CHINA'S ENERGY POLICY

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Submitted to

Central European University

Department of Economics

In partial requirements for the degree of Master of Arts

in Economic Policy in Global Markets

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Budapest, Hungary

2012

ABSTRACT

During the last two decades China experienced rapid economic growth and became the second largest economy in the world. The expanding economy and continuous development requires constant acceleration of energy contribution. The Chinese energy position in the world is a significant global issue which influences the distribution of global energy resources and their availability. The key issue of China's energy policy is how to provide the supply security which is required for further economic development. The clear and coherent national energy policy will help to solve the problem of energy supply. In this research I analyze the socio-economic development of China, its energy sector situation, future demand projections, identify key policy makers and analyze the recent energy policies. The last section contains policy recommendations for sustainable development of the country's energy sector, which include such policies as supplier diversification, energy mix reshuffling, energy efficiency improvement, market liberalization, and other.

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INTRODUCTION

The energy policy of People's Republic of China is gaining increasing attention lately. The importance of the energy sector for economic development, attention to the overall rapid economic growth of China, the increasing influence of the country in international markets and energy geopolitics, growing energy demand and other aspects are the major reasons behind the academic and energy policy formulation interests in this topic.

The expansion in energy exploitation has tremendously boosted the growth of the world economy and society progress. Currently developed countries have consumed significant amounts of energy resources since their industrialization. Nowadays some emerging countries are going through industrialization process and the energy use increase is unavoidable for their economic and social development.

During the last two decades China experienced rapid economic growth and last year became the second economy in the world. Even during the global financial crisis China had more than 8% economic growth in 2009 and more than 10% growth a year later. China is the largest emerging country in the world, and its economic growth and poverty elimination stay the key priorities for the government. The expanding economy and continuous development requires constant acceleration of energy contribution. The great amount of energy requires satisfying the country's increasing consumer demand along with the world's demand for Chinese goods.

The Chinese energy position in the world is a significant global issue which influences the distribution of global energy resources and their availability. Being the world's second-largest energy producer and consumer, China rapidly expanded the energy utilization what raised concerns in the global energy market. As an irreplaceable component of the global energy

market, the country influences the global energy security along with driving energy prices due to its constant economic growth.

So, the main puzzle of China's energy situation nowadays is energy supply security. How China can achieve and retain the energy supply security with constantly growing energy demand? How can China maintain sustainable development of the energy sector to secure undisruptive energy supply for further economic development? These questions form the following research. In this thesis I examine China's energy policy as one of the engines of rapid economic development, identify problematic aspects of this policy and offer recommendations for the energy sector development which benefits the growth of the economy – the main strategic goal of China's overall economic policy.

The basic methodology used in this work is a mixed method combining the qualitative estimation of the energy industry and policy, along with the particular case studies supported by the quantitative data. This mixed methodology provides more depth analysis of current energy policy in China, trying to predict future perspectives based on current trends, what allows choosing the most reasonable energy policy options to maintain sustainable development of the economy. Touching upon the current energy supply and demand trends based on at most credible empirical and qualitative data, secondary sources, legal documents, related energy policy literature provides systematic analysis and helps to find the most relevant solutions.

The works of such authors as Andrews-Speed (2004, 2008, 2011), Downs (2010), Burke (2009), Miller (2010), Weigang (2006), Bahgat (2007), Guo (2010), Liu (2009), Meidan (2008), Rosen (2007), Zhou (2010), Li (2010), Neves (2010), Velasquez (2010), and reports of the government and international organizations like International Energy Agency, World Bank, and other were used in this research.

Given the nature of the Chinese political system and approach to the information disclosure, especially in such strategic area as energy industry, the relevant data collection is challenging. To correctly estimate the current situation in the energy sector, expected future development, to provide an assessment of previously implemented energy policies, and moreover, recommend possible strategies for sustainable development of the sector, the reliable data is essential. Chinese official statistics has a very controversial reputation and needs to be verified for the policy formulation process. The most of the data used in the thesis had international verification and re-estimation being published by international organizations, research institutes or by distinguished scholars in the energy field. Even though the issue of energy policy making in China is gaining the academic interest, there is still lack of substantial researches providing clear policy orientation and reasonable suggestions.

The contribution of this research lies mainly in China's energy policy analysis and suggestions of possible strategies addressing identified policy makers in the country. China is expected to pursue further sustainable economic development if most of the goals of these policies are achieved.

This research is divided into seven sections.

The second section studies economic and social development of China. It also examines the energy sector situation, briefly analyzing oil, gas, coal, renewable, and electricity industries. Future China's energy demand projections, identifying the tremendous energy demand increase in the following decades, finalize the second chapter.

The third section examines the major stakeholders and policy makers responsible for energy strategy in China. It is identified that the policy making framework in the country's energy sector is fragmented, bureaucratic, and, consequently, provides limited efficiency. It was

concluded that to achieve effective energy supply and maintain economic development the energy policy formulation and implementation process should be reformed.

The fourth section is the factual background data on socio-economic development of the country and energy sector situation.

The fifth section analyses past and current energy policy in China, identifies the successful results and existing gaps in energy sector improvement. The major areas which should be improved include low energy efficiency of the economy, risks of supply disruption, inefficient policy formulation and implementation mechanism, underdeveloped infrastructure, lack of technologies, pollution of the environment, and other aspects.

The sixth section contains energy sector policy propositions for sustainable development of the sector itself and the entire economy of China. The recommendations are mostly concentrated on diversifications of supply sources, energy mix reshuffling, the reorganization of the current policy making institution, the establishment of clear and accumulated national energy policy, energy efficiency improvement, energy market liberalization, and other. These policies' implementation is predicted to increase the energy efficiency and provide a stable energy supply which will be able to meet the growing demand in the developing economy.

The last section, containing the most important findings and propositions, concludes the research.

SECTION 1. OVERVIEW OF CHINESE ECONOMIC GROWTH AND ENERGY SECTOR DEVELOPMENT

Energy resources a play crucial role in economic activity of any country since it is an important factor of production of any product consumed. As the population of the planet and global economic activity continue to grow, the demand for energy resources and their prices increase as well. As a result, humankind faced the new type of race – race for energy resources, and China is a significant player in this race.

Chinese economic development requires considerably increasing amounts of energy. Moreover, to project changes in the energy sector, economic conditions and state of social development should be also examined. To better understand the process of energy policy making for further energy policy analysis the conditions and major features of the energy sector of China should be examined. Since the energy supply security is the central problem for sustainable economic development of China, the future demand predictions should be also considered. Brief socio-economic analysis followed by the energy sector assessment and further energy demand projections are presented in this section.

1.1 Current economic and social development

Before the late 1970s People's Republic of China was the centrally planned, closed economy then transformed to a significantly more market oriented economy after Deng Xiaoping liberal reforms. These reforms were gradually implemented starting from phasing out of agricultural collectivization, and continued with slow price liberalization, decentralization of fiscal policy, increased independence for the companies (even the state), the diversified banking system establishment, the stock markets creation, private sector development, and the overall

opening of the country to the international trade and foreign investment (Velasquez & Pichler, 2010).

Today China shows significant progress both in economic and social development. The economic and social growth promotes higher demand for energy. In order to provide sustainable development and continue economic growth China needs to establish the sophisticated and clear energy policy securing at least current pace of the country's growth.

1.1.1 Economic development

The economic reforms resulted in efficiency gains and let the economy to increase ten times higher than in 1978. The Chinese economy became the second largest in 2011 with the accumulated GDP of 11.29 US$ trillions (CIA, 2011). According to the US Central Intelligence Agency (2011), "…the dollar values of China's agricultural and industrial output each exceed those of the US; China is second to the US in the value of services it produces". The average GDP growth accounts for 8% for the last two decades (Figure 1, Section 4). Figure 1 shows that there was a significant increase in 1991. The drop in GDP growth due to the Asian crisis of 1997 was more significant than during the recent economic crisis of 2008 where China had near 9% growth. The average annual GDP growth rate is 8% for last 20 years. Many experts believe that such fast pace of economic development can lead to overheating of the economy. This year Chinese government decided to stick to the lower growth target of 7.5% in order to maintain sustainable development of the economy. The Chinese share in the global economy in 1978 was 1.8%, and in 2008 the share increased to 6.4% (The World Bank, 2012).

Even thought the aggregate GDP is one of the highest in the world, the per capita income shows not impressive results - $8,400 in 2011 what puts China to the upper middle income country group. The Gross National Income per capita is so low since, first of all, the population

of China is huge and even the second largest economy's income cannot overshoot the tremendous number of population, moreover, the average income level of Chinese citizens is moderate indeed. However, in Figure 2 we see the significant and undisruptive growth of this indicator over time what also signifies the rapid economic development.

There are significant gaps in regional economic development (Figure 3). The eastern coastal provinces are much more economically advanced than the interior provinces, while the least developed areas of north and west have the largest amounts of energy resources. Nearly 80% of internationally financed companies are concentrated in the maritime region (China's Statistics Database, 2012). This area is the most comfortable zone for foreign investment with the preferred treatment, open economic regions, and technical and economic development zones. The Chinese government visibly broadened independence in external economic activity, which has led to the forming of the enclaves of high growth and development and attract even more investment and trade to the region. The disparity between well developed eastern areas and resourcefulness of western implies that the energy resources transportation costs are significant for the country given its size and geographical conditions.

The Chinese economy has developed in a tremendous pace mostly because of the export orientation and foreign direct investment flow. From 2007 China is on the 2nd place in exports after EU and the 3rd place in imports after the USA and EU (CIA, 2011). From 1990 to 2000 annual export increase was near 15%, and from 2000 to 2008 annual increase was 24%. In 1950 the international trade volume was 1.13 billion dollars and by 2008 it grew to 2.56 trillion dollars (59% of GDP), it increased 2267 times (The World Bank, 2012). In 2009 country made in one day the GDP of the entire year of 1952 (365 times increase) (Velasquez & Pichler, 2010).From the Figure 4 we see that China is a net exporter since 1993. China has the current account surplus

during the crisis times of 1997 and 2008, even though there is a logical drop in trade and, consequently, both imports and exports during the crisis. The fact that China became a net oil importer from 1993 might signify that by the increase in production to facilitate exports China needed additional energy supplies, particularly oil.

China was ranked 48th economy in The Enabling Trade Index 2010 (when Hong Kong is on the 2nd place and Taiwan 28th). China has the 79th place in the Market access category (81 in domestic market access, and 83 in foreign market access), 48th in Border administration (40 in efficiency of customs administration, 33 in efficiency of trade procedures, and 56 in transparency of border administration), 43rd place in Transport, and 41st place in Business environment. (Lawrence, Hanouz, & Doherty, 2010) Such ranking shows that the solid trade position of China, however, there is a room for improvement in bureaucratic procedures and infrastructure. The additional energy supply in the short term can be imported. Improvements in trade will benefit and ease the energy sector development by energy supply stabilization through liberalized trade.

China has a very specific market economy with socialist features; mostly political issues influence economic openness and trade freedom. According to Figure 5, there is a decline in Openness index (the ratio of trade volume to GDP) from 2006, but almost with the same pace the Trade freedom index (the measure of the absence of tariff and non-tariff barriers) increases gradually along with the world. Trade freedom has increased significantly and almost the same level as the world's average, while the openness of the economy has decreased to lower than the world's level during the global crisis of 2008. China has a diversified pattern of partners, which has changed over time (Figure 6). The biggest partners are the US, Japan, Hong Kong, South Korea, Taiwan and Germany. This multitude of trade partners is particularly significant for the

energy sector, which expanding with the economy and requires increasing supply. Partnering with diverse energy resource rich countries China can decrease its energy supply vulnerability.

The government experiences several significant challenges in the pursuit of economic growth and welfare, which include: a high domestic savings rate which lowers domestic demand; the need for the job growth for the increasing number of new labor force entrants; still the high rate of corruption; availability of energy capacity for rapid development; social tensions and environment issues connected with the fast growth.

Recently China has experienced the increasing inflation which was mostly caused by the credit-fueled stimulus program as a crisis response. Some inflation reduction measures stabilized it a bit, however, GDP growth decreased to 9% for 2011 as a response to that. From Figure 7 we see how inflation fluctuates for two decades, severely decreasing in crisis times converting to dangerous for the economy and hard to tackle deflation and increasing during economic growth and recovery after recession. The inflation is a significant dimension in economic development structure and is highly influenced by energy price fluctuations.

The sovereign debt crisis which is unfolding in Europe is predicted by IMF experts to drag Chinese growth in 2012 and even later (Hussani, 2012). Debt accumulated by mostly the stimulus program, particularly by local authorities, and a property price bubble, worsens the economic situation in the country. However, the overall external debt in comparison with many developed countries, including the US, Japan, and others is much lower and is acceptable by international standards for sustainable economic growth for developing countries (lower than 30% of GDP). The external debt to Gross National Income is actually decreasing over time since the overall income is growing tremendously, as we can see from Figure 8.

The unemployment rate (Figure 9) is increasing over time what is connected with the population increase and significant migration to the cities. However, the value of unemployment is not that significant as in many even developed countries which got hit by the global crisis. It is worth mentioning that China reports only city's unemployment rates, the data for rural unemployment is unavailable.

1.1.2 Social development

The Human Development Index provided by the United Nations is an alternative measure for income showing the country's development in different aspects (Figure 9). It is a broader definition of wellbeing and is a compound measure of three parts of human development: health, education, and income. China's HDI is 0.687 with a rank of 101 out of 187 countries, however, China is placed above the region average what shows that not everything is perfect but still human development is in progress and shows the results (Human Development Reports, 2011). From the graph we see that recently China matched the World's average in HDI value leaving behind the region and countries with medium development of HDI which China belongs to.

According to the World Bank (2012), the literacy rate in China has significantly increased from 78% of the total population from 15 years in 1990 to 94% of the adult population in 2010. The poverty ratio based on purchasing power parity at the level of $2 a day in 1999 was 62% and now it decreased to 30%, what basically means that in 12 years the percentage of the population leaving on $2 a day has decreased almost twofold what is a very significant improvement in social development. Even though people started to live significantly better, the income disparities are evident. Index Gini is one of the best dimensions depicting social inequality – in 1990 index Gini was 32.43 and it gradually was increasing over time to 42.48 in 2010. Since the Gini index of 0 means perfect equality, while an index of 100 shows perfect

inequality, the inequality of China can be perceived as significant, moreover, it is growing. (The World Bank, 2012)

Figure 11 indicates the consistent growth of urbanization. Urban population is constantly increasing and already has reached 45% of the population (Human Development Reports, 2011). Rural areas are not attractive any more for developing society of China since they gain more income and education. Cities consume much more energy than rural areas and such rapid urbanization heavily burdens energy security.

The internet and mobile phone users' data can also identify the income and social development status. The availability and affordability of these services has increased dramatically, especially in the last decade, also the ability to use these services by the population and their interest in technologies provides positive information about their social status and overall level of social development. The extensively growing use of high tech appliances contributes to the energy consumption pattern.

The more society develops the more energy requires to satisfy its needs. The improving social factors indicate that if such trend is retained the increasing amount of energy will be needed to satisfy the growing needs of society along with their growing income. From this analysis we see that the country has experienced and is experiencing the rapid economic growth, increasing welfare and stabilization of social aspect. With such pace of development China needs significant sources for energy to maintain sustainable development.

1.2 Energy sector analysis

China has the largest population in the world along with the rapidly developing economy, what results in higher overall energy demand in the country. The average annual growth rate of consumption is more than 5% what is higher than the OECD and world average (Guo, Zhang, &

Lo, 2010). According to Figure 13 the total consumption of energy growth slightly slowed down close to the period of Asian crisis times then started to grow again, significantly speeding up from 2002. There was no disruption of energy consumption growth during the recent global recession. Moreover, the country's overall energy consumption in the world's total energy consumption also increases every year. In 2011 China has become the largest global energy consumer in the world and the second largest oil consumer after the US, according to the International Energy Agency (IEA, Key World Energy Statistics, 2011).

Since the 1970s' dramatic economic changes, energy consumption has increased significantly. In 1970s the country's energy intensity (opposite to efficiency) was twice more than in the US and near three times more that of Japan (Crompton, 2004). By 2000s the country's energy intensity had declined mostly due to structural and technical advances along with final consumption energy efficiency improvements. From Figure 14 the energy efficiency, measured in GDP per unit of energy use, is increasing last 20 years. However, Figure 15 shows that even though the efficiency of China's energy consumption increased, it still below developed countries and even below its BRICS developing block counterpart Brazil (Figure 15). The energy consumption in China in per capita terms is insignificant and was near 0.5 ton of oil equivalent (toe) in 2001 while it was 5.4 in the USA, 2.7 in Japan and 3 in Germany (Energy Statistics, 2010, Crompton, 2004). There is a considerable disparity between rural and urban consumption in diverse regions of China. However, since the income distribution in China is constantly changing the consumption pattern of both rural and urban areas can experience changes in near future – rural will get closer to urban areas' consumption pattern what will affect the accumulated energy demand in China.

The demand for energy is heavily influenced by automobiles, air conditioning and other energy intensive appliances and products. Car ownership in China is 100 million currently owned vehicles with 30% and 50% increase in 2009 and 2010 and by 2020 is expected to double (Chang, 2011). Since the WTO accession, Chinese energy consumption was growing fast and in 5 years from 2001 to 2006 increased by almost 72%, what means that it was growing faster than the economy with 12% and 10% correspondingly (Crompton, 2004). Before the WTO entrance in 2001 this trend was reversed – the economy was growing much faster than consumption (9% and 5% correspondingly).

According to Figure 16, China's energy mix heavily relies on coal with 71%, then oil with only 19%, natural gas is only 3% even though it is one of the cleanest and easiest to use energy sources (International Energy Outlook: China , 2011). Such composition is generally considered to be unbalanced, especially comparing with such nations as Germany and the US where energy resources are much more evenly distributed in the country's energy mix. This heavy reliance on coal is connected with a large domestic market share of coal in the country, even though it has decreased in years (Crompton, 2004). The renewable, natural gas, nuclear shares are minor. Such intense reliance on coal imposes high costs on the environment. There is a need for this pattern to be changed for better energy sector efficiency and reducing risks of energy supply disruptions, moreover environmental concerns pressure government to the more extensive use of cleaner energy.

1.2.1 Oil industry

China is the second-largest oil consumer and net importer of oil with currently proven oil reserves of 20.4 billion barrels (International Energy Outlook: China , 2011). Country's oldest and largest oil fields are in the north-east region. From the Figure 17 it is evident that most of the

oil production capacity is situated onshore inside the country, mostly in already mature fields. The northwest region is one of the biggest contributors to oil production and Xinjiang Province was announced to become the largest oil and gas production field. The production has peaked in most of onshore oil fields, meaning the productivity of these fields is decreasing and there is a need for new exploration and sources diversification. Oil companies turning to largely unexploited reserves in the west and several offshore fields, attracting foreign cooperation. Country's total oil production became 4.3 million bbl/d in 2010, increasing 0.28 million bbl/d from previous year, what was mostly achieved because of new offshore production development (Sheehan & Sun, 2007).

Near 15% of total oil production in the country is from offshore reserves, and it is predicted that most of the production increase in oil will come from them. Since China is experiencing the growing dependence on imports of oil and there is a serious need for diversification of energy sources. National oil companies in China strive to find additional sources in foreign countries. Currently, the PRC is trying to take advantage of global economic downturn thanks to the global crisis and utilize the lower values of assets to increase its global acquisitions. Chinese oil companies have bought assets in Canada, Middle East and Latin America from 2009 up to $28 billion to enforce acquisitions of oil and gas companies (International Energy Outlook: China , 2011). They also have bilateral oil-for-loan agreements with Russia, Brazil, Kazakhstan, Bolivia, Ecuador, Venezuela, Ghana and Angola. Africa and the Middle East are the major sources of crude oil imports with near 47% coming from the Middle East and near 30% from Africa, and only 4% from Asia-Pacific region (2011; Energy Statistics, 2010). Particularly, Saudi Arabia and Angola are the major oil partners accounting together for nearly one third of China's imports (Figure 19). Territorial disputes are one of the

biggest obstacles to explore major sea offshores near China, mostly with Japan, the Philippines, Malaysia, Taiwan, and Vietnam.

Along with global oil market integration, China tried to integrate country's domestic oil pipelines as long as to create international pipeline connections with national network to diversify oil imports. Today most of the pipelines interconnections serve the most industrialized parts of the country. But there is a need to interconnect diverse regions and several links to lower developed areas are under construction and some of them have already been built. Today China is connected by the pipe oil network with Central Asia, Russia and Myanmar.

Chinese NOCs (National Oil Companies) have an important influence on the country's oil sector. By 1998 government has reorganized the majority of state owned oil and gas assets into two companies: CNPC (China National Petroleum Corporation) and Sinopec (China Petroleum and Chemical Corporation), which dominated upstream and downstream oil markets (International Energy Outlook: China , 2011). CNPC and PetroChina, account for near 60% and 80% of country's overall oil and gas production (International Energy Outlook: China , 2011) . Sinopec is traditionally focusing on downstream activities, which include refining and distribution where it holds also near 80% of the entire sector. There are some other state owned companies which have emerged recently. CNOOC (China National Offshore Oil Corporation) which is specializing in offshore exploration and production. CNOOC is an emerging competitor for CNPC and Sinopec. The other two relatively new companies are Sinochem Corporation and CITIC Group have become competitive and somewhat influential in the Chinese oil market, even though they are still relatively small comparing the leading sector giants. Onshore oil production in the country is mostly granted to CNPC and CNOOC, however, international oil companies are gaining little by little access. Conoco Phillips, Shell, Chevron, BP, Husky, Anadarko, and Eni are

those companies which have a limited but still access to oil market by mostly providing technologies and industry expertise. (International Energy Outlook: China , 2011; BP Energy Outlook 2030, 2012; The Outlook for Energy: A View to 2040, 2012)

1.2.2 Gas industry

Gas has only near 3% in China's energy mix, however, the consumption of this energy source is increasing (Figure 20). China is producing its own gas with 2.93 Tcf (trillion cubic feet) and had total proven reserves of 107 Tcf in 2011 (China's Statistics Database, 2012). In 2007 China became a net importer of natural gas.

The major natural gas rich regions in China are Sichuan; the Xinjiang Uygur Autonomous Region and Qinghai; and Shanxi produce almost 65% of overall gas output (International Energy Outlook: China , 2011). The offshore gas fields are located in the South China Sea.

The gas sector structure is similar to oil and is dominated by three state owned companies: CNPC, Sinopec, and CNOOC. CNPC accounts for more than 80% of upstream and downstream natural gas production, while CNOOC specializes in LNG.

By 2009 China already had 21,000 miles of gas pipelines carrying near 3.5 Tcf (International Energy Outlook: China , 2011). The pipeline system in the country is very fragmented and government is working on its integration. The first foreign pipeline for China, which started the operation in 2009, was the Central Asian which connects Turkmenistan, Uzbekistan, and Kazakhstan. There are also several other foreign pipeline options for China: The Eastern pipeline from Russian Sakhalin to the northeast of China and Myanmar's pipeline to Kunming which will start the operation in 2013.

The largest amount of gas imports comes in the form of LNG (liquefied gas), mostly from Indonesia, Malaysia, and Australia. LNG imports to the country are expected to increase if more terminal capacity is established and prices are lower than natural gas prices. Many experts consider that the future of China's energy sector will heavily rely on unconventional gas resources, such as CBM (coal bed methane), tight and shale gas. The Chinese government attracts foreign investors to explore and produce such sources.

1.2.3 Coal industry

PRC is both the largest producer and consumer of coal globally; its consumption is almost half of total global consumption. According to Figure 21, both production and consumption of coal have increased over time and in 2009 China started to produce less than it consumes. From being a net coal exporter because of tremendously developing economy and correspondingly increasing demand, China became net importer, trading with Indonesia, Australia, Vietnam, and Russia (Sheehan & Sun, 2007). China has the third largest coal reserves in the world after the US and Russia. The coal is produced in 27 provinces and more than half of coal production is used for generation of power.

The entire industry has been scrappy combining large coal mines owned by the state, local coal mines, and thousands of smaller mines with inadequate investment, out-of-date equipment, and low safety standards prevent the complete deployment of coal. Small mines also are inefficient in terms of reacting to the market demands. The top three companies produce only 15% of total coal production in the country (International Energy Outlook: China , 2011). Moreover, the transportation of coal is a big obstacle – the major transportation source is the railways which are used to full capacity and highly inefficient in terms of speed, availability of extra capacity and infrastructure in remote areas. In order to increase sector efficiency, the

country is gradually opening to foreign investment for sector modernization and technological innovations.

1.2.4 Non-fossil fuels industry

Currently the largest hydroelectric dam in the world – Three Gorges Dam, is under construction from 2003 and it will start full operation in 2012. Country has a serious target to have at least 15% of total energy consumption relying on renewable by 2020 (Meidan, Andrews-Speed, & Xin, 2008). China is the top global investor in renewable energy, investing near $160 billion by 2010. According to EIA (2011), it is the leading producer of hydroelectric power from 2009. The government wants to increase its capacity even more. Wind energy is the second largest renewable sources for the country, and China is at the fifth place in the world producing wind energy (CIA, 2011). The capacity of this sector is doubling every year since 2005 and government plans to double it in ten following years.

One of the alternative sources for energy mix is nuclear energy and China is serious about increasing its nuclear production and changing energy mix for nuclear benefit. Nuclear energy is considered to be very clean and highly efficient source of energy. Today, the country's nuclear capacity is insignificant, accounts only for 11 GW or just 1% of total energy mix. Country's government decided to tremendously increase nuclear capacity by 2020 at least to 70 GW (International Energy Outlook: China , 2011). The Fukushima Daiichi incident in 2011 in Japan did not stop government to expand the nuclear sector, however, they have made strict regulations for currently operating nuclear plants and newly constructing – all plants had and will have strict safety reviews before granting operation permission. Figure 22 shows that even though the alternative energy has an insignificant share in the country's energy mix, it is growing and has reached 3.6% in total energy consumption.

1.2.5 Electricity

The electricity sector is dominated by fossil fuels (near 80%), especially coal (The World Bank, 2012). However, there is an evident tendency to expand gas capacity in electricity generation. The electricity power generation should be increased to meet the growing country's demand, especially from the South and Eastern parts of the country. However, the current economic crisis slightly lowered the electricity demand. The considerable amount of investment, especially the investment into the transmission grid flow which exceeded the production investment in 2008, was the response to the growing electricity demand.

The Chinese government made a significant change in the industrial organization in 2002 – they separated the SPC (State Power Corporation) into separate electricity generation, transmission, and service parts (International Energy Outlook: China , 2011). Since then the sector is dominated by five major companies which generate a half of Chinese electricity. All the rest is produced by independent producers. Such deregulation also opened the industry for foreign investment which increases its efficiency.

1.3 Future projections

According to International Energy Agency's World Energy Outlook (2011), the major dynamics in energy markets are increasingly determined by non-OECD developing countries, including China. Developing countries have near 90% of population growth, 70% of the economic output growth, and near 90% of energy demand increase from 2010 up to 2035. (IEA, World Energy Outlook, 2011; BP Energy Outlook 2030, 2012)

IEA predicts that China will strengthen its position as the energy consumer and become the world's largest energy consumer in 2035. In 2000 China exploited half of the energy used in the United States, today it is almost as much, and by 2035 it is predicted to consume

approximately 70% more than the US. According to their predictions, China accounts for more than 30% of global growth in energy demand from 2009 to 2035, and its share in energy demand will increase from 19% to 23% in 2035. (2011)

According to IEA (2011), BP (2011) and Exxon Mobil (2011) researches and scenarios, oil production is predicted to rise to over 4.5 million bbl/d in 2012 (2011). EIA predicts that China's oil consumption will maintain grows during 2011 and 2012, and would represent almost 40% of projected world oil demand increase during the two year period (IEA, World Energy Outlook, 2011). The gas demand is forecasted to at least triple by 2035, increasing by 5% on average per year (2011). To meet increasing demands China needs to import more gas from diversified sources by pipelines and also LNG (liquefied gas). The increase of gas share in the energy mix will reduce pollution significantly. The share of coal in the energy mix is predicted to decrease to near 62 % by 2035 (IEA, World Energy Outlook, 2011). Mostly such drop will correspond to efficiency increase and the country's aim to decrease carbon emissions. Even though there will be a change in the energy mix, absolute coal consumption is expected to double by 2030, resulting in the significant growth in overall energy consumption (BP Energy Outlook 2030, 2012).

Figure 23 shows future Chinese energy demand based on IEA predictions in comparison with the rest of the world. As we can see from this graph, the Chinese demand is going to be tremendously higher by 2035 and the largest for a single country, almost the size of the European Union, the United States and India all together.

As the Chinese economy is developing it will be more dependent on oil imports because of the raise in energy consumption combined with the largest population in the world. The energy imports will influence on the energy mix reshuffling towards other energy sources, like

oil, gas, renewables, and nuclear power (Figure 24). The oil increase in the energy mix is also accounted to the growing of the transportation sector in China.

China will account for nearly half of the world's increase in nuclear energy use by 2035 according to New Policy Scenario of IEA (2011). The share of renewable energy, including wind, geothermal, marine, modern biomass, hydro, solar, etc is projected to increase from 7% to 14% by 2035 (IEA, World Energy Outlook, 2011). The natural gas demand primarily depends on the prices, however with the unconventional gas exploration boost and LNG development, the share of gas in the energy mix is also going to increase.

The high energy intensity or low energy efficiency is one of the major problems affecting energy supply in China. Figure 25 shows that the energy intensity of China will increase, however, it still will be much lower than in other countries. This problem should be addressed by the government to better meet the growing energy demand.

Rapid economic growth and social development lays a significant burden on the energy consumption growth and demand for energy diversification to secure the supply from possible disruptions. For such tremendously developing country the energy security is a very significant problem. China's growing economy and energy consumption needs made it a very influential player in the global energy market. The increasing Chinese energy demand will influence global energy commodities prices.

China is the largest energy consumer in the world and will continue to be so. Even though oil is not the primary energy source utilized, China is the second largest consumer of oil. The coal is going to stay the major energy source for Chinese economy for the nearest future, even though the government tries to facilitate the unconventional and renewable energy sources development by investing itself and encouraging even foreign investment in these fields. In order

to provide sustainable development and continue economic growth China needs to establish sophisticated and clear energy policy securing at least current pace of the country's growth.

The effective energy policy has to be consistent with social, economic and political objectives and make sure that the relevant actors respond to such measures, also ensuring the targeted policy makers with an adequate supply of tools and authority to address these objectives. The offered policy instruments have to be consistent with energy sector political and economic development position. The next section will identify key policy makers and stakeholders of China's energy policy process.

SECTION 2. POLICY MAKERS AND STAKEHOLDERS IN THE PROCESS OF ENERGY POLICY MAKING IN CHINA

In order to make energy policy recommendations connected with current and future trends of China's energy sector, first it is necessary to identify the major policy actors and distribution of authority and responsibilities in this field. The main energy policy actors' identification, an overview of the legal system and current energy legislation will allow a better understanding of the trends in energy sector, institutional limits and constraints to changes in energy strategy and its implementation.

2.1 Key energy policy makers

Policy making in China is dispersed with a massive amount of actors having usually conflicting interests, especially involving strategic interests of energy sector. Different levels of authority are involved in the process of energy policy making. The hierarchy of administrative units is frequently ambiguous and the relationship of administrative structures and state companies are rather loosely regulated. (Burke, 2009) Moreover, the fact that such industry as energy is one of the national security concerns further complicates the policy making.

The energy industry in China is different from the Western style energy industry. In Western countries' government regulates, but does not have operational control over energy assets, whereas China following the socialist principles, the government still owns and controls major energy companies, even though these companies had massive semiprivatizations through public offerings, the overall government grip was loosen up and companies can behave freer on the market. (Miller, 2006) The public offerings have helped government to cooperate with Western companies and gain some industry expertise and technology sharing from the global

giants in the energy industry like BP, Exxon Mobil, Shell, and other at the same time earning on selling minorities (Bahgat, 2007). Chinese government does not support the full free market economic stance in such strategic sector as energy and is pursuing the micromanagement of the major energy companies as an extension of the entire economic policy and energy strategy.

It is logical to have separate authority to coordinate energy policy in China taking into account all the challenges of this industry and special features of the country itself, its economic and political issues. Until 2008 there was no such separate authority to coordinate energy policy what has impeded the energy governance with the fragmented energy bureaucracy. (Downs, 2008) According to Miller (2006), China's energy regulation system (before the creation of the special agency "has fibrillated between fragmentation and centralization with no one held responsible for system's continuous failures". Without the single special agency coordinating the interests of diverse stakeholders different energy institutions fought for influence and projects, moreover, the failure of energy laws to specify the responsible for the content of laws agencies disturbed their proper implementation. One of the examples can be the fuel tax implementation issue which was approved in 1999 by the National People's Congress (NPC). However, the ministers of State Administration of Taxation, Finance and Transportation could not agree on who will be responsible for the 27,000 people who would lose their jobs after the implementation of this fuel tax. (Downs, 2008) The National Energy Agency (NEA) is supposed to take the lead in the energy governance. (Burke, 2009) It is a sort of a ministry which is ruled by officials with the ministerial status, and the power of decisions is relative to ministerial level. Nevertheless, the NEA is considered by many experts as not "strong enough to mitigate bureaucratic infighting and coordinate the interests of ministries, commissions and state-owned energy companies".

(Burke, 2009) (Downs, 2008) (Almeida, 2010) So, the creation of NEA has not changed the situation significantly and the fragmentation of the industry's authority is still an issue.

On the other hand, the state owned companies are very powerful and "relatively autonomous" players. (Downs, 2008) Their influence comes from top executives who are former or current ministers and top figures of the Communist Party, international subsidiaries, industry proficiency, and overall profitability. The situation when these companies initiate important energy projects and policy targets happens frequently. For example, the West-East Gas Pipeline passing through 66 cities in 10 provinces from West to Shanghai owned by PetroChina and the foreign energy assets acquisition were initiated recently by state-owned energy companies. These energy companies even sometimes promote corporate interests over national ones. Many Chinese energy companies cut their output on purpose to make the government increase prices of electricity and refined products which are set by the state and have not kept up with the market prices of oil and coal. Moreover, it is becoming more common when Chinese energy companies neglect central government guidance about the possible foreign investment targets, like CNPC invested in Sudan even when after in 2007 NDRC excluded Sudan from investment preferential country's list (Downs, 2008). As the result, these politically influential and relatively independent state-owned energy companies play a significant role in the energy policy making in China.

There are a number of challenges in the energy policy making process in China. The main actors involved in energy policy making are following:

1. The highest political authority in the country is the Communist Party of China (CPC) which has the main policy developing role.

2. The top executive body of the state is the State Council, which is responsible for the policy implementation of the CPC policies.
3. The primary ministry responsible for energy policy is the National Development and Reform Commission (NDRC). The NEA, which was mentioned before, was separated from NDRC in 2008 to be an agency in charge of energy issues in the country.
4. A senior strategic organ which is in charge of everyday activities was also established – the National Energy Commission (NEC).
5. There is also an agency which is responsible for investment issues of all country's state owned companies, however, it does not have a substantial influence. There are also many other government bodies having a secondary role in the energy policy making process in China. (Burke, 2009)
6. Giant national oil companies like CNPC, Sinopec and CNOOC have also a significant influence on the policy making in the energy sector since they are former ministries and their executives are top members of the party.
7. Several research institutes like Development Research Center, the Energy Research Institute and other academic institutes conducting research in the energy field. (Burke, 2009)
8. Such financial institutions as China Export-Import (EXIM) Bank and China Development Bank (CDB) play also an important role in energy strategy formulation and implementation.

The biggest challenge of energy policy formulation in China is the fragmentation which brings multiple actors to determine the course of the future energy policy. China still lacks the

strong agency which will combine all possible levels of policy formulation and has a single authority to coordinate diverse stakeholders. China has tried to overcome this challenge recently; nevertheless, the current situation in this field cannot be considered as successful. (Almeida, 2010)

2.2 Political factors influencing the development

Taking into consideration the socialist features of Chinese political structure, the influence of political factors on economic development is evident. According to Li, Cheng and Wu, one of the major goals of current economic reforms in China has been to "depoliticize" the economy. (Weigang Li, 2010) Certainly this does not imply that the economy should be isolated from politics, but politics should serve the economic development. It seems that Chinese politicians understand that since the country has chosen the path of the market economy and the accompanying transformation, while politically staying a one party dictatorship. The unique Chinese system is constantly criticized, especially in the West, mostly for human rights violation and lack of effort to improve the situation with human rights; however, Chinese government claims that this violation resulted in significant economic growth. (Downs, 2008)Indeed the special governance format in China is considered to be the main development factor of China's economic growth in the past decades. Many advocates of the Chinese system of development claim that it is more efficient than democratic systems and give diverse examples (Weigang Li, 2010). One of the most frequent examples is the Pudong International Airport case in Shanghai which was built in two years while Narita Airport in Japan took approximately 16 years. Such examples are certainly controversial, but show the speed of development in China.

2.3 Legal system

Country's legal system has its special features associated with its economic and political development. The legal framework status is hard to define. The country's legal framework is attached to the party's leadership and the government since the CPC is the only ruling party, what differs from the most systems in Western countries, for example. Taking into consideration the political structure of China it is apparent that sometimes cases may be distorted in favor of certain groups (Weigang Li, 2010). China's legal system is a mixture of civil law and common law; moreover, it is mixed with the country's legal traditions. Historically legal framework in China was influenced in different periods by the Soviet Union framework, then after the abandoning of the Soviet system they came back to civil law, the influence of US laws was growing after the WTO accession, while usually economic and financial markets laws are adjusted to special features of the country's political and economic system. As a result, the modern legal system in China is a combination of traditional Chinese principles, civil law features, and also an influence of US laws (Weigang Li, 2010).

As economic reforms in China, legal reforms also follow the "trial-and-error" approach and legal reforms are implemented under a "bottom-up method". (Weigang Li, 2010) China is also criticized for common inefficient law enforcement – there is a gap between the law and actual practice. Mostly the reasons behind that are corruption and the enforcement process itself. It is widely common in China that not only locals are trying to violate the law, but also foreign companies adjust to the system and behave as locals.

2.4 The Energy Law

The Energy Law has been presented came into force in 2009. The main purpose of this law is to be the base to guide and regulate legislation in the country's energy industry. This law covers all types of primary energy: coal, oil, gas, renewable energy, nuclear energy, along with secondary energy as electricity, petroleum products and thermal power. (Jaques, 2008) There are other laws regulating energy issues like the Renewable Energy Law, Energy Conservation Law, and Electric Power Law, but this new Energy Law covers all these specific laws and their measures. The main purposes of this Energy Law are stated in Article 1 and are following: to regulate the development and use of energy; create stable and sustainable energy supply; enhance energy efficiency; provide energy security; promote the resource efficient society and clean environment, etc. (Jaques, 2008) This law mainly affects all actors who are involved in the development, use of energy and its management within the territory of China.

After the identification of the main actors in China's energy policy, the legal framework in the country and a brief overview of the energy legislation, the next step of China's energy policy research will be the current energy industry situation and energy policy analysis. The next section will summarize the current tendencies, strategies and targets of the energy policy in China, also the analysis of more or less successful and unsuccessful policy implementations will be made before proceeding to the section of policy recommendations.

SECTION 3. CURRENT ENERGY POLICY

The third section's identification of policy makers and general explanation of the energy policy making process helps to conduct the energy policy analysis. Policy analysis is presented in this section examining the main economic policy targets and achievements, current strategies and priorities, the major problems in past and current policy making. This analysis along with the factual background assessment helps to formulate the energy sector policy recommendations which are presented further.

Chinese energy industry development is significant for the global energy market, since China became the biggest energy consumer in 2011. It is the largest producer and consumer of coal in the world, the second largest consumer of electricity and oil. With constantly rising imports of energy resources the country's impact on global energy market is evident. Being the biggest consumer of energy in the world and consuming coal extensively, China is a considerable polluter of the environment (the second in the world). Because of the energy sector scale, its rapid growth and constant need for more investment and modern technologies it attracts increasing numbers of international companies eager to invest. Moreover, Chinese companies are extensively investing overseas themselves and working on diverse projects in cooperation with foreign companies. Playing a bigger role in the energy sector China is increasing its influence in global energy geopolitics.

The influence of the developing structure of the domestic energy sector on the entire economy is an important feature. The energy sector in China is experiencing transition from the 'planned' economy structure to a more or less market one with relative independence and much less control. Since energy is the strategic sector of the economy it is one of the last in transition. State owned oil and gas companies have been restructured, partially privatized and corporatized.

Furthermore, the electricity companies have been divested and generating assets were transferred to new generating companies. The coal mines also owned by the government were forced to consolidation and bankruptcy. (Andrews-Speed, The Energy Policy and Regulation in the People's Republic of China, 2004, p. 4) From the beginning of the transition the financial and technical performance of the companies has significantly advanced. Foreign investors were not only allowed to operate, but also encouraged along with allowing national companies to go overseas. The energy prices (both producer and consumer) were loosen and allowed to be increased. All these have extensively enforced the international resources trade.

Despite such solid development in the industry, the actual policy making process including the establishment of the clear cut national energy strategy and its coherent implementation is lagging behind. In many countries, especially developing and resource rich, the energy sector is one of the last to be liberalized since it is technically sophisticated to reform, strategic sector of the economy – the "power engine" of growth. Energy also is considered by many, especially in societies with the socialist and post-socialist background, as a public and non-tradable good. (Andrews-Speed, 2004, p. 4) The policy making process in the energy sector is usually highly politicized and composite. Energy policy making in China is no exception, it is even more complicated by immature legal system and frequently hindered law compliance.

3.1 Challenges of the China's energy sector

The energy security is the dominant challenge for the government – maintaining adequate supply of energy for sustainable economic development at reasonable costs for producers, consumers and states itself. According to Andrews-Speed there are five major groups of challenges in Chinese energy sector: (2004, pp. 30-31)

1. The lack of domestic primary energy resources, such as oil and gas. China has a shortage of such reserves given that energy demand is constantly increasing. Even though the reserves of coal and hydro power are significant, the utilization has a huge environmental impact and much lower efficiency per unit of energy than oil and gas. (Andrews-Speed P. , 2004, p. 30; Guo, Zhang, & Lo, 2010)
2. Local energy shortages due to difference in economic activity and resourcefulness of the regions and inadequate transportation of energy resources, especially coal. (Guo, Zhang, & Lo, Long Term Energy Scenario for China, 2010) Most of the energy resources, coal in particular, are being extracted in the northern and north-western parts of the country and the major economic activity and abundant energy demand is in south-east coastal areas of China.
3. "Inefficient production and transformation of energy resources." (Andrews-Speed, The Energy Policy and Regulation in the People's Republic of China, 2004, p. 30) This disadvantage is mostly caused by technological and managerial skills shortages, weak regulatory system and insufficient incentives to improve financial scarcity for infrastructural upgrading.
4. Still not efficient final energy consumption. Even though the government has already significantly improved the situation, there is still much to be done to increase the end-use efficiency. Only if the energy users have appropriate technologies, information and incentives both financial and non financial they can improve the end-use efficiency of the energy consumption (Guo, Zhang, & Lo, 2010).
5. Environment pollution from the energy resources utilization is growing and is one of the highest in the world (Andrews-Speed, 2004, pp. 30-31). Coal, one of the most

polluting elements in the energy production, is the major primary energy supplier in China's energy mix and is projected to remain the main source for a long time. The substitution of coal with cleaner energy resources requires a sustainable strategy, tremendous financial investments, and significant time.

In last two decades the Chinese government has undertaken a number of steps to address energy industry challenges. Progress has been made; however, several challenges still complicate the energy sector environment.

There are still several distortions in the energy sector. One of the most significant is the energy consumer and producer disparity. Consumers are usually less regulated and rely more on the market forces of the economy, while producers are more regulated and are mostly in hands of the government. Even though improvement of financial, technical, managerial components has been made along with significant improvement of the marketization of the "producer part", more fundamental reformation of the industry is needed to achieve better efficiency. In fact the reformation of state owned companies gave more power to the top executives of these energy companies. The judiciary and other legal institutions do not have enough supremacy to enforce these influential players to completely obey their directions. Consequently, the powerful energy producers, who are also transporters and transformers of the energy, have one of the most significant roles in the energy policy formation in China.

After the 1990s the Chinese government announced a number of objectives targeted at the improvements of the energy sector, from energy efficiency advancement to the reduction of environment pollution, and other. Though the objectives have been stated, the strategies and means of these objectives achievement have not been established and indicated. The same situation is repeating constantly: the policy might sound very convincing, but the implementation

process is not specified and as a result objectives have not been reached entirely. Partly the Ministry of Energy's lack of power during its short life, partly the multitude of actors in policy implementation before the special agency responsible for energy policy establishment in 2008, partly the novice nature of the new agency could be the reasons for the policy implementation process (Meidan, Andrews-Speed, & Xin, 2008). Moreover, the national energy companies, which have acquired much more power lately, do not have the sector wide interest in the energy policies, but even industry wide caring mostly for their individual interests and are not interested in much of a competition.

3.2 China's energy policy analysis

Traditionally, energy policy in China consists of diverse objectives for production, consumption, investment for each energy industry. Even though several targets have been reached, the overall policy suffers from inconsistency, sudden changes and lack of coherency. (Andrews-Speed P. , 2004, p. 59; Liu & Jiang, 2009; Meidan, Andrews-Speed, & Xin, 2008; Ziegler, 2006) The state priorities as in many other socialist countries are declared in a form of a "five-year plan" strategy followed by diverse documentations and directives of all-levels officials in the proposed plan's framework.

The strategic energy policy goals in last two decades were the following:

- the energy production and exploitation efficiency increase;
- concentration on both utilization and conservation of energy;
- improving the price setting mechanism to benefit both consumers and producers;
- advancing the energy consumption structure by increasing the utilization of oil and gas along with the unconventional sources, as renewable;

- since the coal is going to remain the major primary energy source, the modernization process China will need more electrical power capacity (Burke, 2009);
- energy production emissions are heavy burden for the environment and the pollution should be cut significantly (Liu & Jiang, 2009).

All the latest energy policy strategies more or less followed this framework of priorities in the energy sector frequently emphasizing each priority.

From 1996 the energy strategy has changed considerably from the long-employed standard previous policies and the energy policy has started to acquire a bigger place in the country's development strategy. The energy conservation began to play a bigger role than energy utilization. The strategy to increase energy production in energy rich regions of east and to stabilize the import of western well-developed but energy poor areas was established. In late 1990s China became a net importer of oil and the foreign oil and gas reserve exploitation was openly encouraged (Liu & Jiang, 2009). The other major innovation in the Ninth Five-Year Plan (1996-2000) was the support of the huge hydropower projects, clean coal production and renewable energy development.

These priorities were mentioned in the following five-year plans also. The Tenth Five-Year Plan (2001-2005) emphasized the foreign oil and gas imports even more, along with the development of home based oil and gas industry and exploration of new reserves. Oil and gas imports, given the tremendously rising demand, had to increase, especially in the sectors where the operation is based on these energy sources, like transportation or some manufacturing. Moreover, the pressure to reduce coal consumption for diverse reasons from the efficiency point of view to environmental concerns also brings much bigger demand for alternative sources of energy like oil and gas which in the short term can be only satisfied by importing. In terms of the

coal production and transportation inefficiencies the government decided to try the new approach of the mine-mouth power plants which are constructed at the mines and allow avoiding transportation inefficiencies (Pan, 2006). From these five-year plan targets, the opening up of the strategic energy sector of Chinese economy has started when the official proclamation of the gradual opening up of the sector for foreign investment was made. During this period the environment concerns and consequent pressure for Chinese government were rising internationally and domestically. (IIP, 2011)

The main energy policy goal of the 11th Five-Year Plan was the energy intensity target of the energy consumption per unit of GDP to be decreased by 20% below 2005 level by 2010 (Fan, 2006). It was the first time when the government proposed an economy-wide energy goal. To achieve this target it has launched several strategies like the Top 1000 Energy-Consuming Enterprises Program for the biggest energy consuming companies, Ten Key Projects which target technological upgrading in ten areas to support the national objectives of decreasing energy intensity, Small Plant Closures plans and outdated capacity phasing out (IIP, 2011). There were also other measures, including special energy efficiency standards for diverse appliances, economic restructuring and energy efficient building technologies implementation (Pan, Key Points of the 11th Five-Year Plan, 2006). The government reported that by February 2011 the main target was basically met with the overall country's level of 19.1% (IIP, 2011). These planned target achievement is an indicator of the successful national strategy implementation, which proves the necessity of the national energy policy.

The new 12th Five-Year Plan (2011-2015) is mostly concentrated on the renewable energy sources development and increase of their participation in the country's energy mix. The clean energy targets state that non-fossil fuel should account for 11.4% of primary energy

consumption (Shasha, 2011). According to this plan, energy consumption is supposed to be cut even more – by 16% while the CO2 emissions per GDP should be also cut by 17% by the end of the 12th plan period (Shasha, 2011).

The growing attention of the government to energy issues proved by increasing mentioning in the major political targets of the country, Five-Year Plans, shows energy sector is viewed as a strategic sector of the economy. Diverse researchers and foreign experts consider that even though the government has done a lot for the energy sector development in China, still there is a need for fundamental changes from significant energy market liberalization to greater integration into the global energy markets along with other significant changes for sustainable development of the sector, the entire Chinese economy, and international energy market (Andrews-Speed P. , 2004; Guo, Zhang, & Lo, 2010; Downs, 2008; Almeida, 2010)

Analyzing currently implemented energy policies, the main priorities of them can be identified as: the domestic resources utilization, investment in foreign energy resources and increasing imports of diverse primary energy components, transportation infrastructure upgrading, energy prices restructuring, energy demand restriction, emergency capacity establishment, market mechanisms implementation, and other.

3.2.1 Domestic resources utilization

From the foundation of the People's Republic of China in 1949 the government has proclaimed the self sustained strategy to maximize domestic resources exploration and utilization. The enormous investments have been made without expected results. For example, the major oil field Tarim Basin had a tremendous investment and the result was pretty humble. The offshore exploration with the foreign investors' involvement was held in South China Sea, East China Sea, and only the Bohai Gulf in the northern part of China brought some significant

results. (Andrews-Speed, The Energy Policy and Regulation in the People's Republic of China, 2004) Almost all oil rich reserves have matured and experienced the peak, so it has become much more expensive to extract necessary amounts of oil. However, the domestic gas production has been growing more successfully. Onshore and offshore reserves, especially in the northern parts of China are thought to have a high potential. Nevertheless, the transportation of gas is the biggest issue – the only way to transport natural gas is the pipeline and its construction is expensive and geographically problematic. To offset the imbalances in resource rich north-west regions and resource poor but economically most developed regions in the east, the West-East pipeline from western province Xinjiang to Shanghai was built (Bahgat, 2007). Even though this huge pipeline was built, to construct vast pipelines connection is still more expensive than to apply special technologies to freeze the natural gas and transform it to LNG – liquefied natural gas, which can be transported much easier. According to Andrews-Speed, it is doubtful that the transporting of domestically produced gas from the north is going to be cheaper than transport it piped from Russia, or use LNG to ship it. (2004, p. 31) However, China still strives to develop the domestic gas production and has started recently an extensive exploration of unconventional gas reserves like shale gas and other. In order to obtain the most up-to-date technologies for unconventional gas extraction China for the first time attracted foreign investor – The Royal Dutch Shell Company, not for the investment opportunity only, but for cooperative exploration of the unconventional gas reserves (Hussain, 2012). This contract is making a history since it shows the attempt of the government to let international companies to penetrate into the strategic sector, what might signify that the government is ready to reform the sector, liberalize it more and loosen up the control in order to allow the energy sector development. According to some studies China has the biggest shale gas reserves in the world (Hussain, 2012). However, the

exploration of these newly investigated reserves requires modern technologies, know-how and significant investment. Cooperation with foreign companies having expertise in this source exploration and production will benefit fast development of unconventional gas segment.

Coal will remain the major energy source for China for a long time since it has the biggest reserves among all other energy resources, and it is not an easy task to switch to other energy resources in a short term. It requires time, tremendous investment and the substituting resource should be in abundant supply. Considerable investment was made to upgrade large coal mines and improve the infrastructure. However, the overproduction of coal in late 1990s – beginning of 2000s (with the help of the small mines) led to the significant price drop for coal and consequently decreased investment drastically which prevented the further improvement of the coal industry including transport infrastructure (Andrews-Speed & Dannreuther, 2011, p. 21)

Being water rich, south-west and center of China have great potential for renewable water energy supply. The biggest hydro-electric plant in the world was constructed in 2011 – Three Gorges Dam. The main goal of this unique plant is to achieve the 30% of electricity supply in the country (Chmutina, Saffa, & Zhu, 2010).

3.2.2 Foreign investment

Starting from the late 1990s China pursued the investment in foreign oil and gas exploration and manufacturing to secure supplies (Andrews-Speed, 2004). Oil was preferred to be refined in Chinese refineries. The government recognized the opportunities resource rich neighbors and partners could bring and was willing to import oil and gas from Russia, Central Asia, and Middle East. Later China added African continent to their list of preferred partners in energy trade and production. This was the start of the supplier diversification strategy which should be even more enhanced to provide stable energy supply.

After China officially joined the World Trade Organization in 2001, the General Secretary of the Communist Party proclaimed the "going out" strategy, fostering more aggressive investment into foreign energy assets and cooperative exploration and production of energy resources. Consequently, the economic opening up and increased international trade cooperation favored the energy sector liberalization. By the time this policy was established the Chinese national energy companies had limited experience in mergers and acquisitions – only in Yemen, Oman and Indonesia. (Bahgat, 2007) Today China is active in Latin America, Africa, Middle East, Central and South East Asia. Chinese energy giants tried to penetrate mostly where American and European players are not present or have left. Such countries as Turkmenistan, Uzbekistan, Venezuela, Sudan, Iran and other usually pursue policies different from the Western ideologies and have complicated relations with Western powers. China offers an attractive perspective for these countries leaders' of no intrusion into domestic policy, but only business relations since they are only interested in resources (Ziegler, 2006). This approach also brings risks of political instability and current example of Sudan and South Sudan separation can be a big issue for oil supply security since while there was a military conflict between two areas, the oil supply disruption occurred. Even though Middle East and Africa are politically unstable and risky in terms of energy resources supply disruptions, main China's oil supply is still concentrated in these regions. Such cooperation endangers the sustainability of energy supply and even might slower down the economic growth due to lack of energy imported.

Neighboring Russia is currently one of the biggest Chinese trade partners. Russia is one of the biggest energy producers: in 2009 it was the largest crude oil producer in the world. Russia holds the biggest gas reserves, the second largest coal reserves and eighth largest oil reserves (Country Analysis Brief - Russia, 2011). However, up until the last decade energy cooperation

was not very convincing. Close cooperation in energy trade, production and exploration could greatly benefit both partners, since Russia is the major producer of diverse energy resources, while China is in need of growing foreign supply as the economy is developing fast and domestic resources are insufficient to provide the sustainable growth. Many researchers and experts give diverse reasons for the slow development of the strategic energy cooperation. Most of them agree on the following: regardless of related perceptions and common interests of both partners, Russian politicians are concerned about Chinese development and its growing influence, Russian Far East and Siberia are vulnerable to significant immigration from northern provinces; both partners are interested in the influence in Central Asia's former Soviet Union republics; and major uncompromising struggle of national energy companies of both sides over the prices and conditions in oil and gas delivery (Bahgat, 2007; Danchenko, Downs, & Hill, 2010; Itoh, 2011; Trenin, 2012; Downs, 2010). These contradictions have held back the strategic cooperation in energy field, however, there is still an interest of both sides to work harder on mutual understanding since this cooperation benefits both partners tremendosly. The relations are making progress and the pipeline from Russian Siberia to China's north-east and new oil Pacific terminal on Russian coast of Japanese sea built in 2011 were one of the major projects between two countries (Gorst, 2010). In exchange for future delivery China gave a $25 billion loan, which commits Russia to export 300,000 barrels each day for 20 years (Gorst, 2010).

China is interested in Central Asian partnership for several reasons. First, the region is hydrocarbon reserves rich. Second, the suppliers diversification from excessive dependence on the Middle East importing oil and gas from Central Asian countries could be an alternative strategy. Moreover, the pipeline connection and land transportation of oil and gas from Central Asia allows China to avoid the US military control of the sea routs (Bahgat, 2007). From the

other hand, the Central Asian countries can decrease the Russian influence in energy resources trade and diversify its consumers. In 2006 China and Turkmenistan started the construction of the pipeline which has expolitated form 2009. Moreover, the Chinese CNPC has purchesed two Kazakh companies who have the right to operate 11 oil fields in Kazakhstan (Bahgat, 2007). Kazakhstan and China also have a mutual transnational oil pipeline from 2006.

In the last several years accumulated Africa became one of the largest oil supplier in China with two thirds of the supply, especially Angola – a leading supplier among African countries (Bahgat, 2007, Ziegler, 2006). China and several African countries have agreements to explore and utilize energy resources on the principle of long term cooperation and mutual development (Blankendal, 2008). So, in exchange for energy China promised African continent to turn their energy reserves into the economic growth opportunity what is beneficial for both partners.

In terms of the absence of political pressure and pure commercial interests, energy trade relations between China and Middle East are identical. The Middle Eastern countries are interested in a long-term buyer of resources, while China is also interested in a long term partner in oil supply (Bahgat, 2007). Iran is one of the China's biggest Middle East partners, where China has the significant investment in exploration and production of hydrocarbons, moreover, these countries have a long-term LNG delivery contract (Ziegler, 2006). However, this region is politically unstable, what brings risk in supply, for example, in 1997 China and Iraq signed the 22-year oil supply contract, but after the overthrow of Saddam Husein regime the argeement was not fulfilled (Ziegler, 2006). Another powerful oil and gas partner is Saudi Arabia – the leader in energy industry supply. There are several agreements of the energy industry development of the both sides and oil suply contracts.

3.2.3 Energy price reform

Before gradual energy price reform, prices were set by the central government below international prices and/or long run marginal cost levels. (Andrews-Speed & Dannreuther, 2011) Chinese government made substantial progress in raising prices but not much in loosing price control. The major energy resources prices have reached the level of the production cost and even international prices lately, but each component of energy mix has its own price mechanism.

The coal pricing mechanism is very important since it is the primary energy commodity in China's energy mix and a significant issue for inflation regulation. (Andrews-Speed & Dannreuther, 2011) From mid 1990's the gradual marketization in the coal inductry had started. The prices depended more on the quality of coal and the additional amounts of targeted coal production could have been sold at the market price. However, the large power plant's coal sometimes sold at controlled prices.

The oil prices have the similar pricing mechanism – the extra amounts of oil produced could be sold at close to the market or bargaining price. Then the special price referral index based on international prices was introduced by State Development Planning Comission which allowed for comparable to international prices domestic prices fluctuations (Guo, Zhang, & Lo, 2010).

Since in early 2000s gas fields were scattered around the country and gas was available in very few areas, the prices differed radically from province to province (Bahgat, 2007). These was a need for the significant investment in order to increase the gas industry development and the government realized that to foster investment the price raise is necessary. Nevertheless, this approach does not address market needs – the gas might be produced and shipped but there is a doubt that consumer would be available to buy this gas at higher price.

The elecricity prices were rising steadily until the Asian crisis in 1998 when the electricity demand drop led to an eventual price decrease. From this time the electricity prices were moderate in order to provide citizens with adequate supply of electricity during the increased unemployment and significant overall income drop after the crisis (Andrews-Speed, 2004). In 2000 the government started to raise prices again until the new crisis in 2008.

3.2.4 Increasing energy efficiency

In order to maintain sustainable development, a constant energy supply provision is not enough; the energy efficiency should be also increased along with the relative demand constrain. Chinese government has persistantly pursued demand constraining and energy consumption efficiency strategies, so energy intensity has declined significantly in the recent decades (Figure 15). Most constraint was connected with coal consumption, electricity in manufacturing, offices, and households. (Andrews-Speed, 2004) Moreover, the oil demand was also targeted to be constrained, even though the conservation, energy efficiency advancement and substitution by other energy commodity would be much better option (Andrews-Speed & Dannreuther, 2011, p. 31). There were attempts to transfer the public transportation to gas or other cleaner and more available energy sources than oil, this not only benefit the environment, but also helps to substitute necessary for other needs energy intensive fuel as oil. This policy failed in many big cities with heavy traffic because of the lack of extra available gas supply, since again such cities are in the developed economically but resource poor areas and the transportation of additional gas supply for public vehicles appeared to be too expensive along with significantly expensive technologies for oil-to-gas or -coal vehicle's fuel transferring (Chang, 2011). In general the fuel substitution for industry, household, appliances, vehicles and other requires modern expensive technologies and significant financial investment.

According to Zhou, Levine and Price (2010), from 70s to 2000s country had significantly limited energy demand increase through forceful energy efficiency strategies. Energy consumption per unit of GDP decreased by 5% annually during this period, though, from 2001 it increased by approximately 4% per year. The policy of 20% reduction in energy intensity by 2010 had a significant impact, as it was already mentioned previously. The achievements of this policy show the capabilities of Chinese authorities to accomplish energy policy strategies, particularly, significant energy efficiency increase in a very short term. The most important efforts provided results were: famous Top-1000 companies program, foundation of the generous fund for investments in energy efficient projects, advocacy of the Communist Party and diverse levels of government for energy efficiency, all sectors attention to energy conservation and efficiency. (Zhou, Levine, & Price, 2010) The energy efficiency reforms institutionalization is significant issue which will influence on the further reductions in energy intensity. Even though the government achieved several targets and energy efficiency showed the considerable progress, the energy efficiency policy should continue to improve since the energy security can be achieved not only by growing supply, but also by means of energy efficiency advancement. Referring to the figure of energy efficiency comparing with other countries (Figure 15), China is still lagging behind and there is a room for considerable improvement.

3.2.5 Energy emergency reserves

One of the conditions of being a member of IEA is the constant maintenance of the emergency oil reserves no fewer than 90 days for OECD countries. This benchmark of 90 days is considered to be the most adequate measure for emergency reserves for developed economies. China still does not have such oil stocks, even though there is a clear improvement in this issue. In 2007 the government started to move towards the 90 days strategic emergency reserves

benchmark. They introduced the “two part” system of government reserves and which is supposed to be completed in three phases (China's Energy Security: Strategic Petroleum Reserves, 2009, p. 3). The first phase was completed in 2008 and had the capacity of 102 million barrel reserves while the second, completed in 2011, had an additional 170 million barrels. The third phase will increase the reserves by 204 million barrels what will actually bring 90 days of oil supply reserves by 2020. (2009, p. 3) Emergency energy reserves is a significant energy security tool and the fact that Chinese government is concerned with this issue is important. However, in constantly growing energy demand it is challenging to provide additional considerable supplies for emergency purposes. Such crisis reserves should include not only oil, but other fuels to ensure better stability and have much larger emergency system.

3.2.6 Liberalization of energy market

From 1998 the government of PRC started the gradual energy industry restructuring along with giving more power to state energy companies and putting the energy prices more in line with international. This process is much slower comparing to other industries. The overwhelming majority of energy production, transformation and transportation is still controlled by the government. Even though energy prices has become in line with international prices much more, they are still controlled by the government, along with export and import quotas. (Andrews-Speed, 2004) Liberalization reform is limited by the heavy political influence, structural peculiarities and technical features. It seems that the power of national energy companies will remain significant, the integration to the global energy markets will be heavily controlled, while the energy security will also stay the strategic direction of energy policy for a long time. If the government decides to liberalize sector for enhanced efficiency, it needs to establish a coherent liberalization strategy and implement it systematically, so the overall energy

policy will become much more market oriented. If the liberalization reform is implemented, the Chinese energy sector will be much more integrated into the international energy market and the supply security will be provided with smaller costs.

3.2.7 Renewable energy policy

The development of renewable energy sources became one of the main priorities of Chinese governement in energy policy framework. The main target of China is to raise the renewables' share up to 15.4% by 2020 and even to 27.5% by 2050 (Chmutina, Saffa, & Zhu, 2010, p. 3). Government has already applied diverse instruments, incentives and laws to obtain such ambitious targets. In 2005 the Renewable Energy Law was introduced, regulating all the issues connected with this industry. There are several challenges which prevent renewable industry to develop fast enough to notably contribute the China's energy supply, such as: the lack of established financial apparatus; discrepancy between private and social costs in project benefits measurement; the renewables integration into the energy grid issue; again the absence of long term renewable industry strategy; poor renewables infrastructure and insufficient R&D investment. The renewable energy production is more expensive than conventional sources – near 1.2 times cost for small hydropower, 1.5 for biogas, 1.7 times for wind etc (2010, p. 6). Renewables are the alternative source for China's constantly growing energy appetite, however, to rely on them more the cost reduction and technological improvement should be made.

One of the most fundamental problems of the policy making process in China is the multitude of objectives, lacking coherence and well-established strategies how to achieve these objectives. Even though several policies were implemented pretty succesfully, the majority of stated objectives do not reach the final implementation. For example, the electricity industry have not followed any clear cut long term industry development strategy, just separate tagets and

objectives have been implemented to reach some immediate goals. The gas industy has a lack of clear policy, it has only the major target of the lagrer participation in the country's energy mix. To develop gas industry, especially possibly highly pitential unconventional gas resources, there is a need for the investement incentive and the absence of coherent and clear development strategy in the industry considerably diminishes such incentives. The fragmentation of the energy policy is unavoidable since the institutions of policy making are rather fragmented. Even though the National Energy Administration – the long waited energy policy formulation and implementation authority was established in 2008, its functions are still practically unclear. It still lacks power since the energy administration is spread among diverse actors and some experts even consider it became a "bargaining shop" for giant national energy companies, instead of being policy making institute. (Andrews-Speed & Dannreuther, 2011, p. 35) The absence of a long term energy strategy instead of the short plans for five-year targets cause by failure to realize the importance of the reforms in the sector and to recognize that inactivity is not feasible for long term objectives.

The infrastructure development in China for energy production and transportation required trillions of yuan. The overwhelming majority of this investment lies on governement, or partially autonomos but still state-owned energy companies and government banks. The infrastructure development needs even more upgrading since the energy sector is growing. Particularly energy transportation infrastructure is one of the major obstacles for the fficient energy supply and needs considerable investment and modernisation. The foreign investment involvment along with significant government's contribution is essential for energy sector sustainable growth.

In terms of the energy supply partnership the government has to further diversify suppliers, since the more fragmented supplier structure provides less supply disruption risk. Today China heavily relies on potentially politically risky regions which might unintentionally stop supply, damaging the Chinese economy. Moreover, government seem to be aware that heavy coal reliance has to be changed, however it is a long term process. There are no significant results by now, only incremental changes in energy mix. Even though the emergency response system is developing, it needs to be improved since it does not respond the current needs of emergency supply.

The energy sector's strategic focus on the supply side was turned in 2003 also to the demand side contraction. The sector experienced diverse energy consumption contraction and energy efficiency measures, most of which have achieved their goals. Such measures included several inefficient plants liquidation, diverse targets for the largest companies and local governments, the increase in end-user prices, etc. These targets were intended to improve not only the energy sector, but also the environment. However, the energy efficiency is still low, comparing to other countries. Moreover, the environment pollution is severe. Environment conditions experienced the most serious consequences of the government's previous focus on production of energy instead of also concentrating on energy conservation. Both comsumption and production of energy led to considerable pollution. So, the energy efficiency and environment protection policies have to be further developed.

Technological development is significant to utilize new sources of energy, use more efficienct energy production techniques and make energy consumption more efficient, securing persistent supply. There is a need for further significan investment in technological development

along with international cooperation. International cooperation can also be facilitated by market liberalization.

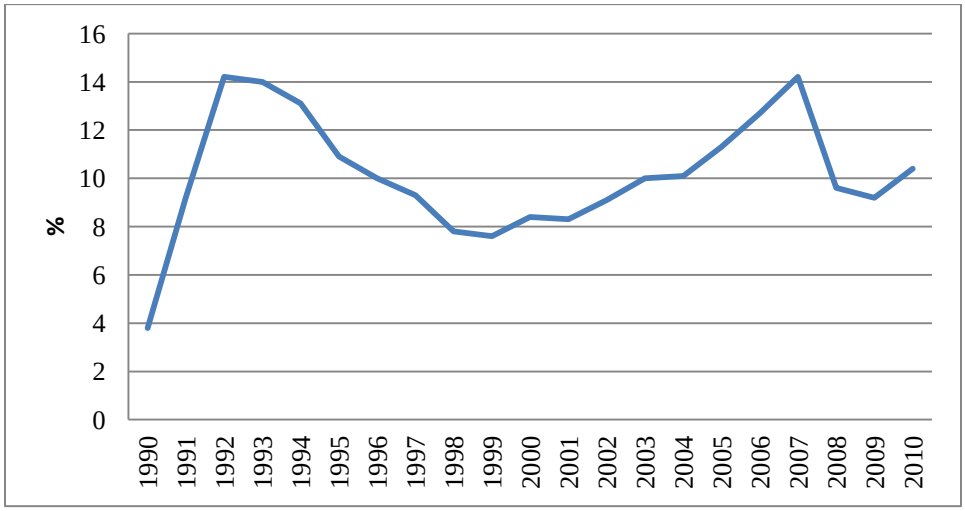
Even though the government started to liberalize the energy sector, it still needs more improvement to enjoy the benefits of liberalization. Government control can be justified by the strategic nature of the sector and the need to provide energy supply security for the economy. However, in reality the implications which follow from most of the government ownership bring limited supplier dependence, barriers for foreign investors, and overall inefficient management of the sector which reduce the national energy security.

The unreliable or partially reliable data is also a very significant issue complicating the energy policy making process. The reliable energy data is extremely hard to obtain, so the decision was made to mostly use the statistics from already published articles by respected researches, international agencies and organisations to provide more or less trustworthy data, not relying much on Chinese official statistics since it has obtained quite contraversial reputation. Such situation with the official energy data extensively constrains the policy making process. The majority of articles, researches, documents and other data were collected via English language electronic database of the National Library of China in Beijing. The data section with factual background is presented in the next section.

SECTION 4. FACTUAL BACKGROUND OF SOCIO-ECONOMIC DEVELOPMENT AND ENERGY SECTOR POSITION

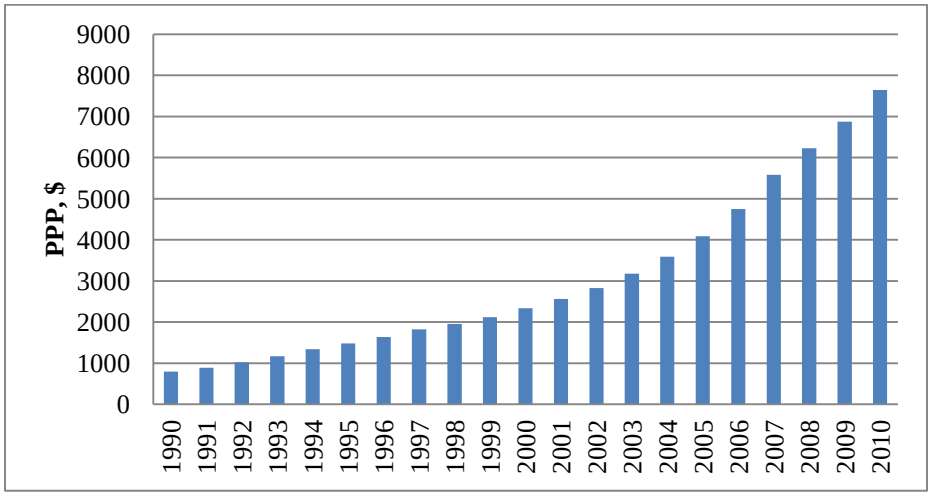
4.1 Chinese socio-economic development

Figure 1. GDP annual growth (%)



Source: The World Bank Data, China

Figure 2. GNI per capita, PPP ($)

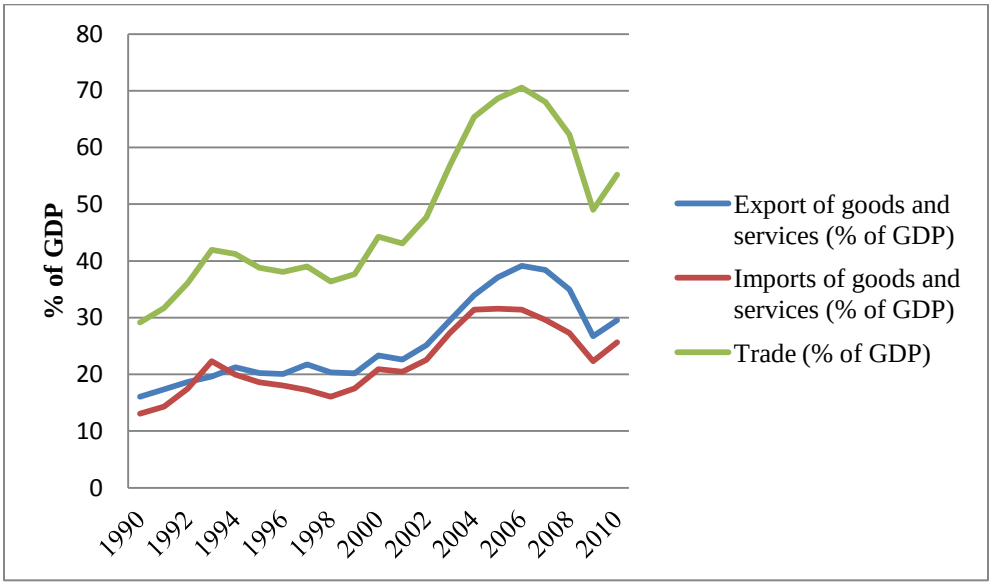


Source: The World Bank Data, China

Figure 3. Gross Regional Product (Yuan)

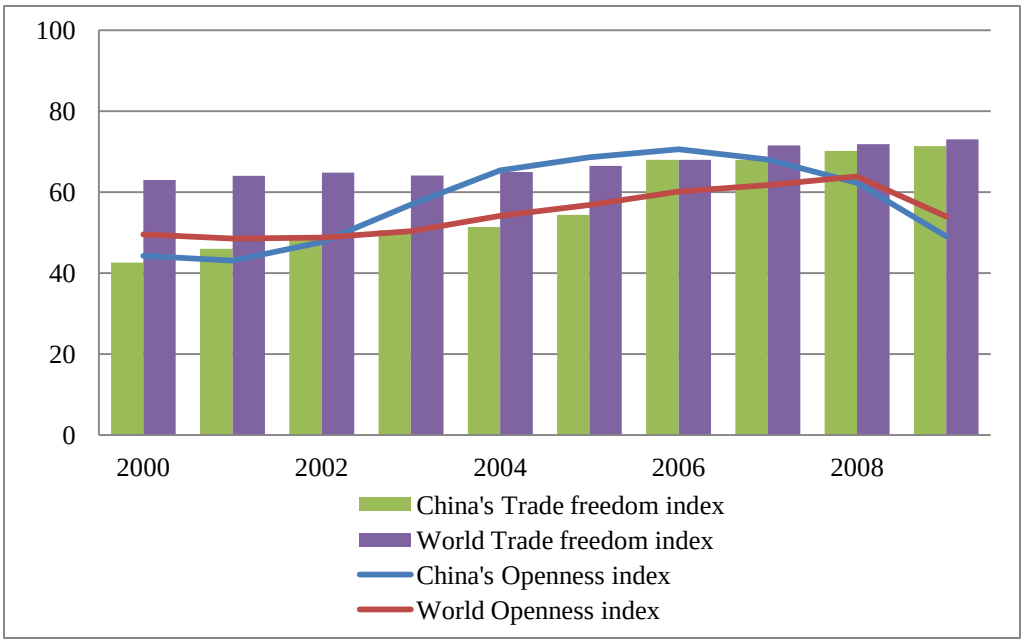
Source: National Bureau of Statistics of China Database

Figure 4. Trade (% of GDP)



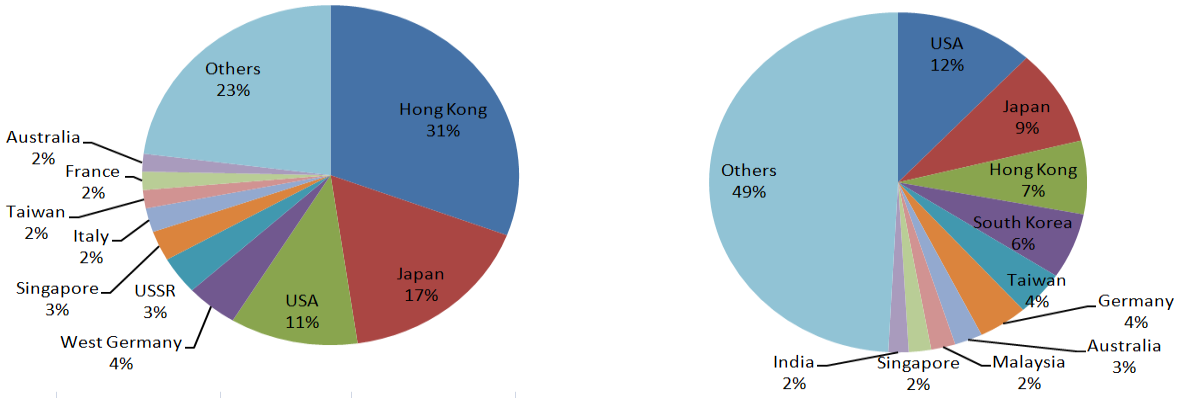
Source: The World Bank Data, Chin

Figure 5. Openness and Trade Freedom Indexes of China



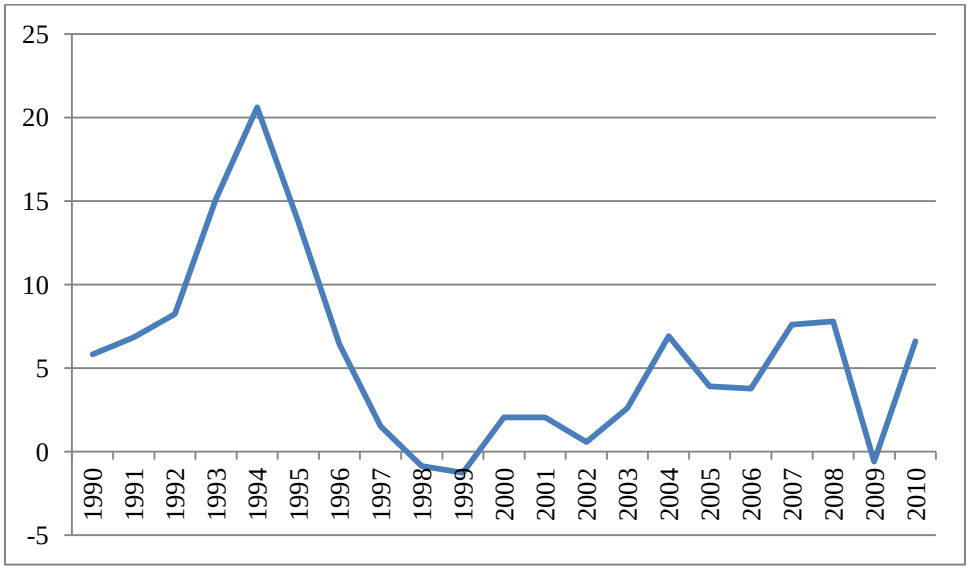
Source: The World Bank Data, China; The Global Enabling Trade Report (2010)

Figure 6. Top trade partners of China in 1989 and 2009



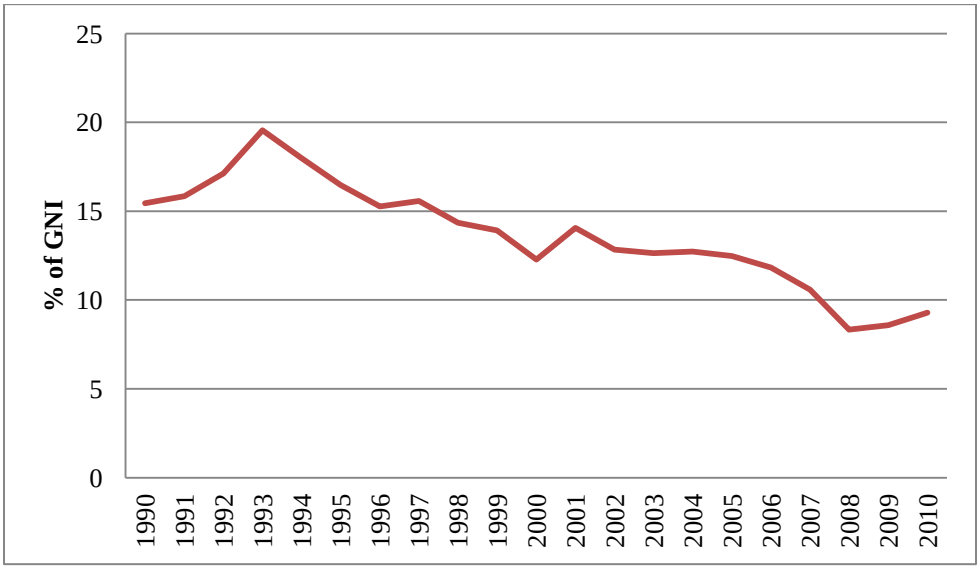
Source: CIA World Factbook

Figure 7. Inflation, GDP deflator (% annual)



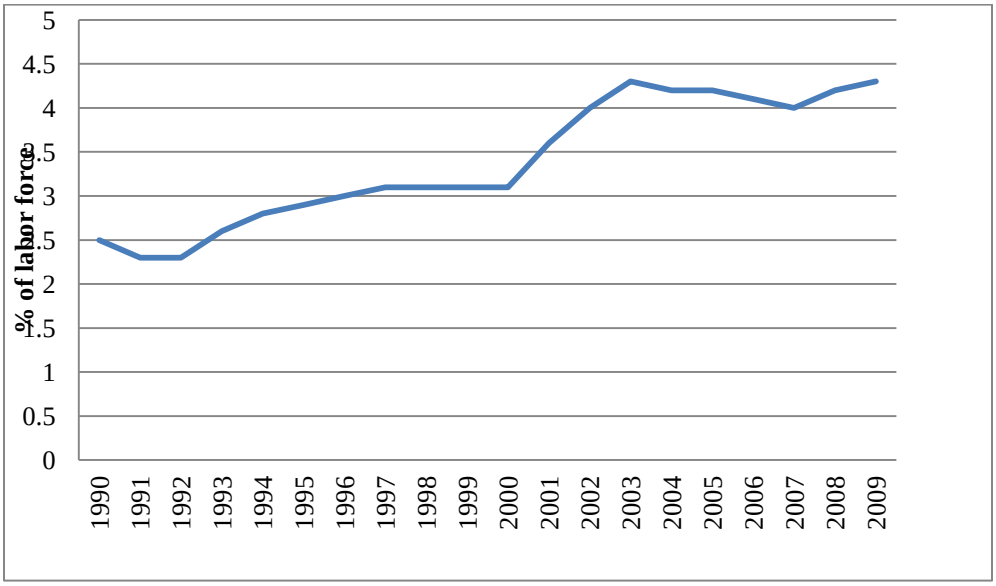
Source: The World Bank Data, China

Figure 8. External debt stock (% of GNI)



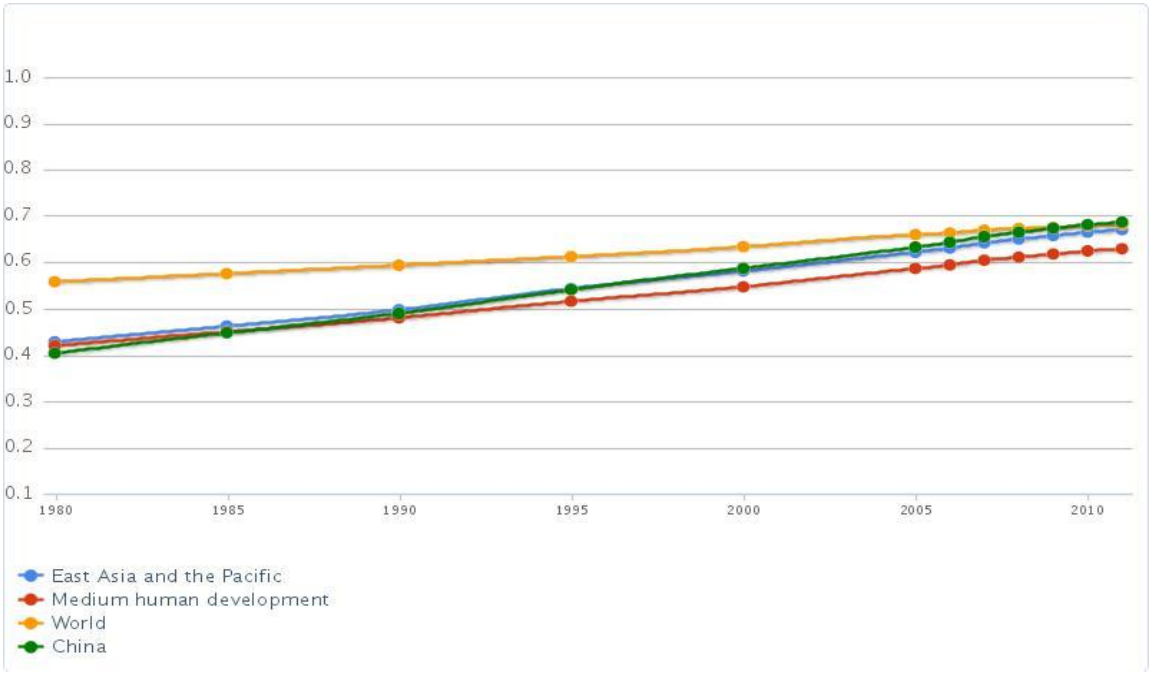
Source: The World Bank Data, China

Figure 9. Unemployment, total of labor force (%)



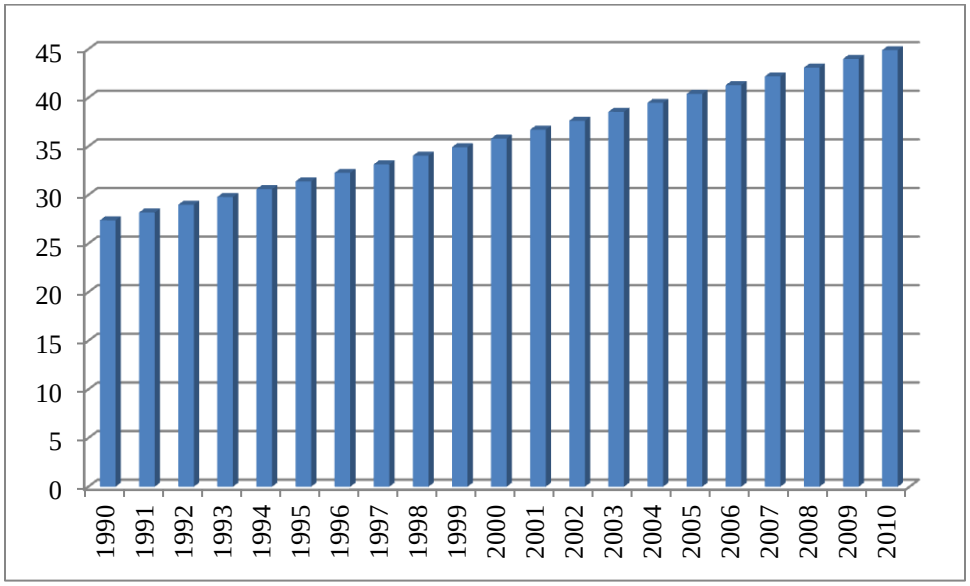
Source: The World Bank Data, China

Figure 10. Human Development Index



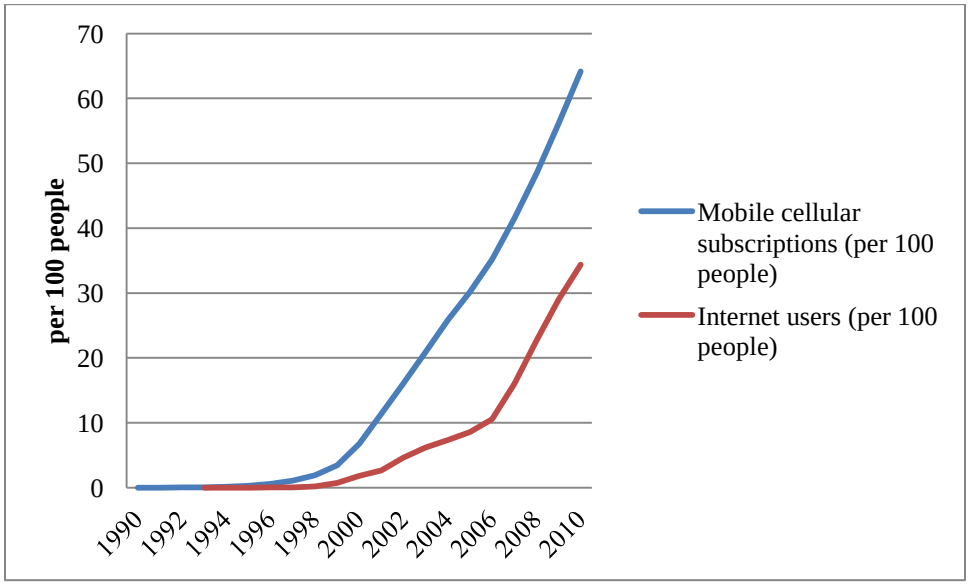
Source: Human Development Reports, UNDP (2010)

Figure 11. Urban population (% of total)



Source: The World Bank Data, China

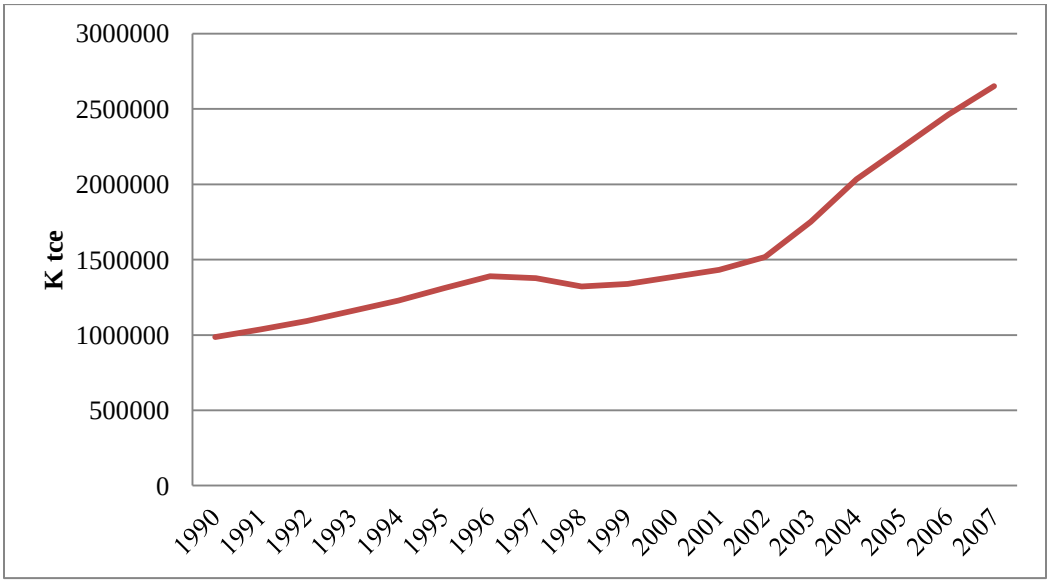
Figure 12. Cell-phone and internet users



Source: The World Bank Data, China

4.2 China's energy data

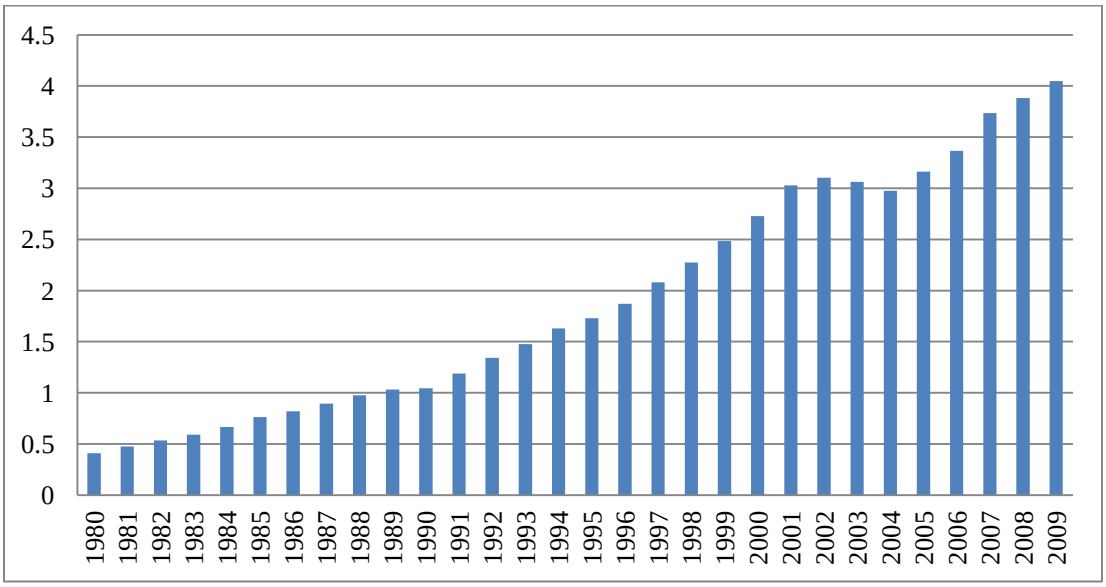
Figure 13. China total energy consumption (K tce)*



**Note: K tce - kilogram ton coal equivalent*

Source: Guo, Zhang, & Lo (2010)

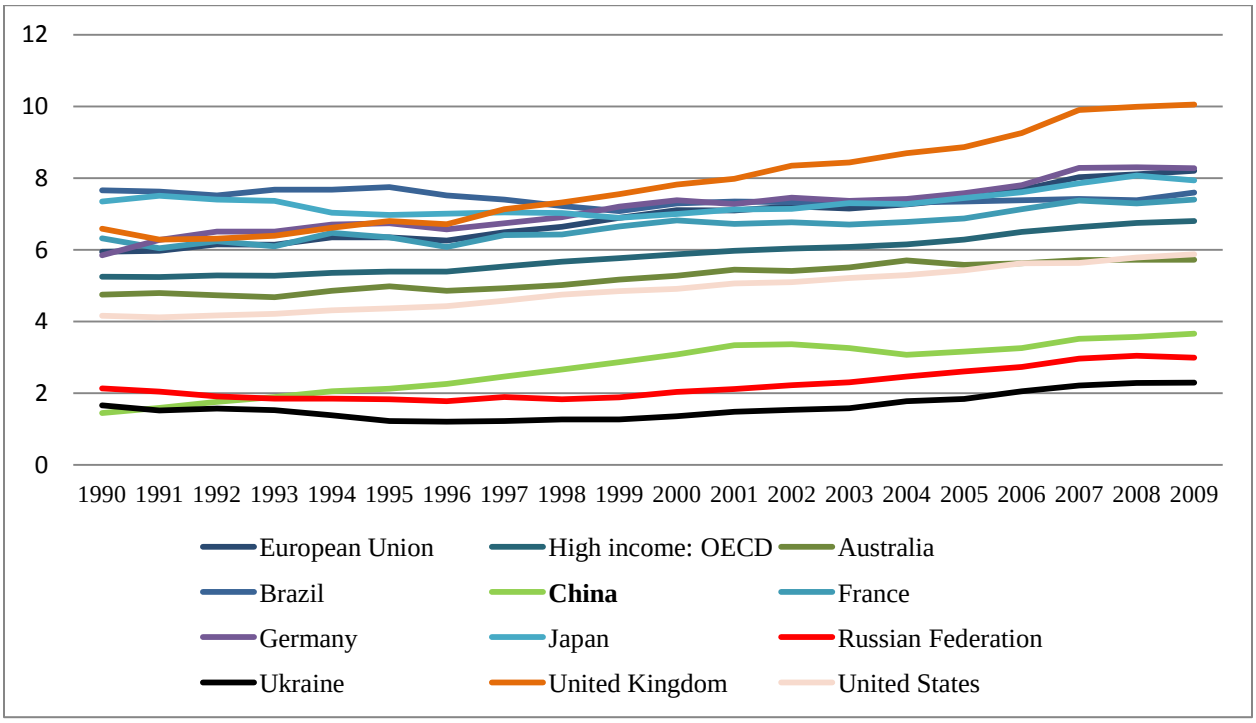
Figure 14. Energy efficiency* of China (PPP $ per kg of oil equivalent)



**Note: GDP per unit of energy use*

Source: Source: The World Bank Data, China

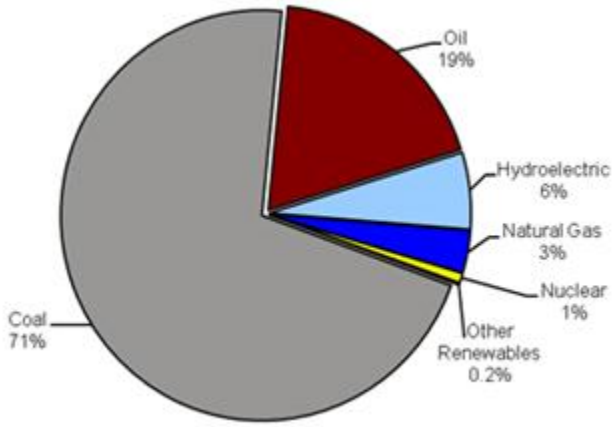
Figure 15. Energy efficiency*



**Note: GDP per unit of energy use (constant 2005 PPP $ per kg of oil equivalent)*

Source: The World Bank Data

Figure 16. Total energy consumption in China by type, 2008

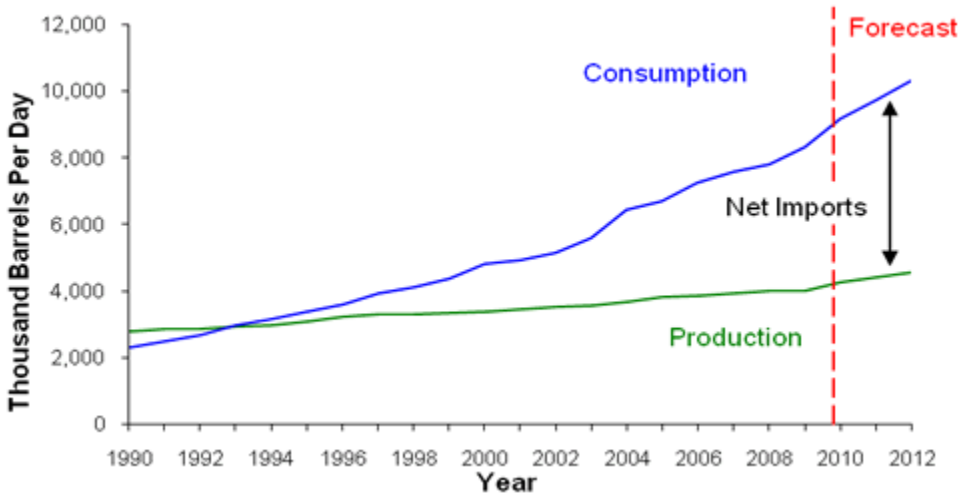


Source: EIA, The US Energy Information Administration (2011)

Figure 17. China's proven oil reserves map

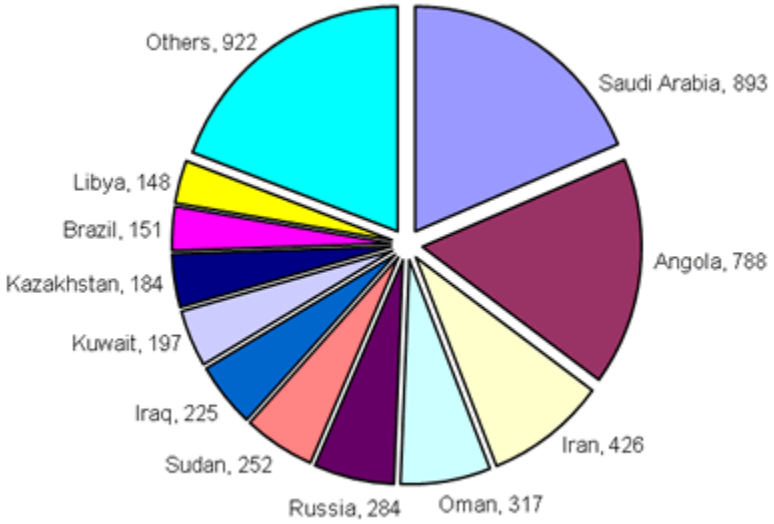
Source: EIA, The US Energy Information Administration (2011)

Figure 18. Oil production and consumption



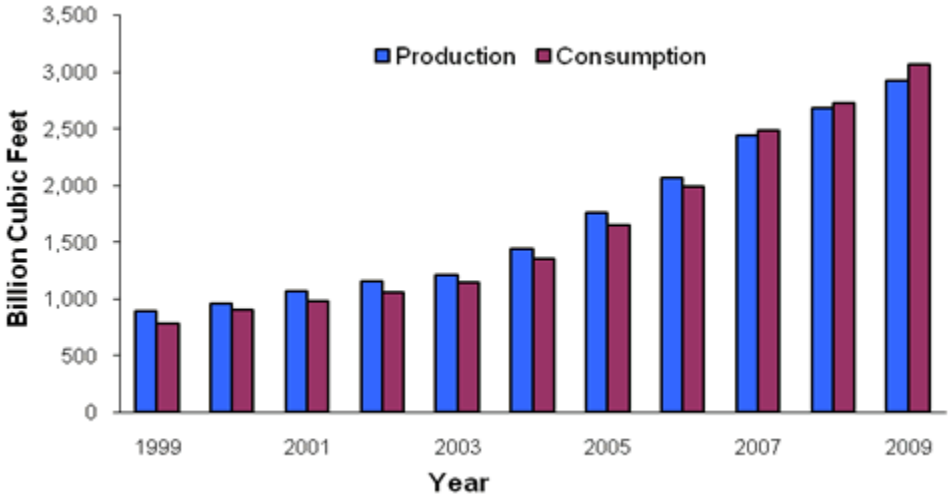
Source: EIA, The US Energy Information Administration (2011)

Figure 19. China's crude oil imports by source, 2010 (1000 barrels per day)



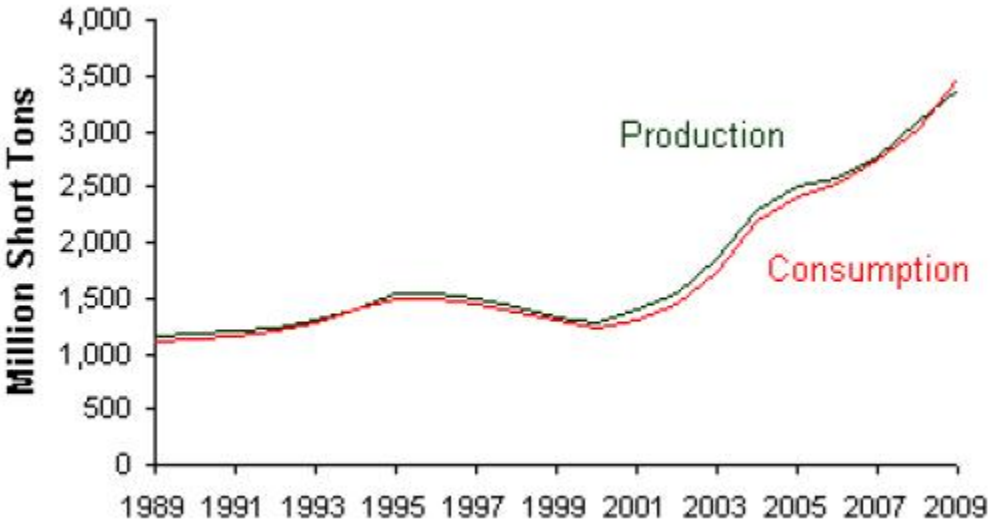
Source: EIA, The US Energy Information Administration (2011), National Bureau of Statistics of China Database

Figure 20. China's natural gas production and consumption



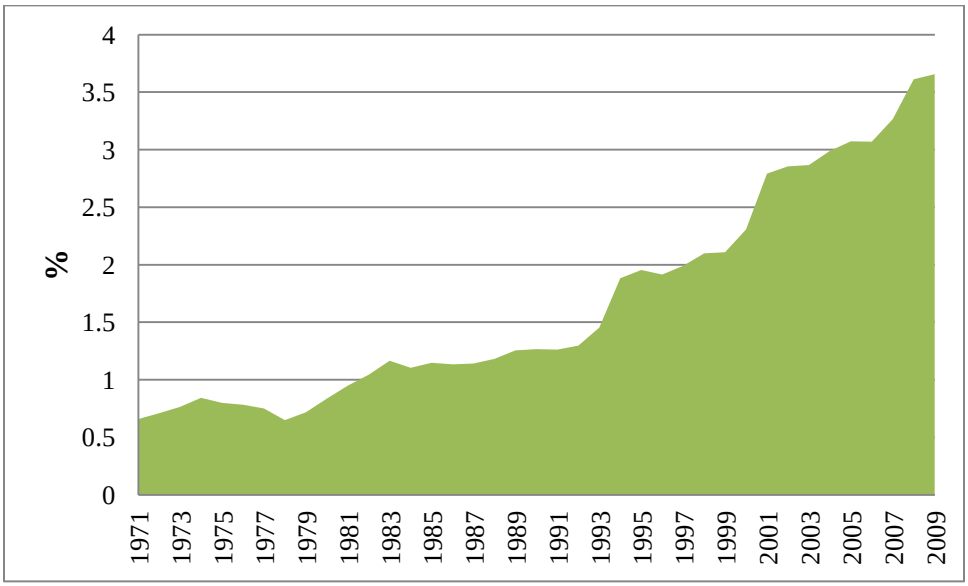
Source: EIA, The US Energy Information Administration (2011), National Bureau of Statistics of China Database

Figure 21. China's coal production and consumption



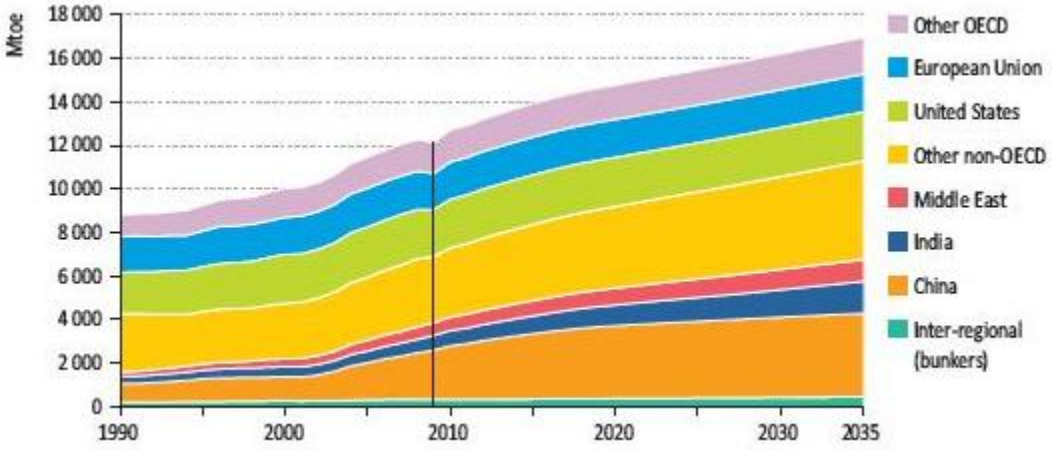
Source: EIA, The US Energy Information Administration (2011)

Figure 22. Alternative and nuclear energy (% of total energy use)



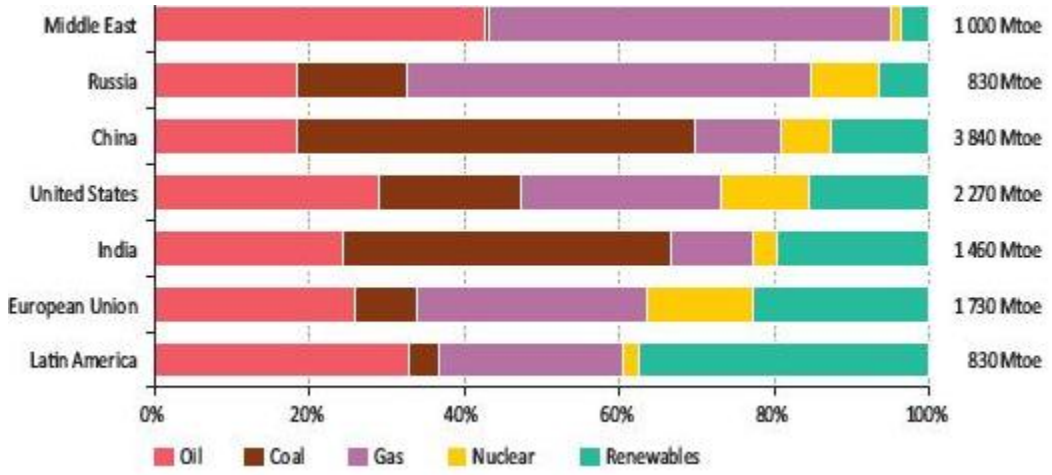
Source: The World Bank Data, China; National Bureau of Statistics of China Database

Figure 23. World primary energy demand by region



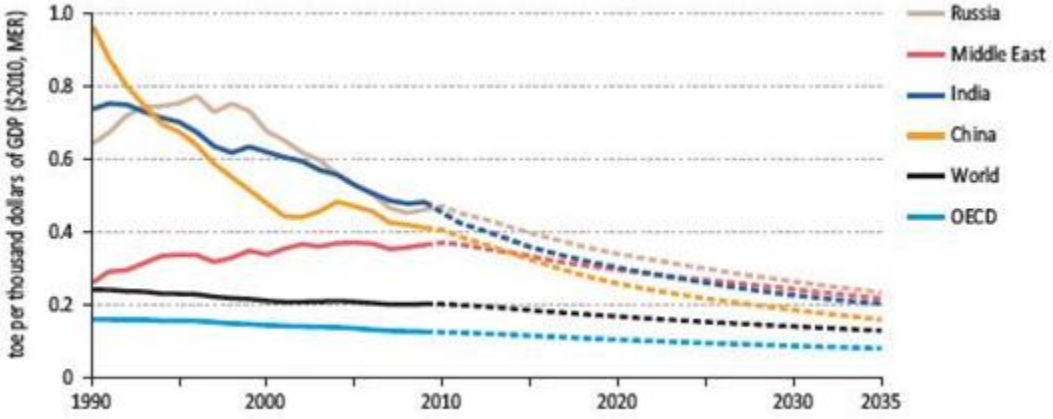
Source: IEA, World Energy Outlook (2011)

Figure 24. Energy mix in selected countries and regions in 2035



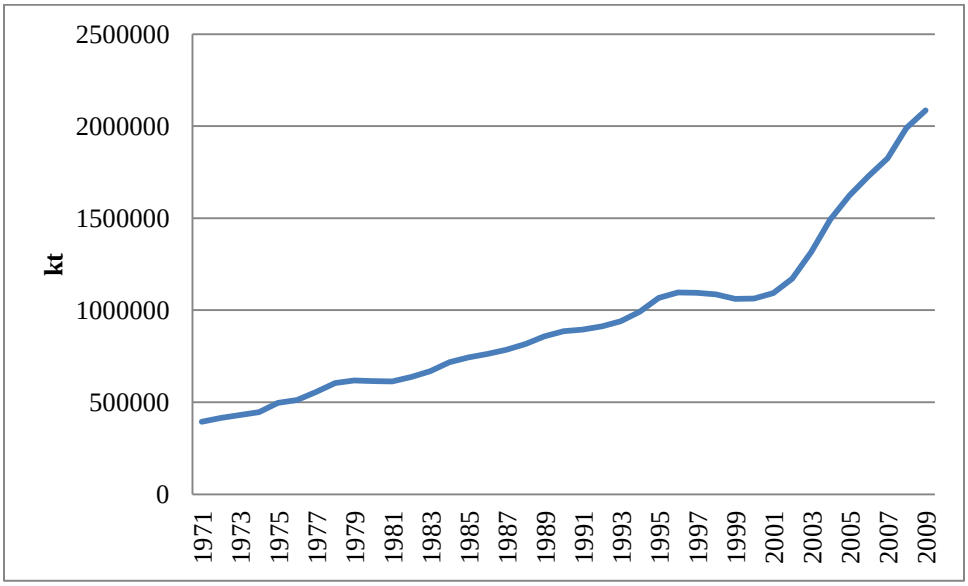
Source: IEA, World Energy Outlook (2011)

Figure 25. Energy intensity in selected countries and regions



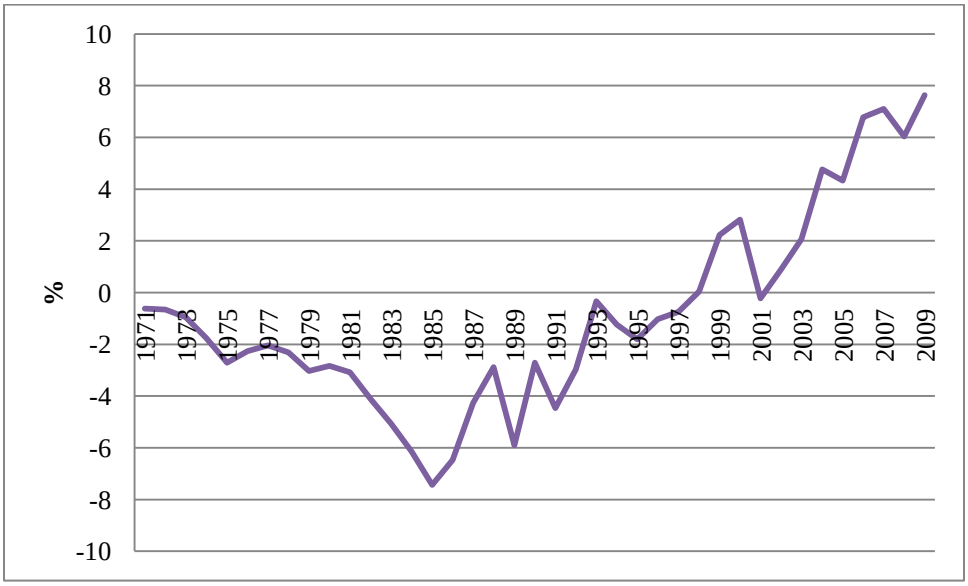
Source: IEA, World Energy Outlook (2011)

Figure 26. Energy production (kt of oil equivalent)



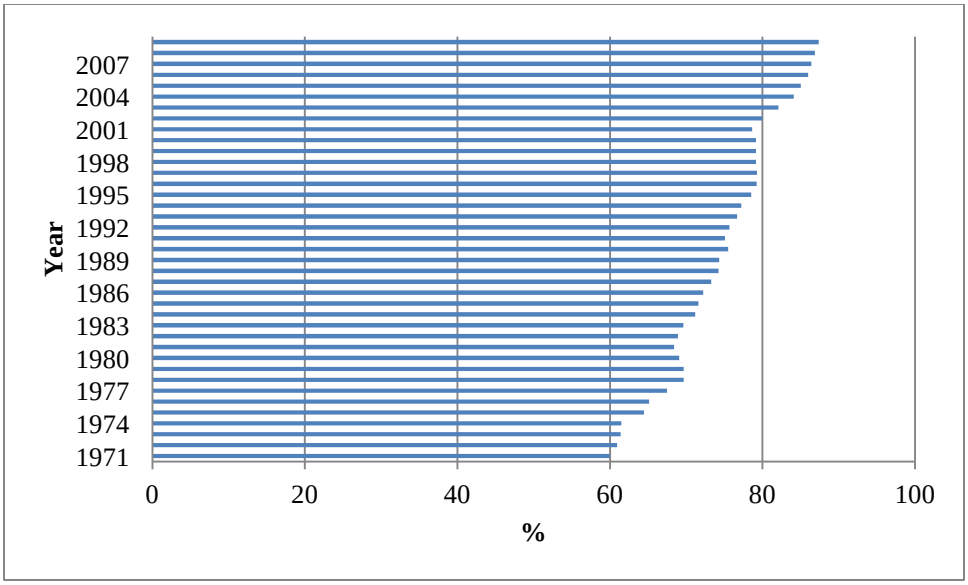
Source: The World Bank Data, China; National Bureau of Statistics of China Database

Figure 27. Energy imports, net (% of energy use)



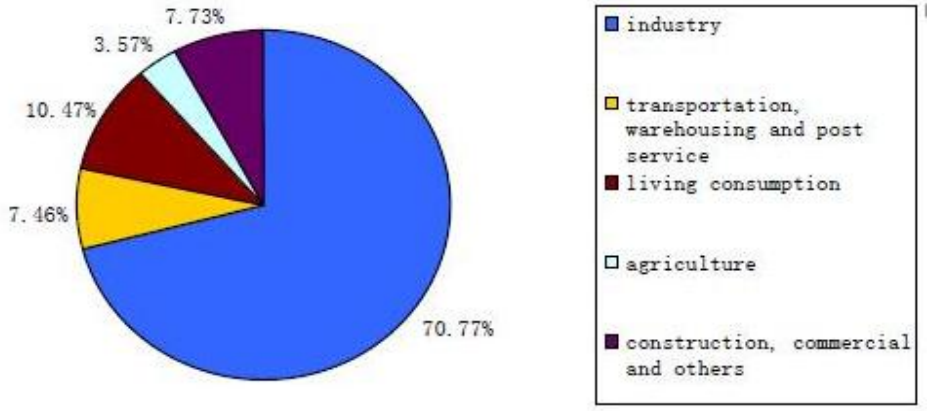
Source: The World Bank Data, China; National Bureau of Statistics of China Database

Figure 28. Fossil fuel consumption (% of total)



Source: The World Bank Data, China; National Bureau of Statistics of China Database

Figure 29. Energy consumption structure in China



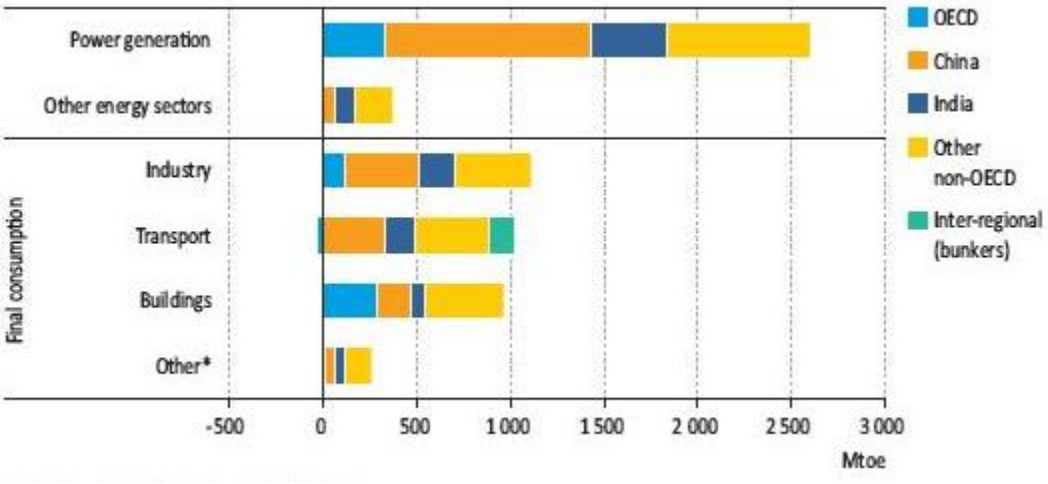
Source: EIA, The US Energy Information Administration (2011)

Table 1. World's largest oil and gas producers by output

Rank	Company	Mboe
1	Saudi Arabian Oil Co	4148.83
2	Gazprom	3313.35
3	National Iranian Oil Co	1810.74
4	Petroleos Mexicanos	1666.23
5	PetroChina Co Ltd (CNPC)	1040.51
6	Exxon Mobil Corp	983.32
7	Sonatrach	904.36
8	Kuwait Petroleum Corp	892.44
9	Petroleos de Venezuela SA	817.6
10	Total SA	732.24
19	BP Plc	485.05
23	Royal Dutch/Shell	421.93
26	ChevronTexaco Corp	384.44
30	Sinopec	314.68
33	ConocoPhillips	281.47
38	CNOOC Ltd	210.99

Source: Rosen & Houser (2007)

Figure 30. Incremental energy demand by sector and region in 2009-2035



Source: IEA, World Energy Outlook (2011)

SECTION 5. POLICY RECOMMENDATIONS FOR SUSTAINABLE DEVELOPMENT

Having analyzed the major recently implemented polices in energy sector and their actual influence on the sector development, now the existing gaps in the energy policy have to be addressed to ensure stable energy supply for the sustainable economic development. This chapter provides potential policy suggestions for China's energy policy improvement and strategies how to achieve main policy targets. China's energy policy formulation, objectives targeting and some limitations identification are essential parts of the energy policy making process which are prerequisites for policy implementation which contributes to the sector's advancement. The following recommendations are based on the energy data assessment, the analysis of the country's socio-economic development, its energy sector situation, long term energy demand projections, identification of the policy makers and stakeholders influencing the energy policy formulation and implementation, and recent energy policies analysis.

Suggested policies try to provide the solution for the main puzzle of Chinese energy system – how to maintain sustainable development of the energy sector to secure disruptive energy supply for further economic development in China.

5.1 Supplier diversification

Current distribution of partners in total energy suppliers' mix heavily relies on Middle East and African countries, including such partners as Saudi Arabia, Angola, Iran, Oman, Sudan, Iraq, Kuwait, Libya, etc (Figure 19). Given the recent political distabilization in both regions and further possible development of the internal and external conflicts, the energy supply, particularly oil, may be disrupted. Such a disruption possibility endangers the sustainability of economic growth due to the lack of energy resources and insufficient emergence response mechanism.

To minimize the risk of disruption, China should expand energy trade cooperation with more suppliers to smooth out the shares in imports. Long term contracts for more than 20 years with revised conditions for supply disruption punishment can also help to diminish supply disorder. However, the major limitation of such contracts might occur with decreasing prices – if the market price for energy commodity decreased in comparisson with the contracted one, China might be worse off. But energy supply disruption is the bigger price for the development.

Relations with Russia in energy sector cooperation should be significantly improved, since these partners' energy relations have the biggest potential and benefit both. Today the potential of such cooperation is not effectively fulfilled. From the Chinese perspective, Russia is the neighbouring country with abundant supply for energy, being one of the major energy producers in the world. Deeper cooperation with Russian oil and gas companies providing bigger share in energy supplies can provide lower transportation costs and diversified energy supply. From Russian side, the exports diversification is also beneficial. Russian major energy corridors are targeted towards Europe, while many European countries apply diversification strategy themselves and seek for alternative partners and energy sourcess. The Asian route provides additional energy revenues for Russia with growing potential, especially partnering with China, tremendously developing and constantly demanding more energy, provides long term partnership potential and stable income. However, the Russian energy companies' reputation is slightly damaged by some accidents in Europe. The political risks and conflict potential in major supplying counties are bigger concerns for supply disruption than several occasions which were not fully justified still and have involved several associates.

5.2 Diversification of energy mix

China's unbalanced energy mix, heavily relying on coal, incrementaly utilizing gas, nuclear, renewable and other energy sources, is inefficient not only because the coal itself is less energy efficient than oil and gas, for example, but also it heavily pollutes the environment. The diversification of energy mix is needed to secure increasing demand and economy's energy efficiency.

One of the best alternatives for coal substitution is gas, both natural and unconventional. Natural gas is highly energy intensive resource and one of the cleanest fossil fuels. The only problem is the transportation – natural gas in its normal state can be transported only by pipes which is limiting its transportation abilities and constrains China to its neighbours since the more countries are tied by the pipeline, the more interests should be considered, the less resource China gets, and the less realistic and economically rational project is. In this case the cooperation with Russia which has the largest natural gas reserves and long border with China is also beneficial. Unconventional gas, including shale gas, tight gas and coalbed methane, has a huge potential in satisfying the domestic demand for energy. However, there are two concerns – the heavy investments on exploration and technologies, and environment impact of some extraction technologies, like fracking for shale gas which destroys natural environment. Liquified Natural Gas (LNG) can be one of the best options, being the same conventional gas and having the equal benefits, but in a liquid form, making the transportation much easier. The construction of LNG facilities and the technological development need significant investment.

Renewable energy has already caught the attention of the Chinese government and the target has already been stated: to reach 15% of the energy mix share by 2020 and even 27.5% by 2050 (Chmutina, Saffa, & Zhu, An Overview of Renewable Energy Policies and Regulations in

People's Republic of China, 2010). The government's initial efforts to implement several policies to increase the exploitation of renewable energy should continue and overcome the existing barriers. This industry is still in the development and investigation process. There is a need for special strategy to foster technological development in the industry, since it havily relies on the modern energy production technologies. Moreover, R&D initiatives should be established along with industrial integration of the renewable energy technologies, and preferencial tax treatment for companies which explore and develop renewable energy projects. To promote greater use of renewable energy, companies may be granted tax subsidies. Renewable policies should be established and implied not only at the country level, but also locally. The utilization of renewable energy is cleaner than fossil fuels, but more expensive.

The nuclear energy has also many benefits. It is clean and emission free energy, requiring large investments in the beginning but bringing returns for its entire life cycle, safe and reliable energy source, compact and energy efficient it can considerably substitute fossil fuels. However, the nuclear reactor construction requires large investments and is not safe in areas with the potential for natural hazards. The latest Fukushima tragedy in Japan in 2011 where the nuclear power station exploded after the earthquake and thsunami hit raised many concerns about utilizing nuclear energy and constructing nuclear power stations, especially in Europe where, for example, Germany, having a diversified energy mix, decided to shut down all nuclear power plants. China has many areas potential for natural hazards like earthquakes, floods and other, which can complicate the development of this industry, however, applying the latest technologies and locating these plants in more safe areas can reduce such danger of nuclear energy.

5.3 National Energy Administration's reorganization

To ensure sustainable development of energy sector and providing effective energy supply for the growing economy, the coherent planning system should be established. The system implies the national long term energy strategy and the authority establishing and implementing such policy. According to Downs, the attempts to establish an effective national energy policy making institution since 1950s resulted in lacking authority, resources, apparatus and autonomy to properly manage the energy sector institution. (Downs, 2008) Even the establishment of new National Energy Administration has not changed the situation much. Even though the separate energy ministry was established and supposed to conduct the national energy policy, it still lacks the tools, authority and resources to formulate coherent policy based on central government's guidelines and implement it. NEA should have the energy ministry functions not only on the paper but also in reality. There is a need to reshuffle the agency, revise its work and functions. The new functions should include the following:

- long term planning and implementation in China's energy sector;
- energy sector's data allocation, analysis and future projections, reports preparation and information sharing;
- control of mergers and acquisitions of national energy companies along with their international cooperation;
- international representation of China's energy interests in the global arena;
- formulation and implementation of the legislation for energy sector;
- sharing the responsibility of energy resources management;
- energy revenues, subsidies and financial investment allocation in cooperation with the Ministry of Finance and Economic Affairs, and other.

5.4 Establishment of coherent national energy policy

Since China has a fragmented energy policy concentrated on the diverse incoherent targets and objectives mostly for short and medium term, to achieve concrete results in energy security and provide sustainable development for the economy, a national energy policy accumulating all the targets and guidelines should be established. The main actor in energy policy formulation and implementation should be the renewed National Energy Administration. A country-wide long term energy policy with constantly revised achievements, projections, further uniform policies and concrete implementation targets instead of fragmented and particularly industry oriented policies will ensure stable development of the energy sector and the economy. This national strategy should be linked with local energy policies and provide development guidelines for particular areas also. (Such policy will be mostly concentrated on securing energy supply, energy conservation and efficiency, diversification of energy, technological development and other.)

5.5 Energy efficiency improvement

For persistant energy availability it is essential to continue working on energy efficiency advancement, drop in energy intensity, streightening energy conservation. Improvement of energy efficiency will reduce the risks and costs associated with high energy intensity of Chinese economy and make it possible for the country to ensure energy security, stimulate sustainable economic development, economize on the lower energy consumption and use the available financial resources to import extra what facilitate further development growth. The energy efficiency improvement will reduce the risks and costs associated with high energy capacity of the Chinese economy and give an opportunity to increase the degree of energy security; improve

the competitiveness of enterprises; provide savings to federal and local budgets; reduce emissions and negative environment impact. Energy conservation and efficient use of energy should become a mandatory part of central and regional energy policies.

The Department of Energy Efficiency and Conservation – special department of NEA responsible for energy efficiency issues should be created. This department will perform the following tasks:

- Formulating technical requirements in the energy efficiency area by setting standards of control and certifying energy efficient projects;
- Providing necessary advice on energy conservation policies to government bodies and diverse stakeholders;
- Consolidation of state projects in the area of energy efficiency;
- Collecting information on energy production and utilization at different levels to monitor energy efficiency improvements.

It is also necessary to label diverse appliances to inform consumers about the energy efficiency of the product to let them compare and choose less energy intensive product to save the energy. The distribution of information about energy saving and its promotion can also help to raise energy efficiency awareness and get citizens involved into energy saving campaigns. In order to improve energy efficiency households, enterprises and government agencies must have information regarding how to recognize and apply energy efficiency approaches and technologies.

The government subsidies reduction of energy prices can also improve energy efficiency in China. Setting prices below the market price government is trying to ensure that the majority of citizens will get the strategic supply of energy, for example electricity. However, the

artificially low prices bring an incentive to over-consume energy resources since electricity is still too cheap to expect a reasonable return on investment and reduction of its consumption. Establishing the market prices can be an effective solution to change the final consumers' behavior and preferences toward energy efficiency. However, the extent of prices changes influence on energy savings will depend of price elasticity of energy resources. Basing on the long-term estimates of demand price elasticity for energy resources in the OECD countries, it is clear that energy products are highly inelastic and hard to substitute for something else. (Gillingham, Newell, & Palmer, 2009) Consequently, to cut expenses end-users will have to reduce energy consumption or at least use it more efficiently.

There are two problems with this approach. First is the actual availability of energy for poorer sectors of population. This issue, however, should be solved by direct subsidies – providing income increase for the same amount as energy prices increase. The other more serious problem is the reduction of Chinese companies' competitiveness. Companies have incentives to consume less provided by the increase of the energy costs. This increase of costs is an issue which can cause strong dissatisfaction of the heavy industry production companies mostly located in the remote less developed provinces.

Government should use the financial incentives to increase energy efficiency. Such incentives will promote energy saving appliances and technologies' investments by reducing investment costs using direct measures (subsidies or soft loans) or indirect (fiscal incentives) (Gillingham, Newell, & Palmer, 2009). Energy efficiency subsidies were applied massively in the majority of developed countries to upgrade existing buildings and equipment reducing the investment burden of consumers, distributed by diverse means as fixed sum, particular percentage, or proportional to energy savings amount. However, there are some possible

problems associated with distribution of subsidies: they may be used by people who would apply energy savings even without them increasing budgetary expenses; or some targeted people will not use them if there is a lack of information and if the application process is too bureaucratic. Energy efficiency can also be promoted by banking institutions which provide soft loans with interest rate below market for the purpose of investing in energy saving technologies and equipment. In addition, energy efficiency can be encouraged through fiscal incentives such as accelerated depreciation (targeting industry and commercial sector), tax credits and tax deductions (for households).

5.6 Energy market liberalization

Energy market liberalization will allow market forces to influence the energy sector development. The transition to a more liberalized energy market will attract foreign investment, facilitate deeper cooperation and might help in implementation of the suppliers' diversification strategy. Liberalization will improve productivity and sector's financial performance, reduce investment burden of the government attracting private investment, the quality of energy products and services will also increase due to competition. However, the main risks of liberalization is that it brings uncertainty and no guarantee that the energy sector objectives will be reached. The clear liberalization policy can solve these uncertainties. Consistent liberalization plan with minimized risks and maximized benefits will attract investors by rising the confidence and promoting public awareness.

The occasional energy resource shortage illustrates the ineffectiveness of current energy system, which is the restricting factor for country's economic growth. If China establishes a competitive energy market it will provide energy development, better supply securitization and economic growth. The energy system restructuring is the last in the transition to the market due

to its strategic nature. After the creation of the sector's supervision system on the basis of National Energy Administration, heavy regulation energy of sector and government intervention should be significantly diminished. This will relax market access and attract domestic and foreign private capital. It is also very important to establish an adequate price mechanism including not only energy production costs, but also the resource and environment costs built into the price. (Liu & Jiang, 2009) This should include the reflection of the supply and demand structure on the market, environment costs and scarcity of resources; moreover, market prices can protect the lowest income people ensuring basic needs. (Liu & Jiang, 2009) By applying the market price mechanism and opening the futures market for energy commodities China can use its influence on the international energy prices.

5.7 Infrastructure development

Infrastructure development will contribute significantly to energy sector development, and consequently ensure better and more stable energy supply. The transportation infrastructure is the focal point for coal supply facilitation since the main mean of transportation is the railway net which is highly inefficient since network now operates at the full capacity. Moreover, the railway system do not go to every remote area. The pipeline network development for gas industry growth is an essential part of the transportation process – without infrastructural development the gas will not reach the customers. The situation with LNG is the same, which requires construction of special facilities for production and transportation. The energy infrastructure requires significant amounts of investment but the expansion of the energy mix is impossible without infrastructure enlargement.

5.8 Technological development

To provide energy security, China should invest in development of technologies. Energy efficiency can be increased by utilizing new technologies. A significant amount of investment is needed to develop alternative and unconventional energy sources. To facilitate research and development practices, advance its independent technological potential, encouraging clean coal, renewable, nuclear energy, new technologies for low energy intensive vehicles, ensuring higher energy security of the country, the additional large capital and human investment is required. It is also necessary to facilitate international cooperatuion in research and development, technologies sharing and exchange with foreign partners. Technological advances will cut the demand for energy what will provide better energy security.

5.9 Environment protection and cleaner energy use

The advancement of the energy sector is closely tied to environment protection concerns, since the sector is one of the major contributors to environment pollution. Environment protection concerns can become the major issues influencing the development of the energy sector. China has statred to pay close attention to the environment protection – a lot has been already done and still a lot should be done to provide more efficicent environment protection and sustainable development of Chinese energy sector, society and overal economy. China's energy consumption still needs to be adjusted and clean energy resources production should be facilitated to protect the environment.

5.10 The improvement of emergency system of energy reserves

Government has already planned to provide conventional 90 days of oil supply in the near future. However, such an emergency supply management system has to be established for

other fuels to secure better the minimum amount of energy supply for the potential disruption. Moreover, the strategic reserves legislation and standards should be established. Such legislation will provide the guidelines and operation mechanism for the emergency reserves utilization procedures.

The key challenge for the government is to ensure the implementation of the policy options since many of the stakeholders can interfere and bound the policy implementation for the sake of their interests. The possibility to avoid such interferance and disturbance depends on the availability of well adapted to the current energy system, economic structure and institutional development tools, meaning that the energy policy should be well adapted to the Chinese system. For this reason the thorough analysis of diverse aspects influencing the energy supply was needed to offer the possible energy policy objectives which are created to benefit the sector and entire Chinese economy.

The main and the most viable objectives for sustainable development of the energy sector and energy security are:

- suppliers diversification;
- energy mix enhancement;
- establishment of the coherent nation-wide energy policy;
- continuation of energy efficieny improvement.

CONCLUSION

The Chinese economy expands requiring constantly increasing sources for its growth. One of the major factors of sustainable economic growth is the energy supply security. In this research I tried to provide a thorough analysis of the Chinese economic development, its significant influence on the energy demand, the overall structure of the energy sector, its current state, main authority influencing the strategy formulation and implementation for the sector, and their recent policy results. The systematic analysis of the energy supply security problem provides solid background for further policy formulation. I attempted to offer several policy recommendations which should improve the situation in the energy sector, ensure more disruptive supply of energy what will contribute to sustainable economic growth of the country.

These policies mostly targeted towards identified problems of recently implemented policies, such as: lack of coherent national energy policy; fragmented structure of policy making institutions and ineffective energy affairs administration; outdated or inadequate infrastructure for such rapid growth of the sector; foreign partnership with politically risky suppliers what can lead to potential energy supply disruption; undiversified energy mix; ineffective emergency response system; low energy efficiency; not liberalized energy market; severe environment pollution, and other.

Chinese government persistently implements incoherent and ad-hoc energy objectives instead of structured national long term energy policy, what is significant problem for the sector development. There is a need for structured policy – if the future supply is not planned and the strategy how to achieve the supply targets is not established, there is a significant potential for supply disruption. The problem of energy policy makers' fragmentation and inefficiency of new

National Energy Administration can be addressed by providing this agency with more authority, autonomy and tools for policy implementation.

Infrastructure development, especially transportation infrastructure, is essential part of the energy supply provision and requires significant investment. This investment usually comes from the government, but with the considerable enlargement of the energy sector government might not have the available resources, so the foreign investment should be attracted. Without the significant liberalization of the sector, the foreign participation is problematic. Clear liberalization policy will raise the investors' confidence in the Chinese energy market and attracts necessary amount of capital.

The energy mix diversification and substitution of the considerable share of coal by cleaner energy resources like gas, renewables and nuclear power will not only help to secure more stable supply, but also reduce the environment pollution. Such substitution is expensive and long term process, however, it is necessary for sustainable development of the sector and economy. The suppliers diversification is also necessary policy for China's persistently growing energy demand satisfaction. By having more suppliers of diverse energy resources China can have more flexible options in energy strategy.

The high energy intensity or low energy efficiency problem should be also addressed, since by efficiently cutting the amount of energy inputs country can save the additional resources for development. Financial incentives, price changes, creation of special separate department dealing with energy efficiency problems and other incentives should help in energy intensity drop.

Recommended policies can help to maintiain sustainable development of the Chinese economy through securing undisruptive energy supply and providing the energy sector

development. Conducting this study and formulating the policy options I identified two areas of further possible research, one of which is the energy cooperation of China and Russia. This seems to be very important topic for both countries. However, apart from economic development concerns, migration and constant disputes about energy prices there is insufficient concrete reasoning why the cooperation between two partners is still insignificant. Another possible area of further research might be the creation of the economic 'growth points' – special zones in the resource rich, but less industrially developed provinces. The further research is necessary to find out whether it is actually realistic to create special zones enjoying benefits of resourcefulness based on the example of eastern clustering.

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