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Impact of Economic Transformation on Energy Demand in Southwest China and Forecast

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Abstract

"Economic transformation" has become the main path to promote China's social and economic development, and many regions have increased the importance and attention to "economic transformation", and the Southwest region is no exception. Many cities in Southwest China are developing new energy sources to promote economic development and economic transformation. Economic transformation and economic development in Southwest China are mutually influencing and interacting, while energy development in Southwest China and its local economic development are mutually promoting and influencing, so economic transformation also affects energy demand and development in Southwest China. The importance of economic transformation should be taken into consideration.

Keywords: Southwest Region; Energy Demand; Economic Transformation; Impact and Forecast

1 INTRODUCTION

Energy development in the southwest region not only affects the economic development of the southwest region, but also affects the socio-economic progress of China and the efficient use of various energy sources, so the development and utilization of energy in the southwest region has been of great concern to all sectors of society. Some scholars point out that "strengthening the forecast of energy demand, energy development and utilization in the southwest region of China not only promotes the economic development of the southwest region of China, but also plays a great role in promoting the social and economic development of China, and provides sufficient energy for the urbanization and healthy and sustainable development of each region, so it is necessary to pay attention to the forecast of energy demand in the southwest region [1]. " Economic transformation has always been a major influence on the development of the southwest region, in addition to the significant impact on socio-economic development and urbanization construction, but also directly affect the energy demand and forecast in the southwest region, so as a relevant staff, in addition to pay attention to the impact of economic transformation and energy demand in the southwest region, but also need to accurately forecast energy demand based on economic transformation, to provide a reliable basis for energy development and utilization.

2 CURRENT ENERGY SITUATION IN THE SOUTHWEST

The southwest region includes areas such as Sichuan Province, Chongqing City and Tibet Autonomous Region, which are rich in natural resources and energy, such as water resources, natural gas resources and light resources, making the southwest region the most influential energy base in China, for example, Sichuan has become a water energy base, Chongqing has become a natural gas energy base, and Tibet has become a light energy base, and these bases have provided other regions in China with These bases have provided a large amount of water resources and natural gas energy to other regions of China, which have played a positive role in promoting the economy of the southwest region and even the whole Chinese society and economy.

Nevertheless, there are still many problems with the energy advantages and regional economic development of the southwest region of China, among which the uncoordinated development is the most prominent and contrasts with other regions. The problems of energy development within the Southwest region are as follows:

(1) Serious energy waste. For example, 14.95 billion kWh of abandoned hydroelectricity occurred in southwest 2016, of which Sichuan peaking abandoned hydroelectricity accounted for the largest proportion, accounting for about 94.58% (141.4/149.5), and there were also varying degrees of nesting in the process of sending power outward, which, although effectively resolved in 2018, still had a certain adverse impact on the local economy.

(2) Imperfect energy structure. Although Southwest China is very rich in natural resources and energy, it is limited by the level of technology and technical talents, such as fewer advanced energy development technologies and fewer professional talents in energy development, resulting in many energy sources not being developed effectively, thus leading to an imperfect energy structure.

(3) The accuracy of energy forecasting needs to be improved. Energy forecasting is the key to improve energy development and utilization, but many regions in southwest China are economically and technologically backward, resulting in less technology and funds available for energy forecasting, which affects the accuracy of energy forecasting and is not conducive to energy development and utilization. In addition, there are also problems such as insufficient motivation for energy technology innovation and high cost of secondary energy conversion, which affect energy development and local economic development in southwest China to different degrees [1-2].

3 THE IMPACT OF ECONOMIC TRANSITION ON ENERGY DEMAND

Although there are still many shortcomings and problems in energy forecasting and development in Southwest China, they have been effectively solved with the comprehensive promotion of economic transformation. For example, the main influencing factors of energy demand can be determined according to the quantitative determination index of economic transformation, the characteristics of different economic development stages, etc. Then, the gray correlation degree analysis method can be used to analyze the influencing factors of energy demand, and finally, the energy demand in Southwest China can be predicted with the help of ARIMA model, multiple regression forecasting method, Markov chain energy demand structure forecasting method, etc. [2]

Other scholars point out that "economic transformation" not only promotes energy demand and development in Southwest China, but also inhibits it, because in the context of economic transformation, economic development, energy development and utilization in Southwest China face various challenges and difficulties, and the demand for energy is rapidly increasing, which will gradually eliminate high-energy-consuming industries. This will gradually phase out energy-intensive industries and thus transform the industrial structure. However, in general, the economic transformation can maximize the energy utilization in the southwest region and gradually change the energy demand pattern with the guidance of various macro policies and technological support.

From the perspective of economics, the quantitative evaluation indicators of economic transformation are closely related to energy demand, and the correlation between each indicator and demand can be calculated by using the gray correlation analysis method to predict energy demand. Based on the gray correlation analysis method, a quantitative evaluation index system of economic transformation can be established, in which indicators X_1, X_2, ···, X_n can be used to form a sequence matrix and correlate with the system characteristics Y sequence to obtain coefficients L_j that can be used to express the impact of quantitative evaluation indexes of economic transformation on energy demand, i.e., the larger the correlation coefficient, the stronger the correlation and the greater the impact of economic transformation on energy demand [3]. The correlation coefficient L_j is calculated as follows:

$$L_j = \sum_{i=1}^{t} \omega(i) \lambda_{ji}$$

$$\lambda_{ji} = \frac{\min\limits_{i=1,2,\ldots,t} \Delta_{ji} + \rho \max\limits_{i=1,2,\ldots,n}}{\Delta_{ji} + \rho \max\limits_{i=1,2,\ldots,n} \Delta_{ji}}$$

$$\Delta_{ji} = \left| x_{ji} - y_i \right|$$

where

$\omega(i)$ — Weight of the correlation system in year I;

ρ — Resolution factor, usually taken as 0.5;

Δ_{ji} — Difference;

j — Number of indicators (j =1, 2, ..., n);

i — Number of years of historical data (i =1, 2, ..., t);

L_j — Number of correlation coefficients (the larger the coefficient, the stronger the correlation, positive correlation).

Some information shows that the impact indicators of economic transformation on energy demand are mainly GDP, energy elasticity coefficient and residential consumption level, etc., all of which can be calculated through the gray correlation analysis method to find out the correlation between different indicators and energy demand, and the specific impact indicators are shown in Table 1.

TABLE 1 INDICATORS OF THE IMPACT OF ECONOMIC TRANSITION ON ENERGY DEMAND [4]

Serial Number	Impact Indicator	Serial Number	Impact Indicator
1	GDP	5	Energy Elasticity Factor
2	GDP annual growth rate	6	Energy intensity
3	Output value of secondary industry	7	GDP per capita
4	Output value of tertiary industry	8	Resident consumption level

4 SOUTHWEST ENERGY DEMAND FORECAST BASED ON ECONOMIC TRANSFORMATION

4.1 Total Energy Demand Forecast

In this paper, the grey forecasting model, ARIMA model and multiple regression method are used to forecast the total energy demand as follows：

(1) Gray forecasting model. It is an exponential function, which can be used to predict energy demand subject to many uncertainties and difficult to identify, and can be used without considering the impact of economic transformation on energy development trends, which is the least difficult to predict, the simplest calculation method, and a highly applicable energy demand forecasting method [5].The core of the gray forecasting model for forecasting energy demand is to do cumulative data processing on the original series y, and then establish the white differential equation on that basis and generate a time response series with the relevant parameters as follows：

$$dy^{(1)} / dt + ay^{(1)} = b$$

$$\hat{y}^{(1)}(k+1) = (y^{(0)}(1) - \frac{b}{a})e^{-ak} + \frac{b}{a}$$

where

superscript (0) - the original data.

superscript (1) - cumulatively generated data.

A, b - parameters that can be solved using the least squares method.

K - the number of samples sampled (k = 1,2,...,n).

The gray prediction model can be tested by three methods: residual test, correlation test and posterior difference test.

(2) ARIMA model. Its forecasting principle lies in the use of the non-smooth characteristics of energy demand data, time-series fluctuation characteristics to predict time-series data, and then on that basis to smooth the original data

series using linear difference equations and build a d-order difference series, and finally build a demand forecasting model [6]. The d-order difference series in the model can be expressed as:

$$\Delta^d y_t = (1 - B)^d y_t$$

The ARIMA (P, d, q) model is then expressed as:

$$\varphi_p(B)\Delta^d y_t = \theta_q(B)\alpha_t$$

where

y_t — Time series data at moment "t";

B — Delay operator;

Δ — Difference operator;

$\varphi_p(B)$ — Autoregressive coefficient polynomial of order "p";

$\theta_q(B)$ — "Sliding average polynomial of order "q;

α_t — White noise series.

(1) Multiple regression method [7]. Its forecasting principle lies in the establishment of a fitted regression model of economic indicators with high energy correlation, including logit and polynomial models, taking into account the rate of economic development and rigid energy demand, etc., as follows:

Logit Model: $In(y_i) = \beta_1 + \beta_2 In(x_i) + u_i$

Polynomial model: $y_i = \beta_1 + \beta_2 x_i + \beta 3 x_i^{\ 2} + u_i$

where

β — Parameters to be determined;

u — Random disturbance amount.

4.2 Energy Demand Structure Forecast

The conditional probability matrix is constructed mainly based on Markov chains, and then a quadratic programming model is built on this basis, and finally a one-step transfer probability matrix is calculated to predict the energy demand structure [8]. The Markov chain is essentially a Markov process with discrete time and state, where "i" is the current state and "j" is the next state, then the conditional probability is set as , and the one-step transfer probability matrix from state i to state j is expressed as:

$$P = [p_{ij}] = \begin{pmatrix} p_{11} & p_{12} & \cdots & p_{1n} \\ p_{21} & p_{22} & \cdots & p_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ p_{n1} & p_{n1} & \cdots & p_{nn} \end{pmatrix}$$

Assuming that $W_i(t)$ is the ratio of the ith energy consumption to the total energy consumption at time t and P_{ij} is the one-step transfer probability of being in the ith energy source at time (t – 1) and in the jth energy source at time t, we have:

$$W_i(t) = \sum_{i=1}^{n} W_i(t-1) p_{ij} + \varepsilon_j(t)$$

Let the minimum error be "$\sum_t \sum_{i=1}^{n} \varepsilon_j(t)$", Then the quadratic programming model is

$$\min \sum_{t} \sum_{i=1}^{n} \left[W_j(t) - \sum_{i=1}^{n} W_i(t-1) p_{ij} \right]^2$$

$$s.t \begin{cases} \sum_{j=1}^{n} p_{ij} = 1 \\ pi_j \geq 0 (i, j = 1,2,...,n) \end{cases}$$

4.3 Forecast Results of Total Energy Demand in Southwest China

The gray forecasting method and ARIMA forecasting method are growing faster, while multiple regression is relatively stable and the trend of total energy demand growth is gradually slowing down [9]. The forecast model of total energy demand based on multiple regression method integrates the relevant effects of GDP per capita, total GDP and output value of secondary production on total energy demand, and the total energy demand in Southwest China is expected to reach 362.79 million t (standard coal) in 2020, which is 1.11 times more than that in 2016.

4.4 Energy Demand Structure Forecast Results

A quadratic programming model based on a chi-square Markov chain for the structural transfer of the system is solved to obtain a one-step transfer probability matrix as:

$$\boldsymbol{P} = \begin{bmatrix} 0 & 0.333 & 0 & 0.333 & 0.333 & 0 \\ 0.272 & 0.113 & 0.408 & 0.136 & 0.068 & 0.003 \\ 0.330 & 0.083 & 0.495 & 0 & 0.083 & 0.010 \\ 0.531 & 0.133 & 0.133 & 0.133 & 0.066 & 0.004 \\ 0.615 & 0.154 & 0.154 & 0 & 0.077 & 0 \\ 0.610 & 0 & 0.152 & 0.152 & 0.076 & 0.010 \end{bmatrix}$$

According to the formula: $\min \sum_{t} \sum_{i=1}^{n} \left[W_j(t) - \sum_{i=1}^{n} W_i(t-1) p_{ij} \right]^2$

$$s.t \begin{cases} \sum_{j=1}^{n} p_{ij} = 1 \\ pi_j \geq 0 (i, j = 1,2,...,n) \end{cases}$$

The energy structure of the southwest region is obtained as shown in Table 2:

TABLE 2 FORECAST RESULTS OF ENERGY STRUCTURE IN SOUTHWEST CHINA (%)

Year	Coal	Oil	Natural Gas	Domestic Hydropower	Outward Hydropower	Other
2017	52.1	11.6	20.3	8.2	7.5	0.3
2018	512	10.8	19.6	9.8	8.9	0.7
2019	49.6	12.2	21.4	8.5	7.0	1.3
2020	47.8	10.4	16.2	8.4	8.2	1.2
2025	38.3	8.8	25.7	13.7	10.2	3.3

From Table 2, it is easy to see that the overall energy consumption structure of Southwest China has changed under the influence of economic transformation, and the proportion of coal in the total energy is decreasing year by year, while clean energy such as natural gas and hydropower is increasing year by year, but in general, coal still dominates in Southwest China.

5 SUGGESTIONS FOR COUNTER MEASURES

5.1 To Adhere to the "Local Conditions" to Promote the Energy Revolution

Southwest China has a complex and diverse energy structure, with many areas rich in coal and natural gas resources, such as Sichuan, Chongqing and Tibet. However, these regions are located in areas with complex topography and surrounded by mountainous areas, so they are very dependent on various energy sources for transportation and construction, which makes the energy demand in the southwest region remain high. Because of the topography and climate and other reasons, it has become more difficult to develop energy in the southwest [10]. In this regard, it is necessary to predict energy demand and develop energy development strategies based on local conditions, including local geography, climate and human environment, as well as to introduce a variety of advanced technologies.

5.2 Focus on the Harmonious Development of Regional Economy, Social Economy and Ecological Environment

Firstly, energy demand forecast and energy development must be integrated with specific regional development strategies and take into account factors such as sustainable regional economic development and ecological environmental protection to open up a harmonious development path conducive to human society and nature. Secondly, ecological environmental protection should be emphasized in the process of energy transformation and development, for example, old industrial bases should enhance ecological environmental protection while improving the utilization rate of energy development.

5.3 Achieve Inter-Regional Energy Collaboration and Win-Win Cooperation

Combining the resource endowment of each region, the current situation of the energy system, the current status of economic and social development and potential, infrastructure construction, etc., taking into account energy security, ecological environment and other factors, taking into account social equity, and promoting cross-regional energy collaboration in an integrated manner. Strengthen the coordinated development of regional energy and promote the realization of inter-regional energy dispatch matching.

6 CONCLUSIONS

Energy development and utilization is the key to promote the productivity enhancement and socio-economic development of our society, so it attracts not only the attention of related work, but also the attention of various parties. Southwest China is the main source of energy, and many southwest regions contain a large amount of energy, which becomes the main driving force for the development of southwest China, so it is very important to strengthen the forecast of energy demand in southwest China. Economic transformation is the new path and direction of economic development in Southwest China in recent years, which has an irreplaceable influence on the productivity and energy development of Southwest China, so the energy demand and forecast of Southwest China are also influenced by economic transformation. Therefore, the above briefly outlines the economic transformation, the current situation of economic development and energy development in Southwest China, then analyzes the impact of economic transformation on energy demand and forecast in Southwest China, and finally proposes measures to facilitate energy demand forecast and energy development in Southwest China based on economic transformation.

REFERENCES

[1] Lu L, Liu L, Cheng Haozhong, et al. Impact of economic transformation on energy demand in southwest China and forecast[J]. Journal of Power Systems and their Automation,2019,31(7):117-122.

[2] Yang Wanping,Li Dong. Green development transition in eight regions of China's economy:Dynamic differences and structural decomposition[J]. Statistics and Information Forum,2022,37(8):90-105.

[3] Yao L., Yin R., Meng Z. Yi. The problem of "water and electricity abandonment" in southwest China in summer needs multiple measures to promote hydropower energy consumption during the abundant water period[J]. China Development, 2022,22(3):93-94.

[4] Gao Dan, Kong G, Ma Linwei, et al. Study on the current situation of regional energy and the focus of medium and long-term development strategy in China[J]. China Engineering Science,2021,23(1):7-14.

[5] Kuang Han. Study on the decoupling relationship between regional energy consumption, carbon emission and economic growth: a case study of Sichuan, Zhejiang and Henan provinces [D]. Sichuan:Southwest University of Finance and Economics,2020.

[6] Zhang Xiekui,Wang Delei,Liu Wei. Research on the evaluation of renewable energy generation performance in western region[J]. Learning and Exploration,2021(4):128-135.
[7] Mao X, Zhu LY, Wang SJ, et al. The concept of "carbon cycle economy" in the development pattern of "double cycle" and its implications for China's energy transformation[J]. China Energy, 2021, 43(2):16-20.
[8] Shi Huiwen. Exploring financial support paths to help energy economic transformation[J]. Northern Finance,2022(8):28-30.
[9] Li Qiang. Analysis of the influencing factors and prospects of new energy economy development in the context of transformation[J]. Brand research,2022(8):161-163.
[10] Wei Wei, Wang Zanxin, Li Bing. A simulation study on the impact of energy transition on China's economic growth potential based on "weak sustainability perspective[J]. China Environmental Management,2020,12(2):76-83.