



Editorial

Clean Energy: Opportunities and Challenges

Yuzhuo Zhang

Shenhua Group Corporation Limited, Beijing 100011, China



Human existence depends on energy, which is our basic material safeguard. Energy is imperative for economic and social development, and energy technology is an important conduit through which energy is harnessed and utilized, thereby promoting social development and progress. Throughout the history of humankind, every significant progress in human civilization has been accompanied by the substitution of an energy source and

by a major revolution in energy technology. The invention of steam engines and the application of electricity led to the large-scale development and utilization of coal, which gradually replaced firewood as the primary energy source for humankind, enabling us to transition from the Firewood Age into the Coal Age. Starting in the mid-19th century, the large-scale exploitation of oil and gas greatly facilitated the rapid development of industries such as automobiles, airplanes, and ships, thus bringing great changes to human society. As a result of the increased ratio of oil and gas in energy consumption, humankind gradually entered the Oil and Gas Age. At present, with three major fossil fuels (coal, oil, and natural gas) being the world's most important energy sources, humans are considered to be in the Fossil Energy Age.

Over the past century, with industrialization on a sharp rise and a vast improvement in living standards, energy consumption, and especially fossil energy consumption, has increased dramatically. Scarcity and the gradual depletion of fossil energy resources are real and important factors restricting global economic growth. At the same time, the large-scale and long-term exploitation and utilization of fossil energy have resulted in serious ecological and environmental problems, in addition to the issue of climate change due to the greenhouse effect. These factors bring forth tremendous challenges to the energy structure dominated by fossil energy.

Thanks to the constant discovery and utilization of new energy as well as continuous innovations and breakthroughs in renewable energy technology, adjustment and transformation have occurred in

the energy structure, bringing a measure of hope to humankind and allowing us to face these challenges. We are now in a Multi-Energy Complementary Age, as we are in the process of transitioning from fossil energy to new and renewable energy. We are also embracing a modern era that is dominated by new and renewable energy.

However, it is important to remember that the energy industry typically requires large investment, has a long cycle, and possesses strong inertia. No transformation and change in energy structure can be achieved overnight, and such a transition must overcome huge challenges. To achieve this transformation, we need policy guidance and support from governments. We also require joint efforts of the academic world and the industrial community to achieve significant innovations and breakthroughs in technology.

At present, fossil energy is our main energy source and has been so for a long period of time. In this scenario, we need to suggest solutions to resolve the regional ecological damage and environmental pollution issues caused by the large-scale exploitation and utilization of fossil energy. We also need to tackle global climate change problems resulting from large carbon dioxide emissions. Clean and low-carbon energy development will transform the exploitation and utilization of fossil energy in future.

Transformation and change in the energy structure can be realized only when new and renewable energy sources are developed at low cost and on a large-scale basis. The development of new and renewable energy faces several additional challenges due to the diversity and instability of new and renewable energy resources, as well as the complexity of related technologies. Therefore, we need to not only achieve low-cost development but also solve new problems that will inevitably arise, such as issues in nuclear safety, wind power, and solar power generation and grid connection. It becomes imperative for different industries, sectors, and disciplines to work closely together.

It is encouraging to note that enormous progress has been made in recent years in the clean and low-carbon development of traditional fossil energy, the large-scale application of renewable energy, and many other aspects. The 11 articles included in this special Clean Energy issue showcase our achievements in different facets of the current transformation of the energy structure; we hope they will be of some help to you.