

Industry Structure and Energy Consumption Optimizing Models of Hebei Province

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Abstract: Hebei Province is an energy consumption province, It is critical for Hebei Province to handle the relation between energy consumption and economic development. Establish the optimal model that coordinates the relation between energy consumption and industrial structure can optimize the industrial structure and the energy consumption structure. This paper that based on the goal of 11th five-year of Hebei Province and the current energy consumption and the value of the three industries established optimization model. Through the analyze the model, obtain the gap between the optimizing model results and actual data that contains the account of three industrial and energy consumption intensity. In order to coordinate the development of energy consumption and economic growth, Hebei Province must improve the industrial structure and take measures to realize optimized objectives.

Keywords: Energy consumption; The industrial structure; Factor decomposition method; Structure effect

1 Introduction

In recent years, economic of Hebei Province has grown greatly, but with the rapid development of economic, the contradiction of energy and economic is more and more outstanding, energy consumption has been increasing, but the energy utilization efficiency are relatively low, At the same time, because of extensive pattern of economic growth, environmental pollution in some areas are common. Therefore, It is the urgent problems for Hebei Province to discuss a guarantees hebei energy supply, ecological balance to development the road that ensure energy supply and the ecological balance ,that ensure economy sustained, stable and rapid development.

Establish energy consumption optimization model that coordinate development of the industrial structure and the energy consumption, can optimize the industrial structure and energy consumption structure. Energy consumption optimization model based on industrial structure optimization, solve the problem of how to use limited energy resources to make each material production complete even more than established production target . Thus, this paper uses linear program to optimize the system of energy consumption of Hebei .

2 Hebei province energy consumption and economic development situation

Energy consumption strength has come to decline since 1980, from 14.23 to 1.49. Energy utilization efficiency has increased year by year. But the national level is 0.75 .the energy consumption intensity of Hebei Province is high, energy utilization efficiency need to improve, should adopt technical innovation method to improve energy efficiency. energy consumption structure of Hebei Province have come to optimize, but coal-based energy production structure determines the energy consumption structure , the proportion of kinds of energy is constant roughly in the recent 20 year.

Three industries proportion of Hebei Province have changed in the recent 30 year, the proportion of the third industry increased from 21% to 35%. The proportion of the first industry presents descendant trend. The second industry is still the top priority of Hebei province, accounts for half of the proportion.

According to the relevant scholars study shows [1], the influence factors of energy consumption intensity is mainly technological factors, the industrial structure, etc. So in the current energy total limited conditions, Hebei Province should optimize energy consumption structure which does not affect economic development.

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3 Hebei Province energy consumption optimizing model construction

Energy system model mostly expresses all activities of internal system in the form of a flowchart; its optimization method usually adopts the linear programming or modern control theory of modeling. Energy system model build energy system optimization model to solve linear programming and show system operation rule in the optimized conditions. The current energy system model have linear programming model and mixed integer models, this paper mainly use linear programming model to solve relation problem [2].

The basic idea of establish energy consumption optimization model of Hebei Province have two steps, first of all, in the condition of economic growth target and the constraint of economic structure optimization, calculates the annual optimiatize output value of the three industrial and energy consumption of 2009 using energy consumption and three industrial output data in 2008. Then compared with actual value, analyze the gap between the current economic structure, energy consumption structure and the result of the optimization model, to keep the optimization proportion of economic. Realizes the minimum energy consumption and the goal of energy saving and emission reduction.

3.1 model objective function, constraint condition and set decision-making variables

The ultimate goal of the optimization model is minimum the energy consumption intensity in the condition of economic growth and economic structure optimization. So the constraint conditions including economic growth target constraint, the industrial structure optimization and energy consumption constraints.

First point; Set decision variables of model. The decision variables is divided by three industrial, the optimization model contains variables as follows, $E_{1,t}, E_{2,t}, E_{3,t}, G_{1,t}, G_{2,t}, G_{3,t}; E_{i,t}$ Represents energy consumption of i industry in t. $G_{i,t}$ Represents the value of the I industry in t. the t of the formula refers to the year of the solution, that is 2009. The base period is 2008. $E_{i,t}/G_{i,t}$ Represents energy intensity of i industry in t.

Second point; Energy consumption constraints, Energy consumption supports the economic growth, and is necessary. Therefore, It is not reality to directly set constraint value of energy consumption, this question should be understood as the maximum range of energy utilization efficiency level in keeping a certain economic growth speed, thus the energy consumption constraints convert into set range of energy utilization efficiency. Specific steps are that assume energy consumption intensity in t higher than in the based period. And according to the "11th five-year" plan, set the overall target of reduce energy consumption is reduce around 20%, annual reduced by 4%.

$$E_{1,t} \cdot E_{2,t} \cdot E_{3,t} > 0; G_{1,t} > G_{1,0}; G_{3,t} > G_{1,0} \quad (1)$$

$$\frac{E_{1,t}}{G_{1,t}} \leq \frac{E_{1,0}}{G_{1,0}} \quad \frac{E_{2,t}}{G_{2,t}} \leq \frac{E_{2,0}}{G_{2,0}} \quad \frac{E_{3,t}}{G_{3,t}} \leq \frac{E_{3,0}}{G_{3,0}} \quad (2)$$

$$\left| \frac{(E_{1,t} + E_{2,t} + E_{3,t})}{(G_{1,t} + G_{2,t} + G_{3,t})} \right| \leq (1 - 4\%) \left| \frac{(E_{1,0} + E_{2,0} + E_{3,0})}{(G_{1,0} + G_{2,0} + G_{3,0})} \right| \quad (3)$$

Third point; Industrial structure optimization goal, In recent years, Hebei province increase the pace of the adjustment of industrial structure, develop the third industry, narrow the second industrial development scale. But the proportion of the second industry remains above 50%, and the third industry proportion is relatively minor. the proportion of the tertiary industry is 35% in 2009. So in order to realize the optimization of industrial structure, the proportion of the tertiary industry is an important goal of Hebei province. According to the 11th five-year plan, no specific proportion of each industry specific values, assumes the proportion of the tertiary industry of Hebei province is 38%.

$$|G_{3,t}/(G_{1,t} + G_{2,t} + G_{3,t})| \geq 0.38 \quad (4)$$

Forth point; Economic growth target, Assume the economy growth keep certain goal, the economic growth target of optimization model based on the 11th five-year plan of Hebei Province. Durning "11th five-year plan" period, the main objective of economic and social development is, in the condition of improve efficiency and reduce consumption, annual growth of GDP is around 11% in 2010. Therefore, assumed GDP growth rate of hypothesis analysis is not less than the growth speed presented in "11th five-year, in addition, because there is not specified goal value of three industrial in "planning". So assumes three industrial output values not less than last year's value.

$$(G_{1,t} + G_{2,t} + G_{3,t}) \geq (1 + 11\%)(G_{1,0} + G_{2,0} + G_{3,0}) \quad (5)$$

3.2 Set optimization model and algorithm

Determine various parameters contains the target function and constraints .etc. Establish the energy consumption optimization model of Hebei province based on economic growth and the optimization industrial structure as follows,

$$\min = \frac{(E_1 + E_2 + E_3)}{(G_1 + G_2 + G_3)}$$

$$E_{1,t} \cdot E_{2,t} \cdot E_{3,t} > 0; G_{1,t} > G_{1,0}; G_{3,t} > G_{1,0}$$

$$\frac{E_{1,t}}{G_{1,t}} \leq \frac{E_{1,0}}{G_{1,0}} \quad \frac{E_{2,t}}{G_{2,t}} \leq \frac{E_{2,0}}{G_{2,0}} \quad \frac{E_{3,t}}{G_{3,t}} \leq \frac{E_{3,0}}{G_{3,0}}$$

s.t.

$$\left| \frac{(E_{1,t} + E_{2,t} + E_{3,t})}{(G_{1,t} + G_{2,t} + G_{3,t})} \right| \leq (1 - 4\%) \left| \frac{(E_{1,0} + E_{2,0} + E_{3,0})}{(G_{1,0} + G_{2,0} + G_{3,0})} \right|$$

$$|G_{3,t}/(G_{1,t} + G_{2,t} + G_{3,t})| \geq 0.38$$

$$(G_{1,t} + G_{2,t} + G_{3,t}) \geq (1 + 11\%)(G_{1,0} + G_{2,0} + G_{3,0})$$

We can use the LINDO6.1 software to analyze the linear programming problem [3]. LINDO is mainly used in solving linear programming nonlinear programming, quadratic programming and integer programming problems, and also used for the algebraic of some nonlinear and linear equations. Draw optimization analysis results as shown in chart 1. Among them g1, g2,g3 represents the output value proportion of three industrial $E_1/G_1, E_2/G_2, E_3/G_3$ represents the three industrial energy consumption intensity.

Table 1 Three industrial output value proportion, energy consumption intensity of Hebei province and the optimization results

Table 1: Three industrial output value proportion, energy consumption intensity of Hebei province and the optimization results

	g1	g2	g3	E1/G1	E2/G2	E3/G3
Actual data	0.13	0.52	0.35	0.98	2.56	0.47
Optimization results	0.12	0.43	0.45	0.94	1.96	0.49

4 Results analysis

4.1 The secondary industry proportion is too high; the development of tertiary industry is slow

According to the results of optimizing model, in the aspects of industrial structure optimization the proportion of the primary industry has basically achieved 11th five-year plan target, the secondary industry proportion is too high, and the tertiary industry development is slow. In recent year, the problem of resources and environment have come to more serious, Heavy industry development space will become gradually small, it's hard for Hebei Province to provide constant power for economic growth of Hebei province. Therefore, in order to change the condition of energy utilization of Hebei province, improve energy utilization efficiency, realize the sustainable development of society and economy, it is essential for Hebei Province to change the unreasonable industrial structure, Accelerate the development of tertiary industry is the best way to realize this goal [4]. The tertiary industry has less inputs and high outputs, low level of pollution, energy utilization level is the tallest in three industries. The development of tertiary industry not only needs less energy, energy utilization level is high, but also its development will also promote other industrial energy efficiency. Therefore, the industrial focus shifts from the secondary industry gradually to the tertiary industry, vigorously promote the development of the tertiary industry, it will be the main direction of future industrial structure adjustment.

4.2 Industrial energy consumption intensity is high, energy efficiency is low

The decreased degree of energy consumption intensity of primary and tertiary industrial has basically completed the goal of the 11th five-year plan that per unit of output energy consumption reduces by 20 percent, average annual reduced by 4%. But the actual data of secondary industrial energy consumption intensity is different widely from the optimization results; the secondary industry especially industrial energy consumption strength influence optimization of energy consumption and economic growth. Industrial energy efficiency of Hebei province will directly affect the overall efficiency of province energy [5]. In the period of middle Industrialization, heavy industry is the dominant status, such as metallurgy, chemical industry, building materials, coal industry is the main driving force of economic growth of Hebei Province, which obtained fast development in the process of industrialization. However, these industries own less advanced technology, has caused its energy efficiency much lower than other industries of the national economy, energy efficiency stagnant at a low level. In this case, heavy industry realize the rapid development at the expense of high input and high energy consumption inevitably, this is the main reason for rapid growth energy consumption, and its lower energy utilization level also became main reason of restrict energy efficiency improved.

5 Conclusion

The paper constructs a energy consumption optimization model which based on economic growth and economic structure optimization target constraint conditions of hebei province energy consumption, in order to realizes the minimum energy consumption and the goal of energy saving and emission reduction. Through the analysis results of the energy consumption optimization model , the proportion of the secondary industry is excessive , the development of tertiary industry is slow, energy consumption intensity of the secondary industry is too high .In order to coordinate the development of economic growth and energy consumption, Hebei Province should improve the internal industrial structure, develop the tertiary industry vigorously and improve utilization efficiency .

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