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Analysis on Energy Structure in China under the Low Carbon Economy View

Xin Zhang *, Honglin Yang, Lin Wang, Yijin Wang
Institute of System Engineering, Jiangsu University,Zhenjiang, Jiangsu 212013, China
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Abstract: A general energy structure system dynamics model is constructed applying the systematic dynamics theories and techniques.This mode is applied to predict the demand of energy and CO_2 emissions by applying the situation analysis. The results reveal that a 58% reduction was found in the carbon intensity compared with the 2005 level, and we will realize the CO_2 emission-reduction target in the better low-carbon scenario .So that the scenario is the best option for the future development of China's energy structure. It is accordance with the requirement of future development.

Keywords: Energy structure; system dynamics; low carbon economy

1 Introduction

In order to promote economic growth and cope with the climate change,Low-carbon economy which has a minimal energy consumption, minimal output emissions should be advocated. Meanwhile, China is also making great efforts and announcing a CO_2 emission-reduction target to reduce carbon intensity by 40-45% by 2020 based on the 2005 level .China is under great pressure to reduce CO_2 emissions, which would benefit not only the economic growth but also the global environment. Nevertheless, the energy structure is a key factor to decide the CO_2 emissions. Therefore, the energy structure should be adjusted which is an effective method to deal with this problem.

Many scholars from different angles study the energy structure issues[1-7], foreign scholars usually set the empirical model as to reveal changes in the structure of the energy motivation by theory of economics; while domestic literature about energy structure optimization is mainly qualitative research. Through analyzing of the energy structure of our country or region statistical data and points out that energy structure is unreasonable and makes several proposals.Generally speaking, these studies are more fragmented and mostly descriptive study to characterize relatively few quantitative studies.From the perspective of carbon ,this paper aims to improve the status of China's energy structure which long time rely on coal , enhance energy efficiency and reduce carbon emissions .The future development of China's energy structure is simulated by system dynamics theory and methods . By comparing with CO_2 emissions under the different scenario,then seek the best model fitting China's energy structure adjustment.

2 Methodology

Energy is a basic element of promoting national economy development. With the acceleration of industrialization and urbanization in China ,economy growth is more and more depending on it . Energy system is a complex system which intimately associated with economical,social and environmental.

To comprehend the correlations among the various components and master the sustainable developing process of energy system,this paper consider from the interaction and mutual restriction between economy, society, population, resources, and environment. The proposed SD model is composed of five main modules: energy supply module, energy demand module, population module, resource module and CO_2emission module, while supply and demand of energy is divided into three parts: supply and demand of coal,supply and demand of crude oil , supply and demand of gas. The basic elements of the system considered are shown in Fig 1.

*Corresponding author. *E-mail address*: zhangxin407@126.com

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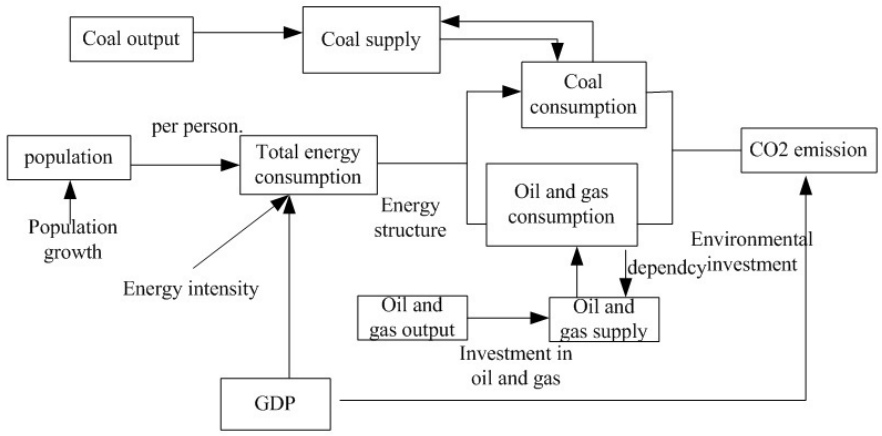

Figure 1: The subsystems of the energy-related system

Only three kinds of non-renewable energy which include coal oil and gas referred to in this paper. The energy consumption is composed of life consumption and output consumption .Energy supply is conditioned by both demand and investment in energy industry .The external dependency was largely decided by imports and consumption. Economic system mainly include value added of the primary industry ,secondary industry and tertiary industry, GDP and the industrial energy intensity.The energy demand growth in industry was largely driven by the rapid dilate of industry.Life energy consumption is affected by the natural population growth.Energy consumption resulted in the massive carbon dioxide . While the development of economy and industry promotes the increase of the investment in environmental protection and thus reduce CO_2 emissions.

Using 2005 as a baseline and according to the GDP growth data, energy resources and related planning data from 2005 to 2010, A energy structure system simulation model is set up by Vensim-PLE software . The causal loop diagram as shown in Fig.2.

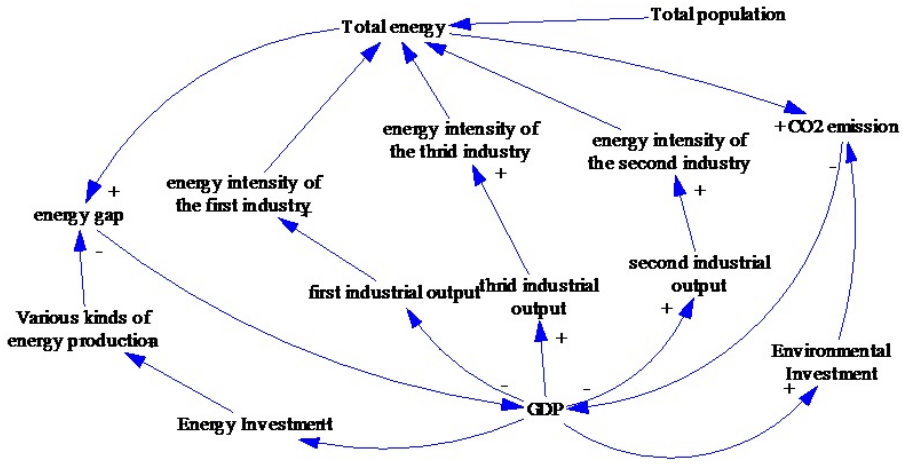

Figure 2: Causal loop diagram of the system

3 Simulation

3.1 Model validation

Based on the statistical data in 2005, we present a system dynamics mode to analyze population, economic development and energy supply and demand in China. The initial value of main variables take from China statistical yearbook,CO_2 emission coefficient of various types fossil energy derived from the standard stipulated in the international and domestic

standards, energy consumption intensity, the proportion of the industrial structure of prediction data is determined by the mathematical statistics method, the future GDP growth, population growth rate data refer to the forecast results of many scholars and all kinds of planning has made.

Simulating calculation the total population and energy consumption from 2005to2009, and analyzing the system error by comparing with the actual data in the same period .The results are shown in table1:

Table 1: Compare with simulated data and real data

	Population (million)		Total energy	consumption	(Million tons)	
Milestone year	Real data	Simulated data	Error(%)	Real data	Simulated data	Error(%)
2005	130756	130756	0	226728	215042	5.15
2006	131448	131529	0.06	246270	237581	3.52
2007	132129	132225	0.07	265582	257406	3.07
2008	132802	132910	0.08	291448	285296	2.1
2009	133450	133587	0.10	306647	315124	2.7

The results show that a margin of error 6 percent,which is given to illustrate the effectiveness and available of the model mentioned in this paper.

3.2 Scenarios of model

Based on current trends of economic growth,three scenarios have been set.A detailed description of each of these follows: Base scenario: This scenario is the continuation of exiting condition.

Low-Carbon scenario:Energy intensity is assumed to be decreased obviously owing to strengthen the government's regulation policy,which prompt the industrial structure has certain optimization.

Better Low-carbon scenario:Energy structure is supposed to be adjusted reasonably, which reduce the proportion of coal and increase the proportion of oil and gas. Through this method, energy use ratio can be move towards the low carbon mode.Meanwhile,increased the development of the tertiary industry, and promoting industrial structure further optimize.

3.3 Computational results and discussion

3.3.1 Simulated results of energy consumption structure

By simulation, it can be seen that under base scenario, the trend of each kind of energy demand is increasing year by year, the total energy consumption will reach 80.3 billion tons standard coal in 2020 , compared with 2005 the level more than 59 billion tons standard coal,increased 2.7%,respectively.Under Low-carbon scenario and better Low-carbon scenario,energy consumption will respectively reach to 57.14 billion tons and 56.5 billion tons less than that of base scenario by 2020.The results of energy consumption and energy structure are shown in table 2 and figure 3.

Table 2: Energy demand and structure

Classification of energy	Total energy consumption Million tons		Energy structure	
Milestone year	2015	2020	2015	2020
Total energy	587726	803340	100	100
Coal	372007	508353	63.29	63.28
Oil	122649	167978	30.5	30.5
Gas	36809.3	49976.67	6.21	6.22
Milestone year	2015	2020	2015	2020
Total energy	557509	571408	100	100
Coal	352881	361587	63.29	63.28
Oil	116343	119481	30.5	30.5
Gas	34916.8	35547.8	6.21	6.22
Milestone year	2015	2020	2015	2020
Total energy	550229	565406	100	100
Coal	346644	322281	63	57
Oil	115548	124389	28.7	34
Gas	45669	50886.5	8.3	9

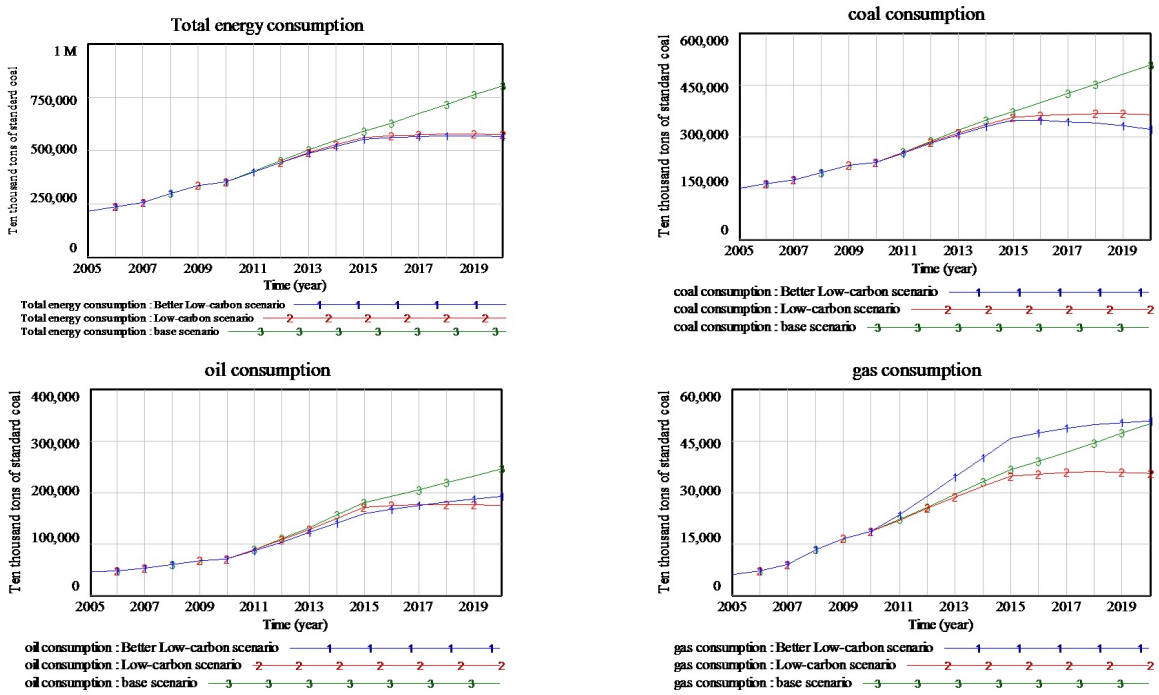

Figure 3: Energy consumption under three scenario

3.3.2 Simulated results of CO_2

As the growing of economy, CO_2 emissions have the same trend.Under three scenarios ,the CO_2 emissions will reach to 4.92534 billion tons, 4.92534 billion tons and 3.30898 billion tons and carbon intensity will reach to 0.457307 tons/one hundred million yuan ,0.325278 tons/hundred million yuan and 0.307232 tons/one hundred million yuan in 2020,respectively.But due to adjust the energy structure less CO_2 emission would be have under better Low-carbon scenario in comparison to that of the other scenario. The results reveal that a 58%reduction was found in the carbon intensity compared with the 2005 level, and we will realize the CO_2 emission-reduction target under better low carbon scenario .So that better low carbon scenario is the best option for the future development of China's energy structure. It is accordance with the requirement of future development.

Table 3: CO_2emissions

	CO_2 emissiions(Million tons)		Carbon intensity	(Million tons / billion yuan)
Year	2015	2020	2015	2020
Base scenario	360369	492534	0.478105	0.457307
Low-carbon scenario	341841	350335	0.453524	0.325278
Better low-carbon scenario	341351	330898	0.452873	0.307232

4 Conclusions

Based on the System dynamic theory and methods, a general energy structure system dynamics model is constructed herein to predict the demand of energy and CO_2 emissions in China by applying the situation analysis. The results reveal that a 58% reduction was found in the carbon intensity compared with the 2005 level, and we will realize the CO_2 emission-reduction target under the low carbon scenario .So that scenario three is the best option for the future development of China's energy structure. It is accordance with the requirement of future development.

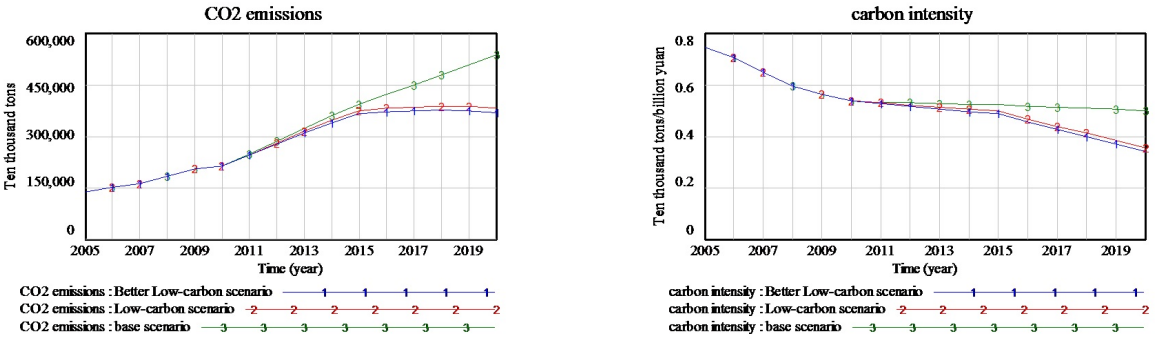

Figure 4: CO_2 emissions and carbon intensity under three scenario

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