



Analysis of Mutual Influence between Low Carbon Economy and Energy Industry Investment

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ABSTRACT

After decade years of economic development, the energy industry played an important role in the national economy in China. But also it brought more troublesome problems - the gradual deterioration of the environment and increasing pressure to reduce emissions. We have to face the reality that carbon emission in China has been ranked first in the world. Therefore, the control of carbon emissions will be a top priority, and the progress in this respect will bring advantages in the world. This paper analysed the characteristics of carbon emissions in the energy industry, studied the relationship between Chinese economic growth, energy intensity and energy industrial investment through the multivariate regression model. It concludes that: (1) There is an inverse relation between energy intensity and GDP, which shows that economic growth of China can be achieved in reducing carbon emissions. (2) Energy industrial fixed assets investment to GDP shows a positive correlation, indicating that the energy industry fixed assets investment has a stimulating effect on the Chinese economy. (3) Carbon emissions and investment in the energy industry has been changing in the opposite direction. More investment in energy, the less carbon emissions, indicating that the Chinese energy economy has transformed, invest to low-carbon and efficient energy industry.

INTRODUCTION

Since the new concept of low-carbon economy has been taken seriously (Jianfei Shen et al. 2014) by governments, businesses and financial institutions have issued a lot of provisions and regulations of investment and financing of low-carbon energy industry development, which makes the concept of environment in-depth awareness among energy companies (Totty Jim 2010). The investment scale of renewable energy has been significantly expanded and temporarily suppressed the phenomenon of high-carbon production in energy industries. The data show that in recent years the investment in Chinese green renewable energy, such as in hydropower, wind power and solar power rose to a new height (Wu & Xu 2013). However, even this does not prevent the existence of the energy industry high carbon production problems in various areas (Huang & Barker 2012). Energy investment, is an important component of the market investment (Bassi Andrea et al. 2012), because of its specificity, it cannot be effectively regulated by automatically adjusting the market mechanism. The paper under the low-carbon background, is based on the analysis of energy industry investment and carbon emissions, researches the relationship between carbon emissions, energy industry investment, GDP and energy intensity, resolves the current main problems of Chinese energy industry investment in reduction emission development process, and makes recommendations accordingly.

There is a complex relationship between the energy in-

dustry investment and low-carbon economy (Zhou et al. 2013), energy industry investment and economic growth (Colenbrander et al. 2015), economic growth and low-carbon. Due to the interaction between the three forms as a whole that cannot be separated, so the study of the three cannot be carried out separately, the organic combination of the relevant parts to form an overall system research.

METHODOLOGY

Based on the study of the characteristics of carbon emissions in the energy industry, the paper firstly does theoretical analysis on the impact of the development of low-carbon to energy industry investment: (1) Tied role and leading role; (2) The low-carbon requirements need energy industry investment. Then, with the data on carbon emissions, GDP, energy investment, energy intensity, from 2005, the year China began to develop low-carbon economy, to 2013, the paper establishes multiple linear regression model of mutual influence of low-carbon economy and energy industry investments. On one side, the paper analyzes the relationship between economic growth, energy intensity and energy industry investments, on the other side, it analyzes the relationship between carbon intensity and energy investments, and at last, comes to the conclusions.

ANALYSIS AND DISCUSSION

Characteristics of Carbon Emissions Analysis in the Energy Industry

Difficult task of controlling carbon emissions of energy industry: In recent years, with the rapid economic development, the production and consumption of the energy industry is increasing year by year. The result is that the total annual carbon dioxide emissions from the energy industry substantially increase (Liu et al. 2012), and carbon emission control increases difficulties. In the course of rapid development, China did not give much attention on the carbon emissions control. Until the environment and climate change caused widespread concern, the low-carbon economy gradually has been put on the agenda. However, in the given rigid target of economic growth, low-carbon energy industry development is also somewhat difficult. For example, the 12th Five Year Plan was proposed in the context of the completion of the annual GDP growth target, energy consumption also should be standardize, every year, to complete the task of decreasing energy intensity and carbon dioxide emissions. This shows that the annual economic growth and reduction of carbon emission, both have difficulties.

Increasing ratio of carbon emissions in the energy industry: Economic development needs the support of energy, so energy is a very important economic development part and many basic living materials are inextricably related to energy. Before the reform and opening up, China lacked the economic development. After reform and opening up, China relied more on the consumption of resources to develop economy, resource consumption was also increasing, and along with consumption of resources more pollutants released into the environment, like sulfide, carbide and the emission is also growing. Energy consumption-based economic growth is not sustainable growth, but in the early stages of development the country had to choose the type of economy (Pardo et al. 2013). If countries want to pursue sustainable, stable and efficient economic growth, it must be controlled on energy consumption and waste emissions, to find non-polluting green energy and non-fossil energy sources to replace fossil fuels, so that the economic growth will be able to achieve sustainable development.

Decreasing carbon intensity in energy industry: During the past ten years, the energy industry output value increased more and more. According to statistics, from 2006 to 2012, the energy industry output value has been more than doubled, and the development of the energy industry for economic growth played a role that cannot be ignored. With increasing energy inputs, the carbon emissions are increasing year by year, but, according to experts survey, the rising rate of carbon emissions was not increased far faster than that of energy investment. It shows that, along with economic growth, the investment in technological innovation, technology optimization and the energy structure optimization became more and more, which greatly increased the effi-

ciency of resource use. Chinese energy industry companies slowly got rid of the waste and inefficient conventional development model (Wang et al. 2012). Thus, while the same amount of energy is consumed, it brings more output and less pollution, not only increased the profits of the industrial enterprises, but also has made a great contribution for the sustainable development of the national economy.

Analysis of Interaction of Low-carbon Development and the Energy Industry Investment

Binding effect: Energy industry investment has binding effect on carbon emissions. The bundling effect referring to each investment will have a certain amount of carbon emissions. When the energy industry investment projects will be put into production, this process will cause energy consumption, which will deduce carbon dioxide and other greenhouse gas emissions. Since the energy investment will result in carbon emissions is an established fact, the direction of the energy industry development is to put money on projects where the energy consumption and pollution are relatively smaller. In contrast, the investment project where the energy consumption and pollution are a great must to be bound with high-carbon, creating a vicious cycle at a later time, investment improvement will become increasingly difficult and carbon emissions will increase significantly.

Leading effect: Reducing carbon emissions have a leading role in energy industry investments. Since the changes in climate and the environment problems attracted national attention of government, investment in the energy industry has also gradually been restricted, and no longer to blindly pursue high yield and high return. Government departments have made and gradually improved the various laws and regulations for high carbon emissions of energy companies, pollution criterion and requirements of energy industry investments are strictly regulated (Asafu-Adjaye John & Mahadevan Renuka 2013). In this situation, energy companies must adjust the investment scale, and make careful selection on the object and amount of investments. To complete the hard targets of emission reductions, energy companies must increase investment, adjust the investment structure, and improve production techniques (Chen Shiyi & Golley Jane 2014).

The Mutual Influence Analysis of Low-carbon Economy and Energy Industry Investment

The relationship of economic growth, energy intensity and energy industry investments: The paper uses a multiple regression approach, with each year data (Table 1) establishes a model, to discuss the relation of Chinese GDP, energy intensity and energy industrial investment in recent years, then to come to the conclusions. Energy intensity is

Table 1: Economic growth, energy intensity and energy investments (2005-2013).

year	GDP (100 million yuan) (The base year is 2005)	Energy intensity (ton of standard coal equivalent/ 10 thousand yuan)	Fixed asset investment in energy industry
2005	184937	1.28	10206
2006	208381	1.24	11826
2007	237893	1.18	13699
2008	260813	1.12	16346
2009	284547	1.08	19478
2010	313855	1.03	21627
2011	381588	0.91	23046
2012	408368	0.89	25500
2013	435851	0.86	29009

Table 2: Descriptive statistics.

	Mean	Std. Deviation	N
GDP	3.0180E5	89640.69404	9
Energy intensity	1.0656	0.15461	9
Fixed asset investment in energy industry	1.8971E4	6421.32340	9

one of the most commonly used indicators, reflecting the economic benefits of energy use. Energy intensity is the energy consumption per unit of gross domestic product (GDP).

Placing the data into the multiple linear regression models, the paper obtains the results as mentioned in Table 2 to Table 3

In Table 3, Pearson correlation coefficient is -0.994, 0.983, the absolute value close to 1, and significant coefficient (Sig (1-tailed).) is 0, from which can be seen that the GDP, energy intensity and fixed assets investments in energy industrial are significantly related.

In the Table 4, R^2 value is larger, indicating that the model and the data fit well. In the Table 5, F statistic is 294.392, and significant level Sig is less than 5%, indicating that multiple regression equation established effectively.

The establishment of a multiple regression model $Y = aX_1 + bX_2 + C$, where Y represents GDP (take 2005 as the base period), X_1 represents energy intensity, X_2 represents the fixed assets investment in energy industry, C represents a constant, then formula (1) can be drawn as the linear regression equation from the data in Table 6.

$$Y = -480155.239X_1 + 2.363X_2 + 768606.076 \quad \dots(1)$$

Correlation analysis of low-carbon economy and energy industry investments: Carbon intensity is defined as the carbon emissions per unit of GDP caused. The formula is the ratio of total carbon dioxide emissions to gross domestic product ratio. For the study, the carbon intensity investment

optimization of energy industries and the efficiency evaluation, it has an important role. The paper builds a multiple linear regression model, with carbon intensity as the dependent variable, GDP, energy investment (fixed asset investment in energy industry) and energy intensity as independent variable.

By the correlation analysis, results in Table 7 can be seen that the carbon intensity is highly correlated with GDP, energy investment and energy intensity. So the paper decides to choose stepwise screening strategy to gradually eliminate the variables.

In Table 8 and Table 9, excluding the two variables, GDP and energy intensity, the model has only one independent variable that is energy investment. Seen by the model summary in Table 10, $R^2 = 0.976$, sig. F change < 0.05 , so it is a significant linear correlation model.

In Table 11, the model coefficients -5.109E-5, it can be drawn that the carbon emissions and energy investment are inversely related, sig = 0.00, model passes by t test.

CONCLUSIONS

1. Energy intensity and GDP show reverse changes in the relationship, which means that the economic growth of China may be implemented with reducing carbon emissions. So energy companies and local governments should work together to develop low-carbon way of promoting economic growth. At the same time, the government should encourage investment in low-carbon energy companies, and to help their investment and financing.

Table 3: Correlations.

		GDP	Energy intensity in energy industry	Fixed asset investment
Pearson Correlation	GDP	1.000	-0.994	0.983
	Energy intensity	-0.994	1.000	-0.982
	Fixed asset investment in energy industry	0.983	-0.982	1.000
Sig. (1-tailed)	GDP	-	0.000	0.000
	Energy intensity	0.000	-	0.000
	Fixed asset investment in energy industry	0.000	0.000	-
N	GDP	9	9	9
	Energy intensity	9	9	9
	Fixed asset investment in energy industry	9	9	9

Table 4: Model summary^b.

Model	R	R square	Adjusted R square	Std. error of the estimate
1	0.995a	0.990	0.987	10396.10028

a. Predictors: (Constant), Fixed asset investment in energy industry, Energy intensity

b. Dependent Variable: GDP

Table 5: Anova^b.

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6.364E10	2	3.182E10	294.392	0.000a
	Residual	6.485E8	6	1.081E8		
	Total	6.428E10	8			

a. Predictors: (Constant), Fixed asset investment in energy industry, Energy intensity

b. Dependent Variable: GDP

Table 6: Coefficients^a.

Model		Unstandardized coefficients		Standardized coefficients	t	Sig.
		B	Std. error	Beta		
1	(Constant)	768606.076	193393.041		3.974	0.007
	Energy intensity	-480155.239	127489.149	-0.828	-3.766	0.009
	Fixed asset investment in energy industry	2.363	3.070	0.169	3.770	0.007

a. Dependent Variable: GDP

Table 7: Correlations.

		Carbon intensity	GDP	Energy investment	Energy intensity
Pearson Correlation	Carbon intensity	1.000	-0.971	-0.988	0.983
	GDP	-0.971	1.000	0.983	-0.994
	energy investment	-0.988	0.983	1.000	-0.982
	energy intensity	0.983	-0.994	-0.982	1.000

Table 8: Variables entered/removed^a.

Model	Variables entered	Variables removed	Method
1	energy investment	-	Stepwise (Criteria: Probability-of-F-to-enter <= 0.050, Probability-of-F-to-remove >= 0.100).

a. Dependent Variable: Carbon intensity

Table 9: Excluded variables^b.

Model	Beta in	t	Sig.	Partial correlation	Collinearity statistics Tolerance
1	GDP	0.010a	0.028	0.978	0.012
	energy intensity	0.358a	1.171	0.286	0.431
					0.034
					0.035

a. Predictors in the Model: (Constant), energy investment

b. Dependent Variable: Carbon intensity

Table 10: Model summary^b

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	Change Statistics F Change	Sig. F Change
1	0.988a	0.976	0.973	0.05496	0.976	285.047	0.000

a. Predictors: (Constant), energy investment

Table 11: Coefficients^a.

Model	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	3.214	0.060	3.329	0.000
	Energy investment	-5.109E-5	0.000	-0.988	-1.883
					0.000

a. Dependent Variable: Carbon intensity

- Fixed asset investment in energy industry is changed in the same direction with GDP, indicating fixed assets investment of energy industry has a stimulating effect in Chinese economy. Thus increasing the scale of investment in the energy industry can not only increase productivity, promote low-carbon energy industry to develop, but also drive the national economy. So the government not only continues to strengthen its efforts to support the energy industry, but also introduces various preferential policies to encourage energy industry investment and financing. Energy companies should actively improve the investment situation, optimize investment structure, establish and improve the investment mechanism, while make efforts to broaden the investment and financing channels, to promote the prosperity and healthy development of the energy industry investments.
- Carbon emissions and energy industry investment were changed in the opposite direction. More investment in energy, the less carbon emissions, indicating Chinese energy economy has transformed, and invested to low-carbon and efficient energy industry, clean energy, namely hydrogen, solar, wind, hydro, biomass, ocean energy and other renewable energy sources.
- Requirements for low-carbon have a leading role in energy industry investment. In the areas where energy in-

dustry develops well, the emissions situation is paid more attention by energy companies, and its total energy investment is greater. But in the areas where energy industry development are relatively backward, the energy companies are more concerned with productivity rather than their emission standards. For energy companies in these areas, the government should strengthen its production and emission aspects of the supervision and management, strictly treat the problems accordance with the relevant legal provisions, forcing energy companies to expand their investment scale, adjust the investment structure.

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