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Economic Growth (EG) Relationship of Energy Consumption (EC) Based on Growth Perspective

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Abstract: Energy is the foundation of the development of the national economy. With the rapid development of the economy, the degree of human dependence on energy also increases. Energy utilization is also a complex system, which is closely related to external factors such as economy, population, and locality. How to understand China's changing energy use culture and the relationship between China's energy use and economic development is an important boundary issue. To this end, the text studies the relationship between EC and EG from the perspective of growth. This paper analyzes the relationship between EC, metering capacity and system development through different model methods; studies the different effects of industrial production on EC in different periods. Experiments show that, along with the slowdown in the growth rate of EC, EC and EG have returned to a weak decoupling state in the past ten years, the growth rate of EC has dropped to an average annual rate of 5%, and the growth rate of GDP has continued to stabilize at 9.3%.

1. Introduction

The massive consumption of energy is one of the important supports for my country's rapid economic development. Extensive EG model makes EC show the characteristics of large total amount, low efficiency and serious energy waste, forming an unreasonable industrial and energy structure. At the same time, the inexplicable misuse and inefficient use of energy has led to serious environmental pollution, which not only hinders economic development, but also endangers the health of the people. Getting EG out of dependence on EC, in other words, realizing the decoupling of EC and EG is one of the important ways to achieve sustainable development in my country [1-2].

In a related study, Badea et al. provided an opportunity to assess the knowledge level of the

environmental impact of the Bitcoin mining process from the perspective of EC and carbon dioxide emissions [3]. The findings suggest that Bitcoin remains a tool for various purposes in the economic environment. Magazzino et al. observed that the causal flow from EG to EC dominates at smaller scales (up to 4 years), while at higher scales the strength of the causal link from energy use to growth decreases [4]. Therefore, the impact of EC on EG can only be detected significantly at smaller scales.

Scientifically analyze the relationship between energy use, economic development and industrial structure, and provide scientific support for subsequent energy analysis. This paper uses descriptive methodology to analyze the scale and potential of my country's energy efficiency (EE) and institutional structure, institutional and industrial development, and looks at the development culture and existing problems of EE; builds a comprehensive production model, including energy utilization, and analyzes EC and measurement capabilities through different model methods. The relationship between EC and system development; analyze the relationship between EC and industrial structure, examine the relationship between EC and EC, and study the different effects of industrial production on EC in different periods; analyze the impact of industrial system changes on EE. Factors; summarizing in EE construction, under the model of economic development and industrial structure, through energy response function and analysis differentiation. Based on the above analysis, relevant decisions have been made for my country to solve energy problems, and scientific strategic policy recommendations have been put forward.

2. Design Research

2.1. Energy and Economy

Energy promotes the development of human society and economy, and economic development drives EC. Energy is an important factor of production and means of living, which can neither be completely replaced by other factors of production, nor can it be completely replaced by other consumer goods. Throughout history, more energy is required for national production and life, and this consumption will increase with the expansion and improvement of production scale and consumption structure [5-6].

With the advancement of technology, the type of human energy utilization has undergone a major change, from firewood to coal to oil, and is currently trying to move from oil to clean and renewable energy, and economic development has played a role in promoting it. On the one hand, EG promotes the continuous improvement of the development level of science education, and the improvement of education level improves people's cognition and quality, deepens their understanding of energy, and continuously improves energy utilization technology; on the other hand, the development of energy resources Utilization requires certain material support. Energy development generally has the characteristics of large investment and long construction payback period, and the level of economic development can determine the scale and degree of energy development and utilization.

The traditional EG theory holds that the sustained growth of the economy will not be constrained by energy. The early mainstream EG theories all regard energy as an intermediate variable of basic production factors such as labor and capital, which is exogenous. Can offset the cost problems caused by energy constraints. People realize that the importance of energy and energy security cannot be completely replaced by other elements, and technological progress cannot completely solve the constraints of energy on EG, and energy needs to be studied as a separate input element. Since then, scholars have begun to focus their research on energy supply security and energy

substitution [7-8].

2.2. Basic Principles of Decoupling Optimization

(1) The decoupling and optimization of EC and economic growth should be guided by the concept of sustainable development. my country's previous development model has resulted in that economic growth is heavily dependent on a large amount of energy input and consumption. Therefore, the optimization of the decoupling state of EC and economic growth should be based on satisfying economic and social development and progress on the one hand, and on the other hand, considering the adequacy, efficiency, greenness and sustainability of EC [9-10].

(2) The decoupling and optimization of EC and EG must adhere to the premise of stable economic and social development. Part of EC is to provide necessary material support for daily production and business activities, which promote economic development.

(3) The decoupling and optimization of EC and EG should insist on giving priority to energy conservation. With the rapid economic development, the pressure of my country's EC continues to rise, and energy conservation has always been one of the key focuses of implementing my country's energy strategy in various development periods. It is necessary to reduce EC and eliminate energy waste through diversified methods and three-dimensional energy conservation. Energy conservation is not only conducive to the efficient use of energy and reducing energy pressure, but also has a positive role in promoting environmental protection and energy security [11-12].

(4) The decoupling and optimization of EC and EG should adhere to the development of multiple structures. Energy development should overcome the problems of unbalanced distribution of regional resources, inconsistent economic development levels, inconsistent living styles of residents, and uncoordinated regional structures with differences in concepts, technologies, and policies. , Economic interconnection. In addition, with the deepening of the process of economic globalization, make full use of the advantages of domestic and foreign energy and other resources, and achieve regional coordination at home and abroad while ensuring energy security. For the energy structure, it is necessary to break the traditional energy development model. Energy and industry complement each other. Industry is the concentrated expression of the relationship between EG and EC. Ensuring the healthy growth of the industry and the rational adjustment of the industrial structure will contribute to the long-term stability of energy and economy. Sustainable development [13-14].

2.3. Decoupling Theoretical Framework of EC and EG

Based on the above analysis, this paper constructs a theoretical framework for decoupling EC and EG [15-16], as shown in Figure 1.

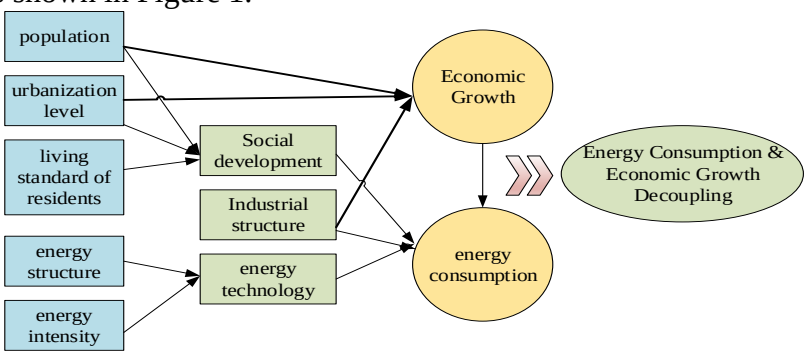

Figure 1. Theoretical framework for decoupling EC and EG

2.4. Interactive Effects among EC, EE and EG

Figure 1 shows the interaction effect between EC, EE and EG, which is essentially the evolution of the path of rational growth of the energy economy. We conduct research based on this consideration, and design research based on macro and overall perspectives. framework, and find the mechanism between the three through quantitative analysis of the mechanism relationship between the three [17-18].

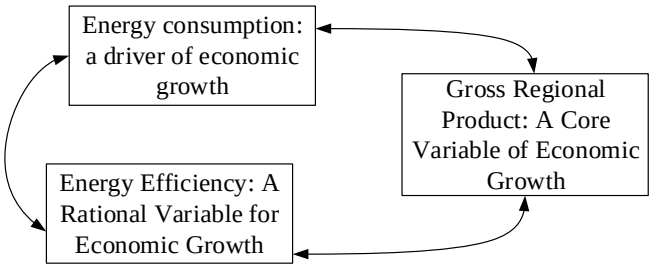

Figure 2. Conceptual framework for rational growth systems in the energy economy

2.5. Empirical Analysis of the Relationship between EC and EG

The establishment of the model: the general form of the production function is as formula (1):

$$Y = F(X_1, X_2, \Lambda\ \Lambda\ , X_k) \tag{1}$$

Among them, Y is the output, X1, X2,..., Xk are various production factors input in the production process.

Adding energy as a production factor to the C-D production function, the three-variable production function model shown in equation (2) is obtained:

$$Y_t = AK_t^{\alpha} L_t^{\beta} E_t^{\gamma} \tag{2}$$

In the above formula, Yt represents output, Kt represents capital input, Lt represents labor input, Et represents EC, A represents technological progress, and α, β, and γ represent the output elasticity of capital, labor, and energy, respectively.

3. Experimental Study

3.1. Decoupling Optimization Objectives

(1) Decoupled state optimization objective

In order to gradually get rid of the dependence on EC for EG, make the economic development mode further healthy and green, the decoupling state of EC and EG will be optimal, and achieve the ultimate goal of sustainable development, my country should continue to maintain both. The weak decoupling between them is unshakable and develops to the best state of strong decoupling as far as possible.

(2) EG target

While optimizing economic development, it is necessary to take into account the impact of urbanization and changes in residents' living standards.

(3) Energy saving goals

The development of my country's energy industry is faced with the situation of continuous growth of EC. Different from the previous increase in the total amount, it is constantly changing towards the high quality and high efficiency of EC. In order to achieve the development goals of my country's EC, it is necessary to effectively implement energy conservation and efficiency issues while controlling the total EC. Implement differentiated differentiation, control and management. Take energy conservation as an important principle of energy reform, implement it in different fields of economic and social development, continuously improve energy conservation standards and measurement systems, improve and implement energy conservation-related policies and systems, and continuously promote EE improvements. At the same time, we must actively do a good job in publicity, advocate reasonable EC patterns and lifestyles, strengthen people's awareness of energy conservation, and improve the public participation system.

(4) Structural optimization goals

There is another aspect to structural optimization, that is, regional structural optimization. Optimizing the regional structure of energy requires a reasonable energy distribution, combined with the energy production and consumption characteristics and economic development advantages of each region, to adjust the energy supply and demand in a targeted manner; increase the construction of energy-related transmission networks, promote the development of energy bases, and effectively use the Internet Improve the level of energy dispatch.

3.2. "EC-EG" System

The "EC-EG" system is mainly composed of the following subsystems:

(1) EG Subsystem

It is mainly reflected in the changing situation of population, capital and technology under certain economic conditions. The EG subsystem mainly includes: total population, population growth rate, population increase, per capita GDP, GDP, labor force increase, employment population increase ratio, urbanization rate, technological progress rate, capital productivity, labor productivity, labor remuneration, Factors such as capital increment, investment ratio and GDP increment.

(2) EC subsystem

Due to the variety of energy in the EC subsystem, if the energy is divided according to different divisions, the energy can also be divided into different types. If the basic form of energy is used as the basis for division, then energy can usually be divided into the following two types: first, primary energy; second, secondary energy. This paper mainly considers the overall EC from the macro level.

The EC subsystem mainly includes total EC, energy intensity, oil consumption, oil proportion, oil and electricity EC, electricity energy proportion, coal consumption, coal proportion, natural gas consumption, conventional natural gas proportion, shale gas to natural gas proportions and other elements.

(3) Environmental subsystem

The environmental subsystem mainly reflects the impact of EC on the environment. It mainly includes: energy intensity, EC, total pollutant discharge, GDP, energy technology progress, carbon dioxide, sulfur dioxide, waste water, net discharge of pollutants, pollutant treatment, environmental pollution factors and other factors.

3.3. Factor Decomposition Model

The decoupling state of EC and EG is affected by the two variables of EC and EG. EG itself is

the main driving factor of EC. Therefore, the driving factor of EC can be approximately regarded as the decoupling of EC and EG. In the definition of the concept of EC, it is pointed out that there are two purposes of EC, to meet the needs of production activities and to meet the needs of residents' living. It can be seen that, according to the purpose of use, EC can be divided into two types: production EC and living EC. Combining the theoretical framework of the decoupling of EC and EG, it can be seen that in addition to EG, production EC is mainly affected by industrial structure and energy technology, while domestic EC is mainly affected by social development and energy technology.

Based on the theoretical framework of the decoupling of EC and EG, this paper establishes a multi-level indicator system for the analysis of the driving factors of the decoupling of the two. It is hoped that through the quantitative evaluation of various factors at different levels, we can understand the influence mode and degree of influence of different factors on the decoupling of EC and EG in the whole and at each level.

Based on the above theoretical analysis and considering the completeness and availability of data collection, this paper chooses the logarithmic mean Diesel index (LMDI) decomposition method based on the Kaya identity principle to study the driving factors of the decoupling of EC and EG. This method solves the problem of residual items and zero values in the traditional exponential decomposition method, and has the characteristics of complete decomposition and the advantage of uniqueness. The article first refines the total EC in terms of production and life:

$$E = E_P + E_L \tag{3}$$

In the formula, E represents the total EC; EP represents the production EC; EL represents the living EC. Among them, the residents' living EC is subdivided into two types: urban EC and rural EC, which are expressed as:

$$E_L = E_u + E_r \tag{4}$$

Eu is the urban living EC; Er is the rural living EC. According to the summation formula of the LMDI decomposition method, the production EC, urban and rural domestic EC can be sequentially expressed as the following formulas:

$$\begin{aligned} E_P &= \sum_i \sum_j E_{ij} = \sum_i \sum_j \frac{E_{ij}}{E_j} \cdot \frac{E_j}{Y_j} \cdot \frac{Y_j}{G} \cdot G = \sum_i \sum_j E_{e\_str} \cdot E_{ei} \cdot E_{i\_str} \cdot E_{es} \\ E_u &= \sum_i E_{iu} = \sum_i \frac{E_{iu}}{E_u} \cdot \frac{E_u}{C_u} \cdot \frac{C_u}{P_u} \cdot \frac{P_u}{P} \cdot P = \sum_i E_{u\_str} \cdot E_{u\_ei} \cdot E_{u\_ls} \cdot E_{ur} \cdot E_{pop} \\ E_r &= \sum_i E_{ir} = \sum_i \frac{E_{ir}}{E_r} \cdot \frac{E_r}{C_r} \cdot \frac{C_r}{P_r} \cdot \frac{P_r}{P} \cdot P_r = \sum_i E_{r\_str} \cdot E_{r\_ei} \cdot E_{r\_ls} \cdot E_{r\_pop} \end{aligned} \tag{5}$$

For EC in production activities, this paper subdivides different industries and different energy types. Eij represents i EC in j industry; Ej is the total EC of j industry; Yj represents the output value of j industry; G is the total GDP. There are four driving factors for energy production, namely: $E_{e\_str} = E_{ij}/E_j$ represents the production energy structure effect; $E_{ei} = E_j/Y_j$ is the EC per unit of output value, representing the energy intensity effect; $E_{i\_str} = Y_j/G$ represents the industrial structure effect; $E_{es} = G$ represents the economic scale effect.

4. Experiment Analysis

4.1. Analysis of the Overall Evolution Trend

This paper combines DSA sampling and Tapio elastic decoupling state measurement model to determine the decoupling state of EC and EG in my country in the past 20 years. The result is as follows:

Table 1. Changes in the decoupling state of my country's EC and EG in the past two decades

Years	Elasticity coefficient	Decoupled state
The first six years	0.34	Weak decoupling
The last four years	1.51	Dilated negative decoupling
Nearly ten years	0.52	Weak decoupling

In general, the relationship between EC and EG in the first six years was in a weak decoupling state, that is, EC increased with EG, with an average annual growth rate of 8.4% and 2.8%, respectively. In the seventh year of joining the WTO, under the influence of economic globalization and the further opening of market competition in the energy industry, EC rose sharply and the growth rate increased. Therefore, in the next four years, EC and EG are in a state of negative expansion and decoupling. Both are in a growth trend, and the growth rate of EC is much higher than that of GDP. Data show that during this period, GDP grew at an average annual rate of 10.5%, while EC rose to 14.5% from an average annual growth rate of 2.8% in the previous period. In the tenth year, it was decided to form a virtuous circle between social and economic activities and ecological and environmental systems. The proposal of the two-oriented society takes into account the sustainable development of multiple systems such as economy, resources, and environment, and puts forward requirements for energy production and utilization. With the slowdown in the growth rate of EC, EC and EG have returned to a weak decoupling state in the past decade. The growth rate of EC has dropped to an average annual rate of 5%, and the growth rate of GDP has continued to stabilize at around 9.3%.

4.2. Industry and Structural Characteristics of EC

(1) EC has the characteristics of industrial concentration and industry concentration

Since energy is the "food" of the industrial sector, this inevitably determines the higher EC in the industrial sector. The sectoral composition of my country's EC in the past six years is shown in Table 2.

Table 2. Sectoral composition of my country's EC in the past 6 years

Industry	1	3	3	4	5	6
Agriculture, forestry, animal husbandry and fishery	1.98	1.96	1.92	1.90	1.88	1.89
Industry	72.51	70.99	70.76	69.35	68.76	67.54
Construction industry	1.62	1.48	1.51	1.62	1.73	1.80
Transportation warehousing postal industry	7.43	7.55	8.09	8.65	8.72	9.01
Wholesale and retail accommodation and catering industry	2.15	2.24	2.36	2.48	2.47	2.59
Other industry	4.22	5.52	4.98	5.10	5.41	5.69
Living consumption	10.09	10.26	10.38	10.92	11.03	11.48
Total	100	100	100	100	100	100

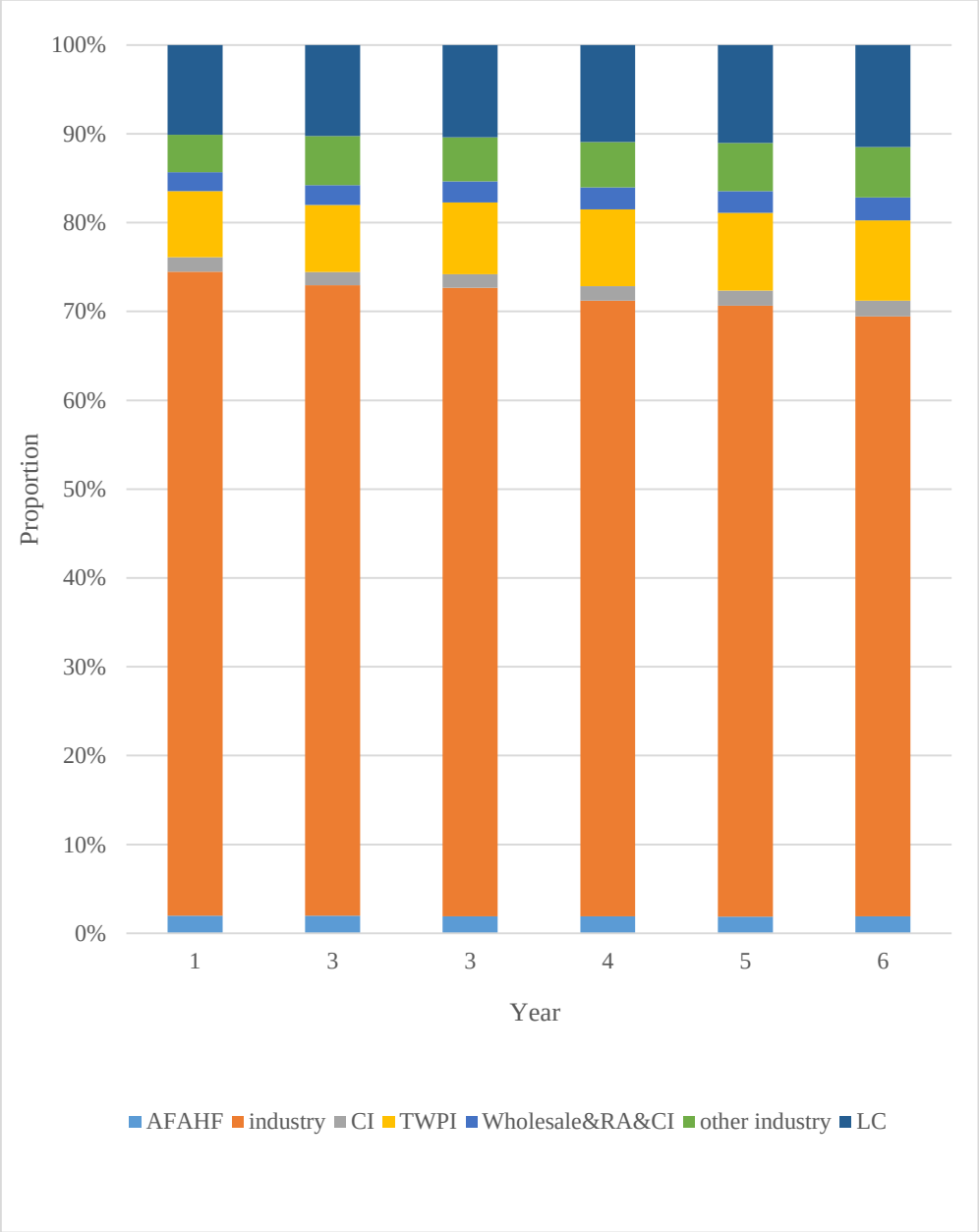

Figure 3. Analysis of the sectoral composition of my country's EC in the past 6 years

It can be seen from Figure 3 that my country's EC has the characteristics of industrial concentration, and the proportion of EC in the industrial sector is the highest, but it shows a slight downward trend year by year.

Due to the high concentration of EC within the industry, Figure 4 lists the EC of the top 10 industries in terms of total EC in one year. They are ferrous metal smelting and rolling industry, chemical raw material and chemical product manufacturing, non-metallic mineral products industry, electric power and heat industry, petroleum product coking industry, non-ferrous metal smelting and rolling processing industry, coal mining and washing industry, textile industry, Agricultural and sideline food processing and food manufacturing, metal products industry.

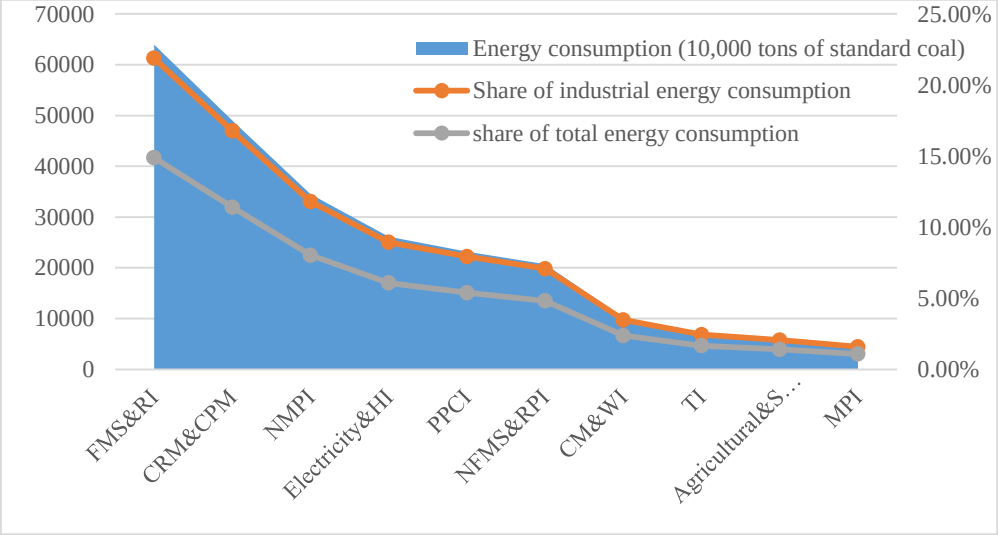

Figure 4. Analysis of the EC of the top 10 industries in terms of EC in the industrial sector during the year

Analysis of the above figure shows that, the total EC of the top 10 industries in the industrial industry within one year accounted for 84% of the total industrial EC and 57% of the total EC, reflecting that my country's EC has industry concentration.

(2) The EC structure of different industries has different characteristics

Table 3 lists the EC structure of coal, oil products, natural gas and electricity and heat in each sector within one year.

Table 3. EC structure of each department in one year

Industry	Coal	Oil	Natural gas	Electricity and heat
Agriculture, forestry, animal husbandry and fishery	33.95%	43.71%	0.21%	22.13%
Industry	41.84%	15.28%	4.85%	38.02%
Construction industry	10.99%	74.62%	0.44%	13.95%
Transportation warehousing postal industry	1.02%	87.44%	7.23%	4.31%
Wholesale and retail accommodation and catering industry	40.30%	12.50%	9.04%	38.17%
Other industry	21.92%	37.62%	4.10%	36.36%
Living consumption	20.61%	28.60%	13.83%	36.96%

Analyzing Figure 5, that the industrial sector has the highest proportion of coal consumption, the transportation, storage and postal industries have the highest proportion of oil consumption, the living sector has the highest proportion of natural gas consumption, and the industrial sector has the highest proportion of electricity and heat consumption, followed by the living sector. It can be seen that the EC structure within each department has industry characteristics and is determined by the production situation of the industry.

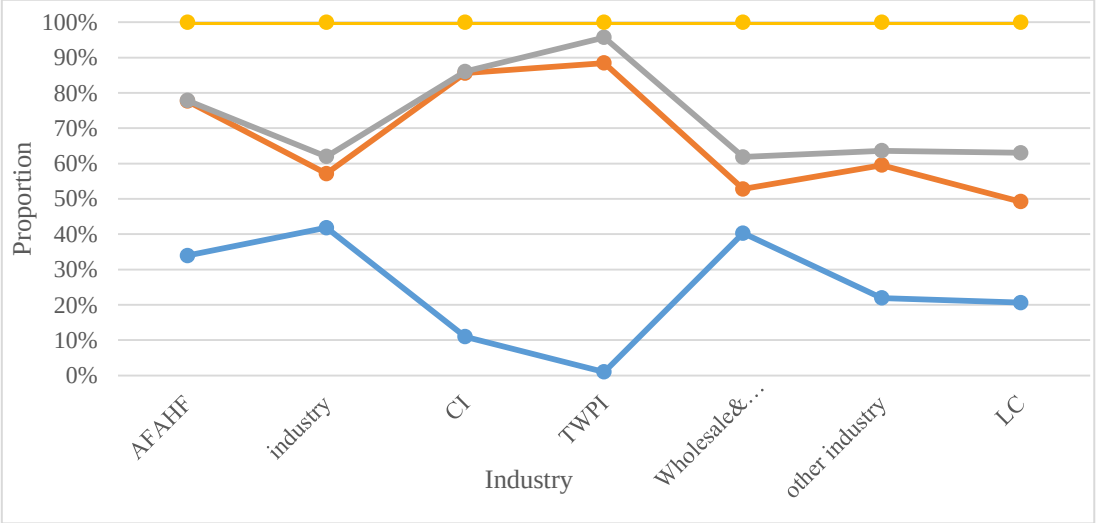

Figure 5. Analysis of the EC structure of each department in one year

5. Conclusion

Energy is an important tool for economic and social development. The rapid economic development of our country depends on the large consumption of energy. The extensive EG model makes the EC show the characteristics of large total amount, low efficiency and serious energy waste, forming an unreasonable industrial and energy structure. In addition, the exploitation, utilization and consumption of energy have also brought serious environmental pollution, which not only hinders EG, but also threatens the survival and development of residents. Freeing EG from dependence on EC is one of the important ways to achieve sustainable development in my country, and research on the decoupling of EC and EG emerges as the times require.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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