

IEEJ Outlook 2027: The Expanding Dimensions of Energy Security and Emerging Challenges

Ken Koyama, PhD

Senior Advisor

The Institute of Energy Economics, Japan

On October 23, our Institute held the 454th Forum on Research Works and released the *IEEJ Outlook 2027* (hereinafter referred to as “the Outlook”). The Outlook presents the Institute’s independent long-term projection of global energy supply and demand through 2050 and is regarded as the flagship publication among the Institute’s research outputs. The Institute publishes the IEEJ Outlook annually in October, providing not only a long-term assessment of global energy trends as an annual exercise but also analyses of topical issues of strategic importance. In addition to examining two principal scenarios, namely the “Reference Scenario” and the “Advanced Technology Scenario,” the Outlook addresses the increasingly diversified nature of energy security and its associated challenges through five thematic studies: “Expanding Energy Security Challenges in a Changing Geopolitical Environment,” “Fossil Fuel Security with a Focus on Asia,” “Electricity Security Challenges Arising from the Expansion of Data Centers,” “Security Implications of Expanding Renewable Energy Generation,” and “Critical Minerals and Energy Security.” The key findings and implications are summarized below.

The Outlook describes how global energy supply and demand may evolve toward 2050 under the Reference Scenario and the Advanced Technology Scenario. These scenarios are forecast-based projections that extrapolate future developments from current trends while incorporating a range of assumptions regarding possible economic, technological, and policy changes. A central consideration in this year’s analysis is how to assess the impact of the Strait of Hormuz Crisis. Since its outbreak in late February 2026, and now approaching its eighth month, the crisis has profoundly disrupted international energy markets and required significant policy responses worldwide. The resulting surge in energy prices and heightened concerns regarding energy supply have underscored critical energy security risks and raised important questions regarding how global energy market structures may evolve in response.

By incorporating these developments, the Outlook presents a forward-looking assessment ahead of other major global energy outlooks, including the IEA’s *World Energy Outlook* and OPEC’s *World Oil Outlook*. A comparison with last year’s IEEJ Outlook is particularly instructive in highlighting the distinctive features of this year’s analysis. While detailed results for the two scenarios are discussed later, one notable revision from the previous edition is the downward adjustment of projected global oil and natural gas demand. In contrast, projected coal demand has been revised upward, particularly through the mid-2030s. Furthermore, expectations for both nuclear power and renewable energy have been

revised upward through 2050. These changes reflect not only the impact of the Strait of Hormuz Crisis but also recent developments in actual market and demand data. Nevertheless, the influence of the crisis is clearly evident in the revised outlook. The following sections provide an overview of the two scenarios.

Under the Reference Scenario, which assumes a continuation of prevailing economic and energy trends, global primary energy demand increases steadily in line with continued economic growth, rising from 15.5 billion tonnes of oil equivalent (toe) in 2024 to 17.3 billion toe in 2050, an increase of 12 percent. Emerging and developing economies account for the majority of this growth, with India and ASEAN serving as the primary drivers. Together, their demand growth represents 89 percent of the total increase in global energy demand through 2050. By contrast, China, historically the principal contributor to global demand growth, experiences a 12 percent decline in energy demand relative to 2024 due to slower economic growth and population decline. By fuel type, demand in 2050 differs significantly: coal decreases by 22 percent, oil remains broadly unchanged, and natural gas increases by 21 percent. Despite these variations, fossil fuels continue to dominate the global energy mix, accounting for 71 percent of total primary energy supply.

The Advanced Technology Scenario assumes the maximum feasible deployment of advanced energy technologies to address climate change and strengthen energy security. Under this scenario, substantial improvements in energy efficiency reduce global primary energy demand in 2050 by 17 percent relative to the Reference Scenario. Renewable energy sources, namely solar, wind, and geothermal power, expand by 455 percent from 2024 levels, while nuclear power generation increases by 133 percent. In contrast, coal demand declines by 60 percent, oil demand by 42 percent, and natural gas demand remains roughly stable through the 2030s before gradually declining, resulting in a 10 percent decrease by 2050. Energy-related CO₂ emissions fall dramatically, from 35.5 billion tonnes in 2024 to 14.0 billion tonnes in 2050, representing a reduction of 61 percent. Notwithstanding these substantial changes, fossil fuels still account for 52 percent of global primary energy supply in 2050, highlighting the continuing importance of maintaining stable markets and secure supplies.

Electrification advances significantly as electricity demand expands across all sectors of final energy consumption. The global electrification rate rises from 24 percent in 2024 to 35 percent in the Reference Scenario and 47 percent in the Advanced Technology Scenario by 2050. This growth is driven not only by the proliferation of generative AI applications and the rapid expansion of data centers, but also by increasing demand for electricity in industrial activities and residential heating and cooling throughout emerging and developing economies. Ensuring reliable and stable electricity supply at affordable prices in the face of this growing demand will constitute a critical policy challenge in the coming decades.

With regard to the five key thematic studies, the report on “Expanding Energy Security Challenges in

a Changing Geopolitical Environment” first provides an overarching framework for understanding the increasingly diverse nature of energy security concerns. Then, the study on “Fossil Fuel Security with a Focus on Asia” argues that the Strait of Hormuz Crisis has exposed significant vulnerabilities in Asia’s fossil fuel supply security. It emphasizes the importance of comprehensive strategies, including diversification of supply sources, development of related infrastructure, expansion of strategic petroleum reserves, maintenance of adequate refining capacity, investment throughout fossil fuel supply chains, and continued promotion of energy efficiency and energy transition measures.

The study entitled “Electricity Security Challenges Arising from the Expansion of Data Centers” focuses primarily on the United States, examining the relationship between data center expansion and issues related to reliable power supply. It highlights the implications for overall power systems, regional electricity markets where data centers are heavily concentrated, and the considerable uncertainties associated with future demand growth. The report identifies three critical requirements for managing these challenges: (1) securing sufficient generating capacity, (2) providing stable electricity supply where it is needed, and (3) ensuring that required investments can be realized under sustainable cost-sharing arrangements. Drawing on the U.S. experience, the report argues that Japan should carefully consider and learn from these emerging challenges.

The report on the “Security Implications of Expanding Renewable Energy Generation” observes that the world is currently engaged in intense competition surrounding the energy transition, with governments increasingly strengthening industrial policies aimed at securing technological leadership and promoting domestic industries. In the field of renewable energy generation, the report notes that China has established overwhelming dominance across the related supply chains, creating economic security concerns that have attracted growing international attention. Furthermore, as electrification progresses and renewable generation expands, the report stresses the increasing importance of maintaining system-wide electricity reliability and security, including robust cybersecurity measures.

Finally, the report on “Critical Minerals and Energy Security” assesses the security of critical mineral supply from four perspectives: (1) resource limitations, (2) supply concentration, (3) political stability of supplying countries, and (4) future supply-demand balances. By evaluating these factors, the report identifies the specific risks associated with individual minerals and underscores the importance of tailored policy responses. Particular attention is given to the strategic significance and challenges associated with rare earth elements. The report concludes by emphasizing that ensuring both energy security and critical mineral security will require an integrated approach involving close cooperation between governments and industry. The authors intend to revisit these important themes in greater detail in future analyses in the series “A Japanese Perspective on Global Energy Landscape”.