

# Development Achievements of China's Electric Power Industry in the Past 40 Years of Reform and Opening-up

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## Abstract

In the past 40 years of reform and opening up, China's electric power industry has developed from "small to large, weak to strong", from "short supply" to "sufficient supply". Through reform and opening-up, China's electric power industry has achieved remarkable development achievements, such as the first power supply scale in the world, safe and reliable operation of power grid, clean development of power supply structure, and rapid development of power science and technology, which has effectively guaranteed the rapid growth of China's economy in the past 40 years.

## Keywords

Power industry; High quality development.

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## 1. Introduction

In the past 40 years of reform and opening-up, China's electric power industry has experienced a process from scratch, from small to large, from weak to strong, and has achieved remarkable development achievements. Its power generation capacity ranks first in the world, and its clean energy and coal power generation capacity ranks first in the world. It has become the largest and most advanced high-level power grid in the world.

## 2. The Scale of Power Supply has Reached the First in the World

The installed capacity and output of power generation are the first in the world. From 57.12 million kW in 1978, China ranked the eighth in the world, developing to 1.78 billion kW in 2017, ranking the first in the world, 31 times as much as at the beginning of the reform, an increase of 170 million kW over 1978. Power generation increased from 256.6 billion kWh in 1978 to 6.42 trillion kWh in 2017 and ranked first in the world, 25 times as much as in 1978.

Per capita electricity consumption exceeds the world average. Per capita installed capacity and per capita generating capacity are important indicators to measure the development of a country's power industry. At the beginning of the reform and opening up, China's per capita installed capacity and per capita generating capacity were much lower than the world average. In 1978, China's per capita installed capacity and per capita generating capacity were 0.06 kW and 268 kWh, respectively. By 2017, they were 1.28 kW and 4773 kWh, which exceeded the world average level, 22 times and 17 times respectively, compared with 1978.

Power generation capacity is at the forefront of the world. Power generation ranked fifth in the world in 1978. Only about one tenth of the world's largest U.S. power generation at that time developed to surpass the U.S. as the world's largest power producer in 2011. By 2017, China's power generation was more than 15 times that of the U.S. power generation of 400 million kWh. The installed capacity

of power generation in China is 1.06 times of that in the United States by 2017, which ranks 8 (57.12 million kW) in the world in 1978 and only 1/9 of that in the United States.

Based on the comparable data of EIA in the United States, this paper compares the status of China's power generation capacity in the world in 1980 and 2014. In terms of installed capacity of power generation, in 1980, China was only 65.87 million kW, accounting for 3.3% of the world's total, ranking seventh in the world. By 2014, China was 1.223 billion kW, accounting for 21.5% of the world's total, ranking first in the world. In terms of power generation, in 1980, China was only 285.4 billion kWh, accounting for 4.0% of the world's total, ranking fifth in the world. By 2014, China's electricity generation capacity was 5144.9 billion kWh, accounting for 22.9% of the world's total, ranking first in the world.

### 3. Safe and Reliable Operation of Power Grid

In the past 40 years of reform and opening-up, China's power grid has developed from a "three-low" power grid with low coverage, low connectivity and low voltage to one with the strongest energy resource allocation capability, the largest installed scale of grid-connected new energy and the largest number of high-voltage transmission lines in the world, and from a power grid with low level of safe operation to one with the highest level of safe operation in the world. All villages are electrified, which solves the problem of electricity consumption for the non-electrified population.

The scale of power grid has developed steadily. In 1978, the coverage of the national power grid was less than half, with relatively isolated provincial and urban power grids as the main grids and few provincial links. The length of 220 kV and above transmission lines is only 23,000 km, and the transformer capacity is only 25.28 million kVA. By 2017, the transmission line with 35 kV and above will have a circuit length of 18.226 million km and a transformer capacity of 6.63 billion kVA. The length of 220 kV and above lines is 688,000 km, and the capacity of substation equipment is 4.03 billion kVA, which is 30 times and 159 times of 1978 respectively.

With the continuous improvement of the voltage level of power grid, the reliability of power supply has been greatly improved. From the perspective of voltage level, at the beginning of reform and opening up, the highest voltage level of China's power grid was 330 kV; by 2017, the highest voltage level reached 1100 kV. From the point of view of power supply reliability, in 1978, the level of power supply reliability in China was low, and the national power shortage lasted for nearly 10 years. By 2017, the average power outage time of urban users in China was 5.02 h/household, which was 91.53 h/household lower than that of 1996.55 h/household in 1991. From the point of view of grid intelligence, by 2017, the coverage rate of smart meters in China will reach 80%, and that of distribution automation in key cities will exceed 50%.

From the perspective of rural power grid construction, rural power grid has been large-scale construction and transformation, rural power security capacity has been greatly improved. In 1978, the electricity transmission rates of counties, townships and villages were 94.5%, 86.8% and 61.1% respectively. By 2017, all three indicators had reached 100%. Since 1998, continuous investment in rural power grids has been carried out in the first and second phases of rural power grids transformation, county-town rural power grids transformation, improvement of rural grids in central and western regions and power construction in power-free areas. By 2017, the state has allocated a cumulative investment of 108 trillion yuan to upgrade the rural power grids for 78,500 small towns and central villages, providing electricity for 1,595,800 wells nationwide, with a total of 331. Ten thousand impoverished natural villages have electricity. In 2017, the reliability rate of rural power supply reached 99.81%, and the time of annual household outage and unqualified voltage decreased significantly.

#### **4. Optimizing Power Supply Structure**

The installed structure of power generation is becoming more and more optimized, the installed scale of clean energy is expanding, and the installed capacity and power output of renewable energy are ranked first in the world. From the perspective of installed capacity of power generation, in 1978, clean energy installed 20.32 million kW, all of which were hydropower, accounting for 30.3% of the total installed capacity of power generation; by 2017, the installed capacity of clean energy generating was 69 million kW, 39 times that of 1978, accounting for 38.7% of the total installed capacity of power generation, which increased by 7.5 percentage points compared with 1978; in 2017, 89.88 million kW of clean energy generating units were added, far exceeding 1978. The total installed capacity (stock) of power generation.

In terms of power generation, clean energy generated 44.6 billion kWh in 1978, accounting for 17.4% of the total power generation; by 2017, clean energy generated 1664.5 billion kWh, 42 times that of 1978; clean energy generated 29.0% of the total power generation, an increase of 11.6 percentage points over 1978. In 2017, 108.19 billion kWh was generated by hydropower, 27 times as much as in 1978; 248.3 billion kWh was generated by nuclear power, 269.5 billion kWh by wind power and 64.8 billion kWh by solar energy. In 1978, China had not yet developed nuclear power, let alone wind and solar power.

Power investment structure is constantly optimized. Power investment has undergone tremendous changes, from concentrated investment in the field of hydropower and thermal power in 1978 to the current power investment "inclined to low-carbon energy power generation". In 2017, 71.3% of the total investment in clean energy sources, such as hydropower, nuclear power and wind power, was completed; 61.794 billion yuan, 74.09 billion yuan, 39.538 billion yuan and 64.314 billion yuan were invested in hydropower, thermal power, nuclear power and wind power, respectively.

#### **5. Great Improvement of Energy Saving Level in Electric Power Industry**

By means of technological innovation, structural adjustment and scientific management, the energy-saving level of the power industry has been greatly improved, and the coal consumption of power supply and the loss rate of power transmission have been greatly reduced. In the field of power generation, the average coal consumption of thermal power units decreased from 471 gce/kWh in 1978 to 309 gce/kWh in 2017, a decrease of 34.4%. Coal consumption of power supply for thermal power units above 6000 kW is 312 gce/kWh, which is 159 gce/kWh lower than 471 gce/kWh in 1978, a decrease of 33.8%. In terms of power grid, the loss rate has been declining from 9.64% in 1978 to 6.48% in 2017.

#### **6. Achieving Leap-forward Development of Electric Power Science and Technology**

After 40 years of reform and opening up, China's electric power science and technology has made a leap forward. Technological innovation is the first driving force for the development of power industry. Scientific and technological innovation and technological progress provide important support for the rapid development of China's power industry. At the beginning of reform and opening up, China's power science and technology lagged behind, and key technologies depended on developed countries abroad. After 40 years of development, China has made tremendous progress in power science and technology, occupying an increasingly important position in the field of world power science and technology. UHV transmission, smart grid, safe and stable operation control of large power grid, new energy access and other aspects have achieved world-leading scientific and technological innovations. China-led international standards such as UHV, new energy integration have become an important norm for the construction of relevant projects in the world. China has the world's highest voltage level (+1100 kV DC transmission and 1000 kV AC UHV transmission), and the manufacturing capacity of

transmission and transformation equipment is in the world's advanced level. New developments have been made in coal-fired power generation technology and pollutant control technology. Ultra-supercritical conventional pulverized coal power generation technology has reached the world advanced level. Air-cooling technology and circulating fluidized bed boiler technology have reached the world leading level. In the field of hydropower, they have reached the world leading level in the field of safety control of super-high arch dams and concrete cutoff wall. Nuclear power technology, from the blank at the beginning of reform and opening up to the breakthrough of key common technology and modern engineering technology, has provided strong support for building a nuclear power.

## 7. Conclusion

In the past 40 years of reform and opening up, China's electric power industry has stepped out of a path of development from "small to large, weak to strong", from "short supply" to "adequate supply", and created a miracle of the development of the world's electric power industry. Reform and opening up are the core driving force for the sustainable development of China's electric power industry. The new era puts forward new requirements for high-quality development of China's power industry. Therefore, we should deepen the structural reform of power supply side, continuously promote the development of clean electricity, scientifically resolve the excess risk of coal and electricity industry, improve the operating environment of power industry, deepen the reform of power market, and promote the high-quality development of power industry.

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