Challenges and countermeasures of China’s energy security

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Abstract

To ensure energy security, the first to know what is energy, and second, what are the factors of non-security, means that the challenge of energy security. Finally, puts forward some policy or in the case of a reasonable method to solve it according to these problems. At present, energy security is facing two challenges of structural crisis and crisis management system. Concretely, main problems in that security are analyzed, which are considered to affect China and mostly embody in such four big areas as the great pressure in energy supply, the scarcity of relative energy resources, foreign oil dependence is too large, crisis management systems of energy security, the shortage of green energy. Furthermore the counter measures concerned are proposed, including saving energy and increasing the energy utilization rate, to establish strategic energy reserves, strengthening environmental protection and adjusting the primary energy structure.

China's rapid economic growth lead to sharp increase in oil imports. Due to China relies on a single chokepoint, the Malacca Strait, which has caused a high degree of concern about the safety of its energy. Nearly three-quarters of its oil imports flowing through the Strait. In view of its strategic importance to China and China’s little sway on the waterway, this view is mainly focused on China’s energy demand and supply in two aspects of concern.

The paper analysis of whether the current energy structure is appropriate and sustainable. Because the energy security is facing China's energy is more and more dependent on imported fuel and the need to convert energy to meet the demand of modern society and the rapid growth of the requirements of the economic challenges. Concludes that the China's new policy should focus on energy efficiency, energy saving, renewable energy and turned to the main energy source of natural gas.

Keywords:

Energy security, China, Challenge, Countermeasures, Oil, Coal, Greenhouse gases, per capital, Malacca, energy structure, oil pipelines, energy efficiency
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Fan Yang
Dongcan Wang
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1. Introduction
This section provides an overview of the research issues. The purpose and outline of this article will be shown in this section.

1.1 Background
Energy resources are indispensable for human beings to survive in today’s world, which are crucial for our society’s sustainable development as well. They are also an integral part of a country and have significant influence on its policies. Any country relies on energy resources to develop its economy so whether a country has sufficient energy resources or not counts a great deal. Take oil for example, as is known to us all that it is a kind of rare resource which is treasured by many countries. Some countries even wage a war for the oil such as America and Iraq. So it is obvious that ensued the energy resources security is very important.

In recent years, the growth rate of China's energy conversion is slower than the growth rate of energy use. The energy resources in China converse at a slower speed than human beings’ energy consumption. So the total energy conversion and total usage gap gradually widening. It causes energy shortage. As China's economy booming, whether China has adequate and stable energy has become an important factor for China’s economic development.

Currently over 60% of China's crude oil is imported from the Middle East and North Africa, where always has war and turmoil, and about 4/5 China’s crude oil transport through the Malacca Strait, forming a constraint on China's energy security, "the Malacca dilemma". So the energy of China’s transport channel is also unsafe.

1.2 Purpose
The purpose of this thesis is analyzing Challenges and countermeasures of China’s energy security.
1.3 Research questions

What is the energy situation and structure in China?

What is the challenge for China's energy?

What measures should we take to ease or to solve these energy security problems?

1.4 Outline

The structure of this paper mainly includes six parts. The first part is the general introduction of energy security and the importance of China's energy. The second part is the main method to complete this article. Then, the third part is a comprehensive theory to discuss the issue of China's energy security and countermeasures. The fourth part shows the energy security problems encountered in our country at present. The fifth part is about how to improve the energy security of China. In the last part, it provides the final conclusion of the paper on the energy security of our country.
2. Methodology

This section provides an overview of the methods we use to achieve our objectives. The methodology section will give the reader a clear idea of how to perform this research, what we did, how we did, and why we choose this method. Specific methods we will see in the next article.

This research is mainly based on the theoretical research. We searched several journals, articles, and books to support the integrity and effectiveness of information. Therefore, the main data and secondary data is the basis of this analysis.

Firstly, the book about energy security is needed to read in detail, based on the basic knowledge to write this thesis. Meantime, find other books from library, search in academic data basis to find some energy security and China’s energy articles, both of them are the foundation framework to writing this paper. Secondly, the comprehensive knowledge about world energy outlook report is clearly showed in website. In addition, the relevant challenges and countermeasures of China’s energy security theory are collected from many academic articles. Different opinions in the article, books, newspapers and periodicals are discussed, and the conclusion is drawn. "Energy security", "China's energy" and "China's energy security challenges” and other key words will be searched in Google academic search.

2.1 Data collection

2.1.1 Primary data

As Walliman (2005) pointed, the primary data is the data observed, experienced or recorded close to the fact, are the nearest one to the truth, this data provides the wealth information for researchers. The primary data can be from the questionnaire, interview, and empirical test and record the results of the observation. So its validity is more than secondary data. Because this theme is not generally free can be a questionnaire survey and interviews, and for the public energy security is too professional and not common, the questionnaire and interviews are more difficult to obtain, so there is no primary data in our article.

2.1.2 Secondary data

Secondary data refers to the collection of data from the sources, mostly from books,
magazines and periodicals. Secondary data are usually readily available. With the wide use of the Internet and the electronic media, the data obtained have been recognized, so the auxiliary data is more reliable. This paper mainly through the collection of secondary materials for writing completed.

2.2 Research method

2.2.1 Quantitative method

Quantitative method is a research method which focuses on the collection and analysis of digital data. For example, statistical data, tables and charts are often used in the article (Walliman, 2005). In this paper, we have used some academic or book data to collect statistics and surveys that have been published. For example, China crude oil consumption and trade.

2.2.2 Qualitative method

As the name suggests, qualitative methods are not involved in statistics and measurement. It aims to analyze the differences between attributes and qualities. Interview is one of the most useful qualitative techniques (Amaratunga et al., 2002). Because of some limitations, there is no interview with our paper.

2.3 Research strategy

Walliman (2005) points out that the study strategy depends on what kind of research, which is not a simple theory, the need to gradually generalize. Case study is a very important study of this paper. In order to help the readers to understand the problem clearly, it is necessary to use the theoretical analysis and the results in the article, and finally give the best conclusion. The research strategy also refers to the case study of information and the two data collection of such research methods.

2.4 Validity and Reliability

2.4.1 Validity

Validity is the quality of the research, so that the data is more scientific and reliable. The validity is divided into two parts, internal and external (Sharan, 1995). In order to guarantee the validity of the work, the internal validity is to show how to get a real result. External validity is the application of one result to the other. On the one hand, magazines,
books and websites of the source are also carefully examined and analyzed to ensure its validity.

2.4.2 Reliability

The certainty of reliability study is sufficient. Primary data and secondary data improve the reliability of the whole work. Published books and periodicals are the basic method of this paper. In particular, the whole paper is based on the situation in different countries. In order to increase the reliability of this paper, a variety of methods for the literature review and the Internet are used for data collection.

2.5 Limitation

There are some limitations in the work:

First, the biggest limitation is that there is no direct interview to support the entire article. We want to write e-mail to the company's energy or related organizations and Research Institute asked whether they can give a chance to interview, but did not reply to a long time.

Second, energy security this topic has certain academic, is not suitable for the text in the form of questionnaire survey the public’s opinion.
3. Theoretical Framework

This part is mainly to give definitions to energy, energy security, the challenge of energy security and countermeasures of energy security.

3.1 Energy Security

Energy security is a systemic issue involving engineering, politics, economics, energy, environment, diplomacy and military affairs (Luo, 2011). The definition of energy security is that in order to protect a country's economic, social and national security, making the energy supply reliable and reasonable. To avoid the risk status of energy supply which is caused by the military, political, diplomatic and other non-traditional security events. Non-traditional security is the factors which can threaten the survival and development of humans. So the concept of energy security has become common place in political and academic discourse. It also becomes one of the principal issues on many country’s national agenda. Such Russia, China, USA and so on. The energy security has three key factors: reliability, affordability and environmental sustainability. Reliability is that energy supply in the quantity and form is secure. Affordability is that energy is available at a price that can sustain and promote economic growth (Luo, 2011). There are linked very closely between energy security, national security and the world security. So it’s very important to ensure China's energy security and make strengthen international energy cooperation.

3.2 China’s Energy Security challenge

At present, China's energy security facing the following two main challenges:

1. The structural crisis.
3.2.1 The structural crisis

At present, our country is in the acceleration period of industrialization and urbanization, the energy consumption is of higher intensity. As the economy further expands its scale, energy demand will continue to increase rapidly, which will create a great pressure on energy supply (Cao, 2013). The structural crises in China are included.

First, China’s energy structure is not reasonable, is still dominated by coal. In China existing energy consumption structure, coal accounted for 68%. According to the International Energy Agency forecast, 2030 Chinese coal still accounts for the total energy consumption of 60% (world energy outlook, 2002).

Second, China’s per capita consumption of energy is low. The distribution of energy resources is uneven. China’s per capita proved reserves of energy are only 33% of the world average level (B.P, 2004). China’s distribution of energy resources is not uniform. Its characteristic is North China is that more than South China, the energy in West China is rich and the energy in East China is poor.

Third, the contradictions of energy supply and demand have become increasingly prominent. From the beginning of 1992, Chinese energy production growth rate is less than the growth rate of energy consumption, total energy production and consumption gap is widening, the contradiction between energy consumption and supply shortages has become increasingly prominent.

Forth, oil is dependent the foreign country too large. The reserve system is not perfect. In2009, China imported 4.3 mb/d, or 51.3% of its demand. In1995, China relied mainly on the Middle East and the Southeast Asia for 82% of its crude oil imports. It now depends more on a single chokepoint – the Strait of Malacca–than it had been before, with nearly 77% of its oil imports flowing through the Strait (Zhang,2011). It caused the Malacca Dilemma.
Fifth, the ratio of energy utilization is low, energy and environmental problems are extrusive. The main industrial products unit consumption is higher 40% than the foreign average. The average utilization rate of energy is only about 30% (Jianmin, 2005). In addition, China’s energy structure dominated by coal is not conducive to environmental protection. According to the statistics report of the World Bank, the top 20 most polluted city, China accounted for 16 (Kong, 2005).

3.2.2 Management of Institutional Dilemma

From the end of the 1980s, Chinese energy management agency always adjusts. The government’s permissions are unknown and responsibilities are unclear (Erica, 2004). In one hand, it’s hard to introduce the unified and coordinated policies and measures, in the other hand, even if introduce the unified and coordinated policies and measures, nor the specialized agencies to implement, this cannot achieve long-term policy goals, exposed the institutional crisis of energy security.

In addition, the monopoly behavior of energy market cannot be ignored in China. At present, the biggest obstacle to the reform and development of China energy industry is behavior which the industry's monopoly and regional market segmentation in violation of the laws of market economy.

3.2 China’s Energy Security countermeasures

According to the theory of petroleum safety, dependence on foreign oil is one of the important indexes to measure a country or area oil security, higher dependence, means that the more vulnerability of the security of oil supplies (Dongbei, 2009).

Stable, adequate and economic energy supply is an important foundation for the development of China. Therefore, we should establish and implement the Scientific Outlook on Development, achieves the comprehensive construction well-off society's strategic perspective to fully understand the importance and urgency of energy work. Use the scientific development concept to guide the energy work, overall the energy,
economic and social development, overall the energy cooperation with foreign country.
4. The challenges of China’s energy policy

A booming domestic economy, rapid urbanization, rising export processing and the Chinese people’s voracious appetite for cars are giving rise to an unprecedented demand for resources and make China’s energy security facing much more rigorous challenges.

4.1 The contradiction of supply and demand relationship

Since 90's of the twentieth Century, with the rapid growth of Chinese economy, energy shortage has become a bottleneck restricting the development of the national economy China. From the beginning of 1992, Chinese energy production growth rate is less than the energy consumption growth rate, between the total energy production and consumption gap gradually widened, the contradiction between energy consumption and supply shortages have become increasingly prominent. For example, Chinese oil consumption is 1.15 tons in 1990, 2002 increased to 2.393 tons, an average annual increase of 6.7%. And China crude oil output in 1990 was 1.38 tons in 2002, but increased to 1.675 tons, an average annual increase of 1.62% to 30% (Jianmin, 2005). Some experts estimate, by 2030, Chinese energy supply and demand gap of about 2.5 tons of standard coal, by 2050 will increase to as 4.6 tons of standard coal (Ma, 2001).

4.1.1 Heavy pressure on energy supply

China’s consumption accounts for about half of the growth of word oil consumption in the last ten years. China is the second largest energy consumer in the world, and the production and consumption of coal ranks first in the world, and the electric power production is second. The proportion of China’s energy sources is coal 70.2%, oil1 9.0%, hydro 6.3%, gas 3.7% and nuclear 0.7%, which differs significantly from that of most industrialized countries. It is predicted that the gross energy demand of China reach 3.8 billion tons of standard coal in 2015. This means that China is likely to become the world’s largest energy consumer, and consumption will reach 4.2-4.5billion tons by 2020 and 5.5 billion tons by 2030. It is also forecast that the dependence on foreign energy, oil and gas will rise from 8.8%, 51.2%,and 5.8% in 2008 to 15%, 60% and 30% in 2015, continue to be up to 25%, 70% and 50% in 2030 (Wang et al., 2011).

Obviously, in the three essentials of energy security, Beijing gives the highest priority to reliability of supply pushes its oil companies to acquire overseas energy suppliers
and infrastructure around the globe (see Table 1). This action out of market-driven energy policy is driven by the government goal to mitigate the dependence on the international market, because crude oil price continues to rise and growth rate of energy use has already exceeded GDP growth. Thus, China wants to rely less on market exchanges and more on long-term trading contracts, which tends to create more opportunity for interaction between geopolitics and energy security (Ma et al., 2012). As we have seen, this has significant strategic implications for China’s international relations. China’s crude imports by region are shown in Table 2.

Table 1 China crude oil consumption and trade.

<table>
<thead>
<tr>
<th>Year</th>
<th>Crude consumption (Mt)</th>
<th>Net crude imports (Mt)</th>
<th>Net import dependency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>114.9</td>
<td>-23.5</td>
<td>-20.5</td>
</tr>
<tr>
<td>1992</td>
<td>133.6</td>
<td>-7.3</td>
<td>-5.5</td>
</tr>
<tr>
<td>1994</td>
<td>149.5</td>
<td>5.2</td>
<td>3.2</td>
</tr>
<tr>
<td>1996</td>
<td>174.3</td>
<td>18.4</td>
<td>10.6</td>
</tr>
<tr>
<td>1998</td>
<td>198.2</td>
<td>34.1</td>
<td>17.2</td>
</tr>
<tr>
<td>2000</td>
<td>224.4</td>
<td>75.8</td>
<td>33.8</td>
</tr>
<tr>
<td>2002</td>
<td>247.9</td>
<td>81.3</td>
<td>32.8</td>
</tr>
<tr>
<td>2004</td>
<td>317.0</td>
<td>150.5</td>
<td>47.5</td>
</tr>
<tr>
<td>2005</td>
<td>325.3</td>
<td>142.8</td>
<td>43.9</td>
</tr>
<tr>
<td>2006</td>
<td>348.8</td>
<td>168.3</td>
<td>48.2</td>
</tr>
<tr>
<td>2007</td>
<td>366.5</td>
<td>184.8</td>
<td>50.4</td>
</tr>
<tr>
<td>2008</td>
<td>373.2</td>
<td>200.7</td>
<td>53.8</td>
</tr>
<tr>
<td>2009</td>
<td>408.3</td>
<td>218.4</td>
<td>53.5</td>
</tr>
</tbody>
</table>

### Table 2 China crude oil imports by region.

<table>
<thead>
<tr>
<th>Year</th>
<th>Percentage of total supply</th>
<th>Middle East</th>
<th>Africa</th>
<th>Europe and Western Hemisphere</th>
<th>Asia-Pacific</th>
</tr>
</thead>
<tbody>
<tr>
<td>1989</td>
<td>41.3</td>
<td>0</td>
<td>0</td>
<td>58.7</td>
<td></td>
</tr>
<tr>
<td>1994</td>
<td>39.7</td>
<td>4.1</td>
<td>0.8</td>
<td>55.4</td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td>46.2</td>
<td>19.8</td>
<td>15.4</td>
<td>18.7</td>
<td></td>
</tr>
<tr>
<td>2003</td>
<td>50.9</td>
<td>24.3</td>
<td>9.6</td>
<td>15.2</td>
<td></td>
</tr>
<tr>
<td>2004</td>
<td>45.4</td>
<td>28.7</td>
<td>14.3</td>
<td>11.5</td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td>47.8</td>
<td>30.1</td>
<td>17.3</td>
<td>4.7</td>
<td></td>
</tr>
</tbody>
</table>

*Source: Zweig and Flanbai (2005), Li (2011).*

#### 4.1.2 Energy resources relative shortage

##### 4.1.2.1 The per capita of energy is low

Although China’s total energy production is the third in the world, but per capita is far lower than the world average. Due to the large population of China, the per capita energy resource in the world has a low level. Only 33% of the world’s average per capita energy reserves in China (B.P, 2004). Coal and water resources per capita are only half of the world average, per capita oil and natural gas resources is only 1/15 of the world's average level.

##### 4.1.2.2 Resources are unevenly distributed

Energy resources of China are unevenly distributed across the whole country that is vast in size. For instance, coal resources are mainly stored in north and northwest region, water resources are mainly distributed in southwest region, oil and natural gas resources stored in eastern, central, western and the sea region. China’s energy consumption is mainly concentrated in the economically developed areas of southeast coastal region. Storage resources and energy consumption have obvious contradiction from the geographical point of view. Furthermore, the energy efficiency of Chinese industry is low. It consumes 50% more energy per unit of GDP than advanced
countries. Due to uneven distribution, low energy efficiency and an inefficient power grid structure, it is hard to meet the rising energy demand solely by improving of supply (Vivod, 2009).

4.2 Foreign oil dependence is too large

The oil security has become the core China energy security. Because of China crude oil production growth is much lower than the oil consumption growth, resulting in Chinese oil supply shortage, the import dependence of soaring. According to the International Energy Agency forecast, to 2020, Chinese daily oil imports up to 6.9 million barrels, accounting for China oil consumption is 70%; In 2007, China dependence on foreign oil is 55%, 2020 is 68%, 2030 Will reach 74% (International Energy Agency, 2004). “United States Energy Information Administration” also predicted that, China dependence on foreign oil is 44.6% in 2010, 2020 is 62.8%, in 2025 will reach 68.8% (United States Energy Information Administration, 2003). In addition, China's crude oil imports more than 60% from the Middle East and North Africa. Therefore, the transport mode is mainly concentrated in the sea, and the transportation routes of 4/5, which is about to import crude oil, need to pass through the Strait of Malacca, which forms the dilemma of China's energy security-- "Malacca dilemma".

4.2.1 Precautions against sudden fluctuations of supply

The first phase national base of a national oil reserve with total capacity of 16.4 million cubic meters, has been built in China, but it is very small compared with the contingency reserve of over 100 days consumption in USA, Japan and EU etc. Natural gas, coal and uranium reserves are still unavailable now. China only constructed six productive underground gas storage facilities of depleted oil-gas reservoirs, which amount to 2% of total gas consumption, being lower 10-15% than average of advanced states of gas industry.

China’s transportation of coal is reliant on a small number of transport nodes. The Datong-Qinhuangdao railway, the Shuohuang railway and the “three Xi” railways account for over 70% of total coal transportation. The networks of coal railways and oil-gas pipelines are clearly inadequate. Coal railway traffic makes up 48% of energy transport, while oil pipelines account for just 11.5%. The infrastructure development supplying the developed areas in the eastern part of China needs to improve.
4.2.2 Overstated effectiveness of China’s transnational oil pipelines

The view of Chinese leaders towards energy security has seen a sea change. In the 1990s, Beijing wanted to maintain self-sufficiency of oil, synonymous with the US claim on “energy independence” in the Obama era, and issued oil import bans in 1994 and 1998, respectively, (Wang, 1999; IEA, 2000). However, they were effective only in their early phrases with their effectiveness fading with the passage of time. Having realized this, plus the fact that China has to import oil to maintain economic growth, Chinese leaders in the twenty-first century actively promote security of oil imports rather than saying “no” to import. Measures include transnational oil pipelines, bilateral oil deals and investment in overseas oilfields; all of which share a higher strategic goal-diversification of oil sources.

At the moment, China has only one operational transnational oil pipeline but has two being built and one in the speculative stage (Fig. 1). All four pipelines share a common strategic goal: avoid the “Malacca Dilemma”, which arises when 70-80% of the oil from Africa and the Middle East towards China according to President Hu Jintao and many analysis (Lees, 2007; Lanteigne, 2008), yet no necessarily true-“must pass” through the Malacca Strait, wedged between Indonesia and Malaysia. Many Chinese leaders believe that this Strait is a chokepoint, with its possible exposure to oil supply disruptions caused by blockade by the U.S. Navy in response to a conflict over Taiwan, or pirate attacks. The fact that East Asia has seen seven naval blockades in the twentieth century and the lesson learned from the 1982 Falklands War, known as the “classic example of modern limited blockade”, (Elleman, 2008, p. 366) both intensify such fears. The pipelines help calm the fears as Chinese leaders believe that overland pipelines can reduce the reliance on the Strait of Malacca.

The 3000 km Kazakhstan-China Oil Pipeline, currently China’s only cross-county oil pipeline, was agreed to be constructed between China and Kazakhstan as early as 1997 and became operational in 2006.2 The pipeline can transport 50 Mt of crude oil yearly, if running at full capacity, but so far China has not been able to secure enough crude in Kazakhstan to exhaust the pipe’s capacity as competition for oil in Kazakhstan is fierce (Cohen, 2008). Even if the pipeline can deliver 50 Mt to China each year, the amount of oil transported accounted for only 12-13% of 2008 demand and less in the future.

Furthermore, China and Russia have “finally” started to build a transnational pipeline, from Skovorodino to Daqing in Heilongjiang Province after a decade of waiting. China and Russia began discussing a pipeline from Angarsk to Daqing, which,
however, were suspended during the Kremlin’s 2004-2007 assault on Yukos. The Yukos plan was replaced by Transneft’s East Siberia-Pacific Ocean (ESPO) pipeline (Erickson and Colloms, 2010).

The ESPO’s first section, from Taishet to Skovorodino to be completed in late 2010 and run in 2011, which initial annual capacity estimated to be 15 Mt and maximum capacity 30 Mt, i.e., 4-8% of 2008 demand. One should note that the added volume of Russian oil, at an average of 15 Mt in 2007 and 2008 (Erickson and Collins, 2010), stops after the operation of the pipeline, because rail transport is more costly or because Russia would want to avoid over-dependence on the China market.³

Moreover, the second half runs from Skovorodino to Nakhodka, on the Sea of Japan, aiming at selling crude to Japan and other Asian-Pacific markets, suggesting that China will not be the only targeted market of Russian oil in Asia.

The third one, Myanmar-China Oil and Gas Pipelines, has been confirmed when Beijing signed a deal with the military junta of Myanmar in March 2009. The pipelines, from Sittwe (a.k.a. Kyaukphyu) in Myanmar to Kunming in China’s Yunnan Province, and eventually on to the cities of Chongqing and Nanning (Reuters USA, 2010), will run 2000 km and cost 1.2 billion dollars. It will bring 12 Mt of crude oil a year into China or 20 Mt after the second stage of development. The project is a joint venture between CNPC, which holds a majority 50.9% stake and state-backed Myanmar Oil & Gas Enterprise with the remaining 49.1% ⁹ (OilVoice, 2009). According to the agreement signed in December 2009, the junta will be responsible for the security of the pipeline (Roy, 2009). The idea of the pipelines was discussed publicly in 2004 by Yunnan University professor Yang Xiaohui and his colleagues, who argued that they can reduce the reliance on the Strait of Malacca and enhance the country’s energy security.

The fourth one, still under consideration, is a Pakistan-China Oil Pipeline, running from Gwadar and Karachi in Pakistan to Kashgar in China’s Xinjiang Uyghur Autonomous Region, serving as an “energy corridor” and reducing reliance on the Indian Sea and Strait of Malacca (Erickson and Collins, 2010).

These pipes for the contribution of China’s energy security are much smaller than the expected.

Firstly, the so-called Malacca Dilemma has been commonly exaggerated. When faced with non-military disruptions on the Strait of Malacca, such as pirate attacks or crasher, oil tankers towards China can always be diverted through alternative
passages, e.g., the Sunda and Lombok straits at an additional cost of as little as one or two dollars per barrel. Considering that pipelines are far more expensive than tankers in terms of what must be spent to move a given volume of oil over a given distance (Erickson and Collins, 2010), the added transport cost of taking alternative passages is negligible.

Secondly, when small-scale armed conflicts occur between the U.S. and China, the U.S. military would order complete blockades, we can assume that all possible channels, including the Malacca, Sunda, Lombok, straits, of course, the seas in Myanmar or Pakistan others, would be completely sealed off. No oil tankers can reach Sittwe or Gwadar as they would be a concentrated target set, highly vulnerable to blockade or even precision strike.

Thirdly, when all-out wars occur between the U.S. and China, some, if not all, China’s pipelines could be sabotaged or bombed, as pipelines are fixed and long objects, making the harder to defend geographically-unless the pipelines are in the ground, like the Baku-Tbilisi-Ceyhan (BTC) pipeline in Central Asia. In the scenario of all-our war between the U.S. and China, Kazakhstan or Russia might be asked by the U.S. to shut down their pipelines. As Myanmar is regarded by the U.S. as “pariah state”, the American voters might not oppose the idea to bombard the Sittwe port and paralyze the Myanmar-China Oil and Gas Pipelines.

Fourthly, Myanmar is politically unstable in the first place-see the 2009 Kokang incident, for example-and Pakistan and its surrounding regions are currently plagued by terrorist activities and territorial disputes. In marked contrast, tankers can often route around any points of disruptions-flexibility enhances security, not reduces it. Alhajji (2007) asked the right question: “how does the security of oil supplies differ from the security of the investments of Chinese, Indian and Japanese oil companies in the oil producing countries, some of which are known for their political instability?”

In short, although pipelines do contribute to China’s energy security – as China would benefit by the construction of new supply routes, in as much as different types of crudes have different qualities – their overall effectiveness is weaker than many assumed. Also, the actual effectiveness of each pipeline varies widely. While the Sino-Kazakh and Sino-Russian oil pipelines bring new oil sources to China safely and stably and help diversify China’s crude import portfolio, the Myanmar-China Oil and Gas Pipelines and the speculative Pakistan-China oil pipeline have built-in political risks and do not reduce China’s oil dependency on the Middle East.
Therefore, some Chinese analysts now believe that Sea Line of Communication (SLOC) security is much more important than pipeline transport lines. They are right; yet no consensus has ever been established on how to protect SLOC security. Realists advocate the modernization of the People’s Liberal Army Navy (PLAN), so that China can protect the SLOC by itself and deter the U.S. from imposing a blockade against it. This long-term project, however, would not benefit China’s energy security in the short term.

4.3 China’s concerns about the Strait of Malacca

As China's crude oil production growth is much lower than the growth of oil consumption, resulting in a shortage of oil energy supply and rising import dependence. At present, China's crude oil imports from the Middle East and North Africa more than 60%. Therefore, the transport mode is mainly concentrated in the sea, and the transportation routes of 4/5, which is about to import crude oil, needed to pass through the Strait of Malacca, which forms the dilemma of China's energy security. -- "Malacca dilemma".

As shown in Fig.2, in 1995, China's crude oil imports mainly depend on the Middle East and Southeast Asia (mainly in Indonesia, about 1/3 of China's total imports). In recent years, China has turned to Africa's emerging oil and gas fields. China's top leaders frequently visit oil producing countries. This high-profile, goodwill based energy diplomacy, to help China achieve significant progress in striking energy trading and the oil reserves of African countries, Guinea Bay, the African Republic, Chad, Congo, Libya, Niger and Sultan. By 2005, China has significantly diversified import structure. As shown in fig.2, Africa accounted for 30% of China's oil imports, while Russia to provide import 10% of the total (Downs, 2006).

However, China is still in the same dependence on the Middle East in 2005, as if 10 years ago, 47% of oil imports came from the Persian Gulf. In addition, because China is heavily dependent on Africa and the Middle East, it is now more dependent on a single choke point "the Malacca Strait", nearly 77% of the oil flow through the Strait (Kennedy, 2011).

Foreign trade has become one of the pillars of China's spectacular economic growth in the last 30 years, and the oil is closely related to. Since most of its oil imports from the Middle East and Africa through the Strait of Malacca, so the Strait of Malacca in China's economy and energy security has a certain importance. As a blocking point, this channel has a direct impact on China's offshore channels, but China has little
impact. Therefore, China has good reason to worry about the safety and smooth flow of its shipments, any emergencies may destroy its trade flows, especially oil imports, which may further attack China's economic development, social stability and military operations (Chen, 2010; Zhao, 2007).

In the past few years, China's top leaders have focused on the strategic vulnerability of the Malacca Strait (Blumenthal, 2008). November 2003, Chinese President Hu Jintao announced that "some of the big powers" is bent on controlling the channel, and calls for new strategies to mitigate the vulnerability. Since then, the Chinese media are quite attached to the country's Malacca dilemma" (Lanteigne, 2008; Storey, 2006). China Youth Daily, a newspaper leading to China, said: "it is not an exaggeration to say that whoever controls the Malacca Strait will also be bound to China's energy path" (Shi, 2004).

4.4 The negative effect of greenhouse gases emissions

The global climate change is exacerbated by the excessive accumulation of greenhouse gases in the earth’s atmosphere, particularly carbon dioxide, which trap massive heat energy from the sun. The accumulation of these gases is linked to consumption of fossil fuels, which release significant amounts of carbon dioxide. World energy demand is surging. Oil, coal and natural gas still meet most global energy needs, and are creating serious implications for the environment. One result is that CO₂ emissions, the main cause of global climate change, are rising. The climate change does not only refer to global warming, but to a broader set of consequence such as the deterioration of floods and droughts (that occurred in China’s provinces in recent years), hurricanes (Katrina destroyed New Orleans in 2005) and typhoons.

Coal use produces the largest amount of carbon dioxide compared with oil and natural gas. Coal accounts for 70% in China’s energy consumption structure. Thus China is becoming the world’s largest producer of greenhouse gases. The huge consumption of coal by industry, plus the widespread use of solid coal and biomass for heating and cooking in rural population, has generated tremendous environmental pollution and health problems. CO₂ emissions in China have risen rapidly (Dhakal, 2009; Rout et al., 2011), as shown in Table 3.

Climate change has been recognized as an international security threat, which is no longer relates only to quality of life and the environment, but also directly affects human and global security. Thus, energy consumption patterns and policies have also become international security issues due to their link to climate change. Resolving the
issue of climate change needs to international cooperation and an essential transformation of energy consumption patterns on a global scale (Li and Wang, 2012). No country can isolate itself from the danger of climate change. Consequently, there has been a shift in China’s energy policy from the pre-occupation with securing supply to greater efficiency and enable the transition to low-carbon economy. The target of a CO₂ emission cut was determined by Chinese state council in 27 Nov.2009, which said that CO₂ emission per unit GDP in 2020 will be 40-45% lower than that of 2005.

Table 3: CO₂ emissions amount in China.

<table>
<thead>
<tr>
<th></th>
<th>1980</th>
<th>2000</th>
<th>2005</th>
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<tbody>
<tr>
<td>CO₂ emission (MTC)</td>
<td>401</td>
<td>891</td>
<td>1424</td>
</tr>
<tr>
<td>CO₂ intensity of GDP (kg C/dollar)</td>
<td>2.192</td>
<td>0.744</td>
<td>0.756</td>
</tr>
<tr>
<td>CO₂ emission per capita (kg C/person)</td>
<td>405</td>
<td>703</td>
<td>1035</td>
</tr>
</tbody>
</table>

Source: He et al. (2010)

4.5 Crisis management system of energy security

From the beginning of twentieth Century 80 at the end of the 1960s, China’s energy management agency has been constantly adjusted. First of all, the first meeting in 1988 seventh session of the National People's Congress decided to withdraw from the Ministry of coal, petroleum, water conservancy and electric power department and the Ministry of nuclear industry, the establishment of the Department of energy. Then, the first meeting in 1993 eighth session of the National People's Congress decided to withdraw from the Department of energy, Ministry of coal, electric power department reorganization. Then, the first meeting in 1998 ninth session of the National People's Congress decided to cancel the coal ministry, the Ministry of electric power. Finally, in 2004 established the China Energy Bureau National Development and Reform Commission, established in 2005, the national energy leading group. At present, China lack effect of the energy security of government management system management systems has exposed the crisis of energy security, mainly reflected in the following two aspects.
4.5.1 Permissions and responsibility are not clear

At present, China lack of unified management of the Department of Energy security. Energy related management, research and development of China’s functions are scattered in the State Development and Reform Commission, the Ministry of land and resources, Ministry of water resources, the Ministry of construction, Ministry of agriculture, Ministry of science and technology, the National Defense Commission, the State Environmental Protection Administration and the State Electricity Regulatory Commission and other departments. In addition, state-owned energy companies, institutions related areas are also involved in energy policy formulates (Erica, 2004). In such a management system, a difficult to formulate unified coordination policies and measures, on the other hand, even if introduced macro energy policy, nor the specialized agencies to implement, but cannot. E.g., at present China petroleum administration power distributed in several ministries and more than 10 department bureau class units. Only the national development and Reform Commission has seven departmental units are the management of petroleum investment, transportation, price, petroleum refining, import and export, oil exploration and development (Bo Kong, 2005). Among them, the exploration and development of management right and dispersed in the two ministries of the three division level units, while the refined oil is scattered in three ministries, respectively in charge of oil products import & export, market circulation and reserve. In the region, petroleum industry is divided into the northwest and southeast, land and sea. Thus it can be seen, the defects in the system of China’s energy security is very obvious, organizational overlapping, lack of coordination (Bo Kong, 2005).

4.5.2 The energy market monopoly

The biggest obstacle to the reform and development of China energy industry is the industry monopoly and regional market segmentation condition. For example, although the establishment of the China State Grid Corp, Huaneng Group power sector "Seven Sisters", but the power industry market competition pattern has not formed completely. In another example, the monopoly behavior of oil field is very obvious, only the three National Oil Co has the right to import oil from abroad.
5. Countermeasures of China’s energy security

In order to achieve the goal which is make China’s economic growth rapidly and reach the level of moderately developed countries in the middle of the next century, China’s energy resources demand will increase greatly. How to ensure the China’s energy resource security is a strategic issue which is related to the success or failure of the modernization of China. Facing the increasingly serious energy security challenges from multiple directions, must have the forward-looking strategic thinking and then proposed the measures.

5.1 Countermeasures of contradiction between energy supply and demand

1. Saving energy and improving energy using efficiency. Compared with developed countries, China's energy using efficiency is low. GDP (Gross Domestic Product) produced by per unit energy use, is equivalent to only 1 / 4 of developed countries. On the other hand, China's energy –saving potential is huge. At present, the main energy usage equipment and technologies are outdated. High energy use products’ per unit energy use is about 40% more than the developed countries on average, and China’s energy usage per unit output value is 2.3 times of the world average level (Luo, 2011). The oil as an example, the global oil consumption growth is 0.7% in 2006. This is the lowest growth rate since 2001, but in the same year, Chinese oil consumption growth rate is 6.7%, the total consumption is 347 million tons. In contrast, the oil consumption of USA is 930 million ton, and the USA use this oil creates about 15 trillion dollars with high efficiency. The oil consumption of China is 347 million tons, but China use this oil only creates about 2.5 trillion dollars (Zhang, 2007). Therefore, China's oil use efficiency is low. So, China should be devoted to low energy consumption in the future.

2. To develop the alternatives of oil. Reduce the dependence on oil resources when develop the national economic, we should develop the high-tech industry which is
named "oil to coal, coal to make oil". It can not only achieve goal which are the coal cleaning use, the coal efficient utilization and the coal value-added utilization, but also can reduce the dependence on petroleum. Then, the energy structure will be optimized, and the oil proportion in energy structure will be reduced. From a long-term point of view, in solving the Chinese oil supply shortage, we should take oil substitution strategy actively. Use high-quality coal to instead of oil, accelerate the development of nuclear power to replace oil, efforts to develop natural gas market, increase the output of natural gas to replace oil.

5.2 Countermeasures of dependence too large for foreign oil

1. To establish strategic energy reserves. At present, the world energy consumption countries not only diverse energy production, supply base, but also set up a large number of reserves in order to balance energy supply and demand, to stabilize the energy market price, respond to emergencies. Strategic energy reserves can stabilize energy price when the energy price abnormal fluctuations, but this is not the ultimate goal of strategic reserve, it main objective is the uninterrupted supply to ensure national energy in war or natural disaster. This can guarantee the security of energy supply.

2. The energy should be based on the domestic (including land and sea) exploration, development and construction. The amount of China’s undersea oil resources is about 20 billion tons, and the amount of China’s undersea natural gas resources is about 10 trillion cubic meters. From the current perspective, offshore oil and gas industry are the fastest growing industries in China, the average annual growth rate as high as 32.3%. China currently has 25 offshore oil and gas fields which are in development, and the oil annual output is about 20 million tons.
5.3 Countermeasures of Malacca dilemma

1. Chinese government is necessary to reconstruct James Shoal (see figure 3), and make the exposed area expansion, then build the naval bases and air base in James Shoal. This would not only protect the passing ships, but also deter neighboring countries so that they dare not blockade the Strait of Malacca. James Shoal is very close to the Strait of Malacca, if the Strait of Malacca has some trouble, Chinese army can go there any time.

*Fig.3. The location of James Shoal*
2. Develop the China, Pakistan and Iran iron triangle relationship vigorously, and Give Pakistan, Iran preferential treatment and support. We should build China-Pakistan-Iran’s onshore oil pipeline as soon as possible. This will make China imports oil from Iron does not pass through the Strait of Malacca, and this channel is safe. In order to achieve this goal which is constructing the road traffic, we should give the help to Pakistan and Iran strengthens.

3. Implement the diversification of oil import. First, China government should reduce oil imports from the Middle East, and vigorously develop the petroleum source which belongs to American base. Then, the government should develop relations with Mexico, Venezuela, Brazil, Argentina and other South American oil producing countries and increase oil imports from these countries. Second, China government should also develop the relations with Russia and the Caspian Sea littoral countries, and increase the oil imports from their countries. Because Russia and the Caspian Sea area is the oil rich area, especially in the Caspian Sea region, its oil reserves can be comparable with the Persian Gulf. The government should develop energy diplomacy vigorously. The supply of oil import country should diversification, to avoid the oil imports dependence for a country or a region.
5.4 Countermeasures of The negative effect of greenhouse gases emissions

1. Adjusting the primary energy structure. It is very difficult to change China’s current energy structure of supply and demand, in which fossil energy still plays an irreplaceable role. China should shape its own energy security policy in terms of resource conditions, technical standards and demand potential, not going on the development path of high carbon industrialization as happened in Western Europe. In the future decades of China, coal will continue to dominate the energy mix, but hydro, nuclear, wind energy and natural gas have a huge development potential. The development of hydro, wind, biomass, solar, terrestrial heat, clean coal and nuclear power station in China has still a long way to go (Cao, 2013).

2. Protect the Chinese energy environmental strengthen. We should adhere to the sustainable development strategy in energy industry. In the development and utilization of the energy resources, we should formulate and implement of technical and economic policies which can conducive to the improvement of the environment. This can slow down or to solve the environmental problems caused by the development of energy.

5.5 Countermeasures of Management of Institutional Dilemma

1. Set up the laws and regulations of energy which should be speed up, such as “Energy Law”. At present, many Western countries set up the laws and regulations which are about the energy, and they can use these laws and regulations to manage their energy industry’s operation and energy company. However, China's energy legislation is inadequate. According to foreign experience, China should make laws and regulations which related to energy security and the development strategy as soon as possible. This can make Chinese government when in the process of energy management in the law, in a feasible method and in legal protection.
2. To establish the National Energy Leading Group. The National Energy Leading Group can control the power which belongs to the Chinese energy. This can implement and administrate the energy industry policy facilitate and strengthen. The energy regulates systems core is management. The National Energy Leading Group’s work includes: Supervise the decide which is made by the leading group implementation; Understand the energy security situation, and put forward the countermeasure and suggestion to the leadership group; Major policies on energy development and conservation, energy security and emergency, foreign energy cooperation and so on. However, the division of labor between the national energy leading group office and the NDRC Energy Bureau is not very clear.
6. Conclusion

In summary, the energy situation of China has experienced from the initial "provide for oneself" to "supply other countries", and now the energy situation of China is "broaden sources of income and reduce expenditure". Today, the China’s energy security facing two major challenges: The first ones is the structural crisis and the second one is management of Institutional Dilemma. Specific performance of these two major challenges is:

1. China’s energy structure is mainly about coal, and the contradictions between energy supply and demand have become increasingly prominent.
2. The government's permissions are unknown and responsibilities are unclear.

Energy resources consumption will gradually increase in the foreseeable future because of the economic development, but the total energy reserves are limited. Contradiction between energy supply and demand can’t be avoided. Energy security will always be under threat. On the other hand, science and technology in the unceasing development, human beings can solve the problem of energy security. For example, reserves of Petroleum are limited can help countries to accelerate the research on oil’s alternative energy; Can promote enterprise and consumers to save energy. In order to save energy, the enterprise and consumers will use high efficiency and low energy consumption technology and equipment; Reserves of Petroleum are limited also can reduce environmental pollution emissions.

At the same time, no countries can construct their own countries by using their own energy resources. Therefore, China should make better use of foreign resources and international market. Then, the energy should be based on the domestic (including land and sea) exploration, development and construction. These can alleviate or solve the problem of China’s energy resource shortage. Adjusting the primary energy structure and develop the new resources of energy. We do these can improve the natural environment. Through strengthen international cooperation in multilateral
and open up new lines of oil imports to protect China's oil supply and transport security. Reform and improve the energy management system to solve the energy management of Institutional Dilemma. Today, China meets huge challenge in energy security. Only doing these countermeasures, can alleviate even if solve the huge challenge in energy security.
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Appendix

Fig.1. China’s existing planned and speculative cross-border oil pipelines, 2010

Source: Guy C.K. Leung (2011)
Fig. 2. China’s crude oil imports by region in 1995 and 2005

Total imports of oil: 17.1 million tons in 1995 and 126.8 million in 2005.
Fig. 3. The location of James Shoal