

Asia's Future Energy Mix and Long-Term Energy Supply and Demand Outlook

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Summary

The Institute of Energy Economics, Japan (IEEJ) makes a long-term forecast annually on the world energy supply and demand situation up to 2035, with particular focus on Asia. This paper reports the major prediction results of the IEEJ's latest forecast. The world's primary energy consumption will grow at a rate of 1.6% per annum during the period 2010-2035, from 11,700 Mtoe (million tons of oil equivalent) to 17,500 Mtoe. Carbon dioxide (CO₂) emissions will increase from 30.4 Gt in 2010 to 43.4 Gt in 2035. In the Advanced Technology Scenario, where advanced low-carbon technologies become widely deployed around the world, CO₂ emissions will be reduced by 13.7 Gt or 31%, about half of which is due to reduction in Asian countries. Asia is the only region in the world to which the import of fossil fuels increases tremendously, thus the mutual relationship between Asia and fossil-fuel exporting countries, such as Middle East countries, will be more and more important in the future.

1. Introduction

The world's energy demand has been expanding rapidly. It increased 2.3-fold from 5,500 Mtoe in 1971 to 12,700 Mtoe in 2010. Particularly, the Asian region has posted a remarkable increase in energy demand. Since 2000 the region has accounted for 70% of global energy consumption growth. The fast increase in energy demand in the region that is poor in oil and natural gas resources has caused various problems within and outside it. For example, China with the world's largest energy demand is rapidly expanding its nuclear and renewable energy introduction, acquiring stakes in international oil pipeline construction projects and in oilfields, and increasing liquefied and pipeline-based natural gas imports. It has thus been trying to secure and diversify fossil fuel supply through every means. In the future, the world, including Asia, will continue to expand demand for energy, particularly fossil fuels. How best to stably supply unevenly distributed fossil fuel resources (coal, oil and natural gas) to demand regions will grow important more and more.

In this study, we used an econometric model to analyze energy supply and demand in Asia and other regions of the world through 2035, based on past energy data and up-to-date energy policy trends. Particularly, we quantitatively projected the future energy mix in Asia that has been

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increasing its presence as a major energy consumer, as well as its future relationship with the Middle East that is the world's largest energy supplier.

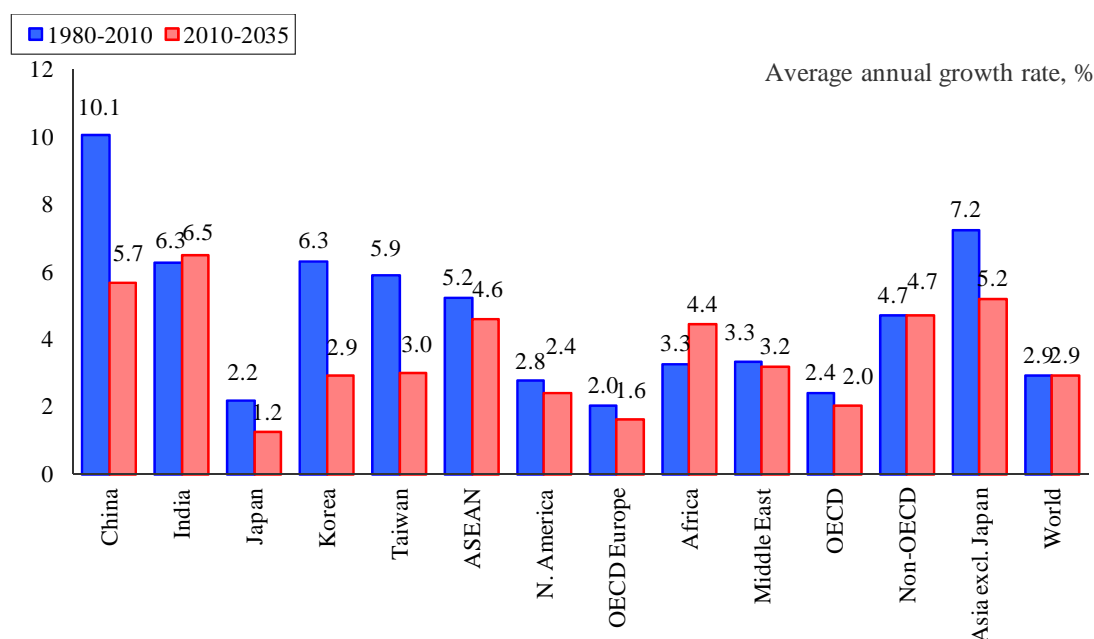
2. Assumptions

On future global population assumptions, we referred to the latest United Nations forecasts. While even developing countries see a birthrate decline in line with their economic development, global population is projected to increase at an average rate of about 1% per annum from 6.8 billion in 2010 to 8.6 billion in 2035. Among developed countries, the United States is projected to sustain a population increase, although the increase may be limited to a moderate one. In Japan, Europe and Russia, population is expected to peak out and follow a downward trend. In developing countries, on the contrary, population is predicted to steadily increase.

Gross domestic product growth rates are assumed as shown in Fig. 2-1, based on forecasts by the Asian Development Bank, the International Monetary Fund and other international organizations, as well as economic development programs announced by governments. After a recent serious slump, the world economy is expected to steadily grow over a medium to long term. Particularly, populous Asia has a great growth potential and has attracted attention as a big consumption market. As the Asian economy continues to drive global economic growth, the world economy is assumed to grow at a moderate rate of 2.9% per annum through 2035.

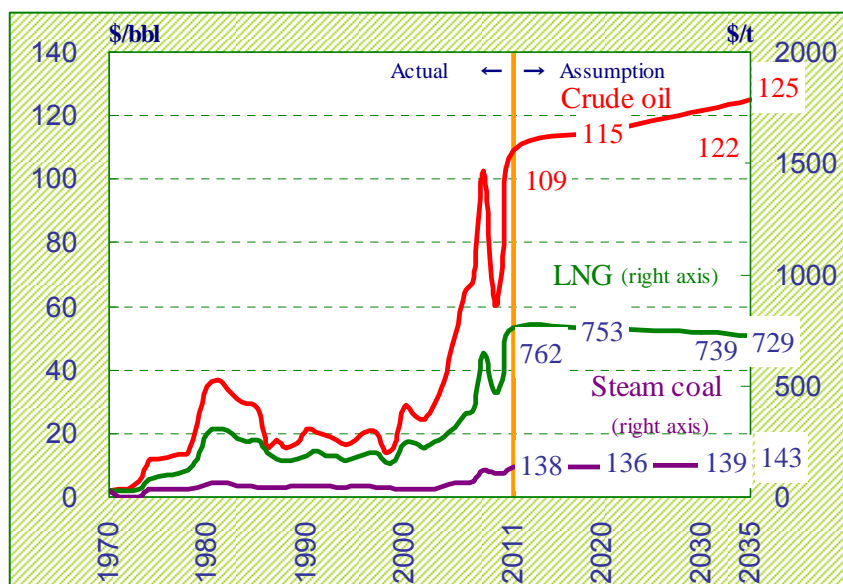
Japan's CIF (cost, insurance and freight) crude oil import price (in 2011 constant dollars) is assumed to moderately rise in line with oil production cost hikes over a long term, reaching \$115/barrel in 2020, \$122/barrel in 2030 and \$125/barrel in 2035. (The nominal price is assumed at \$137/barrel in 2020, \$177/barrel in 2030 and \$201/barrel in 2035.) While prices of LNG for Japan

Fig. 2-1 GDP Growth Assumptions



are expected to remain basically linked to crude oil prices, the relative prices of natural gas against crude oil are assumed to decline in line with a rise in global unconventional resources production and an increase in gas import projects to Asia over a medium to long term.

Fig. 2-2 Primary Energy Price Assumptions (in 2011 constant dollars)



3. Scenarios

In this study, we made estimates based on two scenarios, i.e., the Reference Scenario and the Advanced Technology Scenario. The Reference Scenario reflects past trends, and energy and environmental policies adopted so far. In this scenario, the energy conservation or low-carbon measures of each country are only assumed to be in line with past trends. More ambitious targets vowed by various countries for introducing energy conservation and low-carbon technologies are assumed to fail due to financial and other difficulties.

The Advanced Technology Scenario assumes that the governments will implement a series of energy and environmental policies contributing to securing stable energy supply and enhancing climate change measures and will accelerate the development and introduction of innovative technologies to the maximum extent.

4. Results and Discussions

4-1 World Primary Energy Consumption

The world's primary energy consumption will grow at a rate of 1.6% per annum from 11,700 Mtoe in 2010 to 17,500 Mtoe in 2035. In the 25 years, consumption will thus expand about 1.5-fold. Non-OECD countries will account for about 90% of global energy consumption growth between 2010 and 2035. Particularly, the Asian region will be responsible for about 60%. China alone will

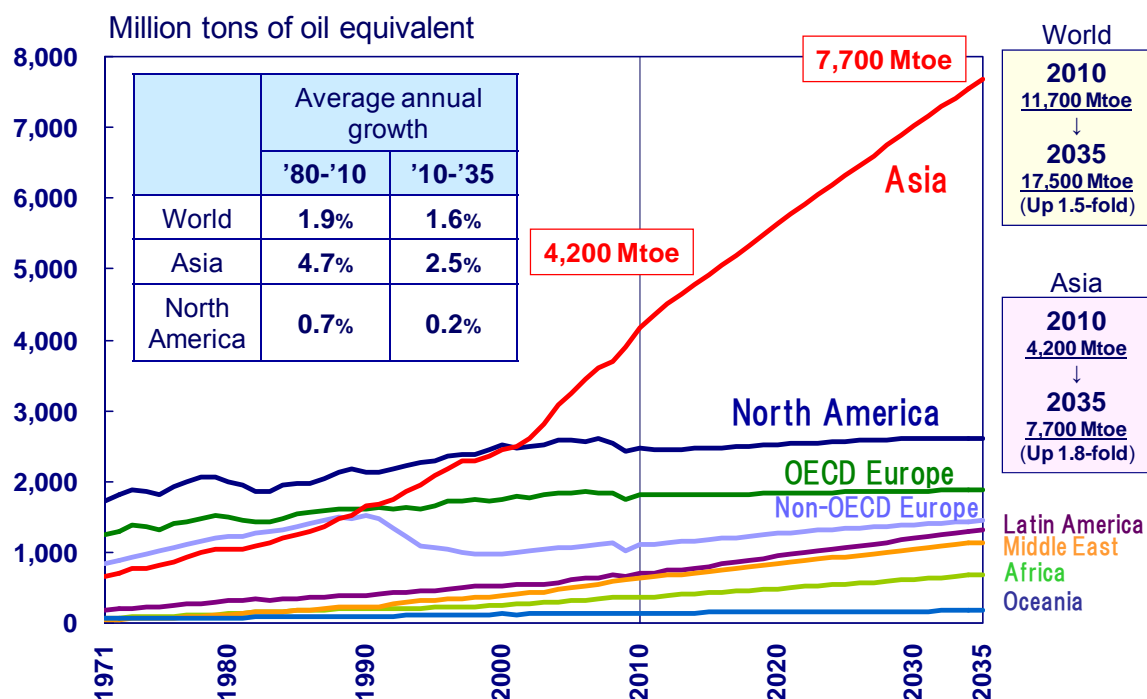
make up about 30%. Non-OECD countries' share of global primary energy consumption will expand from 53% in 2010 to 66% in 2035 in line with their population and economic growths. Asia's share will rise from 37% in 2010 to 45% in 2035 and China's share from 19% to 24%. Against the background of their steady economic growth, China and India will account for about 30% of global primary energy consumption by 2035.

A breakdown of primary energy consumption by energy source indicates that oil will still account for the largest share of primary energy consumption until 2035 in both the Reference and Advanced Technology Scenarios, remaining the mainstay energy source.

In the Reference Scenario, coal and natural gas consumption will expand, leading oil, coal and natural gas to account for almost the same percentage share of total primary energy consumption. Fossil fuels will cover about 80% of primary energy consumption growth between 2010 and 2035. Among them, natural gas will post the largest consumption growth, accounting for 30% of primary energy consumption growth, followed by 25% for oil, 24% for coal, 6% for nuclear, 2% for hydro and 12% for other renewable energy sources.

In the Advanced Technology Scenario, oil consumption will remain almost unchanged after 2030. Fossil fuels' share of primary energy consumption will fall to 85% in the Reference Scenario and 77% in the Advanced Technology Scenario in 2035, while remaining a mainstay energy source. Natural gas will expand its share of fossil fuel consumption, and will not peak out by 2035.

Fig. 4-1 Primary Energy Consumption by Region (Reference Scenario)



4-2 Asian Primary Energy Consumption

Primary energy consumption in Asia will increase at an average rate of 2.5% per annum from 4,200 Mtoe in 2010 to 7,700 Mtoe in 2035. Asian consumption will thus expand 1.8-fold during the 25 years. Particularly, robust economic growth in China, India and the Association of Southeast Asian Nations (ASEAN) will help expand Asian energy consumption rapidly. Even in 2035, per capita energy consumption in developing countries will still be lower than in developed countries, retaining a potential to further expand.

Among various energy sources, Asia will still depend heavily on coal. While coal will log the largest consumption decline among energy sources due to energy conservation and carbon dioxide emission reduction efforts in the Advanced Technology Scenario, it will remain the largest energy source in Asia, accounting for 37% of total primary energy consumption.

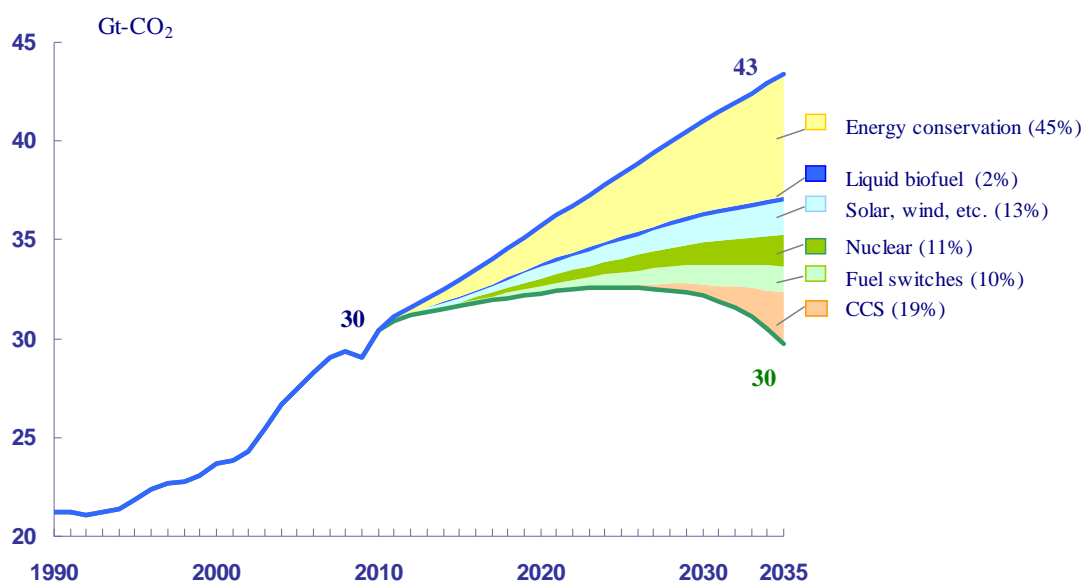
4-3 CO₂ Emissions

The world's CO₂ emissions, increasing at a rate of 1.4% per annum, slightly slower than primary energy consumption, will expand about 1.4-fold from 30.4 Gt in 2010 to 43.4 Gt in 2035 in the Reference Scenario. About 70% of the growth will stem from Asia.

In the Advanced Technology Scenario, CO₂ emissions will increase by 1.9 Gt from 2010 to 2020 and peak out in the 2020s due to further advancement in energy and environmental technologies. CO₂ emissions in this scenario will total 29.7 Gt in 2035, down 13.7 Gt or 31% from the Reference Scenario.

No single effective measure exists for reducing CO₂ emissions. Energy conservation, more efficient power generation, non-fossil energy promotion, fuel switches, carbon capture and storage (CCS) technology, and other measures will be combined to contribute to reducing CO₂ emissions.

Fig. 4-2 World CO₂ Emission Cut through Technological Advancement



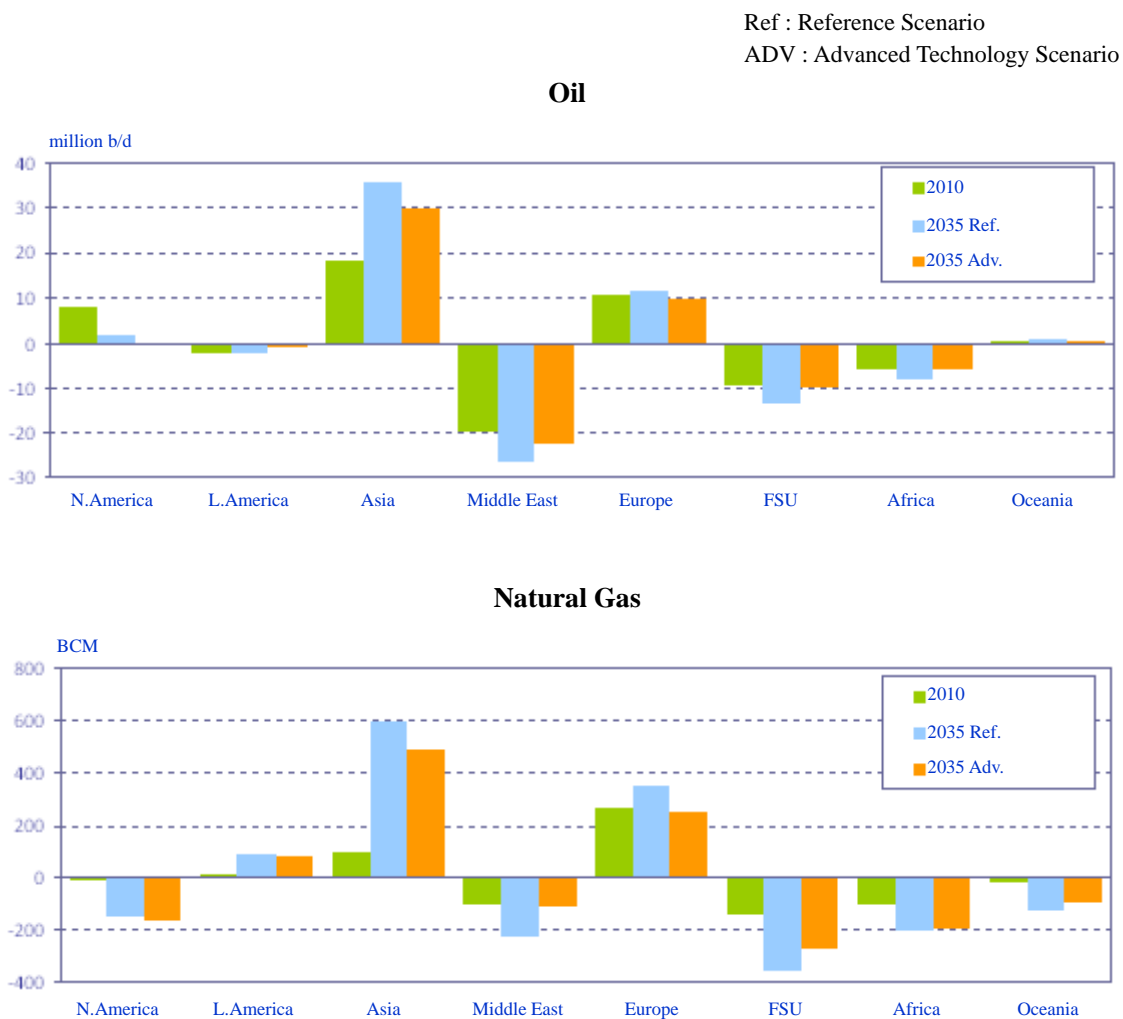
Of the 13.7 Gt reduction from the Reference Scenario to the Advanced Technology Scenario, energy conservation will be responsible for 45%, renewable energy for 15%, nuclear energy for 11%, fuel switches for 10% and CCS technology for 19%.

4-4 World Oil and Natural Gas Import-Export Balance

A characteristic point of Asian energy supply and demand conditions is that the region has abundant coal resources while falling short of having oil and natural gas resources sufficient to cover a future demand increase. As shown in Fig.4-3, only Asia will remarkably increase oil and natural gas imports through 2035, while North America will go in the direction of energy self-sufficiency due to a demand fall and production growth amid unconventional oil and gas resources development, with Europe posting no major rise in fossil fuel demand.

Responding to the Asian oil import expansion will be the Middle East. In the Reference Scenario, the Middle East will account for half of the 18 million barrels per day in Asia’s net oil import increase.

Fig. 4-3 Net Oil/Natural Gas Imports



The Middle East can expect no increase in exports to Europe and a fast decline in those to North America. It may cover the decline with an increase in exports to Asia. Therefore, the mutual relationship between the Middle East as a big oil exporter and Asia as a big oil importer will deepen more and more. But this is not necessarily the same case with natural gas. Former Soviet Union (FSU) countries, Australia, Africa, North America and the Middle East can afford to expand natural gas exports to Asia. Nevertheless, the Middle East will increase both oil and natural gas exports to Asia. Such exports to Asia will account for nearly 90% of total fossil fuel exports from the Middle East.

4-5 Asian Energy Mix

The key to Asia's energy self-sufficiency is its abundant coal resources. In this sense, Asia will continue to use coal over a long term. As oil and natural gas imports are projected to increase substantially as noted above, however, Asia's energy self-sufficiency rate will decline in any scenario. Therefore, an important challenge for Asia is how best to respond to growing energy demand while ensuring the so-called three E's -- energy security, environmental protection and economic efficiency. Promising measures to this end include encouraging energy conservation and aggressively promoting nuclear and renewable energy. All these measures must be implemented to the maximum extent for non-OECD Asian countries. Nuclear and renewable energy should not be interpreted as rivals or mutually interchangeable.

The following discusses the "Case 0: No energy conservation" case where nuclear and renewable energy will remain unchanged from 2010 to 2035 in the Reference Scenario, the "Case 1: Dependence on fossil fuel" case where energy conservation will be implemented to the extent as projected in the Advanced Technology Scenario, and the "Case 2: Advanced renewable energy promotion," "Case 3: Advanced nuclear energy promotion" and "Case 4: Advanced nuclear and renewable energy promotion" cases where renewable energy and nuclear energy, separately and together, will be promoted to the extents as projected in the Advanced Technology Scenario.

Non-OECD Asian countries' energy self-sufficiency rate will decline from 86% at present to 72% in 2035 in the "0. No energy conservation" case. Even in the "4. Advanced nuclear and renewable energy promotion" case, however, the rate will be 74%, indicating no major improvement. This is because renewable energy will substantially replace coal for which the self-sufficiency rate for these countries is very high. But energy conservation and renewable and nuclear energy promotion will greatly contribute to reducing energy-related CO₂ emissions. Energy conservation will reduce CO₂ emissions by 20% from the "Case 0: No energy conservation" case, renewable energy promotion by 9% and nuclear energy promotion by 6%. CO₂ emissions will be thus be reduced by a total 36%. The cut will amount to 18% of global CO₂ emissions in 2035 in the Reference Scenario.

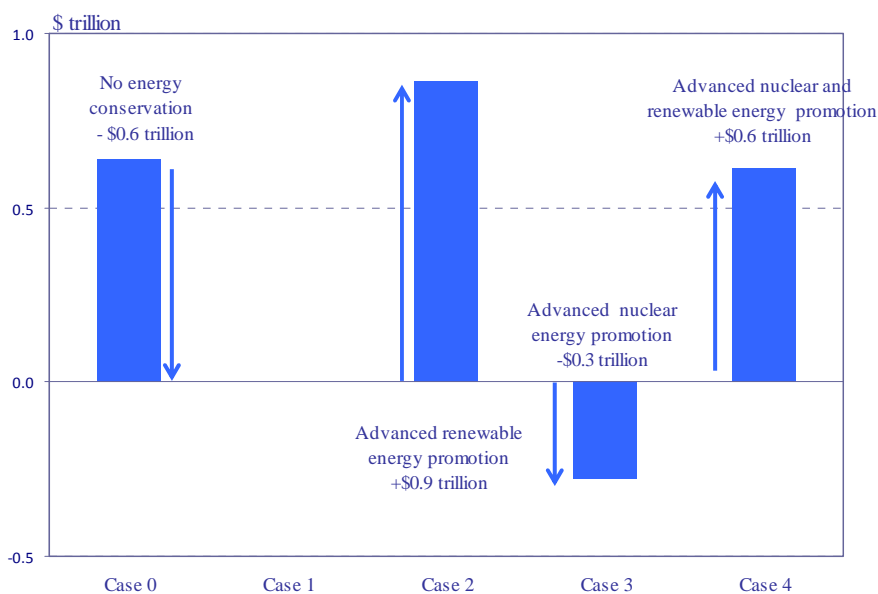
Regarding economic efficiency, cost increases for promoting these measures will be offset by benefits from a cut in fossil fuel purchases. Fig.4-4 indicates cumulative net benefits or costs from the "Case 1: Dependence on fossil fuel" case for the other cases. The whole of non-OECD Asian

countries will get \$0.6 trillion in net benefits from energy conservation and \$0.3 trillion from nuclear energy promotion. But renewable energy promotion will feature far higher costs and bring about a net cost hike of \$0.9 trillion. In making these estimates, we took into account future drops in renewable energy costs as well as cost increase in nuclear power generation due to additional safety measures, location and other policy costs, high-level radioactive waste disposal costs, reactor decommissioning costs and other costs that will be required in response to the Fukushima nuclear plant accident.

We must take note of the fact that fossil fuel prices will have great impacts. If oil and natural gas import prices rise by 30%, the net cost for the non-OECD Asian countries will increase by \$9 trillion. The net cost hike is far higher than the net cost or benefit for each measure as mentioned above, indicating that stabilizing fossil fuel prices will be very important for Asian energy supply. In this sense, promoting renewable and nuclear energy is expected to reduce fossil fuel price hike risks. This may be a reason why the promotion has been encouraged.

Fig. 4-4 Cumulative Costs through 2035 (2011 price)

* Gaps between the “Case 1: Dependence on fossil fuel” and the other cases



Unit: \$ trillion

Demand side (energy conservation) investments	-6.1	—	—	—	—
Supply side investments	1.6	—	2.6	0.6	3.1
Operation and maintenance costs	0.1	—	0.4	0.6	1.0
Fossil fuel purchases	5.0	—	-2.1	-1.5	-3.5
Total	0.6	—	0.9	-0.3	0.6

5. Conclusion

The world's energy demand will expand over a long term, centering in Asia. Oil and natural gas imports will rapidly increase only in Asia, turning around the world's energy supply and demand picture.

For Asia whose energy self-sufficiency rate is destined to decline, enhancing the relationship with the Middle East and other energy producing regions will grow more and more important. As imports in Europe and North America decline, Asia will become the only major customer for the Middle East. In this sense, Asia and the Middle East are expected to deepen their mutual relationship.

Given the three E's for Asian energy supply and demand, coal is expected to make great contributions to Asia's energy self-sufficiency rate and continue being used over a long term. Among other measures, energy conservation can greatly reduce CO₂ emissions and cumulative costs. In this sense, Asia will have to make maximum energy conservation efforts. While nuclear energy promotion will benefit Asia by bringing about reductions in CO₂ emissions and fossil fuel imports, renewable energy promotion will result in a net cost hike without further cost reduction efforts.

Asian energy problems are global problems. No stopgap measure can address these problems. Relevant measures will need to be taken through wide-view and long-term thinking to resolve these problems.

<Reference>

- 1) IEEJ, "Asia/World Energy Outlook 2012 -- Increasing Significance of Asia and the Middle East, and their Interdependence"

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