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Multilateral Cooperation and Best Practices Scenario

The Role of Technology Towards the Resolution of Energy & Environmental Issues in Asia

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Projection Outline

Objective: Attempt to quantitatively simulate realistic energy pictures in a fully logical and consistent way, with elaborate investigation into current status of socio-economic and energy fundamentals, in both world and Asian regions.

Projection Period: 2008 ~ 2035

Scenarios:

- Reference
  Reference scenario anticipates highly probable deployment of energy policy and energy technology based on current economic & political situations, which yields normative future evolution of energy demand and supply.

- Technological Advanced Scenario (Tech. Adv.)
  This scenario develops future picture which assumes;
  - Accelerated R&D encourages global deployment of advanced technology.
  - Global technology cooperation and technology transfer from developed to developing countries are promoted.
  - All the countries of the world take technological advanced measures in order to secure energy demand and supply.
Towards the Realization of 3E (Environment, Economy, Energy security) in Asia and the World

**Low Carbon Society**

**3E in Asia and World**

Procuring Sustainability by the Realization of 3E (Environment, Economy, Energy security) in Asia and the World

**Energy Security**

**Economic Growth**

**Agenda on Energy-Environmental Policy**

Firm resolutions on ensuring energy security, R&D and addressing climate change are significant

- Expansion of Non-fossil fuel
- Best Mix (diversification and efficient energy use)
- Oil & gas supply security

**Technological Strategy of Japan**

Japan should focus on its competitive technological edge.

- Accelerate R&D for Advanced Technology towards 2030 & 2050
- Transfer low carbon technology and knowledge on building energy policy to other countries.
- Achieve economic growth by establishing new energy & environmental industry

**Development and deployment of innovative technology and social system from long-term viewpoint**

**2020**

- Nuclear
- Solar PV, Wind, Bio-fuel
- Environmentally compatible use of fossil fuel
  - Clean Coal Technology
  - MACC
- Clean Energy Vehicles (Plug-in Hybrid Vehicles, EV)
- Battery technology, Power electronics
- Fuel Cell
- Heat-Pump
- Smart Grid, Smart Meter

**2030**

- Energy demand expansion
- Risk of extraordinary price escalation of fossil fuel
- Innovative technology

**2035**

- Fast Breeder Reactor (FBR)
- Innovative industrial process
- Geo-engineering
- Distributed energy system
- Low carbon town
- Hydrogen society
- 3R (reuse, reduce, recycle) technology

**2050**

Low carbon technology ⇒ Sustainable economic growth
By 2035, primary energy demand of Asia achieves twice as much as current level, reflecting high economic growth; 3.6 billion toe in 2007 → 7.1 billion toe in 2035.

Non-OECD will represent 90% of incremental growth of global energy demand toward 2035.
Based on booming economic growth, the share of China and India in Asian primary energy demand will significantly increase to 66% by 2035.

Japan’s energy share in Asia, with its slower-paced economic growth and depopulation, will decline from 14% in 2007 to 7% in 2035.
61% of global energy demand increase to 2035 is due to Asia. In particular, approximately 40% of both China and India dominates the world increase. OECD is responsible for 12%, and Non-OECD, 88%.
Oil will remain the largest energy source in primary energy mix by 2035. Around 2035, natural gas demand will grow with its future extensive use in various sectors, eventually catching up coal around 2035.

- Fossil fuel continues to be the most important fuel by 2035, though its share will slightly decrease from 89% in 2007 to 86% in 2035.
Coal and Oil will continue to maintain its centrality over Asian energy demand until 2035.

The share of natural gas will grow substantially to 16% by 2035, driven mainly by power generation. Fossil fuel dominates 88% of total energy supply and plays a key role by 2035.
In Asia, coal remains the largest of primary energy source reflecting on boosting electric power demand by 2035. Coal share in Asia: 2007: 52%→2035: 43%

Nuclear share in Asia gradually expands with active building-up of nuclear power plants in China, India, Japan and South Korea.
Increase in Primary Energy Demand by Fuel; World

2007-2035 Increase

<table>
<thead>
<tr>
<th>Fuel</th>
<th>2007-2035 Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>23%</td>
</tr>
<tr>
<td>Oil</td>
<td>22%</td>
</tr>
<tr>
<td>Gas</td>
<td>34%</td>
</tr>
<tr>
<td>Nuclear</td>
<td>8%</td>
</tr>
<tr>
<td>Hydro</td>
<td>3%</td>
</tr>
<tr>
<td>Other Renewables</td>
<td>10%</td>
</tr>
</tbody>
</table>

- **Fossil fuel** occupies about 80% of total growth.

**Increase from 2007 to 2035**

- 79% of global energy growth by 2035 will be concentrated on fossil fuels.
- Fossil fuel demand growth to 2035 in Non-OECD will be responsible for about 90% of global fossil demand increasing.
Almost 80% of energy demand increase will be attributable to fossil fuels both in world and Asia.

In Asia, coal will account for more than 30% of its energy demand increase to 2035 and play a central role in terms of energy supply.
Number of Vehicles; World

- Approximately 40% of global automobile increase concentrates on Asia, with vehicle number increase in developed countries showing saturation trend.
- The share of automobile ownership (stock) in OECD will decline from 71% in 2007 to 49% in 2035; Non-OECD will increase from 29% to 51%. The stock in Non-OECD will outstrip OECD by 2035.
- 90% of global coal demand increase is derived from Asia, and the share of coal demand in Asia eventually expands to 67%. Non-OECD shares for 96% of the increase in world coal demand.
- 35% of the increase in global CO2 emissions from 2007 to 2035 comes from coal combustion in Asian region; In order to address global warming problem, environmentally compatible coal use is quite important agenda in Asia.
Coal will be consumed in the power sector in order to meet growing electricity requirements, particularly in China and India, both of which have abundant domestic reserves.
Majority of oil will be used for transportation, while gas and coal will be consumed mainly for power generation.
Coal-fired power generation still remains dominant power supply option by 2035. Natural gas-fired power generation is projected to increase significantly worldwide at highest rate among fossil fuels. Renewables excluding hydro will expand its share in power generation mix to 6.5% by 2035 from 2.5% in 2007.

The CO2 emissions from coal-fired power generation currently dominates about 30% of global CO2 emissions. CO2 emissions from coal-fired generation will increase from 8.2 Gt-CO2 in 2007 to 12.6 Gt-CO2 in 2035. Clean coal technology (CCT) is expected to play an important role in...
The share of coal use in Asia will remain larger than 50%, reflecting abundant resources and the economic advantages. Gas will show a growing trend, the share of which eventually expands to 17% by 2035. The share of nuclear power generation will increase from 8% to 10%; Nuclear plays an important roll in power generation mix.

CO2 emissions from coal-fired generation in Asia will expand by 3.8 Gt-CO2 from 2007 to 2035, this growth being about 30% of global CO2 emissions increase.
Coal-fired power plant is indispensable power supply option in both world and Asia with its economic advantages and the stable availability of its input fuel.
Renewables are expected to expand by technological advancement and supportive political measures such as Fuel In Tariff (FIT) and subsidization.

World PV capacity is likely to grow to 242GW by 2035 and world wind power capacity will boost to 602 GW.

The share of power generation from wind and PV in global power generation will grow from 0.9% in 2007 to 3.6% in 2035.
Nuclear Power Generation Capacity; World

- Nuclear capacity is projected to grow from 392GW in 2007 to 602GW in 2035 (210 GW growth).
- The largest increase in the nuclear capacity is expected in Asia (137GW growth). Asian countries will develop nuclear energy most actively and challenge the largest investment into nuclear power requirement.
World power generation capacity is projected to grow by 71% from 4.5TW in 2007 to 7.7TW in 2035 (3.2 TW growth).

The largest increase in world power generation capacity is expected in Asia (1.6TW growth, 50% of world capacity increase).
CO2 Emission by Region; World

- Increase in Asia will account for 66%, in comparison with North America 3% and Europe 4%.
CO2 emissions of China and India will steadily increase driven by growing coal consumption, and their increase share will account for 70% in Asia.
Technologically Advanced Scenario
Assumptions on Technological Advanced Scenario

Countries all over the world strengthen the numerous measures contributing to ensuring energy security and mitigating global warming. Combined with that, technological development and international transfer of technology will be promoted. As a result, advanced technology becomes commercially available.

**Regulation, National Target etc.**
- Carbon Tax, Emissions Trading, RPS,
- Subsidization, Feed In Tariff, Efficiency Standard, Automobile Fuel Efficiency
- Standard, Low Carbon Fuel Standard, Energy Efficiency Labeling, National Target

**Promotion of R&D, International Cooperation**
- Encouragement of Investment for R&D,
- International Cooperation on Energy
- Efficient Technology, Support on Establishment of Efficiency Standard

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**Demand Side Technology**

- **Industry**
  - Best available technology on industrial process such as steel, paper, oil refinery etc. become internationally penetrated

- **Transport**
  - Clean energy vehicles (Hybrid vehicle, Plug-in hybrid vehicle, Electric vehicle, Fuel cell vehicle) globally expand.

- **Building**
  - Efficient electric appliance (Refrigerator, TV etc.), High efficient water-heating system (heat-pump etc.), Efficient air conditioning system, Efficient lighting, Strengthening heating insulation

**Supply Side Technology**

- **Renewable**
  - More expansion of Wind, PV, Biomass power generation, Bio-fuel

- **Nuclear**
  - Acceleration of more nuclear power plant, Enhancement of operating ratio

- **High Efficient Fossil-fired Power Plant**
  - More expansion of highly efficient Coal-fired power plant (USC, IGCC, IGFC), Natural gas-fired power plant (MACC)

- **CCS**
  - Introduction in power generation (coal-fired, gas-fired) and industrial sector
Further expansion of nuclear and renewables is likely to be realized on the basis of global electricity demand increase.

Biofuel will more boost if cellulosic biofuel, which is not competitive with food production and land use, becomes commercially viable.

Industry sector, building sector and transport sector respectively achieves 300 Mt (9% saving), 500 Mt (14% saving) and 400 Mt (14% saving) of energy saving in 2035 compared with reference scenario.
Clean Coal Technology (CCT): CO₂ Capture & Storage (CCS)

- CCS will be introduced after 2020 in coal-fired, gas-fired power generation and industrial sector.
- In industrial sector, 10% of its total emissions will be captured and stored by 2035.

Cumulative captured and stored CO₂ from 2020 to 2035 amounts to 14 Gt-CO₂.
Theoretical potential capacity of CCS in geological structure is estimated to 10,000 Gt, and that of depleted gas field, oil field and coal field is estimated 1000 Gt, which is sufficient enough to accommodate the captured CO₂ in Tech. Adv. Scenario.
In 2035, world total primary energy demand in Tech. Adv. Scenario decreases by 2300 Mtoe in comparison with Reference Scenario. 2300 Mtoe is approximately 4 times as much as total primary energy supply of Japan.

The saving potential in Asia is particularly immense amount.
CO₂ mitigation of Non-OECD will be almost double as large as that of OECD in 2035. The saving potential in Asia shows massive amount. Technology transfer and swift deployment of advanced technology in Asia is indispensable in order to address global warming problem.
Multiple technological options, such as energy saving, enhancement of power generation efficiency, renewable energy, nuclear power, fuel-switching and CCS will contribute greatly to massive CO2 mitigation.