Analysis of influencing factors of energy data market construction and development based on entropy weight DEMATEL method

ChunLei Zhou[1], JunNi Li[1], TianGuang Yang[2], JinWei Song[1], Yu Zhang[2], SiYuan Gao[3*], YaFeng Wen[3]

*Correspondence: 15653700817@163.com

Big Data Center, State Grid Corporation of China, Beijing 100052, China[1]
Beijing SGITG-Accenture Information Technology, Beijing 100052, China[2]
School of Electrical and Electronic Engineering of the North China Electric Power University, Beijing 102206[3]

Abstract. The construction of data market is of great strategic significance to the development of energy industry. Aiming at the key influencing factors of the construction and development of energy data market, we analyze the influence of policies and laws, market system, value creation and big data technology on energy data market, and construct an evaluation index system of influencing factors of energy data market. Then, entropy weight -DEMATEL method is used to comprehensively evaluate each index. Finally, the evaluation results of the index system are evaluated by experts, and it is concluded that the most basic factors affecting the construction and development of energy data market are business compliance, social benefits of products, environmental benefits of products, data product development, data sharing technology and data privacy protection.

Keywords. energy data market; Data transaction; Energy data; Data assets; Entropy weight -DEMATEL method;

1 Introduction

At present, the data trading mechanism is the research hotspot. Literature [1], aiming at data trading, proposes a data trading mechanism oriented to federated learning, which provides an effective means to get rid of the dilemma of "data island". Literature [2] establishes a data market based on auction mechanism to promote the interaction between renewable energy production and forecast data. Literature [3] proposes a pricing mechanism that comprehensively considers data contribution, integrity and query quality. Literature [4] proposes a data resource pricing method based on the multi-algorithm fusion model for Stacking in view of the information asymmetry between buyers and sellers in data transactions. Literature [5] divides data ownership according to data type and subject classification. Bao Xiaoli [6] also considered the process of data value generation and the legal attributes of data, and proposed a second-order sequential data ownership rule. Literature [7] designed a trusted data trading ecosystem based on blockchain. In order to explore the key influencing factors of

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the construction and development of the energy data market, establishes the evaluation index system of the influencing factors of the energy data market. Then, the entropy weight -DEMATEL method is used to evaluate the expert score results, and the comprehensive situation of the influencing factors of the energy data market is obtained. According to the research results, six indexes, namely business compliance, product social benefit, product environmental benefit, data product development, data sharing technology, and data privacy protection, are the main influencing factors for the construction and development of energy data market, and suggestions are put forward accordingly.

2 Construction of index system of energy data market influencing factors

2.1 Analysis of influencing factors of energy data market

2.1.1Valence dimension selection

At the early stage of the construction of the energy data market, the policy environment plays a guiding role in the market activities.The legal environment regulates the market behavior, which is the basic guarantee for the operation and development of the energy data market.Data trade produces direct economic benefits, and data circulation can bring indirect economic benefits.The construction of energy data market is not only to promote the flow of data itself, but also to promote the flow of energy data value.To sum up, this topic from the policy and legal environment, value creation, market management system, data flow technology, the main influencing factors of energy data market are analyzed from four aspects.

2.1.2Policy and Legal Environment

In recent years, the transformation of digital strategy has become an important strategy of all countries in the world, and many countries and regions have introduced laws and regulations to promote data transaction.Our country, the "14th Five-Year Plan for Digital Economy Development", the "14th Five-Year Plan for Digital Economy Development".Relevant supporting laws and regulations are also being gradually introduced to further promote the formal development of the data factor market.On the one hand, data transactions need to be regulated and restricted by laws. Data ownership, data transactions and data privacy protection all need to be based on laws. Legal transaction compliance is the most basic guarantee of data market.At present,There is no normative document with legal effect aiming at the big data trading activities.On the other hand, policy support is an important power source for the construction of energy data market.

2.1.3Market management system

Through the energy data market management system and the formulation of the code of conduct of participants, the standardization of the whole life cycle of data trading can be realized, with the main rights confirmation, pricing, trading and supervision systems.Data confirmation is the basic condition of data transaction.The confirmation of data ownership is very complicated.In addition, the establishment of property rights of data commodities should consider not only legal attributes, but also market factors.Data pricing mechanism can

standardize the market behavior of data trading fundamentally, and data trading mechanism is the basis of data trading.Establishing and improving the trading mechanism of data commodities is a necessary condition for constructing a complete energy data market.Market transaction regulation is also an essential link in energy data trading.The development of efficient and reliable data asset management system can promote the transformation of energy data resources into data assets.In the aspect of data supply management, data collection and transmission mechanism is a necessary condition for the stability of data market supply.To sum up, from the dimension of data market management system, we select data asset management, data right confirmation system, data circulation system, data pricing system, data trading system, data trading supervision, data operation strategy data reliable collection, and data efficient access as influencing factors.

2.1.4Value creation

As the product of the combination of energy and big data, energy data will further strengthen the connection between energy and information, improve energy efficiency on the one hand, and increase the value of information transmission on the other hand. It is not only of great strategic significance to the development of the energy field, but also of great value to the society, economy and environment. Energy data trading can strengthen the cooperation between government and enterprises, promote the collection and sharing of data in the field of energy and public services, and form a powerful social governance force. The establishment of energy data market creates huge value for the government, enterprises and other data subjects, which will promote the construction of data market and form a virtuous cycle.

2.1.5Big Data Technology

Data trading needs to rely on big data technology, which mainly includes data management and processing technology, data sharing technology, data fusion technology and data product development technology. Data access, storage and access control require the support of data management and processing technology. Data sharing technology mainly aims at the security and sharing efficiency in the process of data transaction. Safe and reliable data sharing environment and perfect privacy protection mechanism are the basic guarantee for data transaction. In the energy data market, there are a wide range of data sources and big data differences, leading to big differences in model standards, design specifications, coverage areas and other aspects, resulting in difficult data aggregation. Therefore, it is necessary to carry out data fusion, so as to lay the foundation for data sharing and trading. Data product development technology is the basic support of data assets.

2.2 Analysis of influencing factors of energy data market

Based on the above research content, an energy data market evaluation index system, including 24 secondary indexes, is constructed from four dimensions of policy and law, market system, value creation and big data technology, as shown in Table 1.

Table 1 index system of influencing factors of energy data market

Dimension	Sub dimension	Influence factor	The serial number
Policy and law	Laws and regulations	Business compliance	A1
	Policy	Level of policy support	A2
		Policy orientation	A3
The market system	Data management system	Data Asset Management	B1
		Data confirmation system	B2
		Data flow system	B3
	Data transaction system	Data pricing system	B4
		Data transaction system	B5
		Data transaction supervision	B6
		Data Operation Strategy	B7
	Data supply incentive	Reliable data acquisition	B8
		Efficient data access	B9
Value creation	Social value	Social benefits	C1
		Environmental benefits	C2
		Industry benefits	C3
		Technical efficiency	C4
	The economic value	Data transaction cost	C5
		Direct economic benefits	C6
		Indirect economic benefit	C7
Big Data Technology	Data processing technology	Data management Technology	D1
		Data processing capacity	D2
		Data Product Development	D3
	Data flow technology	Data sharing technology	D4
		Data privacy protection	D5

3 Construction of index system of energy data market influencing factors

In this paper, entropy weight -DEMATEL method is used to comprehensively evaluate the scoring results of the index system.Considering the complex relationship between different factors, DEMATEL method was introduced to quantify the interaction between different factors based on the entropy weight method.The evaluation method based on entropy weight -DEMATEL can not only overcome the subjectivity of expert rating to a certain extent, but also prevent the internal relationship of influencing factors from being ignored, so as to reduce

the evaluation error.

3.1 Entropy weight method to determine the index weight

Firstly, the original evaluation matrix is normalized. On this basis, the entropy weight method is used to determine the weight of each index.The entropy *j* of the JTH index calculated by the entropy weight method e_j is:

$$e_j = -\frac{1}{\ln m}\sum_{i=1}^{m} p_{ij} \ln p_{ij} \tag{1}$$

$$p_{ij} = z_{ij} / \sum_{i=1}^{m} z_{ij} \tag{2}$$

p_{ij} is the proportion of the ith evaluation scheme of the JTH evaluation index. The dispersion degree d_j of the evaluation data of the JTH index is expressed as $d_j = 1 - e_j$,Therefore, the weight w_j of the JTH index is expressed by the entropy weight method as:

$$w_j = d_j / \sum_{j=1}^{n} d_j = (1 - e_j) / \sum_{j=1}^{n} (1 - e_j) \tag{3}$$

3.2 DEMATEL method was used to calculate impact

DEMATEL method is used to analyze the logical relation and direct influence matrix of each influencing factor.Based on graph theory and matrix operation, the effects of each element on other elements are found out, and the relationship between each element and the position of each element in the index system are found out.To analyze impact using the DEMATEL method, perform the following steps.

1）The direct influence matrix *M* is obtained by quantifying the relationship between various influencing factors.

$$M = \begin{bmatrix} 0 & a_{12} & \cdots & a_{1n} \\ a_{21} & 0 & \cdots & a_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ a_{n1} & a_{21} & \cdots & 0 \end{bmatrix} \tag{4}$$

2）By normalizing the original relation matrix, the norm which directly affects the matrix *N* is obtained.

$$M_i = \max\left\{\sum_{j=1}^{n} M_{ij}\right\} \tag{5}$$

$$b_{ij} = \frac{M_{ij}}{M_i} \tag{6}$$

$$N = \left[b_{ij}\right] \tag{7}$$

3）The comprehensive influence matrix T is obtained from the normalized direct influence matrix.

$$T = N * (I - N)^{-1} \tag{8}$$

4）According to the values $D = (D_1, D_2, \cdots, D_n)$, $C = (C_1, C_2, \cdots, C_n)$, in the comprehensive impact matrix t, the impact degree *Di*, impact degree *Ci*, centrality degree *Mi*, and cause degree *Ri* of each factor were calculated.Impact reflects the impact of an indicator on other indicators.Impact refers to the impact of other indicators on the indicator.Centrality refers to the role of the index in the whole system.The effect of cause degree index on other factors.If the cause degree is greater than 0, other indicators will be affected by this indicator.If the cause degree is less than 0, the indicator will be affected by other indicators.

$$\begin{cases} D_i = \sum_{j=1}^{n} t_{ij} \\ C_i = \sum_{j=1}^{n} t_{ji} \\ M_{i=} D_i + C_i \\ R_{i=} D_i - C_i \end{cases} \tag{9}$$

5）For each index, the weight calculated by the entropy weight method is multiplied by the centrality, and then normalized to obtain the comprehensive obstacle degree of each factor.

4 Analysis of influencing factors of energy data market

4.1 Analysis of evaluation results

Establish an expert review team, and obtain the index value of each business through the expert score.Among them, the quantitative method of qualitative evaluation index is shown in Table 2.

Table 2 quantification of energy data market construction indicators

The index type	The worst/least	Poor/less	Good/high	The best/highest
Benefit index	50	65	80	95
Index of the cost	95	80	65	50

The original matrix is normalized, and then the weight of each index is calculated by entropy weight method.The weights of each index are shown in Table 3.

Table 3 index weight of energy data market construction

indicators	The weight	ranking	indicators	The weight	ranking
A1	0.076	1	D1	0.05	13
C2	0.068	2	D3	0.05	14
C1	0.063	3	B9	0.048	15
A2	0.062	4	D2	0.047	16
D5	0.061	5	C3	0.038	17
D4	0.059	6	B6	0.035	18
B1	0.053	7	C4	0.035	19
B3	0.052	8	B5	0.027	20
B2	0.051	9	B4	0.011	21
B8	0.051	10	B7	0.011	22
A3	0.05	11	C6	0.011	23
C5	0.05	12	C7	0.011	24

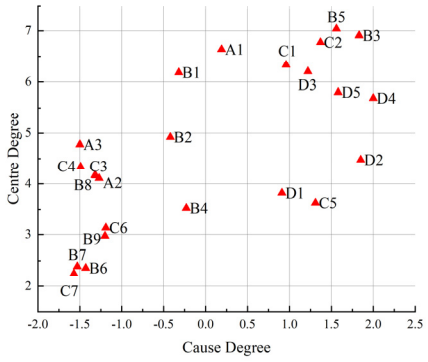

Fig. 1 scatter diagram of centre degree-cause degree

As can be seen from Figure 1, data circulation system, data trading system, product social benefits, product environmental benefits, data product development, data sharing technology, and data privacy protection have a great impact on the system.The index of big data

technology dimension has a high degree of cause, which has a great influence on other factors.The reason degree of benefit index is low, and it is greatly affected by other factors.

Finally, the results of entropy weight method and DEMATEL method are calculated comprehensively, and the results are sorted.The results are shown in Table 4.

Table 4 comprehensive impact

Influence factor	Comprehensive influence degree	ranking	Influence factor	Comprehensive influence degree	ranking
Business compliance	0.5029	1	Reliable data collection	0.2039	13
Data circulation system	0.3429	2	Data management technology	0.1896	14
Environmental benefit	0.3376	3	Data trading system	0.187	15
social results	0.3152	4	Data transaction cost	0.1801	16
Data product development	0.3087	5	Industry benefits	0.1585	17
Data Asset Management	0.3067	6	Technical benefits	0.1536	18
Data privacy protection	0.2888	7	Efficient data access	0.1474	19
Data sharing technology	0.2833	8	Data transaction supervision	0.0835	20
Data confirmation system	0.2441	9	Data pricing system	0.0384	21
Policy orientation	0.2372	10	Direct economic benefits	0.034	22
Data processing capacity	0.2223	11	Data operation strategy	0.026	23
Policy support	0.2076	12	Indirect economic benefits	0.0245	24

It can be seen from Table 4 that the key factors affecting the construction and development of the energy data market include business compliance, data circulation system, product environmental benefits, product social benefits, data product development, and data asset management, with a comprehensive impact of more than 0.3, far higher than other factors. Buiness cmpliance, data circulation system, data privacy protection, data sharing technology,

data confirmation system and other indicators related to the construction of data market system have a greater impact.

4.2 Suggestions and prospects

Based on the above evaluation and analysis, the following suggestions are made for the construction and development of the energy data market.

1）Establish and improve the data market management system

As a platform for the collection and circulation of energy data, the main purpose of the establishment of energy data trading market is to promote the circulation and sharing of data through safe and convenient trading, which requires a perfect system as the basis for the operation and development of data market.With the goal of building a unified large market for energy data that is unified and open, compliant in the circulation of data resources and the trading and circulation mechanism, the market circulation, pricing and trading mechanisms for energy data should be established, and gradually integrated into the overall market mechanism for energy data elements.

2）To explore the social and environmental value of energy data

Adhere to the demand-oriented approach, focus on tapping the national ministries, the energy industry and social enterprises' demand for energy data application, give full play to the value of data elements.By providing a series of data analysis products and services in the field of energy,continuously obtains government support and guidance, establishes a mechanism of government-enterprise joint and multi-party participation, forms a joint construction force, and collaboratively promotes the construction and operation.

3）Big data technology to support the flow of data

Big data technology is the basic support for the transformation of energy data resources into assets.On the one hand, data sharing technology should be developed to improve the efficiency and security of data trading and sharing process.On the other hand, it is necessary to introduce cutting-edge big data technology to fully tap the value of energy data.

5 Conclusion

This paper constructs an energy data market evaluation index system including 24 indexes from four dimensions: policy and law, market system, value creation and big data technology.The index system was scored by experts, and the entropy weight DEMATEL method was used to comprehensively evaluate the influencing factors of energy data market.The conclusion is that the key factors influencing the construction and development of energy data market are business compliance, data circulation system, product environmental benefit, product social benefit, data product development and data asset management. At present, the trading market of energy data is still in the primary stage, and the concrete implementation way of the construction and development of energy data market needs further study.

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