CHAPTER 5

China Country Report

Yu Hoo and Zhiqiang Gai

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CHAPTER 5

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1. Background

1.1 Natural Conditions and History

China has a land area of 9.6 million square kilometres (km) and is situated in eastern Asia on the western shore of the Pacific Ocean, with a continental coastline of about 18,000 km. China's climate is highly diverse, ranging from an unbearable 48°C in the northwest during summer to an equally unbearable –40°C in the far north in winter.

China has more than 5,000 years of history and is one of five countries with a great ancient civilisation. The People's Republic of China was founded on 1 October 1949. China has been implementing reforms and opening its economy for 40 years and has established a socialist market economy, charting the course for socialist modernisation with Chinese characteristics.

1.2 Economy and Population

China's gross domestic product (GDP) in 2019 was about US$14,363.58 billion, which translates into per capita GDP of about US$10,260.0 (in 2019 US dollar terms). China is the most populous country, with about 1.4 billion people in 2019 (China National Bureau of Statistics, 2019). China has implemented a family planning policy since the 1970s, but the 'one child' policy ended in 2015 and couples who satisfy certain conditions may have two children. Urbanisation has been rapid, growing by about 1% annually since 1978, when China started reforms and opening up. By the end of 2019, about 60.6% of the population was living in urban areas.

1.3 Energy Situation.

China is endowed with coal, oil, and gas reserves and tremendous hydropower potential. China is the world's largest coal producer and has the third-largest coal reserves, with recoverable reserves of 114.5 billion tonnes. In 2019, China produced 3.85 billion tonnes of raw coal. China is still a major crude oil producer, with output of 0.191 billion tonnes in 2019 (CCTV, 2020). Driven by the rapid increase in oil demand, China became an oil importer in the 1990s. In 2019, the amount of net imported oil reached 0.51 billion tonnes, with a growth rate of 9.5% (Industry Information Network, 2019) and a dependence level of more than 72.0% (Baijiahao, 2020). China is a large producer and exporter of energy-intensive items. In 2019, it produced 1.20 billion tonnes of finished steel and 2.33 billion tonnes of cement.

China's per-capita energy reserve is considerably lower than the world average. The per-capita average of coal and hydropower resources is only about 50% of the world average, whilst the per-capita average of oil and natural gas reserves is only about 6.7% of the world average. The per-capita average of arable land is less than 30% of the world average, which hinders the development of biomass energy.

Since 1990, coal has dominated primary energy consumption, with 60.7%, whilst oil, natural gas, and hydro consumption account for 13.6%, 1.5%, and 1.2%, respectively. Biomass consumption represents 22.9%, lower than coal consumption. In 2017, coal was still a major fuel, with a share of about 63.7%. The share of other energy sources increased from 1990 levels to 18.5% for oil, 6.4% for gas, and 3.2% for hydro, but the share of biomass decreased to 3.7%. Primary energy consumption increased at an average annual rate of about 4.8% from 873.48 Million Ton Oil Equivalent (Mtoe) in 1990 to 3,066.75 Mtoe in 2017. Energy intensity (primary energy demand per unit of GDP) declined from 1,053 tonnes of oil equivalent per US$ one million in 1990 to 302 in 2017.

Final energy consumption increased at a lower annual average rate of 4.2%, from 657.59 Mtoe in 1990 to 1,995.06 Mtoe in 2017. Coal accounted for 47.4% of final energy consumption in 1990 and 33.3% in 2017. In 1990, oil consumption accounted for 12.9% of total final energy consumption and increased rapidly by 6.9% per year from 1990 to 2017, resulting in a significant increase to 25.8%. The shares of electricity and natural gas consumption increased sharply from 5.9% and 1.3%, respectively, in 1990 to 23.9% and 6.6% in 2017. In 2017, the share of electricity consumption was almost equal to that of oil consumption.

Industry consumes the most energy, followed by the residential and commercial sectors

('others'). The share of industry consumption increased from 35.6% in 1990 to 49.4% in 2017. The share of 'others' declined from 54.1% in 1990 to 29.1% in 2017 because industry and transport grew faster.

Power generation is mainly from coal-fired plants, accounting for about 71.0% of total electricity in 1990. By 2017, this share had decreased to 67.9%. The share of hydro was 20.4% in 1990 but declined to 17.5% by 2017. Gas and oil collectively accounted for about 2.9% of total generation in 2017. The share of nuclear power increased to about 3.8% in 2017.

The government is pushing for the development of a modern energy industry. Resource conservation and environmental protection are basic policies guiding industrialisation and modernisation.

2. Modelling Assumptions

2.1 Population and Gross Domestic Product.

The model results were developed by the Institute of Energy Economics, Japan (IEEJ) based on the business as usual (BAU) scenario and the alternative policy scenario (APS).

The population increased from 1.135 billion in 1990 to 1.386 billion in 2017. Over the projection period, population growth is assumed to increase at an average rate of 0% per year from 2017 to 2050. The population will peak at 1.465 billion in about 2030 and reach 1.403 billion by 2050.

The economy grew at an average annual rate of 9.7%, from US$830 billion in 1990 to about US$10,161 billion in 2017 (in 2010 US dollar terms). GDP is assumed to grow more slowly, at 6.3% per year from 2017 to 2020, because of the economic 'new normal', 5.3% per year from 2020 to 2030, and 4.1% per year from 2030 to 2040. The average annual growth rate of GDP from 2017 to 2050 is 4.2%. GDP is calculated to reach US$39,688 billion by 2050. GDP per capita is assumed to increase from about US$7,330 in 2017 to US$28,280 in 2050.

2.2. Energy and Climate Change Policies and Their Performance.

Although the country is still developing and GDP per capita was about 14.3% that of the United States in 2017 (using the nominal exchange rate), the government has set ambitious

goals for reducing energy intensity and mitigating climate change. Government data in the last 5 years show that China has significantly conserved energy and made remarkable progress in environmental protection and climate change mitigation.

The Outline of the 13th Five-Year Plan (2016–2020) for National Economic and Social Development stipulates that, by 2020, energy consumption per unit of GDP will drop by 15% from 2016. To achieve this goal, the government is implementing administrative, market-based, and legal measures to promote energy conservation. Energy intensity reduction goals are assigned to provincial governments and their progress is announced publicly every year. During the 12th Five-Year Plan (2011–2015), energy consumption grew by 3.6% per year and GDP by 7.8% per year. Energy intensity decreased by 18.2%, more than the targeted 16.0%. Energy consumption per unit of GDP in 2015 decreased by 5.6% compared with that of 2014.

The government proposes controlling total energy consumption. The Energy Development Strategic Action Plan (2014–2020) states that coal consumption (primary energy consumption) will be limited to 2,940 Mtoe in 2020 and primary energy consumption to 3,362 Mtoe. Under the 13th Five-Year Plan of Energy Development, the ratio of coal consumption to total energy consumption should be lowered by 2020 to at most 60% and natural gas consumption should account for 10%. New energy vehicles will number 2 million.

China aims to reduce carbon dioxide (CO2) emissions per GDP (carbon intensity) by 40%–45% by 2020 and 60%–65% by 2030 from the 2005 level; CO2 emissions will peak in 2030. China has implemented ambitious energy efficiency and fuel switching policies, including. In 2019, national emissions of sulphur dioxide, nitrogen oxides, chemical oxygen, and ammonia nitrogen decreased by 4.4%, 3.5%, 3.2%, and 3.3%, respectively. The annual target of CO2 emissions per unit of GDP is expected to be reduced by 3.6% (Ministry of Ecology and Environment, 2020).

China has made great efforts to develop non-fossil fuel and accelerated the development of renewable energy. The People's Congress passed the Renewable Energy Development Law of China in 2005. The government announced it would target increasing the share of non-fossil energy to about 15% by 2020 (measured in coal equivalent) and 20% in 2030. Subsidy policies encourage development of wind power, solar photovoltaic, and biomass energy. In 2019, China was once again the largest investor (US$83.4 billion) in renewable energy, but the amount was down 8% from 2018, the lowest level since 2013. Wind power investment increased by 10% to US$55 billion but solar energy investment fell 33% to US$25.7 billion, less than one-third of the peak in 2017 (International Energy Small Data, 2020).

In 2019, the energy sector eliminated excess capacity, shut down coal-fired power plants producing a total of 20 million kilowatts (kW), developed high-quality advanced production capacity, and promoted wind power. The first nuclear power heating project supports commercial operations, promotes ultra-low emissions and energy-saving transformation of coal power, and advances the orderly planning and construction of coal-fired power plants. Installed capacity of energy from water, wind, solar, and nuclear sources is 799 million kW.

The implementation of clean heating in winter in northern areas has been accelerated, resulting in an additional clean heating area of about 1.5 billion square metres, cumulative replacement of about 100 million tonnes of scattered coal, and a clean heating rate of 55% in northern areas and 75% in key '2+26' citie[1]s . The energy sector has overfulfilled its medium-term goals, produced about 200 billion kilowatt-hours of new electricity, conserved energy and reduced emissions, and reduced national energy consumption intensity by about 13.7% in the first 4 years of the 13th Five-Year Plan (Tencent News, 2020).

The 2017 analysis uses five APS scenarios: APS1 – energy efficiency and conservation (EEC) in final consumption; APS2 – EEC in thermal efficiency in coal, oil, and gas–fired power generators; APS3 – increase of hydro, geothermal, and so on; APS4 – increased use of nuclear power; APS5 – combination of APS1 to APS4. APS in this study refers to APS5 unless specified otherwise.

3. Outlook Results

3.1. Final Energy Demand

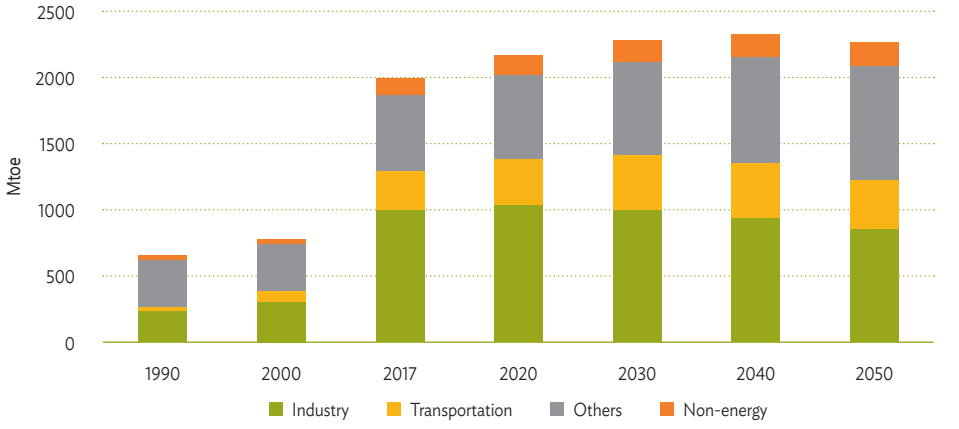
From 2017 to 2050, final energy consumption growth is projected to be slow, reflecting lower assumed economic and population growth.

Business as Usual

Final energy demand is projected to increase at an average rate of 0.4% per year from 2017 to 2050. Non-energy sector demand is projected to grow the fastest, by 1.3% a year, followed by 'others', by 1.2%. Industry energy demand is projected to grow at an average annual rate of –0.4%. Figure 5-1 shows final energy demand by sector under BAU.

[1] Including Beijing, Tianjin, Shijiazhuang, Tangshan, Langfang, Baoding, Cangzhou, Hengshui, Xingtai, Handan, Taiyuan, Yangquan, Changzhi, Jincheng, Jinan, Zibo, Jining, Dezhou, Liaocheng, Binzhou, Heze, Zhengzhou, Kaifeng, Anyang, Hebi , Xinxiang, Jiaozuo, Puyang.

Figure 5.1. Final Energy Consumption by Sector, Business as Usual

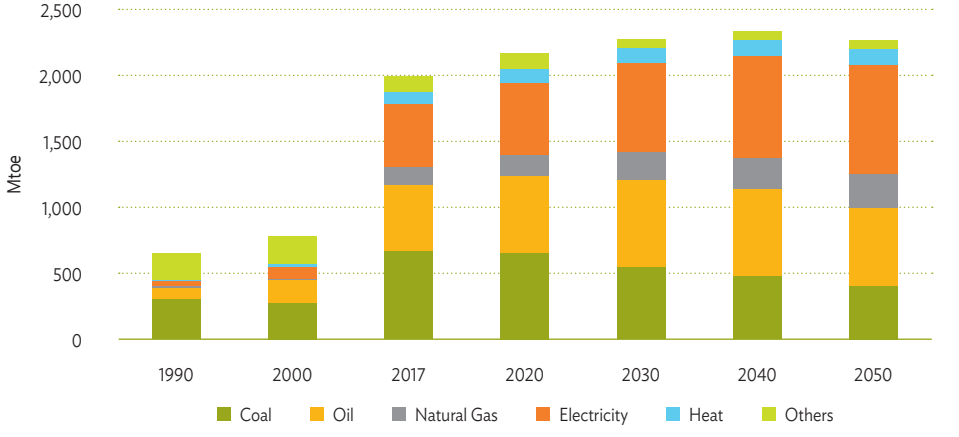


Mtoe = million tons of oil equivalent.

Source: Authors.

Natural gas is projected to grow the fastest, by 2.1% per year, from 131.58 Mtoe in 2017 to 263.94 Mtoe in 2050. Although it still accounts for a large portion of total final energy demand, coal is projected to increase by only –1.5% per year, to 402.60 Mtoe by 2050. Consumption of electricity and of heat are projected to increase at an average annual rate of 1.7% and 0.5%, respectively, over the same period, to 822.60 Mtoe and 113.19 Mtoe by 2050. Oil is projected to grow by 0.5% annually to about 597.38 Mtoe in 2050. Figure 5-2 shows final energy demand by fuel under BAU.

Figure 5.2. Final Energy Consumption by Fuel, Business as Usual



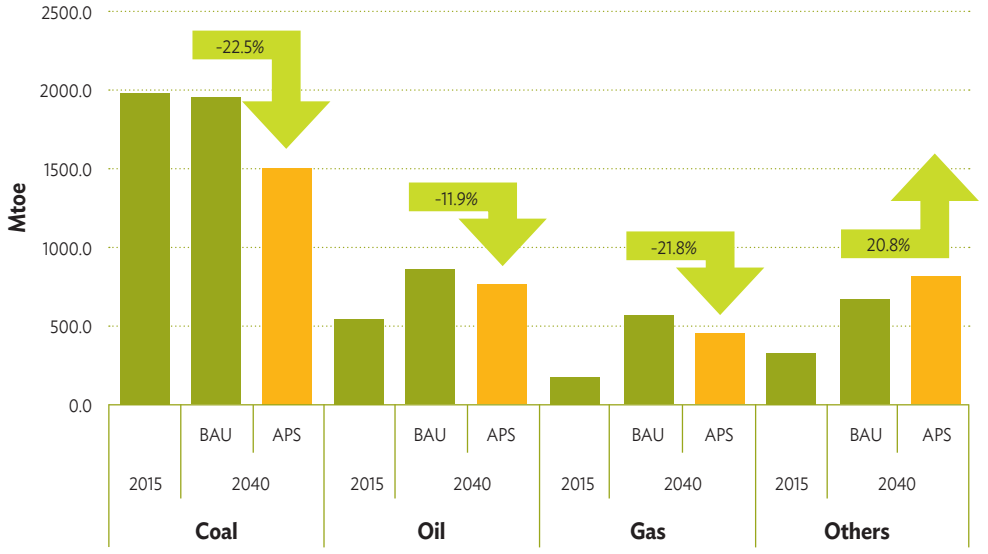
Mtoe = million tons of oil equivalent.

Source: Authors.

Alternative Policy Scenario

Final energy demand is projected to increase by 0% per year, from 1,995.06 Mtoe in 2017 to 2,011.34 Mtoe in 2050, because of EEC programmes. Improved end-use technologies and the introduction of energy management systems are expected to contribute to slower energy growth in all sectors, particularly in the commercial, residential, and transport sectors. Figure 5-3 shows final energy demand in 2017 and 2050 under BAU and APS.

Figure 5.3. Final Energy Consumption, Business as Usual and Alternative Policy Scenario



APS = alternative policy scenario, BAU = business as usual, Mtoe = million tons of oil equivalent.
Source: Authors.

3.2 Primary Energy Consumption.

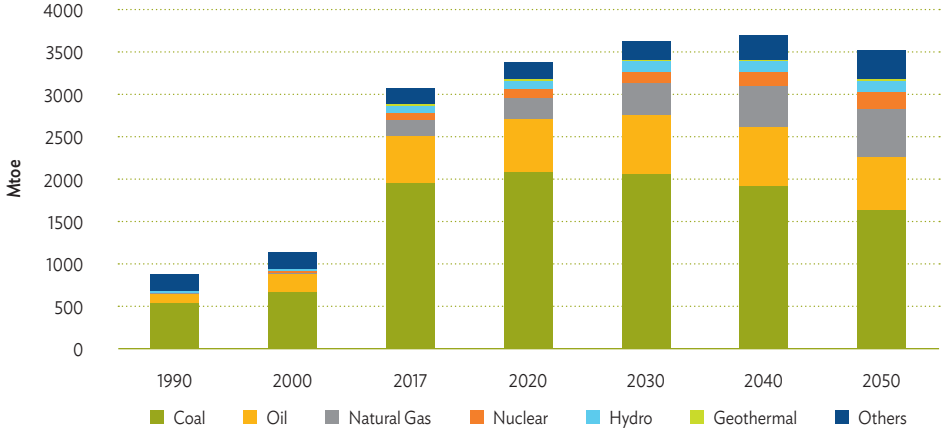
Primary energy consumption is projected to grow more slowly. Growth in primary energy demand is expected to grow slightly more slowly than final energy consumption because of improved efficiency in energy transformation.

Business as Usual

Primary energy consumption is projected to increase at an annual average rate of 0.4% per year, to 3,529.20 Mtoe in 2050. Coal will still constitute the largest share of total primary energy, but its growth is expected to be slower, increasing by –0.6% a year. Consequently, the share of coal in total primary energy is projected to decline from 63.7% in 2017 to 46.1% in 2050.

Solar, wind, and ocean energy sources are projected to growth the fastest from 2017 to 2050, increasing at an annual average rate of 4.4%. Natural gas, nuclear, and biofuel energy will increase by 3.3% per year. Oil and hydro are projected to grow by 0.4% and 0.8% per year, respectively. The share of natural gas is projected to increase from 6.4% in 2017 to 16.1% in 2050. The share of nuclear power will increase from 2.1% to 5.4%. The share of oil is projected to decrease from 18.5% in 2017 to 18.4% in 2050. The share of hydro is projected to increase from 3.2% in 2017 to 3.7% in 2050. Figure 5-4 shows primary energy consumption by energy under BAU. The share of oil is projected to decrease from 18.5% in 2017 to 18.4% in 2050. The share of hydro is projected to increase from 3.2% in 2017 to 3.7% in 2050. Figure 5-4 shows primary energy consumption by energy under BAU.

Figure 5.4. Primary Energy Supply by Fuel Type, Business as Usual



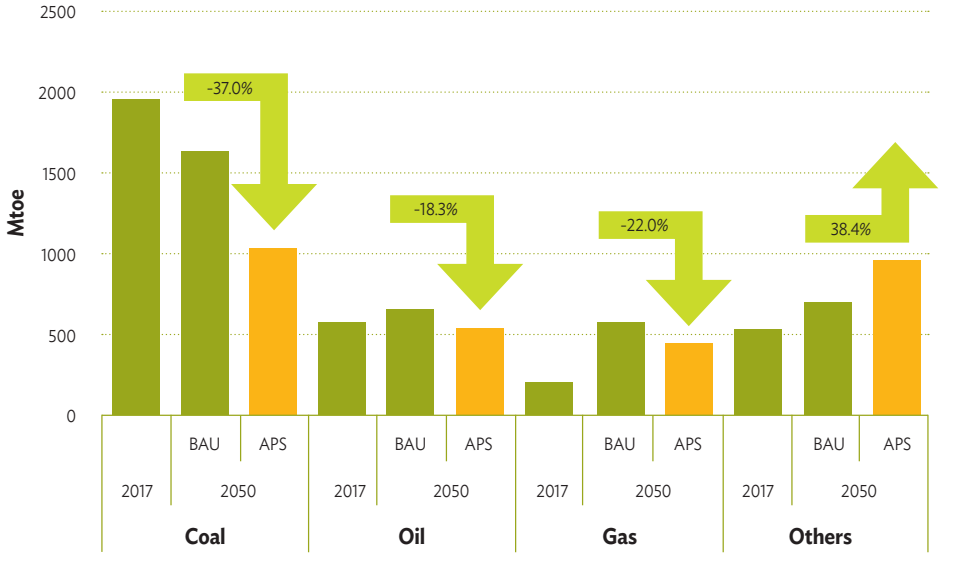
Mtoe = million tons of oil equivalent.

Source: Authors.

Alternative Policy Scenario

Under APS, primary energy consumption is projected to increase by –0.1% per year from 2017 to 2050. By 2050, primary energy consumption is projected to reach 2,948.25 Mtoe. Growth in primary energy consumption is projected to be slower under APS than under BAU (Figure 5-5). Coal is projected to grow by –1.9% a year, oil by –0.2% a year, and natural gas by 2.5% a year. The annual average growth rate of nuclear power will be higher than under BAU, increasing by 4.1% a year from 2017 to 2050. The growth rate of hydro is expected to be higher than under BAU, increasing by 1.1% per year. Consumption will be mitigated because of EEC measures on the demand side.

Figure 5.5. Primary Energy Supply by Source, Business as Usual and Alternative Policy Scenario



APS = alternative policy scenario, BAU = business as usual, Mtoe = million tons of oil equivalent.

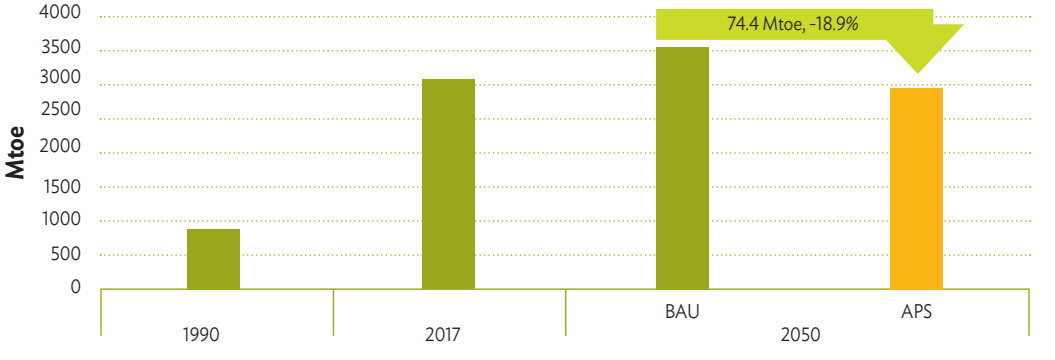
Source: Authors.

3.3. Projected Energy Savings.

Achieving the EEC goals could reduce primary energy consumption in 2050 by about 462.45 Mtoe under APS relative to BAU. Under APS, primary energy consumption is about 18.9% lower than under BAU (Figure 5-6).

Savings in final energy consumption are estimated at 210.44 Mtoe in industry and 20.16 Mtoe in transport in 2050 under APS relative to BAU.

Figure 5.6. Total Primary Energy Supply, Business as Usual and Alternative Policy Scenario



APS = alternative policy scenario, BAU = business as usual, Mtoe =million tons of oil equivalent.

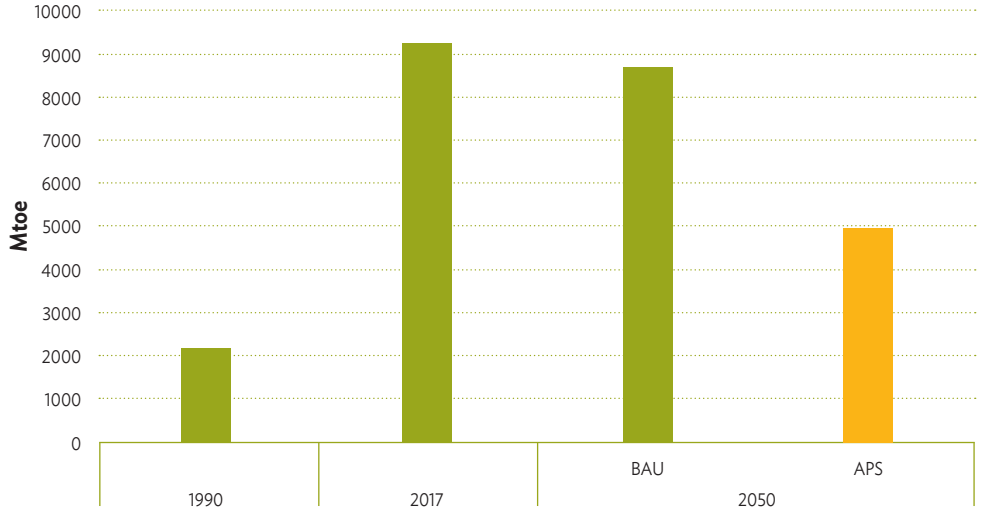
Source: Authors.

3.4. Carbon Dioxide Emissions from Energy Consumption.

CO2 emissions from energy consumption are projected to grow by –0.2% per year, from 9,201.1 Metric Ton Carbon (Mt-C) in 2017 to 8,691.0 Mt-C in 2050 under BAU. This percentage increase is lower than for primary energy consumption (0.4%) over the same period, indicating improvement in emissions intensity.

Under APS, the annual growth in CO2 emissions from 2017 to 2050 is projected at –1.9%, lower than the average annual growth rate of primary energy consumption over the same period. The difference between APS and BAU CO2 emission growth rates indicates that the energy saving goals and action plans are effective (Figure 5-7).

Figure 5.7. Carbon Dioxide Emissions from Energy Consumption, Business as Usual and Alternative Policy Scenario



APS = alternative policy scenario, BAU = business as usual, Mtoe =million tons of oil equivalent.

Source: Authors.

3.5. Power Generation.

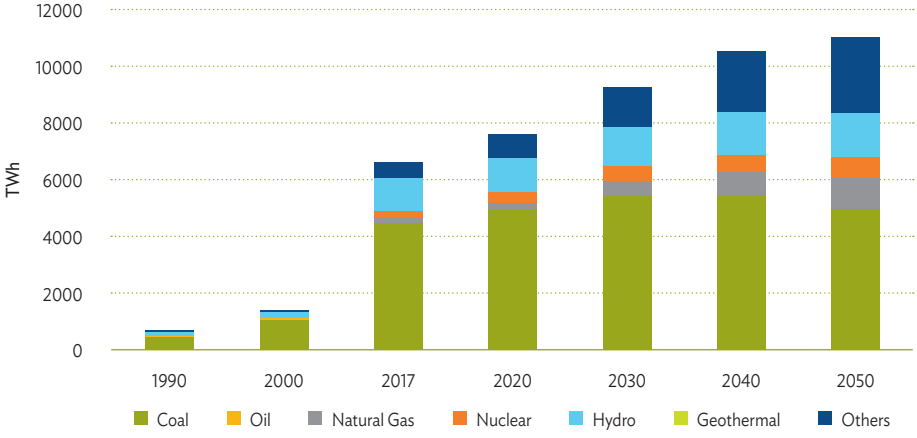
Power generation is projected to grow more slowly from 2017 to 2050 than in the last decade.

Business as Usual

Power generation is projected to grow more slowly, by 1.6% per year, from 6,602.15 Terawatt-hour (TWh) in 2017 to 11,033.80 TWh in 2050 (Figure 5-8).

The share of coal power is projected to decrease from 67.9% in 2017 to 45.1% in 2050. The shares of natural gas and nuclear are projected to grow from 2.8% and 3.8%, respectively, in 2017 to 10.0% and 6.6% in 2050, The share of oil is projected to decrease slightly. Other methods of power generation are projected to increase their share. The fast development of solar photovoltaic power generation is a typical example of adoption of clean power generation.

Figure 5.8. Power Generation, Business as Usual



TWh = terawatt-hour.

Source: Authors.

Alternative Policy Scenario

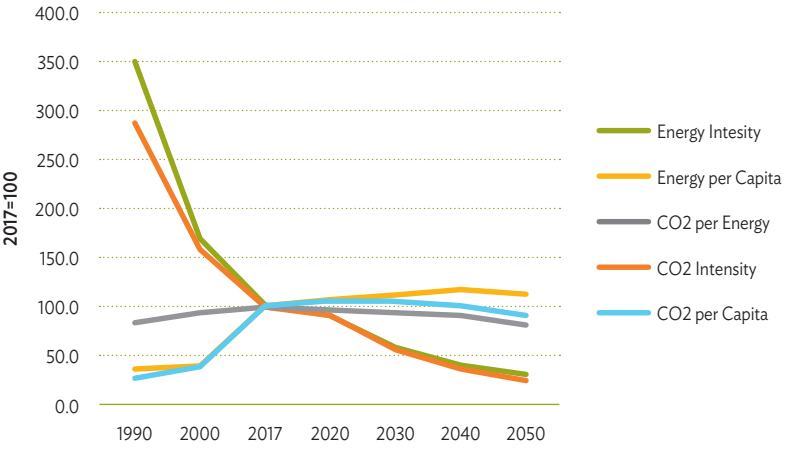
Total power generation is projected to increase by 1.4% per year from 2017 to 2050. By 2050, total power generation output is projected to reach 10,397.05 TWh. Except for coal-fired, oil, and natural gas power, energy sources are projected to grow faster than under BAU from 2017 to 2050. Nuclear, hydro, and geothermal power and 'others' are projected to increase by 4.1%, 1.1%, 5.6%, and 6.8%, respectively, from 2017 to 2050.

3.6. Energy Intensity.

Based on assumed economic and population data and projected energy information, energy intensity – defined as TPES over GDP – and energy per capita are shown in Figure 5-10, along with other vital energy indicators under BAU. From 1990 to 2017, energy intensity dropped remarkably because of energy efficiency efforts. In 2050, energy intensity is projected to drop to about 89 tonnes of oil equivalent (toe) per US$ 1 million (in 2010 terms). With the improvement of living standards, energy per capita under BAU is projected to reach 2.52 toe

per person in 2050. Energy intensity under APS is projected to decrease faster than under BAU, by 4.6%, from 2017 to 2050.

Figure 5.9. Energy Indicators, Business as Usual



CO_2 = carbon dioxide.
Source: Authors.

4. Implications and Policy Recommendations

As the largest developing country, China has always seen eliminating poverty and improving the quality of life as its paramount tasks. China has recently witnessed fast economic growth, but the urbanisation rate is still low, at 60.6% in 2019. As the biggest energy consumer and CO2 emitter, however, China faces great pressure to save energy and reduce CO2 emissions. In the past 3 decades, China has set ambitious targets for energy conservation and climate change mitigation and exerted great efforts to achieve them. At the 2014 Asia-Pacific Economic Cooperation summit, China and the United States issued the Joint Announcement on Climate Change; China vowed to achieve the peak of CO2 emissions and increase the share of non-fossil fuels in primary energy consumption to about 20% by 2030. In April 2016, China signed the Paris Agreement, which includes the above commitments and provides that China must strive to cut carbon emissions per unit of GDP by 60%–65% by 2030 from 2005 levels. The 13th Five-Year Plan (2016–2020) sets the goal of controlling total energy consumption within 41 billion tons of standard coal and reducing CO2 emissions per unit of GDP by 18% compared with 2015.

As GDP will keep growing fast, albeit more slowly than in the last 20 years, China's energy

demand and CO2 emissions will continue to increase. To meet its targets, however, China must reduce its energy intensity (energy demand per unit of GDP) and emissions intensity (CO2 emissions per unit of GDP). The model shows that if sound EEC policies are implemented, China could reduce its total primary energy consumption by about 13.0% and CO2 emissions by about 21.6% by 2040.

Coal consumption has decreased since 2014; it decreased by 3.7% in 2015. It is projected that coal consumption can be cut by 22.5% under APS compared with BAU. To improve urban air quality, metropolises such as Beijing and Shanghai have drastically controlled the use of coal. As a result, coal consumption might grow slowly. The government encourages the development of clean and low-carbon energy, especially renewable energy and nuclear energy. To optimise the energy structure, policies such as energy and carbon taxes should be implemented to limit energy- and pollution-intensive industries. Market-based measures such as electricity market reform, energy pricing reform, and green certificate trade are needed to motivate enterprises to take action.

Energy efficiency improvement under APS has the largest potential to reduce CO2 emissions. Under APS, industry could reduce energy consumption by 10.9%. Small and inefficient power plants and coal mines and small energy-intensive plants in industries such as cement and steel must be closed; energy-intensive industries must meet stricter approval requirements. The industry structure must be changed, from heavy to light industry or industry to services. Now that the economy has entered the 'new normal' of moderately high growth and the tertiary sector accounts for half of GDP, China must increase residential, commercial, and transport energy efficiency to save energy and reduce CO2. The Belt and Road Initiative (BRI), proposed by President Xi Jinping in 2013, is a good chance to further save energy and reduce emissions. The countries along the route of the BRI contribute to 50% of global energy consumption and more than 60% of global CO2 emissions. Establishing a low-carbon BRI community is, therefore, of great significance to improve the energy structure and reduce emissions not only in China but also the world. 'Lucid waters and lush mountains are invaluable assets' is an idea that will guide energy conservation and emission reduction.

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