Study on the Calculation Method of Energy Saving Potential of the Whole Society during the 14th Five Year Plan Period

Wei Tang¹,*, Peng Wu¹, and Jinhui Duan¹
¹State Grid Energy Research Institute Co., Ltd., Beijing, China

*Corresponding author

Abstract. This paper studies the calculation method of the energy-saving potential of key industries, then calculates the structural energy-saving potential, and finally puts forward a method to calculate the energy-saving potential of the whole society during the 14th Five Year Plan period. It is estimated that during the period of the 14th five year plan, the whole society will save about 300-400 million tons of standard coal.

Keywords: Energy saving potential; Energy saving of the whole society; Key industries; Technical energy saving; structural energy saving.

1. Introduction
Under a series of external environment, such as the continuous increase of energy consumption and the aggravation of environmental pollution, energy conservation as an important national strategy has been promoted to an unprecedented height. Energy conservation is an inevitable requirement for China to alleviate the constraints of resources and environment, and an important measure for China to cope with global climate change and reduce greenhouse gas emissions. Energy saving is also an important way to change the mode of economic development in China. It is very important and urgent to carry out systematic research on energy conservation. At present, there is a lack of systematic and in-depth study on the energy-saving potential of different industries in China. At present, although scholars at home and abroad have carried out some research in the related fields of energy conservation and emission reduction, such as literature [1-3], which analyzes the factors of energy efficiency improvement, literature [4-5], which analyzes the energy conservation situation of key industries from the perspective of industry and construction industry, there is no research on the method that can accurately measure the energy conservation potential of the whole society during the 14th Five Year Plan period.

Scientific and reasonable calculation of the "14th five year plan" energy saving potential can provide support for the formulation of total energy consumption control policies, future energy structure development strategies and related routes, provide reference and suggestions for the government to formulate relevant policies for the scientific development and optimal utilization of energy resources, help the state to locate key industry development areas and key technology research and development areas, and further boost energy revolution and industrial upgrading. Mastering the potential of energy conservation in the future will help power supply companies locate key customer areas and key technology research and development, strengthen value-added services, and increase business income and profits.

2. Current Situation of Energy Conservation
The national and regional energy conservation and consumption reduction efforts are increasing, various policies and measures are gradually implemented, and the effect of energy conservation and consumption reduction is relatively obvious. The CPC Central Committee and the State Council actively promote the
transformation of the economic development mode from the extensive type of scale speed type to the intensive type of high-quality and benefit type. Innovation drives the improvement of labor productivity and resource utilization rate, creates an ecological civilization society, builds a resource-saving society, and improves the ecological civilization. At the same time, the quality of economic operation continues to improve, and the ability of sustainable development continues to increase.

In recent years, the energy consumption of key industries in China has declined as a whole, and the energy saving of key industries accounts for more than half of the energy saving of the whole society. The comprehensive energy consumption per ton of steel, electrolytic aluminum and copper smelting all showed a downward trend. Since 2010, China's industrial, construction, transportation and other major sectors have achieved a high proportion of energy-saving technology in the whole society, accounting for more than half. Since the implementation of the 13th five year plan, China has achieved remarkable results in energy conservation and consumption reduction. However, the progress of energy conservation and emission reduction of enterprises is unbalanced. With the economic transformation and structural adjustment, capacity reduction, commodity price fluctuations and other factors, many enterprises' benefit level fluctuates, which affects the further development of energy conservation and emission reduction.

3. Calculation Method of Energy Saving Potential of the Whole Society during the 14th Five Year Plan Period

Select key industries such as electric power, iron and steel, non-ferrous metals, chemical industry, building materials, transportation and construction from the whole society. Firstly, identify the key energy consumption links / products of the seven major energy consumption industries. Secondly, extract the key indicators related to energy conservation based on the energy consumption links. Thirdly, analyze the main energy conservation measures and relevant influencing factors of the key industries. Fourthly, based on the calculation results of key industries, energy saving calculation of the whole society will be carried out.

3.1. Calculation of energy saving potential in key areas based on technical factors

Basic calculation methods: the calculation of energy-saving potential of key industries can be carried out in three directions: first, based on rich historical energy data and economic data, investigate various factors such as economic development and industrial technological breakthrough and transformation direction, and then analyze the industry's energy-saving potential; second, analyze the energy-saving potential through parameter comparison, which refers to selection Select a country with high energy efficiency, and take this as a benchmark, through the comparison of various energy parameters, to find out the differences and deficiencies, and then judge the energy utilization situation, calculate the gap of energy efficiency. This calculation needs to be accurately predicted according to the main products, output, capacity and unit energy consumption of the industry. The third is to find the baseline, that is, the lowest value of energy saving potential, through the energy consumption quota standard of main products The core idea of parameter comparison method is "gap is potential". Low energy efficiency is calculated by comparing with high energy efficiency. This gap is the energy saving potential of low energy efficiency.

Key energy consumption links / products are identified for key industries such as electric power, iron and steel, non-ferrous metals, chemical industry, building materials, etc. the identification results are as follows:

a. the key energy consumption links in the power industry are power generation, transmission, distribution, power consumption, etc;
b. the key energy consumption links in the iron and steel industry are coking, sintering, steelmaking, ironmaking, steel rolling, etc;
c. the key energy consumption link of nonferrous metal industry is smelting link, and the main analysis object is electrolytic aluminum;
d. key energy consumption products in the chemical industry mainly include synthetic ammonia, caustic soda, soda ash, calcium carbide, yellow phosphorus, oil refining and ethylene, etc;
e. the key energy consumption products in building materials industry mainly include three categories: building materials and products, nonmetallic minerals and products, and inorganic nonmetallic new materials. The main products include more than 1000 types of products such as cement, lime, bricks and
tiles, among which the most representative products in building materials industry are cement and flat glass;
f. the main energy consumption fields of transportation industry include highway, railway, water transportation, civil aviation, etc.
g. the main energy use areas in the construction field include public buildings, urban houses and rural houses, among which the key energy use links are heating and cooling for residents.

**Key industry energy saving potential assessment system**

![Graph showing key industry energy saving potential assessment system](image)

**Figure 1.** Valuation index system of key areas.

Now, the energy saving direction of key industries is evaluated, taking the calculation of transportation field as an example:

According to the traffic data over the years, the prediction function is established:

\[
Q = \sum_{i=1}^{n} (A_i \times \Delta \alpha_i)
\]

(1)

\[
\Delta \alpha_i = \alpha_{i1} - \alpha_{i2}
\]

(2)

Where

- \( Q \) - the predicted traffic energy saving potential during the 14th Five Year Plan period.
- \( n \) - number of index varieties: take 4 here, that is to say, the energy saving potential of transportation mainly consists of the energy saving potential of railway, waterway, highway and civil aviation.
- \( A \) - forecast the total converted turnover of the ith mode of transportation during the 14th Five Year Plan period;
- \( \alpha \) - energy consumption per unit transportation turnover of the ith transportation mode: energy consumption per unit transportation turnover during the 13th Five Year Plan period, and energy consumption per unit transportation turnover during the 14th Five Year Plan period.

Based on the prediction of comprehensive technical improvement and structural adjustment, the energy consumption per unit transportation turnover is expected to decrease to 340kgce / (10000 t · km) during the 14th Five Year Plan period, which is 66kgce / (10000 t · km) lower than that in 2017 during the 13th Five Year Plan period. The road conversion turnover reached 7937.9 billion T · km, an increase of 1163 billion T · km over 2017 during the 13th Five Year Plan period. The energy saving of highway will reach 76.98 million TCE (TCE is ton of standard coal equivalent); the energy consumption per unit transportation turnover of railway is expected to decrease to 37 kgce / (10000 t · km), 5.9 kgce / (10000 t · km) lower than that in 2017 during the 13th Five Year Plan period. The railway conversion turnover reached 4735.7 billion T · km, an increase of 693.8 billion T · km compared with that in 2017 during the 13th Five Year Plan period. The energy saving of railway will reach 4.06 million TCE; the energy
consumption per unit transport turnover of water transport is expected to decrease to 29 kgce / (10000 t · km), 6.5 kgce / (10000 t · km) lower than that in 2017 during the 13th Five Year Plan period. The converted turnover of water transport reached 1250.16 billion T · km, an increase of 2632.7 billion T · km compared with that in 2017 during the 13th Five Year Plan period. The energy saving of water transportation will reach 17.23 million TCE; the energy consumption per unit transportation turnover of civil aviation is expected to decrease to 5101 kgce / (10000 t · km), 32.8 kgce / (10000 t · km) lower than that in 2017 during the 13th Five Year Plan period. The converted turnover of civil aviation reached 160 billion T · km, an increase of 51.7 billion T · km compared with that in 2017 during the 13th Five Year Plan period. The energy saving of civil aviation will reach 1.69 million TCE. The total energy-saving potential of key industries will get the energy-saving potential of technology.

3.2. Calculation of energy saving potential of the whole society

According to the proportion of technological energy conservation and structural energy conservation over the years, and according to the proportion, the energy conservation potential of the whole society is calculated. According to 60% of technical energy conservation and 40% of structural energy conservation, the energy conservation potential of the whole society is calculated. According to the proportion of technological energy conservation and structural energy conservation over the years, it is estimated that during the period of the 14th five year plan, the whole society will save about 300-400 million tons of standard coal.

| Table 1. Proportion of technical energy saving and structural energy saving. |
|---------------------------------|-----------------|-----------------|-----------------|
| 2016 compared to 2015 energy savings | 2017 compared to 2016 energy savings | Proportion /% | Proportion /% |
| Technical energy savings industry | 79.95 | 36.7 | 99.72 | 60.0 |
| Transportation | 22.47 | 10.3 | 29.92 | 18.0 |
| Structural energy savings building | 9.84 | 4.5 | 9.77 | 5.9 |
| | 47.64 | 21.8 | 60.03 | 36.1 |
| Total social energy savings | 138.15 | 63.3 | 66.48 | 40.0 |

References
[1] Qi Zhixin, Chen Wenying. Structural adjustment or technological progress -- factor analysis of China's energy efficiency improvement after reform and opening up [J]. Shanghai Economic Research, 2006 (6): 8-16
[2] Wu Qiaosheng, Cheng Jinhua. Energy consumption intensity change and factor decomposition in China: 1980-2004 [J]. Economic theory and economic management, 2006, 2006 (10): 34-40
[3] Zhou Yong, Li Lianshui. Contribution of structural and efficiency factors to energy intensity change in China: An Empirical Analysis Based on AWD [J]. Industrial economy research, 2006 (4): 68-74
[4] China Electronic Information Industry Development Research Institute. 2016-2017 China industrial energy conservation and emission reduction development blue book. Beijing: People's publishing house, 2017
[5] Dai Yande, Bai Quan, et al. Scenario study of China's industrial energy conservation in 2020. Beijing: China Economic Press, 2015