Cool Earth-Innovative Energy Technology Program

(Summary)

March 5, 2008

Ministry of Economy, Trade and Industry

1. Introduction

- The Prime Minister's initiative on global warming, "Cool Earth 50" was announced last May, proposing a long-term objective to "reduce global greenhouse gas emissions by half compared to the current level by 2050."

- It is difficult to achieve this objective with only conventional technologies, and so the development of innovative technologies is considered essential.

- Since Japan has the world's top level technology in the field of energy, we need to strongly promote international cooperation and actively contribute to substantial global emissions reductions by 2050 while reinforcing and maintaining our competitiveness by focusing our research and development resources on the technology fields where we can lead the world, and by accelerating and promoting technology development with the recognition that technology is an important resource for Japan. We considered the following for this purpose:
  - ✓ Identification of which technologies Japan should focus on developing to achieve substantial reductions by 2050
  - ✓ Formulation of technology development roadmaps showing milestones for technology development that requires long-term efforts
  - ✓ How international cooperation can be structured with technology roadmaps to ensure steady advances in technology development from a long-term perspective

- This report summarizes these items of discussion as the report of the "Cool Earth-Innovative Energy Technology Program" Advisory Council.

2. Innovative Energy Technologies to be Prioritized

- Criteria for narrowing down the focus of innovative energy technologies -

- To promote energy technology development effectively and efficiently to enable the substantial reduction by 2050, we narrowed down the specific innovative energy technologies to be emphasized by using the following criteria.
- Obviously the improvement and diffusion of existing technologies that are already commercialized is also important, but we considered innovative technologies that are not extensions of existing technologies as subjects in this examination.

① Technologies expected to deliver substantial reductions in carbon dioxide emissions in the world by 2050

(a)Technologies that can be commercialized by 2030 considering the period required for the diffusion of the technology.

(b)Technologies that can be commercialized after 2030 if the period required for diffusion is short.

② Innovative technologies expected to deliver a substantial performance improvement, cost reduction, expansion in diffusion and so forth through one of the following methods:

(a) Material innovation including the utilization of new principles and the new utilization of existing materials (e.g. PV cells with new structures or materials, an alternative to platinum as a catalyst in fuel cells, etc.)

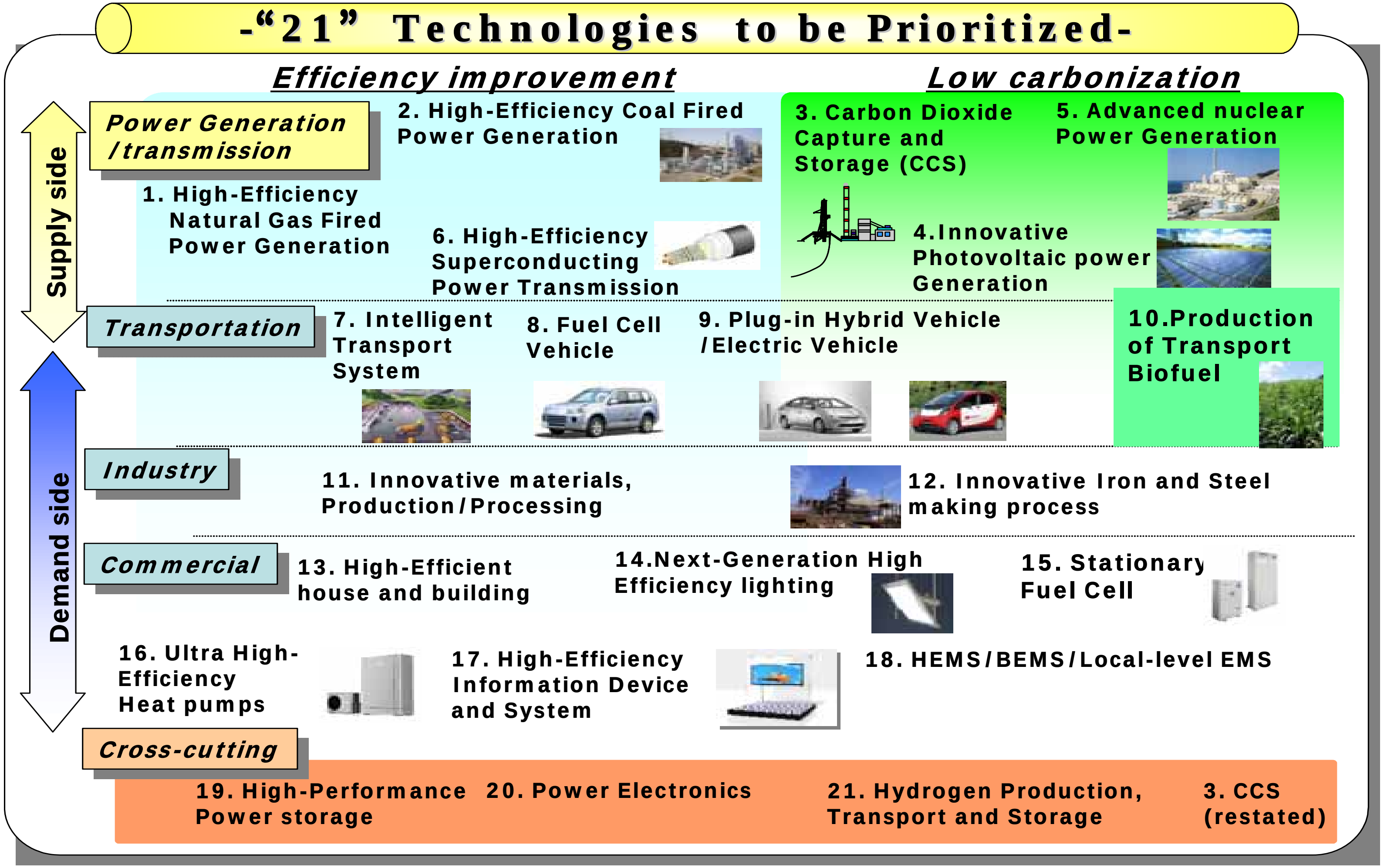
(b) Innovation in production processes (e.g. innovative iron and steel process using hydrogen as the reducing agent, etc.)

(c) Demonstration of systems based on established elemental technologies (e.g. carbon dioxide capture and storage technology)

③ Technologies that Japan can lead the world in developing (this includes areas in which Japan already has a lead in developing the foundational elemental technologies).

－Innovative Energy Technologies to be Prioritized －

We considered the flow from the supply side to the demand side for each energy source and selected the 21 technologies that can contribute to substantial reductions in carbon dioxide emissions by effficiency improvement and low carbonization.



* EMS: Energy Management System, HEMS: House Energy Management System, BEMS: Building Energy Management System

High-efficiency natural gas fired power generation

<Current technology>

○ Japan currently uses ultra super critical pressure (USC) generation and was the first country in the world to implement 600℃-class USC with a power generation efficiency of 42% (transmission end, HHV). Further improving efficiency is an issue.

＜Technology development roadmap＞

○ Advanced Ultra Super Critical pressure power generation: we will aim to commercialize 700℃-class turbines with 46% power generation efficiency by around 2015 and 48% efficiency by around 2020.

○ Integrated coal Gasification Combined Cycle: we will aim to achieve 46% power generation efficiency by around 2010 and 48% by around 2015. Furthermore, we will aim to achieve power generation efficiency of 50% by around 2025 by adopting a 1,700℃-class gas turbine, and increase power generation efficiency to 57% by 2030 and later.

○ Integrated coal Gasification Fuel cell Combined cycle: we will aim to reach a power generation efficiency of 55% by around 2025, and 65% in the long term.

<Effect of technology>

○ Carbon dioxide emissions can be reduced by about 30% if power generation efficiency can be improved to 57%, and by about 40% if efficiency is improved to 65%. In addition, emissions of carbon dioxide can be expected to be reduced to nearly zero by combining this technology with CCS.

<Challenges for effective technology development and diffusion>

○ It is necessary to conduct large-scale demonstration projects in combination with CCS, and strengthen basic research in areas such as materials and catalyst technology.

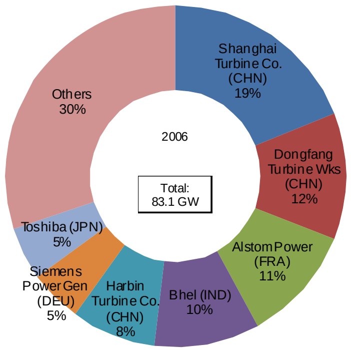
(Reference 1)

- Advanced Ultra Super Critical pressure power generation (A-USC): A-USC is the technology to improve the power generation efficiency by increasing the steam temperature and pressure of pulverized coal fired power generation.
- Integrated coal Gasification Combined Cycle (IGCC): IGCC is the technology for combined power generation that uses gas turbines and steam turbines with coal gasification.
- Integrated coal Gasification Fuel cell Combined cycle (IGFC): IGFC further improves power generation efficiency by combining this process with a fuel cell.

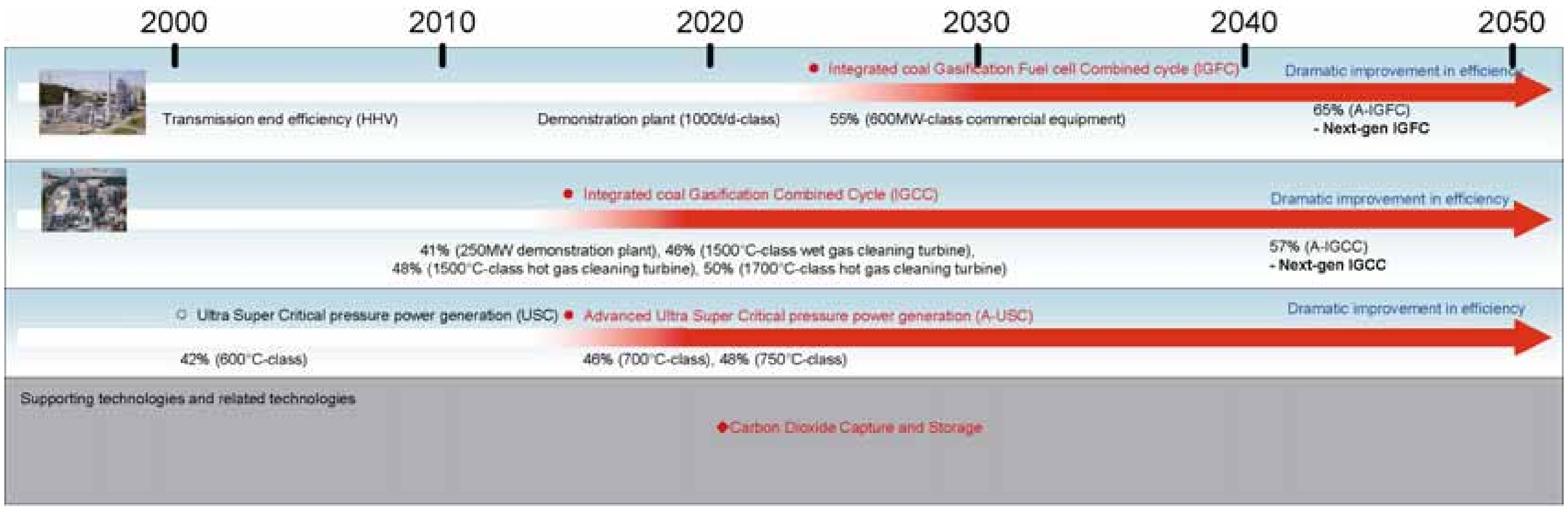
(Reference 2)

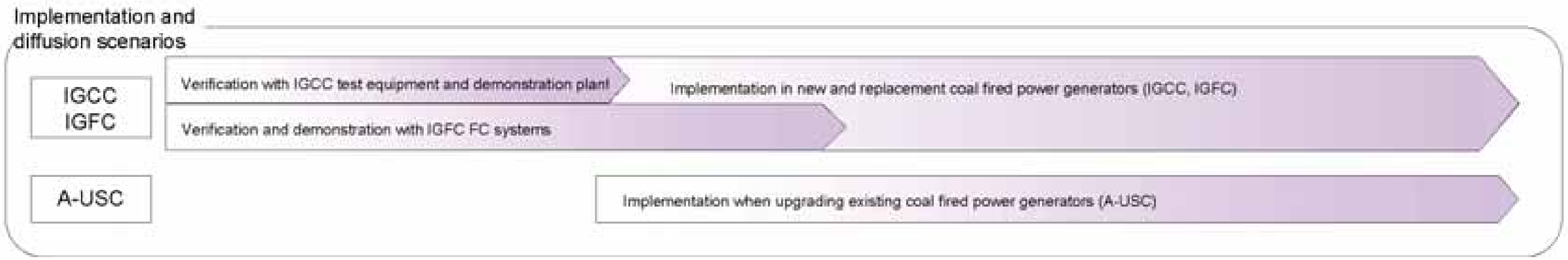
- Along with European manufacturers, Japanese manufacturers are leading the world in this technology.
- Chinese manufacturers have an overwhelming world share obtained through technical cooperation with manufacturers from Japan, America and Europe.

Market Share of Steam Turbines (Output)



Technology Development Roadmap





Carbon dioxide capture and storage (CCS)

<Current technology>

○ In Japan, basic research has been carried out, and small-scale demonstrations of 10,000 ton geological injections have been implemented. The issue is the reduction of the cost for separation and capture, which is currently about 4,200 JPY/t-CO2.

＜Technology development roadmap ＞

○ Development of elemental technology for separation membranes is being undertaken with the target cost of 2,000s-level JPY/ t-CO2 by around 2015 and 1,000s-level JPY/t-CO2 by the 2020s.

○ Carbon dioxide prediction technologies are being developed and Japan was quick to begin working on a large-scale demonstration project, with the aim of practical application by 2020.

<Effect of technology>

○ It is possible to reach zero emissions by combining this technology with large-scale emission sources such as coal fired power generation.

<Challenges for effective technology development and diffusion>

○ We will promote strengthened ties with international partnerships such as CSLF and APP, and work to accumulate technology and know-how through participation in large projects overseas with the aim of demonstrating the technology ourselves.

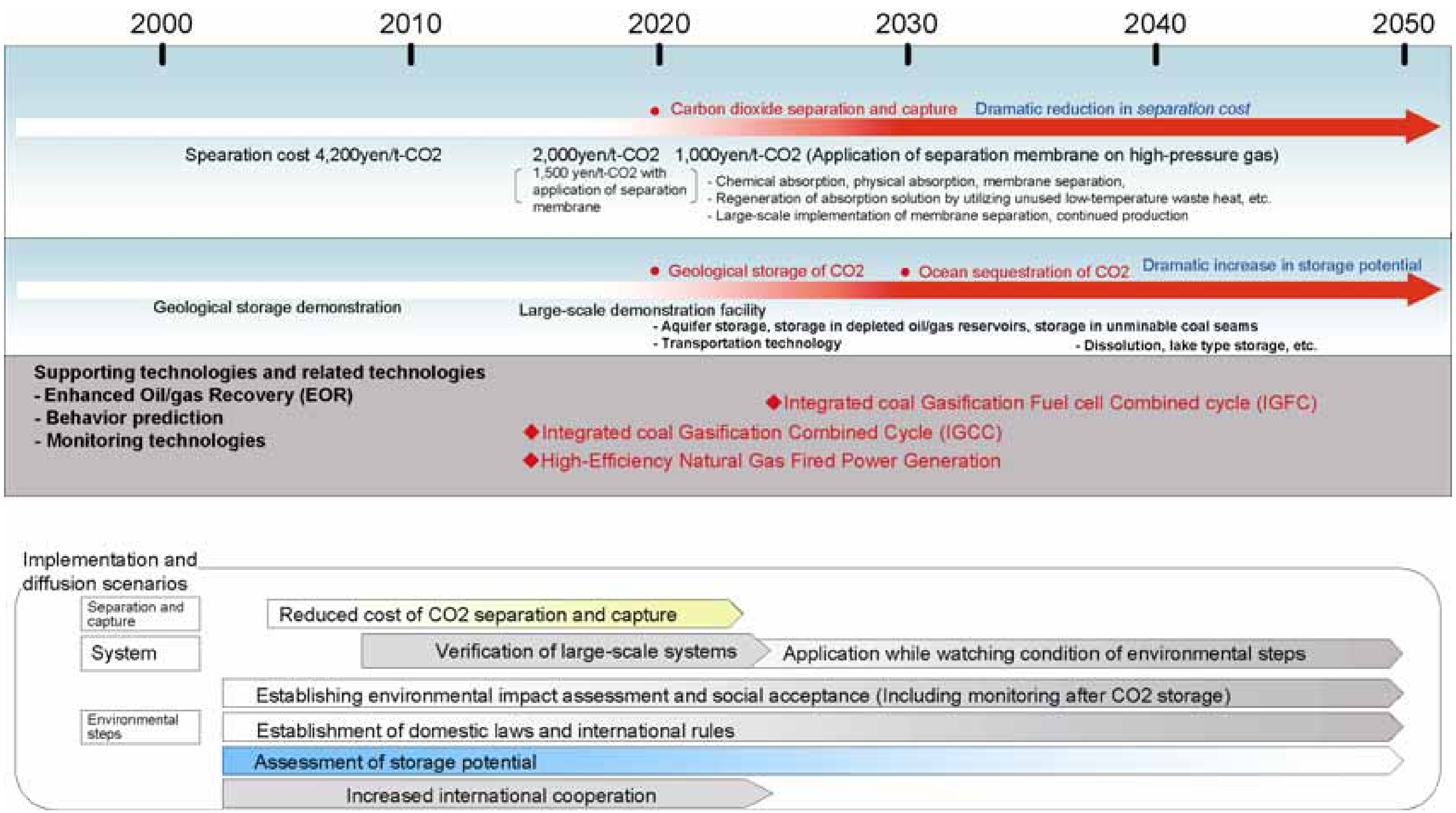
○ It is necessary to consider environmental impact assessments, preparation of laws and ordinances, and ensuring social acceptance through international cooperation with the aim of implementing the technology.

(Reference)

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. Currently, domestic and international attention has been focused on CCS technology as a promising option to mitigate carbon dioxide emission in atmosphere. In Europe and the U.S., technology development is being actively pursued, and Enhanced Oil Recovery technology has reached the stage of commercialization.

CCS technology development is being undertaken in the U.S., Canada, Europe, Australia, China and other countries, and several large-scale demonstration projects and commercial projects are being planned or implemented.

Technology Development Roadmap



Innovative Photovoltaic Power Generation

<Current technology>

◯ Most products currently prevailing in the market use first-generation photovoltaic technology that utilize crystalline silicon. Further improvement of efficiency and reduction of cost are technical challenges.

＜Technology development roadmap＞

◯ The development of a second generation utilizing ultra-thin crystalline silicon, compound thin-film PV cells and organic PV cells utilizing organic materials and dyes is aimed at reducing the power generation cost to 7 yen/kWh and improving power generation efficiency to 40% in 2030.

◯ The third generation will quantum nanostructure PV cells and PV cells utilizing new concepts and principles to increase power generation efficiency beyond 40% in 2050.

<Effect of technology>

◯ No carbon dioxide is emitted during operation.

<Challenges for effective technology development and diffusion>

◯ It is necessary to work on both stabilization of overall system output through storage technology and development of system control technology, in addition to suitably combining field tests and implementation incentives as the private and public sectors work together to ensure the smooth entry of excellent technology development results into the market.

(Reference 1)

- First generation: These are PV cells that utilize crystalline silicon.
- Second generation: These include thin-film silicon, ultra-thin crystalline silicon, compound thin-film PV cells and organic PV cells utilizing organic materials and dyes. They have largely resulted from attempts to reduce the cost by reducing the amount of silicon through thin-film development or by adopting an alternative material to silicon.
- Third generation: These are PV cells that try to achieve both drastic improvements in efficiency and reductions in cost by utilizing innovative materials and structures such as multi-junction and quantum nanostructure.

(Reference 2)

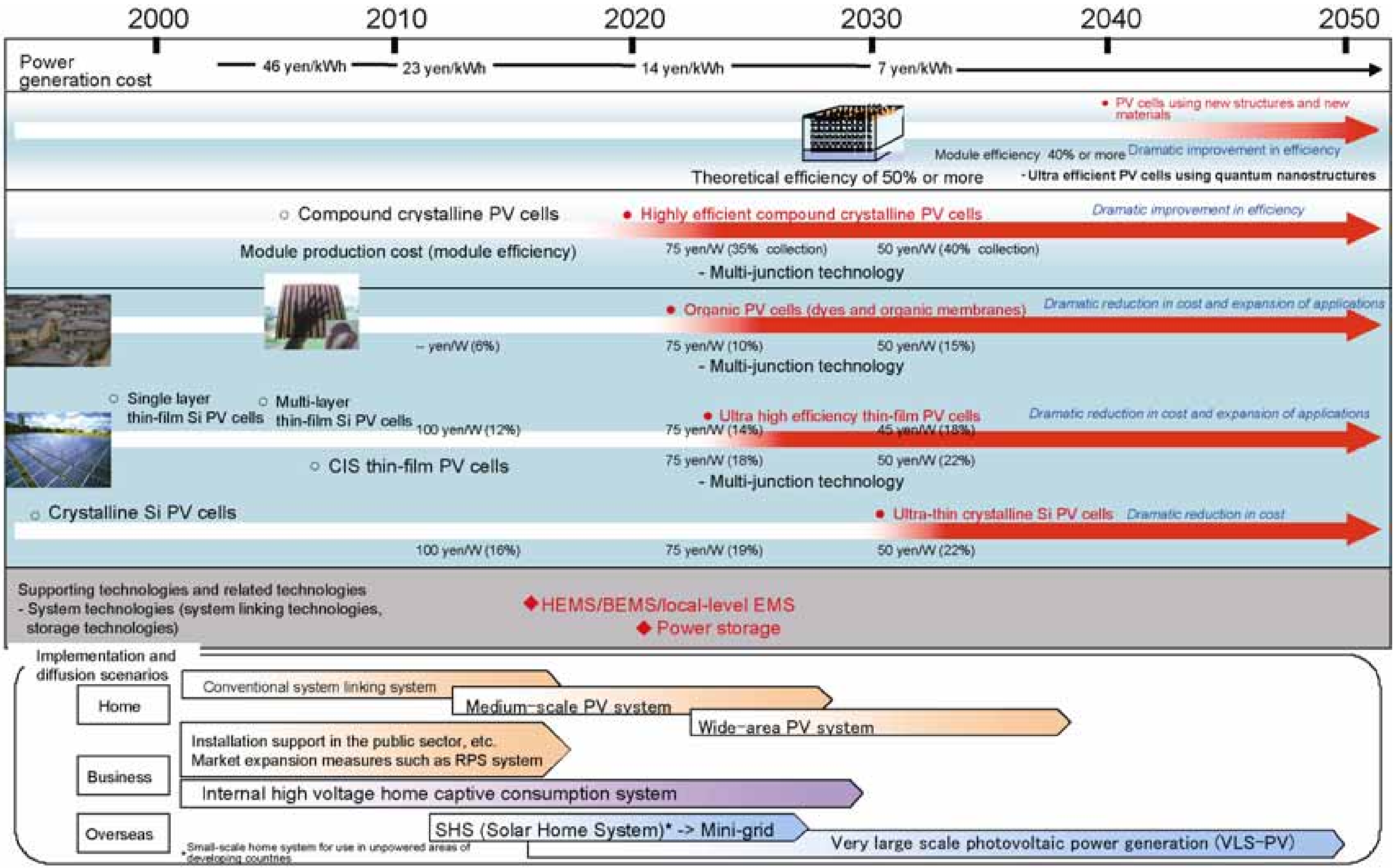
- Germany exceeded Japan in the total amount of installed PV power, and in recent years, production by Chinese companies has increased rapidly, with some Japanese manufacturers of PV modules being acquired. Active technology development is also being carried out by venture companies in the United States.

PV Cell Production by Company

Prepared by METI referring to a report by RTS Corporation

	Company	Production in 2006		2006/2005
		(MW)	(%)	(%)
1	Sharp (JPN)	434.0	17.4	101.5
2	Q-cells (DEU)	253.1	10.1	152.5
3	Kyocera (JPN)	180.0	7.2	126.8
4	Suntech (CHN)	157.5	6.3	192.1
5	Sanyo Electric (JPN)	155.0	6.2	124.0
6	Mitsubishi Electric (JPN)	111.0	4.4	111.0
7	MOTECH (TWN)	110.0	4.4	183.3
8	Schott Solar (DEU)	83.0	3.3	101.2
9	SunPower (PHL)	62.7	2.5	272.6
10	Isofoton (ESP)	61.0	2.4	115.1

Technology Development Roadmap

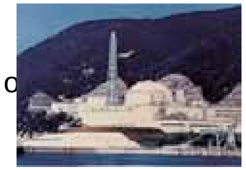


High-efficiency Natural Gas Fired Power Generation

<Current technology>
First in the world to implement 1500 ° C-class turbine and achieve 52% power generation efficiency. Further improving efficiency is an issue.
＜Technology development roadmap＞
We are aiming for 56% power generation efficiency in around 2015, and to achieve power generation efficiency of 60% in around 2025 by combining the technology with fuel cells.
<Effect of technology>
It is possible to reduce CO2 emissions by approximately 7% if power generation efficiency increases from the current level of 52% to 56%, and by approximately 10% if power generation efficiency increases to 60%. In technology terms, zero emissions can be achieved if used in combination with CCS.

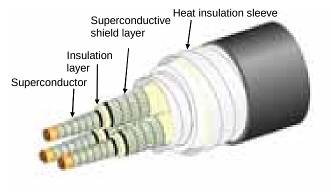
Advanced Nuclear Power Generation

<Current technology>
Nuclear power has excellent supply stability, and is currently the only clean base load energy source in Japan. Japan also boasts world-class personnel and work depth in all areas including technology development, design, construction and operation.
＜Technology development roadmap＞
To address the domestic needs for the replacement of reactors expected around 2030, we will promote the development o next-generation light-reactor technology. We will also promote the development of fast reactor cycle technology with an objective to build a demonstration reactor and a related cycle facility by 2025 and commercialization of the technology before 2050. In addition, we will promote the development of small and medium reactors.
<Effect of technology>
No carbon dioxide is emitted during operation.



High-efficiency Superconducting Power Transmission

<Current technology>
Japan leads technology development of Bi-system cable materials. Issues include improving transmission volume and reducing costs through the use of Y-system cables.
＜Technology development roadmap＞
We will implement superconducting power transmission with Y-system materials in 2020 or later.
<Effect of technology>
The current power transmission loss of 5% can be reduced to a third of that level.



Plug-in Hybrid Vehicles/Electric Vehicles

<Current technology>

- At present, the possible distance plug-in hybrid vehicles can drive on electricity is only about 13 km. In order for electric vehicles to be put into full-fledged practical use, further extension of the cruising distance by the development of large capacity batteries with low cost is essential.

＜Technology development roadmap＞

- We will try to achieve 50% higher performance and reduce cost to 1/7 of current level by 2015 for electric vehicles to be put into full-fledged practical use.
- We will work on technology development with an objective to improve capacity to 7 times capacity and 1/40 cost by 2030 so that the cost will be equivalent to that of gasoline vehicle, and we will also try to extend the cruising distance to 500 km by 2030.

<Effect of technology>

- Plug-in hybrid vehicles reduce carbon dioxide emissions to around 1/2-1/3 the level of gasoline vehicles, a reduce carbon dioxide emissions to around 1/4 the level of gasoline vehicles.

<Challenges for effective technology development and diffusion>

- It will be necessary to examine issues such as promotion of the development of alternative materials to rare metals and standardization. It will be also necessary to examine the establishment of infrastructure such as charging stations as the technology develops.

(Reference 1)

- A plug-in hybrid vehicle is hybrid vehicle whose battery is charged by an external power source and that operates on an electric motor using the charged power over short distances.
- Electric vehicles operate on electric motors using power contained in the battery as the source of energy instead of conventional internal combustion engines

(Reference 2)

- The battery industry of Japan has a large global share and is considered to be in an advantageous position.
- The governments of the U.S., Europe, South Korea and China are taking an active role in the support of battery development.
- Chinese and South Korean companies are growing rapidly in the field of lithium ion batteries.

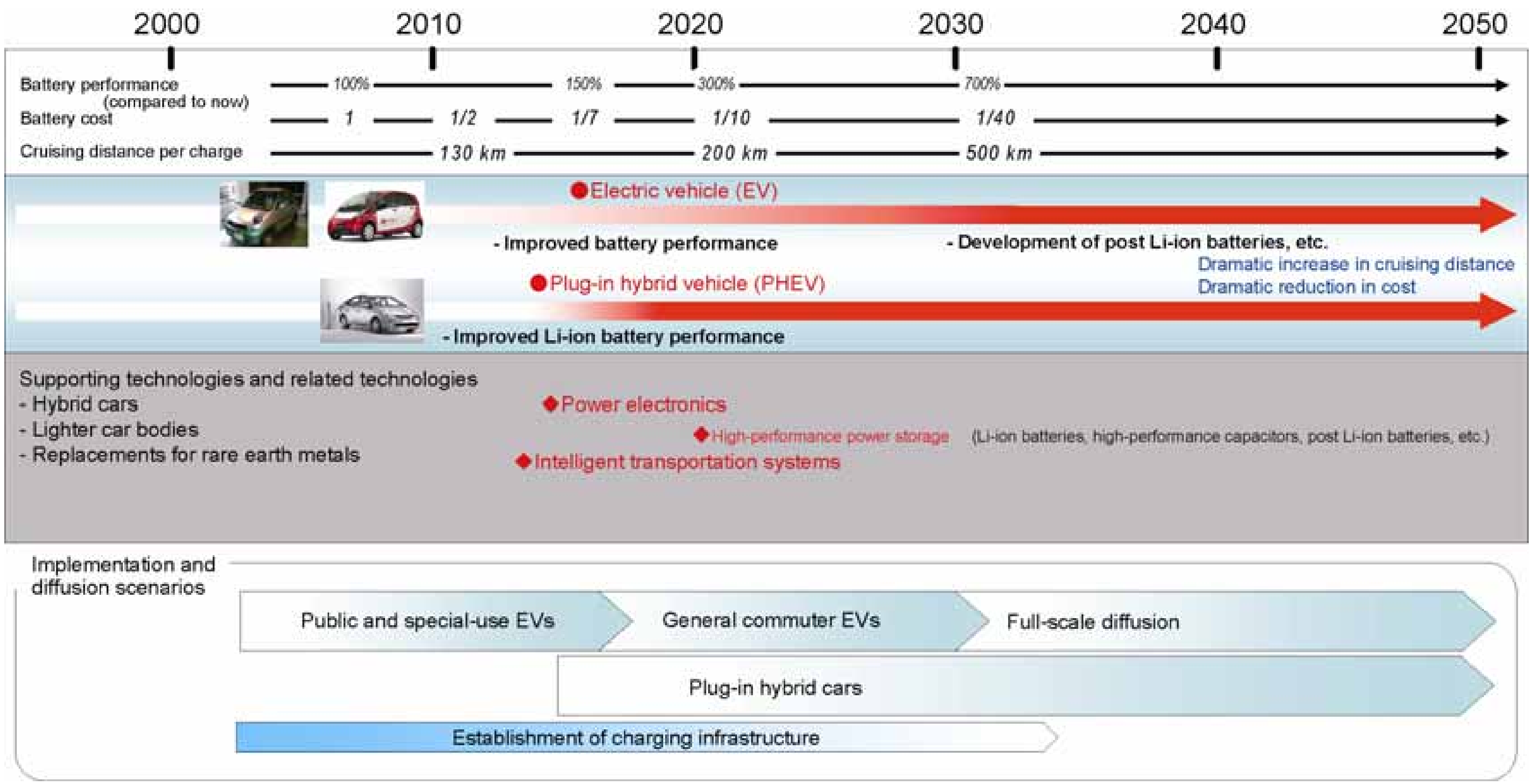
Ranking of Global Share in Lithium Ion Batteries

	2000				2005		
	Manufacturer		Share		Manufacturer		Share
1	Sanyo Electric Sanyo GS Soft Energy	J	33%	1	Sanyo Electric Sanyo GS Soft Energy	J	28%
2	Sony	J	21%	2	Sony	J	13%
3	Matsushita Battery Industries	J	19%	3	Samsung SDI	K	11%
4	Toshiba	J	11%	4	Matsushita Battery Industries	J	10%
5	NEC Tokin	J	6.4%	5	BYD	C	7.5%
6	Hitachi Maxell	J	3.4%	6	LG Chemicals	K	6.5%
7	BYD	C	2.9%	7	Tianjin Liashen	C	4.5%
8	LG Chemicals	K	1.3%	8	NEC Tokin	J	3.6%
9	Samsung SDI	K	0.4%	9	Hitachi Maxell	J	3.3%

C: China, J: Japan, K: South Korea

Prepared by METI referring to a report by Institute of Information Technology, Ltd.

Technology Development Roadmap



Fuel Cell Vehicles

<Current technology>
Thanks to active technology development, Japan currently has the most advanced technology of this kind in the world, and major automobile manufacturers have commercialized fuel cell vehicles. However, there are some issues such as cost reduction remaining to be solved before the vehicles can be diffused.
＜Technology development roadmap＞
We aim to lower costs to about 3 to 5 times the level of internal combustion vehicles by 2010 and to 1.2 times that level by 2020. We also aim to improve the durability of the system and extend the range to 400km by 2010 and 800km by 2020.
<Effect of technology>
Carbon dioxide emissions can be reduced to about 1/3 that of the gasoline vehicles.

Production of Transport Biofuel

<Current technology>
An issue is the reduction of the cost required for extracting ethanol from cellulose biomass that can be obtained in resource quantities without competing with the food supply.
＜Technology development roadmap＞
We will promote technology development and try to lower the cost of production from raw materials that are mainly generated from rice straw, forest residues, etc. to 100 JPY/L as the benchmark by 2015 and to 40 JPY/L as the benchmark when using resource crops which can be produced in large volumes.
<Effect of technology>
Although carbon dioxide reduction effects need to be verified in the lifecycle, these biofuels have been considered carbon neutral in the Kyoto Protocol and reduction effects can be expected.

Intelligent Transportation System

<Current technology>
ITS tries to develop new vehicles for society by adapting to an advanced information society while also solving traffic problems by connecting people, roads, and vehicles in a network that uses leading-edge information & communication technology.
＜Technology development roadmap＞
We will try to commercialize the signal control function utilizing probe information in 2012, and the we will begin the research and development of advanced traffic signal control systems, such as signal linked ECO driving at an early stage to see successful practical applications in the 2020s.
<Effect of technology>
Use of ITS will make it is possible to reduce the carbon dioxide emission generated when 1 vehicle runs 1km by 25% or more by 2050.

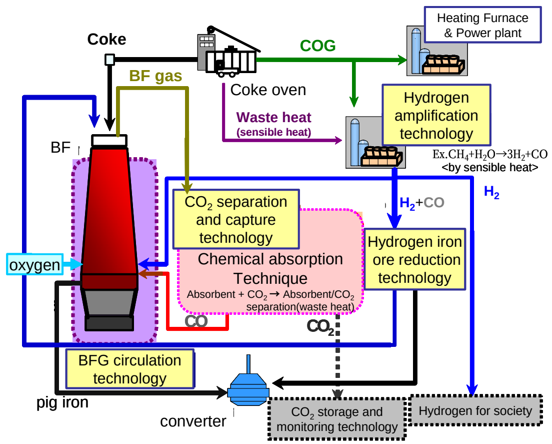
Innovative Iron and Steel Making Processes

<Current technology>

○ Our iron and steel making processes have reached the world's best specific energy consumption through waste heat recovery and waste recycling which includes energy-saving facilities. Further breakthroughs in technology are required to further lower carbonization.

<Technology development roadmap>

○ With the aim of implementation in 2030 – 2050, we will promote the development of new absorption solution to separate and capture carbon dioxide efficiently from Blast furnace gas and technologies to apply hydrogen which is amplified from coke oven gas, as iron reductant.



<Effect of technology>

○ Our objective is roughly at least 30% reduction in carbon dioxide emissions from iron and steel making processes by combining these technologies.

<Challenges for effective technology development and diffusion>

○ Japan considers joint research in basic fields, in addition to actively participating in joint programs operated by the International Iron and Steel Institute (IISI) and the EU to grasp the latest trends in technology development in European nations.

Innovative Materials, Production/Processing Technology

<Current technology>

It is necessary to develop production processes and energy-saving materials technologies to improve the energy efficiency in Japanese production industries that have the world's highest level of energy conservation.

<Technology development roadmap>

We will try to establish a process with glass melting that takes less than half a day and address practical application of small melters by around 2015 and large melters by 2030 by developing technologies to melt small granule glass materials instantly using plasma and other materials.

<Effect of technology>

It is possible to lower energy consumption to about 1/3 of the conventional processes by using energy-saving glass production technology to melt glass utilizing plasma, etc.

High-efficiency Houses and Buildings

<Current technology>
Energy saving technology for home building will use new heat insulation materials and room air quality improvements to improve insulation and shielding.
<Technology development roadmap>
By using technologies such as high-strength (compression) and heat insulation ceramic particle technology, we aim to achieve the practical application of wall materials with a conductivity of 0.002 W/m・K, a heat transmission coefficient of 0.3 W/m^2・K, in addition to enhanced window materials with a conductivity of 0.003 W/m・K, and a heat transmission coefficient of 0.4 W/m^2・K in around 2015.
<Effect of technology>
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.

Next-generation High-efficiency Lighting

<Current technology>
It is necessary to develop lighting technology with luminous efficiency and color rendering that is significantly higher than current fluorescent lamps (80 - 100 lm/W).
<Technology development roadmap>
- In the field of LED lighting, we aim to reach 100 lm/W around 2010, and 200 lm/W around 2020.
- Regarding organic EL lighting, we aim to reach 100 lm/W around 2020, and 200 lm/W around 2030.

<Effect of technology>
Replacing all incandescent lamps and fluorescent lamps with the next-generation high-efficiency lighting of 150 lm/W results in power consumption for lighting estimated to fall by 50%.

Stationary Fuel Cells

<Current technology>
In Japan, approximately 2,200 units have been installed thanks to active technology development and implementation support.
<Technology development roadmap>
- PEFCs are to reduce the current system price of 4 - 5 million JPY per KW to 400 thousand JPY in 2020 - 2030 and improve the durability to 90,000 hours from the current 40,000 hours.
- Solid-Oxide Fuel Cells (SOFCs) will have a durability of 40,000 hours and a system price of 1 million yen per KW around 2020.

<Effect of technology>
It is possible to achieve high overall efficiency (>80%HHV) as a cogeneration system.

Ultra High-efficiency Heat Pumps

<Current technology>
Japan has an advantage in this field as shown by the world's first practical application of high-temperature hot water supply technology, but further cost reduction and improved efficiency continue to be issues.
<Technology development roadmap>
We expect to increase efficiency 50% and reduce costs to 3/4 of the current level by 2030 and double efficiency and halve costs by 2050 through efficiency improvements in coolants and heat exchangers, as well as the development of elemental technologies.
<Effect of technology>
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, and contribute to the reduction of these emissions.

High-efficiency Information Devices and Systems

<Current technology>
In addition to the individual devices, it is necessary to create innovative, energy saving technology for the overall network.
<Technology development roadmap>
- We will implement technology to address energy-saving air conditioning for data centers and for increasing efficiency in servers and power supply systems around 2015
- We will reduce router power consumption by 30% in around 2015.
- We aim to halve LCD backlight power consumption in around 2012 and extend the durability of organic EL displays to 50,000 hours in around 2020.

<Effect of technology>
A doubling of the power consumption efficiency can be expected.

HEMS/BEMS/Local-level EMS

<Current technology>
This is an energy saving technology to implement energy measurement and management for houses, buildings or regions via a network.
<Technology development roadmap>
We aim to establish systems for operating and managing devices in homes and commercial buildings through the development of technology such as telecommunication hardware home sensor networks.
<Effect of technology>
HEMS/BEMS and local-level EMS can reduce carbon dioxide emissions by 10-15%.

Power Electronics

<Current technology>
The technology to save energy in inverters and electric devices by utilizing the next-generation semiconductors, in power generation, transmission and distribution, power storage and other electric devices.
<Technology development roadmap>
We aim to achieve practical application of SiC and GaN power devices in around 2015 and diamond devices in around 2020.
<Effect of technology>
The application of SiC devices is expected to improve efficiency by around 2-10% in the transportation sector including hybrid cars and electric cars (varying depending on load) and by around 4-5% for computer power supplies.

High-performance Power Storage

<Current technology>
This technology includes storage batteries essential for the 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 capacitors with high output density.
<Technology development roadmap>
We will develop an improved lithium ion battery with high performance, a long lifetime, high safety, and low cost with an objective to address lifetime equivalent to PV cells and wind power generation (20 years), and the cost of 15,000 JPY/kWh by 2030.
<Effect of technology>
It will lead to carbon dioxide emission reductions by through the implementation of electric vehicles and renewable energy introduction such as solar power and wind power.

Hydrogen Production, Transport and Storage

<Current technology>
This is a technology for highly efficient production, transport and storage of hydrogen to be used in fuel cell vehicles and stationary fuel cells.
<Technology development roadmap>
We aim to reduce the price of hydrogen to 40 JPY/Nm3 around 2020 by improving the efficiency of reforming from fossil fuels and improving the efficiency of transportation.
<Effect of technology>
It is expected to contribute to the reduction of carbon dioxide emissions by utilizing hydrogen produced by renewable energy or with a combination of CCS as the fuel for fuel cell vehicles.

3. Promotion of International Cooperation in Innovative Energy Technology Development

－Basic view on international cooperation －

Internationally sharing technology development roadmap

- ○It is necessary for countries and regions to work with the IEA to check the current state and progress of technology development while sharing technology development roadmaps, to create a framework for cooperation to ensure steady implementation of technology development.

Acceleration in research and development by international cooperation

- ○ We will work with foreign research institutions and universities to efficiently conduct R&D while complementing research resources if required.
- ○ R&D conducted through international cooperation is expected to provide benefits such as diversification of high-risk research that Japan cannot conduct alone, accelerating R&D by utilizing research resources Japan does not have, making R&D more efficient by understanding advanced technology trends overseas and making the introduction of products into the market smoother by promoting international standardization.

Notes to be made in promoting international cooperation

- ○ It is essential to find an appropriate balance between competition and cooperation by considering the protection of intellectual property and the prevention of unintended leaks of technology to ensure private enterprises' motivation for R&D is not impaired.
- ○ It is necessary to consider intellectual property on a government basis to ensure the smooth transfer of technology.

- Promotion of International Cooperation in the Field of Energy -

Promotion of international cooperation utilizing the existing frameworks

We will promote international cooperation while fully utilizing existing frameworks such as the strengthening of cooperation regarding CCS technology through APP, CSLF and other programs; the strengthening of the exchange of information on fuel cells in IPHE; and strengthening cooperation regarding advanced nuclear technologies within the framework of GNEP and GIF.

Promotion of new international cooperation

○**Carbon dioxide capture and storage (CCS)**
- Promotion of overseas demonstration projects, and promotion of cross-linking among different domestic and international projects.

○**Innovative photovoltaic power generation**
- Strengthening of cooperation related to third generation photovoltaic power generation technology through the invitation of researchers from overseas and by holding symposiums.

○**High-performance power storage**
- It is necessary to consider cooperation with overseas research institutes in basic research efforts

○**High-efficiency superconducting power transmission**
- Participation in overseas demonstration projects and exchanges of information with overseas research institutes.

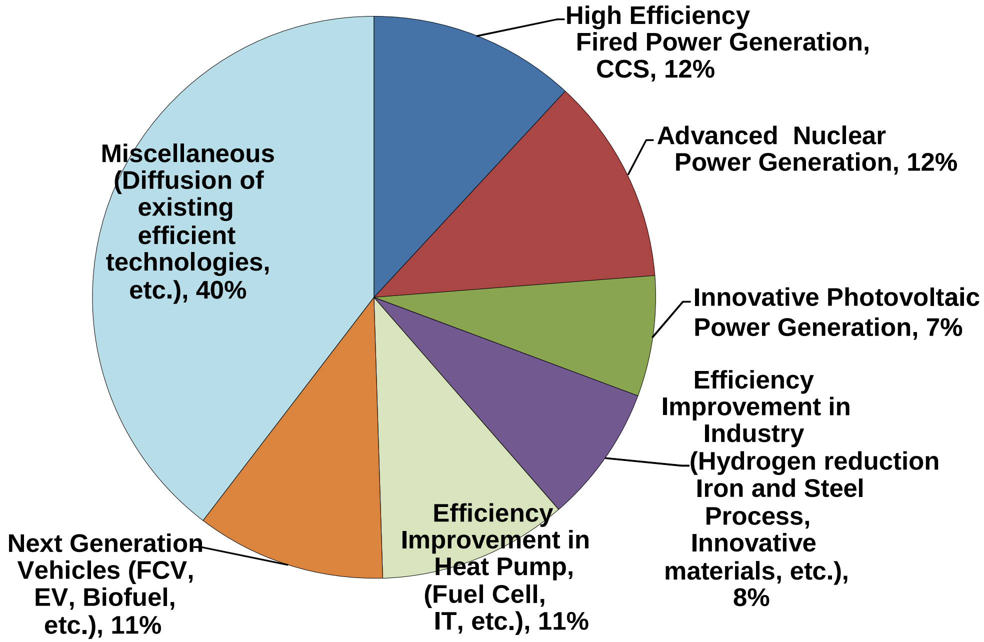
○**Innovative iron and steel making process**
- Examination of the possibilities for joint research in basic and fundamental fields through participation in the International Iron and Steel Institute (IISI).

○**High-efficiency information device and system**
- Holding of an international symposium to form a common recognition on the effectiveness of “green IT”, while also sharing information on research and development trends in other nations.

4. Picture of a Future Social System in 2050 Seen from the Standpoint of Energy Technology

- ◯ Consideration of the contribution of innovative energy technologies assuming that they will reduce carbon dioxide emissions by half in 2050 based on a trial calculation made by the Institute of Applied Energy.
- ◯ The “21” innovative technologies included in this estimation contribute to nearly 60% of the necessary reductions for the 50% of emission reduction. Power generation fields such as nuclear power, CCS and photovoltaic power, together with and transportation fields have relatively large contributions, but it is necessary to address technology development with all our powers in all fields, instead of addressing only one of these technologies.

Contribution of Innovative Energy Technologies for the 50 % Emission Reduction in 2050
Source: A trial calculation by the Institute of Applied Energy



- Image for a Social System in 2050 -

It is expected that Global society will have achieved both rich lifestyles and reduced carbon dioxide emissions by combining significant energy savings on the demand side and the establishment of advanced energy systems.

＜Power generation and the conversion sector including transmission＞

- ○ CCS will reduce carbon dioxide emissions for thermal power plants, and advances will have been made in zero-emission development and power generation efficiency areas.
- ○ With a great premise of securing safety, application of advanced nuclear power generation will expand.
- ○ Implementation of reusable energy, and particularly solar energy, will accelerate in diffusion due to costs coming down on par with thermal power generation. Applications will expand significantly including utilization on building walls as built-in units in houses, and megawatt-class photovoltaic power generation will also be possible.

＜Industry sector＞

- ○ In the iron and steel industries, both of which consume large amounts of energy, carbon dioxide emissions will be reduced drastically with the development of efficient carbon dioxide separation and absorption technology from blast furnaces and partial introduction of hydrogen reduction.

＜Transportation sector＞

- ○ There will be advances in electric vehicles, fuel cell vehicles and biomass fuel. There will be proper control of traffic flow by ITS and dramatic improvement in energy efficiency by diffusion of electric and fuel cell vehicles. Electricity stations and hydrogen fuel stations to support these will also be established.

＜Commercial/residential sector＞

- ○ Energy saving will have been realized through the development of high efficiency houses and buildings with high heat insulation, the introduction of stationary fuel cells, and high efficiency heat pumps. The energy saving of society will be advanced, with energy saving household appliances, devices, and power electronics will also have advanced and energy will be measured and managed without waste by IT utilization.

5. Steady Implementation of the Program

(Sharing of roles by government and private sector depending on the progress in technology development)

- ○ It is necessary that there be an appropriate role sharing between the government and the private sector based on the progress in technology development for technologies near market introduction.
- ○ Appropriate resources will be distributed to both technologies that need basic research and development, and technologies for which application and demonstration should be focused.
- ○ We will promote technology development and diffusion of its outcomes by cooperation over the walls of different industry fields, as well as close industry-academia-government partnership.

(Smooth diffusion and market introduction of research and development outcomes)

- ○ We will introduce and diffuse of the outcomes of technology development based on this program, such as proactive introduction in public organizations, active participation in discussions for international standardization, and concurrent examination to establish the necessary systems and infrastructures.

(Regularly reviewing the technology development roadmap and so forth)

- ○ The program will be conducted with 10 years as the first phase, and the technology development roadmap prepared in this program shall be reviewed regularly based on discussions of related parties in industry, academia and government.