

The Analysis on the substitution of renewable energy and traditional energy, and reduction of CO₂ emission, Beijing

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1 Introduction and background

It has become a hot issue in energy, economy, and environment to mitigate and adapt to climate change in China. The Chinese government has announced to lower its CO₂ emission per unit of GDP by 40%-45% by 2020 compared with the 2005 level, and to increase the share of non-fossil energy in primary energy consumption to 15% by 2020. China is currently in the period of accelerated industrialization and urbanization.

Beijing, as the capital of China and the international city, is our country's second-largest city of energy consumption. With steadily rising energy demand, which means that Beijing's CO₂ emissions will continue to increase. Beijing is under high pressure and faces difficulties in controlling the growth of CO₂ emissions. However, its energy structure is not reasonable, its clean energy is not high, and the environment pollution is still a serious problem. In order to reduce the CO₂ emissions and optimize the energy structure, it is necessary to adopt the new environmental economic policies to develop the renewable energy. 2011, Beijing issued "12th Five-Year Plan" and New energy and Renewable Energy Development Plan. In the Twelve Five-Year Program period (2011–2015) the goal is for the GDP about 8%, and for the energy consumption by 2015 to be less than 90 million tce. Moreover, reduce CO₂ emissions per unit of GDP by 18 % and CO₂ energy consumption per unit of GDP by 17% from 2010 levels. As the non-fossil energy, renewable energy will play a significant role in reducing CO₂ emissions.

Economic development, energy consumption and carbon emissions

With economic development, population growth and urban expansion, energy shortage and changing climatic conditions are emerging in Beijing city. Although Beijing has made great progress in economy, while Energy consumption and CO₂ emission is also growing rapidly (Table 1).

Table 1 Economic development, energy consumption and carbon emissions

Year	GDP (billion RMB)	Energy consumption (million tce)	Energy related CO ₂ emission (million t)
2000	316.2	41.4	61.8
2001	370.8	42.3	62.4
2002	431.5	44.4	64.8
2003	500.7	46.5	66.1
2004	603.3	51.4	75.6
2005	697.0	55.2	76.2
2006	811.8	59.0	78.5
2007	984.7	62.9	85.7
2008	1111.5	63.3	89.3
2009	1215.3	65.7	91.1
2010	1411.4	69.5	91.6

Sources: Sources: 2011 Beijing Statistical Yearbook

(tce :ton of standard coal equivalent)

This table shows that the GDP reach 1411.4 billion RMB in 2010, with the primary, secondary and tertiary industries accounting for 0.9%, 24.0% and 75.1%, respectively. Beijing's total energy consumption will grow from 41.4 million tce in 2000 to 69.5 million tce in 2010, which means that a GDP growth rate of 16.1% can be achieved while energy consumption annual growth rate is 5.3% in the last 10 years. Total energy related CO₂ emission reach 91.6 million t in 2010, with a growth rate of 4.0% per year from 2000 to 2010. CO₂ emissions are discharged by coal accounts for 48% of total CO₂ emissions in 2010. Among the industries and sectors, electricity and heat Sector consumed 53% of total coal consumption. Therefore, how to decrease the consumption of fossil energy have become the hot issues.

Energy consumption structure and Governmental plan

Beijing area's energy consumption is developing toward the encouraging direction. On one hand, the output level of energy consumption is unceasingly declining, it is completely coinciding with governmental policy that is to build a resource-conserving society , promoting the development of the economy well and fast is not at the expense of large amount of resources; on the other hand, the proportion of clean energy act as an upward trend, and coal and other primary energy showed a downward trend, so the energy structure has been continuously optimized to make a positive role in improving Beijing's air quality and the environmental standards.

Table 2 Energy consumption structure

Year	Coal	Oil	Natural gas	New energy and Renewable Energy	Electricity
2005	39.7%	33.6%	6.4%	1.0%	19.3%
2010	30.3%	30.4%	13.1%	3.2%	22.4%
2015	16.8%	28.3%	24.4%	6.1%	24.4%

Sources: 2010 Beijing Statistical Yearbook

Beijing, “12th Five-Year” Energy Development Plan (2011-2015)

Table 2 shows that during 2005-2010, Beijing's energy consumption structure has been continuously optimized. The proportion of Coal is declining in the total consumption, the proportion of coal fell from 39.7 % in 2005 to 16.8% in 2010. With the rapid development of the country's economy, the continued improvement of people's living standard, the upgrading of the consumption structure, as well as more and more environmental control efforts, the energy consumption of electricity, natural gas, and renewable resources have been rapidly growing, the proportion has been rising. In 2010, the consumption of the electricity, natural gas and renewable energy respectively are 15.6 million tons of standard coal, 9.1 million tons of standard coal, and 2.2 million tons of standard coal, accounting respectively for the proportion of energy consumption are 22.4%, 13.1%, 3.2%, Compared to 2005, they respectively rose 3.1%, 6.7 percentage points and 2.2%, the proportion of New energy and Renewable Energy will reach 6.1% in 2015.

"The 12th Five Year Plan Summary Beijing National economy And Social development in Beijing" has cleared out main development targets of Beijing in the next 5 year: to continue to maintain the capital's economic development steady and rapid, and on the basis of optimizing structure, improving the efficiency and reducing the resource consumption.

In 2010, renewable energy resources account for only 6.1% of total energy consumption. However, Beijing has abundant renewable energy resources. in 2011, Beijing issued “the New energy and Renewable Energy Development Plan”, as follow the table 3:

Table 3 “the New energy and Renewable Energy Development Plan”

	2010	2015
General goal	Total of new energy and renewable energy : 2,230 thousand tce	Total of new energy and renewable energy : 5,500 thousand tce
Solar	980 thousand tce the capacity of photovoltaic power generation: 2.3 MW ;	2920 thousand tce the capacity of photovoltaic power generation: 250 MW ;
Geothermal	785 thousand tce	1,500 thousand tce
Biomass	360 thousand tce	890 thousand tce
Wind	80 thousand tce	190 thousand tce
Hydropower	28 thousand tce	

Sources: Beijing, “12th Five-Year” New Energy and Renewable Energy Development Plan

Solar: Beijing has abundant solar energy resources. It receives an annual total isolation that exceeds 5 GJ/m² with more than 2600 hours of sunshine a year. In 2010, solar energy accounts for 44% of the total new energy and renewable energy. Geothermal: in Beijing, high temperature geothermal resources suitable for heat generation are mainly located in changping district. Most of the resources in other areas are of lower temperature. Biomass: Beijing has a wide range of biomass resources that can be used for energy supply. these resources include agricultural and forest residues, Waste oils, Livestock ,poultry manure and Municipal waste. The total of availability of biomass resources is 2 million tce. Wind: the regions with favorable wind resources are concentrated in the northwest of Beijing. It has an annual average wind speed of over 6 m/s.

2 Methodology and purpose

Based on the above discussion, we should let the purpose more clearly and so that focus on the problem we should take more attention, as following figure 1.

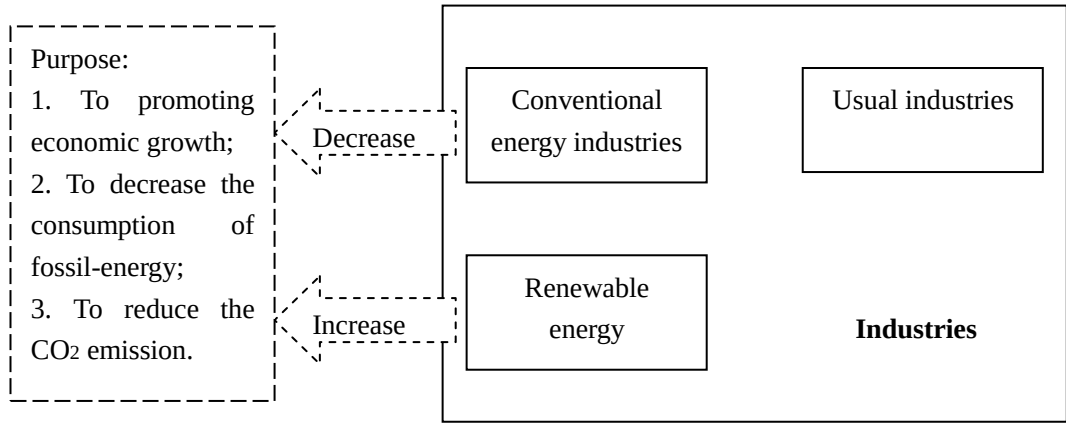


Fig.1 the purpose of this paper

Renewable energy is projected to play an important role in future energy consumption. it is expected to be much more significant in reducing CO₂ emission. The energy produced from sun, wind, biomass gasification processes, anaerobic digesters, or geothermal resources can directly or indirectly substitute for conventional energy consumption for industries users. So it needs to construct a socioeconomic model that is based on an I/O model and introduce the renewable energy industries into economic activities. To promote effective use of renewable energy and restructuring the existing energy consumption structure, some management instruments and economic policies need to be adopted for promotion of economic growth, promotion of renewable energies and promotion of the reduction of the CO₂ emission.

Industry sector consists of usual energy industries, conventional energy industries and renewable energy industries. The industrial classifications in conventional energy industries and renewable energy industries are shown in Table 4.

Table 4 classifications in conventional energy industries and renewable energy

Conventional energy	Utilizing renewable energy
Coals products	Biomass solid briquette
Gasoline	Ethanol fuel
Diesel oil	Biodiesel
power	Solar photovoltaic
	Biomass waste generation power
	wind power
	hydroelectric power
heat	geothermal heat pumps heating

In order to achieve these two purposes, the methodology using in this paper have been modified as following figure 2:

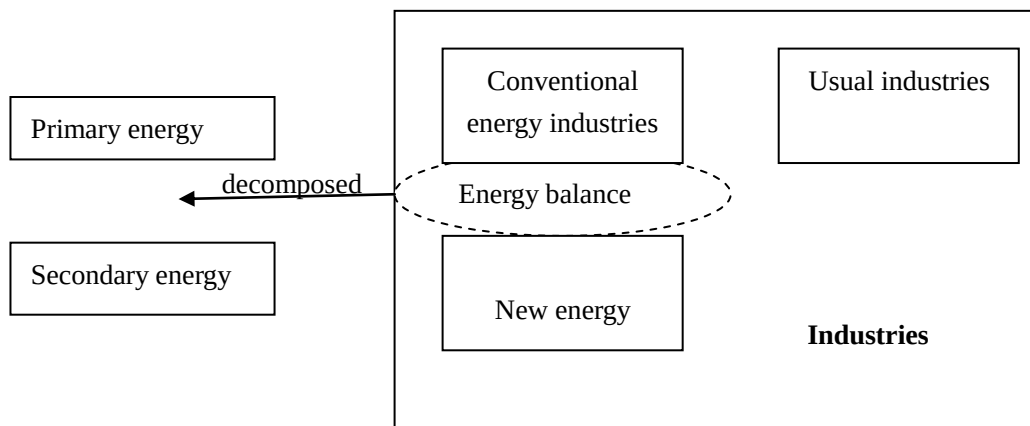


Fig.2 the modified framework of energy balance

Energy balance is the key issue for constructing the socioeconomic model. The energy balance will be divided into primary and secondary energy.

3 Objections

Research purpose: (1) Analyze the effects of the policies on reducing CO₂ emission and promoting new industries. Propose the optimum emission tax. (2) Promote effective use of renewable energy and propose an optimal structure of energy system. (3) Propose an optimal structure of renewable energy, compare with the Beijing's renewable energy development plan. (4) Introduced new energy industries, provide optimal policies, such as emission tax of CO₂ and subsidy, into the comprehensive evaluation model, which includes energy balance, economic balance, and environmental balance. Finally, achieve maximize the GDP and emission reduction objectives.

Simulation: carbon tax for consumption of traditional energy and subsidy for renewable energy. Carbon tax: Carbon tax was an effective policy tool to cope with the climate change and emission reduction. A socioeconomic model was set up to simulate the influence of levy carbon tax on China's socioeconomic, energy saving and CO₂ emission reduction. Subsidy: the reasonable use of the revenue could produce an

important effect on carbon tax collection. The biggest aim of carbon tax is to promote renewable energy industries. Therefore, this research suggests that the carbon tax revenue should follow the policy of special fund for developing special use. The government should set up a national special fund by carbon tax revenue which should be used for the projects of improving energy efficiency, developing low carbon emission energies.

4 Conclusion

Renewable energy resources account for only 3.2% of total energy consumption. However, the growth in CO₂ emission, as well as serious environmental pollution problems caused by consumption of fossil energy, provides arguments for the development of renewable energy resources. Renewable energy potential in Beijing is greater than that indicated by the current level of use. It can play a larger role in the CO₂ reduction. In the next, the researches continue to built the energy balance, complete socioeconomic model and evaluate the economic policies in which the tax and subsidy are introduced.