Chapter 5

China Country Report

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1. Background

1.1. Natural Condition and History

The People's Republic of China has an area of 9.6 million square kilometres and is situated in eastern Asia on the western shore of the Pacific Ocean. China's continental coastline extends for about 18,000 kilometres, and its vast sea surface is studded with more than 5000 islands. Due to its size, China's climate is very diverse, ranging from an unbearable 48ºC in the northwest during summer to an equally unbearable -40ºC in the far north in winter.

China has more than 5000 years of history and is one of five countries with a great ancient civilization. The People's Republic of China was founded on 1 October 1949. Today, China is implementing reforms and opening up its economy. It has established a socialist market economy, thereby charting the course for socialist modernization with Chinese characteristics.

1.2. Economy and Population

China's GDP in 2010 was around US$3246 billion (in 2000 US$ terms), which translates into a per capita income of around US$2400. China is the world's most populous country and it has a population of about 1354 million (2012). To mitigate population growth, China has implemented a family planning policy since the 1970s. China has been experiencing a fast urbanization process, with a 1 percent annual growth rate since 1978 when China's reform and opening up started. Around 52.6 percent of people lived in urban areas at the end of 2012.

1.3. Energy Situation

China is endowed with coal, oil and gas reserves, and hydropower. China is the world's largest coal producer and has the third largest coal reserves, with recoverable reserves of 114.5 billion tonnes. In 2012, China produced 3.65 billion tonnes of raw coal. China is also a major crude oil producer, with output of 207 million tonnes of crude oil in 2012. However, driven by very fast increases in domestic oil demand, China became a net oil importer in the 1990s. Approximately 60 percent of China's oil consumption is met by imported oil. China is also a large producer and exporter of energy intensive manufactured products. In 2012, it produced 953 million tonnes of finished steel and 2.21 billion tonnes of cement, and exported 56 million tonnes of finished steel.

China's per-capita energy reserve is very low, much lower than the world average. The per-capita average of both coal and hydropower resources is about 50 percent of the world average, while the per-capita average of both oil and natural gas reserves is only about one-fifteenth of the world average. The per-capita average of arable land is less than 30 percent of the world average, which hinders the development of biomass energy.

In 1990, coal accounted for 78.7 percent of net primary energy supply while oil was 17.8 percent, natural gas almost 1.9 percent, and hydro 1.6 percent. In 2010, coal was still a major fuel, but with a lower share of about 72.1 percent. The share of other energy sources increased from 1990 levels to 19.5 percent for oil, 4 percent for gas, and 2.8 percent for hydro.

Net primary energy supply in China increased at an average annual rate of around 6.1 percent from 671.7 Mtoe in 1990 to 2212.5 Mtoe in 2010. Energy intensity (net primary energy supply per unit of GDP) declined from 1510.8 tonnes of oil equivalent per million US$ in 1990 to 681.6 tonnes of oil equivalent per million US$ in 2010.

Final energy demand in China increased at a lower annual average rate of 5.3 percent from 466.2 Mtoe in 1990 to 1312.7 Mtoe in 2010. Coal accounted for 68.6 percent of final energy demand in 1990 but this declined to a share of 39 percent in 2010. In 1990, oil accounted for 18.3 percent of final energy demand but its consumption increased rapidly at 7.6 percent per year between 1990 and 2010. This

led to a significant increase in its share to 28.1 percent in 2010. Electricity demand increased very rapidly, with a growth of 10.7 percent per year between 1990 and 2010, higher than any of the other final energy sources. Electricity's share in final energy demand increased from 8.4 percent in 1990 to 22.6 percent in 2010.

Industry is the major energy consuming sector in China followed by the residential/commercial ("Others") sectors and the transport sector. The share of Industry consumption increased from 52.2 percent in 1990 to 54.2 percent in 2010. Conversely, the share of energy consumption by the residential/commercial sectors declined from 31 percent in 1990 to 21.9 percent in 2010 because of the faster growth in the industry and transport sectors.

In China, coal-fired power generation accounted for around 71.3 percent of total electricity generation in 1990. By 2010, this share had increased to 77.8 percent. The share of hydro was around 20 percent in 1990, but has since declined to 17.2 percent in 2010. Gas and oil, collectively, accounted for about 1.9 per cent of total generation in 2010. The share of nuclear power increased to about 1.8 percent in 2010.

The Chinese government is pushing the development of a modern energy industry. The Government takes resource conservation and environmental protection as two basic State policies, giving prominence to building a resource-conserving and environmentally-friendly society in the course of its industrialization and modernization.

2. Modeling Assumptions

2.1. Population and Gross Domestic Product

The outlook results for China have been developed by the Institute of Energy Economics of Japan (IEEJ) and were taken from modelling of a Business As Usual scenario (BAU) and an Alternative Policy Scenario (APS).

China's population increased from 1.135 billion in 1990 to 1.338 billion in 2010, but it is projected that China's population growth will slow as a result of the 'one child' policy. Over the period of 2010-2035, China's population is assumed to

increase at average rate of 0.1 percent per year and will reach 1.382 billion people by 2035.

China's economy grew at a rapid average annual rate of 10.5 percent from US$ 445 billion in 1990 to about US$ 3246 billion in 2010. In this study, GDP is assumed to grow at a slower rate of 5.6 percent per year for the period of 2010-2035 to reach US$ 12,736 billion by 2035. Given the GDP and population assumptions, GDP per capita in China is assumed to increase from around US$ 2,426 per person in 2010 to US$ 9,200 per person in 2035.

2.2. Energy and Climate Change Policies

Although China is still a developing country and has a GDP per capita less than one-seventh of that of the United States, the Government has aggressive goals on energy intensity reduction and addressing climate change issues.

According to official communiqué over the last five years, China has achieved significant energy conservation and remarkable progress in environmental protection. Between 2006 and 2011, the country eliminated 80 Gigawatts of small thermal power units, saving more than 60 million tons of raw coal annually. In 2011, coal consumption of thermal power supply per kilowatt hour was 37 grams of standard coal lower than in 2006, a decrease of 10 percent. In 2011, the installed generating capacity of hydropower reached 230 Gigawatts, ranking China first in the world in hydropower capacity. Fifteen nuclear power generating units were put into operation, with a total installed capacity of 12.54 Gigawatts. Another 26 units, still under construction, will have a total installed capacity of 29.24 Gigawatts, ranking China first in the world in nuclear power capacity. The installed generating capacity of wind power connected with the country's power grids reached 47 Gigawatts, ranking China top in the world. Photovoltaic power generation also reported speedy growth, with a total installed capacity of more than 3 Gigawatts in 2011. Solar water heating covered a total area of 200 million square meters. The State also expedites the use of biogas, geothermal energy, tidal energy and other renewable energy resources. Non-fossil energy accounted for 8 percent of the net primary energy supply in 2011, which means an annual reduction of more than 600 million tons of carbon dioxide (CO_2) emission.

China is also quickening the pace of control of coal mining subsidence areas, and has established and improved the compensation mechanism for the exploitation of coal resources and the restoration of the environment. In 2011, the coal washing rate reached 52 percent and the land restoration rate reached 40 percent. Existing power plants have sped up their desulfurization, upgrading coal-fired generating units with flue gas desulfurization facilities accounting for 90 percent of the national total. Coal-fired generating units reported a 100-percent installation of dust-cleaning facilities and a 100-percent discharge of waste water at the national standards.

The State is intensifying efforts for the development and utilization of coal bed methane (CBM), extracting 11.4 billion cubic meters of CBM in 2011. China became the first country to adopt a national standard for CBM emissions.

In China's Outline of the 12th Five-Year Plan (2011-2015) for National Economic and Social Development, it is stipulated that energy consumption per unit of GDP will drop by 16 percent from 2010 to 2015. In order to achieve this goal, the government has already implemented administrative measures, market based measures, and legal measures to promote energy conservation, and it will continue to implement new policies. Energy intensity reduction goals will be assigned to provincial governments and their progress will be announced publicly every year. In addition to conventional intensity targets, controlling total energy consumption is proposed.

The development of renewable energy has also been accelerated. The People's Congress of China passed the Renewable Energy Development Law of China in 2005 to support renewable energy development in the country. The Government also announced the target of increasing the share of non-fossil energy to about 15 percent by 2020 (measured in coal-equivalent). Subsidization policies have also been developed to encourage development of wind power, solar photovoltaic and biomass.

China has announced its goal of reducing CO_2 emissions per unit of GDP (carbon intensity) by 40-45 percent from the 2005 level by 2020. To meet the target, China will implement ambitious energy efficiency and fuel switching policies. Moreover, the Government has also announced its goal of establishing 40 million hectares of forested land to mitigate GHG emissions.

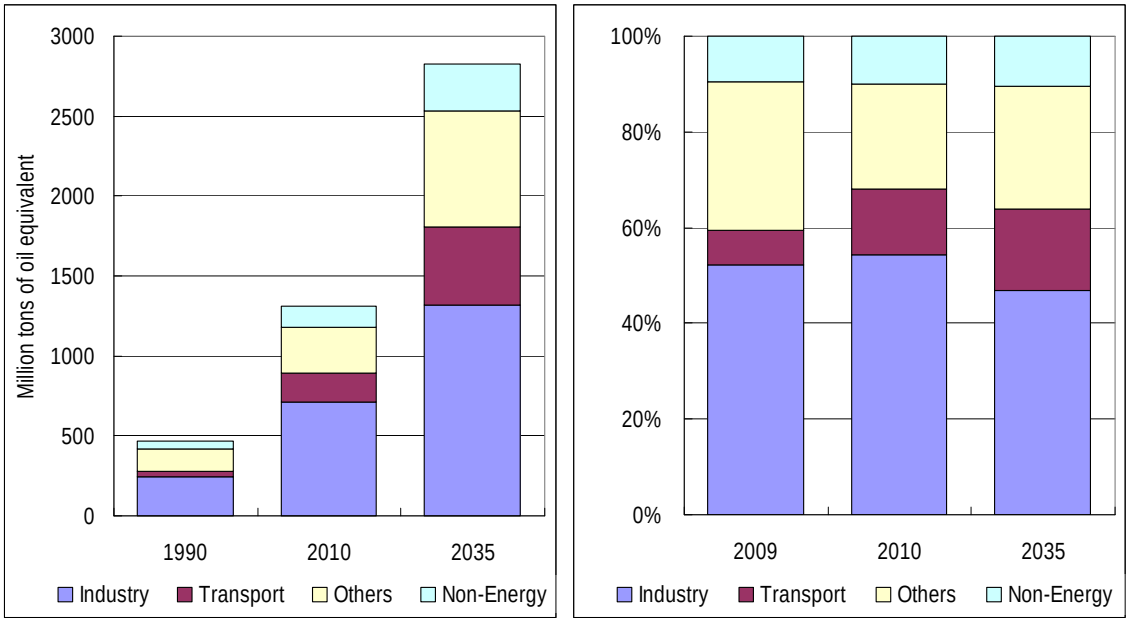
3. Outlook Results

3.1. Business-as-Usual (BAU)

Final Energy Demand

Between 2010 and 2035, the growth in China's final energy demand is projected to slow under the Business As Usual scenario (BAU), reflecting the lower assumed economic and population growth. Final energy demand is projected to increase from 1313 Mtoe in 2010 to 2829 in 2035, an average rate of 3.1 percent per year. The transport sector demand is projected to grow most rapidly, increasing by 4.0 percent per year, followed by the commercial and residential ('Others') sectors at 3.8 percent per year. Energy demand in the industry sector is projected to grow at an average annual rate of 2.5 percent. Figure 5-1 shows China's final energy demand and shares by sector under BAU, in 1990, 2010, and 2035.

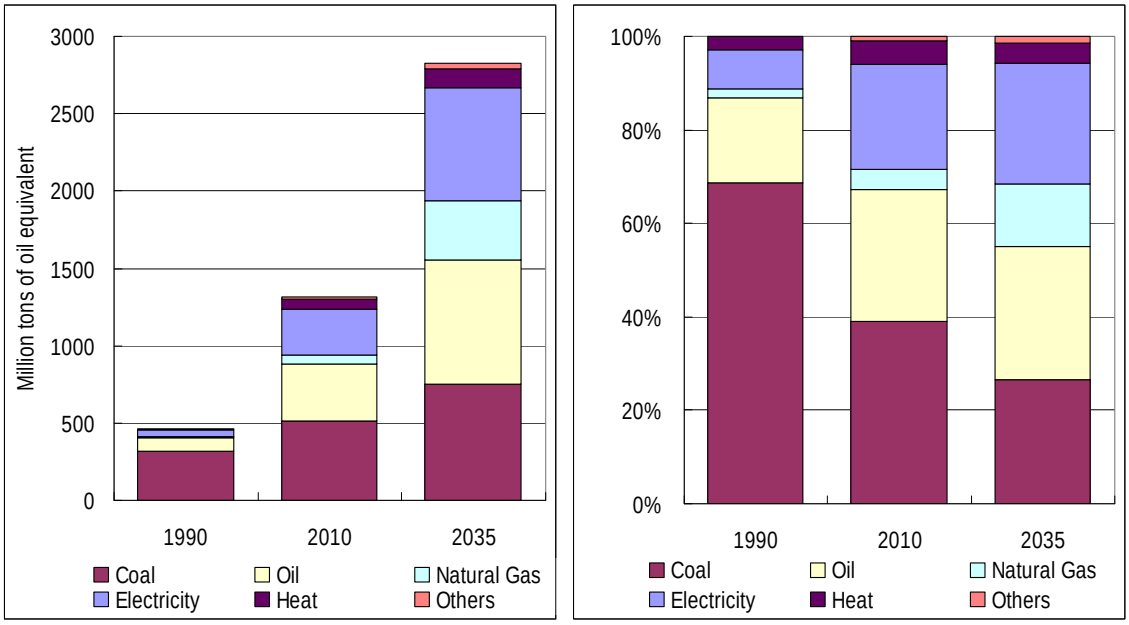
Figure 5-1: Final Energy Demand by Sector, BAU



For the energy sources, natural gas demand in the BAU scenario is projected to exhibit the fastest growth, increasing by 7.9 percent per year, from 57 Mtoe in 2010 to 381 Mtoe in 2035. Although coal will retain a large share of total final energy

demand, it is projected to grow at a much lower rate of 1.5 percent per year, achieving 749 Mtoe in 2035. This is compared with its 2.4 percent per year growth over last two decades. Demand for electricity and heat are projected to increase at an average annual rate of 3.7 percent and 2.5 percent respectively over 2010-2035, achieving 732 Mtoe and 120 Mtoe in 2035. Oil is projected to grow by 3.2 percent per year to around 805 Mtoe in 2035. Figure 5-2 shows China's final energy demand and shares by energy under the BAU, in 1990, 2010, and 2035.

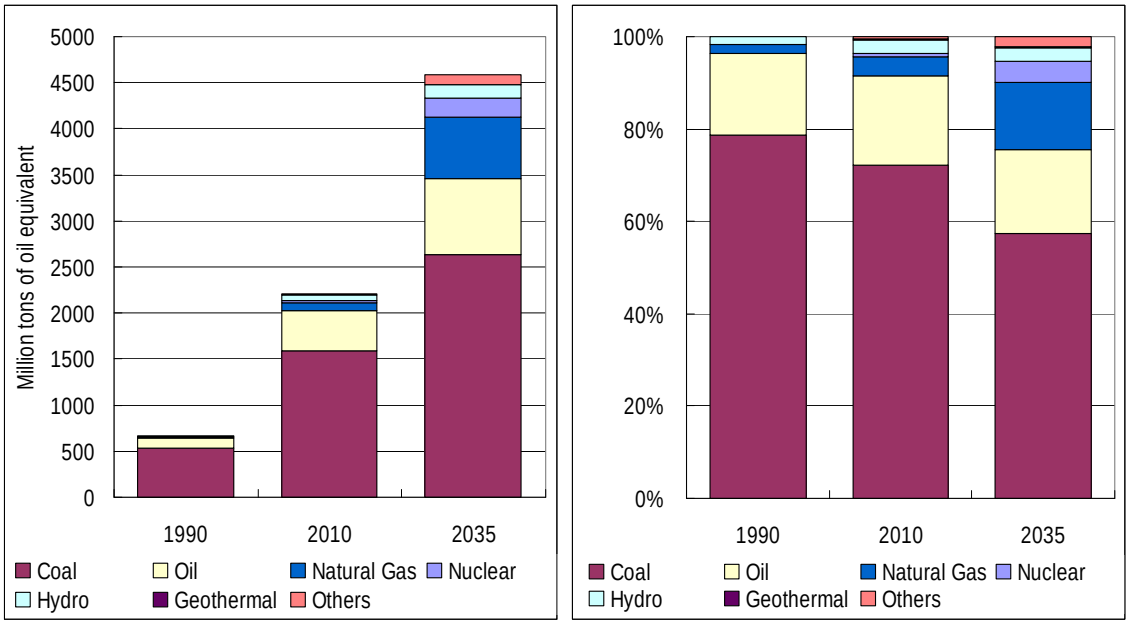
Figure 5-2: Final Energy Demand by Energy, BAU



Primary Energy Demand

It is expected that growth in primary energy demand will be slightly slower than final energy demand because of improved efficiency in the energy transformation sector. China's net primary energy supply is projected to increase at an annual average rate of 3.0 percent per year to 4585 Mtoe in 2035. Coal will still constitute the largest share of primary demand, but its growth is expected to be slower, increasing by just 2.0 percent per year. Consequently, the share of coal in total primary energy requirements is projected to decline from 72.1 percent in 2010 to 57.4 percent in 2035.

Figure 5-3: Primary Energy Demand, BAU



Nuclear energy is projected to exhibit the fastest growth between 2010 and 2035, increasing at an annual average rate of 10.1 percent, followed by natural gas at 8.4 percent. The share of natural gas is projected to increase from 4 percent in 2010 to 14.4 percent in 2035 whereas the share of nuclear will increase from 0.9 percent to 4.6 percent. Oil and hydro are projected to grow at lower rates of 2.7 and 3.3 percent per year, respectively. The share of oil is projected to decline from 19.5 percent in 2010 to 18.1 percent in 2035, while hydro's share is projected to increase from 2.8 percent in 2010 to 3.0 percent in 2035. Figure 5-3 shows China's net primary energy supply and shares by energy under BAU in 1990, 2010, and 2035.

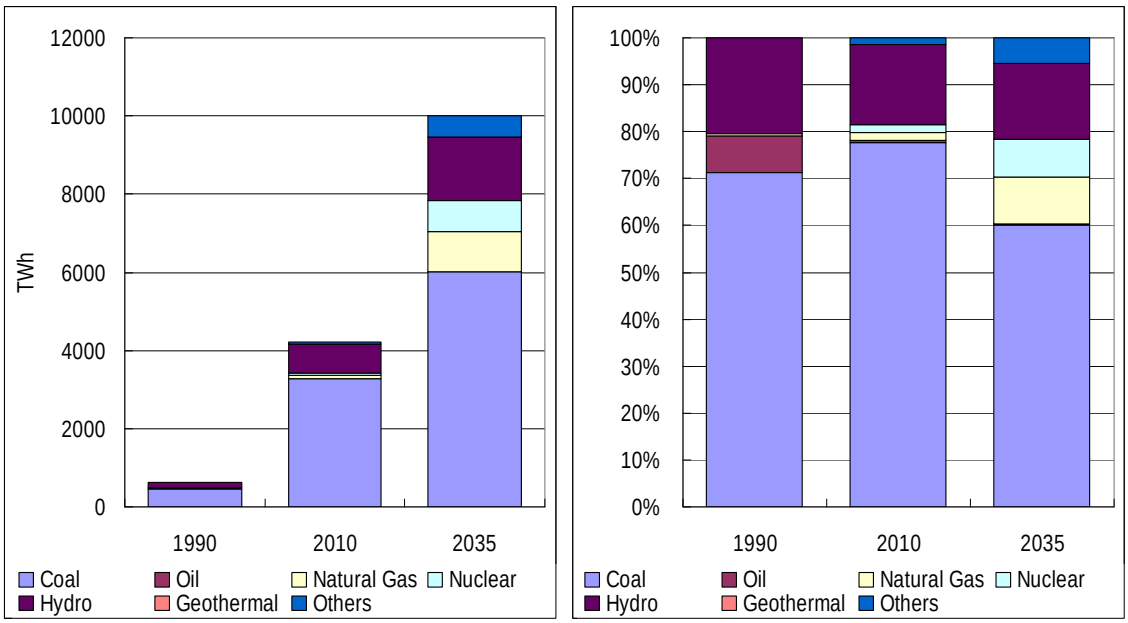
Power Generation

Power generation in China is projected to grow at a slower pace between 2010 and 2035 than in the last two decades. In the BAU scenario, power generation in China is projected to grow at 3.5 percent per year from 4208 TWh in 2010 to 10,009 TWh in 2035 (Figure 5-4).

The share of coal–fired generation under the BAU is projected to decline from 77.8 percent in 2010 to 60.1 percent in 2035. Conversely, the share of natural gas and nuclear generation are projected to grow from 1.6 percent and 1.8 percent in

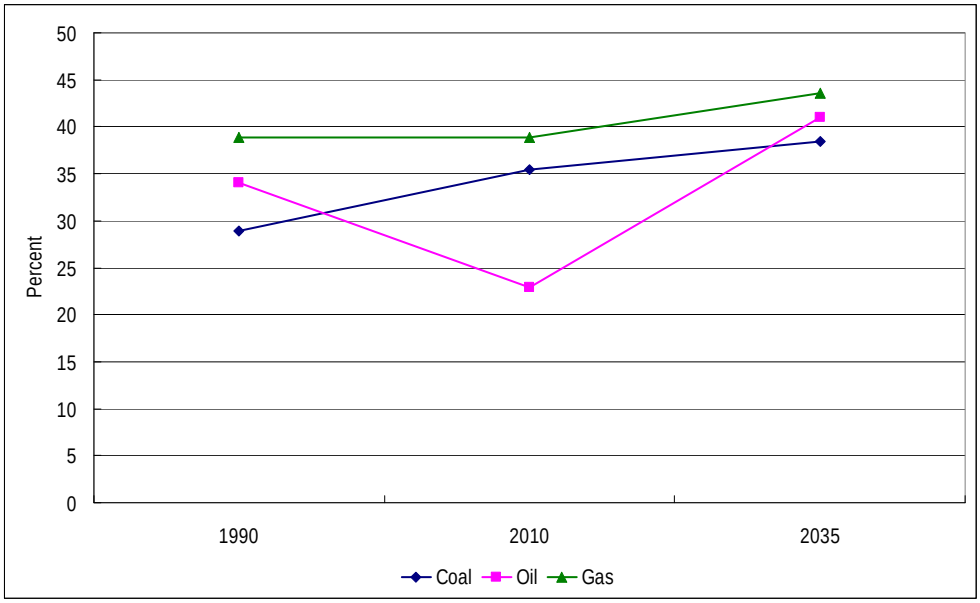
2010 to 10.1 percent and 8.1 percent in 2035 respectively. The shares of oil and hydro are projected to decrease slightly. In addition, other methods of power generation are projected to play an increasing role. The fast development of photovoltaic power generation in China is a typical example reflecting China's growing clean power generation focus.

Figure 5-4: Power Generation, BAU



China's thermal efficiency by fuel under BAU is projected to increase between 2010 and 2035 (Figure 5-5).

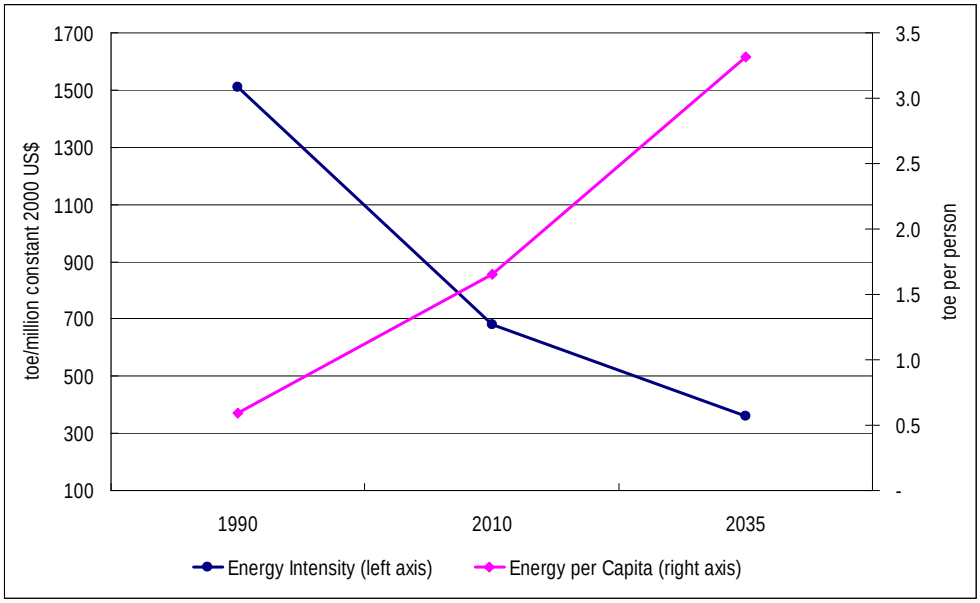
Figure 5-5: Thermal Efficiency by Fuel, BAU



Energy Intensity

Based on the expected economic and population outlook and the projected energy requirements of China, energy intensity defined as TPES/GDP and TPES per capita are illustrated in Figure 5-6. From 1990 to 2010, China's energy intensity experienced a sharp drop through national efforts on energy efficiency and conservation. By 2035, the energy intensity in China is projected to further drop to around 360 TOE per million (in 2000 US$ terms) under the BAU. With the improvement of living standards in China, energy per capita in China is projected to reach 3.32 TOE per person in 2035. Energy elasticity under the BAU, defined as Energy Growth/GDP Growth, is projected to be 0.53 in the future two decades, lower than last two decades 0.59.

Figure 5-6: Energy Intensity and Energy Consumption per capita, BAU

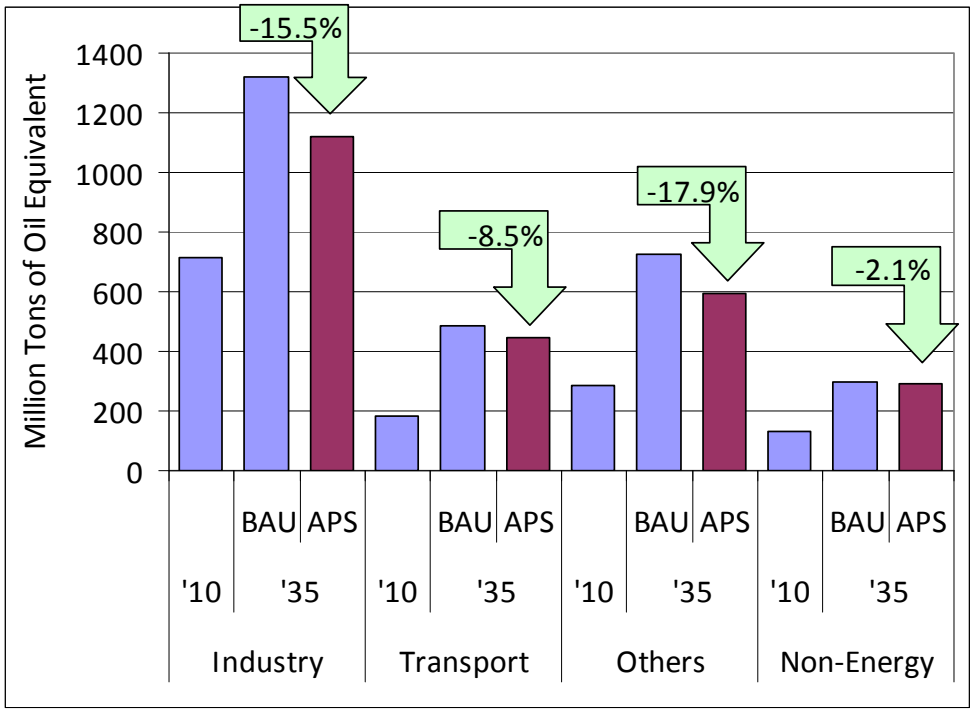


3.2. Energy Saving and CO_2 Reduction Potential

Final Energy Demand

Under the Alternative Policy Scenario (APS), final energy demand is projected to increase at a slower 2.5 percent per year, from 1313 Mtoe in 2010 to 2447 Mtoe in 2035, as a result of China's energy efficiency and conservation programs. An improvement in end-use technologies and the introduction of energy management systems is expected to contribute to slower energy growth in all sectors, particularly in the commercial/ residential and industry sectors. Figure 5-7 shows the difference in final energy demand in China in 2010 and 2035 under the BAU and the APS.

Figure 5-7: Final Energy Demand, BAU and APS



Power Generation

Under the APS, total power generation will increase by 2.6 percent per year between 2010 and 2035, to reach 8031 TWh. While fossil fuel-fired power generation will grow at a slower rate in the APS than in the BAU, the non-fossil fuel power generation will be faster. In 2035, nuclear power, hydro power, geothermal power, and "others" are projected to increase under the APS respectively by 11.7 percent, 4.1 percent, 10.4 percent, 12.2 percent between 2010 and 2035.

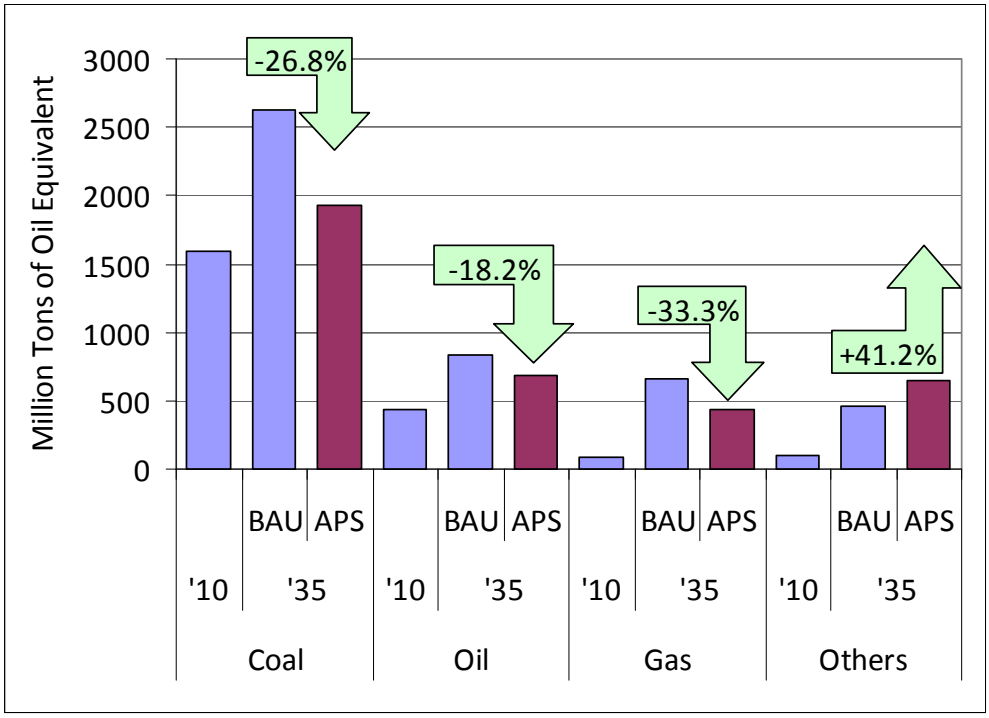
Primary Energy Demand

Under the APS, primary energy demand is also projected to increase at a slower 2.1 percent per year between 2010 and 2035, with primary energy demand reaching 3699 Mtoe in 2035. Coal is projected to increase by 0.8 percent per year, oil by 1.8 percent per year and natural gas by 6.6 percent per year.

Reflecting the change in power generation sector inputs, the annual average growth rate for nuclear will be higher than under the BAU, increasing by 11.7 percent per year between 2010 and 2035. The growth rate of hydro in the APS is

expected also to be higher than the BAU, increasing by 4.1 percent per year (Figure 5-8).

Figure 5-8: Net Primary Energy Demand by Source, BAU and APS

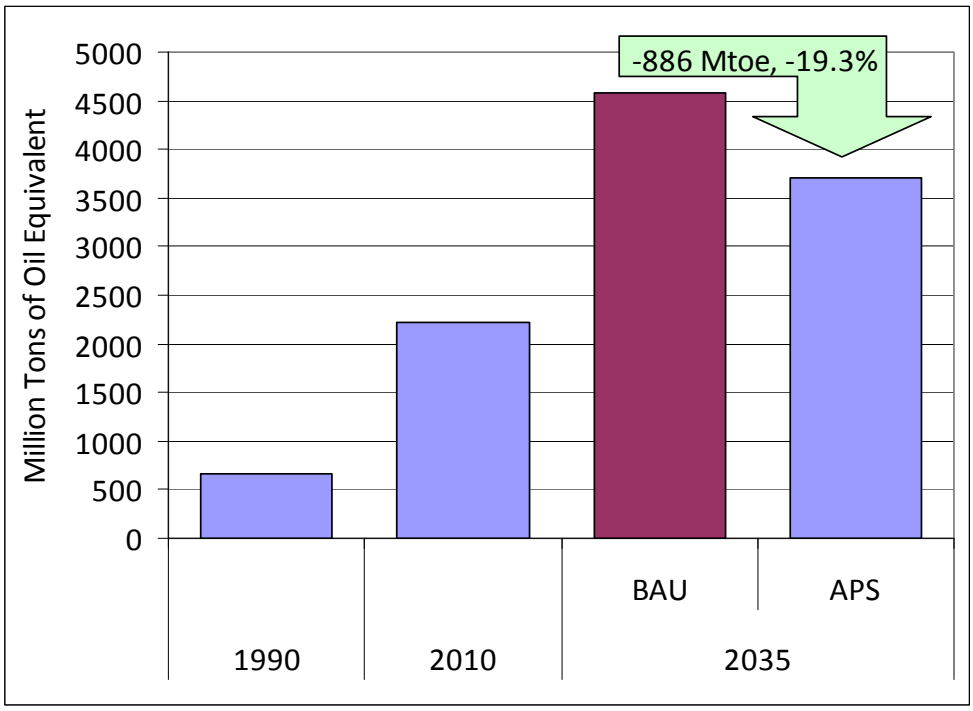


Projected Energy Savings

It is estimated that the implementation of energy efficiency and conservation goals and action plans in China could reduce net primary energy requirements in 2035 by about 886 Mtoe under the APS, relative to the BAU scenario. In the APS, China's primary energy demand is around 19 percent lower than the BAU (Figure 5-9).

In terms of energy savings in the final energy demand sectors in 2035, there are estimated savings of 204 Mtoe in the industry sector, 42 Mtoe in the transport sector, and 130 Mtoe in the residential/commercial sector under the APS, relative to the BAU scenario.

Figure 5-9: Total Net Primary Energy Supply, BAU and APS

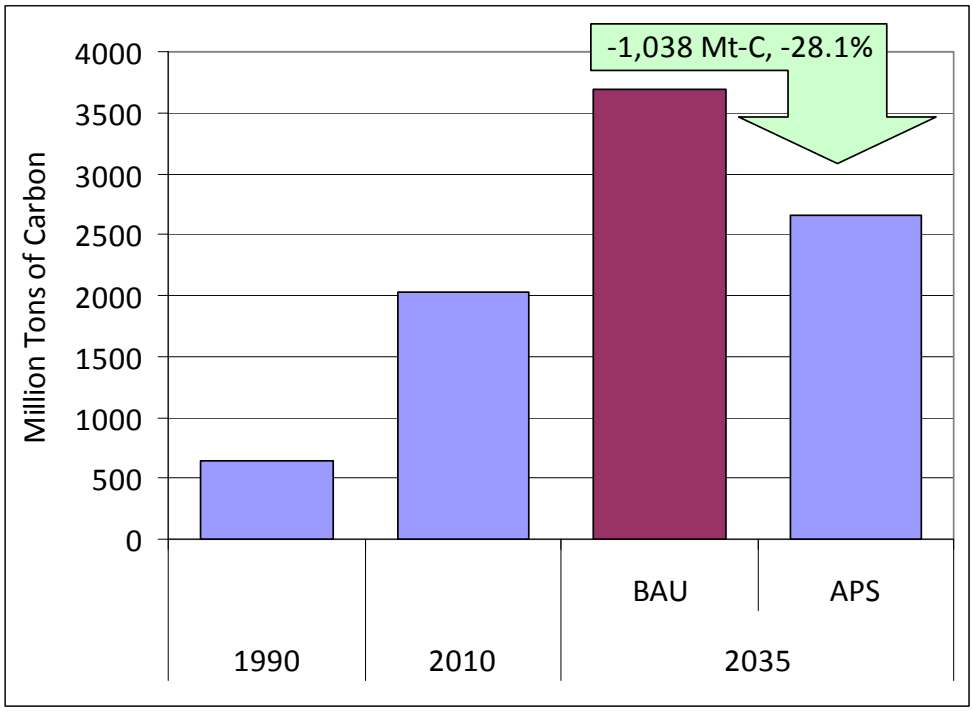


CO_2 Emissions from Energy Consumption

Under the BAU scenario, CO_2 emissions from energy consumption are projected to increase by 2.4 percent per year from 2025 Mt-C in 2010 to 3693 Mt-C in 2035. This growth rate in CO_2 emissions is lower than the growth in primary energy demand (3.1 percent) over the same period, indicating an improvement in the emissions intensity of the Chinese economy.

Under the APS, the annual increase in CO_2 emissions between 2010 and 2035 is projected to be 1.1 percent. This rate is also lower than the average annual growth rate in primary energy demand (2.1 percent) over the same period. The difference between the APS and the BAU CO_2 emissions growth rates indicates that the energy saving goals and action plans of China are effective in reducing CO_2 emissions (Figure 5-10).

Figure 5-10: CO_2 Emissions from Energy Consumption, BAU and APS



4. Implications and Policy Recommendations

As the world's largest developing country, it is paramount for China to remove poverty and improve life quality. China is in a fast growth phase and its urbanization rate is relatively low. Consequently, China will maintain its fast GDP growth, and its energy demand and CO_2 emissions will continue their fast growth, albeit at a slower pace compared to the last 20 years. It will be critical that China continue its focus on energy efficiency policy and programs, and that it continues to achieve the successes of the last three decades. While China's energy demand and CO_2 emissions will increase in the future, the energy intensity (energy demand per GDP) and CO_2 emission intensity (CO_2 emission per GDP) will decline with the implementation of sound energy efficiency and non-fossil fuel technology policies. Based on the APS of this analysis, China could reduce its total primary energy requirements by more than one-sixth and its CO_2 emissions by more than one-fourth by 2035.

There is a further great potential for energy saving in China, with around 50 percent of this achievable through structural change of the economy from a focus on heavy to lighter manufacturing industries and to development of China's services

industry. It is urgent to lengthen the life cycle of China's buildings and infrastructure: current short life cycles and the need for rapid turnover results in excessive production of energy intensive products such as steel and cement.

The closure of small inefficient power plants, coal mines, and small energy-intensive industries like cement and steel plants has been essential in improving China's industry structure to date. In the longer term, energy efficiency in the residential, commercial and transport sectors will be increasingly important in addressing energy saving given China's booming real estate market and automobile market in recent years. In addition, the market uptake of non-fossil and renewable energy technologies is vital for a future environmental friendly energy market structure.

The Government should formulate and put in place, as soon as possible, market-based measures to motivate enterprises and consumers to take action. This would include energy pricing reform such as removal of the current energy subsidies and the establishment of energy taxes, and the establishment of a carbon tax.

As a more immediate action, China should draw on international experience to develop and implement Minimum Energy Performance Standards (MEPS) and energy efficiency labelling to ensure that industry and consumers are able to invest in high efficiency technologies and appliances.