Driving Force and Challenge of Developing Low-Carbon Economy in China

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Abstract

With the growth of population and development of the global economy, the unrestrained use of natural and energy resources have seriously influenced environment and economy of world. Many people start to realize the serious environmental problems that come from the high energy utilizations, especially of high carbon dioxide (CO₂) emissions. So Low-Carbon Economy has become focus of attention around the world; it also has become every country’s strategic goals for future development under this global situation.

As the biggest country of CO₂ emissions in the world, China’s development of Low-Carbon Economy is increasingly influencing the economy and environmental development in the world, and the country has faced more and more pressure after United Nations Climate Change Conference, 2009. Transition to Low-Carbon Economy is essential road for China, whether respond to the threat of climate change or balance domestic economic development with environmental sustainability. However, China also faces lots of challenges and pressure in the process of transition to Low-Carbon Economy.

This thesis combines quantitative method with qualitative methods to do a research about driving force and challenges of developing Low-Carbon Economy in China. Firstly, it discusses the driving forces for China to develop Low-Carbon Economy from two aspects—pressures and benefits. Secondly, it investigates challenges that China is likely to face in Low-Carbon Economy development from energy and economic aspect. Finally, it uses cause and effect diagram to explain the bottlenecks of Low-Carbon Economy development in China.

Our conclusion is that China faces the bottleneck between challenges and driving force to develop Low-Carbon Economy. And this situation was caused by national actual situations and conditions in China. This explains also why China requested in Copenhagen Conference that “developing countries take appropriated measures to emission control and reduction in terms of receiving the funding and technology support from developed countries. Those emission reduction actions should be done according to the national actual situations and conditions.”

Key words: Low-Carbon Economy, renewable energy, driving force, challenges, CO₂;
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1 Introduction

This part includes background, purpose and methodology. It introduces the internal and external environment for China to develop Low-Carbon Economy.

1.1 Background

1.1.1 Global picture

With the growth of population and development of the global economy, the unrestrained use of natural and energy resources have seriously influenced environment and economy of world. Many people start to realize the serious environmental problems that come from the high energy utilizations. It includes smog, photochemical smog, acid rain and high CO2 emissions. (The Climate Group, 2009)

Under this background, a series of new concepts and new policies have been put forward in the entire world. This part shows the global background from two aspects: Global climate change and development of Low-Carbon Economy.

1.1.1.1 Climate change

The greenhouse effect is one of the most serious problems that have attracted the world’s attention. Table 1 shows the major greenhouse gases and their characteristics, it is so clear that atmospheric concentration of CO2 is the biggest problem to influence global climate. Although it’s annual rate of growth is not higher than CFC, its lifetime is the longest than other gases, 50-200 year. What’s more, its contribution rate is the highest for greenhouse effect, also 55% below. (Yuqing X, etc, 2008)

Table 1: The major greenhouse gases (Source: Yuqing X, etc, 2008)

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<thead>
<tr>
<th>Gases</th>
<th>Atmospheric concentrations (PPM)</th>
<th>Annual rate of growth (%)</th>
<th>Lifetime (year)</th>
<th>Contribution rate (%)</th>
<th>Main source</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO₂</td>
<td>355</td>
<td>0.4</td>
<td>50-200</td>
<td>55</td>
<td>Coal, oil, natural gas, deforestation</td>
</tr>
<tr>
<td>CFC</td>
<td>0.00085</td>
<td>2.2</td>
<td>50-102</td>
<td>24</td>
<td>Blowing agents, Aerosols, Refrigerants, Cleansing agent</td>
</tr>
<tr>
<td>CH₄</td>
<td>1.714</td>
<td>0.8</td>
<td>12-17</td>
<td>15</td>
<td>Wetlands, rice Paddies, Fossil fuel, Livestock</td>
</tr>
<tr>
<td>NOₓ</td>
<td>0.31</td>
<td>0.25</td>
<td>120</td>
<td>6</td>
<td>Fossil fuels, Fertilizers, Deforestation</td>
</tr>
</tbody>
</table>

(CFC-Chlorofluorocarbon, NOₓ-Nitrogen Oxide-, PPM- parts per million)
What’s more, the world’s CO₂ emission shows an upward tendency from 1971 to 2007 (*Figure 1*), and it continues to grow in future. This tendency directly result a series of environmental, energy and economic issues. So, Low-Carbon becomes a top topic in the world.( International Energy Agency , 2009)

![Figure 1. CO₂ emission of the world (1971-2007)](image)

(Source: International Energy Agency, 2009)

1.1.1.2 The emergence and development of Low-Carbon Economy

This part intruduces major events in the process of developing Low-Carbon Economy from 1992 to 2009.

**United Nations Framework Convention on Climate Change (UNFCCC), 1992**

The international responses have emerged with the development of UNFFCCC. It was adopted at the United Nations Conference on Environment and Development in New York, 22<sup>nd</sup> May 1992. For present and future generations, it aims to stabilize atmospheric concentrations of greenhouse gases at a certain level that would prevent the negative impacts of human activities to damage the climate system. (United Nations Development Program , 2010)

**Kyoto Protocol, 1997**

Kyoto protocol is a supplementary provision to the UNFCCC. It was established on 11<sup>th</sup> December 1997 at Kyoto and entered into force on 16<sup>th</sup> February 2005. It is an
international agreement that brings countries together to protect environment and reduce the effects of global warming and greenhouse emissions. In brief, it goal is to fight global warming. To December 2009, there are 187 countries have signed Kyoto Protocol, including China. The provisions of the Kyoto Protocol are legally binding on the ratifying nations, and stronger than those of the UNFCC. (UN,1998)

Energy white paper, 2003-Our energy future: creating a Low-Carbon Economy
The British government released the Energy White Paper on 24th February 2003; it’s the first time to bring the “Low-Carbon Economy”, that is a new economic development that means low emission, low energy consumption, low pollution, and full combination with economic benefits, social benefits and ecological benefits. It addresses some energy challenges and gives a new direction for energy policy. The Energy white paper shows that people need urgent global action to tackle climate change. (Department of Energy&Climatechange, 2003)

The theme of World Environment Day (WED), 2008- Kick the habit: Towards a Low-Carbon Economy
5th June 2008, United Nations Environment Programme determines the theme of World Environment Day2008, “Kick the habit: Towards a Low-Carbon Economy”. It shows a way forward that mitigates climate change, reduce poverty and promote economic and political stability. Achim Steiner, Executive Director, United Nations Environment Programme, he said the theme is more than a strong and catchy phrase. “If we are to move the global economy to a greener and cleaner one, a sharp reduction in the inefficient use of fossil fuels allied to an increased up take of renewable energy must be at the centre of the international response.” (United Nations Environment Programme, 2008) Low-Carbon Economy is a huge opportunity rather than a burden.

The Climate Change Conference in Copenhagen, 2009
The United Nations Framework Convention on Climate Change, it is 15th Conference of Parties (COP 15) and hold on 7th December 2009, Copenhagen, Denmark. It aims to formulate a landmark global climate accord to take the place of Kyoto Protocol. Some countries have built their energy consumption and pollution reduction targets during the conference. (UNFCCC, 2009)

This accord shows funding program of $100 billion a year by 2020 from developed countries to address the needs of developing countries, and temperature control objectives,
namely to ensure that global average temperature is no more than 2 degrees Celsius. (Copenhagen Accord, 2009)

Because of the serious differences between developed countries and developing countries in emission reduction, financial support and supervision mechanism, this conference didn’t achieve expectation, the Copenhagen accord is just a political agreement instead of legally binding accord. Developing countries considered developed countries have historically responsibilities for global warming, and developed countries should provided financial support, furthermore, it should not be considered a favor; Developed countries forced developing countries to accept international monitoring of their national mitigation actions, but developing countries rejected this actions, they strongly expressed it is intrusion on national sovereignty. (Saleemul H, Achala C, Simon A, 2010)

The COP 15 is a confrontion of environmental and economy, developing and developed countries, UN Secretary-General Ban Ki-moon said this conference is not perfect at this time, but it was very significant step forward and a strong driving force to development of Low-Carbon Economy.

1.1.2 National picture

This part introduces internal environment for China to develop Low-Carbon Economy from four aspects.

1.1.2.1 Basic national conditions of China

This part are going to show lots of data that come from National Bureau of Statistics of China (2009).

**Population:** 1.3 billion, about 20% of total world population, is the most populous county in the world, population aging issue exists.

**Resource:** a great variety but distribution is not well balanced, the total amount of resources rank the first of the world, but resource quantity of each person is small.

**Box 1.**

*The Brazilian presidential Luiz Inacio Lula da Silva, said “These papers cannot threaten the individual sovereignty of each country; each country has to have the competence to do its own oversight”. (Transcript of President Lula's address in Copenhagen, 2009)*
**Energy:** the total energy reserves of China rank the first of the world, while is the second largest energy producer and consumer in the world. Energy structure is coal-dominated, the development and utilization of renewable energy is low. Coal accounts for 90% of the total primary resources in China. Coal is in the position to dominate the production and consumption of total China energy resources.

**Economy:** since reform and opening-up of China in 1978, China has rapid increased in economy. The growth rate of GDP has 8%~9% for many years.

**Technology:** there is still a big gap between China and developed countries in advanced technologies. China always faces with technology blockade. China relies on technology introduction rather than technology innovation.

![Figure 2.Industrial structure of main countries (2007)](Source: National Bureau of Statistics of China, 2009)

The industrial structure in China is dominated by the primary industry and particularly dominated by secondary industry. *(Figure 2)* Secondary industry includes heavy industry and construction industry. These two industries are high energy consuming industry and they will lead to high carbon emission in China. In the western, most countries have finished industrialization and urbanization, and the economy development was promoted by the tertiary industry. However, China is in the middle of the industrialization and urbanization, the proportion of the secondary industry in China is greater than other countries in the figure. This situation will last in the future for a long period of time.
1.1.2.2 China’s economy development was restricted by “High-Carbon”

In the past 30 years of reform and opening-up, the economy of China has developed rapidly. In 1970s, China was economic entity with high planning and central control. Currently, China changed from highly centralized planned economy to remarkable dynamic market economy. From the reform and opening-up in 1978, the GDP in China was increased in the 9.8% of average annual growth rate. The per capita income was increased and about 500 million people lift out of their poverty. The GDP in China has remained high growth rate, even in 2009, the economic crisis did not stop the grow speed of China economic development. Many elements in ‘Millennium Development Goals’ of United Nations have been achieved in China.

However, China has to faces many potential crises and challenges while China achieved mentioned-above achievements. In the past 30 years, China’s economic growth highly depended on consumption of coal and other high-pollution fossil fuels. Dependence on such fossil fuels makes China having high carbon emission in the process of industrialization and urbanization. According to ‘China human development report’ of 2010, the emission of CO2 was increased rapidly from 1970 to 2006 under the process of industrialization and urbanization. In 2006, the emission of CO2 in China has exceeded the United State and ranked No. 1 in the world. (Figure 3)

![Figure 3 Trends of China's total emissions and per capita emissions (1970-2006)](image)

(Sources: United Nations Development Program 2010)
In the long-term, such the economic growth pattern of ‘High-Carbon’ will restrict China economic development.

In the recently conference of ‘Framework of China’s carbon balance of trade’, vice minister of Ministry of Environmental Protection (MEP) in China, Pan Yue, made a speech that ‘domestically, the ‘High-Carbon’ will seriously restrict China’s future economic development.’ In his point of views, the specific influences were performed as follow: (Ministry of Environmental Protection of the People's Republic of China, 2008)

- China is now in the stage of heavy industrialization, and heavy industry was supported by energy. The prices of international energy and resources products were increased sharply. China has to pay more and more money to and become increasingly dependence on those energies and resources. Risk resistance capacity of China is becoming weaker. This situation has negative impact on the stability of economic growth in China.

- Under the situation of ‗financial tsunami‘ sweeping across the world, ‘carbon emission’ has become the ‘green barrier’ for developed countries to suppress and restrict the exports of China traditional competitive products.

- In the future, ‘carbon emission’ will become the most important international strategic resource in the world. In the past, countries fight for land, oil, coal and mineral resources. Now, countries will compete for carbon emission rights. Currently, China is in the bottom of the industrial chain in the international system of industrial division. China’s resources and energy-intensive products account for large proportion in exports. The China’s energy consumption accounts for a quarter of the world. And the total emission amount of CO2 accounts for one fifth of the world. This situation will restrict the development of local industries in China.

- From the social point of view, carbon emission and other environmental pollution has led to serious consequences. According to many social researches, environmental pollution was associated with wealth gap. It will affect the social stability. It means that ‘carbon emission’ is not only an environmental issues but an economic and social issue.

Pan Yue said, “In the situation of global climate change, the world is experiencing a huge revolution of economic and social development. That is to develop Low-Carbon technology, set up the modes of Low-Carbon Economy development and Low-Carbon
consumption. Low-Carbon Economy is the basic way and breakpoint of construct eco-
civilization in China.”

If China does not fully consider the impacts of climate change, then the achievements of
reform and opening-up in past 30 years will be under the risk of regression.

1.1.2.3 The historical process of China in Low-Carbon Economy

This part introduces major events in the process of developing Low-Carbon Economy
from 2006 to 2009 in China. (World Low Carbon and Eco-economy Conference&
Technical Exposition, 2009)

2006

Ministry of Science and Technology, China Meteorological Bureau, National
Development and Reform Commission, State Environmental Protection Administration
and other relative ministries associated issued the first ‘National Assessment Report on
Climate Change’ in China.

2007

June, China officially released the ‘China National Climate Change Program’.

July, the premier of China, Wen Jiabao, was hold the first leading group meeting of
addressing climate change and energy conservation work, and hold the State Council
Conference, which mainly studied and planned to address the climate change issue and
organizing the implementation of energy saving and emission reduction.

September, on the 15th leaders meeting of Asia-Pacific Economic Cooperation (APEC),
the president of China, Hu Jintao, solemnly put forward four proposals, explicitly
advocated ‘develop Low-Carbon Economy in China’. In his speech, there were four main
aspects. It included developed Low-Carbon Economy, research and develop Low-Carbon
ergy technology, increased carbon sinks, promoted carbon sequestration technology
development.

He also proposed: ‘To educate the public on national climate change and increase their
awareness of energy conservation and emission reduction. Every citizen should make
effort on slowing down the climate change.’ He suggested that set up ‘the Asia-Pacific
Network on Forest Rehabilitation and Sustainable Management’, jointly promote Asia-Pacific forest rehabilitation and growth.

At the same month, the National Science and Technology Minister, Wan Gang, called for great efforts on developing Low-Carbon Economy on annual meeting of China Association of Science in 2007.

October, ‘building eco-civilization’ was put in the seventeenth congress of the CPC report, China was first time putting forward the concept of ‘building eco-civilization’.

December, the State Council Information Office published a White Book ‘China’s Energy Conditions and Policies’, it highlighted the multiple development of energy. The renewable energy was defined as an important element of national energy development strategy. ‘Coal-dominated’ was not mentioned anymore.

2008

January, Tsinghua University was the first to formally establish the ‘Low Carbon Economy Research Institute’ in China. It focused on systematical and deep research of Low-Carbon Economy policies and strategies. And it was committed to do a research and give suggestions on global economic and social sustainable development.

June, on the National People's Congress (NPC) and Chinese People's Political Consultative Conference (CPPCC), the member of CPPCC, Wu Xiaoqing, clearly put ‘Low-Carbon Economy’ on the agenda. He considered that whether China can go forefront of world development in the next few decades was largely suggested to the ability of China to adjust the development of Low-Carbon Economy. China should take actions as soon as possible to response to this challenge. He suggested that China should develop Low-Carbon Economy as soon as possible, consider the relevant technical problems and do a pilot study.

October, Chinese government released a White Book ‘China's policy on climate change and action’. This book gave introduction to the policies and actions on slowing down the climate change in China.

2009

June, Chinese Academy of Social Sciences published a ‘City Blue Book: China Urban Development Report (NO.2)’ in Beijing. This book indicated that under the situation of
global climate change, decision makers of all levels should reach a consensus to develop Low-Carbon Economy. Low-Carbon Economy is the important mean to control the global warming and fulfill the sustainable development. At the same month, the climate negotiation between China and the United State, which both are the largest emitters of green house gases in the world, was opened.

**September**, the president of China, Hu Jingtao, made an important speech in United Nations Climate Change Conference and indicated that “To develop a green economy, actively develop the Low-Carbon Economy and the recycling economy, develop and promote the climate friendly technologies”.

**December**, the Premier of China, Wen Jiabao, also made an important speech with topic ‘*Reach a consensus, enhance cooperation and promote the historical process of climate change*’ and promised that “By comparing with 2005, the total volume of emission of CO2 per unit of GDP in China will reduce by 40%–45% in 2020”.

1.1.2.4 China’s position in Copenhagen Conference

As the biggest CO2 emission country in the world, it showed its position with considering national practical situation and its responsibilities in Copenhagen Conference. (UNFCCC, 2009; Copenhagen Accord, 2009)

Clarify emission reduction commitment of developed countries in the second commitment period of ‘Kyoto Protocol’. And ensure some developed countries which did not approve the ‘Kyoto Protocol’ to take comparable commitment of emission reduction.

Make an effective arrangement to ensure that the developed countries make good on their promises to give funding and technology support to developing countries.

Developing countries take appropriated measures to emission control and reduction in terms of receiving the funding and technology support from developed countries. Those emission reduction actions should according to the national actual situations and conditions.
1.2 **Purpose**

According to the background above, this thesis aims to study driving forces and challenges of transition to Low-Carbon Economy in China, and tries to find the bottlenecks its development under analysis of driving forces and challenges. What’s more, this thesis discusses Low-Carbon Economy in China from three aspects: Energy, Environmental, and Economy. Finally, it presents the bottlenecks of Low-Carbon Economy development in China according to cause and effect diagram in outcomes.

In this thesis, the focus is on these three researches:
1. What is driving China to make transition to Low-Carbon Economy?
2. What kinds of challenges and difficulties is China likely to face transition to Low-Carbon Economy?
3. What will China face the bottlenecks when it develops Low-Carbon Economy?

1.3 **Methodology**

The *Figure 4* shows the main idea of working step in final thesis. Firstly, this thesis talks about the driving force to make transition to Low-Carbon Economy from two aspects—pressure and benefits; secondly, investigate to challenges from three aspects: energy, environmental and economy; finally, it presents the bottleneck of Low-Carbon Economy development in China according to cause and effect diagram in outcomes.

![Figure 4. The main idea of working steps (Source: Lei Wu, Yang Zhao)](image-url)
This thesis combines quantitative and qualitative methods and critically analyse empirical data of different kinds according to review scientific literature. (Walliman N, 2008)


- Used Website. The internet is main source of this thesis. Because this thesis base on data analysis, we got scientific data from official website to support our arguments. Such as National Bureau of Statistics of China, United Nations Development Program, and China Council for International Cooperation on Environment (CCICED), International Energy Agency (IEA), etc.

- Qualitative interview. Get relevant environmental policy of Low-Carbon Economy in China according to a qualitative interview with public officers Ms. Chen who work in Environmental Protection Bureau. This interview last two hours, we asked many open questions and got more Low-Carbon Economy knowledge from her. However, it is not main method of this thesis, because sometimes those officers’ opinions are over subjective.

- Comparison. Find some results from different aspects, such as compare between developed and developing countries to get their differences and contradiction on reduction task of CO2, it is more easy to find the distance between China and other countries by comparison.; and compare China’s past and present situation about energy, environment and economy to find the tendency of Developing Low-Carbon Economy.


Our thesis results are based on our data analysis from scientific articles. The scientific articles can give support to the thesis. However, less focus on the other relative journals
will make us just follow our own way to formulate our point of views and overlook some other existing possibilities. Therefore, the thesis may not very comprehensive.
2 Theoretical framework

2.1 Low-Carbon Economy

2.1.1 Definition of Low-Carbon Economy

Low-Carbon Economy is an economic model which has a minimal consumption of High-Carbon Energy (coal, oil, etc) and output of greenhouse gases (GHG), specifically CO2. It will replace in High-Carbon Economy model in Figure 5. High-Carbon Economy is no restraint on the carbon intensity of energy production and energy consumption. Low-Carbon Economy aims low energy consumption, low pollution, low emission and high technology, high energy efficiency, high economic benefit. (Source: World Low Carbon and Eco-economy Conference& Technical Exposition, 2009)

![Diagram of Low-Carbon Economy]

Figure 5. The aims of Low-Carbon Economy
(Source: World Low Carbon and Eco-economy Conference& Technical Exposition, 2009)

Through new energy development, technological innovation in energy production and recycle, system innovation, industrial restructuring, Low-Carbon Economy will balance
economic development and environmental protection and realize economic development and carbon emissions of energy consumption do not affect each other.

In a word, Low-Carbon Economy is to achieve high energy utilization, development of renewable energy and GDP under sustainable development.

2.1.2 Characteristics of Low-Carbon Economy

Low-Carbon Economy can be characterized according to four aspects. (European Union@United Nations, 2009)

- All waste must be minimized, that means reduction, restage, recycle;
- Energy production and consumption should be used low carbon energy sources and methods - renewable and alternative energy sources, Carbon Capture and Sequestration;
- Higher efficiency of energy utilization. All resources should be used efficiently - more efficient energy conversion devices, combined heat and power;
- There is high awareness and compliance with environmental and social responsibility initiatives - industry, commerce and individual.

2.2 Renewable energy

2.2.1 Definition of renewable energy

**The Renewable Energy Law of the People's Republic of China**

Renewable energy refers to wind, solar, hydro, biomass, geothermal, ocean and other non-fossil energies. (The Central People’s Government of the People’s Republic of China, 2006)

**Texas legislature**

Renewable energy means all kinds of energies that can be regenerated in a short time. It can be derived from sun directly including thermal, photochemical, and photoelectric, or can be derived from sun indirectly including wind, hydropower and biomass. Renewable energy is not including the fossil fuels and inorganic fuels. (TREIA, 2010)

**International Energy Agency**
Renewable energy can be called clean energy. It refers to inexhaustible resources which can be constantly generated and sustainable used. It has less negative impact on environment. Renewable energy is widely distributed and is good to be developed and used locally. It mainly includes wind, solar, hydro, biomass, geothermal, ocean energy. (IEA, 2008b)

2.2.2 Characteristics of renewable energy

Renewable energy can be characterized according to five aspects. (IEA, 2008b)

- Abundant in resources, renewable, can be sustainable used for human.
- Energy density is low, usually needs a large space to develop and use.
- Non-carbon or low carbon content, it has less negative impact on environment.
- Wide distribution. It is good for small-scale and distributed use.
- Intermittent, volatile. It is unsuitable for continuous application.

2.2.3 The advantages and disadvantages of renewable energy

Renewable energy will not be reduced when it is used. It can be replenished periodically and can be sustainable used. It has less impact on environment and is widely distributed. It is very important to energy structure adjustment, diversity of energy supply, energy safety and environmental protection. It is comply with requirement of sustainable development. (IEA, 2008b)

Renewable energy is intermittent and volatile. It is unsuitable for continuous application. Currently, the cost on development and utilization of renewable energy is greater than the cost of fossil fuels.
2.2.4 Elements of renewable energy

Solar
Solar generally refers to the radiant energy of sun. It is normally used in modern power generation. The creature on earth depends on light and heat to survive. Solar was further to be developed when reducing in use of fossil fuels. The utilization of solar was used by two ways. One was photo thermal conversion. The other was photovoltaic conversion. Solar is emerging renewable energy. Generally, solar is the main source of other energies. Such as, wind, chemical and hydro energy. (IEA, 2008b)

Wind
Wind energy is kinetic energy which was generated by air movement on the surface of the earth. Because of the differences in temperature change caused by solar radiation and the differences in water vapor content in air, the pressure is different around the world. High pressure air moves to low pressure areas. And it forms wind. It is estimate that the total amount of the wind in world is about 130 billion kilowatts. The total amount of the wind in China is about 1.6 billion kilowatts. In nature, wind is a renewable, clean energy with large reserves. The utilization of wind was used by two ways. One was used as driving force. The other was used to generate electricity. (IEA, 2008b)

Biomass
Biomass is various organisms formed by photosynthesis. It includes all of plants, animals and microorganisms. Biomass is that solar store in biomass in the form of chemical
energy. That is the energy using biomass as a carrier. It can be derived directly or indirectly from photosynthesis. It can be converted to solidity, liquid, gaseous fuels. It is renewable energy which can be constantly used. Meanwhile, it is also only renewable carbon source. (IEA, 2008b)

**Geothermal**
Geothermal energy is the natural thermal energy from the earth. This kind of energy is coming from lava inside the earth and exists in form of heating power. (IEA, 2008b)

**Hydro**
Hydro power is going to generate electricity power in the way of conversion between kinetic energy and potential energy. Hydro energy is mainly used in electricity generating. The advantages of hydro energy are low-cost, continuous renewable and non-pollution. The disadvantages of hydro energy are easily restricted by climate, landforms and hydrology. (IEA, 2008b)

**Ocean**
Ocean energy is one of renewable energy depends in the sea. It includes tidal energy, wave energy, thermal sea power and salinity difference of ocean water. (IEA, 2008b)

### 2.3 Model analysis of three scenarios

(IEA, 2008a)

**Reference scenario (BAU)**
It is the situation that China does not take any measures to control and reduce emission.

**Controlling scenario (EC)**
It is the situation that China takes a series of advanced measure to control the CO2 emission. But China did not introduce large scales of expensive energy technology. The premise of EC is that it will not cause economic recession in China.

**Abatement scenario (EA)**
It is the situation that China will develop Low-Carbon Economy and try to overcome the technical difficulties and to offer the maximum potential to reduce the emission.
2.4 Other relative terms

2.4.1 Environment

The greenhouse effect
The greenhouse effect is the rise in temperature that the Earth experiences because certain gases in the atmosphere (water vapor, CO2, nitrous oxide, and methane, for example) trap energy from the sun. Without these gases, heat would escape back into space and Earth’s average temperature would be about 60ºF colder. Because of how they warm our world, these gases are referred to as greenhouse gases. (US EPA, 2006)

Greenhouse effect mainly was caused by releasing large amount of CO2 into atmosphere after burning too much coal, oil and natural gas. CO2 has a heat absorption and heat insulation function. With the increase of CO2 in the atmosphere it is the result of the formation of an invisible glass; this glass causes too much heat to build up in earth. (US EPA, 2006)

2.4.2 Energy

Installed capacity
The capacity of generating electric power of all actual installed electric generators. (IEA, 2008a)

The Carbon lock-in effect
The lock-in effect is the notion of a Techno-Institutional Complex (TIC), this lock-in occurs through combined interactions among technological systems and governing institutions. It emerges over time as energy and economic development in industrialized countries has proceeded. The lock-in effect is formed by composition between technology systems and management of its spread and application of public and private sector. Technology and government regulation of the systems are interrelated and interdependent. Once the formation of a stable TIC system, this system will require maintaining stability development and resist the changes. Therefore, the carbon-based the energy system that benefit from increasing returns long term might emerges lock in effect, this situation prevent innovation of Low-Carbon and renewable energy technology. (Gibbins, J. and H. Chalmers , 2008)
2.4.3 Economy

Reform and opening-up
It was put forward in ‘Third Plenary Session of the CPC’ in 1978. It is a strategic policy of ‘reform to inside, open up to outside’. It is the first basic state policy for opening up in China. It makes China open to the world. (Cui, 2009)

Primary industry
It is the industry of getting products from nature directly, including agriculture, forestry, and fishery. (Cui, 2009)

Secondary industry
It is divided into four main aspects, including mining, manufacturing, power and heat production, and construction. (Cui, 2009)

Tertiary industry
It is not producing physical products. It supplies their productivity and gets the reward by the way of actions. It is always called service. (Cui, 2009)

Energy-intensive industry
It refers to some industries that highly depend on the use of energy. (Cui, 2009)

GDP
The full name is Gross Domestic Product. It can be defined as the market price of the final products and services in a specific time (usually one year), in a specific region or country. (Lou, 2008)

Structural unemployment
Every change in economic industry requires the manpower supply should quickly adapt to this change. However, the structural feature of manpower market does not match with the demand of manpower. This will leads to unemployment. It is usually called “structural unemployment”. Structural unemployment is caused by the change of economic structure (such as, industrial structure, product structure and regional structure, etc.), and the existing knowledge, skills, conceptions and distributions of manpower cannot adapt to this change, then it cannot match with the market demand. And cause unemployment eventually. (UN’s Environment Program, 2009)
Green jobs

Green jobs come from the rise of the environmental protection industry, it is also called Green-collar job, substantially contribute to preserve and restore environmental quality. Those jobs help to protect biodiversity and ecosystems; reduce energy, materials and water consumption through high efficiency strategies and avoid generation of all forms of waste and pollutions. (UN’s Environment Program, 2009)
3 Results

3.1 The Driving Force

It is can be clearly shown from background that every country in the world are now positive putting forward various strategies to deal with the environmental problems which cause by the growth of carbon dioxide emission. With the end of Copenhagen Conference, reduction of green house gas emission and transition to Low-Carbon Economy has become the globally actions. The total volume of CO$_2$ emission becomes the serious problem that every country focuses on.

As the biggest CO$_2$ emission country, China has to attract more attention and blames from different communities in the world. Furthermore, with the rapidly growth of CO$_2$ emission, China will be under the domestic pressures from environment, energy and economy. Face such huge external and internal pressures, China are forced to take appropriate actions to reduce the carbon emission. And the Chinese government has already recognized the benefits of developing Low-Carbon Economy. China wished that the environmental, energy and economic structure can be improved by developing Low-Carbon Economy. As a result, in this part, there will be a discussion on the reasons for China to develop Low-Carbon Economy. And these reasons will be analyzed from international pressures, domestic pressures and the benefits for China to develop Low-Carbon Economy.

3.1.1 International Pressure

The main international pressure is the increase of CO$_2$ emission in China. Increase of CO$_2$ emission will make bad influence on global environment. And the most countries in the world will give big pressures to China in order to force China to reduce CO$_2$ emission. In recent year, the CO$_2$ emission in China has present upward tendency. It has grown rapidly from 1970 to 2006 in the course of industrialization and urbanization (Figure 7 and Figure 8). (United Nations Development Program, 2010)
Figure 7 Cross-country comparison of total emission (1970-2006)

(Sources: United Nations Development Program, 2010)

Figure 7 shows that China has overall surpassed the United States and become the highest CO2 emission country in the world. China’s per capita emissions level was still far below that of world average per capita CO2 emission from 1970 to 2002, but it was rapidly increasing from 2002 to 2006. In 2006, China’s per capita emissions level was same with world average capita CO2 emission. (Figure 8)

Figure 8 Trends of China’s total and per capita emissions (1970-2006)

(Sources: United Nations Development Program 2010)
Increased of CO$_2$ emission has negative impact on environment. And this will put China in the backward position in the environmental-related issues. According to the 2010 Environmental Performance Index (EPI) ranks, China’s Environmental Performance Index reduced from No.94 on 2006 to the No.121 on 2010. (Yale Center for Environmental Law & Policy, 2010a, 2010b)

**Box.2** In EPI ranks, there are total five scores areas:
- 100-85(excellent performance), 85-70(good performance),
- 70-55(satisfied performance), 55-40(weak performance),
- 40-25(poor performance).

There are total four countries in the excellent area:
1 Iceland 93.5
2 Switzerland 89.1
3 Costa Rica 86.4
4 Sweden 86.0

China is in the weak area, and its score is 49.0
(Yale Center for Environmental Law & Policy, 2010c)

Furthermore, China received a lot of criticisms and blames from external. Such as:**(Box.3)**

**The United Nations** have the important tasks that tack climate change and support the move to a Low-Carbon Economy and society.

**The United Nations Climate Change Conference** was opened on December 7, 2009 in Copenhagen, Denmark. This Conference aims to establish the global emissions reduction agreement 2010 to 2017, the UN secretary-general Ban Ki-moon call it as “The significant step forward” in the global fight against the greenhouse warming. (Xinhua News Agency, 2010) Which countries should take more responsibilities for global temperature rise and when will the emissions be peaked in the world? Different countries have varied interpretations. Most of developed countries all think China must share greater responsibility; China can not retreat from the responsibility in this affair.

**Sweden** hopes that China guarantee to reduce emissions 15-30% by 2020, and China should not only aim domestic emission reduction into a world of height. (Sustainable industry, 2010)
Under those of international pressures, China, as the biggest CO2 emission country in the world, should take an appropriate action to reduce the CO2 emission. Therefore, developing Low-Carbon Economy becomes the focus of attention in China.

**Box. 3**

*Achim Steiner*, UN under secretary- General and Executive Director of the United Nations Environment Programme (UNEP) said China played a significant role in the process leading up to Copenhagen Climate Change Conference, and in a sense it became very engaged at the highest international political level in the process. (Xinhua News Agency, 2010)

*Khalid Malik*, UN Resident Coordinator in China, said “China is at a critical juncture where the ‘business as usual’ growth model is insufficient in meeting the country’s emerging challenges and pressures.” “The shift to a low carbon development pathway is imperative as China balances further economic development with environmental sustainability and the need to respond to the threat of climate change.” (UNDP China, 2009)

*Kaergelin*, Swedish Environment Minister visited China to discuss climate change issues. He said “We agree with the emission reduction targets, China has made in such manner as to five-year plan, but we hope that China at the 12th and 13th Five-Year Plan to establish a clear emission reduction targets. At the same time, so that they can in the international situation, as China’s 2020 emission reduction targets. We believe that China would like to explain their goals and achieve low-carbon growth prospects, it is very important. We know that China’s goal is very lofty, but it is also possible. We hope that China’s goals at a high level.” (Sustainable industry 2010)
3.1.2 Domestic pressure

China not only suffers pressures from international communities, but also treats lots of domestic pressures of energy depletion, loss of wealth and environmental issues. China has to make transition from traditional economy to Low-Carbon Economy under these domestic pressures. (National Bureau of Statistics of China, 2009; National Bureau of Statistics of China-Statistical Data)

a) **Energy depletion**- high energy consumption made energies resources gradually reduce in China.

**Total energy**

China is the high energy consumption country in the world. It is clear see from **Figure 9**; the total volume of energy consumption in China has increased rapidly in the past 30 years from 1980 to 2008.

![Total Production and Consumption in China](image)

**Figure 9 Total energy production and Consumption in China**

(Source: National Bureau of Statistics of China-Statistical Data)

In **Figure 9**, the total production and consumption in China is substantial increased from 1980 to 2008. However, it is clearly show from the chart that there was a turning point in 1992. Before 1992, the total energy production was greater than total energy consumption. That is to say, the energy supply in China was enough for consuming. The opposite after 1992, the growth rate of energy consumption exceed the growth rate of energy production. It means that the output of energy was reducing and is difficult to cope with the growing consumption. The concrete data of energy production and consumption in China can be seen from **appendix 1**. (National Bureau of Statistics of China, 2009)
In 1980, the total volume of energies production in China was 637.35 million tons of standard coal, and the total volume of energies consumption in China was 602.75 million tons of standard coal. It has clearly showed that China is the net export country of energy. In 1992, the total volume of energies production in China was 1.07256 billion tons of standard coal, and the total volume of energies consumption in China was 1.09170 billion tons of standard coal. The energy consumption began to exceed the energy production.

In 2008, the total volume of energies production in China was 2.48 billion tons of standard coal, and the total volume of energies consumption in China was 2.85 billion tons of standard coal, the gap reached 370 million tons of standard coal. It means that China has become energy importing country.

China is in the development stage of industrialization and urbanization. And the development mainly depends on the use of coal and crude oil. The data from Figure 10 and Figure 11 shows that China is now facing the crisis of coal and crude oil depletion.

**Coal**

The total volume of coal consumption in China is from 1.32 billion tons in 2000 to 2.39 billion tons in 2006. The growth rate is up to 81.2%. This data shows that the coal consumption in China was growing rapidly in the past few years.

![Figure 10 The volume of coal production and consumption in China (1990-2006)](Source: National Bureau of Statistics of China, 2009)
Crude oil

In *Figure 11*, the total oil consumption in China was rapidly increased from 1980 to 2005. However, the total oil production was grown slowly. It is clearly show from the chart that there was a turning point in 1994. Before 1994, the total oil production was greater than total oil consumption. That is to say, the oil supply in China was enough for consuming. The opposite after 1994, the growth rate of oil consumption obviously exceed the growth rate of oil production. It means that the output of oil was reducing and is difficult to cope with the growing consumption. The chart indicated that China will import 80% of its oil by 2020. The domestic oil resources are in the crisis of depletion.

![Figure 11 Crude oil production and consumption in China (1980-2005)](source: National Bureau of Statistics of China, 2009)
b) **Loss of wealth**—China spends a lot of money to import energy resources from other countries.

It can be seen as above part, China is the high energy consumption country in the world, and it has already become the energy importing country. Over depending on energy importing, China has to spend a lot of money on it.

**Total energy importing**

From *Figure 9 and Box 3*, it is clearly indicate that the volume of China energy importing in past few years. (National Bureau of Statistics of China, 2009) Since 2000, the total volume of energy importing in China has increased dramatically. That means there would be a lot of expenditure on the energy importing.

![Figure 12  Total volume of energy importing in China (1980-2007)](Source: National Bureau of Statistics of China, 2009)
Coal importing

Box.5
China total imported coal from Australia, Vietnam, Indonesia, Russia, and Mongolia on 2009.(UNDP China , 2009)

![Graph of coal imports](image)

It can be seen from the Figure 13 that coal importing volume has increased dramatically in China from under 5 million tons in 1999 to over 40 million tons in 2007.

**Figure 13.** The import of coal volume in China
(Source: National Bureau of Statistics of China-Statistical Data)

It is clearly see in Figure 14, the expenditure on coal importing in China has increased dramatically from 60.86 million U.S dollars in 1999 to nearly 3.5 billion U.S dollars in 2007. What’ more, China has become the net importing country of coal on 2009 from the one of largest coal export country in the world.

**Figure 14.** The imports of coal value in China
(Source: National Bureau of Statistics of China-Statistical Data)
Figure 13 and Figure 14 shows that the volume of coal importing just increased with little range while the value of coal importing increased by a large margin from 2006 to 2007. That means China needs to spend more money to import a unit of coal. And the specific growth data can refer to appendix 2.

Crude oil importing

In Figure 15, it can be seen from the chart that crude oil importing volume has increased dramatically in China from under 40 million tons in 1999 to nearly 180 million tons in 2007.

Figure 15. The imports of crude oil volume in China (1999-2007)
(Source: National Bureau of Statistics of China-Statistical Data)

It is clearly see in Figure 16, the expenditure on crude oil importing in China has increased dramatically from 4.64 billion U.S dollars in 1999 to over 122 billion U.S dollars in 2007.

Figure 16. The imports of Crude Oil value in China (1999-2007)
(Source: National Bureau of Statistics of China-Statistical Data)

It is the same with the coal import. The growth rate of the import value is greater than the import volume from 2006 to 2007. It means China needs to spend more money to import a unit of crude oil. And the specific growth data can refer to appendix 3.
c) **Environmental issues**-the green house effect in China

China current energy structure is coal-dominated, crude oil and natural gas also be used simultaneously. Over depending on these fossil fuels leads to continuous increasing of total carbon emission. The China leads the world in the total amount of coal production and consumption. And the high consumption of coal is the main reason of carbon emission in China.

It can be seen from *Figure 8* that, the emission of CO2 in China has continuous increased from 1970 to 2006, and it leads to the green house effect in China. It has brought bad effects to China sustainable development.

From 1970 to 2002, the total emission of CO2 has increased from 900 to 3800 steadily. And the total emission of CO2 has dramatically increased from 3800 to 6000 from 2002 to 2006; it reaches to a high value.

### 3.1.3 Benefits

After analysis of pressures for China to develop Low-Carbon Economy, it is now turning to analyze what kinds of benefits will be brought to China when develop Low-Carbon Economy. These kinds of benefits are also one of the driving force to push China make transition to Low-Carbon Economy. It can be shown these benefits from three aspects: environment, energy and economy.

#### 3.1.3.1 Environment

There is a close relation between the use of fossil fuels and emission of CO2. High energy consumption leads to high CO2 emission. Low-Carbon Economy is a kind of economic model featuring low energy consumption, low pollution and low emission, If China develops Low-Carbon Economy, the emission of CO2 will decline in the future. In *Figure 17*, there is a comparison of future emission of CO2 in three different situations. (IEA, 2008a)
**Reference scenario**

In the reference scenario, the emission of CO2 in China will grow rapidly. The total amount of emission of CO2 in China will be up to 11.4 billion tons, 13.9 billion tons, 16.2 billion tons in 2020, 2030 and 2050 respectively. (Tao W, Jim W, 2009)

**Controlling scenario**

In the emission controlling scenario, China takes a series of advanced measures to control the CO2 emission, including the measures for energy saving and renewable energy development. However, China did not introduce large scales of expensive technologies, including energy technology of carbon capture and storage, Photovoltaic and electric auto. The total amount of emission of CO2 in China will be up to 8.2 billion tons, 8.8 billion tons, 9.5 billion tons in 2020, 2030 and 2050 respectively. Comparing with the data in reference scenario, the total amount of emission will be reduced by 3.2 billion tons, 5.1 billion tons, 6.7 billion tons. The emission intensity of CO2 per unit of GDP will be reduced by 51%, 69% and 85% in 2020, 2030 and 2050 respectively (Figure 18). The increment of green house gases emission will be controlled in 700 million tons from 2030 to 2050. And the per capita emission of CO2 will be controlled in 6.3 ton, which will be 74% of Japan per capita emission of CO2 and 33% of U.S per capita emission of CO2 in 1990. (Tao W, Jim W, 2009)

In this situation, the emission controlling still be constraint in backward technologies and weak supply of renewable energies.
**Abatement scenario**

In the emission abatement scenario, China will try to overcome the technical difficulties and to offer the maximum potential to reduce the emission. In that time, the total amount of emission of CO2 in China will be down to 7.9 billion tons and 5.5 billion tons in 2040 and 2050 respectively. In 2050, the total amount of emission of CO2 in China will be reduced by 66% from reference scenario to abatement scenario. Comparing with 2005, the emission intensity of CO2 per unit of GDP will be reduced by 91% in 2050. (Tao W, Jim W, 2009)

According to the forecast of China future emission of CO2 in three different situations, the facts can be show that if China takes measures to develop the renewable energies and introduce advanced energy technology, the emission of CO2 will be decline. This will obviously be beneficial to the environment. This truth makes China want to change its traditional economic structure into Low-Carbon Economy.

![Figure 18. The emission intensity of CO2 per unit of GDP in China (2005-2050)](source: Tao W, Jim W, 2009; Kejun. J., 2009)
3.1.3.2 Energy

There is a comparison of future energy demand in three different situations. The energy demand in China will be in the upward trend in future in all of those situations below. (IEA, 2008a)

**Reference scenario**

In this situation, the demand of primary energy which includes coal, crude oil and natural gas goes up from 2.25 billion tons of standard coal in 2005 to 6 billion tons of standard coal in 2050. The growth rate is up to 172%. It shows that coal is still the main energy supply in China. And the crude oil is second energy supply source. The demand of renewable energies in China is still small. *(Figure 19)*

(Million tons of SEC)

![Figure 19. The demand of primary energy in Reference scenario (2005-2050)](image)


**Controlling scenario**

Comparing with reference scenario, the total energy demand in China will be reduced from 7.14 billion tons of standard coal to 5.69 billion tons of standard coal. The primary energy demand is the main reducing point. It will be reduced from 6 billion tons of standard coal to 4 billion tons of standard coal. The reducing rate is up to 33%. In the energy structure, the demand of renewable energy is gradually raised and the demand of primary energy is declined. *(Figure 20)*
**Abatement scenario**

In this situation, the demand of primary energy will be dramatically reduced to 3.5 billion tons of standard coal. The reducing rate will be up to 42%. On the other side, the demand of renewable energy will be increased obviously. It shows that the energy structure in China will be changed gradually. *(Figure 21)*

![Figure 20. The demand of primary energy in controlling scenario (2005-2050)](source)


![Figure 21. The demand of primary energy in abatement scenario (2005-2050)](source)


According to forecast of China future energy demand in three different situations, it indicates that the China energy structure will be changed. And the demand of primary energy reduced dramatically under the situation of emission abatement. It means that if
China fulfills the low emission control, the demand of primary energy, especially coal and crude oil will be reduced. It will bring out two main benefits to China.

- Declining energy demand can make reduction of dependence on energy import.

It is well known that China has already become the energy importing county, especially in coal and crude oil. China has to spend a lot of money to import those energies from other countries in response to the high energy consumption. It makes China loss of wealth. Developing Low-Carbon Economy means reduce the energy consumption. Low energy demand can reduce the dependence on energy imports. And it leads to the declining expenditure on energy use eventually.

- Application of renewable energy makes development of energy technology in China.

As the biggest developing country in the world, the technology development is lagging behind the developed countries. Low technology development makes low energy efficiency in China.

In 2005, the energy efficiency was 36%, which was closed to the level of Europe in 1990s and the level of Japan in 1975. (Lou Hushan, 2008) There is a big gap between China and developed countries in the level of technology development.

Developing Low-Carbon Economy is the driving force to the development and innovation of energy technology. On one side, China will introduce the latest advanced Low-Carbon technologies in response to the application of renewable energies. On the other side, China will cooperate with other developed countries to improve or replace the traditional technologies and explore the new one. The cooperation and introduction of energy technologies can push the development in these areas. (Box.6)
3.1.3.3 Economy

◆ Development of Renewable Energy Industry

Low-Carbon Economy aims to reduce carbon emission by reducing the use of traditional fossil fuels. Therefore, it is necessary to fulfill the use of renewable energy instead of primary energy. And the relevant renewable energy industries will under the great development when China develops Low-Carbon Economy.

In the world, most of western developed countries are going to foster a new point for economic growth. And this new point will be a renewable energy industry.

In the United State, Obama administration indicated that they will put 150 billion U.S dollars to alternative energy research in the future 10 years. (UN's Environment Program, 2009)

In EU, the European Commission (EC) indicated in their ‘Economic recovery plan’ of 200 billion euro that EU will invest in low carbon technologies and renewable industries to Enhance the long-term economic competitiveness of the EU. (UN's Environment Program, 2009)

In China, the National Development and Reform Commission indicated in the ‘long-term development plan for renewable energy’ of 2006 that the proportion of renewable energy in the entire energy supply will be from 7% to 15% by 2020, which means that the renewable energy industries will be invested in 1.5 trillion RMB in future 15 years in China. Therefore, it can be clearly seen that renewable energy industries will be increasingly developed and show high growth rate. Solar, wind, biomass, fuel cells and other renewable energy industries will be continued to expand. And the relative renewable corporations will have more spaces for development. (Wang, 2006)

Currently, China has clear strategic goals of renewable energy development.

- By 2010, renewable energy will be defined as supplemental energy and it will account for 10% of total energy use.
- By 2020, renewable energy will be defined as alternative energy and it will account for 15% of total energy use.
- By 2030, renewable energy will be defined as main energy and it will account for 25% of total energy use.
By 2050, renewable energy will be defined as dominate energy and will account for 40% of total energy use.

Figure 22 Analysis of historical development for renewable energy industry in China
(Source: World Low Carbon and Eco-economy Conference & Technical Exposition, 2009)
From Figure 22, it is showing that China is moving forward to develop Low-Carbon Economy, and the relative renewable energy industries were under the great developed.

Figure 23 Life-Cycle Analysis of renewable energy industry in China
(Source: Wang, 2006)
Figure 23 shows that there will be a great development period for renewable energy industry from 2000 to 2050. In this period, solar, wind, biomass, geothermic and other renewable energy industries will be expand rapidly. Take four main renewable energies industries for example, the renewable energy industry show growth trend in the future China (Figure 24). (Cui, 2009)

![Figure 24. Four main renewable energies industries show growth trend in China](image)

(Source: Cui, 2009)

- In hydroelectric power industry, the installed capacity of hydroelectric power will be increased from 117 million kilowatts in 2005 to 300 million kilowatts in 2020.
- In biomass energy industry, the installed capacity of biomass energy power will be increased from 2 million kilowatts in 2005 to 30 million kilowatts in 2020.
- In wind power industry, the installed capacity of wind power will be increased from 1.26 million kilowatts in 2005 to 30 million kilowatts in 2020.
- In solar power industry, the installed capacity of solar power will be increased from 70,000 kilowatts in 2005 to 1.8 million kilowatts in 2020.

As the continuous development of Low-Carbon Economy in China, the relative renewable energy industries will be widely promoted. And these kinds of renewable energy industries will be the new point of economic growth in China.
**Create more green jobs**

UNEP’s shows that the green technology will have more space to develop in the future and there are more and more jobs will be offered by environmental industries, and it estimated that the investment of renewable energy industry will create at least 20-30 million jobs every year, the renewable energy industry will become an important source of employments. *(Box.7)* *(UN’s Environment Program, 2009)* All the green industries in the world, the renewable energy industry has more future potential to progress green jobs. *(Table 2)*

**Table 2. Green job progress to-date and future potential**

(Source: UN’s Environment Program, 2009)

<table>
<thead>
<tr>
<th>Industry</th>
<th>Greening potential</th>
<th>Green job progress to-date</th>
<th>Long-term green job potential</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Renewable</td>
<td>Excellent</td>
<td>Good</td>
<td>Excellent</td>
</tr>
<tr>
<td>CCS</td>
<td>Fair</td>
<td>None</td>
<td>Unknown</td>
</tr>
<tr>
<td><strong>Steel</strong></td>
<td>Good</td>
<td>Fair</td>
<td>Fair</td>
</tr>
<tr>
<td><strong>Aluminium</strong></td>
<td>Good</td>
<td>Fair</td>
<td>Fair</td>
</tr>
<tr>
<td><strong>Cement</strong></td>
<td>Fair</td>
<td>Fair</td>
<td>Fair</td>
</tr>
<tr>
<td><strong>Pulp and paper</strong></td>
<td>Good</td>
<td>Fair</td>
<td>Good</td>
</tr>
<tr>
<td>Recycling</td>
<td>Excellent</td>
<td>Good</td>
<td>Excellent</td>
</tr>
<tr>
<td><strong>Fuel-Efficient Cars</strong></td>
<td>Fair to good</td>
<td>Limited</td>
<td>Good</td>
</tr>
<tr>
<td><strong>Mass Transit</strong></td>
<td>Excellent</td>
<td>Limited</td>
<td>Excellent</td>
</tr>
<tr>
<td><strong>Rail</strong></td>
<td>Excellent</td>
<td>Negative</td>
<td>Good</td>
</tr>
<tr>
<td><strong>Aviation</strong></td>
<td>Good</td>
<td>Limited</td>
<td>Limited</td>
</tr>
<tr>
<td><strong>Green building</strong></td>
<td>Excellent</td>
<td>Limited</td>
<td>Limited</td>
</tr>
<tr>
<td><strong>Retrofitting</strong></td>
<td>Excellent</td>
<td>Limited</td>
<td>Excellent</td>
</tr>
<tr>
<td><strong>Lighting</strong></td>
<td>Excellent</td>
<td>Good</td>
<td>Excellent</td>
</tr>
<tr>
<td><strong>Efficient Equipment and Appliances</strong></td>
<td>Excellent</td>
<td>Negative</td>
<td>Excellent</td>
</tr>
<tr>
<td><strong>Small-scale sustainable farming</strong></td>
<td>Excellent</td>
<td>Negative</td>
<td>Excellent</td>
</tr>
<tr>
<td><strong>Biogas</strong></td>
<td>Good</td>
<td>Limited</td>
<td>Good to excellent</td>
</tr>
<tr>
<td><strong>Environmental service</strong></td>
<td>Good</td>
<td>Limited</td>
<td>Good to excellent</td>
</tr>
<tr>
<td><strong>Reforestation</strong></td>
<td>Good</td>
<td>Limited</td>
<td>Good to excellent</td>
</tr>
<tr>
<td><strong>Agro forestry</strong></td>
<td>Good to</td>
<td>Limited</td>
<td>Good to excellent</td>
</tr>
<tr>
<td><strong>Sustainable Forestry Management</strong></td>
<td>Excellent</td>
<td>Good</td>
<td>Excellent</td>
</tr>
</tbody>
</table>

According to *Figure 25*, total investment of renewable energy in the world has increased from 10 billion dollars on 1998 to 66 billion dollars on 2007. It will still increase rapidly in the future; and the investment of renewable energy will increase to 343 billion dollars on 2020 and 630 billion dollars on 2030. *(UN's Environment Program, 2009)*

*Box.7*

Achim Steiner, UN Under-Secretary General and UNEP Executive Director, said: “The financial, fuel and food crises of 2008 are in part a result of speculation and a failure of governments to intelligently manage and focus markets”. “But they are also part of a wider market failure triggering ever deeper and disturbing losses of natural capital and nature-based assets coupled with an over-reliance of finite, often subsidized fossil fuels,” he said. “The flip side of the coin is the enormous economic, social and environmental benefits likely to arise from combating climate change and re-investing in natural infrastructure - benefits ranging from new green jobs in clean tech and clean energy businesses up to ones in sustainable agriculture and conservation-based enterprises.” he added. *(UN’s Environment Program, 2009)*
The renewable energy industry in the world has created about 2.3 million green jobs on 2006. Wind power industry has about 300,000 employees, Solar photovoltaic have about 170,000 employees, etc. (Figure 26, Figure 27) And it estimated that industry will provide more and more jobs on 2030. (Cui Minxuan, 2009)

Figure 25. Total investment of renewable energy in the world (1998-2030)

(Source: UN’s Environment Program, 2009)

The number of green jobs in the renewable energy area (2006)

(Sources: Cui, 2009; The UN's Environment Program, 2009)
The number of green jobs in the renewable energy area (2030)

Figure 27. Estimated green jobs in the renewable energy sector (2030)
(Source: Cui, 2009; The UN's Environment Program, 2009)

What’s more, those people who worked in the renewable energy industry on 2006 mostly come from China. *(Table 3)* As the country with biggest population in the world, developing Low-Carbon economy and renewable energy industry will certain to bring more green jobs.

*Table 3. Estimated employments in the renewable energy sector, selected countries and world (2006)*
(United Nations Development Program, 2010)

<table>
<thead>
<tr>
<th>Renewable Energy Source</th>
<th>World*</th>
<th>Selected Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind</td>
<td>300,000</td>
<td>Germany 82,100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>United States 30,800</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Spain 35,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>China 22,200</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Denmark 21,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>India 10,000</td>
</tr>
<tr>
<td>Solar PV</td>
<td>170,000**</td>
<td>China 55,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Germany 35,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Spain 26,449</td>
</tr>
<tr>
<td></td>
<td></td>
<td>United States 15,700</td>
</tr>
<tr>
<td>Solar Thermal</td>
<td>624,000-plus</td>
<td>China 600,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Germany 13,300</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Spain 9,142</td>
</tr>
<tr>
<td></td>
<td></td>
<td>United States 1,900</td>
</tr>
<tr>
<td>Biomass</td>
<td>1,174,000</td>
<td>Brazil 500,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>United States 312,200</td>
</tr>
<tr>
<td></td>
<td></td>
<td>China 266,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Germany 96,400</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Spain 10,349</td>
</tr>
<tr>
<td>Hydropower</td>
<td>39,000-plus</td>
<td>Europe 20,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>United States 19,000</td>
</tr>
<tr>
<td>Geothermal</td>
<td>25,000</td>
<td>United States 21,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Germany 6,200</td>
</tr>
<tr>
<td>Renewables, Combined</td>
<td>2,882,000-plus</td>
<td></td>
</tr>
</tbody>
</table>
◆ Improve international competitiveness

Under the background of global climate change, the current international economic situation and the trade rules will change. The industries with high energy consumption and high carbon emission will be bound by new international trade rules and this will affect the long-term competitiveness of one country. Currently, the main economic power countries pay more attention to game about carbon emission trading standards and systems. Carbon productivity will become one of the core indicators in international competitiveness. International trade rules will be adjusted under the international climate change framework. Border adjustment tax of carbon emission and carbon tariffs will become the focus. As the standards of ISO 14001 and ISO 19001, development of Low-Carbon Economy and high carbon productivity will become the competitiveness criteria for the countries to acquire competitiveness advantages and avoid future export trade disruption. And this is very important for China which mostly depends on exporting. Currently, China is under the urbanization and industrialization. This situation will make China become high carbon emission country. Now, China needs to be transformed into Low-Carbon Economy country to develop renewable energy industry with low carbon emission and make a rush for international renewable energy market share in the emerging carbon trading markets. If China fails to catch the right opportunities in the right time, China will lose its way. Once the Low-Carbon technology was developed and entered into the commercialization stage in the rest of world, China will have to follow its old track to imitate and depends on low-cost competition rather than depends on innovation. Therefore, it is very important for China to transform into Low-Carbon Economy and make competitiveness advantages in the world. (Wang, 2006)
3.2 The challenges and difficulties

We analyzed above the driving force for China to develop Low-Carbon Economy. Those driving forces are pushing China on its way to develop Low-Carbon Economy. However, Low-Carbon Economy development is not an easy problem for China. China will face and experience a lot of potential challenges and difficulties because of restricted by its actual situations and conditions, such as population, energy structure or economic structure.

The big problem for China to develop Low-Carbon Economy is how to balance the development of environment, energy and economy. And how to make these three aspects mutual develop rather than restrict to each others.

Therefore, in this part, it will mainly analyze what kinds of challenges and difficulties that China will probably face in developing Low-Carbon Economy. And it will be discussed from two main parts-energy and economy.

Figure 28. The situation of Environment, Energy and Economy under the Low-Carbon Economy (Source: Lei Wu, Yang Zhao)
3.2.1 Energy

In energy part, development of Low-Carbon Economy was mainly restricted by energy structure and energy technology in China.

3.2.1.1 Energy structure

The main energy source in China is coal. The resource conditions in China can be described as “rich in coal, short of gas and petroleum”. Therefore, China is a coal-dominated country in the world. (Figure 29)

![Figure 29. Main energy structure in China](image)

(Source: Lou Hushan, 2008)

Although China always tries to optimize its energy structure from early 70s, the coal is still a dominate energy in China energy structure. Its proportion in China is far more than the proportion in other countries.

According to BP Statistical Review of World Energy 2009, the total coal consumption only accounts for 29.24% in the global primary energy consumption in 2008. However, the coal accounts for 70.23% in China. (Figure 30) (Cui, 2009)
Coal-dominated structure leads to difficulties in carbon emission control. It is well known that China is in the industrialization and urbanization stage of development. And the economic development mainly depends on the secondary industry, which is called energy-intensive industries. (See Figure 30) It means the industry development should depend on the high energy consumption. In additional, China is a populous country with large increasing population, so the energy demand will only increase. The energy structure and the China’s actual conditions makes China have to use coal to reply to the large energy demand. Therefore, the situation of reliance on coal in China will not be changed in the short term. And this will directly lead to the increase emission of CO2. Comparing with crude oil and natural gas, the amount of carbon emission caused by coal is higher than caused by crude oil and natural gas.

For example, it is assume that the required energy output is 10000 kcal. (Figure 31)

✓ It needs 1.23 cubic meters of natural gas, it will generate 2.26 kilogram of CO2;
✓ It needs 1.09 kilogram of crude oil, it will generate 3.37 kilogram of CO2;
✓ It needs 1.73 kilogram of coal, it will generate 5.14 kilogram of CO2.
The assumption of energy input and output

(Source: Lou, 2008)

Through comparison, it is clearly show that the emission of CO2 caused by coal is higher than caused by natural gas and crude oil under the same required energy output.

China is one of the major coal production countries in the world. Coal is main energy source in China. It leads coal-dominated structure in China for a long time. So far, coals accounts for over 70% in the total energy consumption in China. Which has brought the serious environmental pollution to China. The coal will cause higher carbon emission intensity than other primary energy because of the higher carbon intensity of coal. As the adjustment of energy structure will be to some extent constrained by the resource structure, coal-dominated structure will not be changed fundamentally in a long period of time in China. It makes China have to face greater difficulties in reduction of carbon emission under the development of Low-Carbon Economy.

Box.8

China’s energy it was 36% in 2005, 8% lower than average level of developed countries. This is close to the level of Europe in the 1990s and Japan in 1975. (United Nations Development Program, 2010)
3.2.1.2 Energy technology

Low-Carbon Economy can not developed without the support of advanced technologies. As a major country associate with fossil energy production and consumption, China’s competitiveness of technology infrastructure is the lower level in the world. Compared with developed countries, its energy efficiency is below that of the developed countries and the R&D capabilities of core Low-Carbon technology are also limited.

In order to achieve the transition to Low-Carbon Economy, China has to focus on technology development and innovation in clean and high-efficiency technologies in order to improve energy efficiency and conserve non-renewable energy, such as carbon capture and storage, energy conservation, and renewable energy technologies.

However, as a developing country, China’s technologies development from “high-Carbon” to “Low-Carbon” faces lots of challenges and bottleneck.

Figure 32. The challenges of developing Low-Carbon technologies in China
(Source: Lou, 2008)
The Carbon lock-in effect restricts development of low-carbon technology

Dependence of high-carbon energy impedes the development of low-carbon technologies.

With explosive industrialization, urbanization and economic growth, China’s energy demand will increase in a measured way, at the same time, it has emerged the energy shortage crisis because of sharply increasing energy demand.

What’s more, backwardness of low carbon technology and rapid growing energy demand are interacted to accelerate the high-carbon economy in China. Even though China has had better alternative low-carbon technologies, China can not easily discard the fossil fuel-dominant energy technologies in order to apply the rapid industrialization and energy demand. Its future economic development still primarily depends on domestic fossil energy. It is unrealistic in a short time that fossil-dominated energy consumption mix will be successfully transformed to alternative energy sources. (Zou, et al., 2009)

Actually, shortage of high-carbon energy and acceleration of high-carbon technology re-investment drive up the Carbon lock-in effect. (Figure 33)

**Figure 33. The Carbon Lock-in effect in China**

(Source: Zou, et al., 2009)
Development of low-carbon technology has greater uncertainty and lacks cost advantage

Compared with traditional high-carbon technology, development of low-carbon technology is largely uncertain. Most low-carbon technologies are new technology, so these technologies face greater technical risk, investment risk, and their future performances have greater uncertainty. These risks will influence the potential investors and users. But traditional high-carbon technologies have been a long-term evolution and become maturation, less risk. These advantages will give a positive driving loop to accelerate re-investment in the traditional high-carbon technologies. (Tao W, 2009)

What’s more, low-carbon economy is still in experimentation stage and the cost of developing low-carbon technology is still high, such as early development cost and building capacity cost, and operation and maintenance of new technologies will also have a high cost. Compared low-carbon technology, the investors and user by traditional high-carbon technologies do not pay so much those external costs. This makes the low-carbon technologies lack the cost competition.

Under these circumstances as above, Carbon lock-in effect have emerged and lead to development of low-carbon technologies lack competitiveness in China.

Backwardness of overall technical level in China restrict development of low-carbon technologies

Because of backwardness of overall technical level, especially in R&D capabilities area, China has to acquire the needed technologies from developed countries. Although developed countries are forced to provide technology transfer to developing countries, China has to face this challenge.

Nowadays, China needs to import 70% of the key low-carbon technologies in carbon emissions. For achieve cut target of CO2 emissions, China have to hold mostly 60 low-carbon technologies, but from which 42 are absolutely necessary and china have not been hold in hand. (Global times ,2010)
3.2.2 Economy

In economy part, there is have discussion on the difficulties for China to develop Low-Carbon Economy from three aspects—cost, tax and employment.

3.2.2.1 Cost

It is very important in the process of Low-Carbon Economy development that renewable energy become the main energy supply instead of primary energy. Therefore, China should introduce and develop these renewable energy technologies. And it absolutely leads to intense economic cost pressures for China.

It can be seen from Figure 34 and Figure 35, there is a large increasing cost in the controlling scenario and abatement scenario. The figure shows that if China wants to achieve the carbon emission control or reduction in carbon emission in 2050, China needs to add up to 9.5 trillion U.S. dollars and 14.2 trillion U.S. dollars of incremental investment from 2010 to 2050 under the controlling scenario and abatement scenario respectively. (Equivalent to 240 billion U.S. dollars and 355 billion U.S. dollars of incremental investment per year) that is to say, with the improvement of emission reductions, the corresponding incremental investment will be substantially increased. (National Bureau of Statistics of China, 2009)

(One billion dollars)

![Figure 34 Incremental cost (per year) under controlling scenario](Source: National Bureau of Statistics of China, 2009)
In controlling scenario, the estimated total emission reduction will reach 3.2 GT, 5.1 GT, 6.7 GT in 2020, 2030 and 2050 respectively. The data in table shows that:

In 2020, the incremental cost is 86 billion U.S. dollars and the unit reduction cost is 27 U.S. dollars per ton CO2. It means that each Chinese household will need to pay 182 U.S. dollars of additional costs per year.

In 2030, the incremental cost is 269 billion U.S. dollars and the unit reduction cost is 56 U.S. dollars per ton CO2. Each Chinese household will need to pay 538 U.S. dollars of additional costs per year.

In 2050, the incremental cost is 523 billion U.S. dollars and the unit reduction cost is 78 U.S. dollars per ton CO2. Each Chinese household will need to pay 1006 U.S. dollars of additional costs per year. (Table 4)

In abatement scenario, if China wants to further reduce the emission of CO2 to 5.5 billion tons, the incremental cost will up to approximately 1.6 trillion U.S dollars and the unit reduction cost is 148 U.S. dollars in 2050. It is about 6% of GDP that year. It means

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**Figure 35 Incremental cost (per year) under abatement scenario**

each Chinese household will need to pay up to 3046 U.S dollars of additional costs per year. *(Table 4)*

**Table 4. Incremental costs under energy controlling and abatement scenario**


<table>
<thead>
<tr>
<th>Year</th>
<th>Energy controlling scenario</th>
<th>Energy abatement scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2020</td>
<td>2030</td>
</tr>
<tr>
<td>Per capita emission t-CO₂</td>
<td>5.6</td>
<td>5.8</td>
</tr>
<tr>
<td>Reduced carbon emission intensity (compared with 2005)</td>
<td>51</td>
<td>69</td>
</tr>
<tr>
<td>Total emission reduction Gt-CO₂ (compared with 2005)</td>
<td>3.2</td>
<td>5.1</td>
</tr>
<tr>
<td>Incremental costs (1 billion dollars at constant prices 2005)</td>
<td>86</td>
<td>269</td>
</tr>
<tr>
<td>Unit reduction cost (USD/t-CO₂)</td>
<td>27</td>
<td>56</td>
</tr>
<tr>
<td>Share in GDP (%)</td>
<td>1.2%</td>
<td>2.2%</td>
</tr>
<tr>
<td>Cost per household (USD/year)</td>
<td>182</td>
<td>538</td>
</tr>
</tbody>
</table>
Table 5. Incremental costs under the energy controlling scenarios with 40 and 45% cuts in carbon intensity

(Source: National Bureau of Statistics of China)

<table>
<thead>
<tr>
<th>Cuts in CO₂ emissions per unit GDP in 2020 over 2005 levels, %</th>
<th>Energy controlling scenario -40% cut</th>
<th>Energy controlling Scenario -45% cut</th>
</tr>
</thead>
<tbody>
<tr>
<td>Per capita emissions, t-CO₂</td>
<td>6.9</td>
<td>6.3</td>
</tr>
<tr>
<td>Total emission reductions in relative to the reference level, one billion t-CO₂</td>
<td>1.4</td>
<td>2.2</td>
</tr>
<tr>
<td>Incremental abatement cost in relative to the reference level (US$ 1 billion/year)</td>
<td>≤0º</td>
<td>≤30</td>
</tr>
<tr>
<td>Unit abatement cost, USD/t t-CO₂</td>
<td>≤0</td>
<td>14</td>
</tr>
<tr>
<td>Share of unit abatement cost in GDP (%)</td>
<td>≤0</td>
<td>≤0.4</td>
</tr>
<tr>
<td>Equivalent cost per household, US$/year</td>
<td>≤0</td>
<td>≤64</td>
</tr>
</tbody>
</table>

At the end of 2009, the Premier of China, Wen Jiabao, made an important speech with topic "Reach a consensus, enhance cooperation and promote the historical process of climate change" and promised that “By comparing with 2005, the total volume of emission of CO₂ per unit of GDP in China will reduce by 40%–45% in 2020”.

Zou Ji, the former climate negotiator, and his team do a research and shows that If China want to fulfill the target of emission reduction of CO₂ by 45% in 2020, China need to add up to 30 billion U.S. dollars. It means that every Chinese family should over handle 64 U.S. dollars in the future ten years. (Zou Ji, Wang Ke, Fu Sha, et al. 2009.) Faced with such a huge reduction targets, China have to cost a lot of money to reach it.
However, as a big developing country, China is still in the lower level of economic development. There are a large number of poor people with low income in China. Per-capita income in China is still in the bottom of the world. As a result, economic development is priority in China.

Periods of economic development remains the top priority. Most studies have shown that controlling greenhouse gas emissions will have a negative impact on the Chinese economy. It would reduce the per capita income and living standards of urban and rural residents. The potential negative macroeconomic effects will affect the China to improve per-capita income and to solve the poverty problems.

China as a developing country, there are still 40 million rural residents living below the poverty line (1,067 RMB/ Year), this is a large number. Moreover, with the urbanization development driving towards, the wealth gap between urban and rural residents will wider and wider. (The State Council leading Group Office of Poverty Alleviation and Development, 2009)

Comparing with the world, the poverty line in China is lower. According to the forecast of the World Bank (WB), the world poverty line is 1.25 U.S. dollars/Day. And the number of poor people in China will larger. (World Bank, 2009)

Therefore, facing such big poverty number and such huge controlling cost of CO2, China will under the big pressures and have difficulties in the development of Low-Carbon Economy.

3.2.2.2 Tax

Carbon tax is the common measure to control the carbon emission in the world, and it will have negative impact on people's lives and industrial development in a short term.

It is well know that, high energy consuming products were mostly produced by developing countries and export to developed countries. “Made in China” has taken very large share in the market. Once the carbon tax is widely adopted in developed countries as a one of the tariffs, and it will make a deep harm to China. The exporting products in China are low-end products with high carbon content. If developed countries impose carbon tax to China’s exporting products, China export trade will be blocked. In
additional, carbon tax will increase the production cost to Chinese enterprises and reduce their exporting competitiveness.

Furthermore, the coal mining industry, oil industry, power industry and other high carbon emission industry in China will be blocked by the carbon tax. And it will yield a lot of relative fees for Chinese people. Such as electricity fee, petrol expenditure, gas fee and so on. That is to say, additional expenditure caused by carbon tax will eventually borne by Chinese consumers. When the vital interests of the people were infringed, they will not agree with development of Low-Carbon Economy in China.

3.2.2.3 Employment

Although the development of Low-Carbon Economy will bring a large number of green jobs, it will create large amount of unemployment of High-Carbon energy industry in the short time, particularly energy-intensive industries. China has to face the structural unemployment. (UN Environment Program, 2009)

The implementation of china’s energy saving policy will restrict energy-intensive industry, such as iron, steel, thermal power, cement, heavy chemical industry. Many of energy-intensive and highly polluting enterprises will be closed gradually. This will bring the corresponding jobs cut and cause low-end technical unemployment.

In the long term, by developing new technologies and new industries, green jobs can offset these unemployed; however, people who have green jobs are different with these unemployed people, actually, it may be considerable dislocation.

Because of potential people who face unemployed risk are the lower level of education and skill, they can not quickly master the new technologies, it is very difficult to complete transformation in the short term; so people who have higher skill and new technologies will get green jobs instead of those unemployed people.
4 Discussion

With the ever-increasing of global population and economic scale, the problems from energy use become the most important issues that people concerned. Use of energy will lead to the emission of green house gases, particularly emission of CO2. And the emission of CO2 making the global climate change has been recognized as an undisputed fact in the world.

The issue of global climate change has already become the common concern of mankind. 2009 is critical and meaningful to the negotiations of global climate change. The international community will follow the “Bali Roadmap”, and reach a new agreement of reducing emissions of global green house gases on Copenhagen Climate Change Conference in Denmark. As the world’s leading energy consumer and emitter of green house gases, China will suffer a huge pressure of making promises to reduce the carbon emission from other countries.

China is a developing country. Economic development excessive relies on the consumption of fossil energy resources. It will leads to the continuous increasing of total amount of carbon emission and environmental pollution. And it has seriously affected the quality and efficiency of economic growth and sustainable development. The report of the Seventeenth Party Congress has clearly pointed out that “building eco-civilization, and basically forming the eco-consuming, eco-economic growth and eco-industry. Efficiently control the discharge of major pollutants and improve the environmental quality.”

On September 22nd, 2009, the president of China, Hu Jintao, made an important speech entitled “addressing climate change together” on the opening ceremony of the United Nations Climate Change Conference and indicated that “To develop a green economy, actively develop a low carbon economy and the recycling economy, develop and promote the climate friendly technologies”. Meanwhile, he emphasized that China will further take four measures to address climate change. One of them is “develop Low-Carbon Economy”.

◆ Ideal situation

Facing with the deteriorating environment and the pressures from international community, China is already on the path way of developing Low-Carbon Economy.
However, China is still a developing country and under the stage of industrialization and urbanization. This will leads China excessive depending on the use of energy. In additional, the per capita income in China is low, and the poverty problems still exist in China. Therefore, economic development continues to be top priority in China. As a result, China wants to reach an ideal state when it develops Low-Carbon Economy. This kind of ideal situation is decoupling of economy, environment and energy. It means that China wish these three elements can be mutual developed rather than restrict to each other in developing Low-Carbon Economy. In the result, it discusses the benefits of China to develop Low-Carbon Economy. According to analysis of these kinds of benefits, it can be clearly showed the specific performances of this ideal situation:

**Environment**
The desire of China on environment is control and reduces the emission of CO2. According to the forecast of China future emission of CO2 in three different situations, the total amount of emission of CO2 in China will be reduced by 66% from reference scenario to abatement scenario. And comparing with 2005, the emission intensity of CO2 per unit of GDP will be reduced by 91% in 2050. *(Figure 17, Figure 18)* The reduction in emission of CO2 results in less negative impact on environment. And the series of environmental pollutions and natural disasters can be overcome.

**Energy**
The desire of China on energy is use renewable energy instead of traditional fossil fuels. According to forecast of China future energy demand in three different situations, the China energy structure will be changed. And the demand of fossil energy resources reduced dramatically under the situation of emission abatement. *(Figure 21)* After changing China energy structure, the demand of fossil fuels in China will be reduced. And this can make China reduce the dependence on energy import. And the expenditure on importing will be declined as well. In additional, China can focus on the development of renewable energy technology.

**Economy**
The desire of China on economy is the development of relative renewable energy industries. And those renewable energy industries can be as a new point for economic growth in China. Since the development of renewable energy industries, there are more green jobs can be created. And the employment rate can be increased as well. In additional, China can make itself more competitive to adapt to the new international rules under the background of global climate change.
Actual situation

In the ideal situation, China desire that energy and environment can be improved simultaneously when economy was developed. However, the actual situation in China is that energy, environment and economy are restricting to each others. If one of the elements was developed, the other two elements will be sacrificed. The specific performance of the actual situation can be seen as follow cause-and-effect diagram.

Figure. 36 The cause-and-effect diagram
(Source: Lei Wu, Yang Zhao)
The cause-and-effect diagram shows that there is a bottleneck in China to develop Low-Carbon Economy. On one way, if China was going to develop Low-Carbon Economy. That means China will take measures to control and reduce the emission of CO2. The consequence of emission control is to use of renewable energy instead of traditional fossil fuels. Due to the backward Low-Carbon technology in China, China has to cost a lot of money to introduce the mass of advanced technologies to develop renewable energy. Furthermore, use of renewable energy will definitely leads to the reduction in use of fossil fuels. And the relative industries with reliance on fossil fuels will be collapsed. And the people who work in these kinds of industries will be forced to face the unemployment risk. Meanwhile, in order to effective in reducing the use of fossil fuels, carbon tax will be adopted. This will leads a block in China’s export trades. The relative cost caused by carbon tax will be increased for Chinese people.

On the other way, China is under the stage of industrialization and urbanization. The industrial and urban development requires abundant of use in energy. Meanwhile, the energy structure in China is coal-dominated. China has a mature high-carbon technology, but backward in Low-Carbon technology. As a result, the carbon lock-in effect will be caused in China. And China has to use fossil fuels to make an economic development. Eventually, the emission of CO2 in China will be increased under the use of fossil fuels.

Therefore, China faces the bottleneck in developing Low-Carbon Economy. This situation is caused by the external environmental factors and internal national conditions in China.

Figure 37. China’s the bottleneck in developing Low-Carbon Economy
(Source: Lei Wu, Yang Zhao)
Finally, it can be seen the figure as above, these gears of environment, energy and economy cannot gear into each other, and cannot run very well. It means that there is a big barrier for China to develop Low-Carbon Economy.
5 Conclusion

With the deterioration in the external environment and the pressures from international community, China is under its way of developing Low-Carbon Economy. However, because of the restriction from actual national conditions, when China develops Low-Carbon Economy, it has to face and experience a lot of difficulties and challenges. Those difficulties and challenges make China should take actual conditions into account when develop Low-Carbon Economy. This is a root causes for China to have many frictions with many other developed countries in many international conferences.

For the most developed countries, they have completed the development of industrialization and urbanization and have entered into the post-industrialization and post-urbanization. Thus, the traditional competitiveness of economic growth for developed countries has been gradually disappeared. Instead, it is a new mode of economic growth. That is Low-Carbon Economy.

However, for the most developing countries including China, they are now under the middle even the early stage of the industrialization and urbanization. These developing countries are in the early stages of economic growth. Therefore, they have to excessive depended on the energy use when they have the economic development. At this point, if there was a sudden change in developing countries from high carbon mode to low carbon mode, then the economic competitiveness of those developing countries will be greatly weakened. Most of developing countries would not want to face that situation.

Therefore, there is a big controversy between the developed countries and developing countries in Copenhagen Conference. The position of developed countries is that require developing countries take more responsibility to reduction of carbon emission. The position of China is “developing countries take appropriated measures to emission control and reduction in terms of receiving the funding and technology support from developed countries. Those emission reduction actions should according to the national actual situations and conditions.”

Further research:

In final thesis, we mainly do a research on the driving force and challenges of developing Low-carbon Economy in China. Meanwhile, we further explained the reason for China that why Low-carbon Economy development in China would be into the bottleneck.
However, we still have long way to go if we want to make a deep understanding about the problems and development of China’s Low-carbon Economy. As a result, there are some further research can be done based on our final thesis.

1. It can do a supplement research on the challenges of developing Low-carbon Economy in China based on our original research.

2. It can do a research on policies that Chinese government made for Low-carbon Economy development. It includes the policies that Chinese government has issued or will issue when Low-carbon Economy face with those challenges.

3. The Chinese government how to reasonably balance three aspects of energy, environment and economy in the investment on Low-carbon industries. And Chinese government how to deal with the bottleneck in Low-carbon Economy development in China.

4. Do a research on the development and limitation of renewable energy resources in China.

5. Study the development of Low-carbon Economy in foreign countries and look for which kinds of experiences can be referred by China.
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Appendix

1. Total Production and Consumption of Energy


![Total Production and Consumption of Energy](image)

2. The growth data of coal importing volume and expenditure in China (1999-2007)


<table>
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<th>Year</th>
<th>The imports volume (10 000 tons)</th>
<th>The import value(10 000$)</th>
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3. The growth data of crude oil importing volume and expenditure in China (1999-2007)

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