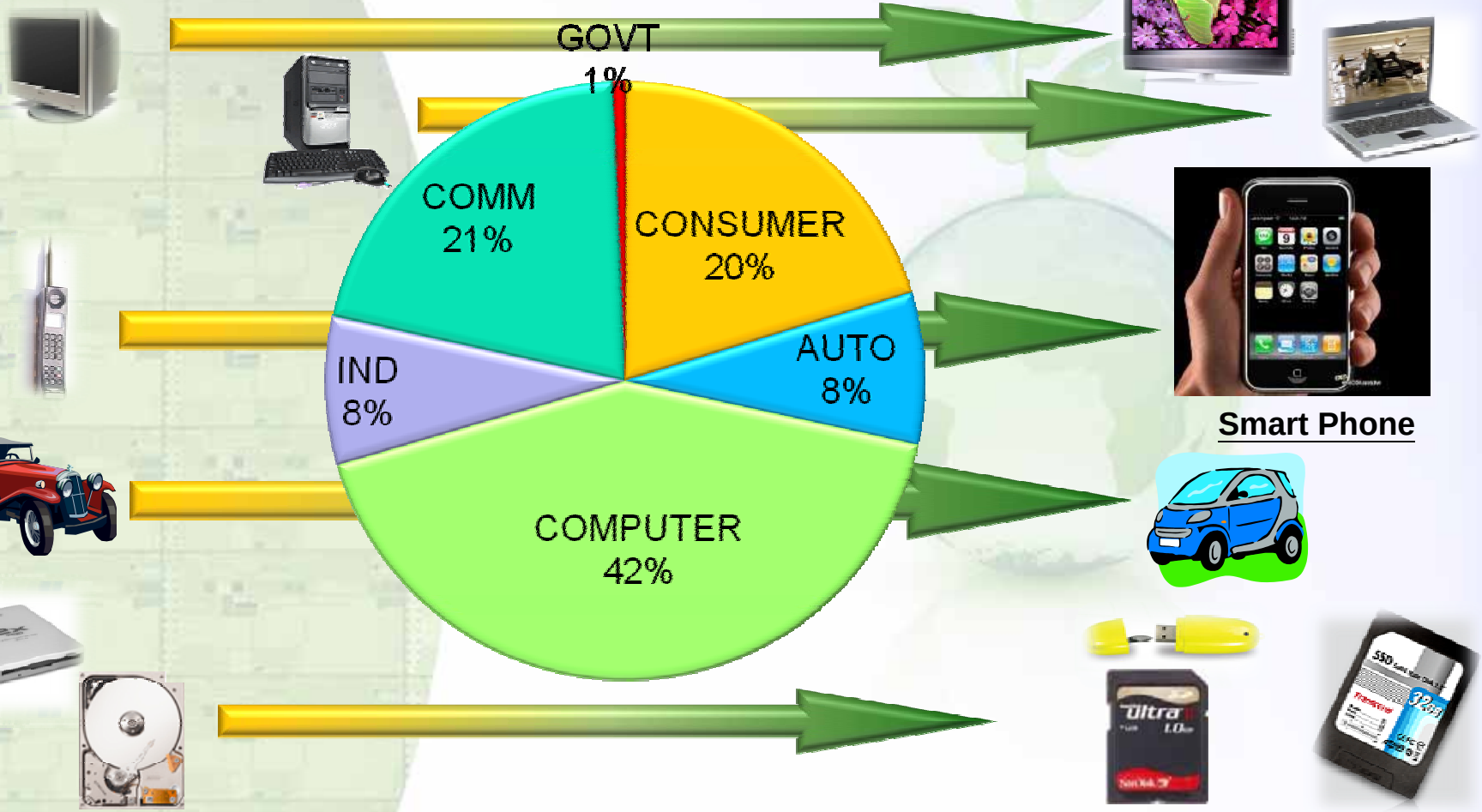
Worldwide Semiconductor Market Trend



- In 2007 global semiconductor shipment reached 580.2B pcs, with a growth of 11.8%
- In 2007 global semiconductor ASP was down 7.7% to 0.441USD
- In 2007 the worldwide semiconductor market grew 3.2% to 256B USD

Sources：WSTC; Gartner; (2008/3)

Semiconductor products work for energy saving everywhere…



Sources : SICAS； ITRI/IEK(2008/3)

ENERGY SAVING ACTIVITY & CONTRIBUTION

The semiconductor industry has the large leverage effect over our society overall

How can the semiconductor industry contribute …

Semiconductor industry's role in energy saving

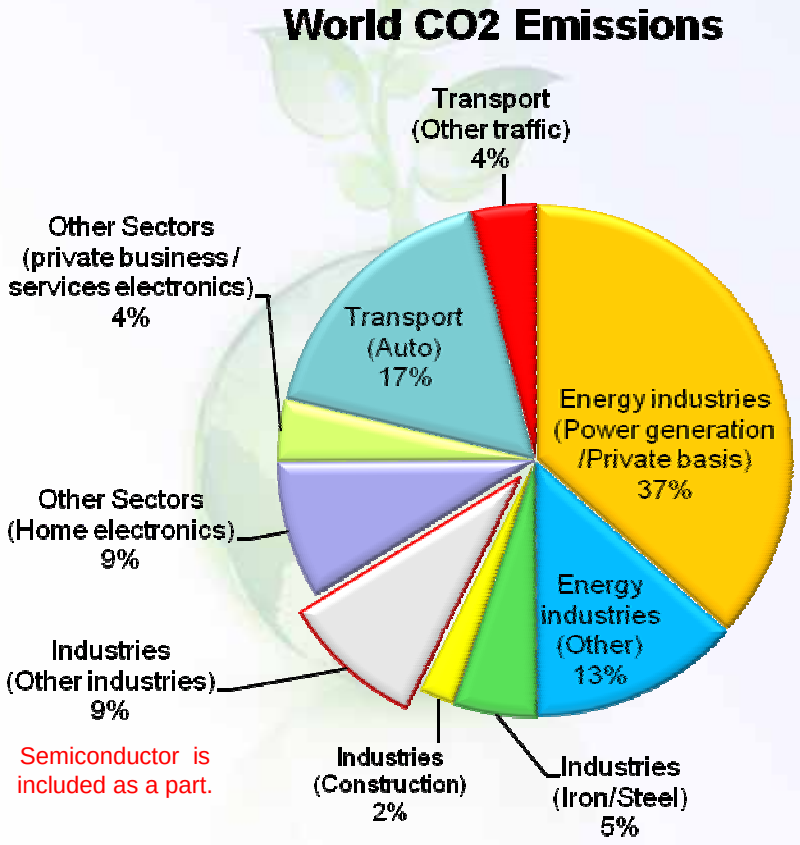
- Direct Contribution
  - Designing Green semiconductor products that use less energy.
  - Purchasing Green inputs to make semiconductors.
  - Building Green fabs that use less energy to make chips.

- Indirect contribution
  - Designing products that enable energy savings at the electronic systems level.
  - Providing products that enable customers and society to save energy (Green IT).


Green Society
Green
End Products
Green Products
Green Fab

The semiconductor opportunity

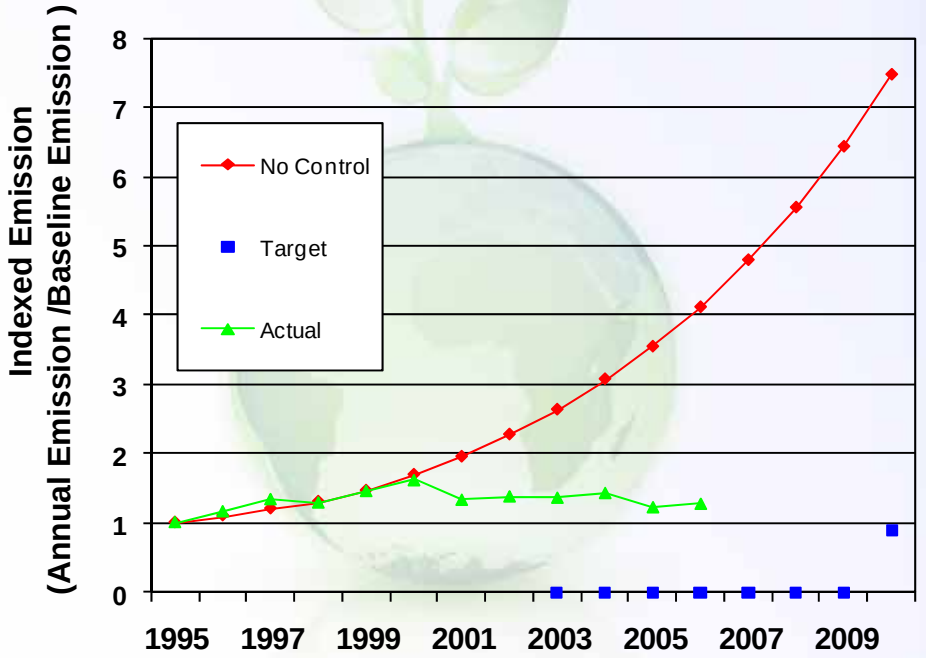
- The semiconductor industry emits relatively small amounts of global warming gases.
  - None-the-less, the industry is proactively and voluntarily reducing its emissions on a global basis.
- However energy saving offers the greatest opportunity for the semiconductor industry to contribute to a sustainable environment.



Source：Ministry of Economy, Trade and Industry (METI)

WSC will reduce PFCs

- Semiconductor manufacturers have been able to reduce PFC emissions by taking a number of actions including
  - Process optimization,
  - use of alternative chemicals,
  - improved abatement systems.
- Semiconductor industry was one of the first global sectors to organise and set emission reduction targets for greenhouse gas reductions.

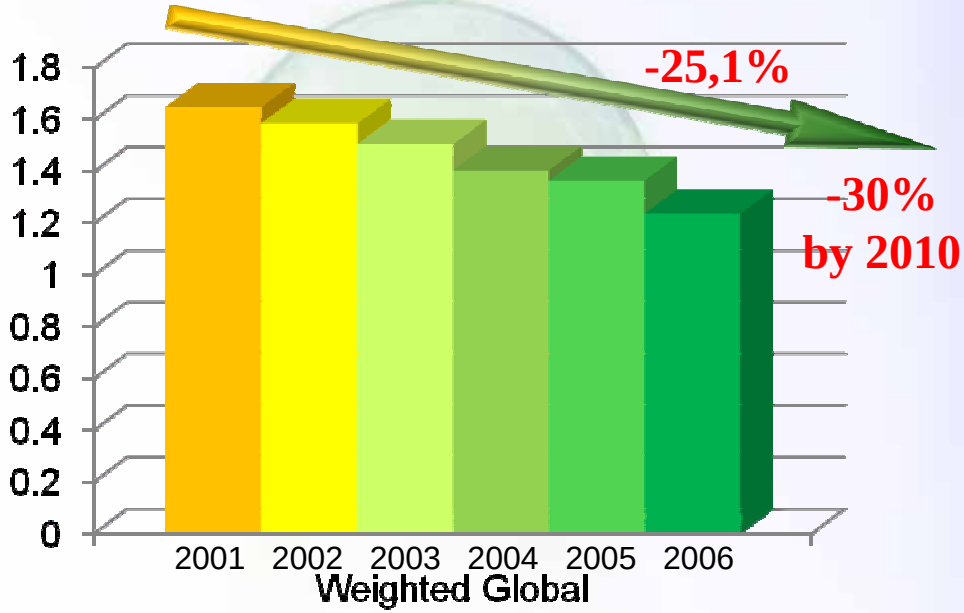


- WSC program to reduce PFC emissions to 10% below 1995 baseline by 2010 is on target (insert 2007 agg data green plot)

WSC can save electricity

- WSC also cooperates on energy savings and resource conservation programmes .
- WSC has a common global metric for a global data collection on the parameters of electricity normalized on the basis of cm2 of silicon.
- WSC has also agreed in 2008, a common definition of expectation levels for the reduction of electricity from the semiconductor production process on a global basis.
  - **Expectation level for…**
    - WSC normalized electricity reduction 2001 –2010 (30%)

WSC Electricity Data: 2001- 2006
Normalized Weighted Global Average:
Kilowatt-Hours per cm^2 Silicon



SIA in China data included beginning 2004

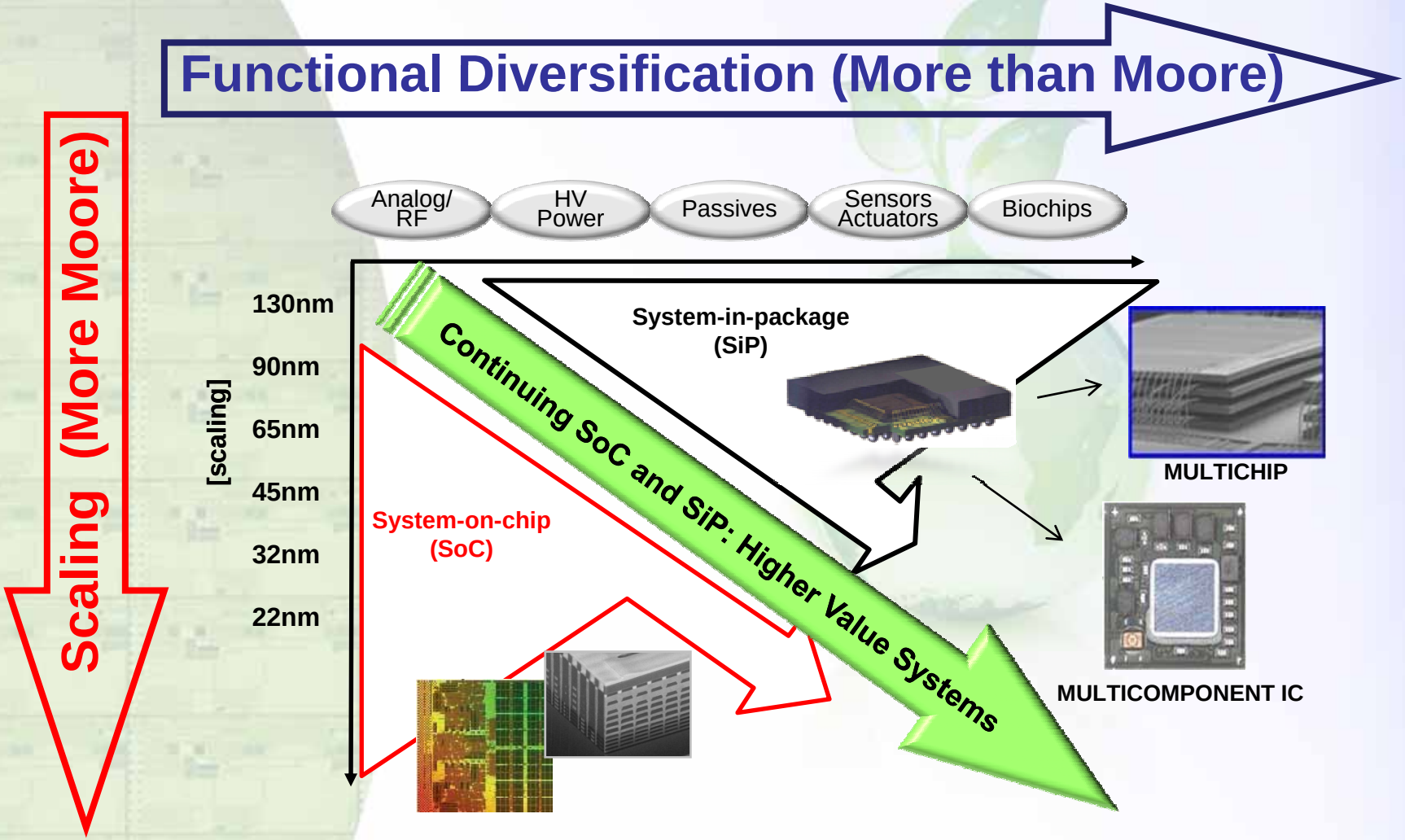
Green Society

Green
End Products

Green Products

Green Fab

Moore's Law & More



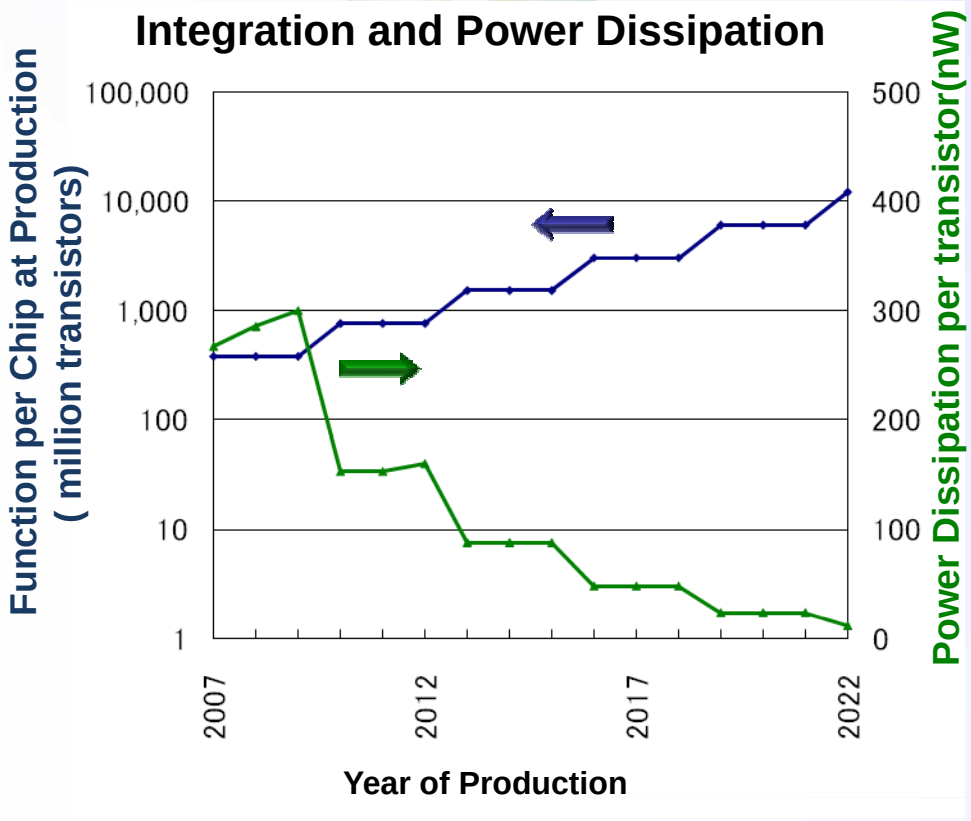
Source: JSTC, adapted from ITRS 2005

Miniaturization for lower power/higher performance

- Miniaturization will
  - realize the same function with smaller chip and lower power. (directed to lower power)
  - Realize more functions without increasing power.

    (directed to Integration)

- The power consumption to activate one transistor has decreased one xx ten thousandth since first transistor was made 50 years ago.



Source: JSTC, adapted from ITRS

Green Society

Green End Products

Green Products

Green Fab

How can semiconductor products contribute to energy saving in end-products?

- Firstly Contribution
  - Use semiconductor products that use less energy.
- Secondly contribution
  - Use products that enable energy savings at the electronic systems level such as MCU function and importing software.

- **Cell phone towers**
- **Data centers**
- **Engine Control Units**
- **PC, Solid (flash) memory**
- **Stand-by power**
- **Tire pressure**
- **Monitor**
- **Consumer electronics and appliance**
- **Solid state and florescent lighting**

Semiconductors drive Solid State Lighting

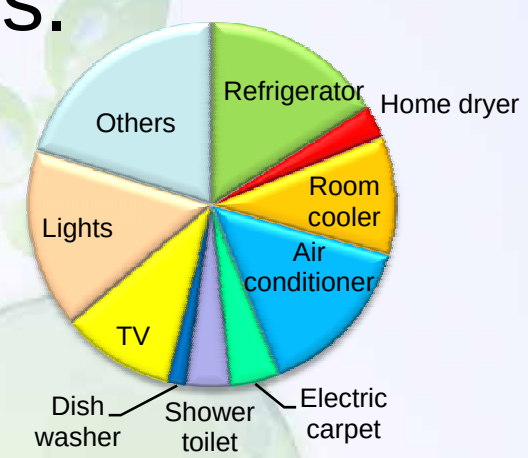
- Solid State Lighting is the new, energy saving lighting solution that uses high brightness Light Emitting Diodes (LEDs)
- Applications examples:
  - Traffic lights
  - Portable consumer devices
  - Automotive
  - In-outdoor lighting
- The bright colors and high intensity of the integrated SSL solutions result in consuming less overall power compared to other lighting technologies
- Lighting uses worldwide 19% of the electricity use
- When taken into account that there is a potential saving of 25 - 40% possible with new lighting solutions → this means possible savings of >550 million tons of CO2 emissions/year

Semiconductors drive Consumer Electronics and Appliances Energy Savings.

- Household appliances in Japan
  - Air conditioners: 99 million
  - Refrigerator: 58 million,
  - Washing machine: 41 million

- Electricity saving by semiconductor devices, i.e. inverter control
  - Air conditioner: 400 (kWh/year/unit)
  - Refrigerator: 100 (kWh/year/unit)
  - Washing machine: 10(kWh/year/unit)

- Potential total electricity saving by semiconductor devices in Japanese households = 46 billion kWh
  - Equal to reduction of 20 million-t CO2 emissions.



Total: 191 billion kWh

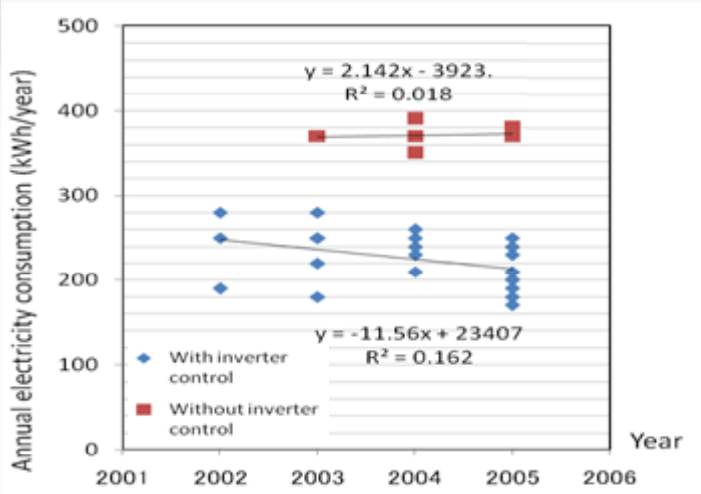


Fig. Annual electricity consumption of household refrigerator (Non-fluorocarbon refrigerant 351-400 L)

Source: Tokyo University

Semiconductors drive replacement of Hard Disk Drives

- Solid Power Efficiency
- SSDs require less than half the energy of a conventional hard drive. And with almost no heat emissions, the SSD doesn't need a fan to keep its cool.

SSD Benefits over HDD

- High Performance, Fast booting & recovery
- High Reliability, Ruggedness
- Low-power consumption, Light weight

2.5” SSD	Power use	2.5” HDD
1 W	active	2.1 W
0.1 W	Idle	1.5 W
0.06 W	Stand by	0.2 W

Sources：Semiconductor Industry Association in Korea

Semiconductors drive Automobile Networking

Networking

- The electronic content in cars is rapidly increasing. A typical modern car has up to 100 electronic control modules
- Enabling a more safer, more comfortable, higher performance and more efficient driving experience
- Standards: CAN, LIN, MOST, FlexRay (new)

Car Wiring: 50 Kg!

- Multiple systems on the same cable
- Huge reduction of car wiring
- Less weight = less fuel

Weight saved = 30 kg per car

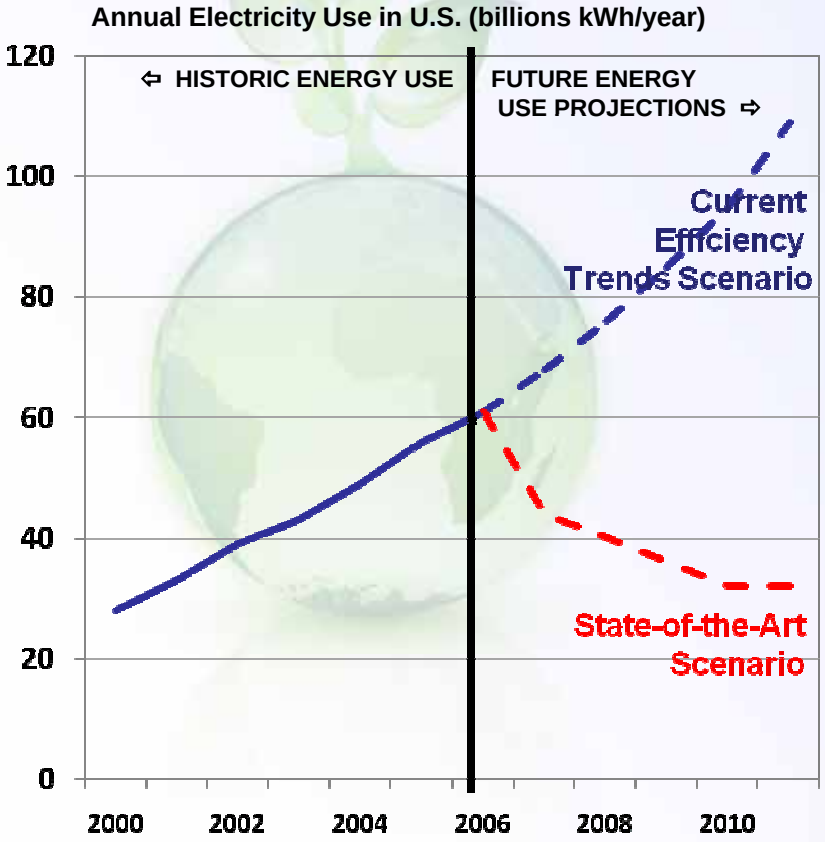
15 Megatons of CO_2

- Globally - annually –

Semiconductors drive Server and Data Center energy savings

- In 2006 servers and data centers in the U.S. consumed 61 B Kilowatt hours, double the amount consumed in 2000.
  - This represents 1.5 percent of total U.S. electricity consumption.
- Under current efficiency trends, U.S. energy consumption by servers and data centers could nearly double again in five years.
- Energy consumption can be reduced by adopting state of the art technologies such as:
  - Aggressively adopt “energy efficient” servers.
  - Up to 80% improvement in efficiency of chillers, fans, pumps, and use of direct liquid cooling.
  - Enable power management at data center level of applications, servers, and equipment for networking and storage.

Aggressive actions on Servers and Data Centers can have dramatic results



US Environmental Protection Agency, “Report to Congress on Server and Data Center Energy Efficiency Public Law 109-431”, August 2, 2007

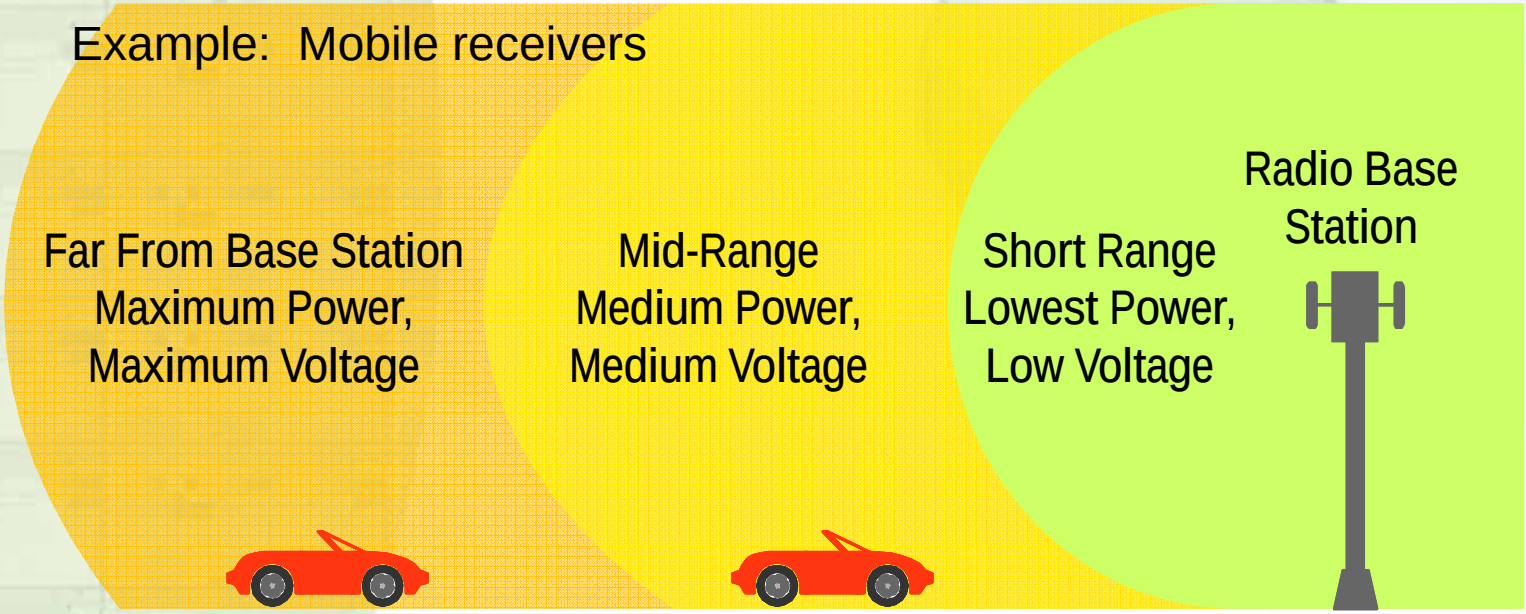
Semiconductors drive energy savings in industrial applications

- Semiconductors enable variable speed motors, which consume 1/8 of the energy as a constant speed drive.
- Two-thirds of the world's industrial electricity runs electric motors and only 5% of these use variable speed drives,
- The 5% of electric motors that do use variable speed drives are estimated to save the energy produced by 10 power plants and annually prevent the emission of 68 million tons of greenhouse gases.
- It is estimated that industrial applications of new energy-saving chip technologies could improve energy efficiency by up to 88% due to more efficient motor control and power management.

Semiconductors drive Power Management solutions

- Chip-Level Power Management
  - Idle, Standby, Halt Modes
  - Adaptive Voltage Scaling

- System Level Power Management
  - Peripheral shutdown
  - Reduced Power Modes



Green Society

How can semiconductor products contribute to energy saving in Social System?

- Evolutionary Contribution
  - Semiconductor improve the energy efficiency in social system.
- Revolutionary contribution
  - A Highly energy efficient Social System is possible using IT.

- **Telecommuting**
- **Smart Metering**
- **Smart office building**
- **Intelligent Transport Systems**

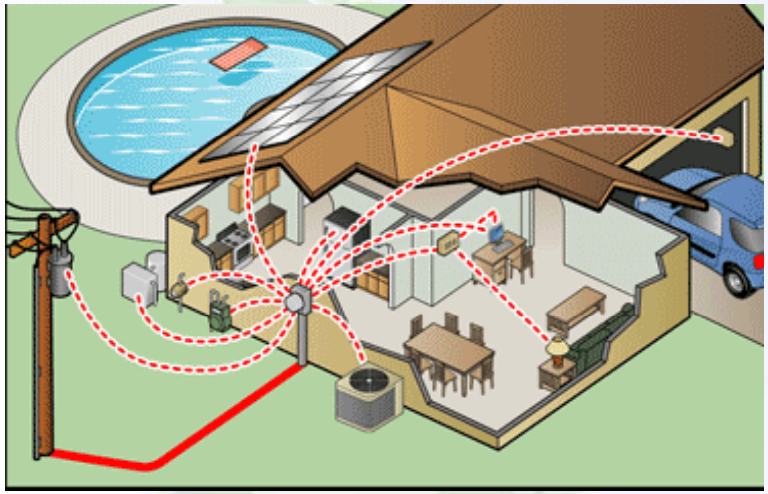
Semiconductors enable energy savings through telecommuting

- Today many people work with information rather than tangible products. The internet allows these people to work from home rather than the office.
- An average U.S. telecommuter lives 22 miles from work. One person telecommuting just one day:
  - Saves 1.4 gallons of gasoline, the equivalent of up to 12 hours of an average household's electricity use, and
  - reduces CO2 emissions by 17 to 23 kilograms per day
- The 3.9 million telecommuters in the U.S. reduced gasoline consumption by about 840 million gallons
- This reduces curbing CO2 emissions by nearly 14 million tons, an amount equal to removing 2 million vehicles from the road every year.
- telecommuting saves the equivalent of 9 to 14 billion kilowatt-hours of electricity per year — the same amount of energy used by roughly 1 million U.S. households every year.

Source: Consumer Electronics Association (CEA) "The Energy and Greenhouse Gas Emissions Impact of Telecommuting and e-Commerce;" September, 2007.

Semiconductors enable Smart Metering

- Energy Efficiency & Management
  - Electric utilities seek to improve demand management capabilities
  - Increasing efficiency at the point of use helps avoid need to build additional power plants
- Smart Meter Functionality
  - Traditional meters only measure total consumption – not when consumption occurs
  - A Smart Meter identifies consumption in more detail – typically time of use.



•Time of use information enables basic demand management
•Smart Meter communicates with utility for time of use billing, peak load management, etc.
•Future use of local network within premise enables monitoring and control over end point devices (HVAC, Water Heater, etc.)

Electric power management system of office

Employment of the ECO design for a super skyscraper

～12% reduction of power dissipation in the ECO building

New vibration control system

Adequate core layout

★Energy saving system: e.g. Lights off during personnel absence

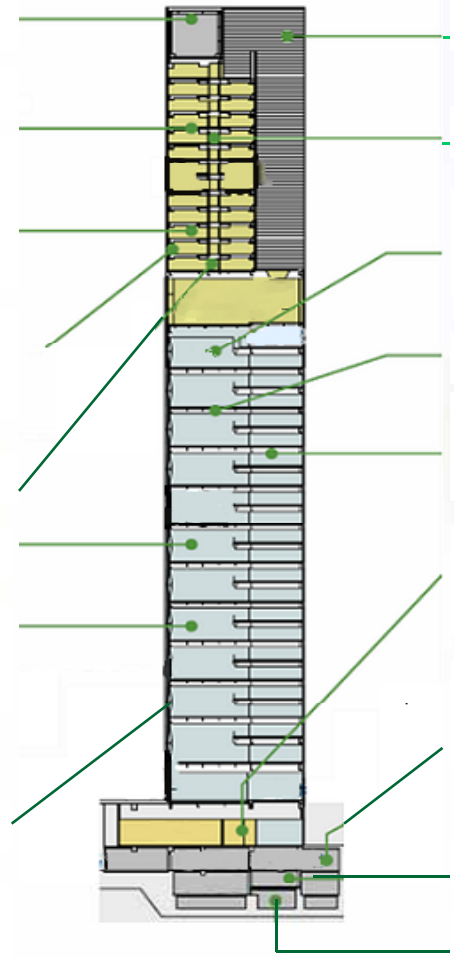
★ ECO rator：Natural air conditioning system

Slab-sleeve unit

Office Garden

★ Intelligent air conditioning system

Windows configuration



Terracotta Tile

Eco shaft

★ Air conditioning with natural ventilation

Metal head lining

★ ECO Lighting System using HF power control

★ BEMS: Building and Energy Management System

★ Chilled-water thermal energy storage system

Reprocessing of kitchen wastewater

Reuse of rainwater

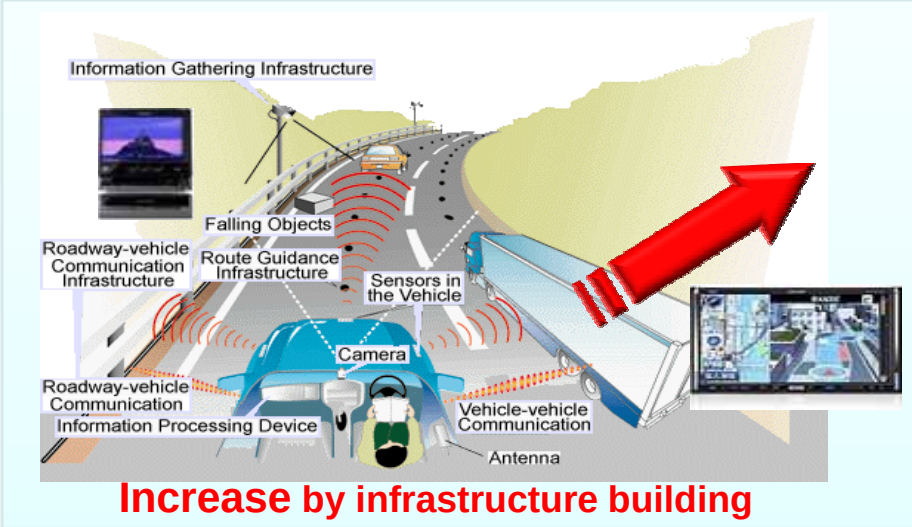
★：*Energy saving areas using Semiconductor/Electronics feature*

Source：Nikkei architecture

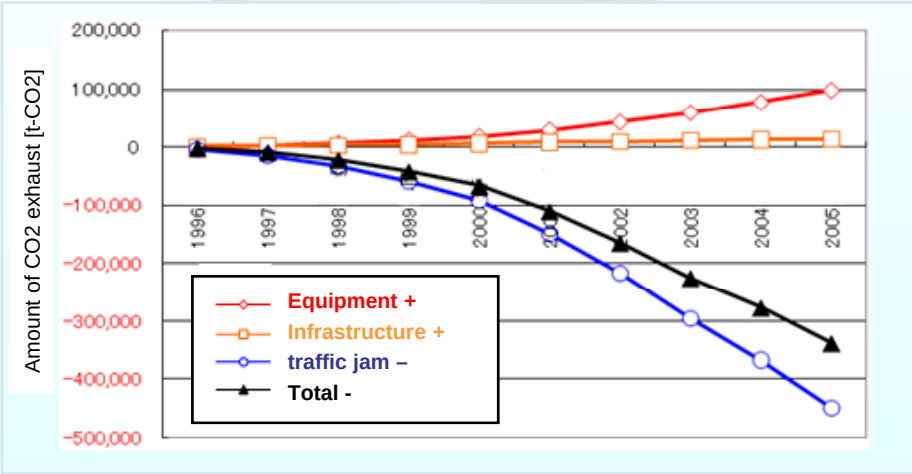
A new transport system (ITS)

- Increase of CO2 emission associated with spread of ITS:
  - Infrastructure construction
  - Increase of terminals on vehicles
- Reduction of CO2 emission associated with spread of ITS:
  - Decreasing traffic jam
- Effects of reduction of CO2 emission by spread of ITS
  - Reduction effects by decrease of traffic jams exceeds greatly increase effects.

ITS : Inteligent Transport Systems



Increase by infrastructure building



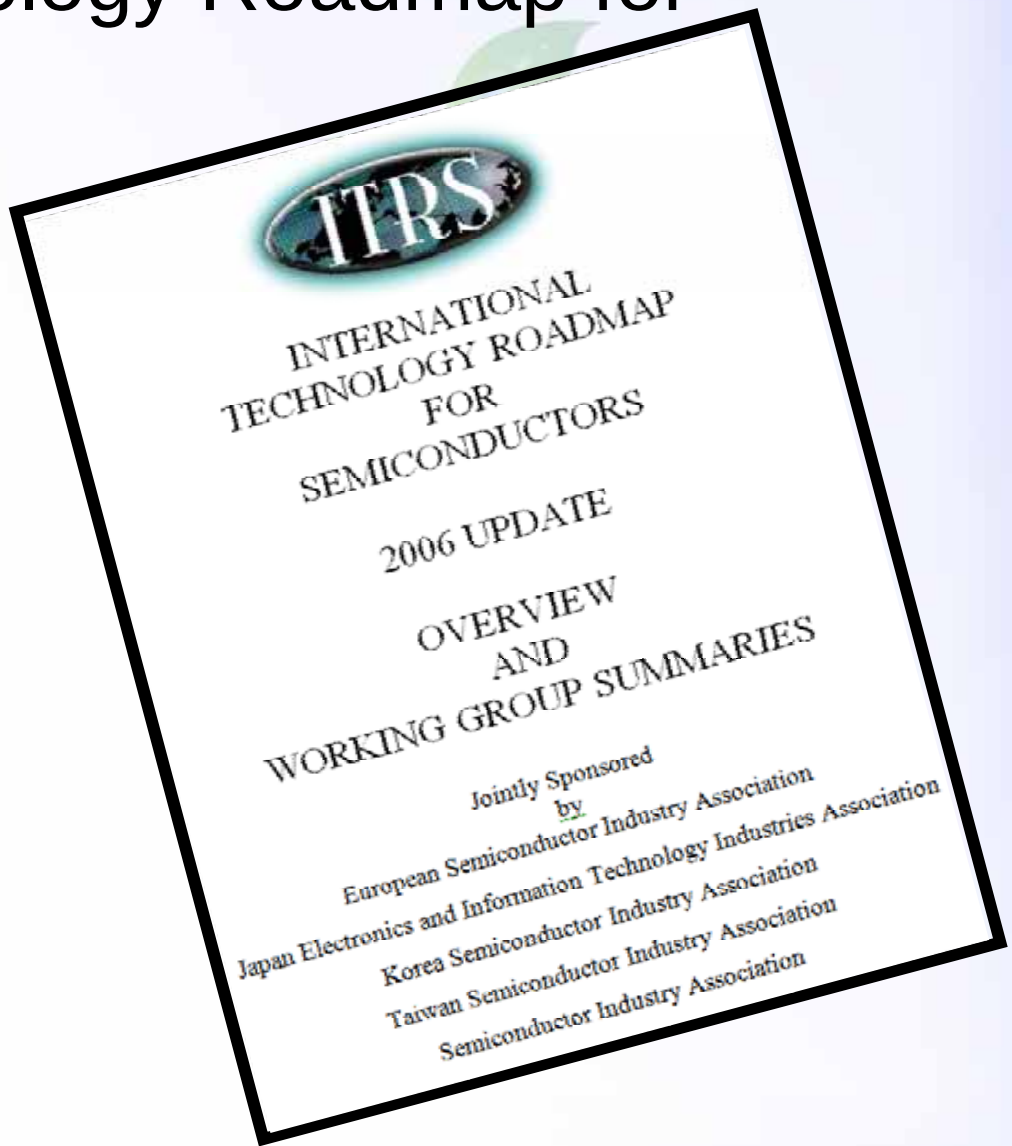
(reference) Mizuho Information & Research Institute Inc.<In Japan>

TECHNOLOGY ROADMAP

More research is needed to generate new ideas that can realize Green society.

International Technology Roadmap for Semiconductors

- ITRS written by over 1200 experts from around the world focused on 16 topics such as design, lithography, test, metrology, interconnect.
- Identifies technical challenges that must be overcome to continue semiconductor technology advances through 2022 and beyond



What topics are in ITRS

- ITRS has included an ESH chapter that covers topics such as chemical assessment, reduction of global warming gas emissions, and ESH as a design element.

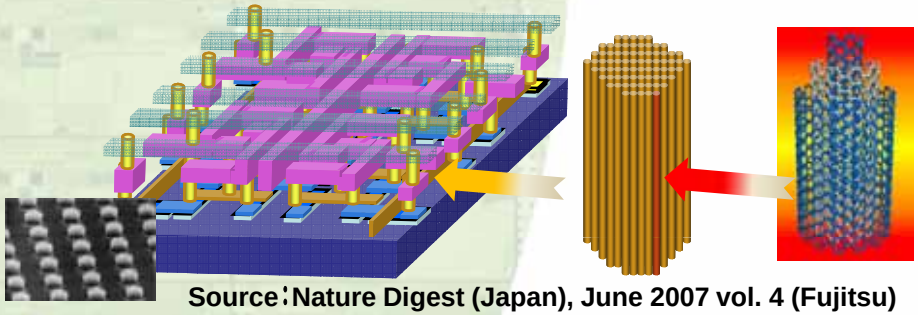
- Recent ITRS have included a System Drivers chapter to align chip roadmaps with the broader electronics industry.
  - *Chapter notes that power is a system driver for portable consumer (battery life), networking/communications, and office equipment*

- The ITRS projects a 5% increase in power consumption in high performance chips as chips run faster and contain smaller circuits that leak power. Increased power usage also creates heat dissipation problems that must be overcome.
  - *Power issues are an important challenge for further research;*
  - *Engineers seek "work a rounds" such as power management to lower system energy usage*

Challenges

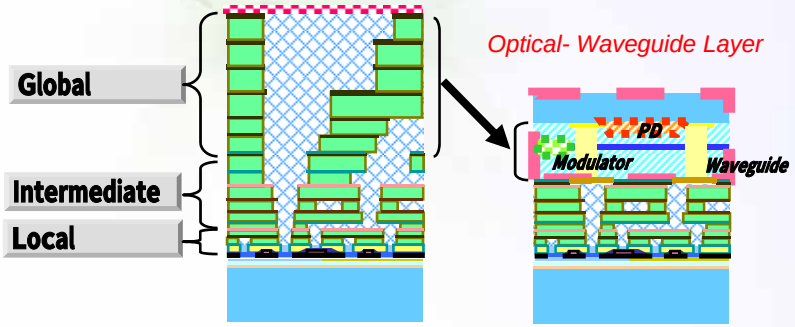
- The ability to continually shrink the circuits on semiconductor is approaching physical and other limits. The ITRS has an Emerging Research Devices chapter that begins to look at replacement technologies.
  - This will be as significant as the transition from vacuum tubes to solid state transistors, or from single transistors to integrated circuits.
- There is currently no replacement technology that would have dramatic energy savings opportunities. More research is needed to generate new ideas that can overcome this problem.

Carbon Nanotube Via



Source：Nature Digest (Japan), June 2007 vol. 4 (Fujitsu)

On-chip optical interconnect



Source: MIRAI-Selete (NEC)

SUMMARY

Governments and Authorities can encourage use of energy efficient IT

- Invest in Energy Efficient Research and Development.
  - Governments can support for research in energy efficient technologies..
- Build Awareness of Energy Efficient Technologies and Practices.
  - Consumer awareness and demand for energy efficient products is the key to developing a scalable and sustainable market for energy efficient products.
  - Governments can help expand consumer awareness about the environmental, health, social and economic benefits that energy efficient technologies deliver.

Governments and Authorities can encourage use of energy efficient IT -- continued

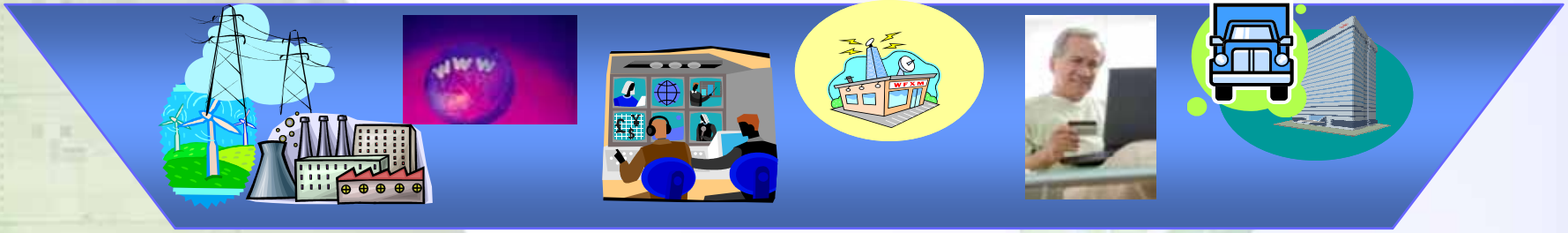
- Incentives for Energy Efficiency.
  - Governments can provide incentives for manufacturers that develop products that meet high standards for energy efficiency and incentives for consumers and businesses to invest in energy efficient products.
  - Examples: tax incentives for manufacturers whose capital investments or products meet high energy efficiency standards, energy utility rebate programs,
- Government-Industry Partnerships
  - Government and industry can create effective standards and share best practices that will increase energy efficiency and reduce energy use.
- Lead by Example
  - Governments can ensure that they only purchase energy efficient products, for example, government data centers can use best available technology to save energy.

Semiconductor industry is contributing to energy savings and environmental protection

- Reducing global warming gas emission.
- Focusing on low power technology.
- Providing semiconductor products to realize high energy efficient end-products.
- Aiming to realize the Green society

The semiconductor industry is…

- providing products to drive energy saving of end-equipment and the social system
- advancing semiconductor technology to achieve future dramatic energy savings.
- achieving healthy growth while being conscious that its products are a key factor to the Green society



Thank you for your attention