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An Examination on the Factors to Increase Uncertainties of Long-term Energy Projections

Ken Koyama, PhD
Chief Economist, Managing Director
The Institute of Energy Economics, Japan

It is very difficult to accurately project future conditions in any field. This is the same case with energy projections. Actual results frequently deviate from national or global energy projections. Difficulties accompany projections even for the immediate future including the next year and increase for medium to long-term projections. This is because various important factors having impacts on energy market trends grow more uncertain for longer terms. Actual moves of factors are likelier to deviate from assumptions for longer terms.

What factors are important for long-term energy projections? How uncertain are these factors? First, factors having great influence on energy supply and demand include fundamental macroeconomic indicators such as economic growth and population. Both an economy and population can be expected to grow in a long-term trend. If economic growth rate projections deviate from actual results by 0.1 to 0.2 percentage points, however, the economic size and energy demand will differ widely over a long term. How fast any regional economy will grow will bring about dramatic changes in the energy market structure. This is obvious, given that China's rapid, substantial economic growth from 1990 to 2010 led to great changes in the world economy and the international energy market.

Second, it may be needless to say that national and international politics and geopolitical problems have great influence on the energy situation, in addition to the above mentioned economic factors. It is also very difficult to accurately project such political trends. Unexpected developments in the past include Middle East upheavals that triggered oil crises, the collapse of the Soviet Union, and the birth of the U.S. Trump administration and its impacts.

Coming third are energy price trends. Clearly, it is extremely difficult to accurately project how crude oil, gas, coal and other major energy prices would change over a long term. A common challenge for forecasters is that they must depict a long-term future market picture even under such extreme difficulties. It must be noted that not only absolute prices of crude oil but also relative prices of competing energy sources would exert great influence on the future picture of energy. While prices of crude oil as an internationally traded commodity are important, final prices that consumers pay are even more important in a sense. As this point involves policies described later, tax and subsidies must be taken into account. In this way, projection grows even more complex.

Fourth, how to view the availability of energy sources is also very important. An uneven endowment of resources has exerted great influence on the energy market power balance, as indicated by the history of energy markets. When thinking about the importance of the Middle East and Russia, we have no choice but to consider the uneven endowment of energy resources. This

issue is clearly important, given the recent U.S. shale revolution that has dramatically changed the global energy situation by making massive energy resources available.

Fifth, we must consider policies that directly influence future energy supply and demand. Policies have directly tapped the abovementioned prices and technologies and people's choices as described below, bringing about large changes in the global energy market. The oil crises in the 1970s prompted the members of the Organization for Economic Cooperation and Development to strongly promote energy policies that dramatically altered their energy supply and demand structures and exerted great influence on the international energy market and crude oil prices. In Japan, strong energy conservation and alternative energy introduction policies significantly reduced dependence on oil. Not only such energy security policies but also policies to address environmental problems are important. Air pollution improvement measures promoted in such countries as China are bringing about key changes in the energy mix. Over a long term, how climate change countermeasures would be enhanced globally and how energy choices would be affected by such countermeasures will exert great influence on the global energy situation. Energy market liberalization or deregulation policies are also key factors that variously influence energy choices and long-term energy investment through competition.

Sixth, the advancement and diffusion of energy technologies and their impacts are difficult to project. Since human beings depended on natural energy before the industrial revolution, industrialization with coal had made progress before the world entered the age of oil in the 20th century. The next energy transition is expected for the 21st century. Behind such transitions were the advancement and diffusion of important energy technologies, as indicated by the history. The problem is that the rapid advancement and diffusion of energy technologies are unpredictable and occasionally lead to disruptive changes in which very rapid, dramatic changes are accompanied by pains for long-existing systems. It is well known that not only resources problems but also the rapid diffusion of horizontal drilling and hydraulic fracturing technologies were behind the abovementioned shale revolution. Recently, interests are growing globally in the advancement of renewable energy technologies resulting in rapid falls in power generation costs, the growing diffusion of electric vehicle and other advanced automobile technologies and the wide-ranging impacts of artificial intelligence and Internet of things technologies on energy. How far these technologies would advance and penetrate the market is surely a key point for projecting long-term energy supply and demand.

Seventh, the impacts of human lifestyles, values and other social factors are also unignorable. How to use energy, what energy we should select and what society we should pursue would have influence on the future picture of the energy market in a bottom-up manner. The influence will be coupled with the impacts of technologies and policies to alter the energy market structure. It is difficult to accurately project the alteration.

Uncertainties of these factors have long existed but have apparently increased more and more recently. In this sense, long-term energy projection has become more difficult. In fact, various institutions' long-term energy outlooks differ widely, depending on the scenario. Particularly, their coal and nuclear projections vary widely. Differences in oil demand projections have also widened as numerous scenarios for peak oil demand have been published since last year.

Long-term energy projections are provided despite projection difficulties because energy problems include those that must be considered for a long term and energy sector investment exerts

influence over a long term. As uncertainties grow, it will become even more important to conduct analyses on the future based on flexible, multiangle approaches without being preoccupied with fixed or biased approaches.

Contact: report@tky.ieej.or.jp
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