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Strategic Thinking and Suggestions on Promoting Regional Energy Revolution Based on Local Conditions

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Abstract: The coordinated development of energy, economic society, and ecology has always been a major issue in China. Although coordinated development has been achieved in some regions, there are still varied contradictions and challenges. Therefore, China should consider these significant differences in regional development while promoting an energy revolution. This study elaborates on the significance of regional energy revolutions and analyzes the current status of the economic society, energy, and ecology in the Beijing–Tianjin–Hebei region, Yangtze and Pearl river deltas, old industrial bases, the central region, energy-rich areas, and the southwestern region in China. To promote the regional energy revolution, China should strengthen top-level designs for the energy revolution and formulate strategic objectives and key tasks for medium- and long-term development. A well-planned and coordinated mode of development should be established by determining the functions of regional energy revolution. The pilots of regional energy revolution should be promoted to allow the exploration of an efficient mechanism for energy revolution. The responsibilities of the regional governments should be clarified; furthermore, an assessment and supervision mechanism should be established to ensure that regional energy revolutions achieve the expected effects.
Keywords: regional energy revolution; regional development differences; coordinated development; new development concept

1 Introduction

Energy is an important element for human survival and development and is the driving force that guarantees economic development. Therefore, the ecological and environmental problems resulting from developments in energy have become a global problem. Energy is crucial for regional economic and social development and ecological protection. The new energy security strategy proposed by the Central Committee of the Communist Party of China (CPC) and the in-depth implementation of the national regional development strategy represented by the coordinated development of the Beijing–Tianjin–Hebei region have provided a basic blueprint for developing energy in the new era.

In March 2018, the Chinese Academy of Engineering launched a major consulting project "Promoting the Revolution of Energy Production and Consumption (2035)—Energy Revolution Promotes Economic and Social Development and Ecological Environment Protection," based on research from phases I [1] and II [2] of the

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"Promoting the Revolution of Energy Production and Consumption (2035)" project, which focused on regional energy revolution strategies in the Beijing–Tianjin–Hebei region, Yangtze and Pearl river deltas, old industrial bases (Northeastern China and Shanxi Province), the central region, energy-rich regions (Xinjiang and the Golden Triangle region for energy), and Southwestern China. This study aims to combine the top-level guidelines on regional development strategies with the reality of energy resource endowments under the new situation to promote regional energy revolution based on local conditions, as well as promote regional economies, social developments, and ecological protection.

2 Significance of co-promoting the energy revolution and regional development

First, the co-promotion of regional development is an inevitable step in the energy revolution. In June 2014, the CPC Central Committee presented the connotations of its new energy security strategy, which noted a direction for energy development and reform in China and became the basic guidance for medium- and long-term energy development. Although positive progress has since been made, some common and inter-regional issues remain unresolved. The restrictions imposed on administrative regions should be removed to promote the regional energy revolution based on differences in regional resource endowment and the actual development stage thereof. This would be conducive to furthering the energy revolution.

Second, the suggested co-promotion is a crucial point to begin with for improving the national energy security. Energy security is, overall, a strategic issue that is related to the national socioeconomic development. Regional energy revolution should be promoted to best utilize rich fossil and renewable energy capacities, such as wind and solar power, in the western region and hydropower resources in the southwestern region to create an energy security system possessing regional characteristics. This would facilitate effective improvements in the national energy security level.

Third, co-promotion is an important part of developing a coordinated regional development strategy. The revitalization of old industrial bases in Northeastern China, among other places; the rise of the central region; and the full implementation of national strategies—such as the coordinated development of the Beijing–Tianjin–Hebei region and the Guangdong–Hong Kong–Macao Greater Bay Area, in addition to regional integration of the Yangtze River Delta—has allowed China to pursue a new coordinated regional development pattern driven by board linkages and a focus on core areas. Although various regions have made some achievements in coordinating the development of the energy, economy, society, and environment, the varying types of contradictions and problems in different regions cannot be neglected. This includes an increased gap in regional gross domestic product (GDP), different GDP growth rates, a large gap in per capita GDP among regions, prominent structural contradictions in regional energy, clear regional characteristics in energy supply and demand patterns, and prominent location-specific environmental problems. Therefore, energy-rich regions are at a critical stage in their development on issues of socioeconomic development and environmental protection. As energy is the material basis of power for regional development, coordinating regional development plans cannot be separated from the support it gets from the energy revolution. Encouraging the regional energy revolution will inevitably further promote the coordination of regional socioeconomic development.

Fourth, co-promoting energy revolutions and development is an effective method to attract attention to the high quality development in China. President Xi Jinping noted that high-quality development involves the incorporation of new concepts in development. Neither domestic nor international conditions will support the extensive economic development method of the past; moreover, it is unsustainable. At the Central Economic Working Conference held in December 2019, it was proposed that promoting high-quality development in the current era should involve focusing more on new principles of innovative, coordinated, green, open, and shared development. The energy economy is an important aspect of the industrial economy, and the proposed development concepts have higher requirements for energy development in this era. Promoting regional energy revolutions will also help fundamentally promote the quality, power, and efficiency of energy reforms in China, based on the characteristics of resource endowments and stages of development in various regions, thereby providing strong support for the achievement of high-quality development in China.

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3 Strategic methods for promoting energy revolutions based on regional conditions

Based on the two development stages of the basic realization of socialist modernization in China from 2020 to 2035 and the comprehensive realization of socialist modern power from 2035 to 2050, full attention should be focused on the in-depth adjustment of international energy supply and demand patterns, trends in development, and challenges of innovating energy technology. New principles of innovative, coordinated, green, open, and shared development should be implemented; the new energy security strategy and the coordinated regional development strategies should be used as guides; regional comparative advantages should be utilized, and regional energy revolutions should be promoted according to local conditions. Other key issues include strengthening the layout of and cooperation among regional energy revolutions; co-promoting and integrating energy revolution and regional development strategies; building benign interaction mechanisms that promote regional energy revolutions and sustainably develop the economy and environment; and developing optimal situations between energy revolutions and the economic, social, and ecological development of the regions. This would provide strong support for building a clean, low-carbon, safe, and efficient energy system, thereby improving the energy security of China; achieving this would also meet two centenary goals and realize the Chinese dream of national rejuvenation.

First, strategic measures to promote energy revolutions based on regional conditions should focus on top-level design and stepwise advances. China is currently facing major changes not seen for a century and is in a period in which important strategic opportunities can be made. Systems theory can be used to study the promotion of energy revolutions and determine the relationship between energy and external developments, as well as development within the energy industry. Concurrently, in accordance with regional development requirements, efforts should be made to conduct systematic and comprehensive top-level design based on future development, clarify the goals and tasks of each development stage, and develop a phased promotion pattern.

Second, measures that use regional conditions to advance national goals, such as energy revolution, should focus on system optimization and regional characteristics. To advance energy revolutions, it is necessary to proceed from an overall optimal perspective, strengthen the overall strategic research deployment, understand commonalities, and comprehensively promote revolution while giving significant importance to the characteristics of each region. The actual situation of each region should be the starting point, followed by supporting the formation of distinct promotion models and development ideas and clarifying the functional positioning and top-level designs for energy development in each region to reflect their regional characteristics and roles. This will create a joint force to promote the coordination of regional energy revolutions with development strategies.

Third, the aforementioned strategies should focus on problems and goals. To advance the energy revolution, we must consider both long-term development goals and practical requirements; flexibly use problem and goal orientation; establish a suitable implementation mechanism; and achieve strategic goals for the energy revolution, socioeconomic development, and environmental protection in China by solving specific problems and achieving a series of phased goals.

Fourth, any strategy should follow comprehensive promotion methods and proven guidance. The comparative advantages of various regions should be utilized, and some regions should be encouraged to actively explore the promotion of regional energy revolutions and socioeconomic development by completely utilizing favorable local conditions, unique resources, rich experiences, and successful models; these should take the lead in systems and mechanisms and summarize and develop experiences such that they can be replicated and promoted across the country, leading to in-depth developments in energy production and consumption.

Finally, strategic measures to promote energy revolutions based on regional conditions should be based on a combination of theoretical guidance and practical innovation. The energy revolution has been widely practiced across China. Therefore, it is necessary to systematically summarize and thoroughly study these practical experiences to ensure the generation of systematic knowledge and regular understanding and combine the latest achievements in modern economics, management, industry, energy, and engineering. This can effectively guide regional energy revolutions and socioeconomic development. Moreover, it is necessary to strengthen practical innovation; seek further breakthroughs within and among many fields; develop innovative concepts and ideas using management systems, mechanisms, and technological innovations; and creatively solve problems while advancing the energy revolution.

4 Strategic measures to promote regional energy revolutions based on regional conditions

The advancement of the energy revolution must be closely integrated with the status quo of the economic, social, and energy conditions and environment of each region in China. Different routes to the revolution must be adopted based on varied regional conditions.

4.1 The Beijing–Tianjin–Hebei region

In recent years, the rapid socioeconomic development of the Beijing–Tianjin–Hebei region has resulted in a continuous increase in the total energy demand, thereby increasing its dependence on external energy sources. Overall, supplies are tight. Structures of energy consumption are dominated by fossil fuels, particularly coal. Coal consumption accounts for more than 70% of the total energy consumption [3]. The Beijing–Tianjin–Hebei region also has the most severe air and water pollution and is where contradictions between resource availability, condition of the environment, and development are most acute. In 2019, the concentrations of sulfur dioxide, nitrogen oxide, and fine particulate matter ($PM_{2.5}$) in the Beijing–Tianjin–Hebei region and its environs (i.e., the "2+26" area) were 1.36, 1.48, and 1.58 times higher, respectively, than the national average [4].

Therefore, this region should focus on promoting the coordinated development of energy, economy, and environment and strive to take the lead on making breakthroughs in ecological and environmental protection. The main measures for this would include promoting the advantages of optimizing and upgrading industrial structures via revolutions in energy technology and continuing to control pollution sources, such as furnaces, motor vehicles, and bulk coal, to improve environmental conditions; focusing on low-carbon strategies and innovation; discussing the layout of technology platforms, such as the national big data center for energy; and promoting the construction of Xiong'an New Area.

4.2 The Yangtze River Delta region

The Yangtze River Delta has a strong economy that generates nearly one-quarter of the GDP of China, is home to one-sixth of the total population of the country, and accounts for 2.2% of the country's land area [5]. There is a very strong demand for energy in the Yangtze River Delta, and it is highly dependent on external energy sources. In 2017, its net inputs of coal, oil, and natural gas accounted for 78.7%, 98.3%, and 97.1%, respectively, of the total national consumption of those goods [3].

Therefore, the Yangtze River Delta region should use the advantages of integrated development and establish an energy system with integrated optimization, regional linkages, and intelligent regulation to promote regional innovation and development. The main measures for this would include leveraging the advantages of having resources in technological innovation, focusing on breakthroughs in energy equipment manufacturing technologies, building a pilot demonstration area for constructing modern energy systems in the Yangtze River Delta, establishing and improving mechanisms to coordinate benefits and compensation, and enhancing the regional energy security capacity to improve the regional ecological environment.

4.3 The Pearl River Delta region

The Pearl River Delta region is the frontier of reforms and opening-up in China and an important engine of economic development in the country. The regional economy is highly dependent on external sources. Approximately half of its GDP comes from international trade. The intensity of energy consumption in the Pearl River Delta region is relatively low, but supplies of fossil fuel-based energy rely mainly on imports and transfers from outside the province; the overall dependence on external power supplies is approximately 60% [3].

Therefore, the Pearl River Delta region should focus on constructions of the Belt and Road initiative and the Guangdong–Hong Kong–Macao Greater Bay Area to build national bases for oil and gas reserves and renewable energy, thereby becoming an important part of the national energy security system. The main measures for this would include leveraging geographic advantages to strengthen international energy cooperation and offshore oil and gas development, accelerating the construction of large-scale bases to receive and reserve oil and natural gas, developing offshore wind power resources in an active and orderly manner, vigorously promoting the large-scale development of renewable energy, using storage and transportation bases to develop natural gas, developing nuclear power safely

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and efficiently, controlling the total coal consumption, and promoting the optimization of energy consumption structures and environmental protection.

4.4 Old industrial bases

Old industrial bases, including the three northeastern provinces and Shanxi province, are important energy bases in China and have made a marked contribution to the country's economy. They are also key areas in China's western development and northeast revitalization strategies. However, they currently have an insufficient economic growth momentum and prominent structural contradictions. The economic growth of the three northeastern provinces has fallen sharply since 2014, ranking last in the country [5]. Energy production and consumption are dominated by high-carbon fossil fuels, and the process of transitioning to low-carbon energy has been arduous.

Therefore, old industrial bases should focus on promoting economic transformation with high-value, diversified, and low-carbon sources of energy and stimulate new momentum for revitalization. The main measures for this would include systematically planning the construction of the "Shanxi–East Mongolia–Northeast China" energy economic corridor; combing the joint forces of coal resources and the advantages of having a local chemicals industry to realize high-value utilization of fossil energy; and promoting the continental shale oil revolution to substantially diversify oil and gas supplies.

4.5 Central China

After the central government enacted the Strategy for the Rise of Central China in 2004, the socioeconomic development of Central China has achieved considerable development. Its medium-to-high rate of economic growth is higher than the national average. However, the central provinces all have considerable energy shortages. Among them, Jiangxi, Hunan, and Hubei have the highest dependence on external energy sources of 83%, 78%, and 73%, respectively [3]; the energy gap is most severe in this region.

Therefore, the central region should fully exert the location advantages of its hub and rely on the West–East Gas Transmission, West–East Electricity Transmission, and North–South Energy Transportation programs to focus on building a comprehensive hub to supply energy to the central and eastern regions. This would serve the rise of Central China and high-quality development in the middle Yangtze River, Yangtze River Delta, and Pearl River Delta economic belts. The main measures of this would include strengthening energy cooperation and building coal, oil, and natural gas reserve capacities; improving energy security by strengthening supply capacity; boosting the construction of energy networks and energy storage facilities; establishing a complementary multi-energy system; and continuing to promote the construction of national energy raw material bases and manufacturing bases that will provide new developmental momentum and promote the green and low-carbon development of the regional economy.

4.6 Energy-rich regions

The primary energy-rich regions include Xinjiang and the Golden Triangle area in the northwest, which are important bases for China's West–East Coal Transport, West–East Gas Transmission, and West–East Electricity Transmission programs. Energy-rich regions rely mainly on inputs of resource elements to drive economic growth based on extensive development and clear homogeneous competition. The resource-based economic development model is still dominant in the industries of Xinjiang and the energy-rich Golden Triangle region. However, these energy-rich regions lack water resources and are faced with severe desertification issues while the energy industry suffers from carbon dioxide emissions and solid waste disposal.

Therefore, energy-rich regions should focus on building a green and sustainable national energy security base using the new round of western development strategies. The main measures for this would include strengthening energy resource exploration, scientific development, and clean and efficient utilization; developing wind and solar resources systematically; extending the field of international energy cooperation; building a western bridgehead and consolidating the pillars of national energy security; coordinating the construction of railways, power grids, and networks of oil and gas pipelines; optimizing networks of coal, oil, natural gas, and electricity transmission and distribution to strengthen the functional construction of bases guaranteed to provide national energy security; realizing the complementary of multi-energy resources and integrating these to promote overall low-carbon energy resources in the region; and adhering to ecological priorities to build a strong ecological barrier in western China.

4.7 Southwestern China

Southwestern China is an underdeveloped region due to its low level of overall economic development, large poor population with per capita income lower than the national average, and low-quality industrialization. However, Southwestern China is rich in clean resources, such as water, electricity, wind, solar, and natural gas [6], and these could provide important sources of support for implementing the national energy strategy of transmitting electricity and gas from west to east.

Therefore, the southwestern region should focus on promoting the development and consumption of clean energy, winning the war against poverty, and sharing the benefits of developing sources of energy. The main measures for this would include rationally formulating hydropower development schedules; strengthening research on electricity transmission from Tibet; promoting the comprehensive development and utilization of complementary wind, solar, and hydropower-based energy; increasing the consumption of renewable energy, such as hydropower; promoting the large-scale development and utilization of shale gas; and deepening inter-provincial mechanisms of clean energy consumption in Southwestern China.

5 Countermeasures and suggestions

5.1 Strengthen the top-level design of the energy revolution and clarify the strategic goals and key tasks for medium- and long-term energy development in China

Faced with major changes not seen in a century, China—the second-largest economy in the world and the largest energy producer and consumer—is taking the development of and revolutions in energy very seriously. According to the requirements of modernizing the national governance system and other governance capabilities, China should further improve its capability to strategically manage energy, guide important energy resources as part of a national strategy, promote high-quality development in the energy sector, and provide strong support for achieving the two centenary goals and realizing national rejuvenation. Given the two development stages that modern China could go through—from the basic realization of socialist modernization by 2035 and the comprehensive realization of socialist modern power by 2050, respectively—China should fully consider the future development of world energy and trends and challenges in the innovation of energy technology; clarify the strategic goals, major tasks, and major policies of its energy revolution by 2035; and strategically deploy the energy revolution by 2050.

5.2 Clarify the functional positions of the regional energy revolution and develop suitable overall planning patterns and coordination to promote regional energy revolutions

We should also organize extensive research; solicit the opinions of relevant departments of development and energy management; and clarify the functional positions, strategic goals, and development plans of the aforementioned seven regions in terms of their energy revolution policies. The roadmap and path to implementing the energy revolution in each region should be planned accurately while combining top-level design and step-by-step advances, system optimization and regional characteristics, and problem and goal orientation. Furthermore, we should promote energy revolutions in different regions according to local conditions; focus on regional comparative advantages; strengthen the coordination of regional energy revolutions with socioeconomic and environmental development; create a pattern of promoting regional energy revolutions with clear internal characteristics, coordination, and significant effects in each region; promote the connection of energy infrastructure in all regions for mutual benefit and support; enhance the level of development of regional energy integration; and achieve a win-win pattern of “1 + 1 > 2” development in the regions.

5.3 Strengthen regional energy revolution pilot programs and accelerate the exploration and development of an efficient mechanism to promote the energy revolution through reform

We should also encourage the exploration of and innovations in the energy revolution and actively conduct pilot energy revolution projects based on the actual conditions in each region to gain advanced experience and solve major issues related to the energy revolution. We should accelerate the organization and implementation of the energy revolution in Shanxi and promptly summarize the experience and distribute it nationwide. China should also take advantage of the historical opportunity of the construction of the Xiongan New Area and aim to promote world-class

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pilots in energy revolution; promote pilot projects in the energy revolution in the Beijing–Tianjin–Hebei region to explore advanced experience in strengthening energy cooperation and environmental governance in integrated regions; construct a pilot demonstration area for energy integration in the Yangtze River Delta; and promote the development of cooperation on energy from single projects to comprehensive and in-depth integrated goals. Pilot projects should be conducted for the energy revolution in Southwestern China, and techniques to summarize the use of hydropower must be explored to promote local economic development and shared development. Finally, China should promote pilot energy revolution projects in the energy Golden Triangle region and Xinjiang region, and also explore and summarize the models used in energy-rich regions and key strategic energy reserves.

5.4 Clarify the responsibilities for implementation and mechanisms to supervise the regional energy revolution to ensure that the revolution achieves expected results

The organization of regional energy revolutions should be strengthened and guided. Furthermore, the responsibility of local governments at all levels to fully implement the new energy security strategy and that of various departments and local governments at all levels should be strengthened. China should also strengthen the management and control of energy with regional characteristics, support the establishment of a mechanism to jointly coordinate regional energy revolutions, discuss the establishment of special committees or related mechanisms focused on different regional characteristics, promote joint development and control, and lead regional energy revolutions in a unified manner to promote related policies based on principles of adapting measures and implementing policies to local conditions. Furthermore, the active cooperation of various regional administrative entities should be promoted and coordinated while the unified guidance and action of regional energy revolutions are strengthened. At the national level, it is necessary to strengthen the regional coordination of the energy revolution while actively guiding various regions to cooperate with international actors in energy.

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