

# Construction and Application of Evaluation Index System for New and Old Kinetic Energy Conversion

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## ABSTRACT

This document decomposes the connotation and goals of the old and new kinetic energy transformation into seven dimensions: development effectiveness, innovation development, openness, environmental protection and people's livelihood, etc. Then, through the analytic hierarchy process and comprehensive evaluation method, the evaluation index system of new and old kinetic energy conversion is constructed. And we quantitatively evaluate the effectiveness in Shandong Province. Compared with the effects in the advanced areas of the east and the backward areas of the central and western regions, we find that in terms of openness, environmental protection, people's livelihood development and digital economy development, Shandong Province has a large gap with Guangdong, Jiangsu, and Zhejiang, and even lower than the backward provinces such as Anhui and Henan; in terms of development effectiveness, innovation development and factor supply, the gap between Shandong, Guangdong, Jiangsu and Zhejiang is relatively small, but there is no significant advantage compared with the backward provinces such as Anhui and Henan; in terms of system supply, Shandong and Guangdong, Jiangsu, Zhejiang are similar.

**Keywords:** new and old kinetic energy conversion, evaluation index system, entropy weight method

## 1. INTRODUCTION

At present, China's economy has shifted from high-speed to high-quality, and is in the process of transforming the development mode, optimizing the economic structure, and transforming the growth momentum. Facing China's current macroeconomic operation, the poor conversion of old and new kinetic energy is an important challenge. Accelerating the transformation of old and new kinetic energy is not only the inevitable choice for solving the problem of China's economic development in the new era, but also the key to the successful transformation of the stage of economic development. In January 2018, the State Council approved the construction of a comprehensive test area for new and old kinetic energy conversion in Shandong Province. This is the first regional national development strategy approved after the 19th National Congress and the first regional development strategy with the theme of conversion of old and new kinetic energy. Shandong not only has the advantages and foundations of leading development in developed regions, but also faces the problems and confusions of the transformation and development of resource-based and heavy industrial structures. As a comprehensive test area for new and old kinetic energy conversion, Shandong is typical and representative. Therefore, it has important theoretical and practical to evaluate index system and implementation path of the new and old kinetic energy conversion, and take Shandong as an example for application analysis and compare it with the advanced areas in the east and the backward areas in the central and western regions.

Domestic scholars have constructed and analyzed the old and new kinetic energy conversion index system. From the

statistical perspective, Liu Qitao[1]used the relevant data of Qingdao City as an example to make a basic analysis measure, and built an index system from six dimensions: knowledge ability, economic vitality, innovation drive, transformation and upgrading, and development effectiveness. Then adopted the quantitative measure of the index analyzed the conversion of new and old kinetic energy in Qingdao. Sun Xiumei[2] used the analytic hierarchy process and fuzzy comprehensive evaluation method to select indicators from four aspects: quality and efficiency, innovation and development, openness and environmental protection and people's livelihood, and constructed a new and old kinetic energy conversion performance evaluation index system. Then compare and analyze the effectiveness evaluation of new and old kinetic energy conversion between Shandong Province and Hebei, Zhejiang, Jiangsu and other three eastern coastal provinces. Generally speaking, there are certain limitations in the selection of performance evaluation indicators for the "new and old kinetic energy conversion" currently, and it cannot fully consider the development potential, environmental protection and other factors. This paper constructs an evaluation index system of new and old kinetic energy transformation from seven levels of development, innovation, openness, environmental protection, elements, system s and digits, and uses the analytic hierarchy process and entropy method to quantify the weight. Use the advanced provinces in the east and the backward provinces in the central and western as examples to apply the index system. We find that there is a gap between Shandong and the eastern advanced provinces, and based on this, propose the implementation path of the new and old kinetic energy conversion in Shandong.

## 2. NEW AND OLD KINETIC ENERGY CONVERSION EVALUATION INDEX SYSTEM CONSTRUCTION METHOD

### 2.1. Index System Construction Principle

In the process of establishing a new and old kinetic energy conversion effectiveness evaluation system, this paper mainly follows the following principles: 1. Systematic principle: There must be a certain logical relationship between the indicators. They not only reflect the effects of the conversion of old and new kinetic energy from different aspects, but also have certain internal links between the indicators; 2. Main factor principle: The indicators should be able to comprehensively reflect the main aspects of the effectiveness, and take the seven aspects as evaluation targets; 3. Quantitative principle: In order to avoid the impact of

subjective evaluation on the evaluation results, the selected indicators should be the relevant indicators published in the relevant bulletin and the statistical yearbook, or the data directly or indirectly calculated by relevant national data. Indicators can also reflect the qualitative content of the indicators evaluated to a certain extent.

### 2.2. Indicator Selection

On the basis of a comprehensive analysis of the effectiveness achieved by the conversion of old and new kinetic energy, following the relevant principles, through the consultation and investigation of relevant government departments, and referring to the government implementation plan related to the conversion, this paper designs an evaluation index system of conversion effectiveness. The new and old kinetic energy conversion effectiveness evaluation index system is shown in Table 1.

**Table 1** New and old kinetic energy conversion effectiveness evaluation index system

Target layer	Criteria layer	Indicator layer	coding	Indicator attribute
New and old kinetic energy conversion effectiveness evaluation index system	Development effectiveness (X1)	New economic proportion	X11	Positive
		Full labor productivity	X12	Positive
		The proportion of general public budget revenue in GDP	X13	Positive
		The proportion of the added value of strategic emerging industries in GDP	X14	Positive
		The proportion of the added value of modern service industry in GDP	X15	Positive
		Industrial Informatization Fusion Index	X16	Positive
		Number of top 100 most valuable brands in China	X17	Positive
		Resident per capita disposable income	X18	Positive
		R&D investment as a percentage of total production	X21	Positive
		Contribution rate of scientific and technological progress	X22	Positive
	Innovation development (X2)	Number of high-tech enterprises	X23	Positive
		R&D staff per 10,000 people	X24	Positive
		PCT international patent filings	X25	Positive
		Internet plus index	X26	Positive
	openness (X3)	Per capita information consumption	X27	Positive
		Economic extroversion	X31	Positive
		The proportion of high-tech industry exports	X32	Positive
		Exports to countries and regions along the "Belt and Road" account for the national proportion	X33	Positive
	Environmental protection and people's livelihood(X4)	10,000 yuan regional GDP energy consumption	X41	Negative
		Respirable particulate matter (PM2.5) concentration	X42	Negative
		Clean energy generation ratio	X43	Positive
		The proportion of clean energy in new power generation installed capacity	X44	Positive
	Factor supply(X5)	Per capita years of education	X51	Positive
		The proportion of fixed assets investment in high-tech industries to investment	X52	Positive
	System	The proportion of General public budget expenditure in GDP	X61	Positive

Target layer	Criteria layer	Indicator layer	coding	Indicator attribute
	supply(X6)	The proportion of non-state-owned holding companies	X62	Positive
		Urbanization level	X63	Positive
		Marketization level	X64	Positive
		Business Environment Index	X65	Positive
		Corporate e-commerce sales ratio	X71	Positive
	Digital economy(X7)	Corporate e-commerce purchases ratio	X72	Positive
		The proportion of online retail sales in retail sales	X73	Positive

### 2.3. Indicator evaluation method

In the process of evaluating the effectiveness, the main calculation steps are: 1. Data dimensionless processing; 2. Calculate the weight of each indicator; 3. Synthetic evaluation result.

#### 2.3.1. Data dimensionless processing

Determine the target value of each indicator, according to the relevant standards designated by the country and the development plans of relevant cities. The relevant data is dimensionlessly processed according to the determined target value. Among them, the processing method of the positive index is the ratio of the index value to the corresponding target value; the processing method of the negative index is the ratio of the corresponding target value to the index value.

#### 2.3.2. Calculate the weight of each indicator

We use information entropy to calculate weight of each indicator. First, calculate the entropy value  $H$  of each index by using the dimensionless data  $x$  obtained in step 1. The calculation formula is:

$$H_j = -\frac{1}{\ln(n)} \sum_{i=1}^n X_{ij} \ln(X_{ij}) \quad (1)$$

Then use the result of equation (1) to calculate the degree of discrimination  $F$ . The calculation formula is

$$F_j = 1 - H_j. \quad (2)$$

Finally, the weight  $w$  of each evaluation index is calculated, and the calculation formula is:

$$W_j = \frac{F_j}{\sum_{k=1}^n F_k} \quad (3)$$

#### 2.3.3. Synthetic evaluation result

By multiplying the index value after the dimensionless processing and the corresponding weight, and summing up, the evaluation results corresponding to each province and city are obtained.

## 3. APPLICATION OF NEW AND OLD KINETIC ENERGY CONVERSION EVALUATION INDEX SYSTEM

In the eastern coastal areas of China, industrial restructuring, transformation and upgrading are at the forefront of the country. In order to study the gap between Shandong Province and the eastern coastal areas, Guangdong, Jiangsu and Zhejiang were compared as advanced areas. Anhui and Henan are developing relatively fast, and the gap with Shandong is shrinking. Therefore, Anhui and Henan are compared as backward areas. Calculate the values of each indicator in Shandong, Guangdong, Jiangsu, Zhejiang, Anhui, and Henan in 2017.

Calculate the weights of the dimensionless processed data by information entropy, and obtain the weights of the indicators under each criterion and the final weights of all indicators. The weights of new and old kinetic energy conversion effectiveness evaluation index system are shown in Table 2.

**Table 2** New and old kinetic energy conversion effectiveness evaluation index system weight

Target layer	Criteria layer	coding	Target value	Weights	Final weight
New and old kinetic energy conversion effectiveness evaluation index system	Development effectiveness (X1)	X11	40	0.1287	0.0324
		X12	30	0.1247	0.0314
		X13	30	0.1260	0.0317
		X14	20	0.1284	0.0323
		X15	50	0.1284	0.0323
		X16	100	0.1293	0.0326
		X17	30	0.1081	0.0272
		X18	10	0.1263	0.0318
	Innovation	X21	5	0.1533	0.0321

Target layer	Criteria layer	coding	Target value	Weights	Final weight
	development (X2)	X22	80	0.1557	0.0325
		X23	40000	0.1337	0.0280
		X24	150	0.1503	0.0314
		X25	30000	0.1007	0.0211
		X26	100	0.1550	0.0324
		X27	6000	0.1513	0.0316
		X31	120	0.3142	0.0294
	openness (X3)	X32	70	0.3419	0.0320
		X33	50	0.3440	0.0322
	Environmental protection and people's livelihood(X4)	X41	0.6	0.2549	0.0325
		X42	70	0.2529	0.0322
		X43	50	0.2402	0.0306
		X44	100	0.2520	0.0321
	Factor supply(X5)	X51	15	0.5047	0.0325
		X52	30	0.4953	0.0319
		X61	30	0.1971	0.0318
		X62	100	0.2012	0.0325
	System supply(X6)	X63	100	0.2005	0.0324
		X64	100	0.2008	0.0324
		X65	100	0.2004	0.0324
	Digital economy(X7)	X71	80	0.3374	0.0311
		X72	80	0.3280	0.0302
		X73	80	0.3346	0.0308

By multiplying the dimensionlessly processed values by the corresponding index weights and summing them together, we can obtain the evaluation results of the new and old kinetic energy conversion results of six provinces in 2017. On the whole, descending order of the six provinces is Guangdong, Zhejiang, Jiangsu, Shandong, Henan, Anhui in 2017.

According to different criteria, Shandong Province has a large gap with Guangdong, Jiangsu and Zhejiang in terms of openness, environmental protection, people's livelihood development and digital economy development, even lower than that of Anhui, Henan and other backward provinces. In terms of development effectiveness, innovation and supply of factors, Shandong has a small gap with Guangdong, Jiangsu and Zhejiang, but it has no significant advantage over the backward provinces such as Anhui and Henan; In terms of system supply, Shandong is equivalent to Guangdong, Jiangsu and Zhejiang.

In terms of openness, the main reason for the low score in Shandong is that the economic outwardness is low, only 23%, not only far lower than Guangdong's 76.0%, but also a big gap compared with Zhejiang (49.3%) and Jiangsu(46.5). In this regard, Shandong should expand its exports, especially the export of high-tech products, with its unique geographical location, industrial upgrading and transformation, and the Belt and Road strategy.

In terms of environmental protection and people's livelihood development, Shandong is lagging behind Guangdong, Jiangsu, and Zhejiang in the energy consumption per 10,000

yuan, PM2.5 concentration, and clean energy power generation, especially in 10,000 yuan regional GDP energy consumption. The data of Shandong was 0.5, while the energy consumption data of Guangdong, Jiangsu and Zhejiang were all around 0.4. The 10,000 yuan regional GDP energy consumption in Shandong was higher than that of Guangdong, Jiangsu and Zhejiang by more than 20%. Therefore, Shandong should rationally control the development of high-energy-consuming industries, accelerate the withdrawal of excess capacity, and improve the indicator by developing an intensive economy.

In terms of the development of the digital economy, there is a large gap between Shandong and Guangdong, Jiangsu, and Zhejiang in the proportion of online retail sales to retail sales, the proportion of corporate e-commerce sales, and the proportion of e-commerce purchases, and compared with the backward provinces, Shandong has the similar level. In this respect, Shandong should promote the development of the digital economy through sound institutional guarantees, active promotion of digitalization of local enterprises, and vigorous introduction of e-commerce enterprises.

In terms of system supply, Shandong is equivalent to Guangdong, Jiangsu, and Zhejiang. It further illustrates the achievements of Shandong as a national comprehensive test area for new and old kinetic energy conversion, and shows that the new kinetic energy has a good development environment and policy support in Shandong. The conversion

effectiveness of new and old kinetic energy in Shandong Province and typical provinces is shown in Table 3.

**Table 3** The new and old kinetic energy conversion effectiveness

	Shandong	Guangdong	Jiangsu	Zhejiang	Anhui	Henan
Comprehensive evaluation	0.45	0.56	0.59	0.70	0.42	0.43
Development effectiveness (X1)	0.46	0.54	0.53	0.59	0.41	0.39
Innovation development (X2)	0.37	0.49	0.43	0.71	0.32	0.30
openness (X3)	0.33	0.61	0.54	0.61	0.35	0.53
Environmental protection and people's livelihood(X4)	0.49	0.57	0.79	0.89	0.53	0.53
Factor supply(X5)	0.48	0.57	0.53	0.65	0.47	0.49
System supply(X6)	0.70	0.70	0.72	0.73	0.59	0.61
Digital economy(X7)	0.21	0.51	0.69	0.80	0.18	0.21

#### 4. MAIN CONCLUSION

Based on the principles of systemic, major and quantitative, this paper constructs an evaluation system of new and old kinetic energy conversion effects from seven perspectives. In terms of openness, environmental protection and people's livelihood development and the development of the digital economy, Shandong has a large gap with Guangdong, Jiangsu and Zhejiang, even lower than the backward provinces such as Anhui and Henan. In terms of development effectiveness, innovation development, and factor supply, the gap between Shandong and Guangdong, Jiangsu, and Zhejiang is small, but it has no significant advantage over the backward provinces. In terms of system supply, Shandong is similar to Guangdong, Jiangsu and Zhejiang. Realizing the transformation of old and new kinetic energy is a dynamic and long-term process. It is necessary to persist in deepening reform, promoting innovation, and expanding openness as the fundamental driving force for the transformation of old and new kinetic energy. Strengthen institutional design, systematic planning and coordinated promotion, and continuously stimulate the vitality and creation of the whole society. Constantly enhance the endogenous driving force of economic development, promote the quality transformation, efficiency change and dynamic change of economic development. Improve total factor productivity and promote higher quality, more efficient, fairer and more sustainable economic development.

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