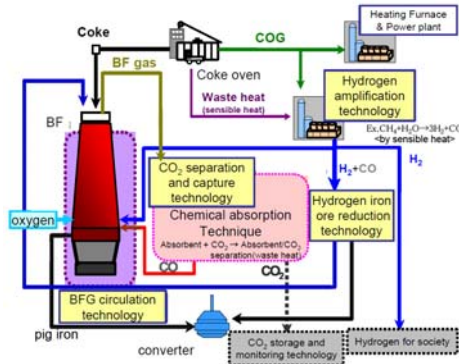


17. Hydrogen Reduction Iron and Steel Making Process

Technology Summary

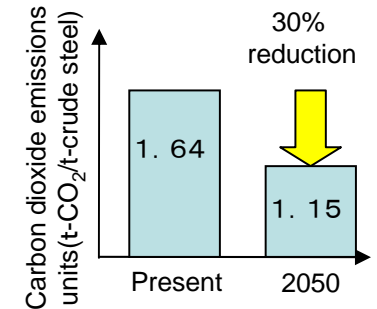
○ Technology developed to reduce large amount of carbon dioxide emissions in the iron and steel making process, in which about 70% of the energy is consumed in integrated steel works.

○ Specifically, as a steel production technology, hydrogen, which is produced by hydrogen amplifying technique using the coke furnace gases, is used as reducing agent instead of a part of coke. And the technology for separation and capture of carbon dioxide from blast furnace is also developed.



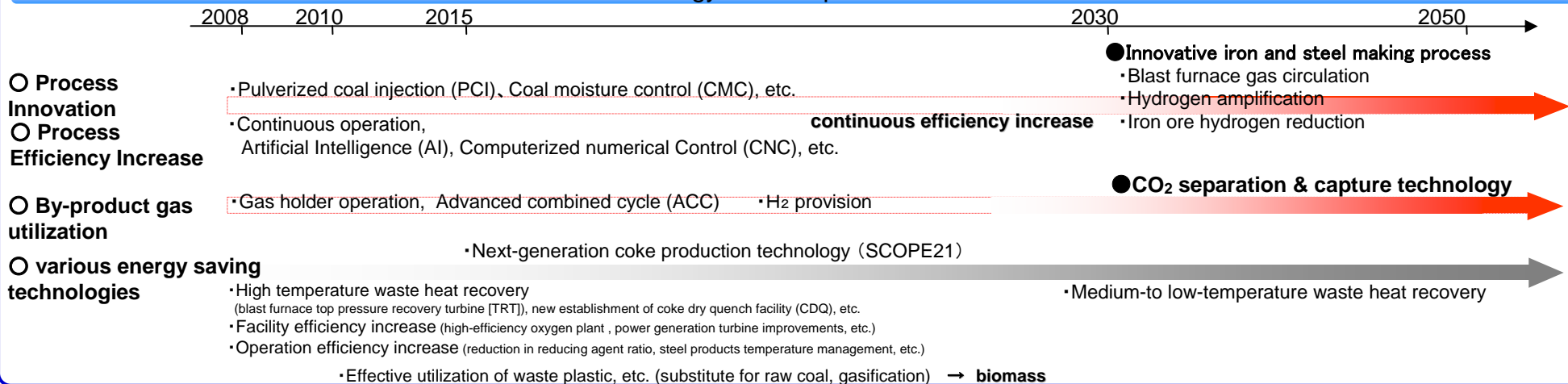
Greenhouse Gas Reduction Effectiveness

- Due to little implementation by 2030, calculation on CO₂ emission reductions in 2030 is difficult.
- The goal is reducing CO₂ by 30% in the iron and steel making process.
- Regarding results in Japan, assuming that goal is met and that this technology spreads through the entire iron industry in Japan, present CO₂ emissions of about 1.64 (t-CO₂/t-crude steel) (※) will be reduced to about 1.15 (t-CO₂/t-crude steel).



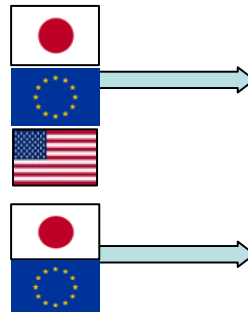
※ Calculated by the Cabinet Office based on the Voluntary Action Plan drawn up by the Japan Iron and Steel Federation

Technology Roadmap/ Diffusion Scenario



International Competitiveness

- Iron and steel making using hydrogen as reducing agent instead of a part of coke
 - Basic research is being carried out on hydrogen reduction in Japan, the United States and Europe
 - Japan has original technology for hydrogen amplification (catalyst improvement with coke furnace top layer gas).
- The technology for separation and capture of carbon dioxide from blast furnace
 - Regarding separation and energy recovery, Japan is predominant in the chemical absorption method for exhaust heat.
 - Europe is going ahead starting a test bench furnace to improve the consistent process and blast furnace circulation.



International Expansion

- Japan will promote technology development in this field through the innovative development program CO₂ Ultimate Reduction in Iron and steel process, by innovative technology for Cool Earth 50 (COURSE50) and active participation in joint programs operated by the International Iron and Steel Institute (IISI) and the EU to grasp the latest trends in technology development and examine possibilities for joint research in basic fields in European nations.



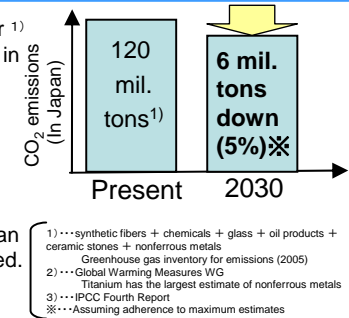
18. Innovative Material, Production and Process Technology

Technology Summary

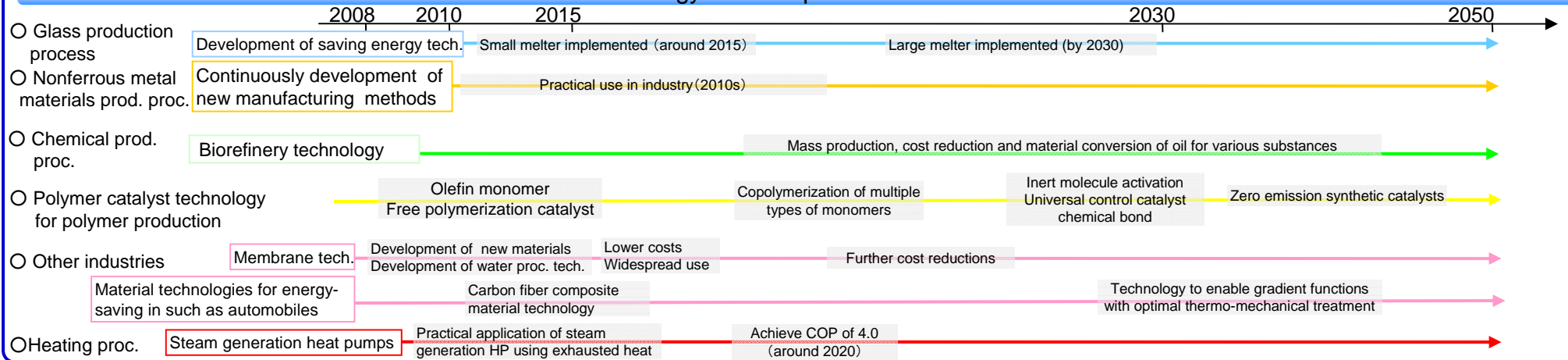
- Energy-saving technology and manufacturing processes to greatly increase energy efficiency in Japanese manufacturing industries, where energy conservation is at a top level in the world. Specifically:
 - Energy saving glass production technology to melt glass using plasma, etc. to lower energy consumption to about 1/3 of the conventional processes.
 - Drastic efficiency improvement technology in nonferrous metal material production processes.
 - Chemical production technology using biomass, etc.
 - Separation membrane technology to drastically reduce energy consumption in water treatment regarding river water, etc.
 - Material technology to save energy in vehicles, etc.
 - Heating process technologies such as steam-generation heat pump, etc.
 - Polymerization catalysts for polymer production.

Greenhouse Gas Reduction Effectiveness

- CO₂ emissions by related industries are 120 million tons per year ¹⁾
- If the technology is completely adopted, the following reductions in manufacturing are calculated for around the year 2030: (※)
 - Glass Δ1 mil. t (66%) (1/3 energy conservation)
 - Chemical Δ4 mil. t (20%) (biomass plastic 2)
 - Nonferrous metals Δ1 mil. t (20%)²⁾ etc.
- Global manufacturing emissions of CO₂ in glass are 40 mil. to 50 mil. tons (2004), and 500 mil. tons for nonferrous metals. If the technology is adopted and the same amount of reduction as in Japan is achieved, global annual reductions of 130 million tons is calculated. (※)



Technology Roadmap/ Diffusion Scenario



International Competitiveness

- There are advantages in glass dissolution technology using plasma in air, that was developed first in Japan.
- Regarding biorefinery technology, manufacturing processes using gene recombining microbes is progressing outside and inside Japan. In this field, Japan also has original technology, which is developed by different approach from the European and American technologies.
- Regarding technology for producing nonferrous metals (titanium refinement), innovations have been lacking all over the world since the invention of the current process. And Japan is developing a original continuous production process to replace the present method.

International Expansion

- Regarding that Introducing these technologies to such as China and India will make a large effect on CO₂ emission reduction, it is necessary to promote transfer of these technologies in business.
- Due to the large effects on the world by the diffusion of chemical products produced by biorefinery technology, Japan would be dominant relative to other countries by establishing this applied technology in this field.

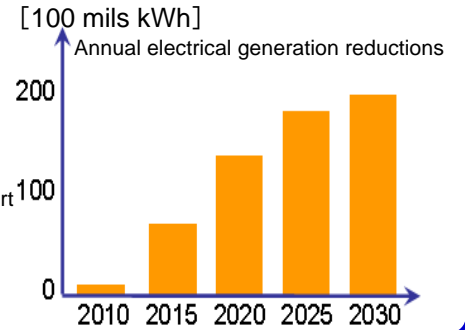
19. High-Efficiency Lighting

Technology Summary

- Lighting technology with drastically improved luminous efficiency and high color rendering properties compared to the conventional fluorescent lamp will be developed. It is possible to reduce carbon dioxide emissions by addressing efficiency that exceeds the luminous efficiency of incandescent lamp (15-25 lm/W) or the fluorescent lamp (80-100 lm/W). This will be done using next generation lighting technologies such as high-efficiency LED, organic EL and microcavity.
- A new lumination system different from the lighting equipment used until now. Present fluorescent lights undergo heat loss of about 80%, but this technology can bring that to one-tenth or less and raise lighting efficiency to 90% or above. It is cool lighting technology that emits little heat.

Greenhouse Gas Reduction Effectiveness

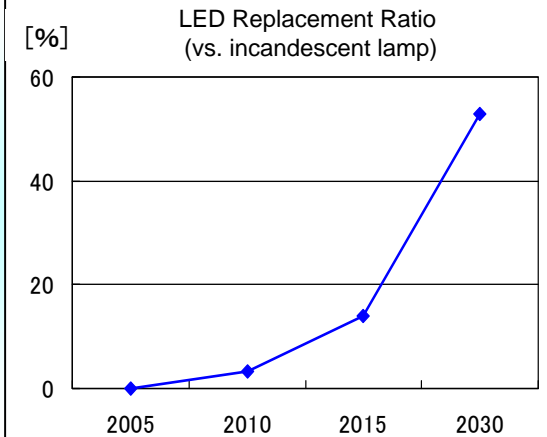
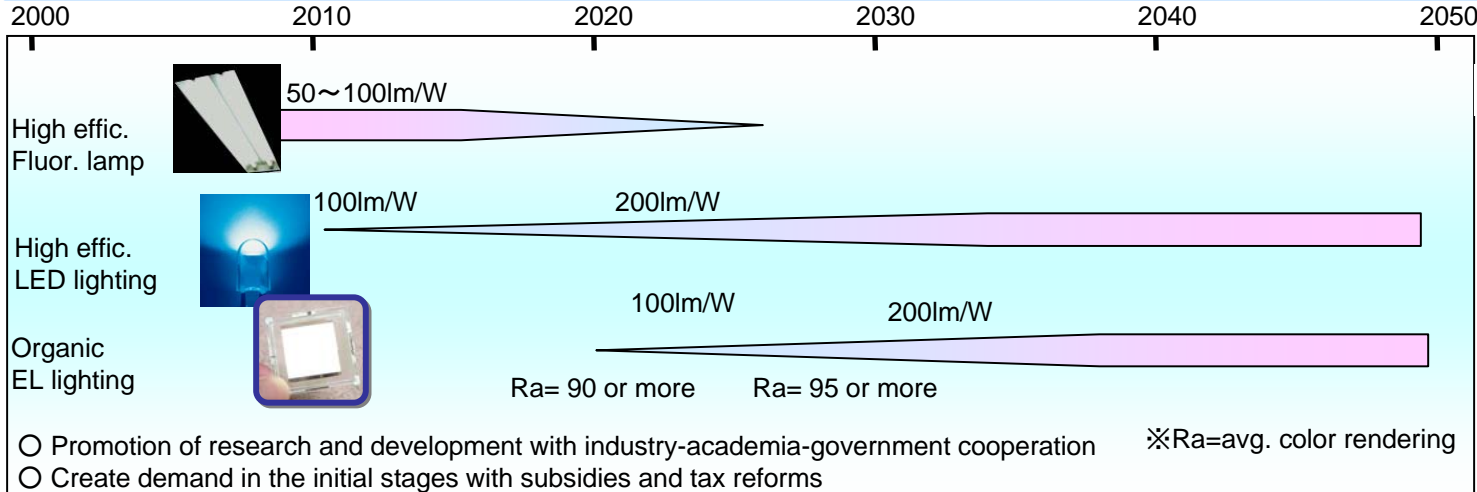
- Assuming that LED lamp will spread to about 30% usage for indoor lighting in Japan by 2030, CO₂ emissions can be reduced by about 7 million tons assuming 18.7 billion kWh converted at a rate of 0.34kg-CO₂/kWh.



- Source: Japan Machinery Federation, Japan Research and Development Center for Metals Investigative Report
- With electrical illumination at 1.9Gt=190 mil. t-CO₂, potential CO₂ emission reductions of 75-90% are possible.

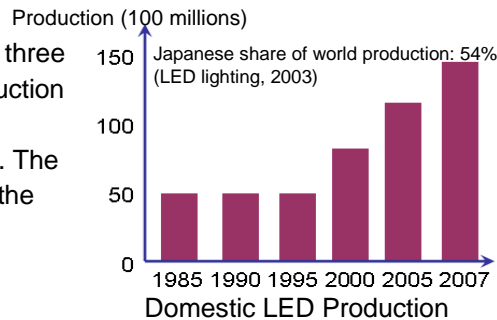
Source: IPCC AR4

Technology Roadmap/ Diffusion Scenario



International Competitiveness

- Invented in the 1990s, was set to three colors (red, green, blue), allowing for the production of all colors. In combination with fluorescent lamps, makes possible. The share of Japanese manufacturing is at the world's top level.



International Expansion

- Bans on the sale of incandescent lamp bulbs in Australia and California (USA) are being considered, and interest in high-efficiency lighting has been rising around the world.
- In Europe as well, the time is ripe for the introduction of fluorescent lamps in place of incandescent bulbs. Since this technology, which can offer great savings in energy conservation, has considerable international competitiveness, Japan is planning on being a leader in the field overseas.

20. High-Efficiency Heat Pump

Technology Summary

- Heat pump is a technology that obtains heat necessary for air conditioning and hot water supply by transferring heat.
- Unlike room heating and hot water supply created by the combustion of fossil fuels, it is possible to achieve efficiency exceeding 100% drastically by actively using solar heat via heat of air or ground.
- It is possible to apply this technology in the air conditioning and hot water supply, which comprise nearly 50% of carbon dioxide emissions in the commercial/residential sector. Further reduction can be expected with heat pump technology that has drastically improved efficiencies over conventional technology. It is also possible to have applications in the air conditioning and cooling/ heating process used in the industrial sector.

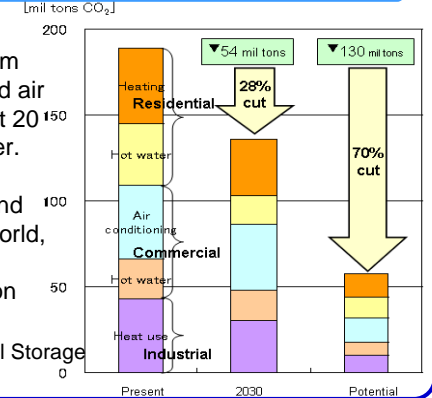
Greenhouse Gas Reduction Effectiveness

	HP application	Present situation		
		25%	50%	75%
Industrial	Heat use (100°C)	○	○	○
	Power, lighting, etc.	×		
Residential	Cooling	○	○	○
	Heating	○	○	○
	Hot water	○	○	○
	Power, lighting, etc.	×		
Commercial	Air conditioning	○	○	○
	Hot water	○	○	○
	Power, lighting, etc.	×		

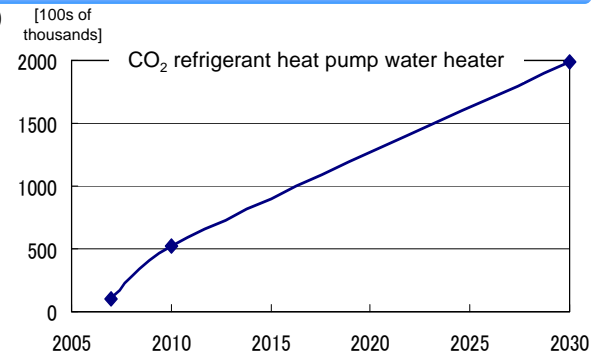
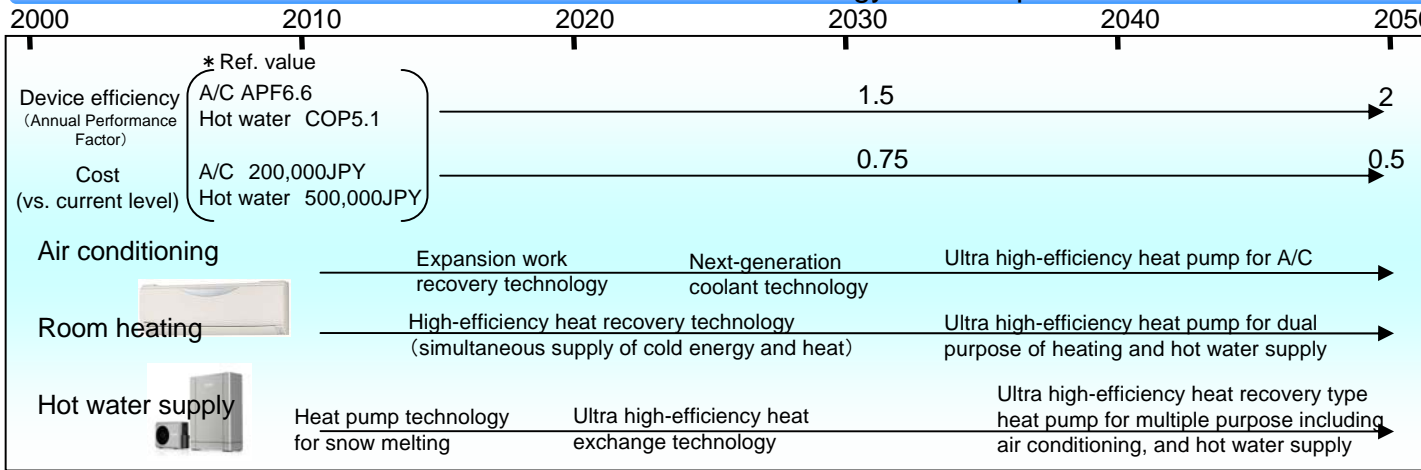
■ Heat pump
 ■ Combustion type
 ○: Applicable
 ×: Not applicable
 □: Not applicable

- CO₂ emissions can be reduced by 54 mil tons from the about 30 mil household air conditioners and the about 20 mil heat pump water heater.
- With adoption by households, consumers and factories throughout the world, CO₂ emissions can be reduced by about 1.2 billion tons.

Source: Heat Pump & Thermal Storage Technology Center of Japan



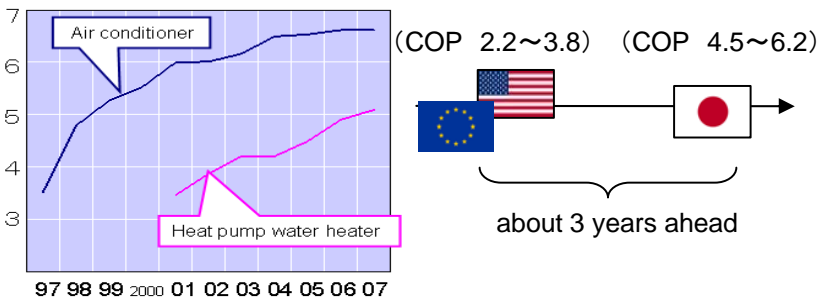
Technology Roadmap/ Diffusion Scenario



- Promote introduction with subsidy and tax benefits
- Information release to the public
- Promotion of research and development with industry- academia-government cooperation

International Competitiveness

- Japan has the world's top-level high-efficiency heat pump technology.
- Japan put into first practical use of CO₂ refrigerant heat pump water heater in the world.



International Expansion

- In Europe, compared with the common steam heating pump, there is high demand anticipated. They are seen as a source of renewable energy, and there is room to study their placement domestically.
- From here on, demand is anticipated among India and China's middle class for hundreds of millions of units.

21. Stationary Fuel Cell

Technology Summary

○ Fuel cell is the technology for electric power generation directly by electrochemical reaction between fuels such as hydrogen and oxidants such as oxygen, without heat generation pathway. Since the fuel cell can directly convert chemical energy into electricity, the theoretical generation efficiency is high, and the efficiency is not affected by system size. Therefore the overall efficiency can be high (>80%HHV) in the case of cogeneration system. It is thus expected to contribute to reducing carbon dioxide emissions. It is expected that this energy can be used from small devices (laptop computers, cellular phones and others) to large scale (automobiles, cogeneration system for consumer and industrial use, and power generation plants). Development is focusing on polymer electrolyte fuel cells (PEFC) and solid oxide fuel cells (SOFC).

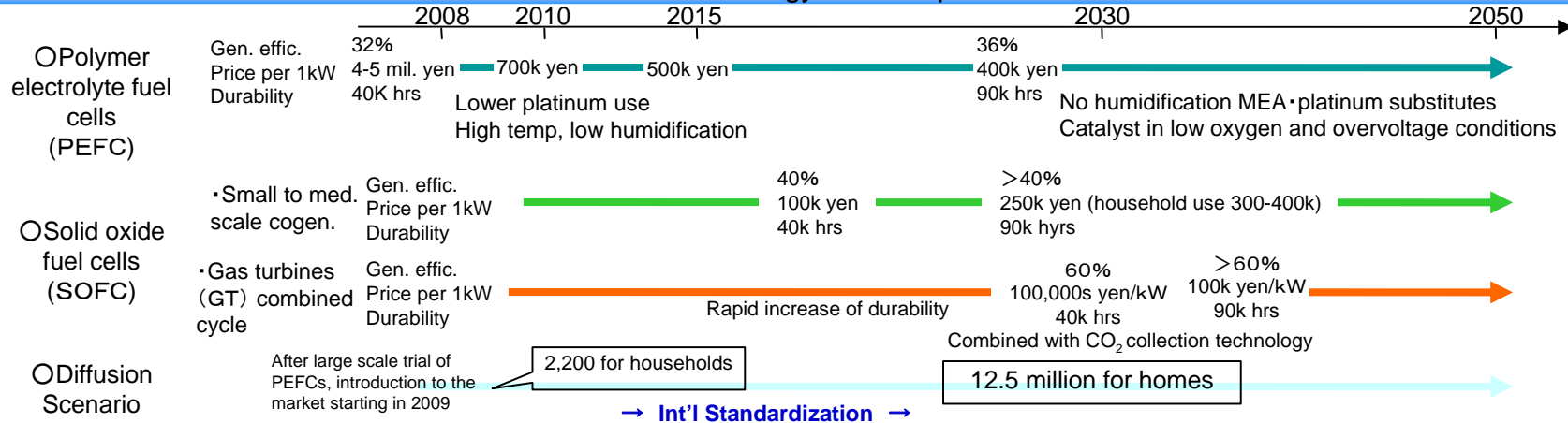
Greenhouse Gas Reduction Effectiveness

○ In Japan
CO₂ reduction is about 1.4 tons annually with 1kW stationary fuel cells. In 2030, 1kW stationary fuel cells will number 12.5 million, and in total amount of CO₂ reduction will be 17.5 million tons (calculated based on emission factor of thermal power generation).

【Sources】

- 1) 14th Joint Meeting of the Industrial Structure Council subcommittee on global environmental and Environmental Sciences and the Central Environment Council on Earth and Environmental Sciences
- 2) Document 2, state of progress on the Kyoto Protocol Target Achievement Plan
- 3) 12th Fuel Cell Implementation Strategy Research Committee

Technology Roadmap/ Diffusion Scenario



International Competitiveness

- Japan has been planning to improve its performance by steady technology development. And large scale trial of 2,200 PEFC for households has been carried out by the end of 2007.
- Since the first commercialization on the world market is planned for 2009, Japan is the top-runner in practicalizing of the stationary fuel cells.

【Source】

"Happy Project" Home Fuel Cell System 1st Edition, 2009

International Expansion

- Japan is promoting necessary international standardization and strengthening of companies' technological development and competitiveness towards the international expansion of fixed use fuel cells regarding the International Organization for Standardization/Hydrogen Technology (ISO/TC 197).
- Also regarding the International Energy Agency Hydrogen Implementing Agreement (IEA-HIA), Japan is supporting joint ownership of information related to hydrogen technology for the world community, which is concerned about safety and the environment, as well as comprehensive hydrogen R&D and analysis, for the realization of a hydrogen-based economic system.
- For the purpose of hydrogen economy, information exchanges related to policies in the United States and Europe are being strengthened by using the International Partnership for the Hydrogen Economy (IPHE).

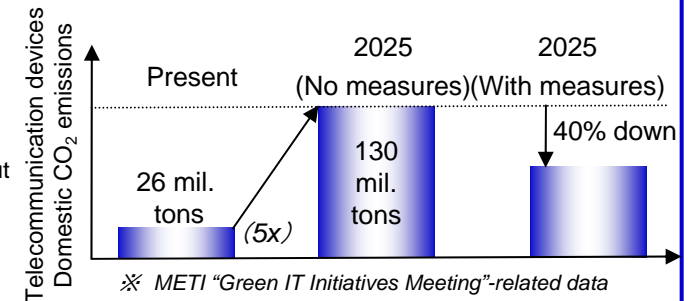
22. High-Efficiency Home Electronics and Information Device (Green IT)

Technology Summary

- Information and Communication Technology (ICT) enhances energy efficiency by optimizing the flow of people and distribution. However, ICT devices itself emits additional CO₂.
- Especially, drastic increase in data flowing through networks are expected, which leads to significant growth in electricity consumed by ICT devices. "Green IT" such as miniaturization of semiconductors, application of photonic technology, development of new displays, and development of network systems with optimal control technology will restrain and reduce electricity consumption to half.
- Changes in lifestyles, large size devices, increasing services, and standby power, lead to more electrical power usage and raising home alliances CO₂ emission trends.

Greenhouse Gas Reduction Effectiveness

- ICT devices account for approximately 5% of domestic CO₂ emissions.
- It is expected that the volume of information will increase 200 times, and without preventive measures CO₂ emissions will increase five times.

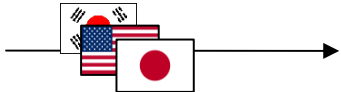


Technology Roadmap/ Diffusion Scenario

	2010	2020	2030	2040	2050	
Home Appliances	(LCDs) (Organic EL Displays)	2.7kWh/year · inch Luminous efficiency 70lm/W	50k hrs lifespan	1.6kWh/year · inch General use		
	{ Entire System }	Control Standardization Remote control (reduce standby power)		Control based on transmission volume (30% reduction in electricity consumption) Optical routers (1/50 electricity consumption)		
ICT Devices	(Ind. devices)					
	{ System optimization }		Server / data center virtualization Optimize ICT systems energy conservation, High efficiency cooling			
Semiconductors	(Core architecture, etc.)		Heterogeneous many cores		Optical computers	
	(Miniaturization)	hp45nm		Hp11nm (1/10 electricity consumption)		
Promotion Measures	○ Promote R&D, by industry, academia and government collaboration ○ enlightenment through conference, international symposiums ... etc.			○ Tax subsidies, financing ○ Promotion of Leading Runner Approach		

International Competitiveness

○ Semiconductors

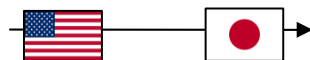


○ Energy conservation network devices

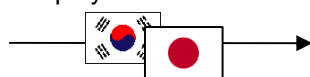


- Japan is the leading in energy conservation technologies, home appliances, and optical transmission technology, though other countries are catching up in other fields.

○ Energy conserving home appliances



○ Organic EL Displays



International Expansion

- An explosive increase in ICT and data processing is anticipated, and there are needs for minimization of electrical consumption by related devices. Also, with excellent energy conserving functions in Japanese-made flat-screen televisions and home appliances, goods manufactured in Japan are in predominant position.
- During recent years, energy consumption has effected device performance advances, and therefore energy conservation is indispensable. As a result, Japanese energy conservation technology is gathering global attention.
- Cooperating in international symposiums and other countries' consortiums, strengthening Green IT initiatives, contributing to international standardization, and understanding research and development in other countries are important.

23. Energy Efficient Housing (Insulation, Insulating Glass)

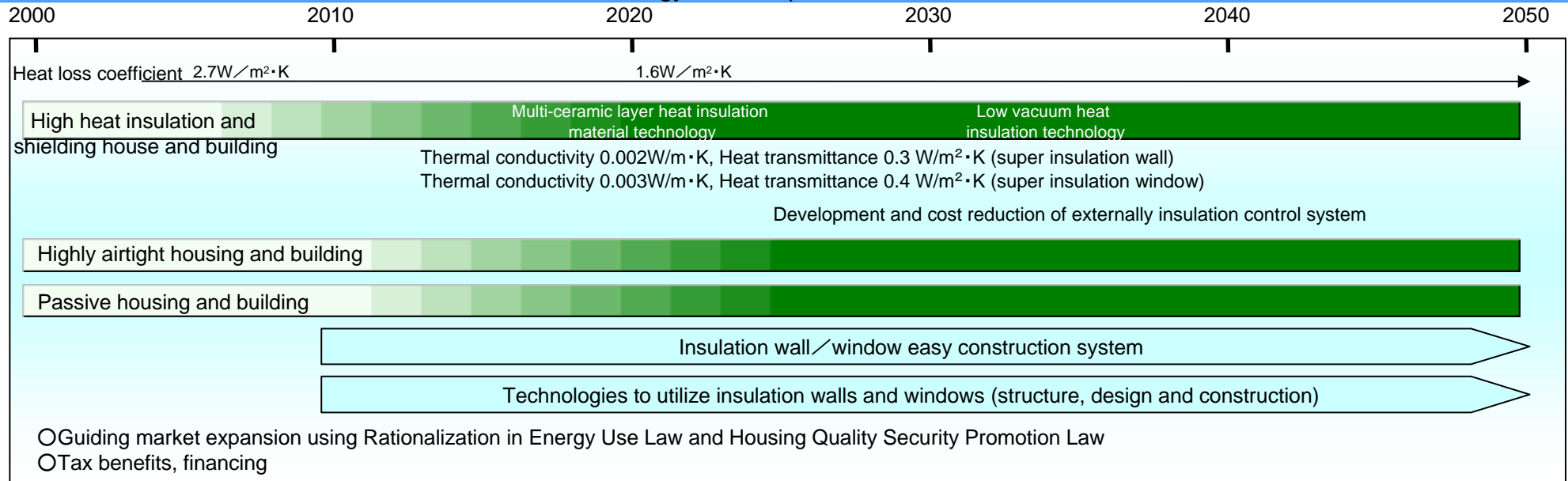
Technology Summary

- Energy saving technology for home building will use new heat insulation materials, room air quality improvement to improve insulation and shielding.
- Heat insulation for building walls and windows will be enabled by the development of heat insulation materials that use multi-ceramics layer.
- It is possible to reduce air conditioning energy use by 50% through high heat insulation conditioning, shielding and other technologies, which are expected to contribute to a reduction of carbon dioxide emissions.

Greenhouse Gas Reduction Effectiveness

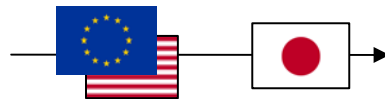
- It is possible to reduce CO₂ emissions about 3 million tons per year with 1,083 thousand kℓ less per year by insulating buildings for business use in Japan.
(Source) METI
- If the same level of highest insulation standards are used for buildings in advanced countries, CO₂ emissions can be reduced by 0.7 tons.

Technology Roadmap/ Diffusion Scenario



International Competitiveness

- In Europe and the United States
 - 1) Mostly only thought of for winter use
 - 2) House and building space is ample, and the thickness of walls and windows are thought to provide insulation, similar technology is not in development much.
 Japan is taking the lead in vacuum insulation.



International Expansion

- It is possible to reduce air conditioning energy use in house and building with insulating materials and insulated glass, as well as reduce warmth from refrigerators and such with vacuum insulation materials, and this technology can be spread around the world.

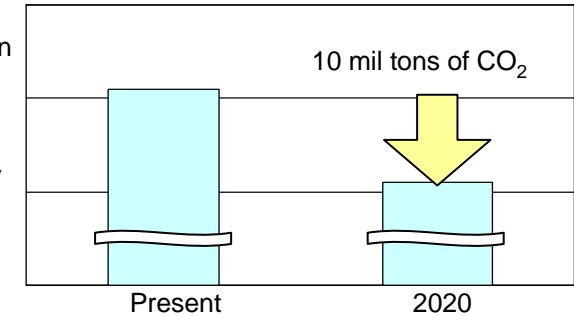
24. Power Electronics

Technology Summary

- Saving energy technology in inverters and electric devices by utilizing the next-generation semiconductors, in power generation, transmission and distribution.
- Inverters are popularly used in various field including commercial, transportation, industry, and conversion sectors. This technology has also been used in equipment such as motors, various power supply systems, information appliance, home appliances, DC power transmission in power generation field.
- Power electronics semiconductors improve the energy efficiency through energy saving from these inverters. Expected efficiency improvements are about 2-10% in transportation field such as hybrid vehicle and electric vehicle, 4-5% in computer power supplies when SiC device is applied in each of these.

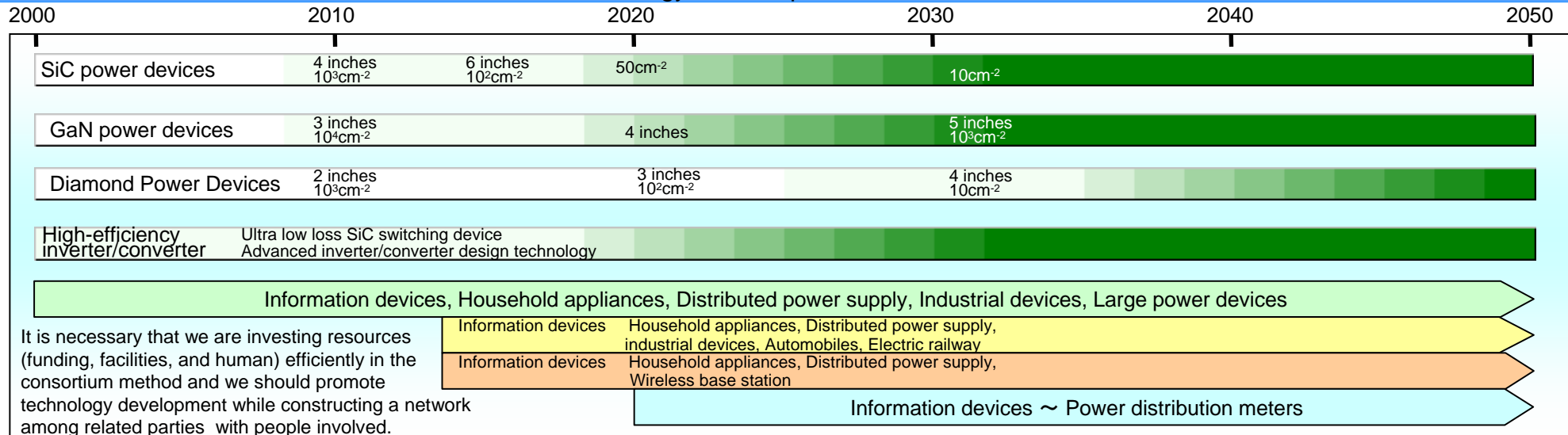
Greenhouse Gas Reduction Effectiveness

- In Japan: Assuming 5 million next generation vehicles, 30% use of generic inverters, and 65 million CPU power supplies, CO₂ emissions can be reduced by about 10 million tons.



Source: EE Times Japan 2007.5

Technology Roadmap/ Diffusion Scenario



International Competitiveness

- While competition in technology development is fierce among Japan, the United States and Europe.
- Our processes, devices and mounting technologies in the semiconductor field are at the world's top level.



International Expansion

- Promote initiatives leading to international standardization.
- Power electronics is popularly used in various field including commercial, transportation, industry, and conversion sectors. This technology has also been used in equipment such as motors, various power supply systems, information appliance, home appliances, DC power transmission in power generation field, so diffusion and expansion of end products with core energy conservation technology to other countries will be promoted.

25. Intelligent Transport Systems (ITS)

Technology Summary

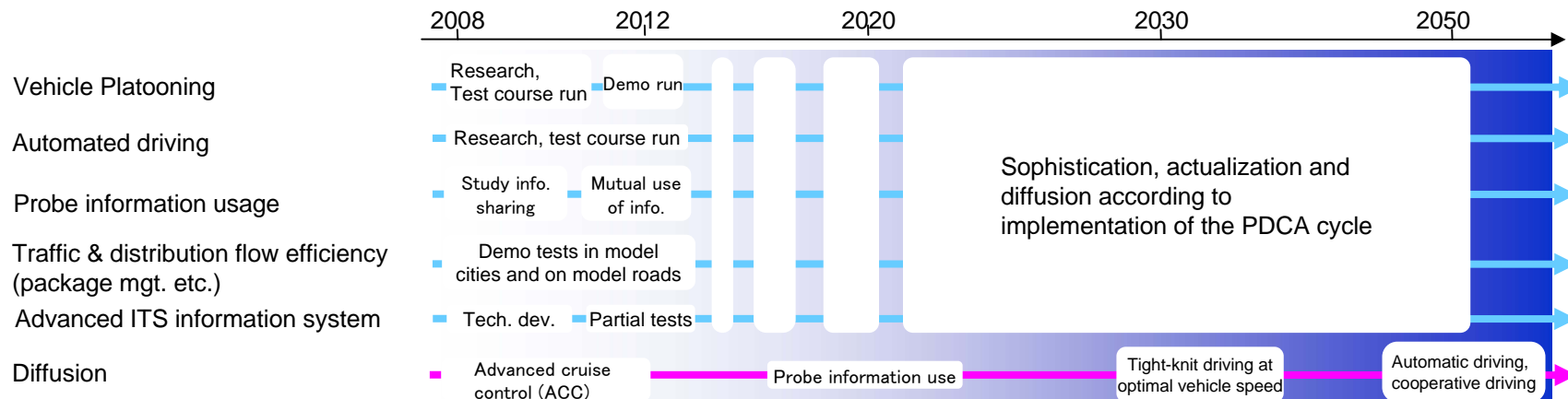
- Reduces CO₂ emissions by energy conserving drive and congestion reduction by utilizing road-vehicle / vehicle-vehicle communication technology, positioning systems such as GPS and radars, and information gathered (probe information) from each vehicle.
- Run simulations with gathered data and Optimize traffic flow by dynamic course guidance systems and traffic signals. Also, safe and effective travel and transport is achieved through advanced cruise control (ACC), vehicle platooning and automated driving.
- Establishment of international assessment methods of CO₂ emission reduction and standardization of ITS technology is important.

Greenhouse Gas Reduction Effectiveness

- Based on ETC, VICS and the central control of traffic signals in 2012, ITS will reduce CO₂ emissions by about 4 million tons. ※
- Regarding longer term CO₂ emission reductions by spreading ITS technology, it is necessary to study the combined effects of initiatives for individual automobiles and road maintenance. Therefore, it is difficult to calculate the reductions to be had from ITS alone at this moment.

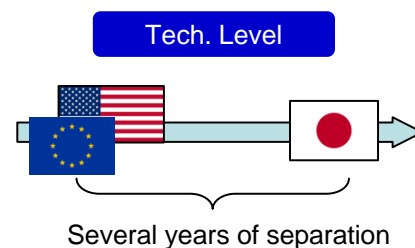
※ Kyoto Protocol Target Achievement Plan (revised March 2008)

Technology Roadmap/ Diffusion Scenario



International Competitiveness

- Japan is the world leader in developing and introducing car navigation systems and safe driving support systems.
- Japan is superior in on-time information distribution and vehicle/obstacle detection technology, compared to other countries.



International Expansion

- Japanese automobile and car electronics industries are at the top in technology level and the number of sales, and has great influence.
- Traffic congestions are becoming more severe in Asia and Pacific region, where populations are concentrating in cities and motorization is suddenly rising. Since each country is introducing ITS, advanced Japanese technology has a large role to play in responding to this problem.
- Crude oil prices are rising steeply, and expectations for lower fuel consumption is rising around the world. ITS technology is anticipated since it can reduce fuel consumption throughout the system without requiring new vehicles.

26. Areal Use of Energy (HEMS/BEMS/Local Area EMS, etc)

Technology Summary

○ Energy conservation technology to measure and manage energy through networks of residences, buildings and localities.

The range of applications are as below:

HEMS (Home EMS), BEMS (Building EMS), TEMS (Town EMS), CEMS (Cluster EMS)

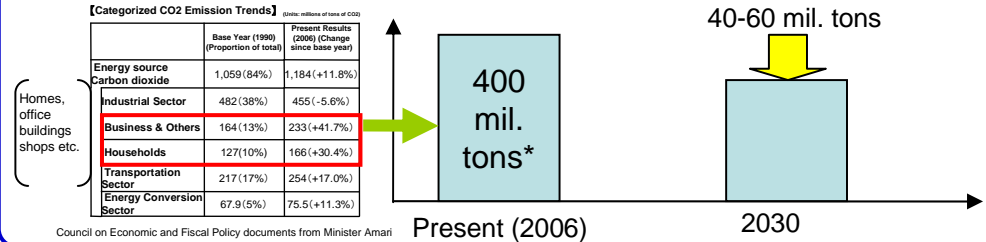
○ It is necessary to develop communication hardware, home and building sensor networks (communicating with all devices), microsensing, and prediction as technology elements.

○ It is necessary to develop technology renewable electric and heat energy optimization and assessment, power storage and other technology related to renewable energy from area cogeneration systems and solar power, in addition to HEMS/BEMS, as EMS technology on the local level.

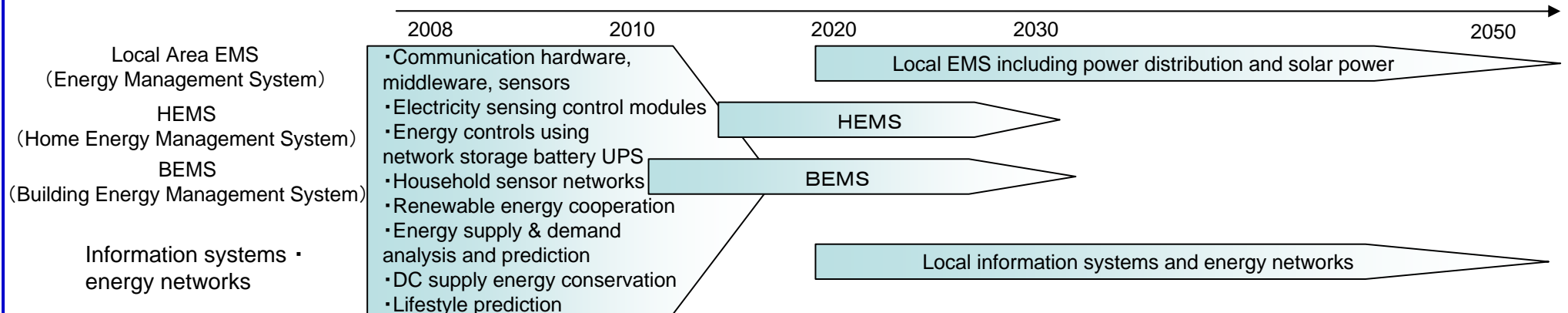
Greenhouse Gas Reduction Effectiveness

2030: 10-15% reduction (METI data)

(Eg. With timer/recorder standby power and timer control, which go unnoticed by people, 4.5 million tons (Ministry of Internal Affairs and Communications data))



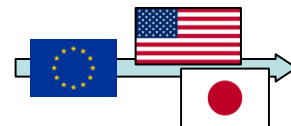
Technology Roadmap/ Diffusion Scenario



International Competitiveness

○ Globally, the maintenance of information system foundations in Japan are top class, Japan is predominant in energy technology such as electricity distribution tests and next generation power storage.

○ It is urgently necessary to carry out the integration of information systems and energy networks from here on.



Japan is barely ahead of the United States in batteries, while Europe is somewhat behind, though the difference is not large.

Domestic LED Production

International Expansion

○ Japan will craft alliances with China, South Korea and other neighboring countries, and take a leadership role while constructing a cooperative body in the Asian sphere. While holding on to the leadership of the Asian sphere, Japan will act on international standardization with Europe and the United States.

○ It is necessary to knowingly understand the activities of various standardization organizations establishing de facto standards, and to promote cooperative standardization to realize a strong system in the early stages, so that a great variety of connecting information home telephones and sensors can exist.

○ Japan is relatively predominant in leading initiatives, though South Korea and Europe are quickly catching up by concentrating on R&D and testing. Technology standardization will be sought with the International Telecommunications Union (ITU) while cooperating with these countries.

27. Telework

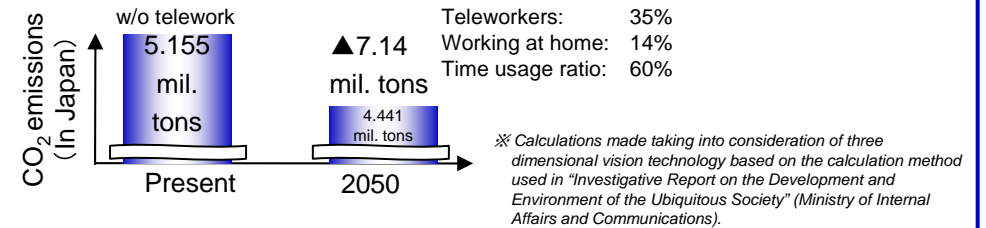
Technology Summary

- By integrated control of transmission and presentation technology such as ultra high-resolution videos, three dimensional images and sounds, this technology reproduces a sense of realism for objects and the presence of people at long distances.
- CO₂ emissions caused by workers commuting and travelling are reduced by decreasing people and objects movement through teleworking and teleconferencing. With less working hours and less commuting by improved business efficiency, consumption of energy at the office will also be reduced.
- Work-life balance can be established by changing commuting time (one hour forty minutes on average ※) into free time.

※ "Basic Study of Social Life 2006" (Ministry of Internal Affairs and Communications)

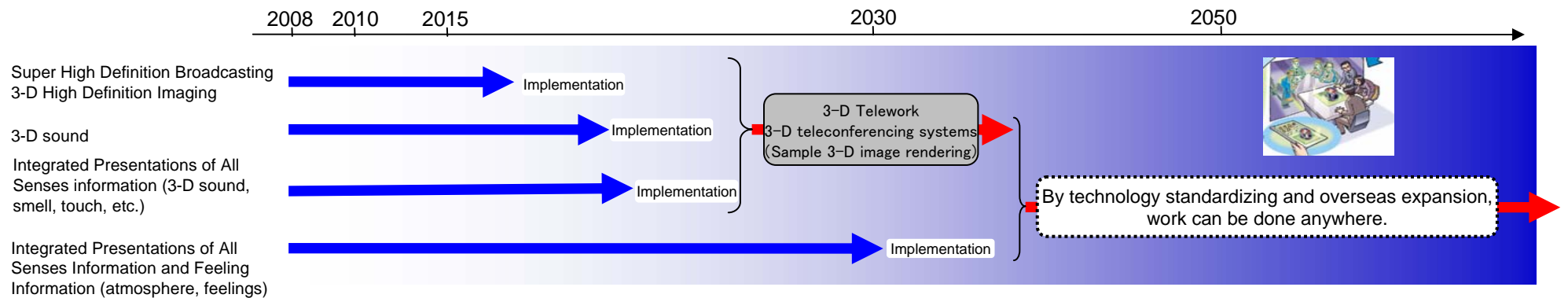
Greenhouse Gas Reduction Effectiveness

- Reductions of CO₂ emissions by less commuting and travel



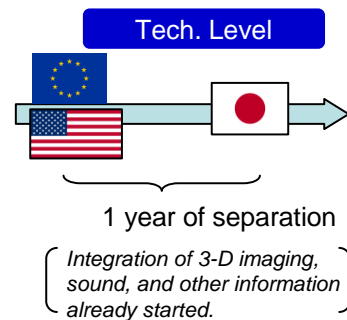
- CO₂ emissions can also be reduced by reduced office hours.

Technology Roadmap/ Diffusion Scenario



International Competitiveness

- Japan is leading the world on three dimensional imaging technology.
- Japan is pioneering in research on three dimensional sound, all senses information transmission, and sense information recognition and transmission.



International Expansion

- Contributes to reducing global CO₂ emissions by pressing on improvements in work efficiency and decreasing movement of people and objects on a global scale.
- Contributes to Japan's international competitiveness by allowing easy participation in international meetings and cooperative projects without going abroad, and makes up for Japan's geographical disadvantage in the movement of globalization.

28. Comprehensive Assessment System for Building Environmental Efficiency (CASBEE)

Technology Summary

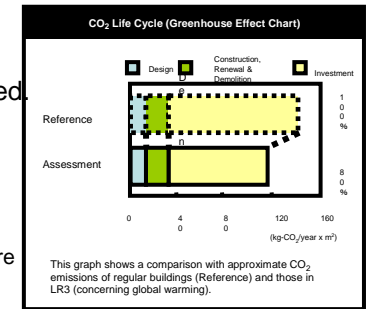
- This technology integrally assesses composite environmental efficiency to lessen the environmental load put on the Earth by improving home and building livability (the indoor environment), and evaluates it an easy to understand way (CASBEE: Comprehensive Assessment System for Building Environmental Efficiency).
- By raising awareness of consumption regarding home and building efficiency, it is possible to select homes and buildings with excellent energy conservation.

$$\text{CASBEE: BEE (Building Environmental Efficiency) is expressed by} \\ = \frac{\text{Building Environmental Quality (Q)}}{\text{Building Environmental Load (L)}}$$

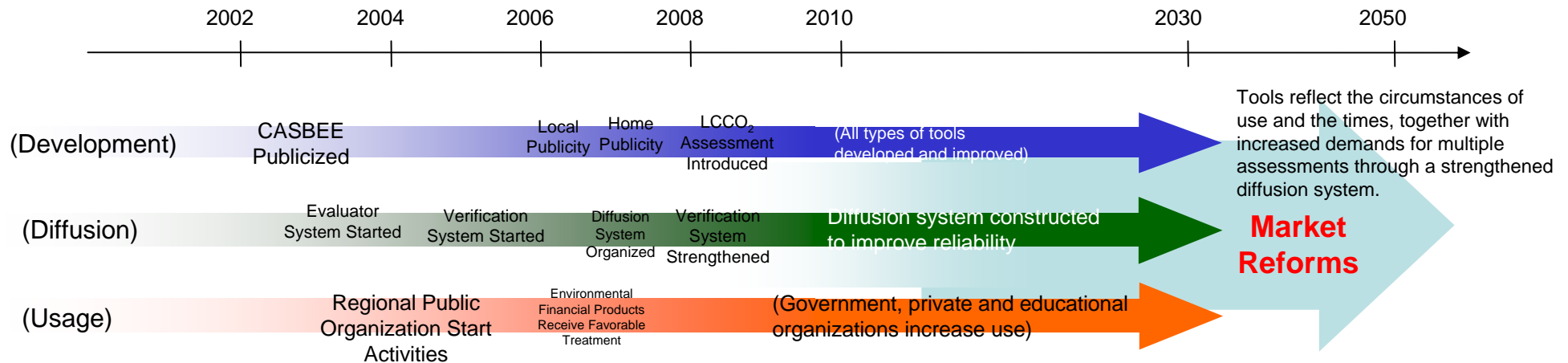
Greenhouse Gas Reduction Effectiveness

- By allowing the owner or consumer to compare building efficiency regarding CO₂ emissions at the construction stage (visualization), CO₂ use is lessened. (Chart: Warmth Effect)

- ※ By instituting CASBEE assessments in several municipalities, reports have exceeded 2,000 in number, and actual standards are in the process of coming into being. Examination of use assessment results regarding quantitative effects of diffusion are continuing to be considered.



Technology Roadmap/ Diffusion Scenario



International Competitiveness

- Compared with assessment systems overseas, CASBEE is an original method of evaluation by assessing both environmental quality and environmental load, making it a better than that overseas.
- Most assessment systems overseas do not indicate LCCO₂, so Japan is taking the lead here.
- In the GOBAS assessment system for facilities at the Beijing Olympics, the CASBEE way of thinking is being widely adopted.

International Expansion

- The CASBEE homepage offers free downloads of assessment tools in English and provides the latest information.
- Also, scholars participating in international conferences (the World Green Building Council and the World Sustainable Building Conference) made announced regarding CASBEE. In 2005, information was actively provided to the world at SB05 Tokyo.
- Standardization of environmental assessment systems for buildings is being examined at the ISO, and many Japanese are participating in discussions. Japan is responsible for one of the chairmanships.

29. High-Performance Power Storage

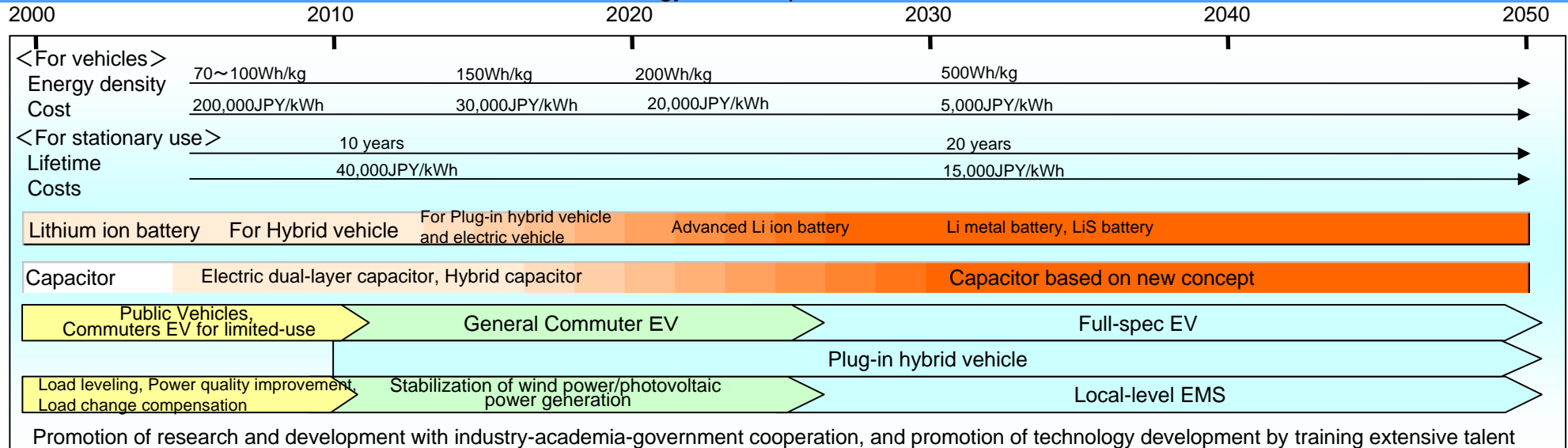
Technology Summary

- This technology includes storage batteries essential for large-scale grid connection of renewable energy such as solar power and wind power and for electric vehicles, as well as power storage technology utilizing capacitor with high output density.
- Lithium ion, nickel hydrogen, sodium-sulphur (NAS) and redox flow storage batteries possess safety, durability and efficiency.
- Regarding capacitors, electric dual-layer capacitors provide superior performance in power storage (non-failing power supply), safety, reliability and environmental friendliness. Storage capacity and costs are themes.
- It is expected for load leveling when charging plug-in hybrid vehicles and electric vehicle at night.

Greenhouse Gas Reduction Effectiveness

- It is not possible to directly calculate initial reductions of greenhouse gases through the cooperation of renewable energy with power storage in plug-in hybrid vehicle and electric vehicle.

Technology Roadmap/ Diffusion Scenario



International Competitiveness

- Japanese battery manufactures have led the world mainly in the field of battery technology in mobile devices. National projects have been launched in the United States, Europe, China and South Korea and the situation does not allow our current advantages to be taken for granted.
- Global share of lithium ion batteries: Japan 57%, South Korea 17%, China 13%, Others 13%
- Electric dual-layer capacitors
- Regarding prototypes for home use, the first were developed in 2006. They appeared at the Electric Vehicle Symposium (EVS), there were over 20 references. Patents are being created for basic technology related to electric dual-layer capacitors, with 290 domestic applications for related patents, 140 registrations, 88 overseas applications, and 48 registrations.

International Expansion

- Japan's battery technology is still predominant, though there are many basic researches for the development of new materials and large amounts of money being committed by Western countries to develop new positive pole battery materials. Therefore, it is necessary to continue cooperation in basic research with overseas research institutes. Also, international standardization of battery technology will be promoted.
- Power storage is indispensable to solar power, and priority for diffusion to the world will be given to developing countries where infrastructures are not in place. As it is thought that the potential for acceptance in advanced countries is higher due to costs, diffusion will occur parallel to ascertainment of area with potential for introduction.

30. Hydrogen Transport and Storage

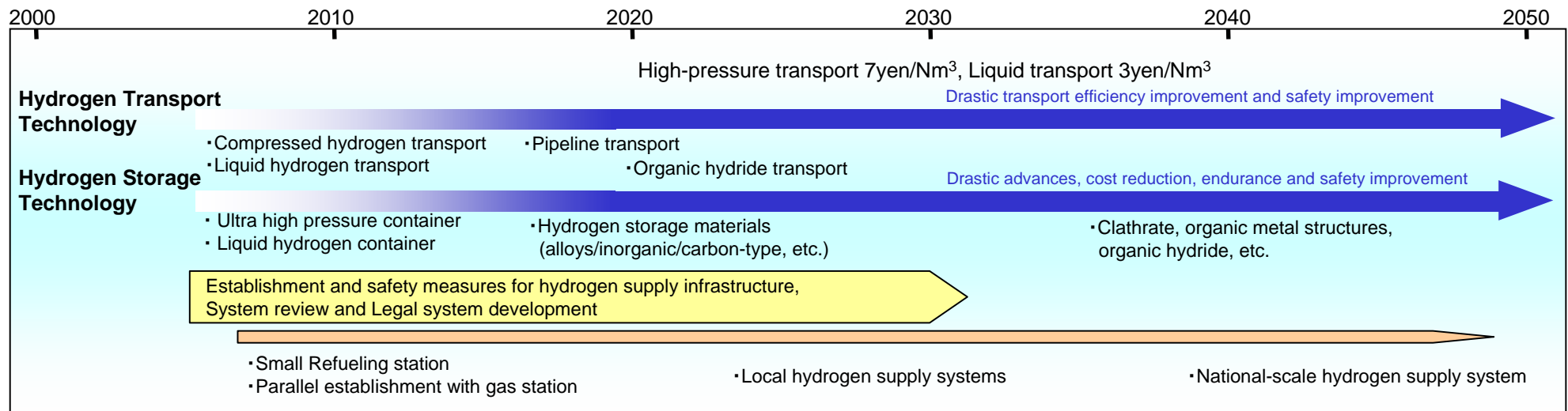
Technology Summary

- This is a technology for transport and storage of hydrogen to be used in fuel cell vehicle and stationary fuel cell.
- Possible methods for hydrogen transport include compressed hydrogen transport, liquid hydrogen transport, organic hydride transport in trailers, and pipeline transport. There are already records of compressed hydrogen transport in copper containers.
- Hydrogen storage technologies include storage as gas, liquid hydrogen and hydrogen storing alloy.

Greenhouse Gas Reduction Effectiveness

- Hydrogen can be used as an energy source for fuel cells covering a wide range of uses and on a large scale such as for automobiles, consumer and industrial cogeneration, at power plants, for laptop computers, and cellular phones and other mobile devices.
- The technologies effects cannot be demonstrated independently, so calculations are not possible.

Technology Roadmap/ Diffusion Scenario



International Competitiveness

- This technology has prospects for efficiency on a global level, with basic technology vital for transportation. Concrete assessments in the transportation sector are necessary to find whether it will someday be economically advantageous.
- Development for high targets is ongoing regarding hydrogen storage materials for automobiles (storing alloys, inorganic materials, etc.). Development tests are ongoing for weight and compactness targets. Points to consider are how to take hydrogen from transport to filling and the form of hydrogen in fuel cells before being loaded onto automobiles.
- Verification tests are ongoing for hydrogen gas filling stations and liquefied hydrogen stations. Basic technology of machinery for each kind of station are world class.

(Source) NEDO "Hydrogen Technology Development Symposium" data (June 13th, 2007)

International Expansion

- Regarding the International Organization for Standardization Hydrogen Technology (ISO/TC 197), Japan is promoting international standardization in regards to hydrogen-alloy storing containers and hydrogen tanks, along with proactively promoting joint international research and development with regards to the International Energy Agency's Hydrogen Implementing Agreement (IEA-HIA).
- Japan is participating in the International Partnership for the Hydrogen Economy (IPHE), and strengthening exchanges of information related to policies and development targets with the United States, Europe, etc.
- Through technological information exchanges and joint research with the United States Los Alamos National Laboratory, cooperation is being strengthened and research and development for next generation hydrogen storage technology is being promoted.

31. Carbon Dioxide Capture and Storage (CCS)

Technology Summary

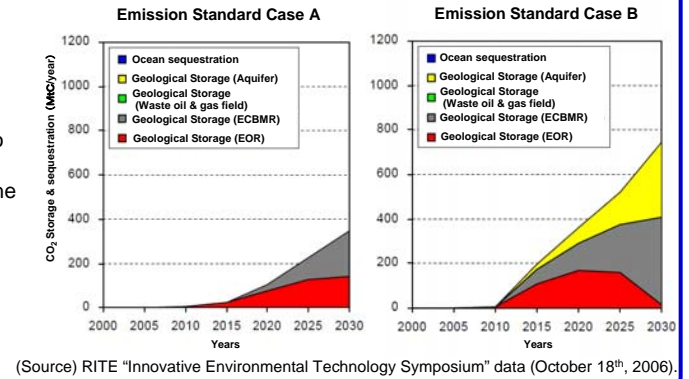
○ CCS is a technology to reduce the amount of carbon dioxide released into the atmosphere and contribute to a substantial reduction in carbon dioxide emissions around the world by separating and capturing carbon dioxide from the exhaust gas of large emissions sources such as thermal power plants and storing or sequestering it in underground geological formations or in the deep ocean for a long time.

○ CCS is a process consisting of 4 stages; carbon dioxide capture, transport, injection and storage. The core in technology development is the carbon dioxide capture and storage technologies. For carbon dioxide capture process, chemical absorption, physical absorption, membrane separation, and cryogenic distillation can be used. Potential technical storage methods are geological storage or ocean sequestration. The former methods involve aquifer (deep saline aquifer) storage, Enhanced Oil/gas Recovery (EOR), storage in depleted oil/gas reservoirs or unminable coal seams. As ocean sequestration methods, dissolution type and lake type storage can be used.

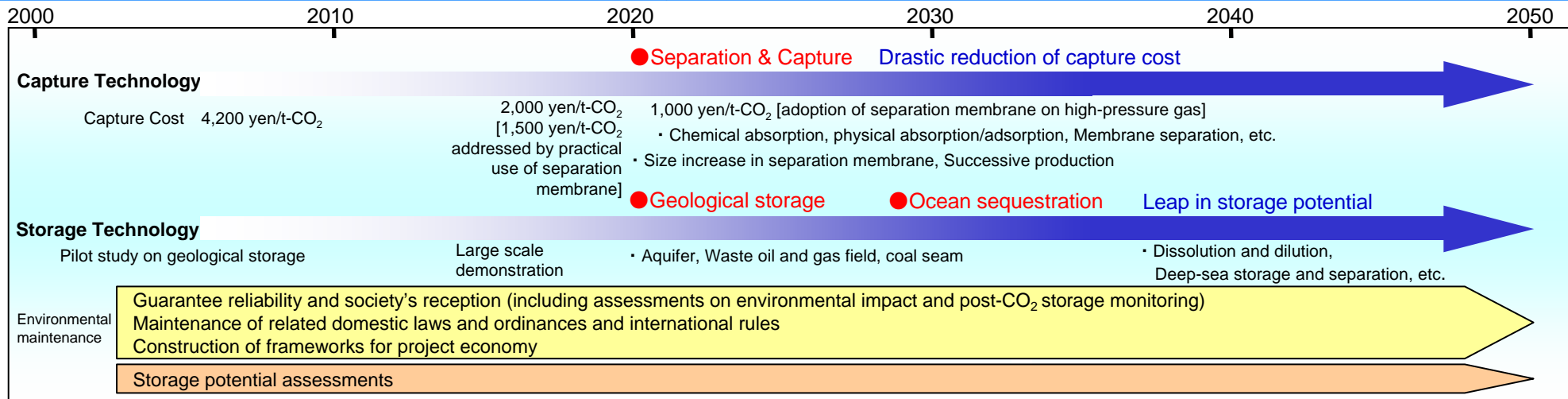
Greenhouse Gas Reduction Effectiveness

○ World
According to a special report by the IPCC, potential reductions of 2 trillion tons is anticipated with underground storage only. Reductions for APP6 countries in 2030 from capturing and storage are calculated to be between approximately 300 million to 700 million tons (110 million to 260 million tons when converted to carbon dioxide). (Refer to the chart on the right for the source and details.)

○ In Japan
Data on the potential for aquifers is limited to basic drilling into their anticlinal structures and shows 520 million tons, though all aquifers are anticipated to accommodate about 15 billion tons. (Source) METI CCS2020.

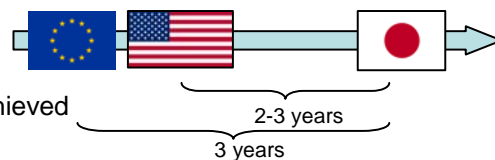


Technology Roadmap/ Diffusion Scenario



International Competitiveness

○ Molecular gate function CO₂ membrane separation
Champion data in the United States
CO₂/H₂ selectivity=10
Japan
CO₂/H₂ selectivity=30 already achieved



International Expansion

○ Through the APP (Asian Pacific Partnership on Clean Development & Climate) and the CSLF (Carbon Sequestration Leadership Forum), cooperation on development of advanced technology (membrane separation and monitoring) for CCS will be strengthened.

○ Regarding the Callide A (Australia) overseas verification project, Japan will prove the superiority of its technology and strengthen collaboration with overseas research institutes and in verification projects through public and private integrated frameworks.

○ Through the IEA, cooperation will be strengthened regarding environmental maintenance with when spreading the technology with environmental impact assessments and ensuring reception by society.

32. Carbon Fixure with Vegetation (Super Tree)

Technology Summary

- Introduction of genes concerned with environmental stress resistance, and development of “super plant” breeding for environments where the Kobaku effect is advancing with salt-air damage, desertification, etc.
- By introducing genes, it is possible to induce traits such as salt resistance, dehydration resistance, acid soil resistance, accelerated growth to maturity, ozone resistance and high cellulose.
- Planting super plants in Kobaku areas through the world can contribute to the prevention of global warming by absorbing CO₂ at the source.

Greenhouse Gas Reduction Effectiveness

Approx. 40 million km² of Kobaku area (30% of the world's land)



In the case that 5% (2 million km²) is planted with super plants in 2030

- ◎ 500 million annual tons of carbon absorption is anticipated※
- 1200K m² of super plants anticipated to absorb 2 billion tons annually of carbon in 2050

※Calculated based on area units for annual absorption of 2.5 carbon tons/ha·year
(Forestry and Forest Products Research Institute)

Technology Roadmap/ Diffusion Scenario

2008 2010 2015 2030 2050 →

Super Plant Development Examples

- Env. Res.
- Large amounts of biomass
- Fast growth

- Salt-resistant eucalyptus
- Dehydration-resistant eucalyptus
- Acid soil (aluminum)-resistant eucalyptus
- Accelerated growth poplar
- Ozone-resistance poplar
- High cellulose poplar, etc.

Development of super plants
(genetic modification,
applicability tests, etc.)

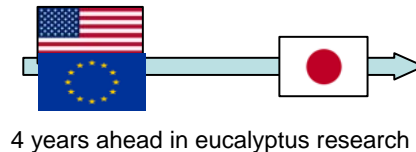
Planting Start
2015 onward

5% of global Kobaku areas
with super plants (2 mil. km²)

20% of global Kobaku areas
with super plants (120 mil. km²)

International Competitiveness

- Japan's research original research into development of genetically modified environmentally resistant plants (Priority is on research related to biomass quantity in Europe)
- Globally, Kobaku areas are growing due to salt-air damage and desertification, and it is possible to plant forests in soil that has been difficult for traditional plants.



International Expansion

- Development and global diffusion of super plants capable of surviving in each type of devastated desert (Kobaku) areas, which amount to 9 million km² of arid land, 27.4 million km² of semi-arid land, and 4 million km² of land with salt accumulation (about 40 million km² in total) on the Earth's surface.

33. Ultra-Long-Term Housing (reduction of waste by increasing longevity)

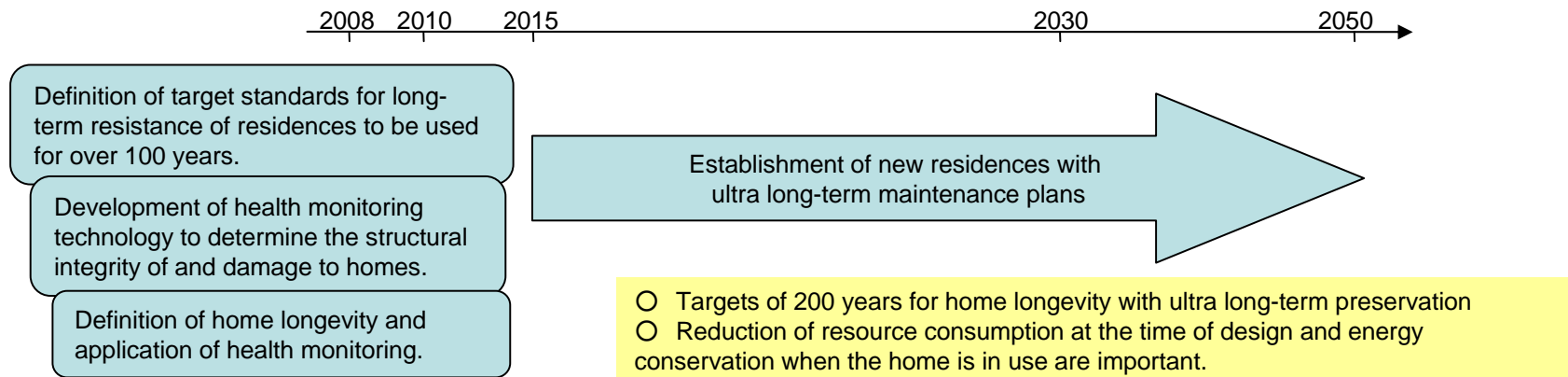
Technology Summary

- Homes last longer than traditional types due to materials and construction tools, and appropriate maintenance.
- Will not collapse and is possible to continue using after a 7.0 magnitude (Japanese scale) earthquake.
- Effective preservation and prevention is possible with regular assessments of the soundness of frames and facilities.

Greenhouse Gas Reduction Effectiveness

- If 50% of homes can be used for 200 years without being torn down, home construction waste will be reduced by about 50 million tons annually.
- Also, CO₂ emissions can be reduced by reducing resource consumption at the time of designing and improving energy conservation performance when the residence is in use.
- Furthermore, from preserving the frame over a long period of time without discarding the lumber used, carbon can be fixated for a long time.

Technology Roadmap/ Diffusion Scenario



International Competitiveness

- Average time for use of homes in Japan before being torn down is about 30 years
(Ref: about 55 years in the USA, and about 77 years in the U.K.)

International Expansion

- Climate, geography and lifestyles vary between countries, and there are various structures for homes, though the overseas prospects are good for home management and techniques for ensuring long-term maintenance standards.

34. Other Greenhouse Gas (Methane, etc.) Reduction Technology

(Optimization of anaerobic treatment of drainage and liquid waste)

Technology Summary

- An efficient and low cost wastewater treatment processing method focusing on anaerobic technology (methane fermentation, etc.) with low excess sludge production and without the aeration energy
- Establishment of high rate and stable wastewater treatment by accumulation (optimization) of anaerobic microorganisms in the wastewater treatment process.
- Collects methane gas emitted during treatment and makes use of it as an energy source.
- Improves water quality by both removing the necessity of aeration for natural flow and by allowing easy treatment.
- Accordingly, greenhouse gas emissions from treatment can be reduced on a large scale.

Greenhouse Gas Reduction Effectiveness

• Aeration will be dropped to zero, and sludge waste will be reduced (1/3 to 1/4).

Energy consumption reduced by 60-70% (CO₂ emissions)

• Conservation by collecting methane

15-20% energy consumption (average)

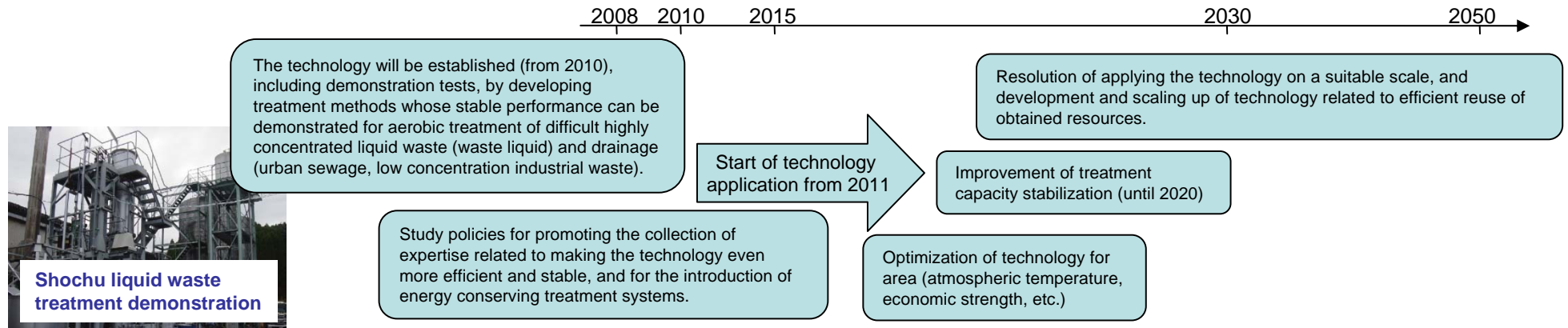


**60-90%
CO₂
reductions**

Greenhouse Gas Reduction Effectiveness by optimizing drainage and liquid waste treatment

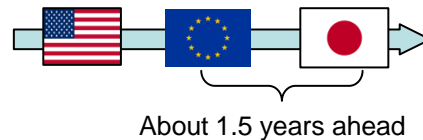
In Japan: 8.07 mil. Tons CO₂/year Overseas (Asia): 250 mil. tons CO₂/year

Technology Roadmap/ Diffusion Scenario



International Competitiveness

- World class level of development of anaerobic treatment technology and research related to management and optimization of microbe groups.
- Secondary effects from reductions in treatment energy and CO₂ emissions, as well as emitted methane collection and effective use (carbon neutral), by the introduction and technological optimization of technologies for untreated industrial drainage (including waste liquid) and urban sewage treatment.



International Expansion

- As greenhouse gas emissions from untreated waste liquid and drainage (by waste ponds, etc.) are serious, this technology will especially spread in developing countries.
- From the fact that the concerned technology will suppress costs down to a low level, attention is being gathered from researches in areas of Southeast Asia and Central America, giving an advantage to the spread of this technology.
- However, as investments will have to be large during the initial stages of introduction, it is necessary to develop appropriately inexpensive techniques while cooperating internationally.
- It is thought that not only a level of technological development, but also support from the country for the introduction of the technology is necessary. Also, it is necessary to not merely export the equipment (technology) abroad, but to also commit to the nurturing of the appropriate talent to manage operations of drainage treatment equipment, and to train in techniques that are practical and effective.

35. Adaptation Technology to Global Warming (Development of crops able to endure drought and cold weather damage)

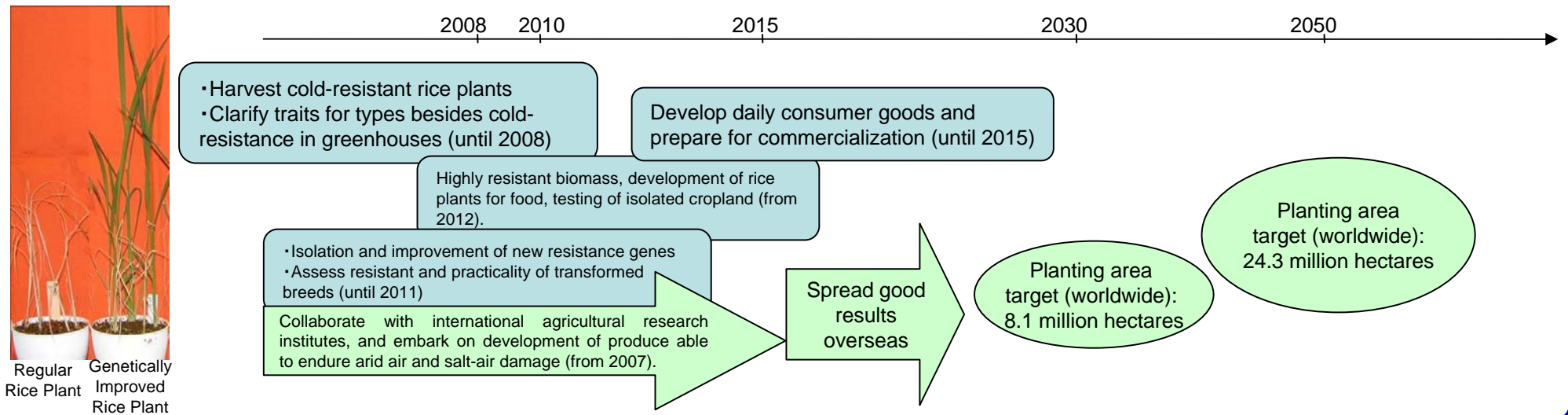
Technology Summary

- Making use of dry air and salt-damage resistant DREB genes and fructan synthetic enzyme genes resistant to cold weather damage to develop crops endowed with strong environmental resistance.
- As a counter-measure to global warming, the stable production of crops under bad environmental conditions is also possible.
- Developing new lands for agriculture (forest lumbering and guaranteeing cropland) will lower dependence maintain forests as a source of CO₂ absorption.

Greenhouse Gas Reduction Effectiveness

- As this technique is meant as a counter-measure to react against global warming, it does not directly reduce CO₂, though through its application a contribution to a reduction in the control of the development and lumbering of forests (8.1 million hectares in 2030, 24.3 million hectares in 2050), and contribute to increasing the amount of CO₂ absorbed by forests.

Technology Roadmap/ Diffusion Scenario



International Competitiveness

- Leading Europe and the United States in research on cold weather damage resistance.
- Japan is first in discovering genes endowed with arid air resistance.

【Research on cold weather damage resistance】



International Expansion

- From 2007, collaborate with international agricultural research institutes, and embark on development of produce able to endure arid air and salt-air damage.
- Assuming that crop areas in developing countries will be reduced by 30% due to the influence of environmental stress, this is an indispensable technique for ensuring stable food supplies.

36. Earth Observation & Climate Change Projection

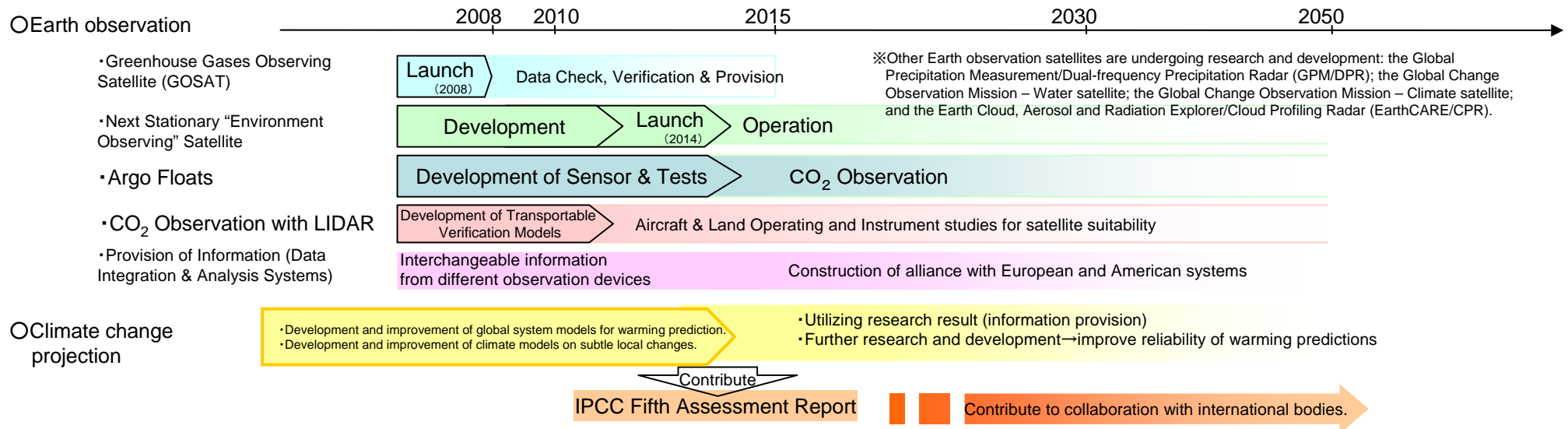
Technology Summary

- Earth observation
With the Greenhouse Gases Observing Satellite (GOSAT) earth observation satellite, environmental observation functions added to stationary weather satellites to create stationary “environment observing” satellites, LIDAR technology to measure concentrations of CO₂ in the atmosphere, and Argo floats on the oceans to measure CO₂ levels, highly precise and long-term continuous measurement can be performed across the globe, and long-term observation information provided related to distribution of greenhouse gas levels and climate change, in order to effectively and efficiently support countermeasures to warming.
- Climate change projection
With the development and introduction of models of CO₂ absorption/reaction interaction between atmosphere, land and sea, as well as models on subtle changes in regional climates, it is possible to make scenarios for stabilizing CO₂ level in the atmosphere, and long-term predictions of the subtle warming effects on melting ice sheets.

Greenhouse Gas Reduction Effectiveness

- These technologies will indirectly contribute to reducing greenhouse gases by predicting detailed climate changes in areas on the Earth’s surface, providing more precise information on observation and predictions, and supporting appropriate countermeasures against global warming worldwide, including for developing countries.
- In addition, with the appropriate technology a much greater contribution can be made towards the IPCC Fifth Assessment Report, thus playing a central role in creating an international framework.

Technology Roadmap/ Diffusion Scenario



International Competitiveness

- Earth Observation
 - The United States has plans to launch satellites for CO₂ observation, though Japan is ahead as GOSAT will be able to observe CO₂ and CH₄. Japan also leads with CO₂-measuring LIDAR and other next generation sensor technology.
- Climate Change Projection
 - Warming predictions from Japan’s climate models can be used in IPCC Assessment Reports, and are acknowledged by the world as being at the forefront of research.
 - The Earth Simulator have been leading research for climate change.
 - Japan is predominant in high-resolution (regional & city level) projection.

International Expansion

- Japan has taken part in the satellite observation network under the World Weather Watch (WWW) program of the World Meteorological Organization (WMO), and invest in stationary environment observing satellites to cover Asian and Pacific regions, to contribute to adaptive measures against global warming.
- Japan will provide observation and projection research results to the world, actively play a central role in the creating of the IPCC Fifth Assessment Report, and continuously promote international cooperation for interchangeable data between researchers and institutes (Global Earth Observation System of Systems [GEOSS]), all to contribute to the research and development of plans for international models and regional predictions of effects through collaboration with research institutes in all countries.
- Additionally, Japan will not only provide information, but also develop capabilities for effective adaptations to global warming, to developing countries.