DOI 10.15302/J-SSCAE-2021.01.005

Strategic Analysis of Global Energy Transition and China's Energy Revolution

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Abstract: Energy revolution is important for realizing the coordinated development of energy system, economic society, and ecological environment. Energy strategies significantly influence the process of national and regional energy revolutions. In this article, we propose a systemic analysis method for energy strategies called SEGO (i.e., sustainable development, energy system, governance of society, and operation of market). Based on this, the global energy transition and China's energy revolution strategy are analyzed from four aspects: energy challenge, energy system, energy governance, and energy market as well as their relationship. The results show that the world faces multiple energy challenges regarding energy equity, energy security, and green energy. Meanwhile, lack of strong energy governance has led to a low progress of the global energy transition. China is expected to play a more active role in promoting global energy transition. Although China has achieved less energy consumption and less emissions in its development, it still faces severe challenges in multiple aspects such as energy system integration. China should focus on the overall optimization and fine management of its energy system while considering economic development and ecological protection. The co-construction, sharing, and co-adjustment should be further coordinated among different types of energy networks. Moreover, disruptive innovation in new energy technologies and industries should be encouraged.

Keywords: energy transition; global energy system; China's energy system; sustainable development, energy system, governance of society, and operation of market (SEGO)

1 Introduction

Promoting an energy supply and consumption revolution and building a clean, low-carbon, safe, and efficient energy system is an important strategy in China's energy development. The *Energy Supply and Consumption Revolution Strategy (2016–2030)*, published by the National Development and Reform Commission and the National Energy Administration in 2016, set out the strategic vision of "Four Revolutions and One Cooperation". From a systems perspective, the "Four Revolutions" and "One Cooperation" are not distinct, but form an organic system with strong internal connections. With China's deepening globalization process, it is necessary to dynamically examine China's energy supply and consumption revolution strategy from the perspective of global energy development in order to promote energy transition, economic and social development, and ecological protection.

For the purpose of a systemic analysis of the energy strategy, this paper proposes the SEGO method (i.e.,

Received date: November 25, 2020; **Revised date:** December 05, 2020

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Funding program: CAE Advisory Project "Promoting the Revolution of Energy Production and Consumption (2035)—Energy Revolution Promotes Economic and Social Development and Ecological Environment Protection" (2018-ZD-11)

Chinese version: Strategic Study of CAE 2021, 23(1): 015–023

Cited item: Zhao Yunlong et al. Strategic Analysis of Global Energy Transition and China's Energy Revolution. *Strategic Study of CAE*, https://doi.org/10.15302/J-SSCAE-2021.01.005

sustainable development, energy systems, governance of society, and operation of the market) to comprehensively analyze the global energy transition and China's energy revolution, accounting for sustainable development, energy systems, governance of society, and operation of the market. Suggestions to advance the energy revolution process in China are proposed.

2 Research method

An energy strategy can be understood to be an overarching plan for energy system development raised by a specific social organization, from the perspective of overall social governance, to deal with the challenges related to sustainable development. Such plans primarily act on the operation of the energy market and ultimately affect the physical composition and technical performance of the energy system, thereby furthering specific goals of social governance and sustainable development. In this study, the SEGO method was used to systematically analyze the energy strategy (Fig. 1). The approach includes four basic components: (1) energy challenges, which refers to the energy challenges related to sustainable development; (2) energy systems, which refers to the physical systems of energy supply, transformation, consumption, and infrastructure; (3) energy governance, which refers to the energy-related governance of society; and (4) energy market, which refers to the operation of energy-related markets.

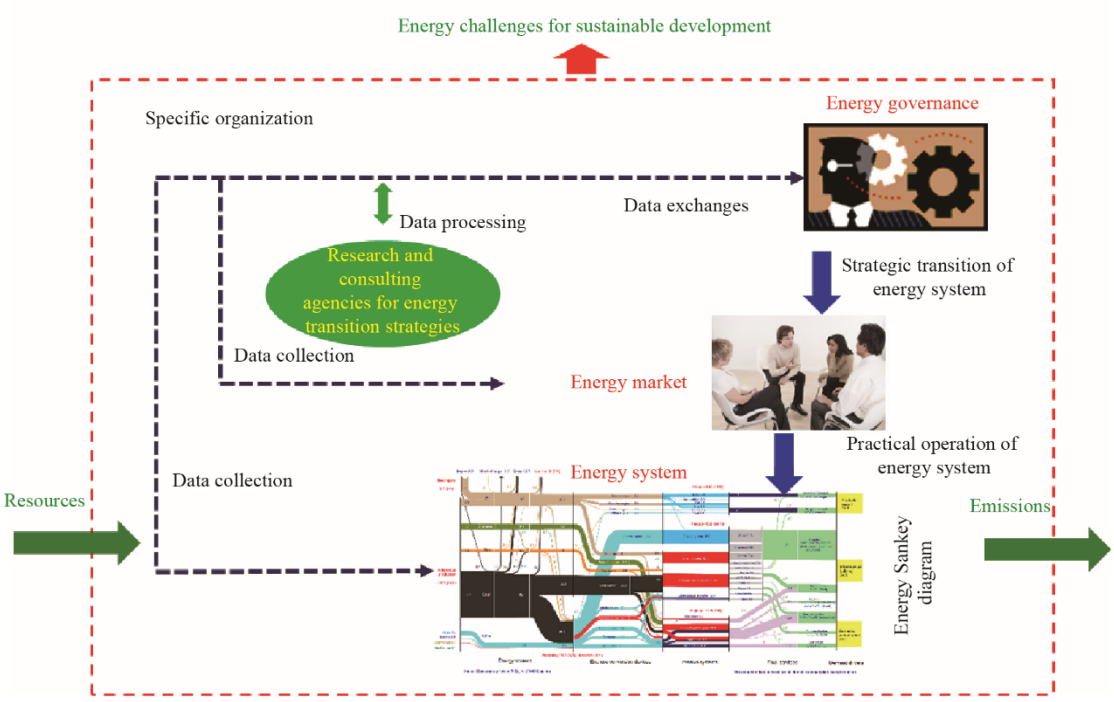

Fig. 1. Schematic diagram of the SEGO framework for energy strategy analysis.

2.1 Energy challenge

Energy is necessary and essential for sustainable development. Energy challenges for sustainable development refer to problems and phenomena questioned by certain social organizations due to the constraints of energy, resources, and environmental concerns, in order to meet the increasing needs of people. The International Institute of Applied Systems Analysis (IIASA) divides the energy challenges facing the world into three categories: energy equity, energy security, and green energy transition [1].

In response to the challenges of the energy sector, countries and regions need to make adjustments with respect to local conditions. For example, in developing countries, economic development is the primary task of national development. China''s vision of sustainable energy development aims to ensure energy security, protect public health and the ecological environment, and eliminate energy poverty without compromising economic development [2]. Therefore, the analysis of energy challenges specific to countries or regions involves the following steps: clarifying the needs of social organizations and the priorities of various energy challenges to ensure that energy challenges are dealt with reasonably; describing boundary conditions such as social conditions and resource environments of

DOI 10.15302/J-SSCAE-2021.01.005

specific regions; and identifying energy demands and challenges of sustainability to meet such demands in the current context, so as to better cope with these challenges.

2.2 Energy system

Energy systems are the carriers of energy conversion and utilization that transform energy resources into specific forms of energy services or useful energy required for social production and day-to-day life. The energy utilization chain includes five processes: source, transportation, conversion, distribution, and end-use. Energy systems vary worldwide. The optimization of energy systems is necessary to meet the challenge of sustainable development. Therefore, an in-depth analysis of the energy system is urgently needed.

Energy system analysis is the qualitative and quantitative analysis of energy systems from production to end-use with a view to optimizing the energy system as a whole, so as to provide reference for decision makers. The first step is to clarify the composition and structure of the regional energy system and determine the system boundaries, related links and departments, and principles of physical system operation. Then, models and methods are used to describe the regional energy system. On this basis, an investigation is conducted to collect relevant data, and models are used to analyze the law and the influence of system changes. Finally, the energy challenges identified are analyzed to pinpoint the root cause of problems in the physical system and improvement measures and feasible schemes are proposed.

2.3 Energy governance

Governance is important to urgently resolving the prominent attributes of public products and externalities in the energy sector. Governance is defined by the United Nations as the use of economic, political, and administrative authority to manage a country's affairs at all levels. Energy governance refers to social governance in the provision of energy services, covering decision-makers, systems, and procedures. It involves energy-related actors, such as governments, non-governmental organizations, companies, citizens, and public-private partnerships as well as agenda formulation, negotiations, implementation, monitoring, and enforcement procedures related to energy regulations.

At present, energy governance at both national and global levels aims to address the challenges of sustainable development, but the focus differs. National energy governance aims to meet the challenge of energy security, while global energy governance serves to tackle the challenges of energy equity and green energy.

2.4 Energy market

The energy market refers to the market in which energy commodities are traded. The operation of the energy market encompasses the routine behaviors and corresponding mechanisms of people or organizations involved in energy development and utilization. The research and analysis of energy market operations is an important part of the systemic analysis of energy strategies.

There are three steps to analyze the operation of the energy market: identifying the stakeholders of the energy market in a certain region, as well as the people or organizations that affect the composition and operation of the energy market; clarifying the roles played by each stakeholder in the energy market and their demands, determining the existing mechanisms and models among these stakeholders, and analyzing the characteristics of the existing mechanisms to determine whether the requirements of social governance are unmet due to conflicts of interest; and proposing the direction of energy market coordination and optimization, taking into account the possible conflicts between current market operations and governance objectives.

2.5 Overall unity of the SEGO method

The four elements of the SEGO method have overall unity, with energy challenges as the cause, energy system as the carrier, energy governance as the means, and energy market as the transmission mechanism. Together, they constitute a complex dynamic mechanism of energy integration and interconnection with ecology, environment, economy, and society, which become indispensable parts of the strategic analysis of energy systems. Their relationship can be described as follows. In order to effectively deal with energy challenges, the first task is to understand the basic composition, development trends, and future technology options of energy systems. For the purpose of transforming and adjusting energy systems, an integration and coordination mechanism at the energy governance level is required. Due to the differences in energy governance models and stakeholders among countries and regions, energy as a commodity must be passed from producers to consumers through the market to realize end-

use. Therefore, it is necessary to examine market mechanisms and discuss conflicts of interest so that energy transition can better meet the energy needs of the whole society under the intervention and guidance of energy governance.

Specifically, the analysis of energy challenges should explain the predicament of energy development based on the difficulties that the world or country has encountered or may encounter. The analysis of the energy system should focus on the structures of the energy production and consumption of the target area. The analysis of energy governance should clarify the authority structure and governance model of the target area and develop reform proposals. The analysis of the energy market aims to clarify the main stakeholders of the energy market in a certain area, and the relationship and conflicts between energy market players, and provide suggestions for the development of market systems and mechanisms.

3 Systematic analysis of global energy transition and the implications

3.1 Global energy challenge

According to IIASA's classification of global energy challenges, energy equity refers to the provision of affordable energy services. At present, more than 2.6 billion people worldwide still have no access to modern energy services. Energy equity is mainly affected by energy supply and energy costs. Energy transmission is essential for a stable energy supply in a region, but it depends to some extent on energy infrastructure because energy commodities are hazardous and difficult to store. For backward economies, infrastructure construction lags far behind due to insufficient investment and thus fails to support stable energy transmission. In addition, because energy is limited, people must pay for the energy used. Especially in regions endowed with limited energy resources, energy transportation costs and tariffs push up energy prices, thereby further exacerbating energy poverty.

Energy security refers to the secured availability of energy for the increased demand of all parts of the energy system, which can guard against and reduce energy-related risks and intermittent supply interruptions and continuously expand energy storage capacity. Traditionally, energy security refers to oil security. Electricity is regarded as an important component in the modern concept of energy security. The problem of energy security stems from the uneven distribution of resources. Energy security has become a prominent challenge for countries dependent on energy imports. The energy monopoly of some countries in the global energy market, which is caused by imperfect mechanisms, increases the risk of energy crises in other countries. Resources, markets, and infrastructure are related to energy security.

Energy greening refers to the gradual increase of green energy as a share in energy use in the process of energy production and utilization. It addresses environmental and ecological concerns. Environmental concerns include air, water, and soil pollution. Ecological concerns include abnormal phenomena of ecosystems associated with unreasonable energy structures, such as global climate change and holes in the ozone layer.

In the past, people have committed to solving energy poverty and supply security through fossil energy usage. However, the excessive use of fossil fuels has produced significant negative effects, with little consideration given to green energy. To achieve energy equity, energy security, and green energy simultaneously, solutions should be designed from the perspective of the energy system, that is, at the physical system level. Since energy is closely related to national and regional security, the structure and related systems of social governance must be adapted to and coordinated with energy development to form an institutional guarantee for the ternary energy goals. Based on established local energy markets, a more complete market mechanism can be fostered at the regional and global levels, which enables the market to fully play a role in optimal resource allocation.

3.2 Global energy system

Reshaping the global energy system requires the joint and collaborative efforts of all countries worldwide to make major and fundamental changes in the energy system. Although the concepts of clean energy and green energy are gradually recognized and highly valued, there have been so far no obvious signs of reduction in the dominance of fossil energy usage. According to statistics from the International Energy Agency (IEA) (Fig. 2), the three conventional fossil fuels, namely coal, oil, and natural gas, occupy a dominant position, sharing 81.4% of the total primary energy supply in 2016 [3].

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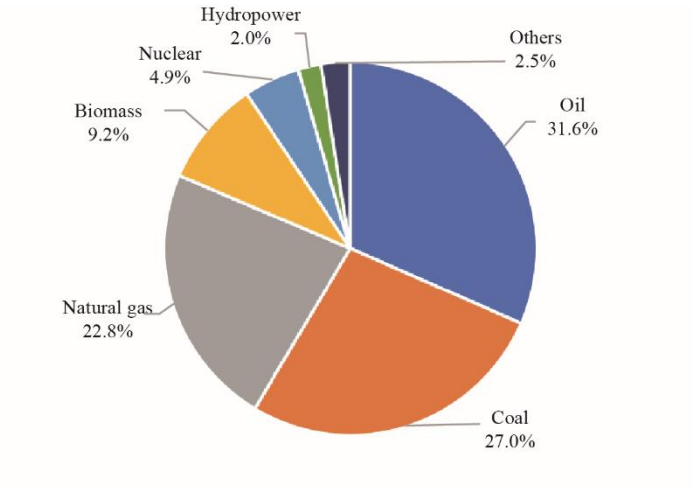

Fig. 2. Distribution of global primary energy supply in 2016.

Over-reliance on fossil-fuel derived energy as the primary solution to energy poverty and other challenges puts huge pressure on the global ecosystem. To this end, it is advisable to limit fossil-fuel based energy consumption, while considering the rational adjustment of the energy structure. According to the 2016 energy Sankey diagram drawn by IEA, based on the electrical equivalent of heat [4], within the end-use energy consumption, approximately 65% of oil was used by the transportation sector, more than 67% of coal by the power generation sector, and approximately 58% of natural gas by the industrial and building sectors. Of the overall energy consumption, 28.8% took place in the industrial sector, 28.8% in the transportation sector, and 33.3% in the building sector. In other words, the industrial, transportation, and building sectors still rely heavily on fossil fuel energy. At the macro level, the global energy mix is seriously solidified, so it is urgent to adjust the structure of the final energy consumption through physical systems. At the micro level, the serious oil dependence of the transportation sector can be reduced by applying advanced engine equipment and developing new vehicles driven by alternate energy and fuel cells. More stringent measures for supervision and administration are needed to alleviate the coal reliance of the industrial sector. Government agencies should strengthen the appropriate guidance on the energy utilization of industrial enterprises and adopt taxation and other administrative measures to adjust the energy utilization structure. In the building sector, distributed, renewable, and accessible clean energy can be incorporated to foster a clean and low-carbon energy mix.

3.3 Global energy governance

Global governance refers to social governance from a global perspective. There are two governance models: a multilateral forces-led model that emphasizes multi-party participation, and a superpower model in which certain countries hold the majority of the power. Most countries in the world favor the first model, which is more equal and reciprocal and is conducive to world peace, stability, and economic development. Energy is an important lifeline of the national economy and plays an important role in international political relations. International organizations formed in the process of global multilateral political power competition, such as the United Nations, have contributed to management and coordination in the energy field. A number of international organizations specializing in energy governance and control have also gradually formed, such as the Organization of Petroleum Exporting Countries and IEA. They aim to promote global or regional energy security and sustainable development.

The primary problem of global energy governance at present is that the role of international organizations is undermined by the long-term superpower status of the United States. Uncertainty also increases amid the conflict between the multilateral force-led model favored by most countries and the superpower model upheld by the United States. In addition, it is common for countries to fight individually in the energy field. Such a pattern of global energy governance brings challenges to clean and low-carbon energy development, but also creates historical opportunities to change the power of various organizations worldwide.

3.4 Global energy market

Energy, as a commodity, circulates and trades around the world, so it is of great significance to analyze energy

issues from a market perspective. The energy market covers energy commodities spot and futures trade and energy technology cooperation and sharing. The world energy trade system is composed of energy-producing countries, transit countries, and energy-consuming countries. International organizations such as the World Trade Organization (WTO) provide unified guidance and coordination at the upper level (Fig. 3). At the same time, financial institutions participate in energy trade as major financial market players and intermediary service agencies. Some multinational companies with businesses extending into multiple regions worldwide are also involved in energy trade by providing value-added services or utilizing their advantages. International organizations represented by the WTO serve as the top energy trade coordination and management system and provide oversight over the signing of the entire trade clause and the implementation of trade.

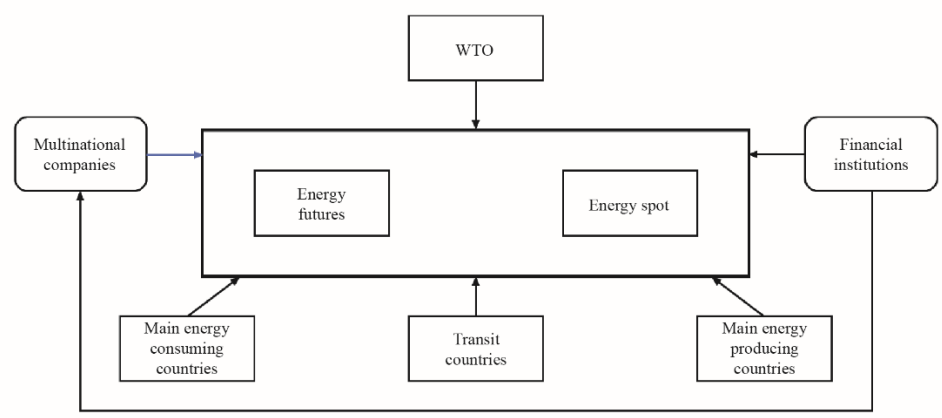

Fig. 3. Diagram of the world energy trade system (simple)

In the process of energy trade, due to the existence of structural power, some superpowers with strong influence intervene in energy trade through the WTO, financial institutions, and multinational companies. To this end, a market-centric trade mechanism for energy commodities should be established to promote energy commercialization so that the market can fully play a role in optimizing resource allocation. Necessary structural optimization of regional governance and social governance is also needed to establish a more mature energy operation system.

3.5 Summary and the implications

At present, the global energy system is facing the challenges of equity, security, and green development, as well as severe uncertainties. Fossil fuel derived energy occupies a dominant position in the global primary energy supply. The structural transformation of the global energy system urgently requires powerful global governance. However, the limited leadership capabilities of international organizations in the fields of energy and climate change, coupled with regional conflicts and differences in development goals, make it difficult to establish a unified leadership system for world energy development. Considering the commodity attributes of energy, a sound market mechanism is needed to facilitate energy trade between countries. Comprehensive improvements in energy systems, governance systems, and market mechanisms can drive the transition of the global energy system toward modernization with low carbon emission and a tiered approach.

The status quo analysis of the global energy system has implications for China. First, the orderly transformation and healthy development of energy systems are inseparable from effective and unified national governance. Highly unified leadership and efficient and resolute implementation of energy issues will benefit the country and people. Second, the commodity attributes of energy cannot be ignored. The energy market is an important bridge linking energy production and conversion, and energy consumption and utilization. China should be actively involved in building the global energy market system, thereby contributing to global energy development, while perfecting its own energy system.

4 Analysis of China's energy strategy and the implications

4.1 China's energy challenge

As a developing country, China needs to coordinate the relationship between economic development and energy challenges while also meeting the three global energy challenges of energy equity, energy security, and green energy.

DOI 10.15302/J-SSCAE-2021.01.005

There are five main energy challenges to energy sustainability in China [2]: huge and rising energy demand, rapidly increasing oil and natural gas usage causing dependence on foreign sources, severe environmental pollution, lack of access to clean energy services in rural areas and small towns, and massive, rapidly increasing greenhouse gas (GHG) emissions.

4.1.1 Huge and rising energy demand

China has a huge demand for energy. In 2018, China's primary energy consumption reached 4.58×10^9 t of coal equivalent (tce), accounting for 23.6% of the world's total energy usage. Simultaneously, China's energy demand continues to expand. In 2007–2018, for example, the average annual growth rate of China's energy consumption was 3.9% [5]. China aims to limit its total energy consumption below 6.0×10^9 tce by 2030 and stabilize the total energy consumption by 2050.

4.1.2 Rapidly increasing dependence on foreign sources for oil and natural gas

In terms of energy resource endowments, China is rich in coal resources but poor in oil and natural gas resources. In 2018, China imported 4.6×10^8 t of crude oil, representing 72.9% of the total crude oil usage. China's natural gas imports surged from 2% of total gas usage in 2007 to 43.7% in 2018 [5].

4.1.3 Severe conventional environmental pollution

There is serious environmental pollution and ecological destruction in China. Environmental pollution mainly includes air, water, and soil pollution, as well as ozone layer depletion and persistent organic pollution. The overall environment has been greatly improved through long-term pollution control efforts. However, problems still exist. For example, the proportion of good weather days in a few areas throughout the year is still below 60%. The problem of phosphorus pollution is grave, as 19.7% of the water areas fail to meet standards. The soil environment is heavily polluted in some non-ferrous metal mining areas and surrounding cultivated land [6].

4.1.4 Lack of access to clean energy services in rural areas and small towns

Compared with urban areas, rural areas lack access to efficient and clean energy services. This is reflected in the following problems: prominent energy equity issues related to low levels of energy consumption; large quantities of low-quality scattered coal consumption and associated large pollutant emissions; backward energy infrastructure; and low utilization rate of renewable energy[7].

4.1.5 Massive and rapidly increasing GHG emissions

In 2018, China's energy-related CO_2 emissions amounted to 9.43×10^9 t, accounting for 27.8% of the world's total emissions. From 2008 to 2018, China's energy-related CO_2 emissions increased by 2.02×10^9 t, with an annual growth rate of 3.2% [8]. In 2015, China pledged at the Paris Climate Change Conference to peak CO_2 emissions around 2030 and strive to peak early. This means that the international pressure on China to control total carbon emissions after 2030 will pose severe challenges to China's energy development.

Among the above-mentioned energy challenges to China, rising energy demand represents the demand for driving economic development. The lack of access to clean energy services in rural areas and small towns is an issue of energy equity, while the rapid growth of oil and gas dependence on foreign sources is an issue of energy security. Environmental pollution and GHG emissions fall into the category of green energy issues. The most important aspect for China is to provide energy for economic development. In the meantime, efforts are required to resolve the existing issues of energy equity, energy security, and green energy to ensure sustainable development.

4.2 China's energy system

Changes in China's primary energy consumption (Fig. 4) and energy consumption structure (Fig. 5) from 1965 to 2019 show that [8]: The primary energy consumption swelled from 1.87×10^8 tce to 4.83×10^8 tce, with an average annual growth rate of 6.25%; energy-related CO_2 emissions expanded from 4.89×10^8 t to 9.83×10^8 t, with an average annual growth rate of 5.74%. During this period, coal usage has remained dominant, but its usage share dropped from 87.0% to 57.4%.

The extensive mode of energy resource utilization has brought many problems to China's society, environment and climate. To address the issue, China has pushed for energy transition over the past ten years. On the one hand, energy consumption was growing. China's primary energy consumption jumped to the first place in the world for the first time in 2009, making China the world's largest energy consumer. On the other hand, energy transition yielded remarkable results. From 2007 to 2018, due to the control of total energy consumption, the average annual growth

rate of total energy consumption plummeted to 3.89%, while that of renewable energy consumption increased to 12.54%. The share of non-fossil energy in total energy consumption climbed from 5.9 % to 13.9%, while the proportion of coal decreased from 73.7% to 58.3%, with a negative growth registered for the first time in 2014. Energy-related carbon emissions also fell for the first time in 2014. Currently, China's energy sector is in the stage of transition from high-speed development to high-quality development. An issue crucial to future development is to coordinate the relationship between serving economic growth and people's yearning for a better life and achieving clean, low-carbon, safe and efficient energy development.

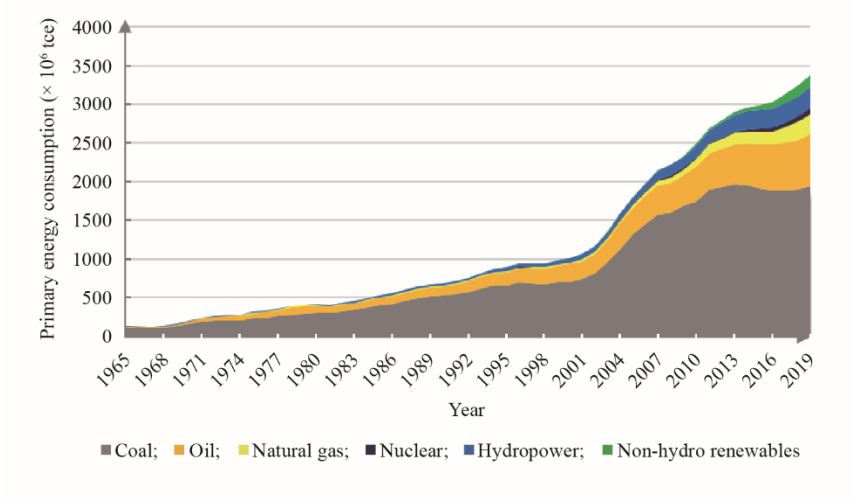

Fig. 4. China's primary energy consumption for differing energy sources with time.

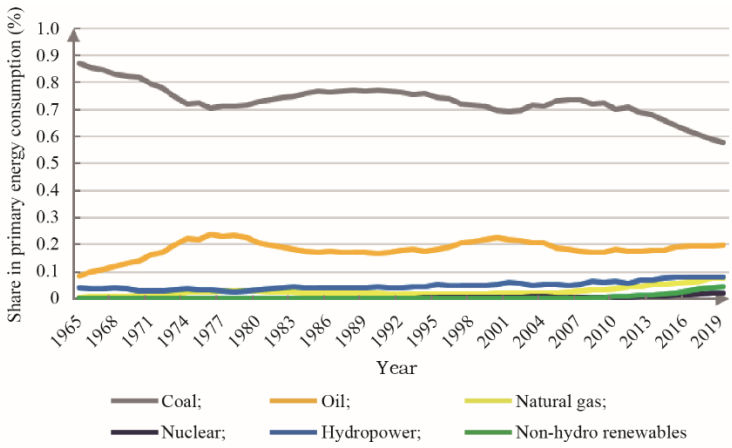

Fig. 5. Structural change in China's primary energy consumption with time.

4.3 China's energy governance

The government plays a decisive role in China's energy governance, organizing various stakeholders to form energy governance systems and rules and guiding and supervising other stakeholders. The central government determines the central theme and general direction of energy governance, and and formulates strategic goals and implementation plans for energy development. On this basis, local governments at all levels prepare respective energy development plans to achieve energy governance in a top-down approach.

Energy governance by the Chinese government is embodied in the following aspects: In terms of political awareness, State leaders, both former and current leaders, have agreed on conserving resources, protecting the environment, and enhancing the capability of sustainable development. From the inclusion of environmental

DOI 10.15302/J-SSCAE-2021.01.005

improvement as one of the targets of building a moderate prosperous society in all respects to the philosophy of ecological civilization that "lucid waters and lush mountains are invaluable assets", the importance of sustainable development has been continuously heightened while insisting on the central task of economic development. In terms of national strategic planning, the national planning for the energy sector is mainly incorporated into the five-year plans. In one word, China strives to foster a clean, low-carbon, safe and efficient modern energy system by launching the energy revolution, optimizing the energy mix, and improving energy utilization efficiency.

Energy governance stakeholders include the government, civil society organizations (industry associations, non-profit organizations, etc.), energy companies, and citizens. These stakeholders play different roles under the leadership and organization of the government.

Facing the energy challenge of sustainable development, China still needs to further strengthen energy governance: control the total energy consumption while maintaining economic growth; improve the structure of primary energy consumption by further lowering the share of fossil energy and increasing the use of renewable energy; improve energy utilization efficiency by promoting advanced energy utilization technologies and phasing out backward production capacity; and raise the level of terminal energy services by further promoting electrification.

4.4 China’s energy market

China’s energy market has basically the same forms and models of operation as the global energy market. In terms of operation forms, there are direct trade in energy commodities, cooperation in and sharing of energy technologies, and trade of energy futures. In terms of basic model, energy producers, transporters and consumers are guided and coordinated by government departments at the upper level. Meanwhile, China's energy market is different from the global energy market in three aspects: i) With coordination and guidance capacity stronger than international organizations, the Chinese government plays a greater role in the energy market; ii) State-owned enterprises, as the dominant energy transporters and producers, can adjust energy prices according to regional actual needs; and iii) Energy futures market is not yet well established in China compared with the global energy market.

4.5 Summary and implications

In response to challenges in energy equity, energy security and green energy, as well as economic development needs, further optimization of energy system based on the understanding of current development situation is necessary, including refining the design of passive systems, strengthening infrastructure connectivity, promoting energy-saving technologies, and enhancing energy system flexibility and capacity to absorb renewable energy. This requires strategic adjustments in energy governance. To put into practice measures of energy governance, effective policy instruments can be adopted to guide the operation of energy market. In the future, it is still important to further improve the relevant systems and rules of energy governance, and at the same time, continue to advance the marketization of energy towards a sound energy market.

5 Conclusions and policy recommendations

5.1 Primary findings

The SEGO method is proposed for systemic analysis of energy strategies and used to examine the global energy transition and China's energy revolution in terms of sustainable development, energy system, energy governance and energy market.

The world faces multiple energy challenges such as energy equity, energy security and green energy. Due to the lack of a strong global energy governance system, it is difficult to effectively integrate the energy strategies of various countries and implement them consistently and vigorously at the global level. As a result, the global energy transition proceeds generally slow. China is expected to play a more active role in driving the global energy transition.

China’s energy challenges have become more complex and severe. Nevertheless, driven by firm political will, a series of energy strategic consensus on "cap control and structural adjustment " has been reached. This has obviously pushed forward the energy transition and enabled reduction in both energy consumption and carbon emissions. As China continues to tighten energy efficiency requirements, energy system integration (with infrastructure as the core) has emerged as a huge challenge and a major opportunity, considering the large-scale introduction of renewable energy and the development of information and communication technologies. China should focus on the overall optimization and refined management of energy system from the perspective of economy, society and environment, appropriately coordinate the construction, sharing and regulation of various types of energy networks such as

electricity, heat and fuel, and accelerate the disruptive innovation in new energy technologies and emerging industries such as renewable energy and information and communication technologies.

5.2 Policy recommendations

5.2.1 Strengthening leadership and management, and establishing the concept of "putting energy conservation and low carbon first and resolutely curbing waste"

The concept of "putting energy conservation and low carbon first and resolutely curbing waste" should be firmly observed in all aspects of energy governance such as policy guidance, development planning, market supervision and financial support. In order to strengthen strategic decision-making and overall coordination, inter-regional energy committees can be set up under the National Energy Commission to strengthen the overall leadership and management of major regions in advancing the energy revolution and facilitate the overall systemic optimization and process-wide refined management of energy development.

5.2.2 Ensuring "two harmonies" and making appropriate plans for energy revolution

Energy planning should harmonize with economic, social, and environmental planning at the national and regional levels. At the same time, regional coordination of energy planning should be strengthened. Long-term plans for inter-provincial and municipal energy revolution and five-year plans for energy development should be formulated for major regions to actively advance the energy transition and ensure the implementation of relevant requirements of energy revolution strategies.

5.2.3 Deepening the reform of the energy market to stimulate innovation

Effective policy instruments should be explored and introduced that further promote the access to energy market and encourage private capital to enter more fields by highlighting the attribute of energy commodities. Independent innovation at the local level is supported to accelerate the subversive innovation of new energy technologies and new industries. Major regions are allowed to develop specific energy market reform plans suitable for respective areas. In addition, regional experience exchange and sharing in energy market reform should be strengthened.

5.2.4 Attaching importance to the development of multi-energy technologies and systems.

Multi-energy technologies and systems should be raised to the level of national energy strategy and advanced as a major systemic project and national key program, such as coal and biomass coupled power generation and heating technology. Local areas are encouraged to propose independently innovative multi-energy technologies and system solutions in respect of their own conditions, and carry out demonstration and application, as well as outreach activities.

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