

Engineering Technology Cooperation in Energy and Resource Industry along the Belt and Road

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Abstract: China has become the world's largest primary energy and mineral resources consumer, and over the years, its energy and resources import percentage has increased. The countries along the Belt and Road are rich in diverse energy resources, complementing China's economic activities. Energy and resource cooperation is an important part of the development of the Belt and Road, and is crucial in transforming geographical proximity and resource advantages into economic growth with mutual and sustainable development. This paper reviews the basis for China's participation in engineering technology cooperation in the energy and resource industries of the Belt and Road, analyzes the problems in the cooperation, studies the cooperation prospects, and proposes measures for strengthening energy and resource cooperation.

Keywords: the Belt and Road; energy and resources; engineering technology; cooperation proposals

1 Introduction

Along with being the world's largest consumer of primary energy and mineral resources, China is also the world's largest importer of crude oil and mineral resources. In recent times, its external dependence on energy and mineral resources has been increasing year by year. In 2018, China's external dependence on crude oil and natural gas exceeded 70% and 43%, respectively. Presently, among the mineral resources, its external dependence on copper and nickel is more than 50%, and its external dependence on minerals such as iron ore is more than 75%. However, China's economic development has now entered a new normal. The growth rate of energy resource demand is slowing down, and quality and efficiency problems are prominent. Nonetheless, the total demand remains at a high level. Therefore, ensuring the safety of energy resources is still a major issue for the sustainable development of the country.

The "Belt and Road" runs through the Eurasian continent, and the countries along the route are rich in energy resources. According to the statistics, the proven reserves of oil and natural gas along the Belt and Road countries account for 55% and 75% of the world's total reserves, respectively [1]. There are nearly 200 kinds of mineral resources worth about 250 trillion US dollars there, accounting for almost 60% of the world's total reserve [2,3], and the region is also a major supplier of global strategic minerals [4,5]. The cooperation between the Belt and

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Road countries and China already has a favorable foundation and is a key area of securing China's future import and cooperation of energy and resources. Advanced and applicable engineering technology, management experience, and the combination of industry and finance are used to create a strategic foothold; deepening energy and resource cooperation between the two sides will help transform the advantages of geographical proximity and rich resources into economic growth advantages of common sustainable development.

2 The foundation for engineering and technological cooperation in the energy and resource industries of the Belt and Road

After years of exploration, development, and accumulation, China's energy and resource industries have certain technical advantages in the field of engineering technology. This agrees with the diversified and differentiated demands for energy and mineral resource development technologies, effectively supporting cooperation in energy and resources between China and other countries of the Belt and Road.

The oil and gas industry has created the technology for exploration and development of complex oil and gas fields with independent intellectual property rights, the construction technology of high-grade steel pipe and complex surface pipelines, refining technologies, and equipment advantages. A series of technologies have played a great role in promoting the development of the land, as well as the old oil and gas fields in Central Asia, Africa, and the Middle East. These include onshore oil and gas geological theories and fine evaluation of mature exploration areas, lithostratigraphy, deep oil and gas exploration evaluation technology, and fine water flooding displacement of old oilfields. Other technologies are carbonate oil and gas exploitation with chemical flooding displacement, ground engineering, high-grade steel, high-pressure, and large-diameter transmission technology for pipeline safety, pipeline automatic welding, trenchless crossing, and complex landform mechanized construction technology.

The technology of coal exploration, development, utilization, deep processing, and equipment manufacturing in the coal industry have developed rapidly. The technologies that have effectively promoted the cooperation for coal development between China, South Asia, Southeast Asia, and Central Asia countries include the surface seismic technology, downhole seismic technology, underground drilling technology, large-diameter well drilling technology, freezing sinking, and other special drilling technologies. The others are mine designing, caving and mining, roadway support technology, a complete set of mining equipment, industrial coal-fired boiler, and coal-fired power generation technology.

The power industry has obvious advantages in hydropower equipment manufacturing capacity, hydropower construction level, and long-distance large-scale power transmission technology, which can meet the technical and engineering requirements of power transmission and transformation cooperation along the routes. In terms of new energy generation, China's new energy technology has developed rapidly, and the manufacturing capacity of wind turbines and photovoltaic panels has been significantly enhanced, laying a solid foundation for China's renewable energy to go global. Currently, the per capita installed capacity and electricity consumption of the Belt and Road countries in Asia and Africa are significantly lower than the world average, and there is a large power gap. The electricity generation market is in significant demand, and there is a great potential for electric power engineering and technical cooperation.

The mineral industry has a complete mineral resource exploration system, and the overall level of mining technology and equipment has a strong advantage. Mineral processing equipment has developed rapidly in recent years, especially in equipment automation and large-scale equipment manufacturing. Different types of large sized crushing and grinding equipment, and wear-resistant materials have been utilized; magnetic separation, gravity separation, and composite field separation equipment have been developed and applied to make industrial products. In terms of metallurgical equipment, China has developed a variety of large-scale smelting equipment with independent intellectual property rights, which have been successfully applied domestically and internationally.

After 20 years of development, under government promotion and business operation, Chinese enterprises in the energy and resource industry have made remarkable achievements with international cooperation. China's energy and resource sector in the cooperation part of the Belt and Road is involved in resource exploration and development processing, energy channel construction, technology and equipment, engineering services, trade, and other fields. By the end of 2018, the oil and gas industry had carried out more than 100 oil and gas projects in 23 countries of the Belt and Road, practically covering the entire oil and gas industry chain. The coal industry has carried out more than 30 projects in nine countries in the region, mainly in the fields of resource development, technical equipment, engineering services, and trade. The power industry has more than 500 cooperative projects

in the region, mainly providing engineering and technical services. The mining industry has about 50 cooperation projects in the region, mainly investing in iron, copper, gold, nickel, lead, zinc, and other mines. The process of energy and resource cooperation with foreign countries has continuously improved the degree of internationalization and operation level of Chinese enterprises. It has also made important contributions to providing stable energy and resource supply for the countries of the Belt and Road and global markets.

3 Problems existing in the engineering science and technology cooperation in China's energy and resource industry

Along the Belt and Road are the game fields of powerful countries, which bear great geopolitical and financial risks. In addition, there is still a gap between the engineering science and technology capability of China's energy and resource industry and that of developed countries. Additional problems include the huge demand for technological research and development and the introduction of external technologies. Moreover, there are still problems in engineering science and technology cooperation between the Belt and Road countries in the energy and resource sector, which are manifested in the following aspects.

3.1 Insufficient capacity for scientific and technological innovation and lack of cooperative R&D projects

Compared to the developed countries, China's actual scientific and technological capacities are still limited; few projects can be done in cooperation with foreign countries. There remains a lack of technologies in the field of oil and gas, marine deep water, shale oil and gas. In the fields of coal, most geophysical exploration technologies and equipment, manufacturing process, materials, assembly, sealing technology, machining accuracy, automation technology of mining equipment, as well as coal quality improvement and processing, the technologies are relatively outdated, meaning they cannot meet the needs of large-scale and high-end projects.

3.2 Weak capacity for independent R&D, and low quality of cooperation

Although China is a big energy consumer, there is still a gap between China and the energy superpowers. Currently, a large part of China's foreign cooperation focuses on the export of equipment and the general contracting of projects, while the important parts of the cooperation process such as consulting services and cooperative research are being paid less attention.

Currently, there are many conventional equipment manufacturers in China with excess capacity, but high-end equipment manufacturers lag behind multinational enterprises in terms of product performance and quality, and their comprehensive competitiveness is in a weak position. Weaknesses existing in the manufacturing level of key power equipment include high-voltage DC wall bushing and power semiconductor devices, which seriously restrict the international influence of China's electrical products. The key equipment of mining, smelting and metallurgy industry, such as large-scale and intelligent equipment, one-step copper smelting pool, automatic stripping during electrolysis, efficient reactor, etc., are mainly imported.

3.3 Insufficient international certification of products and the urgent need to strengthen "mutual recognition" of standards

The international recognition of Chinese products is low. Moreover, the international influence of testing and certification institutions in China is insufficient and some countries do not recognize the results of China's testing and certification processes, making it more difficult to export Chinese products. China needs to urgently strengthen its efforts in widely recognized operating standards and HSE (health, safety, and environment) management standards in the international market and foreign companies.

4 Prospect of cooperation in engineering science and technology in the energy and resource industry in China

In March 2015, the State Council issued the *Vision and Action to Promote the Construction of the Economic Belt and the Maritime Silk Road in the 21st Century*, which explicitly listed "increasing cooperation in exploration and development of traditional energy resources such as coal, oil and gas, metal, and mineral resources" as the focal point for cooperation. At the opening ceremony of the 2nd Belt and Road International Cooperation Forum summit, President Xi Jinping pointed out that the Belt and Road initiative conforms to the historical trend of economic globalization, the requirements of the era of global governance system reforms, and to the strong desire

of people of all countries to live a better life. Facing the future, we must focus on the key points, deepen cooperation, draw up meticulous plans, promote the joint development of the Belt and Road countries, and continue to advance through high-quality development. This will provide more support for China and the Belt and Road countries, and further enhance their cooperation and depth in the field of energy and resource.

Most of the Belt and Road countries are emerging market economies and the region is rich in energy and resources. They have low levels of energy and resource development and a low utilization rate of resources. They also have a foundation of cooperation with China in terms of complementary resources and mutual economic assistance with favorable cooperation potential. In consideration of resource development, oil and gas in the Middle East, Central Asia, Africa, and Russia, coal in Indonesia, Mongolia, and Vietnam, nickel and iron in Indonesia and the Philippines, bauxite and iron in Vietnam, and potash in Thailand and Laos are all bulk mineral products that China urgently needs to import. Most developing countries along the Belt and Road region have a weak power industry foundation in engineering and technology, and their per capita economic and electricity consumption indicators are far less than the global average. Rapid economic and social development in the future requires a large amount of investment in power and other infrastructures. In addition, the power equipment utilized along the Belt and Road region has been running for many years and their aging is a serious issue that urgently needs to be redressed. In terms of economic development, most countries along the Belt and Road area belong to the same development class as China and share common interests. China's rapid and steady development for 30 years since the opening up and reform in 1978 provides a model of development for the vast number of developing countries while accumulating advantages in capital, technology, and management. China has relatively mature technology and financing capacity for energy and resource exploration, development, and utilization, as well as favorable management experience and human resources, which play a positive role in bilateral energy and resource cooperation [6]. The engineering science and technology support for the energy and resource cooperation between China and the Belt and Road countries is a concrete measure that aims to promote international cooperation with the Belt and Road countries, ensuring deeper, more stable, and broader prospects [7].

5 Measures on strengthening engineering science and technology for supporting Belt and Road energy and resource cooperation

5.1 Strengthening top-level design and promoting international cooperation in engineering science and technology in the energy and resource industries

First, through the Belt and Road Forum for International Cooperation, the China International Import Expo, and bilateral and multilateral cooperation organizations, we can increase the promotion of energy and resource engineering technology, strengthen strategic docking between China and the Belt and Road countries' governments, formulate relevant policies and measures, and establish a sound risk classification, prevention, and control method. This will promote the change in risk management and control from qualitative to quantitative and from static to dynamic. Second, there will be multilateral and bilateral mechanisms for timely consultation and resolution of problems arising from international cooperation and coordination of energy and resources in science and technology. Third, by exploring the priority areas and key contents of energy and resource technology cooperation with the Belt and Road countries, we can formulate relevant plans for scientific and technological cooperation, and select a few advanced and representative advanced technologies to carry out the pilot projects. Fourth, by studying the establishment of an international cooperation mechanism for the energy and resource industry standards, we can promote standard exchange, mutual recognition, and standard benchmarking work between China and the standardization authorities in the Belt and Road countries. We can support the project cooperation of standardization and interconnection between the Chinese enterprises and the local companies where the project is located by updating China's standard system to the international standard system, actively encouraging the mutual recognition of standards and strengthening the training of internationalized talents in the field of standards and product certification.

5.2 Exercising "internal work" and strengthening the independent R&D and innovation of energy and resource engineering science and technology

First, by relying on major domestic energy and resources equipment enterprises, we will vigorously cultivate industrial competitive advantages to optimize the industrial structure, and support the construction and improvement of a set of energy and resource equipment R&D centers, industry common testing, and R&D

platforms. We will focus on the construction of domestic manufacturing bases and support industrial clusters and equipment export bases for high- and middle-end equipment, developing specialized collaboration, and promoting the manufacturing upgrading and export of supporting spare parts. Second, we will establish an R&D innovation mechanism for energy, resources, and equipment that combine “production, study, and research,” and take full advantage of various scientific and technological resources such as enterprises, universities and research institutes, and make use of existing or new engineering centers and national laboratories. Experimental research on engineering science and technology is urgently needed to deepen the Belt and Road energy and resource cooperation in China. Third, we will strengthen interdisciplinary cooperation in technological innovation; for example, the development and application of new technologies in the field of electric power cannot be separated from the synchronous development of key materials but also need the support of advanced electronic information technology, and need to coordinate the joint efforts of resources in various industries.

5.3 Promoting the innovation level of scientific and technological cooperation, and improving the quality of cooperation in major projects as a starting point

Based on consolidating the existing cooperation achievements, the energy and resource industry should use its comparative advantages and implement the joint venture cooperation mode in which the Chinese side, international counterparts, and local enterprises cooperate to form diversified cooperation among project stakeholders. We should focus on cooperation between major resource development projects and related large-scale engineering service projects to enhance the innovation capability of scientific and technological cooperation and improve the overall cooperation quality. Meanwhile, we should adapt the new trend of energy transformation characterized by low-carbon, non-carbon, and intelligence. We should also pay special attention to the exchange and sharing of scientific and technological achievements with large international companies.

5.4 Bringing into full play the overall advantages of engineering science and technology in China and developing cross-industry cooperation in energy and resources

The energy and resource industry itself carries out the integrated operation cooperation of “production–transportation–processing–trade” that can achieve deep integration with cooperative countries and coordinated and efficient development of the whole industrial chain. The cross-industry cooperation of energy and resources can realize a new mode of “energy–mineral–metallurgy–industry park–trade” linkage development in resource countries, ensure the transformation of resource advantages to economic advantages, and change the mode of resource development and economic development. It can also help ascertain the sustainable development of the resource countries, and help Chinese enterprises achieve high-quality cooperation in the Belt and Road countries.

6 Conclusion

Countries along the Belt and Road can provide different energy and resources, which are complementary to China, and have a large prospect and space for cooperation. Supporting the Belt and Road energy and resource cooperation through engineering science and technology is in line with the national conditions and economic development needs of both sides. It is not only conducive to promoting policy communication, facility connectivity, smooth trade, financial integration, and cultural communication but also conducive to improving the security of China’s energy and resources, and promoting the long-term economic development of China and the Belt and Road countries.

Presently, the process of engineering, science, and technology cooperation in the energy and resource industry of the Belt and Road should take the rare opportunity to secure economic development and production cooperation of the involved countries. By meeting the rising demands and maintaining favorable political relations, investing more in the energy and resource industry projects, strengthening same-industry and cross-industry project cooperation, optimizing the strategy layout, and building a win-win cooperation scenario through mutual benefit, cooperation in energy and resources between China and the Belt and Road countries can be promoted.

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