3. Energy Conversion

※ Nuclear power and renewable energy sources, both of which can be categorized as "energy conversion technology," are included in the "Management of Primary Energy Sources" section in this publication.

3.1 Research and Development of Hydrogen Energy Technology

[Points]

- While the concept of a hydrogen economy, where fuel cells will be used widely, is drawing keen attention as an effective mean of reducing environmental burden, recognition towards the realization of hydrogen economy differs by region, or by country. (Table 3.1-1).

  EU scenario (Figure 3.1-1): Introduction of a hydrogen economy will be actively pursued through the synchronization of research and commercialization.

  The United States scenario (Figure 3.1-2): Practical application of such the system would be impossible for the moment. Therefore, efforts should be concentrated on research and development alone. The feasibility of a hydrogen economy will be determined around 2015.

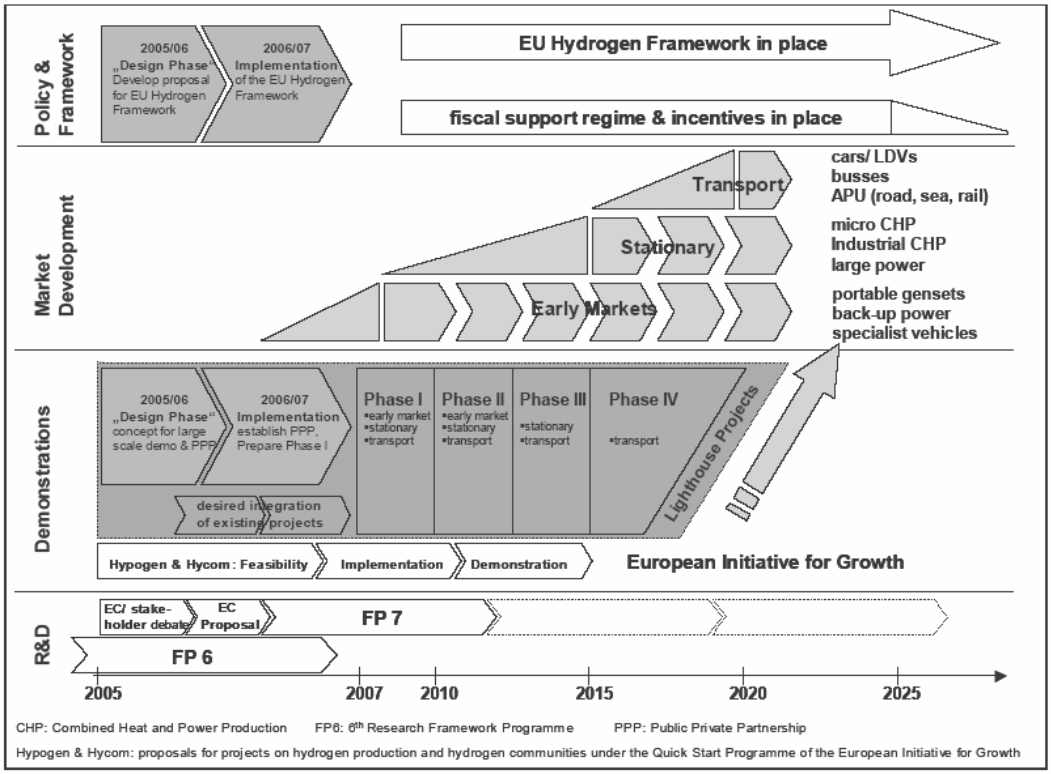
Behind the differences of the stances are a number of challenges to overcome, including technological issues and the radical transformation of the existing energy infrastructures.

[Related Data and Facts]

Table 3.1-1 Positioning of hydrogen energy in Japan, the United States, and Europe

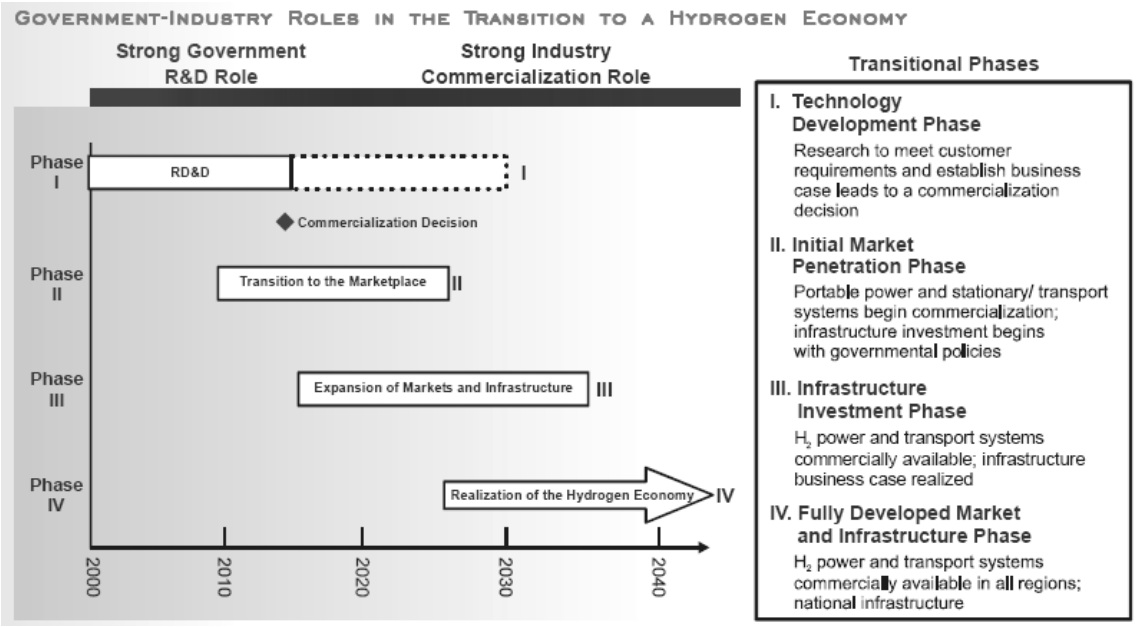
	Japan	United States	EU
Main literature	＊ Fuel cell and Hydrogen Technology Development Road Map ＊ New National Energy Strategy	＊ Hydrogen Posture Plan, etc.	＊ European Hydrogen & Fuel Cell Technology Platform Deployment Strategy, etc.
Outlook	The New National Energy Strategy addresses continuous R&D effort to develop hydrogen energy from a long-term perspective, under NEDO and other organization initiative.	At present, active R&D is promoted. Decision will be made around 2015 concerning the necessity of launching full-fledged efforts towards commercialization.	EU is more active than Japan and the United States, regarding the hydrogen economy. In EU scenario, it will start promoting hydrogen energy immediately for mobile devices, in 2010 for stationary equipment, and in 2015 for automobiles.
Positioning of hydrogen energy	＊ Global warming measures ＊ Energy saving ＊ Diversification of supply sources (to reduce oil dependency)	＊ Improvement of supply stability (reducing oil dependency by utilizing domestic coal reserves and nuclear power)	＊ Global warming measures ＊ Assisting the dissemination of renewable energy

Source: Compiled from relevant materials.



Source: European Hydrogen & Fuel Cell Technology Platform Deployment Strategy (2005)

Figure 3.1-1 EU scenario for the transition to hydrogen economy (mobile use→stationery use→transportation use)



Source: Hydrogen Posture Plan (2004)

Figure 3.1-2 United States scenario for the transition to hydrogen economy

(Decision to be made around 2015 on whether to move on to the wide commercialization)

3.2 Development and Introduction of Clean Coal Technology

[Points]

- Utilization of coal can contribute to the stable supply of primary energy in the world because of its abundant proven reserve and relatively even distribution of the deposits among the regions unlike oil and gas (Figure 2.1-1). On the other hand, coal poses a problem of how we should control its emissions because, among the fossil fuels, it emits the largest amount of CO_2 per unit of energy.
- Clean coal technology (CCT) is a set of technologies for effective utilization of coal, including those for reduction in CO_2 emissions and the multifaceted use of coal (Table 3.2-1). It is essential to accelerate the development and introduction of these technologies.
- In particular, the vigorous activities in the following issues are highly recommended.
  - Most of the abundant recoverable coal reserves are of low grade with low caloric value and poor usability. Technology should be developed for effective utilization of such the coal (Table 3.2-2).
  - Zero-emission technologies need to be developed for coal-fired power generation such as the FutureGen project by the United States.
  - Coal-producing countries are paying eager attention to coal liquefaction for transport use. In 2006, the government of Indonesia issued a presidential decree stating its plan to start using liquefied coal as part of the country's primary energy supply by the end of 2020. Negotiations are under way between Indonesia and foreign manufactures concerning the introduction of coal liquefaction technology.

[Related Data and Facts]

Table 3.2-1 Clean coal technology map

Coal flow	Technology	Needs			CCT	
		Developing country	Coal-producing country	Developed country	Existing technology	New technology
Mining	Pressing	Expanding applications	Expanding applications	Enhancing energy security Expanding applications	CBM/CMM utilization	ECBMR CBM/CMM power generation
Dressing	Dressing	-	Improving efficiency (simplifying processes)	Improving efficiency	Jig, floatation, heavy medium separation	Turbo floatation (Australia)
	Reforming	-	Reforming low-grade coal	Reforming low-grade coal		Hyper coal Low-grade coal (UBC) reformation
Processing	Briquette	Utilizing biomass	Utilizing high-grade coal	Utilizing low-grade coal		Bio-briquette Dry briquette
	Handling	Improving transport efficiency	Reducing costs Improving transport efficiency	Reducing costs Improving transport efficiency		Coal cartridge Coal slurry
Conversion	Liquefaction	Expanding applications	Expanding applications	Expanding applications	CWM/COM	Coking coal liquefaction (NEDOL) Brown coal liquefaction (BCL) CC-TSL, New-IG, SASOL DME
	Gasification	Expanding applications*1	-	Improving energy efficiency	City gas production (dry distillation)	Spouted bed-type coal liquefaction Spouted bed (Shell, Texaco, Dow, etc.)
	Heat decomposition	Expanding applications*2	-	Expanding applications		Multiple-purpose coal conversion Partial coal hydrogenation
	Combustion	Improving energy efficiency	Processing low-grade coal	Improving energy efficiency	Boiler combustion	Fluidized-bed combustion (CFBC, PFBC) Partial combustion (CPC, PCPC)
	Efficient power generation	Utilizing low-grade coal	-	Improving energy efficiency	Pulverized coal-fired power generation	Supercritical-pressure pulverized coal combustion technology (USC) FutureGen (U.S.) Integrated Gasification Combined Cycle (IGCC) Integrated Coal Gasification Fuel Cell Combined Cycle (IGFC)
Post-treatment	Exhaust gas treatment	Improving energy efficiency	-	Conforming to environmental regulations Improving red rates	Bag filter, electrostatic precipitation technology	High-temperature dust collection filter
					Wet limestone/alabaster technology (SOx)	Dry desulphurization Spray drier
					Selective catalytic reduction process	Noncatalytic denitration (SNCR) Simultaneous desulphurization and denitration (activated carbon adsorption) Simultaneous desulphurization and denitration (electron beam)
	Ash utilization	*3	-	Expanding applications	Cement, concrete	Ground stabilization (FGC) Road bed material production High-strength artificial aggregate Fertilizer
CO_2 measure	Reduction	*4	-	Conforming to environmental regulations	Blast furnace with coke	HyPr-RING, ECBMR Recovery, fixation, capture FutureGen (U.S.) CO_2 conversion Pulverized coal oxygen combustion
Industrial use	Steelmaking	Conforming to environmental regulations	-	Dealing with obsolete coke ovens Improving productivity	Pulverized coal injection (PCI)	Molded coke (FCP) Next-generation coke furnace (SCOPE21) Direct reduction iron making (FASTMET, SL/RN, etc.) Direct iron ore smelting reduction process (COREX) Direct iron ore smelting reduction process (DIOS)
	Cement making	Simplifying processes	Utilizing low-grade coal	Improving productivity	Rotary kiln (SP, NSP)	Fluidized-bed cement baking (FAKS)

Note: Objectives of CCT in Japan

- Diversification of energy sources (expansion of applications)
-Improvement in operability
- Improvement in energy utilization efficiency (animal-warming measure)
-Reduction in emissions of SOx, NOx, and smoke dust

*1 New needs expected for city gas sources and chemical materials
*2 New application expected to non-fuel products
*3 Little need expected unless there is a shortage of ash treatment facilities
*4 Top priority expected to be given to improvement in energy utilization efficiency

Source: Compiled based on relevant materials.

Table 3.2-2 Recoverable coal deposits by region

In billions of tons (short)	High-grade coal	Low-grade coal		Total
	Anthracite and Bituminous	Sub-bituminous	Lignite (Brown coal)	
Unites States	125.4	109.3	36.0	270.7
Russia	54.1	107.4	11.5	173.0
China	68.6	37.1	20.5	126.2
India	99.3	0.0	2.6	101.9
Non-OECD Europe, Central Asia	50.1	18.7	31.3	100.1
Australia, New Zealand	42.6	2.7	41.9	87.2
Africa	55.3	0.2	*	55.5
OECD Europe	19.5	5.0	18.8	43.3
Non-OECD Asia	1.4	2.0	8.1	11.5
Brazil	0.0	11.1	0.0	11.1
Latin America	8.5	2.2	0.1	10.8
Canada	3.8	1.0	2.5	7.3
Others	1.8	0.4	0.1	2.3
World's total	530.4	297.1	173.4	1000.9

Source: International Energy Outlook 2006 (U.S. EIA)