CLEAN AIR BRIEF 2019

# CLEAN ENERGY TRANSITION IN CHINA

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ASIA PACIFIC CLEAN AIR PARTNERSHIP

# SUMMARY

The objective of this policy brief is to give an overview of the energy transition of China to attain a cleaner energy future. In general, the brief includes a discussion on the successes in this effort along with the related challenges.

As part of this effort, China is implementing air pollution control policies and climate policies while taking advantage of enhanced clean energy technologies. Key components of the transition are controlling energy demand; controlling coal consumption; strong promotion of clean energy supply; and a large increase in clean energy use in end users' sectors and energy efficiency.

These components combined with a sharp decline in the costs of renewable energies have led to a surprising increase in the consumption of clean energy in China. From 2012 to 2017, installed capacity for wind power and solar power increased from 70 gigawatts (GW) to 300 GW, and the share of coal in total primary energy demand decreased by seven percentage points, from 67 to 60 per cent. In fact, China has become a leading player in the development of renewable energy and currently accounts for one third of the global renewable energy generation capacity. Supporting this drive, are the introduction of feed-in tariffs (FITs) to promote wind and solar power, the promotion of new and clean sources of renewable energy as a key strategic measure in the effort to foster emerging industries of national importance and as part of the national effort to protect the environment, mitigate the adverse effects of climate change and achieve sustainable development, expanding the country's nuclear capacity, decreasing the consumption of coal, increasing the consumption of natural gas and energy conservation.

One of the major challenges associated with this energy transition is the rise in domestic energy consumption as standards of living rise. The economy has grown on an annual basis by 9.6 per cent and the new wealth is raising the need to set targets for more energy efficient residential buildings and passenger vehicles to reflect this reality. Another challenge is that China relies too much on administrative orders, and the population, in general, lacks knowledge on how to save energy. As the number of energy-consumers increases and consumers become more diverse, it is unclear whether this administrative approach will remain effective. Finally, there is problem of the effects of the structural reforms. For example, unemployment in coal mining and related sectors is becoming a headache for central and local government in the areas where the coal mining industry is based even though a lot of effort has been placed on mitigating potential turbulence to the local society.

Going forward, energy conservation will remain a key component in this transition. The Government is placing equal emphasis on development of energy supply and conservation and has listed conservation as a top priority to ensure that the country will have an adequate supply of energy. Regions, organizations and enterprises in China are focusing on energy conservation and efficiency and have made significant progress in that area. The economic and social benefits have been extensive.

To create an energy conservation atmosphere, there must be increased engagement with the stakeholders, including the central government, local government, enterprises and other energy producers and consumers. Stronger capacity and sufficient communication are needed, and the strengths of the government and social enterprises should be tapped and integrated to promote further energy conservation.

# 01 OVERVIEW

China has been challenged with overcoming adverse effects of its booming economy. Its road to industrialization has led to a transformation of the economy, but it has left in its wake some environmental disasters, including dangerously high levels of air pollution in many of its cities. Notably, however, the country has implemented a number of successful policies and measures to mitigate this, which can be replicated in other Asian countries.

China is undergoing an energy transition, mainly driven by air pollution control policies, climate policies and enhanced clean energy technologies. In 2014, President Xi Jinping, during the sixth meeting of the Central Leading Group on Finance and Economy, proposed that China overhaul its energy policy to encourage changes in energy consumption and take advantage of advances in energy-related technology. This has set the stage for China to make guidelines for the transition to a clean energy future.

In recent years, China has been focusing on clean energy through various policies. This has especially been the case after 2012 as a strong push to implement air pollution prevention policies resulted in the launch of the Air Pollution Prevention Action Plan by the State Council in the beginning of 2013. Key components of the plan are controlling energy demand; controlling coal consumption; strong promotion of clean energy supply; and a large increase in clean energy use in end use sectors and energy efficiency.

During the same period, China also set a target to limit carbon dioxide ($CO_2$) emissions by putting an intensity target in its five-year plans. Development of renewable energy and nuclear energy were included in the general policies to mitigate $CO_2$ emissions. Also, emission trading was launched in 2017, and clean energy supply was set as one of the key indicators in the country's low-carbon city initiative.

Those policies combined with a sharp decline in the costs of renewable energies have led to a surprising increase in the consumption of clean energy in China. From 2012 to 2017, installed capacity for wind power and solar power increased from 70 gigawatts (GW) to 300 GW, and the share of coal in total primary energy demand decreased by seven percentage points, from 67 to 60 per cent.

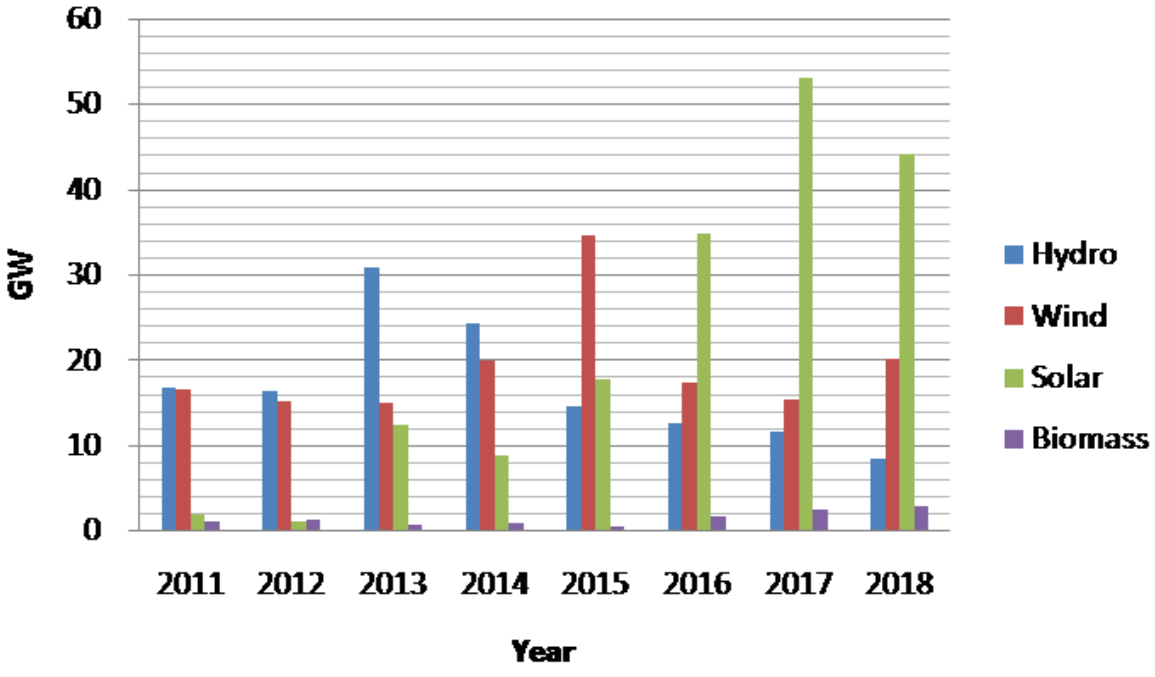
# 02 RENEWABLE ENERGY DEVELOPMENT

China has become a leading player in the development of renewable energy and currently accounts for one third of the global renewable energy generation capacity.

Since 2011, annual growth in wind energy and solar energy has been 22 per cent and 110 per cent, respectively, and in 2015, China became the world's largest consumer of modern renewable energy. In 2017 and 2018, newly installed capacity of solar power was 53 GW and 44.1 GW, accounting for 55 per cent and 43 per cent, respectively, of global newly installed capacity. Figure 1 shows growth in installed capacity of renewable energy in hydropower, wind power, solar photovoltaic (PV) and biomass in China after 2010.

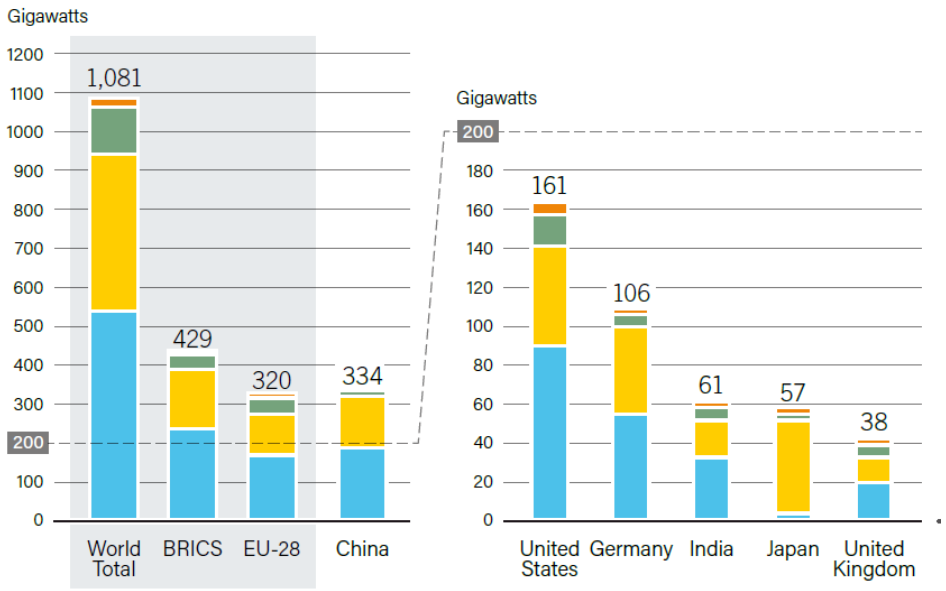
Figure 1 also draws attention to the importance of policy in promoting the development of renewables in China. The country became an important player in the renewable market following the introduction of feed-in tariffs (FITs) to promote wind and solar power. With approximately 700 GW of installed renewable power capacity in 2018, it has more than 29 per cent of the world total and is the global leader in that area, followed by the United States of America, Brazil, Germany and Canada. In addition, more than 50 per cent of this, about 296 GW, is hydro power. In terms of non-hydro capacity, countries with the greatest installed capacity are China, the United States and Germany (Figures 2 and 3).

**Figure 1**: Newly installed capacity for selected renewable energy generation in China




Source: Data collected by author.

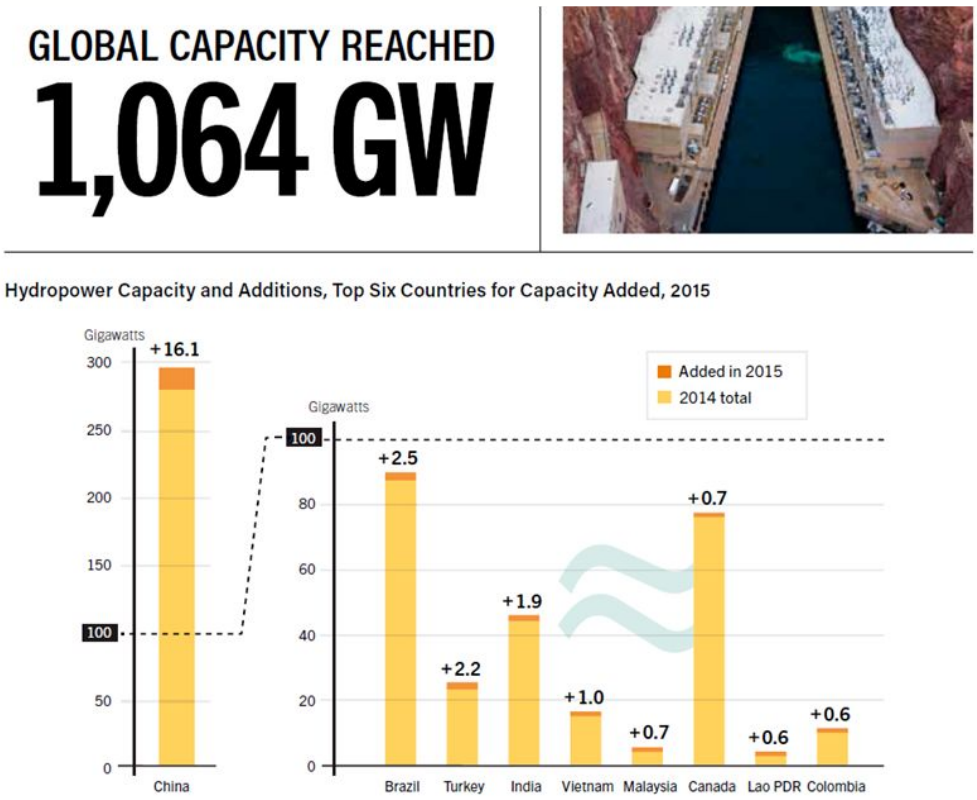
**Figure 2:** Renewable power capacities, in globally, European Union-28, and top seven countries in 2017




Note: BRICS = Brazil, the Russian Federation, India, China and South Africa. *Not including hydropower.

CSP: concentrated solar power
Source: Ren21 (2018).

**Figure 3:** Global and selected countries' installed capacity of hydro-power




Source: Ren21 (2018).

Global new investment in renewable power and fuels reached US$ 279.8 billion in 2017 (not including hydropower projects exceeding 50 megawatts (MW), which increased by 2 per cent from the year before) (Ren21, 2018).

Of the total new investment in renewable power during 2017, 45 per cent was produced by China. Most of the Chinese investment in renewables was in asset financing, which increased by 14 per cent, as compared with 2016. In 2016, China invested approximately the same amount in solar and wind power; however, in 2017, the country experienced a boom in overall solar power investment, up 58 per cent to US$ 86.5 billion, while total investment in wind power declined by 6 per cent during that year. Utility-scale solar power arrays of more than 1 MW accounted for most of the country's solar power total, while its investment in small-scale solar PV project development increased nearly fivefold. By comparison, total investment in wind power in China was US$ 36.1 billion; investment in onshore wind power declined by 28 per cent, while offshore wind power increased 180 per cent to US$ 10.8 billion. China also invested significant sums in large-scale hydropower, commissioning 7.3 gigawatts (GW) in 2017, a large portion of which was projects that exceeded 50 MW.

Development of new and clean sources of renewable energy in China is a key strategic measure in the effort to foster emerging industries of national importance. It is also promoted as part of the national effort to protect the environment, mitigate the adverse effects of climate change and achieve sustainable development. In general, China targeted to increase shares of non-fossil fuels in primary energy consumption to 11.4 per cent and installed generation capacity to 20 per cent by the end of 2030.

In light of the global energy crisis and to mitigate negative effects of air pollution and climate change, development of renewable energy utilization technology has important practical and long-term significance for replacing fossil fuels and realizing sustainable development. Energy security become an increasingly prominent issue, as environmental constraints are limiting energy savings and emission reductions have not been encouraging. In that context, the Government prioritized changes in energy structure and development of alternative low-carbon energy sources. Biomass energy, which is plentiful, can potentially be a substitute for coal, oil and gas. An extra bonus is that the consumption of it would significantly reduce pollution and lead to the achievement of zero emissions of $CO^2$. Accordingly, in recent years, governments at all levels in China have increasingly focused on renewable energy and introduced a series of policies and measures for the sector.

The basic framework of renewable energy development policies in China includes the Renewable Energy Law, a medium and long-term development plan for renewable energy, and the five-year plans, which

provide a short-term strategy to attract producers and users to participate in the development and utilization of renewable energy through the establishment of a series of effective incentive mechanisms.

**Legal basis**

The Renewable Energy Law of the People's Republic of China was issued in 2005 and formally took effect on 1 January 2006. As the first energy law in China, it stresses the importance of renewable energy. The law, which was revised at the end of 2009 and took effect on 1 April 2010, includes establishment of the Renewable Energy Development Fund. The fund supports development of renewable energy with funds collected through additional charges placed on the electricity grid.

**Target system**

The Government's plan to develop renewable energy in the medium and long-term include increasing share of renewable energy in total energy consumption to 10 per cent in 2010 (from 7.5 per cent in 2005) and to 16 per cent by 2020. Under the plan, wind power generation is treated as a key renewable energy source and medium- and long-term wind power development goals were set through to 2020 (Table 1).

In the plan, emphasis is also placed on the development of renewable energy, including wind, solar, hydro, biomass, biogas, densified biofuel and biological liquid fuel. Table 1 shows the targets set in the plan based on requirements of economic and social development in China and biomass energy utilization technology.

Aided by progress in renewable energy technology and strong government policies, renewable energy development, especially wind and solar power generation, consistently exceeded its targets. Consequently, those targets are constantly being revised (Table 2).

The 2005 Renewable Energy Law authorized FITs for wind power based on "government guided" prices, which are based on competitive bidding for wind power capacity, resulting in standardized or "approved" prices, generally on a province-by-province basis. According to Article 14 of Renewable Energy Law, grid enterprises (state grid) should sign FIT agreements with renewable energy power plants companies that have attained permission or have submitted and recorded from the government.

Feed-in tariffs were implemented in China as early as 2003 to support deployment of wind power. Initially, the tariff amount was determined on a case-by-case basis through bidding or negotiations. However, that arrangement created intense competition among large state-owned renewable power generators, which issued speculative bids that were often insufficient to actually implement the project. This practice was considered harmful to the long-term sustainability of the wind power industry.

**Table 1:** Renewable energy development targets for China

| | 2005 | 2010 | 2020 |
|---|---|---|---|
| Renewable energy's share of total energy consumption | 7.2% | 10% | 16% |
| Annual renewable energy consumption | 160 million tonnes standard coal equivalent | 270 million tonnes standard coal equivalent | 530 million tonnes standard coal equivalent |
| Renewable energy's share (excluding hydropower) of total power generation | - | 1% | 3% |
| Hydropower generation capacity | 117 GW | 180 GW | 300 GW |
| Wind power generation capacity | 1.26 GW | 5.00 GW | 30 GW |
| Biomass power generation capacity | 2 GW | 5.50 GW | 30 GW |
| Annual methane gas consumption | 8 billion cubic meters | 19 billion cubic meters | 40 billion cubic meters |
| Photovoltaic power generation capacity | 70 MW | 300 MW | 1.8 GW |
| Solar water heaters' heat collection area | 80 billion square meters | 150 billion square meters | 300 million square meters |
| Annual bioethanol consumption | 1.02 million tonnes | 2.00 million tonnes | 10.00 million tonnes |

Source: National Development and Reform Commission (NDRC 2007), Medium to long-term renewable energy development plan. For more details see http://en.ndrc.gov.cn/

**Figure 3:** Global and selected countries' installed capacity of hydro-power

| YEAR | TARGETS |
|---|---|
| 2009 | Wind 80 GW by 2020 |
| 2010 | Wind 150 GW, Solar 20 GW by 2020 |
| 2013 | Twelfth Five Year Plan: 20 GW of solar PV, 150 GW wind by 2015 |
| 2013 | 35 GW solar PV by 2015 |
| 2016 | Wind 250 GW, solar 100 GW by 2020 |

In response, the National Development and Reform Commission (NDRC) set baseline prices for wind tariffs in August 2009. The minimum tariff ranged from Chinese yuan (CNY) 0.51/ kilowatt-hour (kWh) to CNY 0.61/ kWh, depending on the location of the wind farm, with four classes of wind resource ranking.

In 2011, NDRC set the national solar FIT at CNY 1/kWh for projects starting in 2011. To support FITs, NDRC established a renewable electricity surcharge in 2006 of CNY0.001/kWh. The surcharge was increased to CNY 0.004/kWh in 2009 and again, to CNY 0.008/kWh, in 2011, to support the increasing demand for FITs following the rapid growth of renewable energy. Despite the eightfold rate hike, the surcharge remains low by international standards: the surcharge is 1.5 per cent of the total electricity price in comparison to 20 per cent of the total energy price in Germany. The low renewable electricity surcharge in China is important for the sustainable development of renewable energy because it leaves sufficient room for future expansion of FITs.

Also, at the provincial-level, solar PV preferential tariffs were introduced. In Zhejiang, the tariff was set as a premium of CNY 0.70/kWh (US$0.10/kWh) added to the province-average coal power generation price.

Jiangsu also set preferential tariffs, established a range of tariffs depending on the technology type and put in place a plan to decrease the tariffs progressively. Those preferential tariffs were not, however, considered nationally “approved” prices, which means the money to cover them needed to come from the provincial rather than the national budget.

During the period 2012–2015, it was announced that all new solar projects without state subsidies would be included in the Jiangsu PV subsidy policy based on the national uniform electricity price. The policy would be implemented for the integrated operation of ground-based, rooftop and building-integrated systems. In December 2016, NDRC set a lower FIT for new projects in 2017. For wind power, the tariffs are 15 per cent, 10 per cent, 9 per cent and 5 per cent lower for the four wind resource rankings, while for solar power, the FIT reductions are 19 per cent, 15 per cent and 13 per cent for the three solar resource rankings.

Also of note, based on a recent announcement by the National Energy Administration of China, power companies are required to source more than 15 per cent of their power from renewable energy generation, not including large hydropower. This is another signal to promote further renewable energy development.

Because of the rapid increase of newly installed capacity of solar PV in 2017, and a significant decrease in cost, the National Energy Administration announced a new policy on 31 May 2018, to reduce the subsidy, and stopped formulating a new

plan for solar PV in 2018. This policy significantly affected the solar PV projects, leading to a decline in newly installed capacity in 2017. To compensate for these adverse effects, subsidies for some PV projects were partly provided by provincial governments.

However, because of the lower cost, more than 10 solar PV projects are being implemented without benefiting from the subsidies.

# 03 NUCLEAR POWER

After three years of non-activity involving newly approved nuclear projects, four nuclear units in two nuclear power plants were approved in January 2019, which was a signal for a new nuclear power era in China. Each of the units will use HPR1000. In addition, China signed as agreement with Russian to build four nuclear units using Russian VVER technology.

By 2018, installed capacity of nuclear power in China reached 44.66 GW with 44 units, while another 11 units were under construction and expected to be finished in two or three years. Also, two AP1000 units and one EPR unit became operational. They are the first third generation nuclear units in the world.

Because nuclear power plants are clean, low carbon emitting, high safety, provide supply security, and potentially low cost, they are preferred by many provinces, especially to meet air quality improvement targets.

China has abundant resources for nuclear power. According to three nuclear power enterprises, recent local news media, online public reporting information, and preliminary statistics, the preliminary survey and site selection phases show that nuclear power sites are in three provinces in Northeast China, coastal provinces in southern and eastern China, Hunan, Hubei, Jiangxi, Anhui, Henan, Sichuan, and Guizhou provinces, and Chongqing.

Nuclear is regarded as one of the most important options for China to meet requirements of the Paris Agreement and prevent air pollution. In China, under the 2℃ scenario, there would be 400GW nuclear power by 2050, with its power generation accounting for more than 30 per cent of total power generation. A massive development of the country's nuclear power is essential to achieve the 1.5℃ target. This requires nuclear power to account for more than 30 per cent of the power mix of China by 2050, and a total installed capacity of around 554 GW (assuming annual uptime is 7000 h). Considering the potential increase of the annual uptime, the total installed capacity should reach 500 GW minimum.

Based on discussions for possible planning for nuclear power in China led by the National Energy Administration, there will be 150GW of nuclear power by 2030.

Meanwhile, new technology is being developed. A low temperature nuclear reactor for space heating has been developed by Chinese companies, spurred by demand for air pollution prevention actions. Three pilot projects are under construction, each of them could meet the space heating demand for 600,000 people, or 200,000 families, at a cost that is much lower than for natural gas fired boilers for space heating in China. However, there are difficulties in developing them, mainly because of the lack of regulation for development and administration.

# 04 CLEAN FOSSIL FUEL

In line with the rapid growth of the Chinese economy and population, consumption of fossil energy has risen extensively, which has resulted in greater depletion of traditional fossil energy, and serious ecological and environmental issues.

Up to 2015, total energy consumption was 3.62 billion tonnes standard coal equivalent, the traditional fossil energy consumption (coal, oil and natural gas) was 3.12 billion tonnes standard coal equivalent, accounting for about 88 per cent of the consumption, with the shares of coal, oil, natural gas at 64 per cent, 18.1 per cent and 5.9 per cent, respectively. For the next five years, China has set a cap on annual primary energy consumption to be less than 5.0 billion tonnes of the standard coal equivalent (tce) and has targeted to increase the ratio of non-fossil energy from 12 per cent to 15 per cent.

To decrease greenhouse gas emissions and improve the environmental quality, boosting the use of clean fossil energy with high efficiency remains an important option. Key policies for clean fossil energy in China are focused on the following:

**Decreasing consumption of coal**

China plans to continue to reduce the share of the coal consumption in primary energy. It has set a goal is to limit coal consumption to 4.4 billion in 2020, decreasing the share of coal from 64 per cent in 2015 to 58 per cent in 2020. As a result, coal consumption in the three largest city clusters, the Beijing-TianjinHebei region, the Yangtze River Delta and the Pearl River Delta, will be reduced. According to the announcement of interim measures to replace coal consumption in key areas" from NDRC, all provinces and municipalities are required to set reduction goals of coal consumption. At the same time, measures have been set to improve the standards of energy efficiency and environmental protection and promote energy

conservation and emission reduction in the industrial sectors that consume large amounts of coal, such as steel, construction materials and chemical engineering.

In addition, the use of coal is being managed comprehensively. Increased consumption of natural gas, electricity, waste heat and shallow geothermal energy as a substitute for coal is being targeted over a five-year period in key cities (2+26) around the Beijing-Tianjin-Heibei regions, which are the air pollutant transmission pathways. In other areas, cleaner coal is being used more predominantly, aided by the establishment distribution centres of cleaner coal in the main residential coal consumption areas. Air pollution from residential use of coal should be controlled by rating the standard of energy efficiency of residential stoves or cookers and renovating extensively coal-fired boilers that lack pollutant control facilities and have a substandard discharge.

**Increasing the consumption of natural gas**

The share of natural gas consumption is targeted to increase from 5.9 per cent in 2015 to 10 per cent in 2020. To achieve that goal, the Government initially pushed forward the price reformation of natural gas and developed a practical and reasonable system of gas-electricity price linkage. This will bring down the price of natural gas and encourage greater consumption of it. It then plans to encourage using gas instead of coal consumption in the main “2+26” cities.

The Government is also promoting the development of a natural gas conditioner, separated household heating and natural gas distributed energy when natural gas resources are available. In the remote and countryside areas, access to natural gas is to be enhanced through various ways with pipeline gas, compressed natural gas, liquefied natural gas and liquefied petroleum gas. With regard to the construction of new countryside villages, local government is being tasked with guiding the residents of the villages on using natural gas or developing biogas.

In addition, local government imposed rules against use of fuels causing pollution and expanded areas where fuels are banned based on local conditions. In those areas, polluting fuels are to be replaced by natural gas, electricity and other types of clean energy over a specified period. For example, Beijing, in 2014, banned the consumption of high polluting fuel in its six centre districts, new towns in suburban areas and economic and technological development zones, and set a gradual schedule for replacing them. It is also implementing a project to upgrade industrial fuel and transport. In the first phase of that initiative, industrial enterprises are required to completely replace coal or oil-fired boilers smaller than 20 steaming tonnes in the “high pollution fuel banned areas” with natural gas, based on the standard and deadlines set by the Action Plan on Air Pollution Control. The ratio of natural gas used for public transport, freight and logistics, ship

fuel is expected to increase in the Beijing-Tianjin-Hebei region, and vehicles using liquefied natural gas are being encouraged as opposed to vehicles that consume heavy diesel.

**Developing cleaner production of coal and applying it more efficiently**

Coal is expected to remain the main source of energy in China, with a projected share of energy consumption of about 58 per cent in 2020. Cleaner production of coal and promoting a green and highly efficient application are of utmost importance. In the Thirteenth Five Year Plan, the goals for coal production are more intensive and make obsolete the backwards production capacity by 0.8 billion tonnes per year. The ratio of cleaning raw coal will increase from 66 per cent in 2015 to 75 per cent in 2020, and the ratio of comprehensive used coal gangue will reach 75 per cent in 2020. Ultra-low emissions in coal-fired power plants will be achieved by using the advanced high-efficient desulfurization, denitration and dedusting technology.

# 05 ENERGY CONSERVATION

China has accomplished a lot in its effort with regard to energy conservation and efficiency. Energy intensity decreased by more than 70 per cent from 3.4 tonnes of the standard coal equivalent (tce) in 1980 per 10,000 Chinese yuan (CNY) (based CNY rate of GDP in 2005) to 0.93 tce per 10,000 CNY in 2015. From 2005 to 2015, the economy has grown on an annual basis by 9.6 per cent, while the energy consumption growth rate has been 5.2 per cent. The Seventh China-US Energy Efficiency Forum noted that China accounts for 50 per cent of energy savings in the world over last twenty years.

Progress in energy conservation and the decoupling of economic growth and energy is one of the most notable achievements worldwide in this area. However, there is potential for China to achieve even greater energy savings. It still has a long way to go in that regard.

**History and current status of energy efficiency**

In the late 1970s, China began opening up and instituted reforms. The Government announced that it would place equal emphasis on development of energy supply and conservation and listed conservation as a top priority, to ensure that the country would have an adequate supply of energy. Since then, regions, organizations and enterprises in China have focused on energy conservation and efficiency and made significant progress in that area. The economic and social benefits have been extensive. Since 2005, China recorded double-digit growth. Despite the rapid industrialization, the rate of gross domestic product (GDP) growth

has been greater than that of energy consumption. Owing to energy efficiency and restructuring policies implemented since 2005, as indicated in Figure 4, the rate of energy intensity in China has vastly improved over the previous 10 years (average rate of energy intensity reduction is 4 per cent per year), as compared with the trends over the period 1980–2005 (average rate of energy intensity reduction was 3.5 per cent per year).

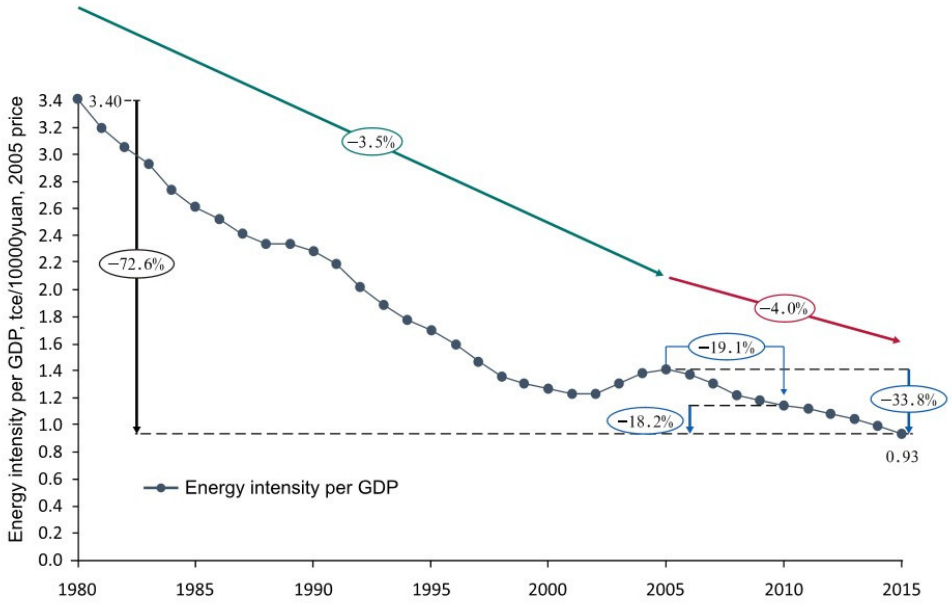
**Government and policies**

Government bodies, agencies and institutions at different levels have been established to coordinate and promote energy efficiency in the country. At the national level, the National Leading Team on Climate Change, Energy Conservation and Emissions Reduction, established in 2007 for discussion and coordination of energy-related issues, is comprised of leaders from more than 20 ministries, the premier and the vice-premier.

In 1997, the Government of China passed the Energy Conservation Law, which provides broad guidance for the establishment of energy-efficiency policies in China. Article 20 of the Energy Conservation Law requires substantial improvement in industrial energy efficiency in 7,200 key energy-consuming industrial facilities.

Over the years, in the five-year plans, the Government has implemented a number of energy efficiency policies and recommended energy-related targets. For example, in the Eleventh Five Year Plan, set in 2005, the Government, for the first time, set a quantitative target of reducing energy intensity by 20 per cent between 2005 and 2010.

**Figure 4:** Trends of energy intensity in China per gross domestic product (1980–2015)




Source: China, National Bureau of Statistics (2016)

In 2010, based on the Eleventh Five Year Plan target, the Government set new targets to reduce energy intensity by another 16 per cent and reducing carbon intensity by 17 per cent within five years. To support efforts to achieve these goals, the Government launched a monitoring programme of 1,000 top energy consuming enterprises. Also, under this plan, the Government invested in ten key energy conservation projects.

In June 2015, China submitted its Intended Nationally Determined Contribution, which included a target for $CO_2$ emissions to peak in 2030 and to make best efforts for it to peak at an earlier date, and, reduce $CO_2$ emissions per unit of GDP by 60 to 65 per cent below the level of 2005.

Also of note, under the One Hundred Energy Efficiency Standard Promotion Programme, as of September 2015, 105 compulsory energy consumption standards and 70 mandatory energy efficiency standards have been published, and included in the Thirteenth Five Year Plan (2016–2020) is the Energy Development Five Year Plan, which contains compulsory energy intensity, renewable energy percentage, $CO_2$ intensity and total coal consumption targets.

**Economic structure and technology factor**

The country's industrial structure has continued to improve, resulting in a decline in energy intensity, which can be attributed not only to energy efficiency improvements, but also to the higher share of less energy intensive industries. Energy consumption of the most energy-intensive industrial products decreased in 2014, as compared to 2000.

However, because of the industrial structure and technology level, the country's overall absolute energy intensity value is still much higher, in comparison with many other countries. Energy consumption of almost all energy-intensive industrial products is above developed-country levels, although this gap has narrowed over the period 2000–2014.

For example, in 2013, the absolute value of energy intensity per GDP (2005 CNY, based on purchasing power parity (PPP)) of China was still 1.43 times that of the United States, 1.64 times that of the total for Organisation for Economic Co-operation and Development (OECD) countries, 1.95 times that of the countries of the European Union and 2.52 times that of the United Kingdom of Great Britain and Northern Ireland. China still has significant potential to further decrease its energy intensity and improve its energy utilization efficiency.

**Sectoral views**

Energy-intensive sectors play key roles in energy conservation. Table 3 contains a list of sectoral relative policies, providing an extended view of the energy conservation policy system.

**Table 2:** Key sectoral energy conservation policies in the Twelfth Five-year Plan and Thirteenth Five-year Plan period

| Sector | Policy | Policy instrument |
|---|---|---|
| Industry | Ten Thousand Enterprise Energy Conservation Programme | Regulation |
| | Obsolete Capacity Retirement Programme | Regulation |
| | Energy Conservation Technology Fund | Incentive |
| | Differential electricity pricing | Economic instrument |
| | Small Business Closure Programme | Regulation |
| Building | Promotion of energy efficiency standards | Regulation |
| | Retrofitting existing residential buildings | Investment |
| | Retrofitting public buildings | Investment |
| | Integrated renewable energy | Incentive |
| | Promotion of green buildings | Incentive |
| | Energy-Efficient Product Discount Scheme | Incentive |
| | Incandescent Lighting Phasing Out Programme | Regulation |
| | Differential electricity pricing | Economic instrument |
| | Ten Thousand Enterprise Energy Conservation Programme | Regulation |
| | Development of the energy services industry | Incentive |
| | National Energy Conservation Campaign | Education |
| Transport | Commercial vehicle fuel standards | Regulation |
| | Road passenger transport capacity control | Regulation |
| | Thousand Enterprise Low-Carbon Programme (transport) | Voluntary agreement |
| | Transport Energy Conservation Fund | Incentive |
| | Transport energy conservation demonstration projects | Investment |
| | Low-Carbon Transport System Development Programme (pilot) | Incentive |
| | Ten Thousand Enterprise Energy Conservation Programme | Regulation |
| | Energy-efficient Product Discount Scheme | Incentive |
| Public | Public sector key energy conservation projects | Investment |
| | City Green Lighting Project | Investment |
| | Compulsory government procurement of energy-saving products | Procurement |
| | National Energy Conservation Campaign | Education |

# 06 WAY FORWARD

Sustainable Development is a basic long-term national strategy in China. Ecological civilization construction has been a focus of the government, reflecting rising concern over environment issues from officials as well as from the general public. China began to enhance its energy efficiency policies and programmes in the Eleventh Five Year Plan when it first set hard targets for energy and environmental indicators. In the Twelfth Five Year Plan and the Thirteenth Five Year Plan, those policies have continued. The main focus of them is to continue to improve energy efficiency in the industrial sector. However, domestic energy consumption is beginning to grow as standards of living rise. Targets for more energy efficient residential buildings and passenger vehicles reflect this reality. In order to achieve the new energy conservation goals in the Thirteenth Five Year Plan and beyond, significant improvement in the area of energy efficiency is still needed.

In that regard, the country is relying too much on administrative orders, and the population, in general, lacks knowledge on how to save energy. It is relatively easy for the Government to regulate and monitor fewer enterprises. However, as the number of energy-consumers increases and consumers become more diverse, it is unclear whether this administrative approach will remain effective.

There is a trend to expand market-based initiatives, such as emissions trading schemes and energy service companies, and the Government is putting more emphasis on operational and post-operational oversight.

Another problem is the effect of the structural reforms, which began under the Twelfth Five Year Plan. Along with technological development, structural change will play a much more important role in reducing energy intensity. Controlling unnecessary and unproductive production and shifting employment to light and higher added value industries and services are priorities set in the Thirteenth Five Year Plan. Excess capacity is already beginning to be shut down. Further improvements in the industrial structure is essential along with the Ten Thousand Enterprises Programme, as it is a central part of the country's energy efficiency policy.

Overall, to create an effective energy conservation atmosphere, more stakeholder must be engaged, including the central Government, local government, enterprises and other energy producers and consumers. Stronger capacity and sufficient communication are needed, and the strengths of the government and social enterprises should be tapped and integrated.

# 07 CONCLUSION

With the policies and technology progress, it is certain that China is transitioning to a clean energy transition, which is becoming a key factor in achieving better air quality and low-carbon development. However, challenges remain in carrying out this transition.

The rapid change in coal, or other fossil fuel industries has already resulted in problems. Unemployment in coal mining and related sectors is becoming a headache for central and local government in the areas where the coal mining industry is based even though a lot of effort has been placed on mitigating potential turbulence to the local society.

The extensive subsidies required to support wind and solar power generation are becoming a large burden for the government. The development of wind and solar power by 2017 will have cost the government more than CNY 1.5 trillion, ($231 billion) to be paid over the next 20 years in subsidies. To reduce this problem, in June 2018, the subsidy rate for solar PV was reduced by 5 cent/kWh.

Another issue is that the grid is not developed enough to support the rapid growth of renewable energy in China. The share for power generation from solar and wind is relatively small; however, when renewable energy is much more developed, the grid must be upgraded.

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