Special Bulletin

A Japanese Perspective on the International Energy Landscape (659) October 20, 2023

IEEJ Outlook 2024: How to Realize Various Pathways to Energy Transition

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On October 20, the Institute of Energy Economics, Japan, published IEEJ Outlook 2024 at its 445th meeting on research reports. The IEEJ Outlook projects global energy supply and demand up to 2050, being positioned as the IEEJ's flagship publication. The IEEJ releases the annual outlook every October, providing a long-term energy supply and demand analysis in the form of an annual regular exercise and special analyses on up-to-date topics. In addition to a long-term analysis based on the Reference Scenario and the Advanced Technologies Scenario for regular exercise, the latest IEEJ Outlook features a special analysis on how to realize various pathways to energy transition, as indicated by the subtitle. The following summarizes key points of the latest IEEJ Outlook.

The IEEJ Outlook features the Reference Scenario and the Advance Technologies Scenario that take a "forecast approach" projecting global energy supply and demand under various assumptions on future changes, based on changes to date. The forecast approach contrasts with the "backcast approach" that the International Energy Agency has adopted for an analysis of global carbon neutrality to consider how global energy supply and demand should change for the achievement of the global carbon neutrality goal. It must be noted that both the forecast and backcast approaches are useful tools for future analysis and have their respective significance.

In the IEEJ Outlook's Reference Scenario in which current trends will be sustained, global primary energy demand will steadily increase under sustained economic growth, posting an 18% rise from 2021 to 17.4 billion tons of oil equivalent in 2050. The increase will be driven by Emerging Markets and Developing Economies, including India and the Association of Southeast Asian Nations, which will account for 67% of the global increase. In China, which has led global energy demand growth, demand will decline due to the declining population and decelerating economic growth. As natural gas and oil demand increases steadily, despite a decrease in coal demand, fossil fuels will continue to account for most of the global energy supply, capturing 73% in 2050.

In the Advanced Technologies Scenario in which advanced energy technologies will spread as much as possible to enhance climate change prevention and energy security measures, primary energy demand in 2050 will be 21% less than in the Reference Scenario due to powerful progress in energy efficiency improvement. Demand will sharply grow for non-fossil energy sources such as renewable energy and nuclear, while slackening for fossil fuels. Coal demand will decrease substantially due to a decrease in demand for coal for power generation. Oil demand will also plunge as the electrification of vehicles makes progress. Natural gas demand will level off in the 2030s before decreasing moderately. As a result, global energy-related CO_2 emissions in 2050 will total 14.7 billion tons, 19.2 billion tons or 57% less than the 33.9 billion tons in the Reference Scenario. The emissions in 2050 are close to those in the Announced Pledge Scenario (in which announced national emission reduction goals will be achieved) in the IEA World Energy Outlook 2022 released last year. Even in the Advanced Technologies Scenario, fossil fuels will still account for 53% of primary energy demand

in 2050, keeping their position as an important energy source.

In the Outlook's special analysis, the following three points are extremely important. First, we analyzed the energy transition in ASEAN, which will drive global energy demand growth and increase its presence in the international energy market, from the perspective of minimizing costs and clarified the importance of balanced, pragmatic efforts according to ASEAN countries' national and energy conditions. We qualitatively demonstrated that it is important for ASEAN to replace coal with natural gas as its main energy source in the early stage of the energy transition, while adequately expanding renewable energy consumption, and later introducing hydrogen and other innovative energy technologies in order to realize carbon neutrality at minimum costs. Deviating from this optimal path would increase energy transition costs and economic burdens. The ASEAN analysis also demonstrated that total energy demand in 2050 will change significantly depending on economic growth and energy efficiency improvement assumptions and that ASEAN's energy mix will have to dramatically change to promote decarbonization.

Second, we analyzed the importance of a stable natural gas and LNG supply. As indicated in the abovementioned ASEAN analysis, gas and LNG are expected to play an important role in promoting the global energy transition in the future. Global LNG demand in 2050 will remain unchanged from the present level in the Advanced Technologies Scenario and increase significantly in the Reference Scenario. This analysis indicated that if a decline in the existing LNG supply capacity is taken into account, an average annual investment of 8 million to 18 million tons in LNG production capacity will be required until 2050. Securing investment to stabilize the LNG market is crucial for LNG to fulfill its expected role. Over the longer term, it will be important to clarify standards for "abated LNG" which can be consistent with decarbonization and promote LNG use in accordance with those standards. From the perspective of LNG buyers, we pointed out that it is important to position long-term contracts to ensure stable supply while pursuing flexibility in the LNG market and promote specific initiatives to secure long-term contracts.

Third, we analyzed negative emission technologies (NETs) that reduce CO_2 in the atmosphere. Energy scenarios of governments and government-related organizations in major countries towards achieving carbon neutrality goals indicate that carbon neutrality cannot be achieved without NETs. Among various NETs options, DACCS (Direct Air Capture with Carbon Storage) and BECCS (Bioenergy with Carbon Capture and Storage) technologies, which combine DAC (Direct Air Capture) and biomass energy use with CCS (Carbon Capture and Storage), are attracting attention from the viewpoint of technical maturity and CO_2 removal potential. For NETs, it is essential to dramatically promote technological development and cost reduction, grasp the CO_2 removal potential, and establish methods for measuring removed CO_2. This analysis also suggested that international cooperation, such as the development of international systems for promoting NETs, will be indispensable.

The Outlook includes a BOX analysis on greenhouse gas emission reduction and critical mineral usage through the electrification of vehicles in the whole of the so-called well-to-wheel energy flow. It showed that GHG emissions from plug-in hybrid vehicles (PHEV) and battery electric vehicles (BEV) are significantly lower than those from internal combustion engine vehicles (ICEV). On the other hand, critical minerals are used for BEVs far more than for PHEVs, indicating that BEV diffusion may exert a great impact on the critical mineral supply-demand balance. It was also shown that when fuel is switched from oil to electrofuels, PHEVs may emit less GHG than BEVs. This analysis presented important issues to be examined regarding vehicle electrification.

Long-term global energy outlooks entail great uncertainties. At present, particularly, the geopolitical situation has become chaotic due to the destabilization of the international energy situation and global divides amid the Ukraine crisis, making it extremely difficult to depict a future picture of the world. Even in the face of such difficulties, however, it is important to take advantage of various ideas to analyze future possibilities for the world. The IEEJ is determined to continuously contribute to solving energy problems in the world through analyses in the IEEJ Outlook.

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