

RESEARCH ON ENERGY SAVING AND EMISSION REDUCTION OF LAN ZHOU BASED ON INDUSTRIAL STRUCTURE EVOLUTION

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Abstract: Recent years, along with the economy development of LAN Zhou, the energy consumption has increase year by year. And the energy saving and emission reduction would be the bottleneck of economic and social development. LAN Zhou is one of the old industrial bases. The secondary and tertiary industries have absolute predominance. The proportion of heavy industry is large. And the proportion of industry with high energy consumption is large. The industrialization and urbanization of LAN Zhou is in the stage of fast promotion. So the research of energy saving and emission reduction is useful. In this paper, the energy-saving potential of LAN Zhou is analyzed based on industrial structure evolution. And the result of research could provide the decision support for the improvement of energy saving and emission reduction work.

Keywords: energy saving and emission reduction, industrial structure evolution, energy-saving potential, correlation analysis

INTRODUCTION

Recently years, because of fossil energy depleting and environment problem, the energy saving and emission reduction has become the focus of international community. Currently, the shortage of global resources and energy is seriously, and the economic development of every country is restricted by the energy bottleneck. At the same time, overexploitation of non-renewable resources has brought seriously impact on the world's environment and economy. Many cities still adopt extensive model of economic development, like LAN Zhou and other Chinese cities. The extensive model of development results in enormous demand of energy and resources, especially oil, natural gas, and coal. And this problem would restrict the development of these cities.

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LAN Zhou is one of Chinese old industrial bases. Secondary industry plays a leading role, and the proportion of heavy industry is too big. And it's in the stage of industrialization and urbanization. So the energy-intensive industries' proportion would be bigger. This would cause the sustainable growth of energy demand and emission would, environment degradation, and enormous pressure of energy supply. In this paper, the coupling law between regional economic development and energy consumption is studied. And the way of energy saving and emission reduction's improvement is proposed based on industrial structure evolution. The research result could provide an efficiency way to improve the cities' energy saving and emission reduction, but not limited to LAN Zhou.

ENERGY CONSUMPTION STATUS OF LAN ZHOU

Recently years, LAN Zhou has been faced the enormous pressure of energy consumption all the time. According relative information, although the wind energy and solar energy have become very popular, the energy consumption of LAN Zhou mainly contains coal, oil, electricity, coke and so on. The energy consumption is about 20,000,000 tons of standard coal in the past few years, and with year-on-year growth of about 7 percents. The energy consumption for per 10 thousand Yuan of industrial value-added is about 5 tons of standard coal. And it was reduced by 30.5 percents in the industrial enterprises above designated size. The energy consumption for per unite of GDP was reduced by 20.9 percents. But the task of energy saving and emission reduction is difficult to achieve.

The energy-intensive industries have an important influence on the whole city's energy consumption in the past few years. The energy consumption of oil processing, coking, chemical raw materials and products manufacturing, non-metal mineral products manufacturing, nonferrous metal smelting and manufacturing, black metal smelting and manufacturing, and production of electric and heating power, is about 95 percents of the whole energy consumption. And the key enterprises' energy consumption has kept growing during the past few years. For example, LAN Zhou Petrochemical company, LAN Zhou Branch of China Aluminum Corporation, and Qilianshan Cement Plant. These key enterprises' energy consumption is about 60 percents of the energy consumption in enterprises above designated size, with year-on-year growth of about 7.5 percents, and makes the energy

consumption in enterprises above designated size increase by 4 percents.

The energy consumption for per unite of GDP depends on the mode of economic development in a large part. According the economic structure of LAN Zhou, the secondary industry is the main part. And the secondary industry is about 50 percents of the economic development. The secondary industry accounts for a high percentage. According to the statistical data of LAN Zhou, the secondary industry's energy consumption is still growing in the past few years. Recently, there are many large projects to start along with the development of LAN Zhou new area. So the energy consumption would be increase further. It would be difficult to realize the target of energy saving and emission reduction. It is key to restricting the increment effect by the structural energy saving. The industrial structure evolution could help to solve the problems.

CORRELATION ANALYSIS ON INDUSTRIAL STRUCTURE AND ENERGY CONSUMPTION

The industrial structure is associated with energy consumption. In this paper, the correlation between industrial structure and energy consumption is analyzed by the industrial structure evolution-energy consumption model and industrial structure evolution- energy consumption for per unite of GDP model.

Correlation analysis on industrial structure evolution and energy consumption

The industrial structure evolution-energy consumption model is based on the correlation analysis on the evolution of the country or region's industrial structure and the change of primary-energy consumption.

The correlation based on the model would reveal the regularity of primary-energy consumption's changing followed the evolution of the industrial structure. The correlation could illustrate the essential characteristic of the regional economic development's primary energy consumption variation¹.

(1) Mathematical expression of the model

¹ Richard G.Newell, Adam B..Jaffe, Robert N.Stavins (2006). "The effect of economic and policy incentives on carbon mitigation technologies". *Energy Economics* [J], 11, pp.563-578; Wang Yafei, Zheng Minghui (2012). "Allocation of Energy Consumption among Provinces in China and Energy Saving Analysis". *Guizhou Agricultural Science* [J], Vol.40, No.5, pp.195-200.

The model's mathematical expression is as follows.

$$EEI=EU/ESD$$

(1)

EU is the region's primary energy consumption.

ESD is the region's coefficient of regional industrial structure diversified evolution.

The computational formula of ESD is as follows.

$$ESD=\Sigma (P/P, S/P, T/P)$$

(2)

P is the output of primary industry.

S is the output of secondary industry.

T is the output of tertiary industry.

(2) Analysis of data

According to the correlation model of industrial structure evolution and energy consumption, the data about energy consumption and GDP is selected from "Lanzhou Statistical Yearbook" (2007-2012). The energy consumption and industrial structure evolution are analyzed by the polynomial fitting method.

The result indicates the primary energy consumption is closely linked with the industrial structure evolution.

First, the fitting curve shows the remarkable association between industrial structure and the primary energy consumption ($R_2=0.9721$).

Second, the primary energy consumption would grow quickly in the future years. According to the unitary and quadratic function ($y=ax^2+bx+c$), the linear term and quadratic term's coefficient are positive (0.4671, 48.721). The result shows that the primary energy consumption would increase continually. It's because of the primary industry' proportion is too low, and the secondary and tertiary industry's proportion is rising. The industrial structure of LAN Zhou should be readjusted effectively to improve the energy consumption problem².

² Wang Mingjie, Li, Yuling, Yang Li (2011). "Analysis on Industrial Energy Saving Potential of Hebei in 12th Five-year Program". *Journal of Shijiazhuang University of Economics* [J], Vol.34, No.1, pp.67-69; Liao Hua, Wei YiMing (2011). "China's Mid to Long Term Energy Conservation Potential: International Comparison and Foreign Experience". *Chinese Soft Science* [J], No.2, pp.21-31; Wu Peilin, Wang Jianjun, Wang Hua (2012). "Energy Conservation Potential Analysis in Compressed Air System for Industry Enterprises". *Compressor Technology* [J], No.1, pp.38-40.

Correlation analysis on industrial structure evolution and energy consumption for per unite of GDP

The energy consumption for per unite of GDP is an important factor for the primary energy consumption, and could reflect the economic efficiency and quality. In order to explain the law of interaction between the economic development and the primary energy consumption, the correlation model of industrial structure evolution and per unite of GDP's energy consumption is introduced. The analysis is to study the energy saving efficiency of the regional industrial structure evolution³.

(1) Mathematical expression of the model

The model's mathematical expression is as follows.

$$EEE=EE /ESD$$

(3)

EE is the coefficient of the regional energy consumption of per unite of GDP.

ESD is the region's coefficient of regional industrial structure diversified evolution, and could illustrate the situation of regional industrial structure diversified evolution.

The computational formula of EE is as follows.

$$EE=EC /GDP$$

(4)

EC is the total primary energy consumption.

GDP is the region's gross domestic product.

(2) Analysis of data

According to the correlation model of industrial structure evolution and per unite of GDP's energy consumption, the data about energy consumption and GDP is selected form "Lanzhou Statistical Yearbook" (2007-2012). The correlation between per unite of GDP's energy consumption and industrial structure evolution are analyzed by the polynomial fitting method.

The result indicates that the energy consumption for per unite of GDP is closely linked with the industrial structure evolution.

The curve shows that the energy consumption for per unite of GDP has reduced clearly. The variation tendency is not only demonstrated

³ Qu Xiaoe (2011). "Chinese Provincial Industrial Energy Efficiency and Energy Saving Potential: Empirical and Simulation-based DEA". *Economic Management* [J], Vol.33, No.7, pp.16-24; Zheng Minghui, Wang Yafei (2012). "Energy Consumption Provinces Configuration and Energy Saving Potential Analysis". *Technology Economy & Management Research* [J], No.4, pp.113-116.

by the model's first order coefficient($C=1.4611151$), but the correlation coefficient ($R_2=0.989526$). The reducing is because of the industrial structure evolution during the past few years.

The correlation between the energy consumption for per unite of GDP and industrial structure evolution, indicates that the industrial structure evolution is an effectively way to reduce the energy consumption. So it's important to optimize the economic structure to further tap energy-saving potential⁴.

THE STRATEGY OF OPTIMIZING THE ENERGY SAVING AND EMISSION REDUCTION

Speeding up the readjustment of the industrial structure, and developing high-tech industries and other industries with low energy consumption

The tertiary industry has grown in the past few years, and its proportion has increased. But the secondary industry accounts for a high percentage of the LAN Zhou's economy. And the secondary industry's energy consumption accounts for a high percentage of the LAN Zhou's energy consumption. So readjustment of industrial structure is essential to decrease the LAN Zhou's energy consumption. And the analysis with the correlation model of industrial structure evolution and per unite of GDP's energy consumption shows that speeding up the readjustment of the industrial structure is an effectively method to reduce the LAN Zhou's energy consumption.

During the readjustment of the industrial structure, the development of high energy-consuming enterprises should be restricted. These enterprises with low energy consumption should be given priority. And the high-tech industries should account for higher percentage of the LAN Zhou's economy. The high-tech industries would improve other industries' equipment of energy saving and emission reduction, and operating with low energy consumption⁵.

⁴ R.K. Kaufmann (2004). "The Mechanisms for Autonomous Energy Efficiency Increases: A Cointegration Analysis of the US Energy/GDP Ratio". *The Energy Journal* [J], 25.

⁵ K. Fisher-Vanden, Gary H. Jefferson, Hongmei Liu (et al.) (2004). "What is Driving China's Decline in Energy Intensity". *Resource and Energy Economics* [J], 26.

Developing the circular economy in the secondary industry, and improving the energy service efficiency of the secondary industry

The energy consumption for secondary industry accounts for a high percentage of the LAN Zhou's energy consumption. And the energy consumption of per unite of GDP is more than the economically developed areas of China. So the energy saving potential of the LAN Zhou's secondary is big.

LAN Zhou should learn from the economically developed areas' experience to develop the circular economy in the secondary industry. Then, the circular economy could improve the energy service efficiency of the secondary industry. During the process of developing the circular economy, the circular economy demonstration zone should serve as a model for others. The demonstration zone could help to popularize the energy saving technology quickly.

Developing the tertiary industry, and promoting the actively development of service industry on energy saving and emission reduction

The energy consumption for the tertiary industry is less than the secondary industry. But the contribution for the economic development should not be underestimated. So, LAN Zhou should promote the development of tertiary industry along with readjustment of the secondary industry.

During developing the tertiary industry, the energy-saving and emission-reduction service industry should be promoted to develop quickly. The policy measures and market measures should be used to help the energy-saving and emission-reduction service industry to develop. Then the enterprises could be served by the professional team to improve their energy saving and emission reduction job. And the enterprises' costs on improvement of energy saving and emission reduction would be reduced. Then the enterprise would be positive on energy-consuming transformation. In a word, the energy-saving and emission-reduction service industry is important.

Improving the energy saving and emission reduction base on the technological innovation

The energy saving and emission reduction should utilize the scientific and technological progress. The technological innovation would improve continually the energy management's technological content

and knowledge intensity. The technology could affect the whole process of energy consuming.

First, the energy supply system should improve the efficiency of energy production by the technological innovation. Then the industrial structure evolution should be promoted by technological improvement and upgrade of products⁶.

CONCLUSION

The energy saving and emission reduction is important for the sustainable development of economy. In this paper, we have studied the correlation between the energy consumption and the industrial structure evolution based on the quantitative analysis. The correlation model of industrial structure evolution and energy consumption shows the law of interaction between the economic development and the primary energy consumption. Then, the correlation between per unite of GDP's energy consumption and industrial structure evolution are analyzed by the polynomial fitting method. From the analysis result, we know that industrial structure evolution could help to improve the energy consumption and emission reduction. At last, some useful strategies are proposed. The readjustment of the industrial structure should be speeded up. The high-tech industries and other industries with low energy consumption should be promoted to develop quickly. Developing the circular economy in the secondary industry, and improving the energy service efficiency of the secondary industry, are the essential ways to improve LAN Zhou's energy saving and emission reduction. Promoting the actively development of service industry on energy saving and emission reduction is also essential. The technological innovation would improve continually the energy saving and emission reduction.

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⁶ S.Murillo, J.L.Míguez, J.Porteiro (et al.) (2003). "Viability of LPG use in low-power outboard engines for reduction in consumption and pollutant emissions". *International Journal of Energy Research* [J], Vol.33, No.5, pp.467-480.

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