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.

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

<table>
<thead>
<tr>
<th></th>
<th>Japan</th>
<th>United States</th>
<th>EU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outlook</td>
<td>The New National Energy Strategy addresses continuous R&amp;D effort to develop hydrogen energy from a long-term perspective, under NEDO and other organization initiative.</td>
<td>At present, active R&amp;D is promoted. Decision will be made around 2015 concerning the necessity of launching full-fledged efforts towards commercialization.</td>
<td>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.</td>
</tr>
<tr>
<td>Positioning of hydrogen energy</td>
<td>* Global warming measures * Energy saving * Diversification of supply sources (to reduce oil dependency)</td>
<td>* Improvement of supply stability (reducing oil dependency by utilizing domestic coal reserves and nuclear power)</td>
<td>* Global warming measures * Assisting the dissemination of renewable energy</td>
</tr>
</tbody>
</table>

Source: Compiled from relevant materials.

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


**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)
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 CO₂ per unit of energy.

- Clean coal technology (CCT) is a set of technologies for effective utilization of coal, including those for reduction in CO₂ 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 manufacturers concerning the introduction of coal liquefaction technology.
### Table 3.2-1 Clean coal technology map

<table>
<thead>
<tr>
<th>Coal flow</th>
<th>Technology</th>
<th>Needs</th>
<th>Developed country</th>
<th>Developed country</th>
<th>Existing technology</th>
<th>New technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mining</td>
<td>Pressing</td>
<td>Expanding applications</td>
<td>Expanding applica-</td>
<td>Enhancing energy</td>
<td>CBM/CMM utiliza-</td>
<td>CCT</td>
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<td>tions</td>
<td>security</td>
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<td>ECBMR</td>
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<td>Expanding applica-</td>
<td>CBM/MM power</td>
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<td>generation</td>
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<td></td>
<td>Dressing</td>
<td>-</td>
<td>Improving efficiency</td>
<td>Improving energy</td>
<td>Jig, flotation,</td>
<td>Turbo flotation</td>
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<tr>
<td></td>
<td></td>
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<td>(simplifying proc-</td>
<td>security</td>
<td>heavy medium</td>
<td>(Australia)</td>
</tr>
<tr>
<td></td>
<td>Reforming</td>
<td>Reforming</td>
<td>Reforming low-grade</td>
<td></td>
<td>separation</td>
<td></td>
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<tr>
<td></td>
<td>Processing</td>
<td>Briquette</td>
<td>Utilizing biomass</td>
<td>Utilizing low-grade</td>
<td></td>
<td>Hyper coal</td>
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<td></td>
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<td>coal</td>
<td>coal</td>
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<td>Low-grade coal</td>
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<td>(UBC) reformation</td>
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<td></td>
<td>Handling</td>
<td>Improving transport</td>
<td>Improving transport</td>
<td>Reducing costs</td>
<td></td>
<td>Coal cartrige</td>
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<td></td>
<td></td>
<td>efficiency</td>
<td>efficiency</td>
<td>improving transport</td>
<td></td>
<td>Coal slurry</td>
</tr>
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<td></td>
<td>Conversion</td>
<td>Liqufaction</td>
<td>Expanding applica-</td>
<td>Expanding applica-</td>
<td>CWM/COM</td>
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<td></td>
<td>Heat decom-</td>
<td>Expanding applica-</td>
<td>Improving energy</td>
<td>City gas produc-</td>
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<td>efficiency</td>
<td>tion (dry distilla-</td>
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<tr>
<td></td>
<td>Combustion</td>
<td>Improving energy</td>
<td>Processing</td>
<td>Improving energy</td>
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<tr>
<td></td>
<td>Efficient</td>
<td>Utilizing low-grade</td>
<td>improving energy</td>
<td>Pulverized coal-</td>
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<td></td>
<td>power</td>
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<td>fired power</td>
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<td>generation</td>
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<td></td>
<td>Post-treat-</td>
<td>Improving energy</td>
<td>Conforming to envi-</td>
<td>Bag filter, electro-</td>
<td>High-temperature</td>
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<td></td>
<td>ment</td>
<td>efficiency</td>
<td>ronmental regula-</td>
<td>static precipita-</td>
<td>dust collection</td>
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<td></td>
<td>Ash utiliza-</td>
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<td>tions</td>
<td>tion technology</td>
<td>filter</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CO₂ measure</td>
<td></td>
<td>improving red rates</td>
<td></td>
<td>Wet lime-</td>
<td></td>
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<tr>
<td></td>
<td>Industrial</td>
<td>Conforming to envi-</td>
<td>Bag filter, electro-</td>
<td>stone/alabaster</td>
<td>desulfurization</td>
<td></td>
</tr>
<tr>
<td></td>
<td>use</td>
<td>ronmental regulations</td>
<td>static precipita-</td>
<td>technology (SOx)</td>
<td>spray drier</td>
<td></td>
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<tr>
<td></td>
<td>Steelmak-</td>
<td>Dealing with</td>
<td>Cement, concrete</td>
<td>Ground stabiliza-</td>
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<td></td>
<td>ing</td>
<td>dioxide</td>
<td></td>
<td>tion (FSC)</td>
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<tr>
<td></td>
<td>Cement</td>
<td>Improving productiv-</td>
<td>Blast furnace</td>
<td>High-strength arti-</td>
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<td></td>
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<tr>
<td></td>
<td>making</td>
<td>ity</td>
<td>with coke</td>
<td>ficial aggregate</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**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 dry 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

<table>
<thead>
<tr>
<th>Region</th>
<th>High-grade coal</th>
<th>Low-grade coal</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Anthracite and Bituminous</td>
<td>Sub-bituminous</td>
<td>Lignite (Brown coal)</td>
</tr>
<tr>
<td>United States</td>
<td>125.4</td>
<td>109.3</td>
<td>36.0</td>
</tr>
<tr>
<td>Russia</td>
<td>54.1</td>
<td>107.4</td>
<td>11.5</td>
</tr>
<tr>
<td>China</td>
<td>68.6</td>
<td>37.1</td>
<td>20.5</td>
</tr>
<tr>
<td>India</td>
<td>99.3</td>
<td>0.0</td>
<td>2.6</td>
</tr>
<tr>
<td>Non-OECD Europe, Central Asia</td>
<td>50.1</td>
<td>18.7</td>
<td>31.3</td>
</tr>
<tr>
<td>Australia, New Zealand</td>
<td>42.6</td>
<td>2.7</td>
<td>41.9</td>
</tr>
<tr>
<td>Africa</td>
<td>55.3</td>
<td>0.2</td>
<td>*</td>
</tr>
<tr>
<td>OECD Europe</td>
<td>19.5</td>
<td>5.0</td>
<td>18.8</td>
</tr>
<tr>
<td>Non-OECD Asia</td>
<td>1.4</td>
<td>2.0</td>
<td>8.1</td>
</tr>
<tr>
<td>Brazil</td>
<td>0.0</td>
<td>11.1</td>
<td>0.0</td>
</tr>
<tr>
<td>Latin America</td>
<td>8.5</td>
<td>2.2</td>
<td>0.1</td>
</tr>
<tr>
<td>Canada</td>
<td>3.8</td>
<td>1.0</td>
<td>2.5</td>
</tr>
<tr>
<td>Others</td>
<td>1.8</td>
<td>0.4</td>
<td>0.1</td>
</tr>
<tr>
<td>World's total</td>
<td>530.4</td>
<td>297.1</td>
<td>173.4</td>
</tr>
</tbody>
</table>

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