Innovative Technology Development

May 2007

Innovative Technologies for Significant Reductions of CO2 Emissions

1. Innovative Zero-emissions Coal-fired Power Generation

The combination of the efficiency improvements of coal gasification power generation and CO2 capture and storage (CCS) technology to realize zero-emissions coal-fired power generation, which currently accounts for around 30% of the global emissions

2. Advanced Reactors for Nuclear Power Generation

The development and commercialization of next generation light water reactors, small and medium reactors, high temperature gas-cooled reactors, and fast breeder reactors (FBR) to significantly increase zero-emissions nuclear power generation

3. Innovative Technology for High-efficiency and Low-cost Solar Power Generation

A significant improvement in the efficiency of solar power generation to reduce its cost to the level of thermal power generation, together with the capacity increase and cost reduction of rechargeable batteries

4. Innovative Technology for the Use of Hydrogen

The cost reduction and efficiency improvements of fuel cells for the wide use of fuel cell vehicles to realize zero emissions in the automobile sector, which currently accounts for nearly 20% of the global emissions

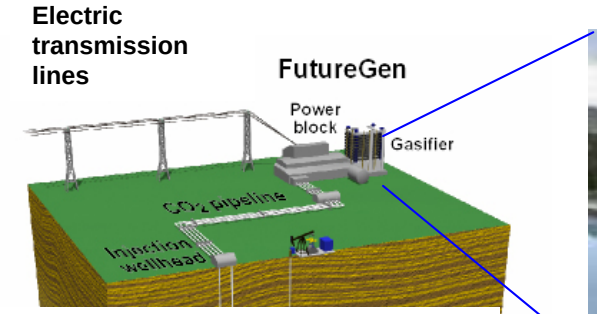
5. Ultra High Energy Efficiency Technology

Ultra high energy efficiency technologies for production processes and equipment to realize significant energy saving and emission reductions, e.g. iron and steel making technology to partially substitute hydrogen for coke as a reducer

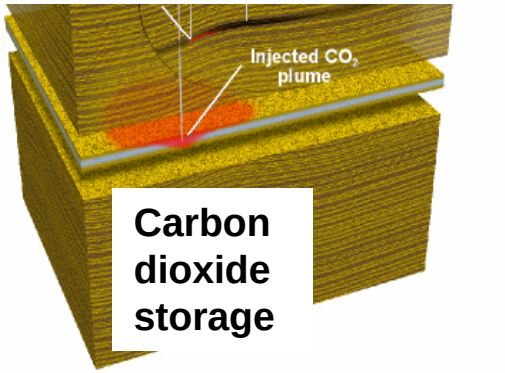
1. Innovative Zero-emissions Coal-fired Power Generation

- Coal gasification to power gas turbines, combined with the use of its waste heat to power steam turbines
- Recovery of hydrogen from the gasification process for the use for fuel cells
- CO2 Capture and Storage (CCS) technology to realize zero-emissions coal-fired power generation
- Innovative separation membrane technology to improve the separation rate of CO2 from hydrogen and nitrogen, and halve the CCS cost

Zero-emissions Coal-fired Power Generation Plant (FutureGen – USA)



Carbon dioxide injection well



Benefits

- Coal-fired power generation currently accounts for around 30 % of the global CO2 emissions.
- The efficiency of coal-fired power generation improves from the current 40% to 55 %, and reduces CO2 emissions by around 30%.
- CCS, together with the above improvement, realizes zero-emissions coal-fired power generation.

Ongoing International Cooperation

- FutureGen was proposed by the US Department of Energy in 2003. The US, Japan, India, South Korea, and China currently participate in the project. This project focuses on the demonstration experiments of ; the separation system of hydrogen and CO2 from coal, and the underground storage of CO2. The total expenditure on this multilateral cooperation project stands at around US$1 billion.
- Since 2003 the Research Institute of Innovative Technology for the Earth (RITE) and the US Department of Energy's National Energy Technology Laboratory (NETL) have been jointly engaged in international research on the separation membranes.

Source: the US Department of Energy website

2. Advanced Reactors for Nuclear Power Generation

○Next generation light water reactors with improved economic efficiency, reliability, and safety to prepare for the domestic and overseas replacement demands around 2030

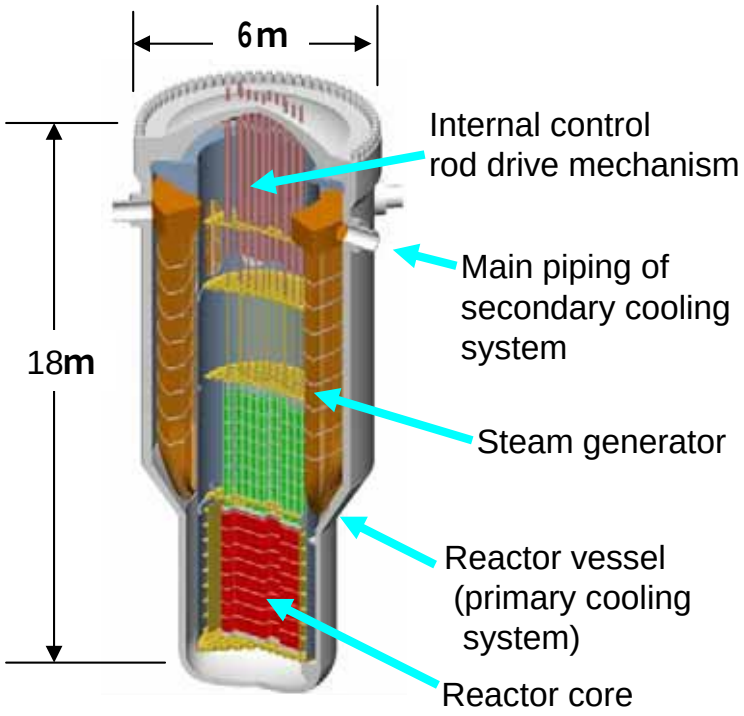
○Small and medium reactors to meet the limited demand for power in developing countries and island countries

○High temperature gas-cooled reactors to produce hydrogen, as well as electricity, by using the high temperature gas from the reactors

○Fast breeder reactor (FBR) cycle technology to realize the maximum efficient use of uranium resources by producing more fuels than consumed, and consequently to secure an almost limitless domestic energy sources

Small and Medium Reactor

(350MWe-IMR)



Benefits

- The global share of nuclear power generation was 16% in 2004, while its share in Japan was as high as 30%. To increase its global share to 30% by replacing coal-fired power generation leads to CO2 emission reductions by around 2 billion tons (nearly 7% of the global emissions).

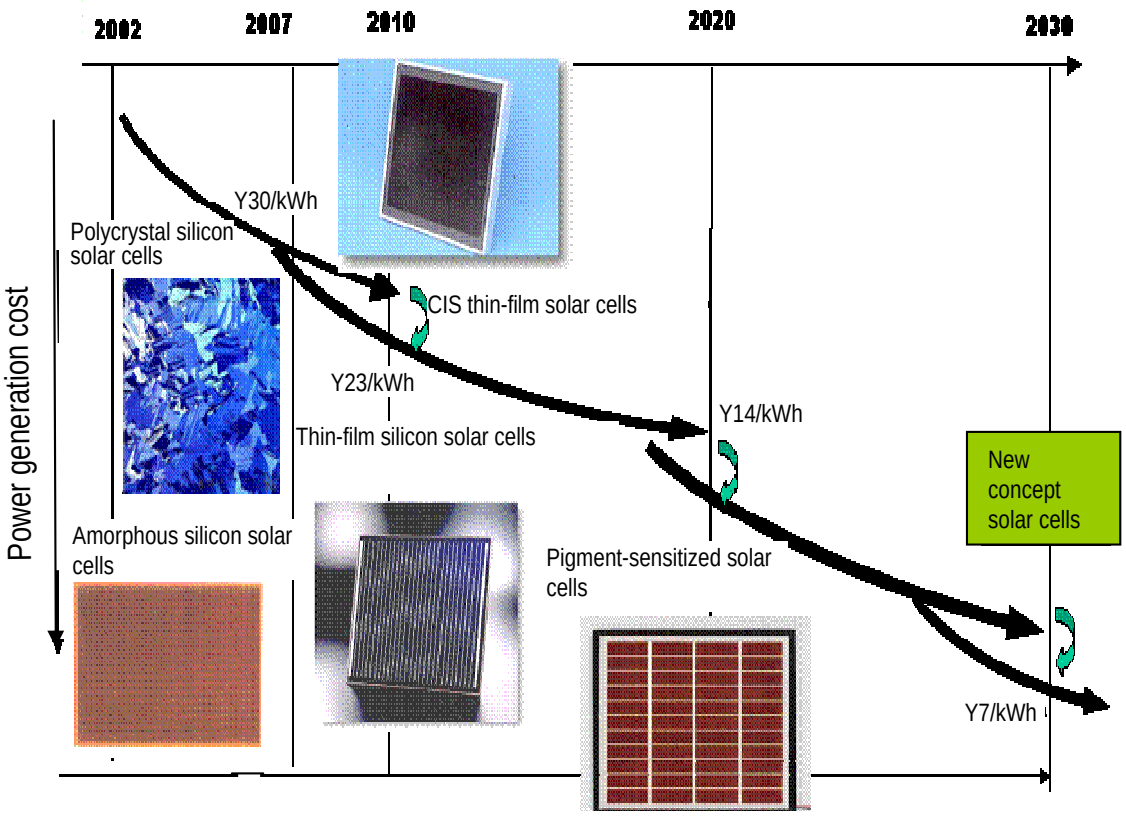
Ongoing International Cooperation

- In February 2006, the US proposed the Global Nuclear Energy Partnership (GNEP), a framework for international cooperation designed to promote both the expansion of nuclear power generation and non-proliferation. Under the GNEP, the US and Japan examined the needs of developing countries, basic requirements for small and medium reactors, and joint research programs between the US and Japan. The US and Japan will summarize the outcomes by December 2007.
- The Fourth Generation Nuclear Power International Forum (GIF) focuses on the international research and development of fourth-generation nuclear power systems including fast reactors. The forum started in 2000 under the leadership of the US, and currently consists of 12 nations including Japan and one organization.

Source: Documents on R&D program subsidized by Ministry of Economy, Trade and Industry

3. Innovative Technology for High-efficiency and Low-cost Solar Power Generation

- ○High-efficiency and low-cost solar cell technology including new compounds and pigment-impregnated materials
- ○Thin-film silicon technology for flexible solar cells with no restriction of installation places
- ○New materials to produce low-cost rechargeable batteries with increased capacity, which is indispensable for the large-scale installation of solar cells to manage a wide fluctuation of output



Source: NEDO, Cabinet Office

Benefits

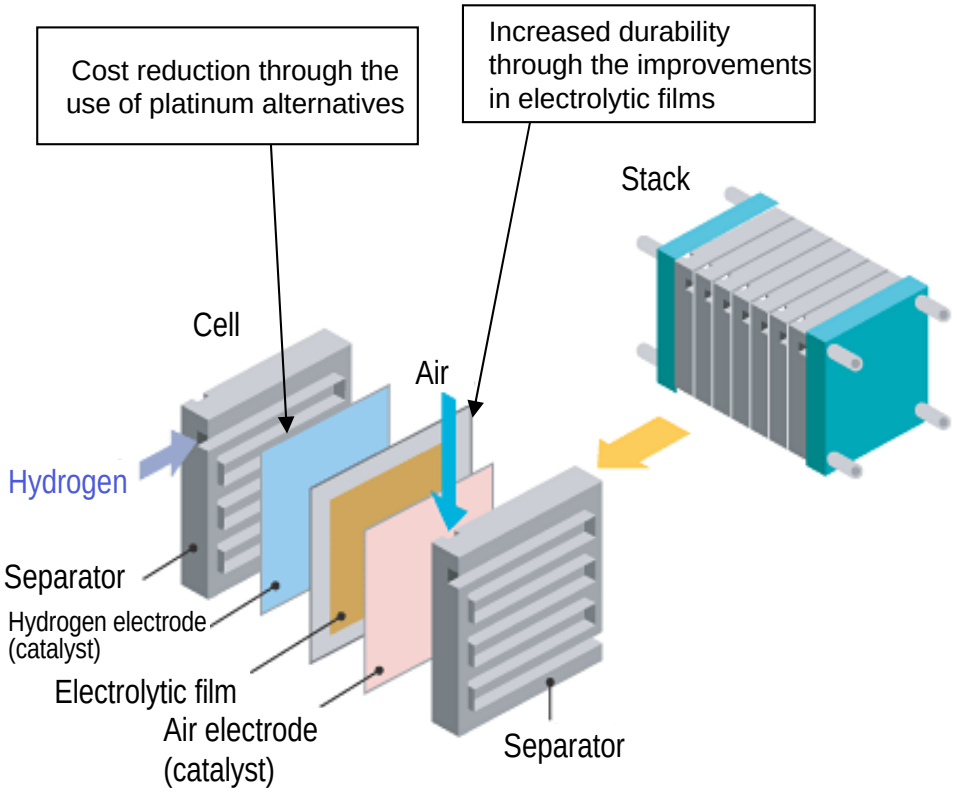
- The efficiency of solar power generation improves significantly from the current 15 – 20% to over 40%.
- The new technology reduces the cost of solar power generation from the current 46 yen/kWh to 7 yen/kWh (the level of thermal power generation).
- Flexible solar cells enable the installation on domed roofs.

Thin-film silicon solar cells

Source: NEDO

4. Innovative Technology for the Use of Hydrogen

- ○ Fuel cell technology for cost reduction and efficiency improvements by using platinum alternatives and electrolytic membranes
- ○ Hydrogen storage technology by using alloy materials to realize the wide use of fuel cell vehicles



Solid Polymer Fuel Cell (Polymer Electrolyte Fuel Cell) Configuration

Benefits

- By improving hydrogen storage capacity from the current 3kg to 7kg, the mileage of fuel cell vehicles rises to nearly 700km, the level of the conventional cars.
- The CO2 emissions from automobiles account for around 20% of the global emissions (2004). The wide use of CO2-free fuel cell vehicles contributes to significant emission reductions.

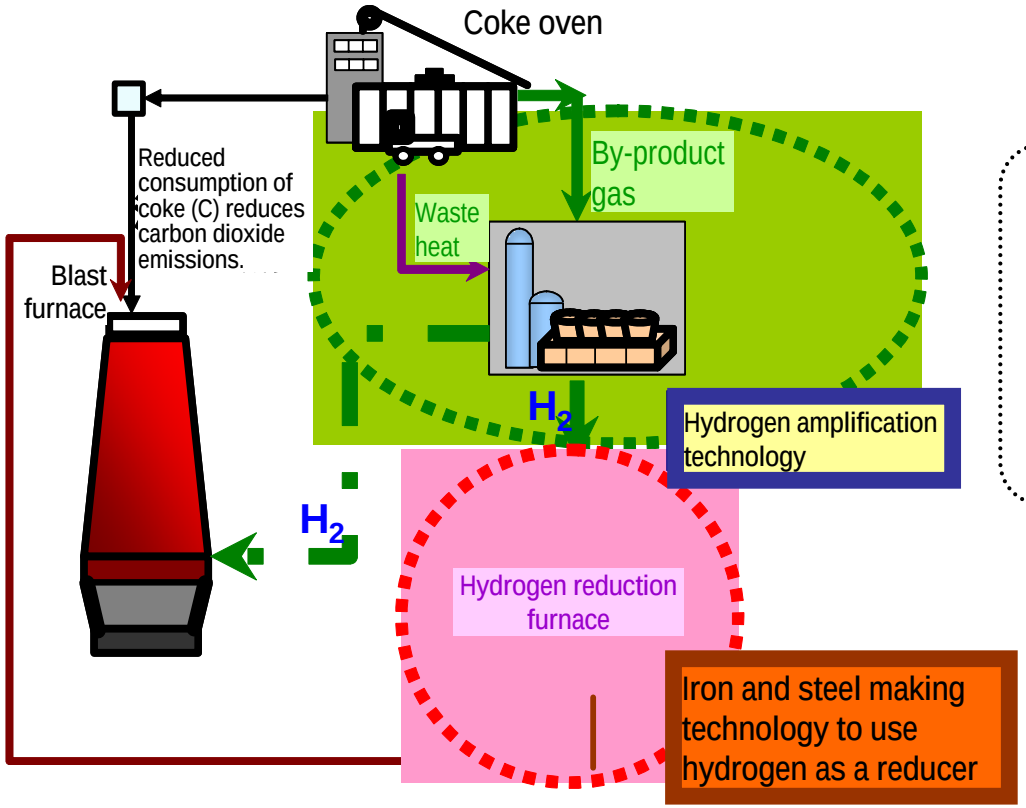
Ongoing International Cooperation

- In 2003, the US Department of Energy proposed the “International Partnership for a Hydrogen Economy”. The international partnership is to promote technology development, standards and standardization, and information exchange in the field of hydrogen and fuel cells. 17 countries including Japan participate in the partnership.
- In September 2006, the National Institute of Advanced Industrial Science and Technology, NEDO, and the US Los Alamos National Laboratory agreed to cooperate in the development of hydrogen storage materials.

Source: Prepared by Ministry of Economy, Trade and Industry based on materials provided by the National Institute of Advanced Industrial Science and Technology.

5. Ultra High Energy Efficiency Technology

- Ultra high energy efficiency technologies for production processes
  - Iron and steel making technology to partially substitute hydrogen for coke as a reducer
  - Biomass complex technology to efficiently produce ethanol from waste materials by using microorganisms
  - Technology to exploit the waste and by-products of other industries as raw materials
  - Cascade use technology to utilize unused heat energy among factories
- Next generation energy-saving technology for semiconductor devices that are used in the consumer electronics, industry and transportation sectors



Benefits

- The IEA estimates, in its 2050 reduction scenario, that the global diffusion of high energy efficiency technology reduces the global emissions by 25%.
- The iron and steel sector accounts for around 7% of the global emissions (2004). Combined with other CO2 reduction technologies, the above hydrogen-reduction technology significantly reduces CO2 emissions.

Source: Japan Iron and Steel Federation