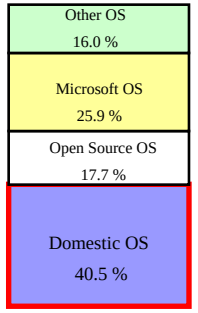
Highly Reliable/Productive Software Development Technology

Outline of Technology

- Improvement of efficiency and reliability of embedded software by the common basic software, such as OS and communication middleware, for various purposes (to achieve the world's top reliability).
- The common basic software supports various micro controllers and a variety of applications.
- Establishment of new software engineering method and model-based development method which improve the development efficiency almost twice.

Superiority of Japanese Technology

- More than 40% embedded software applications use domestic OS in the manufacturing and information communication industries in Japan.
- Embedded software produced in Japan has still advantages of responsiveness and reliability; while the global competition has been increasing.
- Cutting-edge methods on highly reliable embedded software are addressed by the cross-industrial cooperation.

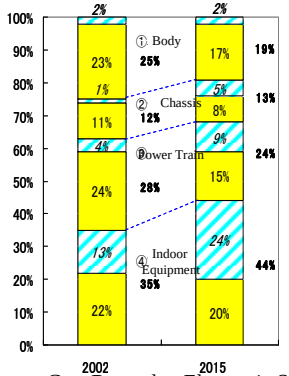


Source: Embedded software industry field survey in 2008

Impact on Society

- Embedded software is used in almost all the products such as cars, information appliances, industrial equipments, and robots, so the sophistication of its functions (or high value-added embedded software) is the key to enhance competitiveness in industries.
- The sophistication of functions, however, enlarged the size of embedded software to several millions lines, and the amount of investment for development has increased by about 15% every year, to 3 trillion JPY in 2007. Challenges are to realize alleviating the burden of development and ensuring the reliability of software products simultaneously.
- The world's top reliability and productivity of embedded software are realized by the establishment of highly reliable method of software development and its cross-industrial expansion. Accordingly, they enhance further the international competitiveness not only of the software industry but also of the equipment manufacturing industry.
- Especially in cars where safety is the matter of the highest importance, highly reliable embedded software is expected to decrease the number of malfunctions caused by the software to almost zero throughout the lifetime of a car.
- In the automotive industry, the increase of software development cost is significant; the percentage of electronics parts and software is expected to increase up to 40% in 2015, twice as much as the current ratio. The development race will be promoted to meet new social needs, such as cost and environments, by creating world standards of the infrastructure software, which is highly efficient in development, and its development methods.

【Cost Structure Change for Automobile and Increasing Rate of Electronic Software】



: Cost Related to Electronic Software for Each Area

Source: McKinsey & Darmstadt Technical Collage HAWK project document etc.

Required Framework for Technology Development

- R&D system in which many manufacturers, such as car manufacturers, car parts manufacturers, embedded software developers, semiconductor manufacturers, and tool (development support software) developers, gather together.
- Collaboration with software engineering specialists on development process.
- System to utilize development results among industries (participation of industries).
- System to promote the infrastructure software and the development methods to the world standards.

Required Reformation in Social System

None

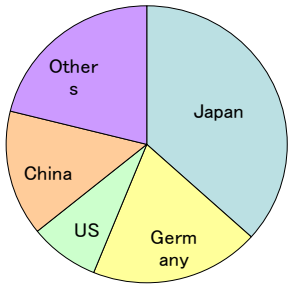
Highly Efficient Photovoltaic Power Generation Technology

Outline of Technology

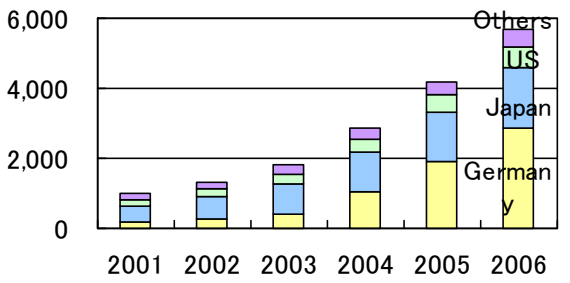
- Photovoltaic Power Generation Technology aiming at low cost through significantly improved quantum nano, multi-junction new materials and structures and organic photovoltaic power generation technology.
- The developmental stages of the technology are classified as first (crystal silicon,) second (thin silicon and chemical compounds,) and third generation (quantum dot, etc)

Superiority of Japanese Technology

Market Share (2006)

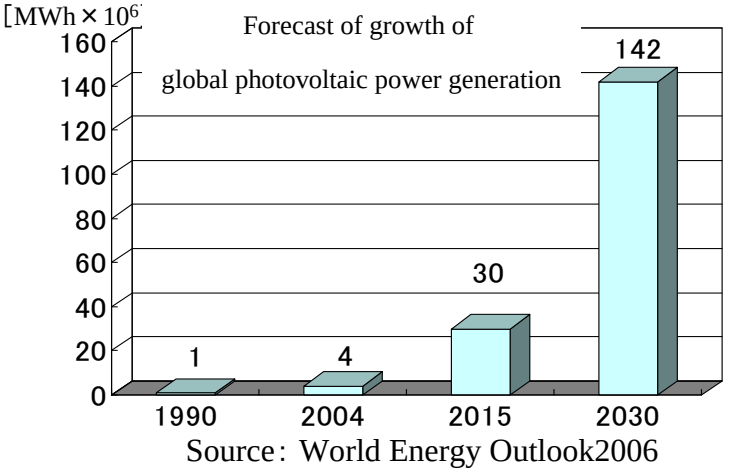


Installations of amounts



Impact on Society

- Power generation cost in 2020 14 JPY/kWh
  Conversion efficiency 10 to 19 %
- Power generation cost in 2030 7 JPY/kWh
  Conversion efficiency 15 to 22 %
- Market expansion by combining the electric generating system with flexible batteries and accumulators that enable a variety of applications through high efficiency and low cost.
- Industry worth over 2 trillion yen in 2030.



Source: World Energy Outlook2006

Electric power supply for Mobile Phones

Photovoltaic Power Station

Required Framework for Technology Development

- Promotion of research and development with industry-academia-governmental cooperation..
  (Promotion integration from the basic study through to application/research and development.)
- Promotion of unifying the different industries and sectors
- Develop international research bases.

Required Reformation in Social System

- Promote its introduction in homes, for public use and industry.
- Steady implementation of RPS system (1).
- Application of green electricity certification system (2).

(1) Institution obligating certain rates electricity generated from natural energy to be used in the net energy demand system of electric power suppliers every year.

(2) Institutionalize with consumers such as business organizations to use electricity generated from natural energy as an autonomous green action.

Hydrogen Energy System Technology

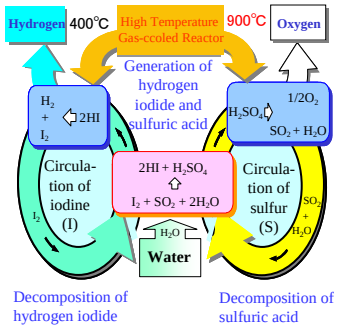
Outline of Technology

・A clean and efficient technology for production, transportation and storage of hydrogen for fuel cell vehicles and stationary fuel cells.

・An innovative technology for large-scale stable economic and CO_2-free hydrogen production, which uses high temperature heat supplied by CO_2-free heat sources such as High Temperature Gas-cooled Reactors (HTGR).

Note that current technology, steam reforming, generates large amounts of CO_2.

Thermochemical IS Process



Superiority of Japanese Technology

<Production>

・A control method of the IS process has been developed (3 patent applications.)

・One week continuous hydrogen production with 30 litres per hour was achieved first in the world (2004). Tests are underway on components used in the corrosive conditions (glass lining pipes (2007), ceramic pump for high temperature sulfuric acid service (2008)).

・High Temperature Engineering Test Reactor (HTTR) is owned, which is the only HTGR that can supply high temperature heat of 950 ºC in the world.

<Transportation and Storage>

・ Hydrogen storage materials (alloys and inorganic materials) for fuel cell vehicles are under development with high target value. High pressure gas containers for vehicle application are being developed and demonstrated aiming to realize lighter and smaller ones.

・Hydrogen gas station and liquid hydrogen station are in demonstrative verification. Performance of elemental technologies for the stations is in a global top level.

Impact on Society

・Hydrogen is a major candidate for substitute of fossil fuel.
Estimation of future hydrogen demand (total demand for fuel cell vehicles and stationary fuel cells)
2015：24.6 billion m^3, 2030：61.0 billion m^3 [1)]

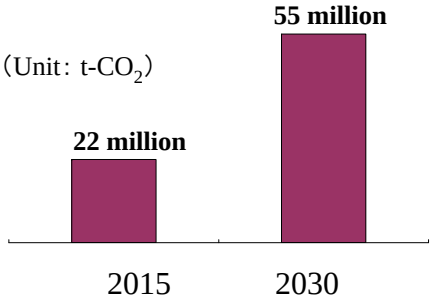
・Hydrogen production with no greenhouse gas emission is possible using this technology.
Reduction potential of CO_2 emission is 55 million tons in 2030, compared to the case of hydrogen production by steam reforming of natural gas (0.9 kg CO_2/m^3-hydrogen [2)]).

・If 40 JPY/Nm^3 (cost of production and transportation of hydrogen) is realized in 2030, it will be almost equal to the 1/3 of the price of gasoline for gasoline vehicles (120 JPY/l, (10km/l)) [3)].

1）Estimation of the Cabinet Office, Government of Japan, based on the data from the Strategic Study Group of Practical Use of Fuel Cell and the annual report from the Institute of Applied Energy

2）PETROTECH, 25, 125 (2002)

3）Estimation of the Cabinet Office, Government of Japan, based on the JHFC data



Greenhouse Gas Reduction Potential

Required Framework for Technology Development

・In order to proceed to the demonstration stage on the feasibility and the reliability of technology after 2020, collaboration of the relating institutions and agencies is necessary for completing the following technical developments. It is necessary to establish an integrated research and development system enhancing collaboration with non-nuclear energy fields.

- ○ Acquisition of high temperature operating data of the HTTR.
- ○ Improvement of economics and enhancement of endurance concerning the hydrogen and electricity co-production system using HTGRs.
- ○ Verification of structural integrity and improved efficiency using an IS process pilot plant.

Required Reformation in Social System

・Improvement of social infrastructure and institution is required for the realization of hydrogen society.

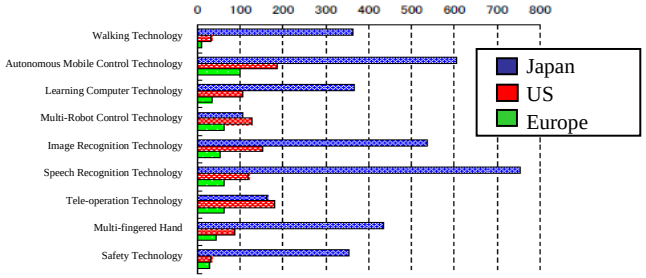
Life Support Robot Technology

Outline of Technology

- Intelligent recognition, decision and actions in robot technology.
- Reduction of development time and cost by the modularization of technology elements and their integration. (The goal is to achieve the development time reduction to less than 1/2 for cellular manufacturing robots.)
- Development of life support robots with high safety, reliability and adaptability which enable the robots coexist with persons in our living environment.
- Making robots the social infrastructure by integrating with ubiquitous technology.

Superiority of Japanese Technology

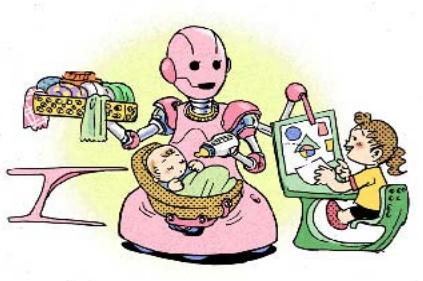
- Japan is in the world's top level for the number of working industrial robots and the number of their patent applications.
- Japan leads the robot technologies on affinity for humans, such as speech recognition and safety, and also the international standardization of various basic technologies for robot development.



Number of patent applications grouped by the nationalities of applicants in 2006 (Researched by Japan Patent Office)

Impact on Society

- Robots will improve living environments and release people from hard works, such as nursing and housework, in anticipation of a super aging society.
  - In 2025, Japan will become a super aging society in which more than 30% of the citizens are over 65 years old.
  - The labor force population in Japan will decline by 8 million from now (in 2025).
  - The percentage of solitary old person households in Japan will increase from 8% (2005) to 13.5% (2025).
- The workforce of robots in Japan is expected to compensate almost the half of the decreasing workforce in 2025.
- The competitiveness of Japanese robot industries in the world will be improved by the formulation of international standards on modularization and integration of robot technologies.
- The market size of robot-related industries in Japan is expected to increase to about 6.2 trillion JPY (including about 4.8 trillion JPY for non-manufacturing fields including life supports) in 2025



'Innovation 25'
From '20 Examples of Innovation with Illustrations'

Required Framework for Technology Development

- Establishment of the R&D concept from the user's point of view and the competitive R&D framework to realize the concept.
- Building up the flexible R&D environments which have open demonstration experimental fields for verifying the robot usage performance, such as effectiveness, safety and so on.

Required Reformation in Social System

- Review of standards and regulations, such as the structure of buildings, to promote installation of robots.
- Deliberation on security rules and systems of robot usage.
- Improvement in information security for network integration.

Self-Support Technology for Elderly/Handicapped People (Brain Machine Interface)

Outline of Technology

- Brain Machine Interface (BMI) is technology that acquires electrical information from the brain in the thought, decodes it into digital signals and controls machines.
- BMI includes sensor technology of monitoring brain information, technology of decoding electrical information and self-support device technology such as artificial limbs and self-support robots controlled by information from the brain.

Superiority of Japanese Technology

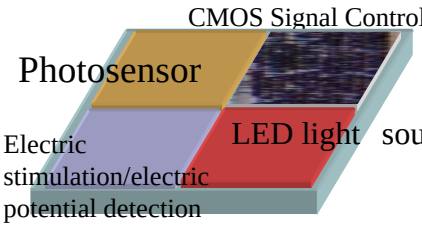
- The infrared light laser technology and microchip sensor technology expected to be the interface with brains in Japan are at the top level in the world.
- Japan has industrial robots and patent applications for them top in the number

Impact on Society

Nursing care support required 4.4 million
Spinal cord injuries 100 thousand

It will be possible to live and behave on their own will even if limb functions have been lost.

Brain Wave Sensor



Microsensor

Multimodal CMOS sensor enabling functional imaging deep within the brain

Brain Machine Interface
(Transfers brain activities to support devices by conversion to digital signals)

Support devices can be controlled by thinking as if making a choice such as in rock- paper-scissors.

Required Framework for Technology Development

- Development of Japanese research bases aiming at global top universities.
- Gathering human resources to make core persons.
- Exchanging and comunication of researchers in encephalology and engineering.
- User participation at the developmental stage.

Required Reformation in Social System

- Early establishment of safety standards at developmental stages.
- Development of guidelines at demonstration experiments.
- Investigation on support system for demonstration experiments.

Low Invasive Medical Device Technology (Built-in Touch Sensor Endoscopes)

Outline of Technology

- Technology for accurate medical treatments such as ablation and sutures when operator will be able to recognise the hardness of the operation site using embedded antenna sensors in the operational tip of endoscopes.
- Technology for viewing the involved operation site through advanced 3D image display for improvement of operation.

Superiority of Japanese Technology

- 41 percent of endoscope technology patents applied in the United States from 1971 to 2003 were Japanese and we have top global class technology.
- We have microscopic sensing technology for the areas concerned that can be incorporated in endoscopes and output with a realistic sense of feel.

Impact on Society

Operation support system will enable sure treatment with less burden for patients by minimally ablating and checking the involved site using with antenna sensor function equipped endoscopes and advanced 3D image equipment.

Contributes to Enhanced Medical Device Development

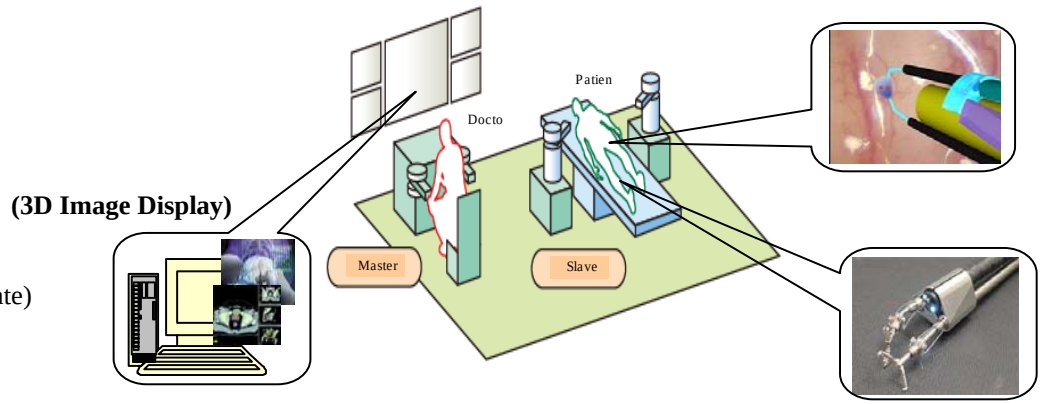
- Market scale for endoscopes in Japan, Europe and USA Approx. 275 billion JPY
- Market scale of operation support robot system Approx. 45 billion JPY (2011 estimate)

Improved Patient QOL

- This technology enables early rehabilitation into society. For example the length of hospitalization would be 7 to 13 days for colon ablations using by this technology.

Reduces Medical Costs

- Reduction of medical costs will be expected by 20 billion JPY through using endoscope operations for early stomach cancer cases.



Required Framework for Technology Development

- Development of a cooperation research system in a collaboration of medical science and engineering.
- Cultivation of human resources with knowledge in both medicine and engineering.
- Influx of constant research funds from collaborative research business organizations and joint ventures.

Required Reformation in Social System

- Application in the health insurance system through prompt utilization of an advanced medical audit system.
- Development of an investigative consultation system at the developmental stage for speeding.
- Development of compensation system for examinees.