

The Role and Future of Fossil Fuel

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Introduction

Energy is essential for sustaining our lives and economic activities, and stable, sustainable energy supplies and prices are crucial for any society or state today. Today, the world's energy supply consists mostly of fossil fuels, namely oil, coal, and natural gas. Most major long-term energy outlooks agree that fossil fuel will remain the dominant energy for at least another two to three decades. Therefore, the future of fossil fuel is a key element in predicting the future of energy as a whole. However, as the growth of non-fossil energies such as renewables and nuclear power gains traction, some predictions expect that the share of non-fossil energies will increase and fossil fuel will decline. Of course, all energy sources have their own strengths and weaknesses, and a perfect energy does not exist. The future of fossil fuel depends on how we can enhance its strengths and overcome its weaknesses and challenges.

This paper examines the future of fossil fuel, identifies the strengths and weaknesses of each type of fossil fuel, namely oil, coal, and gas, and based on this information, analyzes the role of fossil fuel and its future.

Continued Importance of Fossil Fuel

Global primary energy consumption will continue to grow steadily, driven by non-OECD countries. According to the Asia/World Energy Outlook 2016 of the IEEJ, in the Reference Scenario, which assumes that the key trends of energy supply and demand fundamentals will remain generally unchanged from the present, the global primary energy demand will increase on average by 1.2% per year from 13.7 billion TOE (tonne of oil equivalent) in 2014 to 18.9 billion TOE in 2040. Of this increase, non-OECD countries account for 90% and Asia for 60%, reflecting the shift in the gravity center of the international energy market to developing countries and Asia.

Under the Reference Scenario, demand will continue to grow for all energy sources. The global share of energy sources as of 2040 will be led by oil at 29%, followed by natural gas at 25%, coal at 24%, renewable energies excluding hydropower at 14%, nuclear at 6%, and hydropower at 2%. Fossil fuel has a combined share of 78%, which is slightly lower than the 81% in 2014 but is still overwhelming.

Meanwhile, the "Advanced Technologies Scenario," which assumes significant progress in the adoption of advanced energy technologies under dramatically enhanced energy security and environmental policies, predicts a fundamental change in the global supply-demand structure of

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energy. As a result of progress in energy conservation, the global primary energy demand in 2040 would be 16.6 billion TOE, as much as 12% (2.3 billion TOE) lower than the Reference Scenario. Further, renewable energies and nuclear power will grow faster, reaching a global share of 18% for the former (Reference Scenario: 14%) and 9% for the latter (Reference Scenario: 6%). The share of fossil fuels will fall across the board, and in particular, the demand for coal will also fall in absolute value, to 3.2 billion TOE in 2040, 28% (1.3 billion TOE) lower than the Reference Scenario. Consequently, the share of coal will fall to 20% in 2040. The adoption and expanded use of advanced technologies will have a great impact on the future of global energy.

However, even under the Advanced Technologies Scenario, fossil fuel will remain the main source of energy. While its share will fall to 71% in 2040, fossil fuel will remain overwhelmingly important for economic activity and life around the world. In the more distant future beyond 2040, even though the share of fossil fuel is likely to fall gradually as indicated above, it is likely to continue to account for a majority of the overall energy supply for a very long time. Thus, fossil fuel will remain a key player for the global economy and people's lives.

Looking from a different angle, the events and developments in each fossil fuel market will continue to have an impact on the entire global energy market. The developments in each fossil fuel market will affect the global economy and are key for energy security. Fossil fuel will also continue to impact the world in terms of climate change and air pollution through its consumption. Global energy-related CO₂ emissions will increase under the Reference Scenario to 42.5 billion tonnes in 2040 from 33 billion tonnes in 2014. The amount, however, will be 32.3 billion tonnes under the Advanced Technologies Scenario, slightly lower than the current level and as much as 24% (10.2 billion tonnes) lower than the Reference Scenario. Although the level is far higher than what is required for achieving the so-called "2°C target", the decoupling of economic growth from CO₂ emissions on a global scale is a remarkable change.

The efficient and cleaner use of fossil fuels will thus remain key in addressing global energy and environmental issues. All energy sources, not just fossil fuels, have their strengths and weaknesses; there is no perfect energy source. How we can enhance the strengths and overcome the weaknesses of each energy source will determine their future, and in turn greatly affect the big picture of the future of energy. The following sections examine the strengths and weaknesses of oil, coal, and natural gas in the context of the global energy mix, and, based on the analysis, summarize the future outlook of each energy.

Oil

The greatest strength of oil as an energy source is its liquid form, which makes it economically efficient to transport, and convenient and easy to handle. For these reasons, oil has the most developed international market, enabling consumers and suppliers to rely on flexible and abundant supplies in the market. Further, petroleum has outstanding competitiveness for internal combustion engines, and is far superior to other energies in the transportation sector.

However, as a type of fossil fuel, oil has environmental issues including CO₂ emissions, unlike

non-fossil fuels. Further, in terms of supply, with most of its resources located in the Middle East, oil has been affected in the past by global dynamics and geopolitical risks.

Based on the above, the first factor affecting the future of oil is the dependence on the Middle East and associated supply-side issues. It is not possible to change the fact that oil resources are concentrated in the Middle East, where geopolitical risks are growing as the situation becomes ever more volatile and uncertain. With the center of energy demand located in Asia and oil supplies continuing to be in the Middle East, the stability of the Middle East is synonymous with the stability of the oil market and will remain the key factor in the future. Meanwhile, a rival to conventional Middle Eastern oil has emerged and become a game-changer in the oil market: US shale oil. The expansion of shale oil and other nonconventional oil supplies in the US, and outside the US in the long run, is a critical issue that will determine the future of oil.

The most interesting point on the demand side going forward may be whether the global demand for oil continues to grow. The consensus has been that the global demand for oil will keep growing at a moderate pace at least until around 2040, propped up by sustained global economic growth and the increase in vehicles associated with it. However, the use of electric, fuel cell and other vehicles is expanding quickly with the progress in clean auto technology and lower costs, and improvements in fuel mileage. Further, European countries such as Britain and France have announced policy decisions to ban the sale of gasoline- and diesel-powered vehicles from 2040, attracting much attention. The impact of policies and technological progress on the future demand for oil is becoming important in predicting the future of oil.

Coal

The strength of coal is its abundant resources in diverse areas, and its cost-competitiveness. Coal is an energy source that contributes powerfully to a stable supply of energy and energy security. However, its greatest downside is the environmental burden caused by emissions of CO₂ and other air pollutants when burned. In other words, the use of coal involves a trade-off between energy security and environmental problems.

One important point in considering the future of coal is its use in Asia, the center of global energy demand. As of 2016, Asia accounted for 74% of global coal consumption, with 51% in China, 11% in India, and 12% in the ASEAN and other Asian countries. While coal consumption is expected to flatten out and moderately decline in China, the world's greatest consumer, due to tougher countermeasures against climate change and air pollution, India and ASEAN countries are expected to steadily increase their coal consumption. In emerging Asian countries which need large amounts of cheap electricity, the demand for coal is robust. Stronger environmental measures in these countries will significantly affect the Asian and global coal markets.

In this respect, the development and expansion of clean coal technologies are also key. The future of coal will depend on the successful commercialization and adoption of high-efficiency combustion technology, IGCC, IGFC, and other clean coal technologies and CCS which collects and stores CO₂ produced when burned.

Natural Gas

The strength of natural gas is its abundant resources including non-conventional gases, stability of supply through pipelines and LNG supplies, and above all, its cleanest environmental characteristics among fossil fuels. Based on these strengths, some expected the arrival of “the golden age of gas,” advocated by the IEA and widespread use. However, the golden age has actually arrived only in the US so far. The reason is the issues related to price competitiveness, which is a weakness of natural gas. In the US, the only country enjoying the golden age, gas prices have fallen sharply due to the shale revolution and gas continues to capture share from coal in the power generation sector. Outside the US, however, natural gas faces severe competition with coal, renewable energies, and nuclear power primarily in the power generation sector, and demand is not growing as strongly as expected.

Many major long-term energy supply-demand outlooks including the aforementioned Asia/World Energy Outlook predict that the demand for natural gas will enjoy sustained expansion under various future scenarios. For those predictions to come true, and to make the best of the superior environmental characteristics of natural gas, it is important to comprehensively enhance the competitiveness and attractiveness of natural gas. The future of natural gas will depend on whether it can be made more attractive by, in addition to matching other energies in price, enhancing supply flexibility and developing a more flexible and deeper international market, which are the other challenges for gas.

Conclusion

The fossil fuels of oil, coal, and natural gas will remain invaluable global energy sources for humankind at least in the first half of the 21st century. However, as described above, each of these fossil fuels has various problems, and their long-term future is highly uncertain. If individual challenges and weaknesses can be overcome, the energy sources will remain important for a longer time. However, if they fail to keep up with the changing market environment or fail to overcome the challenges, fossil fuels could be hit by structural changes either as individual energies, or collectively as fossil fuels.

The Industrial Revolution in the 19th century was supported by coal as an energy source. The 20th century is sometimes referred to as the century of petroleum. If fossil fuel has a global share of over 70% in 2040, we will still be in the age of fossil fuel. However, further into the future, it is not clear which fuel will drive the 21st century and beyond.

When analyzing the problems of energy sources, we must consider the 3E policy, which represents energy security, environmental issues, and market efficiency. While a perfect energy source does not yet exist, if an energy source with superior 3E+S (the 3Es + safety) appears, it might lead the 21st century. Still, fossil fuel will remain important at least in the first half of this century, and the stability of its markets will remain of utmost importance.

Writer's Profile

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Joined IEEJ in 1986. He holds PhD in 2001 from University of Dundee, Scotland. He has held many senior positions in IEEJ, including Head of the World Oil & Energy Group, Senior Research Fellow, Energy Strategy Unit. He has served as a committee member of energy policy related councils and advisory committees of Japanese government in many occasion. His specialized field of research is: energy security issues and geopolitics of energy; and analysis for global energy market and policy development with emphasis on the Asia-Pacific region. He has authored numerous publications in the area of energy economics.