

# Analysis of the Impact of China's Energy Consumption Structure on Energy Security

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**Abstract.** Energy, as the guarantee of China's economic development, plays an important role in it. Nowadays, however, oil production almost reaches its upper limit and is going downhill. The yearly rising output of natural gas fails to meet the increasingly huge energy demand. Although coal reserves are large, it still gets into a bottleneck period due to environmental and technological reasons. Therefore, the adjustment and optimization of energy consumption structure is the primary problem for China's energy security, and it has become, and will still remain as the core of China's energy strategy in the future. So, it is of great theoretical and practical significance to delve into the inter relationship between energy consumption structure and energy security, and then to optimize energy consumption structure under the new situation.

After an in-depth analysis on how to adjust the energy consumption structure to ensure energy security, the author finds several problems, for instance, an unreasonable energy consumption structure, a serious environmental pollution, a low energy utilization rate, and a recessive role of energy price market. To solve the practical problems, this paper puts forward three measures namely deepening the supply side reform, accelerating the energy technology innovation, and changing the concept in energy use. The improvement in energy consumption structure is not only of general significance to improve the energy security theory, but also of great significance for China to achieve the goal of greenhouse gas emission reduction and ensure energy security.

## 1 Background

Since the 21<sup>st</sup> century, the energy issue, especially concerning oil, has remained as one of the most influential problems to the international situation. For China, as a guarantee for China's economic development, energy issue has also been thought highly of as a national strategic issue. Nowadays, however, oil production almost reaches its upper limit and is going downhill. The yearly rising output of natural gas fails to meet the increasingly huge energy demand. Although coal reserves are large, it still gets into a bottleneck period due to environmental and technological reasons. Therefore, the adjustment and optimization of energy consumption structure is the primary problem for China's energy security, and it has become, and will still remain as the core of China's energy strategy in the future.

In 2020, Saudi Arabia and Russia, the world's major exporters of crude oil, failed to reach a negotiation on reducing crude oil production, together with the global epidemic of the new coronavirus, a negative value in the world crude oil futures market appeared for the first time. The international energy problem is becoming increasingly prominent and difficult to reconcile. China's domestic energy problem also cannot be ignored. Facing a

tense international energy supply, the high external dependence on imports has been highlighted. Especially after the successive crises happened in China's major energy importing countries, the shortcomings of China's insufficient energy self-production and single import channel are thoroughly exposed. In addition, the industrial innovation such as "power market reform" and "oil and gas system reform" and the new energy development in the "combustible ice", "dry hot rock" and etc. are all in a bottleneck. It can be predicted that to ensure energy security, for a long time, reform will present as the core of China's energy strategy, and how to further deepen the reform will be a hot issue of energy research.

## 2 Literature Review

Influenced by several oil supply interruptions in the 19<sup>th</sup> century, the International Energy Agency was established in 1974, and the concept of "national energy security" centered on stabilizing crude oil price and supply was put forward for the first time. Since then, the concept of energy security has been constantly proposed. In the world community, people generally discuss the relationship between international energy consumption structure and energy security as part of the argument of energy security instead of just studying the relationship between them.

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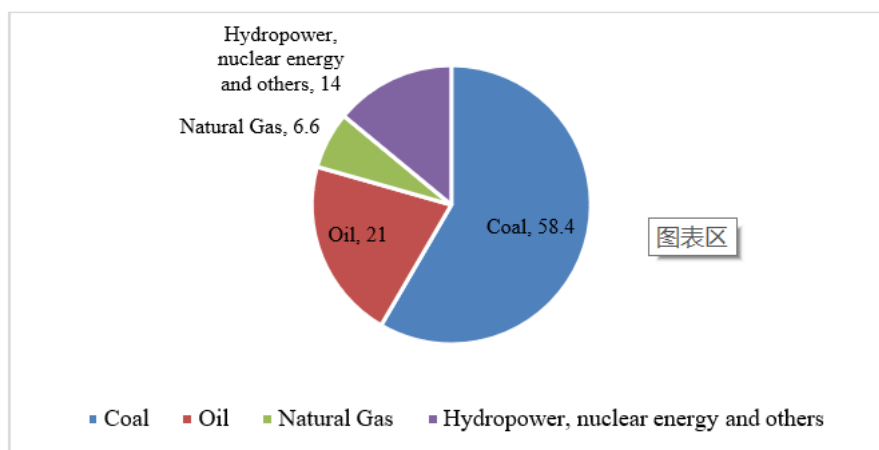
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Salameh (2003) thinks that besides ensuring the security of energy supply, the rationality in energy demand is another issue to be considered in energy security. Sovacool (2011) starts from the basic perspective of energy supply and demand. In combination with relevant management policies, He believes that energy security is not for energy self-sufficiency, but to improve the utilization efficiency by mutual combination and supplement among various kinds of energy. Delving into China's energy security problem, Leung concludes that energy demand security, like energy supply security, occupies an important part in energy security. Related to energy consumption, energy demand is a new dimension in measuring energy security. Domestic research on energy security started later than foreign countries. Zhang Wenmu (2003) discussed China's energy security in detail in his book *China's Security Strategy for the New Century*. Almost at the same time, China also studied the impact of energy consumption structure on energy security. Liu Shan (2002) first analyzed China's energy consumption structure from the point of energy security, emphasizing the importance of oil diplomacy.

### 3 Current Situation of China's Energy Consumption Structure and Energy Security

#### 3.1 Current Situation of China's Energy Consumption Structure

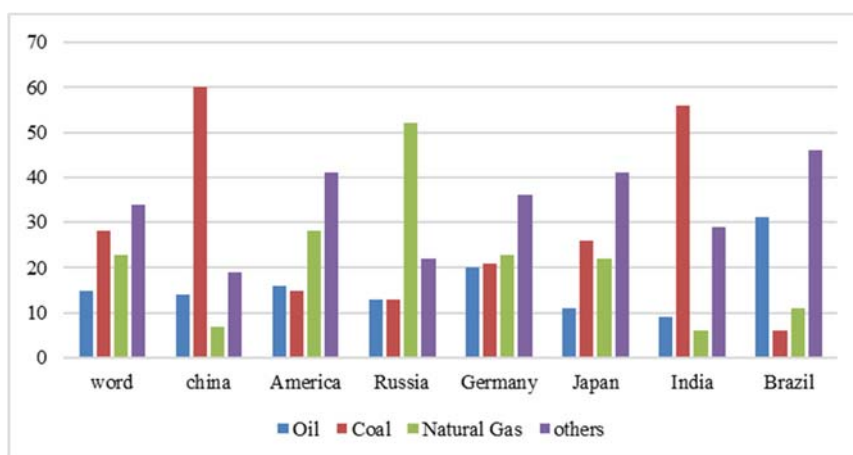
As China's economy develops, energy consumption also increases rapidly. From 2001 to 2019, China's energy consumption has increased from 1469.64 million tons of standard coal to 4860 million tons of standard coal with an average annual growth rate of 6.9%, far exceeding the world average. Since 2016, the growth rate of China's total energy consumption has slowed down to 5% while the total energy consumption ranks first in the world because of a huge amount of total population. However, China's energy consumption structure has not fundamentally changed in the past two decades. In 2019, coal consumption accounted for nearly 60% in China's primary energy consumption, though nearly 20% lower than that in 2001, it still stands in an absolute dominant position. Besides, oil has the fastest growth rate, accounting for 21% of the primary energy consumption structure in 2019, serving as the second largest energy consumption in China. Though natural gas accounts for only 7% of the energy structure, due to its clean feature and national policy support, the average annual growth sees a strong momentum of 8%. However, other energy sources such as, hydro energy, nuclear energy, biomass energy, and solar energy share for 14% in the consumption structure, and except energy sources, the growth rate of others is slow.



**Figure 1** Consumption Structure of China's Major Energy in 2019

Compared with other countries in the world, China's energy consumption structure is very similar to its natural resource endowment. China's proven raw coal reserves account for 53% of the total energy reserves, and the proportion of coal consumption in China's energy composition is about 60%, 24% higher than the international average. China's proven oil reserves are about 24 billion barrels, accounting for 17% of the total

proven energy reserves. Oil consumption accounts for 21% in China's energy composition, which is lower than the world average of 34%. Besides, the proven natural gas reserves account for 14% of the total, and its consumption accounts for only 6.6% of the total energy composition, far lower than the world average of 23%, and also below the Asian average of 8.8%.

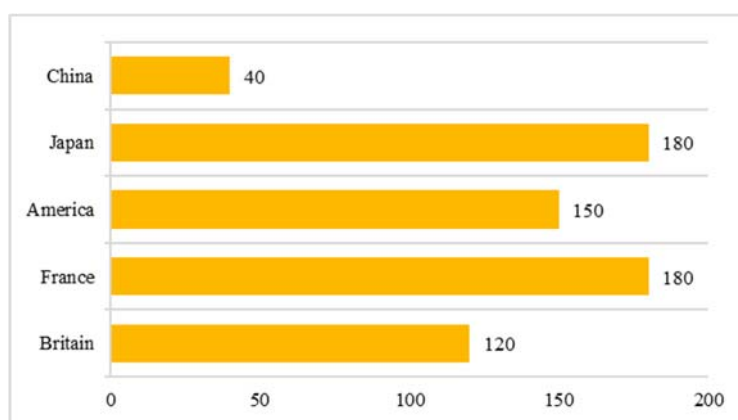


**Figure 2** Comparison of China's Primary Energy Consumption with Major Countries in the World

### 3.2 Current Situation of China's Energy Security Structure

China is a big country of energy production and consumption, but it is also a developing country with scarce per capita resources. At present, in addition to the advantage in coal resources, other energy resources in China mostly rely on imports with an increasingly external dependence year by year. Except for the domestic energy output that cannot meet China's demand, there are many difficulties in international supply. China's top five crude

oil importers in 2019 are Russia, Oman, Iraq, Saudi Arabia and Angola from the Middle East, North Africa, Eastern Europe, South America and etc., but in term of oil quantity, China relies heavily on Russia and the Middle East. Crude oil crude importing from the Middle East occupies 44.1% in China, and Russia accounts for more than a quarter of the total imports. As for strategic oil reserves, China's oil reserves in 2019 are about 33.25 million tons, which is equivalent to China's 39-day net crude oil import. However, it still fails to meet the 90-day safety standard of the International Energy Agency, and is also far lower than Japan, the United States, France and other countries.



**Figure 3** Strategic Oil Reserves of the World's Net Energy Importers in 2018

For transportation channels, more than 90% of China's transportation is by sea because China mainly imports oil from the Middle East and Africa, making the Strait of Malacca become a must pass. It means that once there is any problem happened, it will lead to a major impact on China's energy security. China, in the past two years, has been actively endeavoring to transportation mode, and has established a Sino Kazakhstan oil pipeline with Kazakhstan to transport oil from Central Asia to China. However, as the Southeast of China consumes most of its energy, and the transport terminal of Sino Kazakhstan oil pipeline is only in Xinjiang, it is still necessary but a high-cost to build a pipeline from Xinjiang. The oil and gas pipeline built with Myanmar relieves China's dependence on the Strait of Malacca to a certain extent. However, only 13 million tons of oil cannot meet China's huge demand.

Therefore, China cannot get rid of its dependence on the Strait of Malacca at least in the short term.

## 4 The Problems in Energy Consumption Structure from the Perspective of China's Current Energy Security

### 4.1 Unreasonable Energy Consumption Structure

Since 2016, China has continued to carry out the supply side reform and adjust the supply structure, while great results are not achieved in reality. On the whole, China's energy self-sufficiency rate kept going down from 86.6%

in 2010 to 76.8% in 2018. Although the rate was still maintained at a relatively high level, it must be regarded seriously. Seen from the distribution, the coal dominates in China's energy composition with a proportion of 60%. The proportion of oil in China's energy composition has increased, but only 21%, lower than the world average of 34%. Natural gas accounts for only 6.6% in China's energy composition, which is lower than the Asian average. In the meanwhile, China's energy supply diverges greatly in the relative surplus of coal supply and excessive dependence on oil and gas resources. In high external dependence, even a slight turbulence in the international energy situation will directly impact China's production and life security.

#### **4.2 Insufficient Energy Utilization**

Energy consumption elasticity coefficient and electricity consumption elasticity coefficient are two vital indexes to measure national energy efficiency and economic development quality. In recent years, those two indexes continue to rise, and the energy consumption of per unit GDP is high. In addition, China's energy management is in its infancy in terms of concept establishment, system establishment, and talent training, resulting in a low level of energy management in our country that does not match energy production and consumption.

#### **4.3 Bottleneck in New Energy Development**

China's new energy technology is developing rapidly, with photovoltaic power generation and natural gas hydrate combustion rank the top in the world. However, there are two restrictions in China's new energy technology. On the one hand, due to its distribution, national geographical conditions, etc., the actual use of new energy technology far lags behind developed countries though China's technology, developed from developed countries in Europe and the US, has reached or close to the level of those countries. On the other hand, seriously lacking energy related facilities, the new energy system and the original one of China cannot be well integrated, which means that the power generation in wind, photovoltaic and so on cannot achieve grid-connected in time with thermal power, hydropower. Thus, there are serious waste of electricity in new energy power generation industry. China's high-end technology of new energy is mature, but the technology used for daily life and production relatively lags behind, resulting in a great cry and little wool in the development of new energy.

### **5 China's Countermeasures to the Impact of Energy Consumption Structure on Energy Security**

#### **5.1 Comprehensively Deepen the Supply Side Reform**

First of all, the improvement of energy consumption structure should be a gradual process with a diversified use

of energy reduces the dependence on a single energy. The diversified use of energy in China is supposed to be divided into two parts: basic energy and supplementary energy. Basic energy features mature technology, high stability and high economy, but to ensure the national energy security, we should gradually reduce the proportion of basic energy in the energy structure. The supplementary energy, in immature technology and poor stability of, is hard to guarantee a stable energy supply. At present, we should gradually increase the proportion of clean energy such as solar energy and wind energy in China's energy supply structure.

Besides, to speed up the pace in energy market-oriented reform, we should hold the overall idea in China's oil and gas system reform, that is to establish a perfect modern oil and gas market system as the goal, and give full play to the decisive role of the market in resource allocation. We should liberalize the import and export of crude oil and refined oil in an orderly manner and break the policy boundary between state-owned trade and non-state-owned trade.

#### **5.2 Accelerate Energy Technology Innovation**

To effectively use various fossil energy, the most direct way is to increase technology research, where China is in the first echelon in the world though its related technology R&D is not at the top. China's technology in Coal to Olefins, Ethanol, Aromatics and Coal to Ethylene Glycol Process lead the position in the world. Therefore, the problem cannot be solved only by developing new technology, thus from the reality, we should focus on economic benefits in using clean energy technology. First of all, we should improve the construction of supporting facilities to popularize clean technology. Secondly, we are supposed to establish a sound energy management system by promoting enterprise reform. Enterprises are the most energy-consuming, so energy efficiency can only be improved by improving the energy efficiency of enterprises. Therefore, the reform should be carried out from the following two aspects. For the state-owned enterprises, they need to be equipped with a modern enterprise system and perfect structure. For the non-state-owned enterprises, it's necessary to speed up the establishment of energy management system, through which the administration can monitor the energy consumption of enterprises in real time. At the same time, only on the premise of a market can we play the role of the market and promote the establishment of energy management system.

#### **5.3 Changing the Concept in Energy Use by Developing New Energy**

First of all, we should speed up the technology research in utilizing clean energy. Clean energy technology is costly in development, difficult to put into actual use and slow capital return. The R&D in core technology requires lots of human and material resources. Therefore, China needs to integrate human resources in the field of clean energy development, improve the talent selection mechanism,

and pay attention to infrastructure construction.

Secondly, we should establish a sound new energy policy and energy-saving policy system, clarify the development strategy and goal plan, determine the long-term feasible goal for the development of clean energy with specific development plan. The policy should be implemented in all provinces and cities, and at least be adjusted every year according to the actual situation for the preparation to do a good job under rapid development momentum.

At the same time, we should formulate tax policies in line with development. To develop clean energy, blindly formulating preferential policies is not enough. More importantly, through implementing mandatory tax policies, non-clean energy enterprises should be forced industrial upgrading and establish the awareness of emission reduction.

## 6 Conclusion

Ensuring energy security is an important part in national security. Scholars at home and abroad have made various models and analyses for energy security, mainly from the perspective of supply instead of ensuring energy security by improving energy consumption. From the view of a reasonable energy consumption structure, this paper, through analyzing China's energy consumption structure, evaluates its energy security, finds out deficiencies and proposes corresponding solutions.

From the analysis of China's energy production and consumption structure of living energy, we can clearly see that China's primary energy consumption structure is unreasonable with coal accounts for a high proportion. At the same time, the energy market lacks an effective competition mechanism, leading to abnormal development of energy prices. On the other hand, the energy utilization rate is low. Many industries, lacking the awareness of energy conservation, still follow the habit of high energy consumption and high pollution. What's more, in the rapid development of new energy, the popularization of new energy related technologies is restrained by its high cost. The above-mentioned problems have a profound impact on China's energy security, and how to solve those problems remains a key task in the field of energy for a long time in the future.

To solve these problems, this paper provides ideas and measures from three aspects. First, in view of the imbalance of energy structure, the author proposes the idea that is, through deepening the supply-side reform, to enhance the diversification of energy utilization and reduce the monopoly of a single energy company on the market. Secondly, as for insufficient energy utilization, this paper puts forward two solutions from the nation and industry level. On a national level, the approval of projects with high pollution and high energy consumption should be prohibited or reduced. On the industry level, industry standards should be raised to force enterprises to upgrade and transform. Finally, to solve the bottleneck in the new energy development, this paper proposes to speed up technology R&D and policy implementation, and actively advocates energy saving and emission reduction.

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