2010 revised edition

# Semiconductors Save Energy and Protect The Global Environment

The World Semiconductor Council

September 2010

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**Appendix : "SIRIJ Report :Semiconductors' Social Contribution Report in Japan" Semiconductor Industry Association in Japan presentation at WSC 2010 Seoul**

# 2009-2010 Topics

# Outreach Activities by Region - 2009 Outcome -

**< ALL >**

- Update Green IT presentation material (2009 revised edition)

**< CHINA>**

- Cooperation with government/organization:
  - the Institute of Resources and Environment Standardization Research, CNIS
  - China Solid State Lighting Alliance
  - Ministry of the Environmental Protection and the National Development and Reform Commission
- Translation of the ACEEE report with Semiconductor Industry Association in the US and issue of a white paper about Chinese semiconductor energy savings
- 2nd Sino-US Energy Saving Symposium (Oct. )

# Outreach Activities by Region - 2009 Outcome -

## < CHINESE TAIPEI >

- **Conference on GHG reduction emission (Jan. )**
- **EPA reviewed Semiconductor Industry Association in Chinese Taipei's current status of PFC reduction (Jul.)**
- **Establish semiconductor Product Category Rule (PCR) for future eco-declaration and eco-labeling through GEDnet**
- **Establish "Green Factory Standard" of Hi-Tech industry involving authorities and companies to build a model among industries**
- **Invited to join Chinese Taipei's "2009 State Energy Conference" to form energy and environment sustainability roadmap in next 4 years**
- **The EPA and Industrial Development Bureau have been pushing very hard local industries' carbon inventory preparing for future "Greenhouse Gas Reduction Act". Semiconductor industry finished the first "Industry Supply Chain Carbon Inventory" in 2009 and shared our experience to the authorities and all other domestic industries through 4 forums hosted by the authorities.**

# Outreach Activities by Region - 2009 Outcome -

**< EUROPE >**

- Publication of the Semiconductor Industry Association in Europe Sustainability Brochure (Jan. )
  ➡ See next page
- Non $CO_2$ Greenhouse Gasses Symposium (Jun. )
- EU Green Week Conference (Brussels, Jun. )


**EU ENVIRONMENT COMMISSIONER DIMAS & COUNCIL PRESIDENT MIKO VISIT Semiconductor Industry Association in Europe STAND AT GREEN WEEK**

# Publication of the Semiconductor Industry Association in Europe Sustainability Brochure

# Outreach Activities by Region - 2009 Outcome -

**< KOREA >**

- Korean EPA review of the industrial potential GHG reduction date
- ESH agreement of "Climate Change Meeting" (until 2010)

**< JAPAN >**

- IC Guidebook (Mar. )
- Publication of the Semiconductor Industry Association in Japan Environmental Brochure

**< US >**

- Study finds semiconductor enabled savings of 1.2 Trillion KWHr possible by 2030 (May)

➡ See pp. 28-32 "Semiconductor Opportunities From Recent Energy Studies"

# Outreach Activities by Region - 2010 Plan -

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# Outreach Activities by Region - 2010 Plan -

**< CHINESE TAIPEI >**

- Has formed with the government/authorities a taskforce for adapting the impact of Climate Change in Chinese Taipei, on Science Industrial Parks as the first stage scope:
  - Focusing on area's risk and solution of possible drought, flood, stronger typhoon and infrastructure damage.
  - Covering the regions surrounding the industrial parks.
- Chinese Taipei is within the region of high climate change risk. This is the first time that an industry in Chinese Taipei urging the authorities and leading critical discussions about these physical issues.
- Will continue to assist the legislation related to climate change, green energy and energy tax in Chinese Taipei.

# Outreach Activities by Region - 2010 Plan -

**< Europe>**

- Promotion of SC enabling function through membership of EU Smart Grids and Smart Metering Task Force
- Participation and promotion of SC industry at EU Commission related ICT for *energy efficiency/ Green technology events*
- Continue promotion of the industry with ESIA Sustainability brochure and papers at regular meetings with policy makers
- Marketing on the EE enabling benefits of semiconductor devices– through advertisements in EU policy maker publications

# Outreach Activities by Region - 2010 Plan -

**< KOREA >**

- STOP $CO_2$ Mentoring Scheme
  - Device makers and suppliers will cooperate to reduce GHG and energy
- Manage the organization for “Climate Change”
  - KSIA and device makers have managed this organization

**< JAPAN >**

- At WSC in May & at GAMS in September, introduction of Semiconductors' Social Contribution Report in Japan studied by Semiconductor Industry Research Institute Japan (SIRIJ).

➡ See Appendix

# Outreach Activities by Region - 2010 Plan -

**< U.S. >**

- **Work with DESC on broader energy policy issues**


- **DESC Objective: The ICT industry's contribution to the world's energy and carbon footprint estimated to be two percent and rising. This is the "micro story". ICT also can play a significant role in reducing the footprint of the rest of society—the other 98 percent—through the energy efficiency gains such technologies can help enable. This is the "macro story."**

- **http://www.behindthegreen.org/**

# Outreach Activities by Region - 2010 Plan -

**< U.S. >**

- DESC Members

# Outreach Activities by Region - 2010 Plan -

**< U.S. >**

- SIA will also focus on four specific areas:
  1) computing/servers;
  2) electric transmission/distribution/Smart Grid/Smart House-appliances;
  3) Telecom infrastructure;
  4) renewable energy.

- SIA will integrate energy message in general communications and meet with Department of Energy.

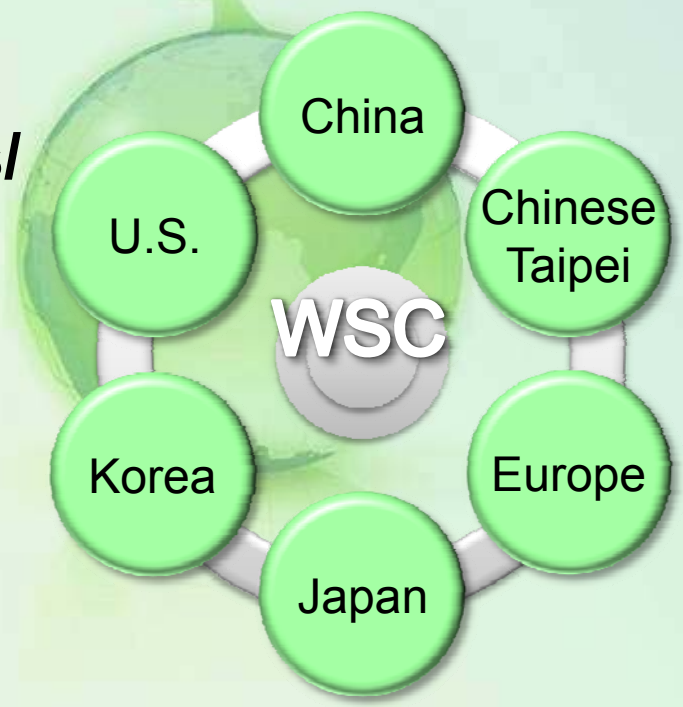
- The House has passed Climate change legislation, but Senate passage is unlikely in 2010.

# 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 worldwide semiconductor 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

# 14th annual meeting in Seoul

- Date: May 27, 2010
- Attendee: 19 leaders of world semiconductor companies & 6 regional industry associations
- Chair: Oh-Hyun Kwon of Semiconductor Industry Association in Korea
- Discussed issues:
  - Cooperative Approaches in Protecting the Global Environment
  - Effective Protection of Intellectual Property
  - Analysis of Semiconductor Market Data
  - Regional Stimulus
  - Free and Open Markets
  - Semiconductor Social Contribution Through Outreach

# WSC won Climate Protection Award

- World Semiconductor Council received the 1998 Climate Protection Award by U.S. Environmental Protection Agency.

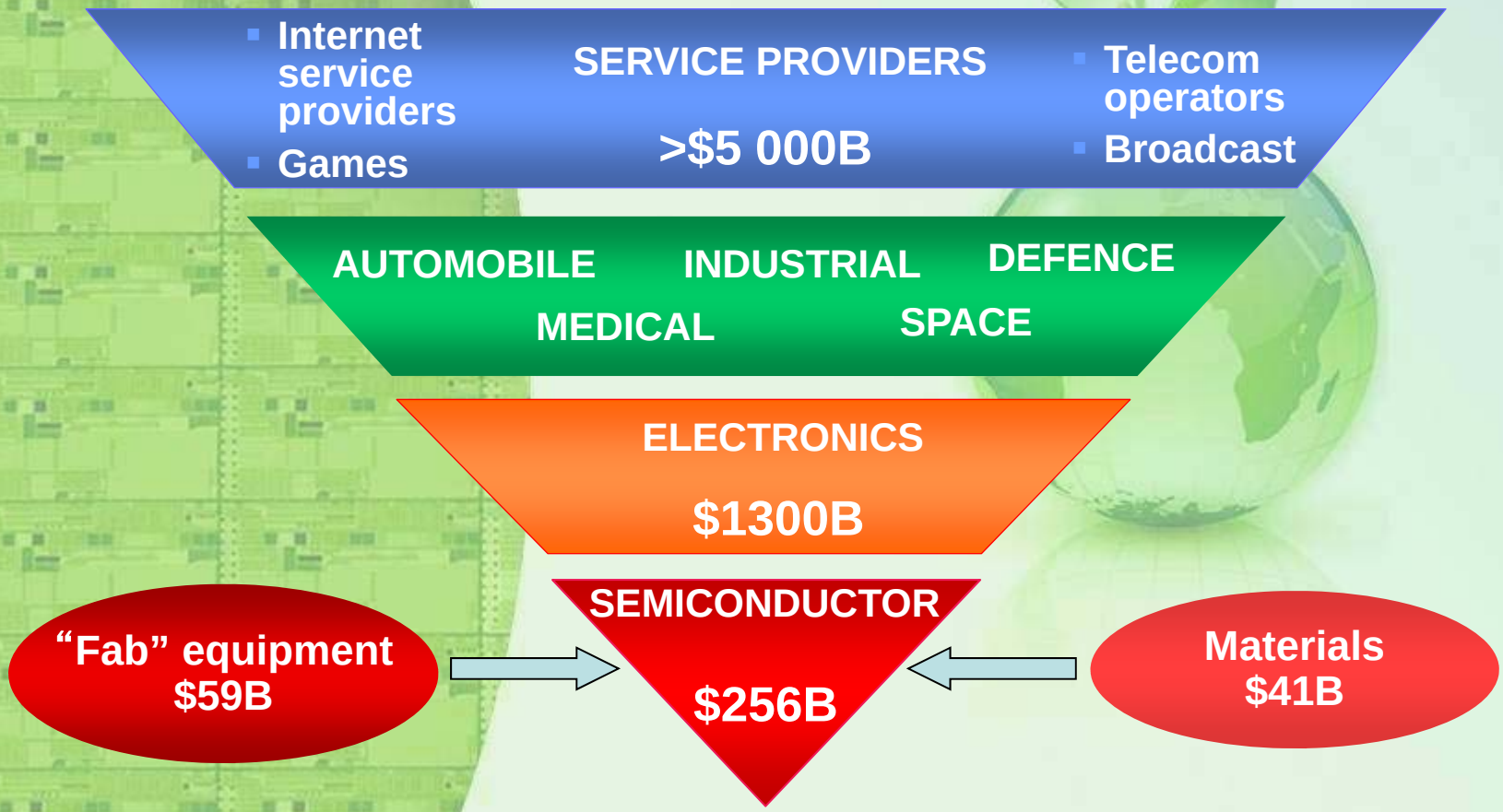
- WSC was prized for PFC reduction activities:
  - Targeting a 10% reduction of the 1995 global PFC emission by 2010.

# SEMICONDUCTOR MARKET

Growing and sustaining most of other industries

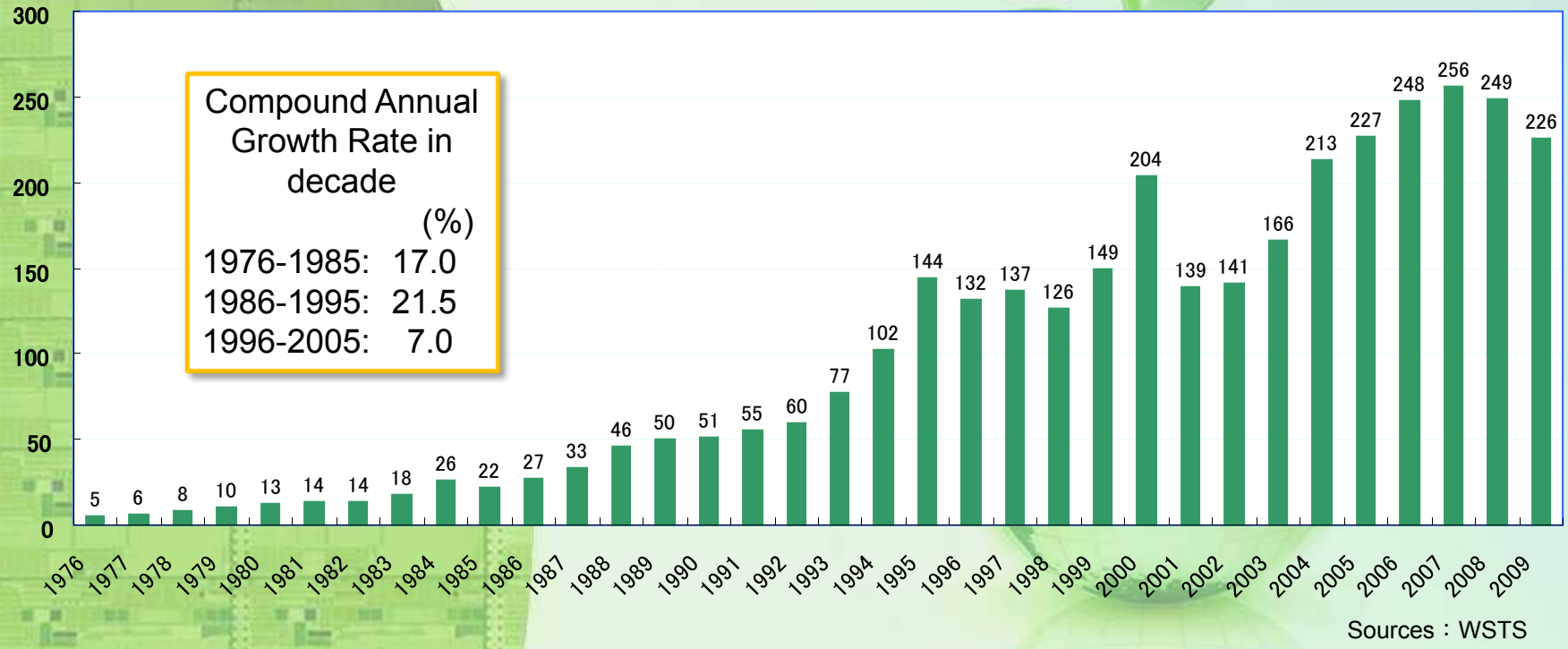
# Semiconductor as “enabling” industry

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



# Worldwide Semiconductor Market Trend

( Billions of US dollars)

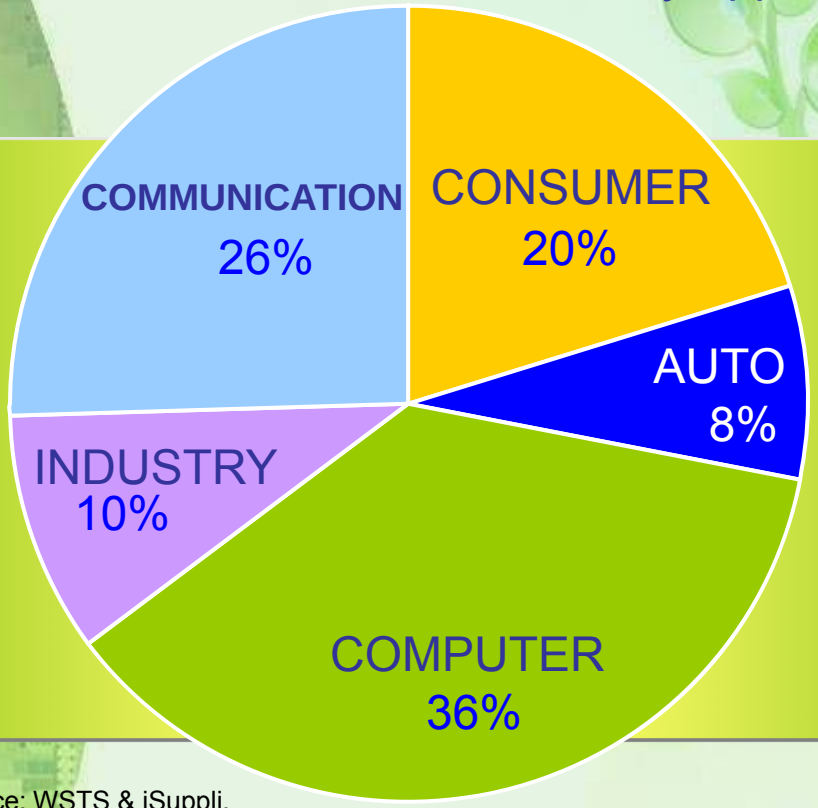



Sources：WSTS

- 2009 world semiconductor shipments declined by 9% from previous year - two years successively decreasing - and reached US$ 226 billion.
- The industry grew by double digit percentage of compound annual growth rate in recent 3 decades, otherwise these several years' gradually-growing market.

# Semiconductor enables to save energy as well as to achieve higher performance in various applications

## 2008 World Semiconductor Market by Application




**Smart Phone**

**SSD**

**NAND flash storage**

Source: WSTS & iSuppli,
"World Semiconductor Council 2009; Market Report;
Semiconductor Market Size by Application 1997-2008"

# ENERGY SAVING ACTIVITY & CONTRIBUTION

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

# 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).

# Semiconductor Opportunities From Recent Energy Studies (1)

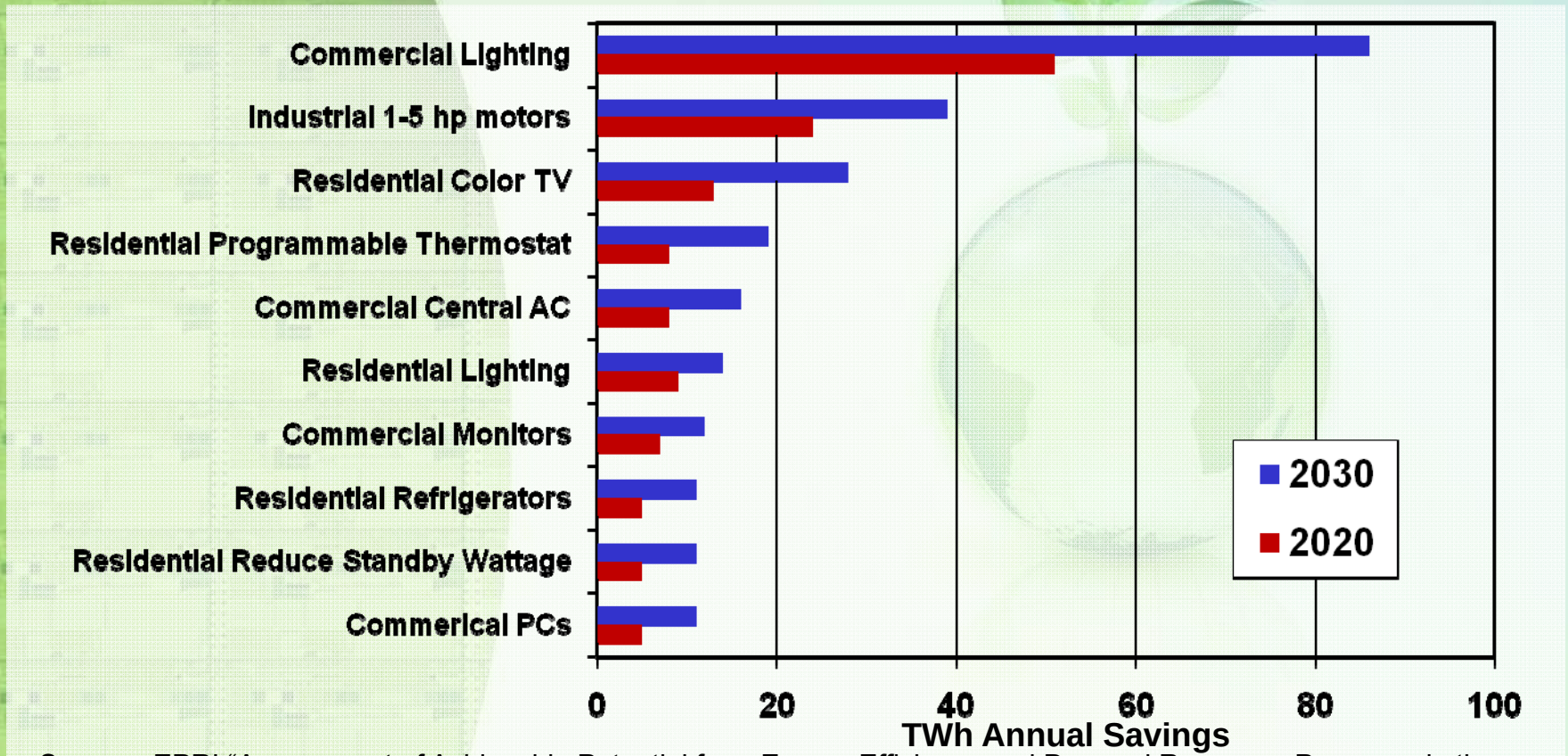
- Three Recent Studies
  - EPRI (Electric Power Research Institute) study
  - GeSI (Global e-Sustainability Initiative) and The Climate Group study
  - ACEEE (American Council for an Energy Efficient Economy) study for Semiconductor Industry Association in the US



ACEEE
American Council for an Energy-Efficient Economy

## Semiconductor Opportunities From Recent Energy Studies (2)

# EPRI Study (2009) Identified Highest Potential Energy Efficiency Opportunities




Source: EPRI "Assessment of Achievable Potential from Energy Efficiency and Demand Response Programs in the U.S. (2010-2030)" 2009.

## Semiconductor Opportunities From Recent Energy Studies (3)

# GeSI/Climate Group Study (2008)

- **In 2007, the carbon footprint of the ICT sector – including both production and use of PCs and peripherals, telecoms networks and devices and data centers – was about 2% of the total carbon emissions.**

- **This figure is expected to grow at 6% annually until 2020.**

**But in spite of this growth, …**

- **ICT emissions in 2020 are five times less than the emissions reductions from the ICT efficiency "enabling effect" on the overall economy.**

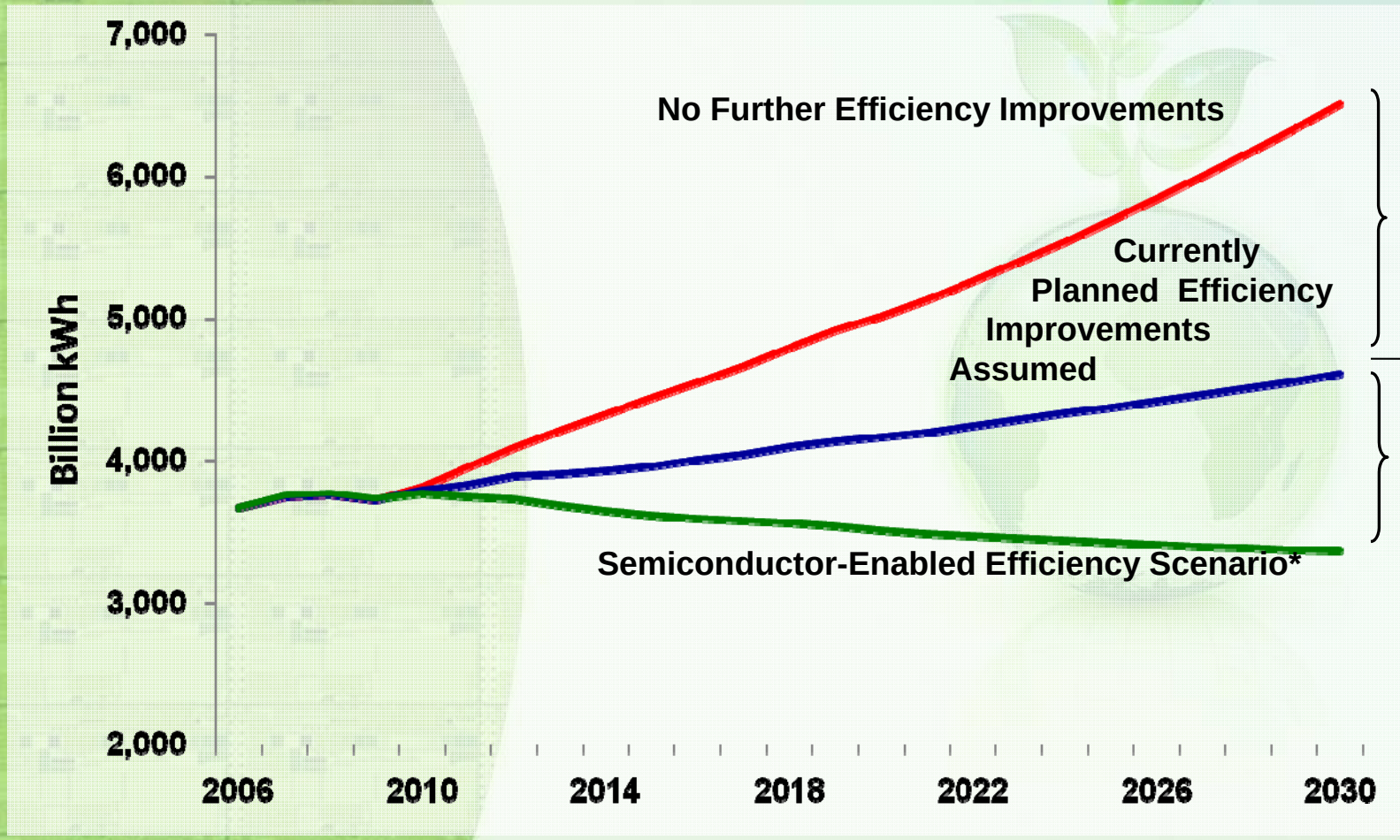
**ICT Emissions (from production & use) = 1.4 $GtCO_2$**

**ICT enabled emissions savings in economy = 7.8 $GtCO_2$**

Source: SMART 2020: Enabling the Low Carbon Economy in the Information Age (2008).

# Semiconductor Opportunities From Recent Energy Studies (4)

## ACEEE Study (2009) -- Semiconductor Efficiency Saves 1.2 Trillion kWh




Source: "Accelerated Investments in Semiconductor-Related Technologies Stimulated by Smart Policies" (2009).

## Semiconductor Opportunities From Recent Energy Studies (5)

# ACEEE Study – What does 1.2 Trillion KWhr savings in 2030 mean?

- 22% less electricity consumed than the reference case, and 11% less than today, even though the economy will be about 70 percent larger
- 733 Million Metric Tons less $CO_2$ emitted in 2030
  - Even more when semiconductor enabled renewable energy (solar, wind) are included.
- 296 plants (600 Megawatt) that are not built by 2030
- $126 B electric bill savings to consumers and businesses in 2030, and $1.3 Trillion in savings cumulative from 2010-2030

Green Society

Green
End Products

Green Products

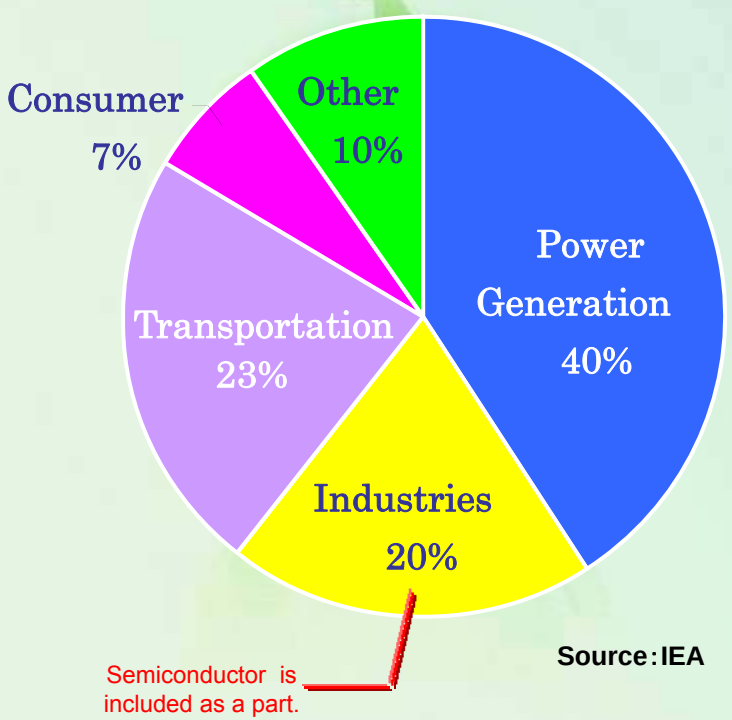
# Green Fab

# The semiconductor opportunity

- The semiconductor industry emits relatively small amounts of global warming gases.
  - Nonetheless, 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 the sustainable environment.

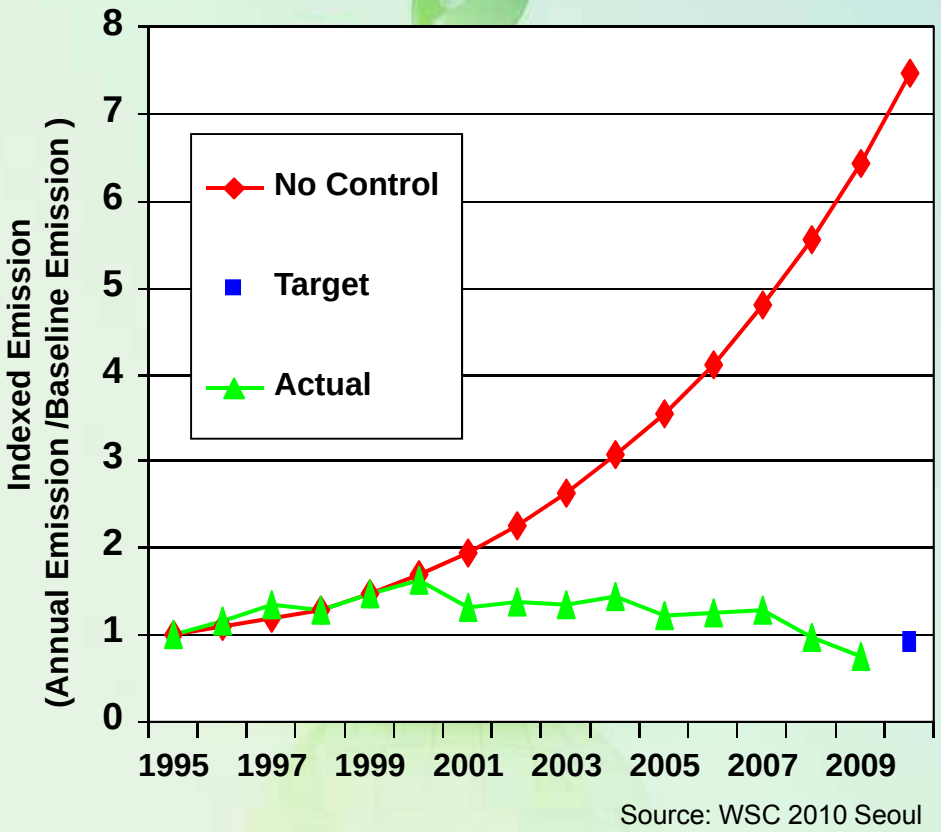
## World $CO_2$ Emissions by Sector

— 2006 World $CO_2$ Emissions: 28 billion ton —



# 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 organize and set emission reduction targets for greenhouse gas reductions.



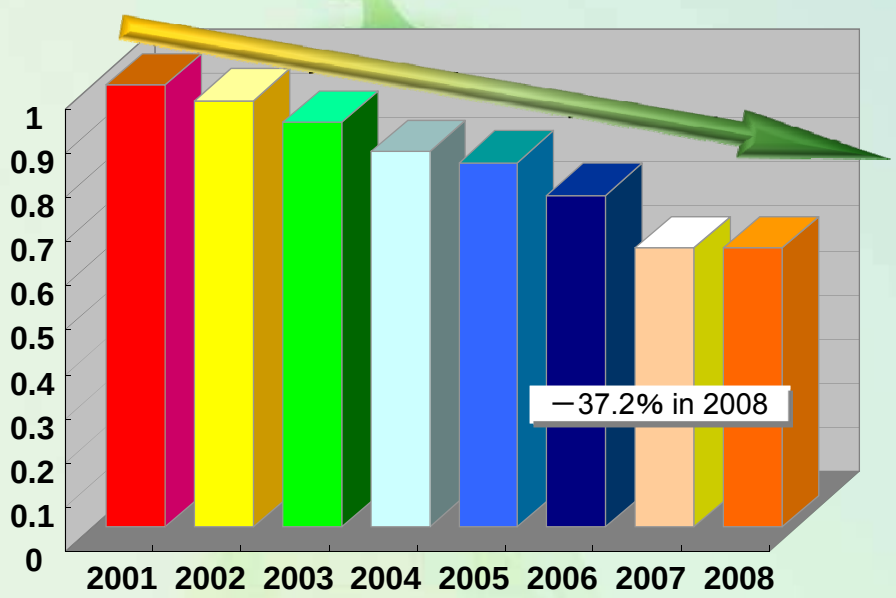

Source: WSC 2010 Seoul

- WSC program to reduce PFC emissions to 10% below 1995 baseline by 2010 is on target

# WSC can save electricity

- **WSC also cooperates on energy savings and resource conservation programs.**
- **WSC has a common global metric for a global data collection on the parameters of electricity normalized on the basis of $cm^2$ 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%)**

Energy Consumption Per Wafer Area
(WSC Electricity Data: 2001-2008)
( Normalized: Year 2001=1.0 )




Source: WSC

Green Society

Green
End Products

# Green Products

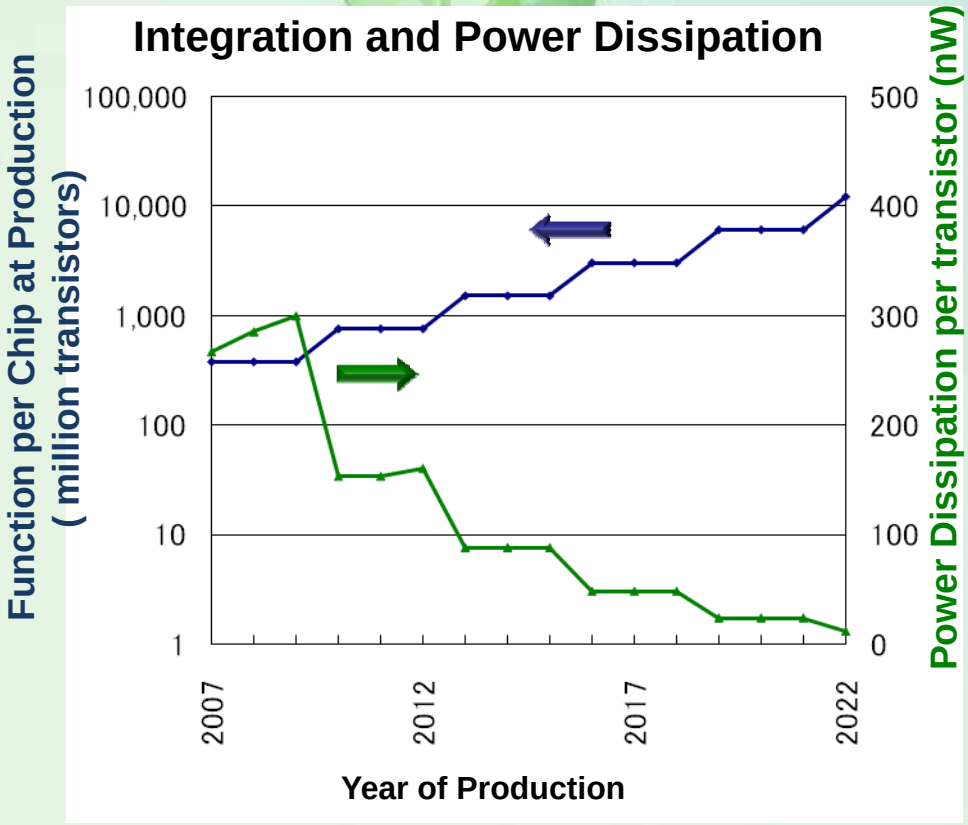
Green Fab

# 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 tens of thousandth since first transistor was made 50 years ago.




Source: JSTC, adapted from ITRS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Green Fab

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

- **Use semiconductor products that consume lower energy.**
- **Use energy-saving products in which ICs and software work as system level energy-saving function.**

- **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 fluorescent lighting**

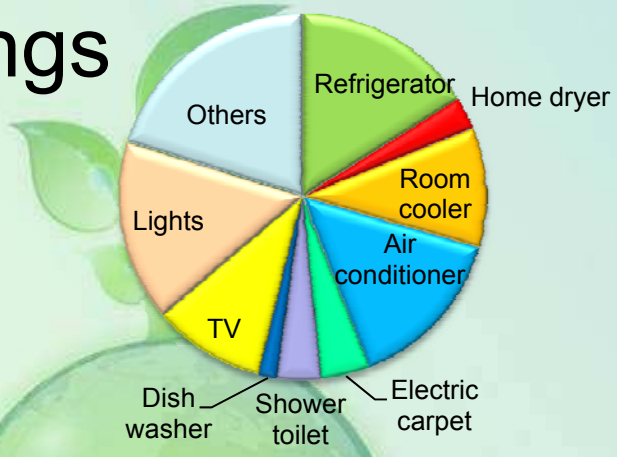
# Semiconductors drive Solid State Lighting

- Solid State Lighting(SSL) is the new energy saving lighting solution that uses high brightness Light Emitting Diodes(LEDs).
- Application examples:
  - Traffic lights
  - Portable consumer devices
  - Automotive
  - Indoor/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 $CO_2$ 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 tons of $CO_2$ emission




Total: 191 billion kWh

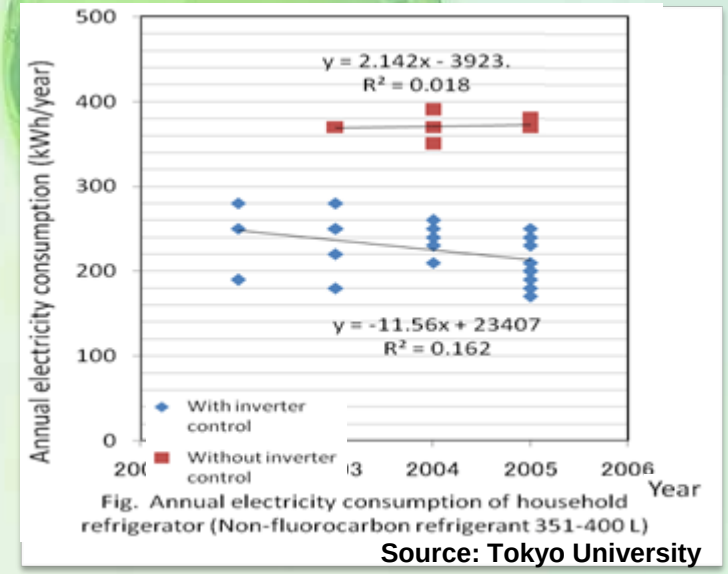



Fig. Annual electricity consumption of household refrigerator (Non-fluorocarbon refrigerant 351-400 L)

**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 safer, more comfortable, higher performance, and more efficient driving experience
- Standards: CAN, LIN, MOST, FlexRay

## 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**

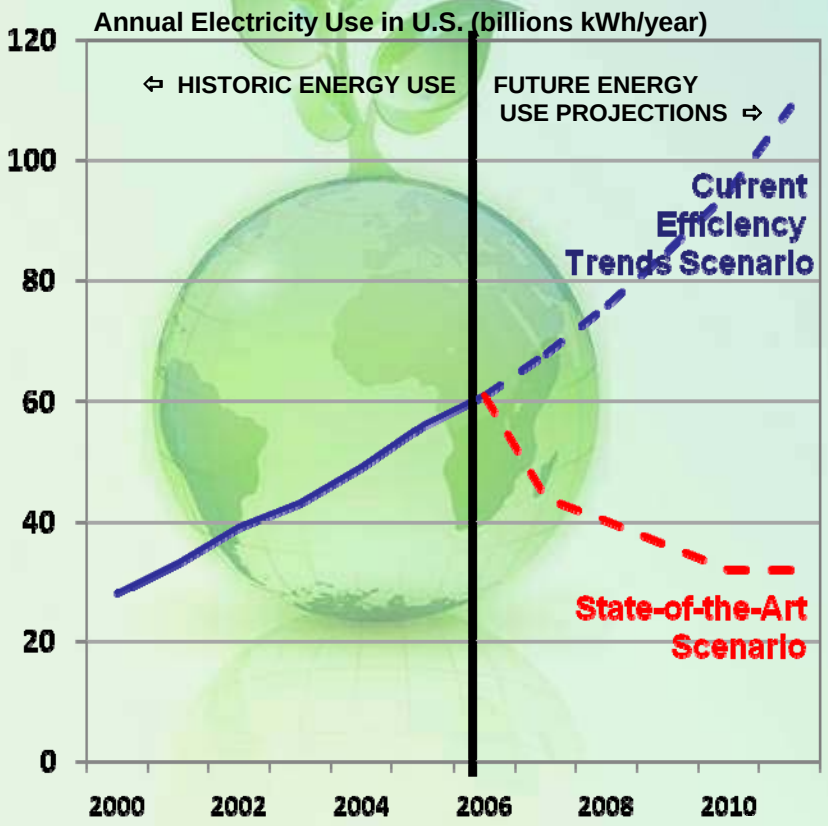
**15 Megatons of $CO_2$**

**- 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

- Industrial activity uses nearly half of all global electrical power and industrial motor systems using the majority of this.
- Motors are inefficient when they operate at full capacity, regardless of need. A “smart” motor can adjust its power usage to a required output through a variable speed drive and intelligent motor controller.
- Variable speed motor systems in key industrial processes can reduce total global warming gas emissions from motor systems by 9% by 2020, and Information Technology driven automation can reduce emissions by an additional 4%.
- Semiconductors can enable a 13% saving by 2020.

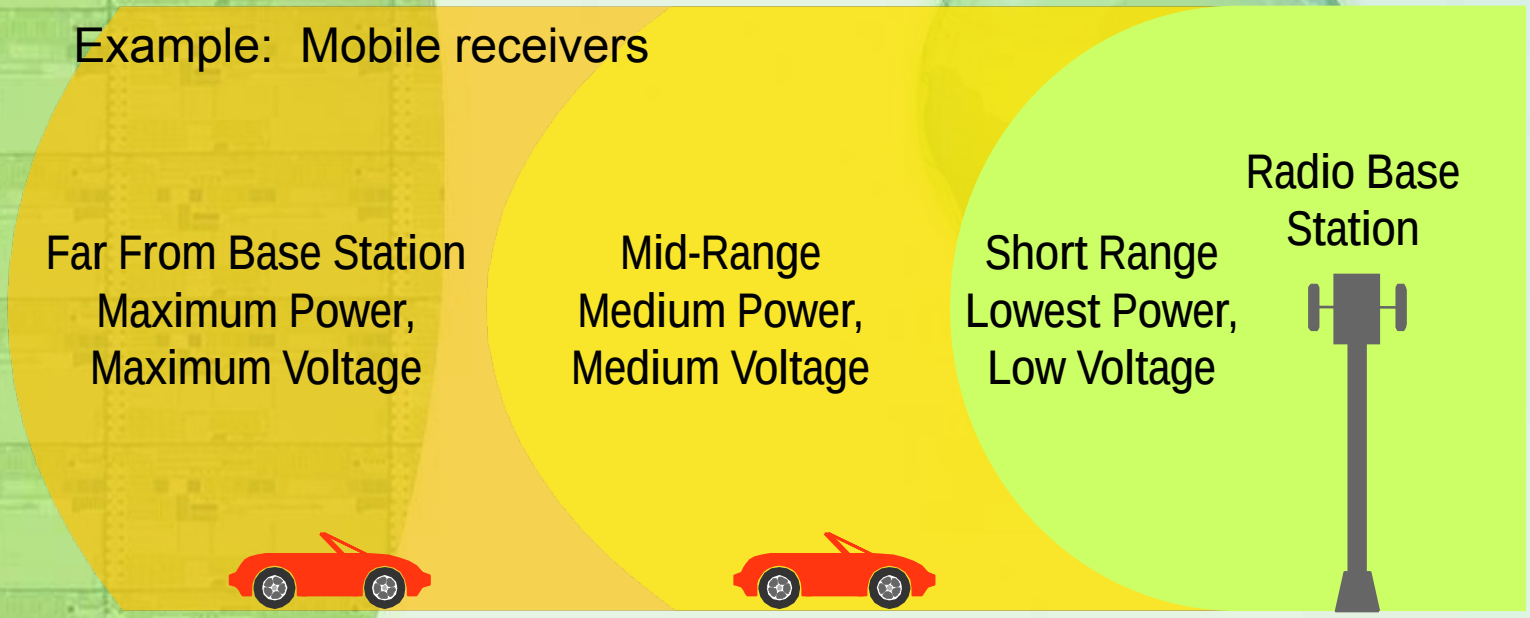
Source: “SMART 2020: Enabling the Low Carbon Economy in the Information Age;” 2009.

# 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

Example: Mobile receivers



# Green Society

Green
End Products

Green Products

Green Fab

# How can semiconductor products contribute to energy saving in our society?

- **Semiconductor enabled technologies help people change behaviors to save energy**
- **Highly networked systems with sensors can automatically save energy**

- **Telecommuting**
- **ecommerce**
- **ebook replace paper**
- **Smart Metering**
- **Smart office building**
- **Intelligent Transport Systems**

# Semiconductors drive Renewable Energy

- Semiconductors are an enabling technology for solar photovoltaic panels and wind turbines.
- Photovoltaic cells are a semiconductor technology.
- Semiconductors convert the DC power generated by solar and wind to the AC power used in most grids.

- Semiconductors can improve the efficiency of renewable energy. For example, solar panels are only as efficient as their weakest link, so clouds, dirt, tree shadows, and even bird droppings can greatly degrade panels' efficiency. Semiconductors can overcome this problem by allowing each part of a solar panel array to contribute power independently.

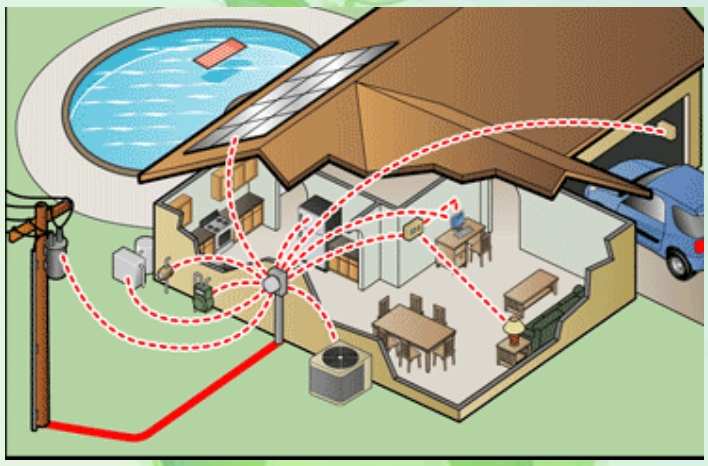
# Semiconductors enable energy savings through Telecommuting

- **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 $CO_2$ 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 $CO_2$ 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

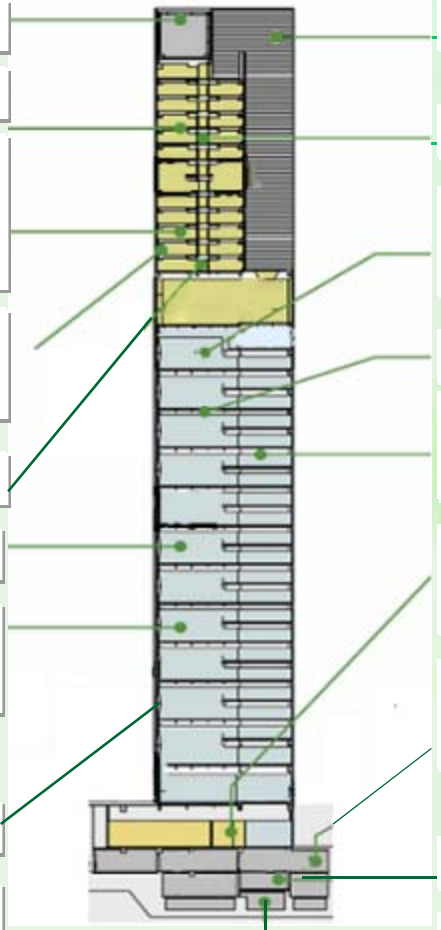
- Energy Efficiency & Management
  - Electric utilities seek to improve demand management capabilities
  - Increasing efficiency at the point of use helps avoid need to build additional power plants
- Smart Meter Functionality
  - Traditional meters only measure total consumption – not when consumption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

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

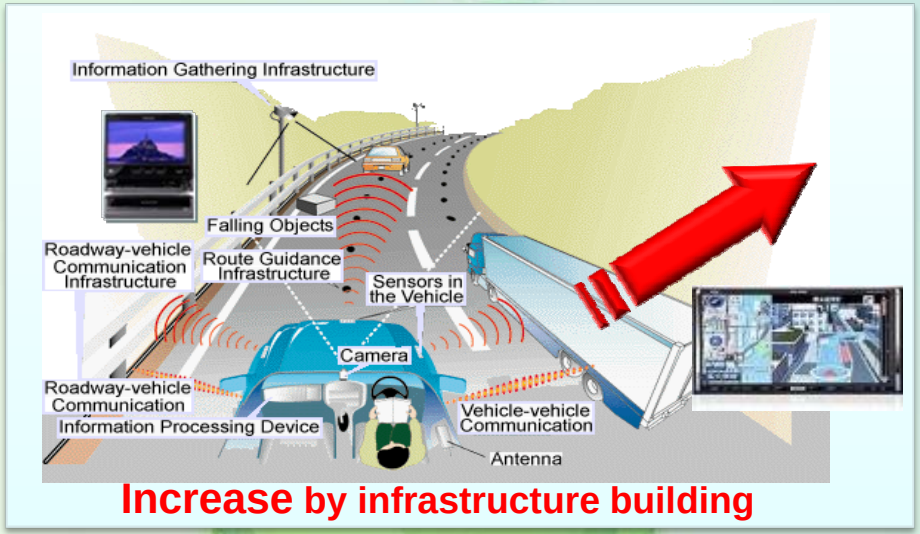
- Terracotta Tile
- Eco shaft
- ★ Air conditioning with natural ventilation
- Metal head lining
- ★ ECO Lighting System using HF power control
- ★ BEMS: Building and Energy Management System
- ★ Chilled-water thermal energy storage system
- Reprocessing of kitchen wastewater
- Reuse of rainwater

Source：Nikkei architecture

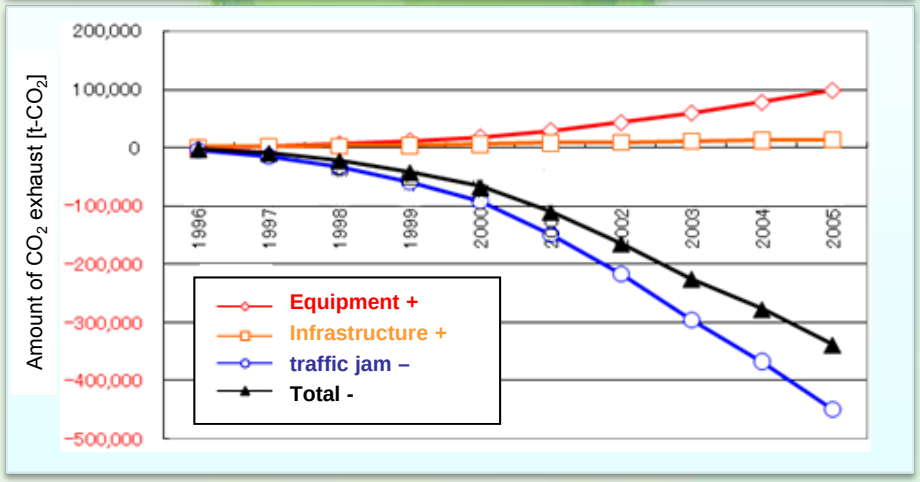
# A new transport system (ITS)

- Increase of $CO_2$ emission associated with spread of ITS:
  - Infrastructure construction
  - Increase of terminals on vehicles
- Reduction of $CO_2$ emission associated with spread of ITS:
  - Decreasing traffic jam
- Effects of reduction of $CO_2$ emission by spread of ITS
  - Reduction effects by decrease of traffic jams exceeds greatly increase effects

ITS : Intelligent Transport Systems




**Increase by infrastructure building**



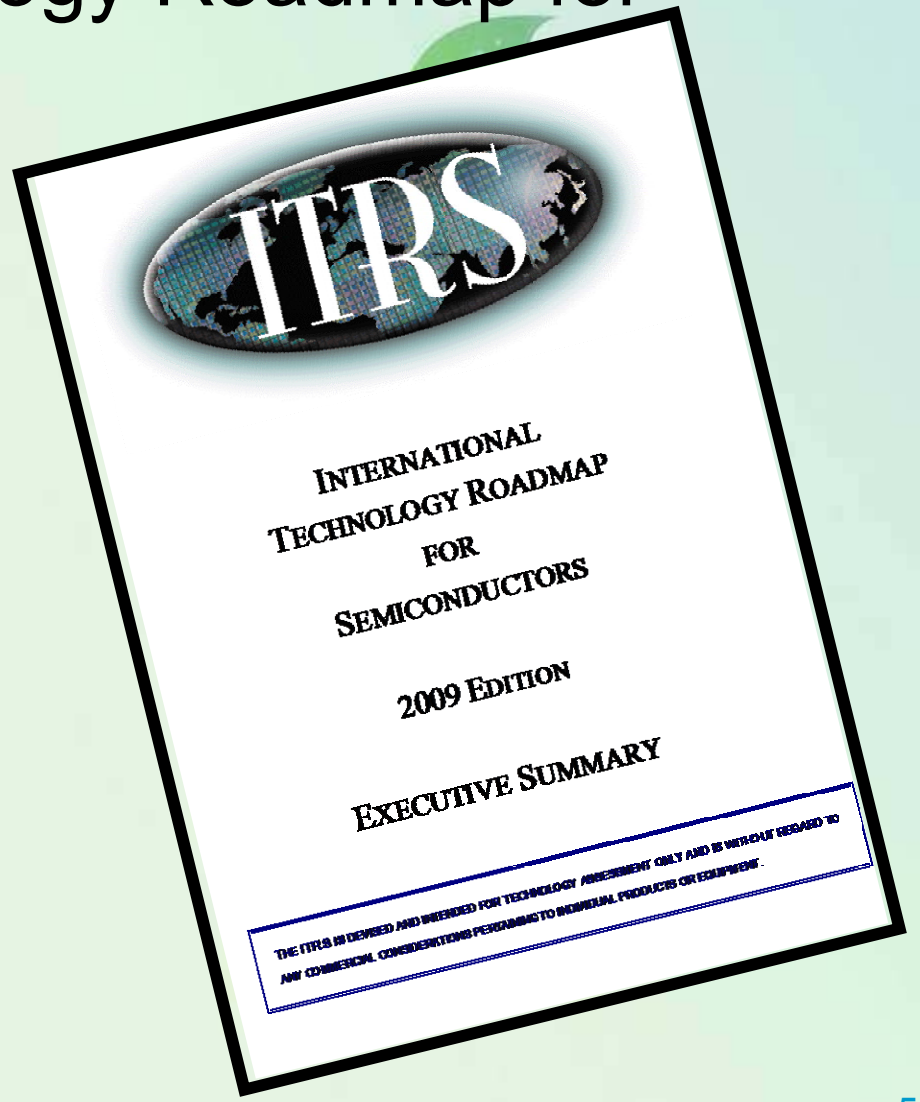

(reference) Mizuho Information & Research Institute Inc.<In Japan>

# 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, etc.
- Identifies technical challenges that must be overcome to continue semiconductor technology advances through 2024 and beyond



# What topics are in ITRS

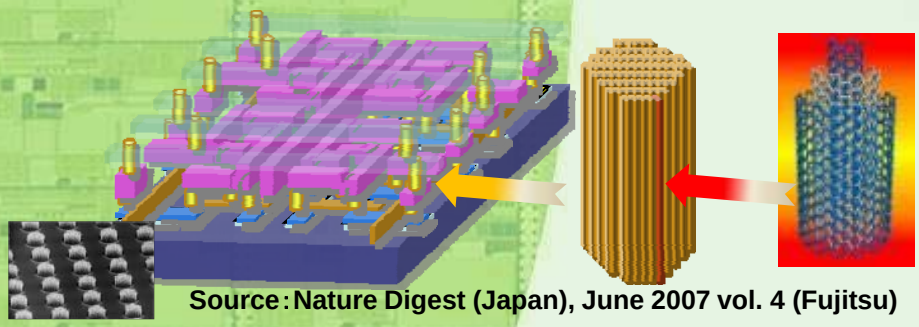
- ITRS has included an ESH chapter that covers 4 strategies such as:
  - Understand processes and materials during the development phase;
  - Use materials that are less hazardous or whose by-products are less hazardous;
  - Design products and systems that consume less raw material and resources; and
  - Make the factory safe for employees.
- 2009 ITRS Special Topics: Energy section notes:
  - Power consumption is now one of the major constraints in chip design, and the ITRS has identified it as one of the top three overall challenges for the last 5 years. Leakage power consumption has been identified as a clear long term threat and a focus topic for design technology in the next 15 years.
  - The major favorable impact on energy usage of advancing semiconductor technology is in the applications, which are often designed to improve the energy efficiency of end-equipments.

# Challenges

- At the Emerging Research Devices section, ITRS evaluates two different scenarios. One scenario addresses charge-based devices and technologies for extending CMOS scaling.

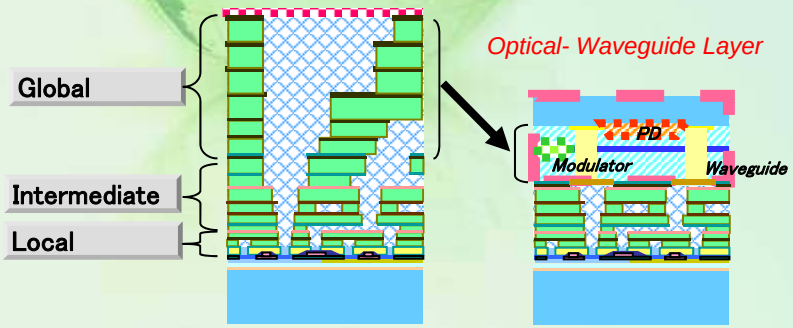
  The other explores "Beyond CMOS" devices.
- For example, carbon-based nanoelectronics is featured as a particular emerging research technology.
- The Architecture section has been re-directed and expanded to include new activities for benchmarking emerging research logic, a new memory architecture, and a new analysis of limits.

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 WTO consistent 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

Appendix

# SIRIJ Report :
# Semiconductors' Social Contribution Report in Japan

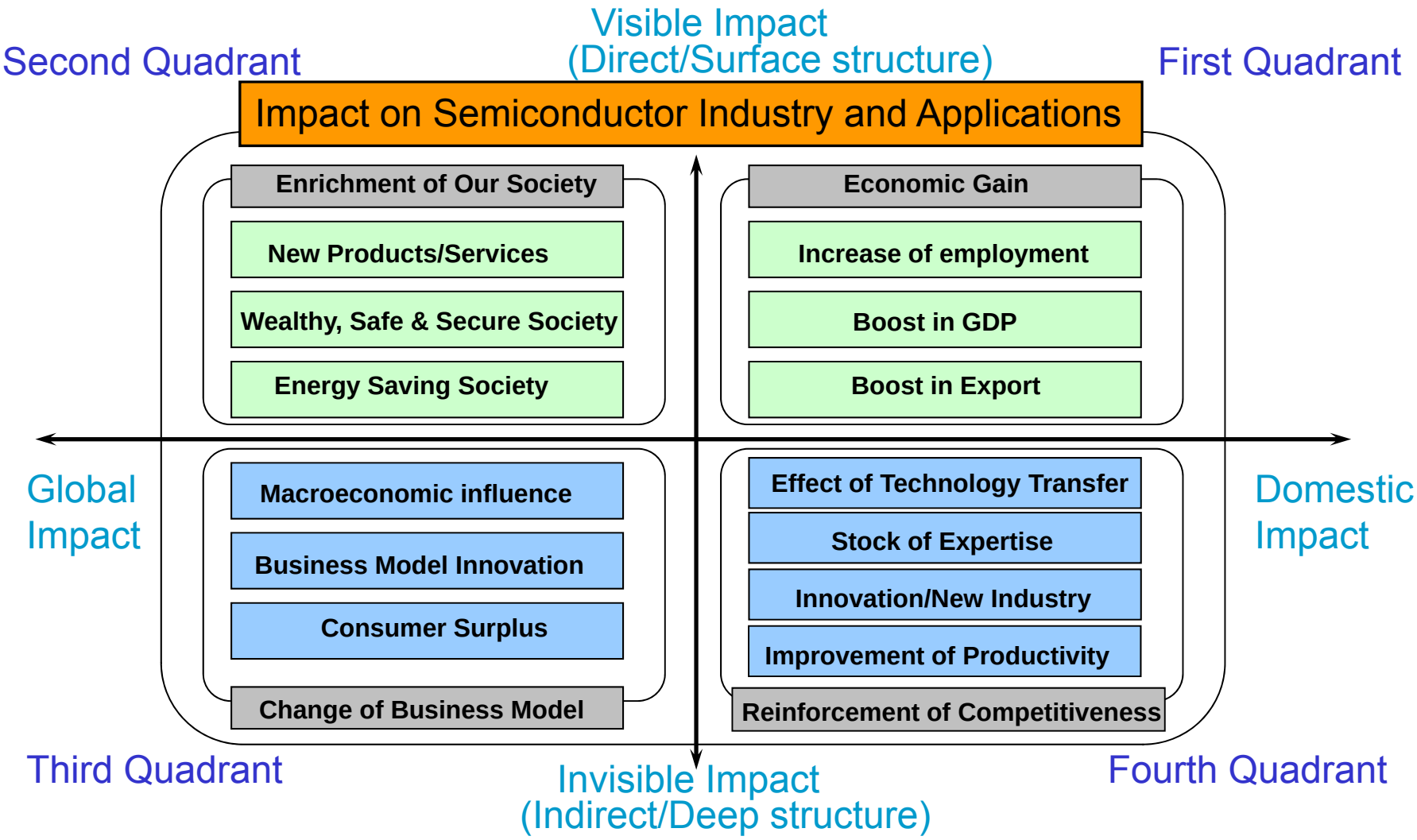
## - Executive Summary -

**May 2010, in Seoul, Korea**

**Outreach Task Force**

The material is based on the"Social-Scientific Analysis of Impact of Semiconductor Industry toward Society, Economy and Environment in Japan - Final Report" issued by Semiconductor Industry Research Institute Japan in 2009.

# 1. Study Framework: Visible Impact and Invisible Impact



# 2. Technology Spreading-out Effect

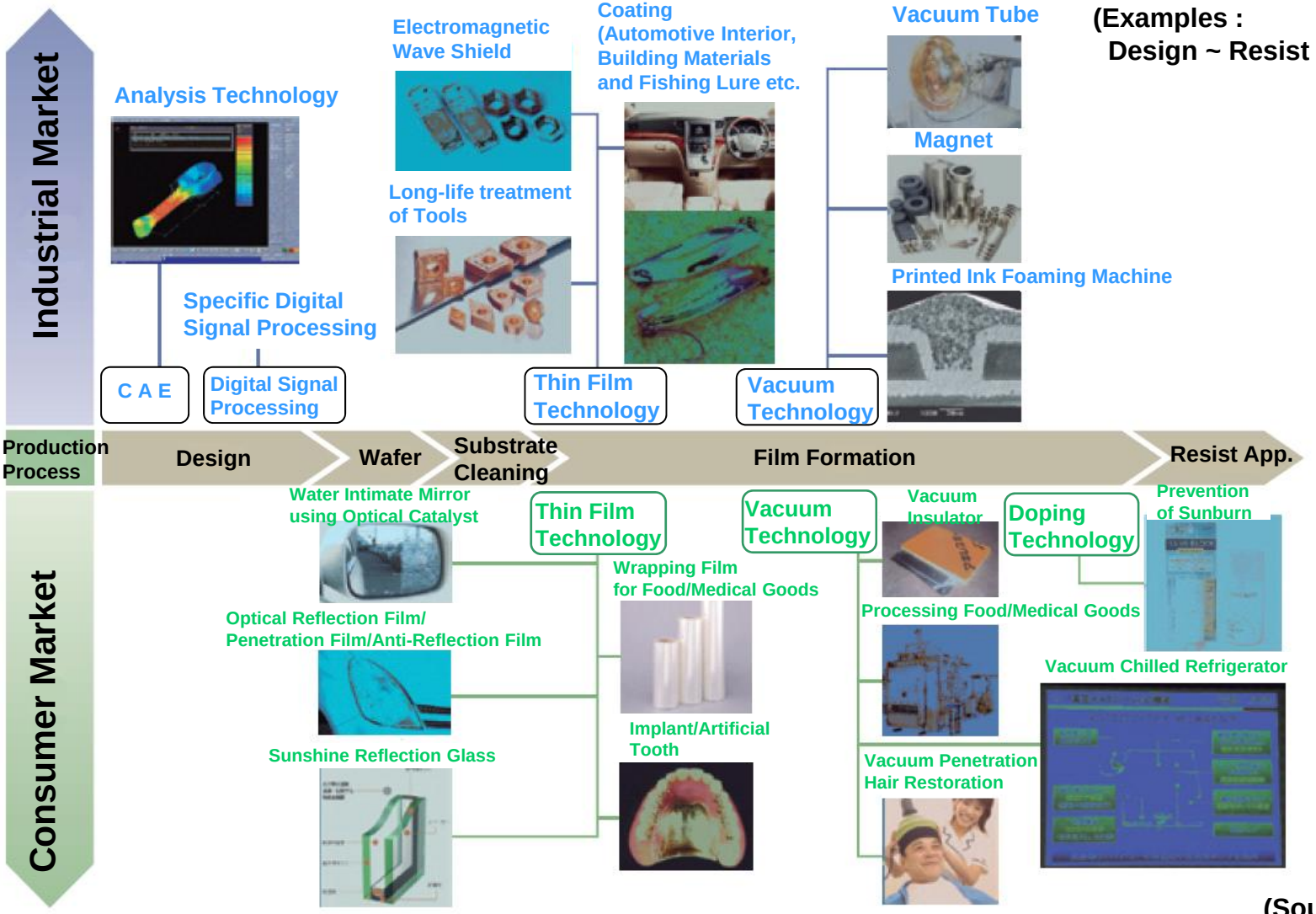
**Semiconductor technology may affect various industries with economic growing in Japan**

| | Aviation Industry | Semiconductor Industry | Automotive Industry |
|---|---|---|---|
| | 1970～2000 | 1970～2007 | 1970～2000 |
| Intra-Industrial Effect (Application Expansion) | ¥12 trillion | ¥285 trillion | ¥872 trillion |
| Inter-Industrial Effect (Technology Spreading-out) | ¥103 trillion | ¥399 trillion | ¥34 trillion |



(Remarks) Semiconductor industry was figured based on industrial correlation table in 2005.
Automotive and Aviation industry were figured based on industrial correlation table in 1995.
(Source) SIRIJ produced based on Mitsubishi Research Institute and Nikkei Electronics issued on July 28, 2008.

# Semiconductor Technology may spread out in various industries.




(Source) SIRIJ

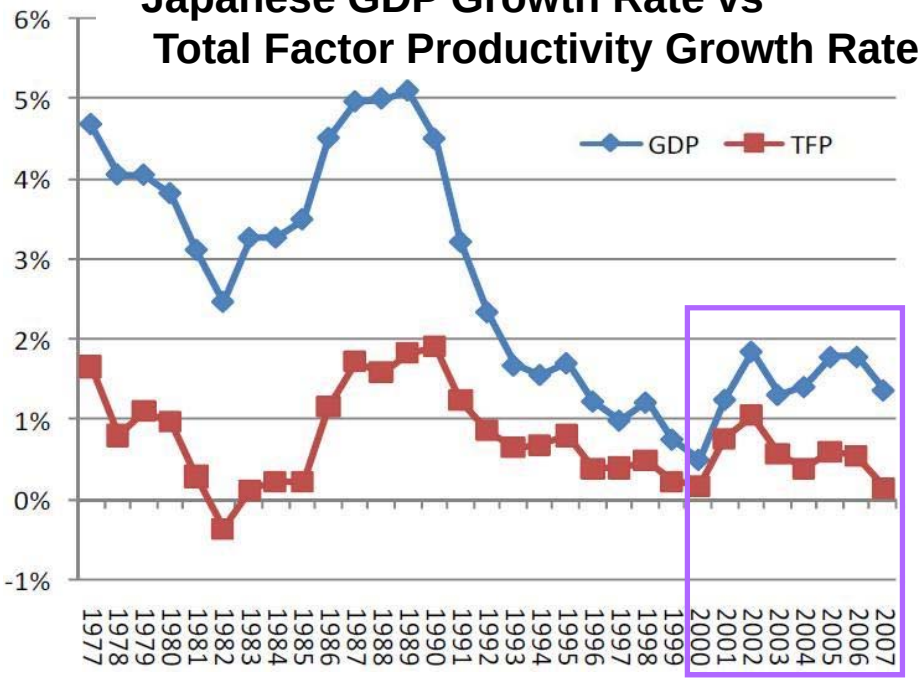
# 3. Influence on Total Factor Productivity

## Semiconductor innovation brings a 23% of TFP growing in Japan (1)

**TFP: Total Factor Productivity**

Total Factor Productivity is a variable which accounts for a relation of the output against the input from all production factors including labor, capital, etc. Actually, TFP is calculated as difference between the variation ratio of the output and the sum of the variation ratio to be contributed by labor and capital input. It is understood to reflect the effect of innovation, innovation-originating improvements of labor and capital, and efficiency of management.

**Japanese GDP Growth Rate vs Total Factor Productivity Growth Rate**




**< 2000 - 2007 in Japan >**

- Average GDP Growth Rate from 2000 to 2007 is 1.45%.
- Average TFP Growth Rate in same period is 0.57%.

(Source) Professor Motohashi, Tokyo University

# Semiconductor innovation brings a 23% of TFP growing in Japan (2)

Semiconductor Innovation → Progress of performance in IT & other application → Price down under keeping performance

**Semiconductor innovation makes higher progress of performance and less increase of input (price down) simultaneously. Thus, Semiconductor innovation contributes to TFP growing.**

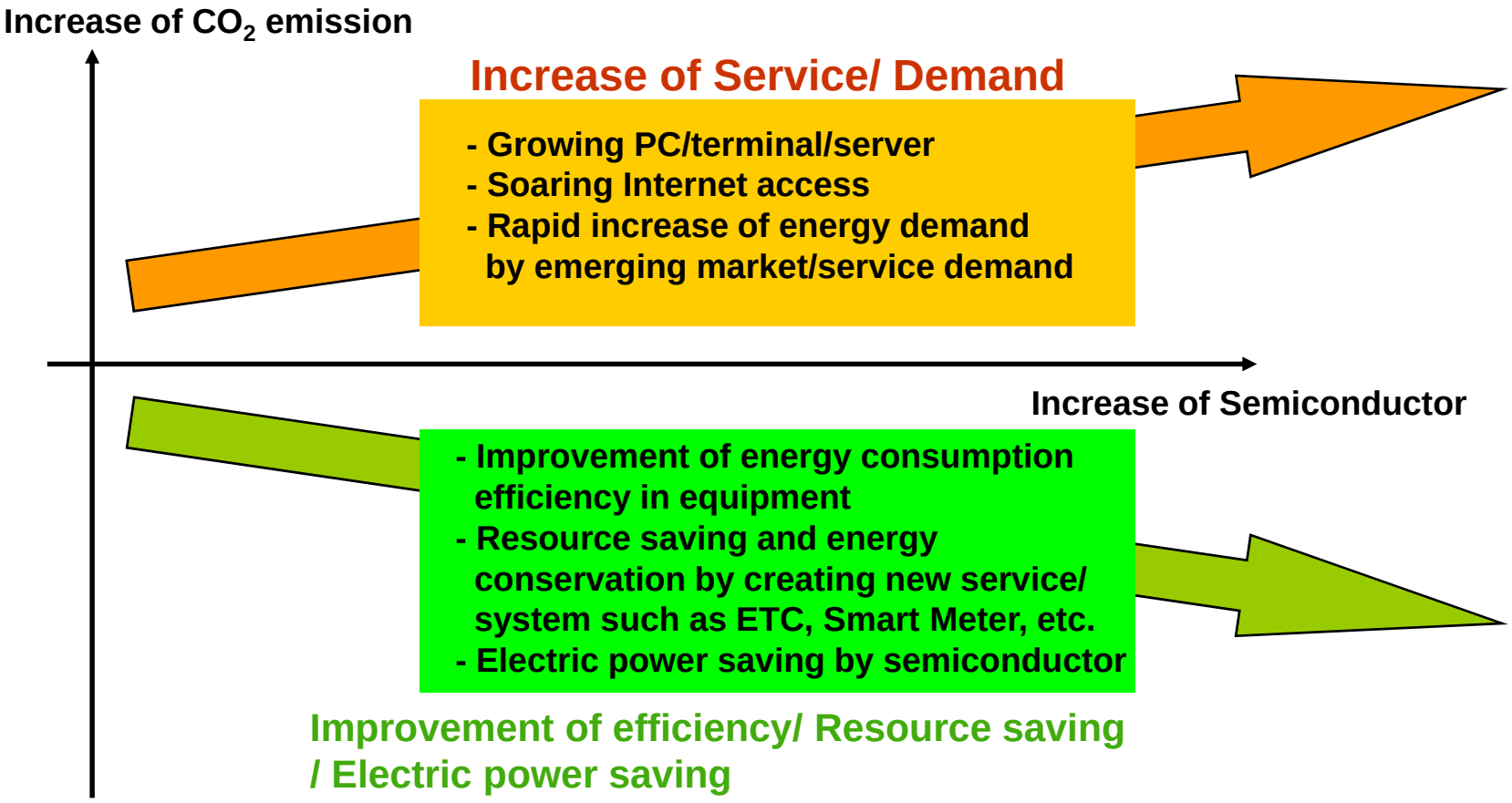
| | 2000 - 2007 |
|---|---|
| **Aggregated TFP Growth Rate** | **0.57%** |
| **Contribution to TFP Growth:** | |
| Information Technology | 0.25% |
| Computers | 0.14% |
| Software | 0.01% |
| Communications Equipment | 0.06% |
| Semiconductors | 0.04% |
| Non-Information Technology | 0.32% |
| Semiconductors | 0.09% |
| (Semiconductors Total) | 0.13% |

Semiconductor innovation influences a 23% of TFP Growth Rate between 2000 and 2007.

(Source) Professor Motohashi, Tokyo University

# 4. Contribution to $CO_2$ Reduction

## Does Semiconductor contribute to reduction of $CO_2$ emission?



**Answer : Yes, Semiconductor contributes to Reduction of $CO_2$ emission.**

**The Report claims Semiconductor contribution, including IT, might be 18 million ton-$CO_2$ of reduction annually.**

# 5. Summary: Semiconductor's contribution to our society

Employment: 200 thousand (Inc. application 2.4 million)

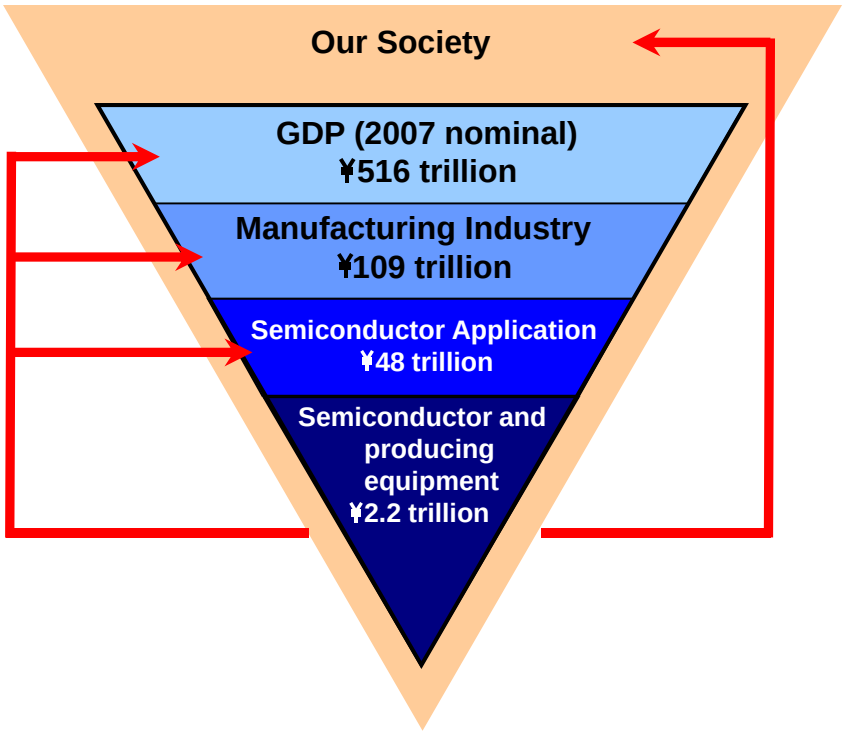
Share in GDP of Manufacturing: 44% (Inc. application)

Trade balance: ¥37 trillion (Inc. application)

$CO_2$ reduction by Semiconductor & IT: 18 million ton/year

Power Consumption of Semiconductor: 2000=100 ⇒ 2007=6

Market of Nano Electronics applied equipment: ¥40 trillion in 2035




Intra-Industrial Effect: ¥285 trillion (1970~2007, accumulated)

Inter-Industrial Effect: ¥399 trillion (1970~2007, accumulated)

Technology spreading-out to 24 industries

Semiconductor's attributable fraction of TFP: 23% (2000~2007)

Consumer Surplus originated by Semiconductor Innovation: ¥6,699 billion (1995~2005)

Energy Saving in Future Home: 3 million ton-$CO_2$/year