Investment and Financing Guidelines: Clean Energy - Hydropower

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Part I. Investment Background

China's hydroelectric power generation can be divided into three categories: conventional hydroelectric power stations, pumped-storage power stations, and tidal power stations.

Table 1 Classification of hydropower stations

<table>
<thead>
<tr>
<th>Category</th>
<th>Definition</th>
<th>2020 Target Size</th>
<th>Installed capacity</th>
<th>Annual power generation</th>
</tr>
</thead>
<tbody>
<tr>
<td>conventional hydropower plant</td>
<td>Generation of electricity from natural sources such as rivers and lakes.</td>
<td></td>
<td>34000</td>
<td>12500</td>
</tr>
<tr>
<td>pumped-storage power plant</td>
<td>Excess power will be used when the load in the power grid is low. The water from the lower reservoir is pumped to the upper reservoir.</td>
<td></td>
<td>4000</td>
<td></td>
</tr>
<tr>
<td>tidal power plant</td>
<td>Use the tidal energy created by the rising and falling tides to generate electricity.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The upstream, midstream, and downstream industrial chain of this industry is as follows: hydropower upstream mainly for power generation equipment, intelligent equipment, insulation materials, and other manufacturing, midstream for the construction of water conservancy projects, hydropower station
operations, and downstream is mainly for power sales industry.

Table 2 Distribution of the Hydropower Industry Chain

<table>
<thead>
<tr>
<th>UPSTREAM</th>
<th>MIDSTREAM</th>
<th>DOWNSTREAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power generation equipment,</td>
<td>Hydroelectric engineering,</td>
<td>Electricity sales</td>
</tr>
<tr>
<td>intelligent equipment, insulation</td>
<td>hydroelectric power plant operation</td>
<td></td>
</tr>
<tr>
<td>materials, etc.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3 Key policies in the hydropower field

<table>
<thead>
<tr>
<th>POLICY</th>
<th>RELEASED TIME</th>
<th>RELEASED UNIT</th>
<th>MAIN CONTENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategic action plan for energy development</td>
<td>2014</td>
<td>The state council</td>
<td>It proposes the active development of hydropower, requiring that, under the premise of ecological, environmental protection and resettlement, the construction of large hydropower bases be actively and orderly promoted, with emphasis on rivers such as the Jinsha River, Yalong River, Dadu River, and Lancang River in southwest China. It further proposes the development of small and medium-sized power stations following local conditions, the planning and construction of pumped-storage power stations, and the comprehensive utilization of water resources.</td>
</tr>
<tr>
<td>Notice on improving the formation</td>
<td>2014</td>
<td>NDRC</td>
<td>The feed-in tariff for hydropower is divided into intra-provincial and inter-provincial. The former one is based on a</td>
</tr>
<tr>
<td>Mechanism of hydropower grid price</td>
<td>Benchmark tariff system, while the latter one is determined by revising the price of electricity in the host province.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guidance on encouraging social capital to invest in hydropower stations</td>
<td>Under the premise of environmental protection, resettlement, and ensuring project safety, hydropower project owners can independently carry out the implementation of the project.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13th five-year plan for hydropower development</td>
<td>In accordance with the principle of giving priority to the development of the main rivers and the protection of tributaries in the river basin, the development of small and medium-sized river basins and hydropower is strictly controlled. The western region, which is rich in hydropower resources and has excellent development potential, will focus on the development of large rivers with concentrated resources and low environmental impact, key river sections and Major hydropower bases, and strict control of small and medium hydropower development. Given the higher degree of development of the eastern and central regions in principle they should no longer develop small and medium hydropower stations.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Notice on</td>
<td>Promote cross-provincial and cross-</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
promoting hydropower consumption in Southwest China

<table>
<thead>
<tr>
<th>Notice on key points of rural water conservancy and Hydropower Work in 2020</th>
<th>2020</th>
<th>MWR</th>
</tr>
</thead>
</table>

Creating green small hydropower demonstration stations in 2020 and build another 50 green small hydropower demonstrative plants with strict standards, procedures, and requirements. Continually improving the level of creative work. Promoting local incentive policies to guide small hydropower plant owners to consciously participate in the creation of green small hydropower demonstration plants.

The Thirteenth Five-Year Plan for Energy Development mentions that China will, during the 13th Five-Year Plan period, develop large hydropower in an orderly manner while controlling small and medium-sized projects. More than 60 million kWh was constructed during the 13th Five-Year Plan period. However, over the last decade, people have become increasingly aware of the potential damage that hydropower projects can cause to the ecological environment, mainly bringing harm from soil erosion and biodiversity destruction. Therefore, small and medium hydropower is no longer considered as ‘green’ in the Green Industry Catalogue of NDRC (2019 edition) released in 2019. However, small-scale hydropower facilities in rural areas are still seen as an incentivized project because of their relevance to infrastructure, such as rural revitalization and energy supply.

As a result, new hydropower installations have been declining in recent years,
with only 4.17 million kWh of new facilities in 2019, which is near the lowest level of the decade. The share of hydropower in China’s total electricity generation has also declined annually since 2016, from 19.5% in 2019 to 17.8% in 2018. But power generation is still growing in absolute terms, with the number increased from 668.1 billion kWh in 2011 to 1,301.9 billion kWh. As for the scale of investment in hydropower construction, the number in the 13th Five-Year Plan period has dropped significantly compared to the 12th Five-Year Plan period. After falling in 2016, the size of hydropower investment picked up slightly, from 61.7 billion RMB in 2016 to 81.4 billion RMB in 2019.

Figure 1 new installed capacity of hydropower in 2011-2019 (10000 kW)
Figure 2 total hydropower generation in 2011-2019 (100 million kWh)

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>Planned installed capacity (10000 kW)</th>
<th>Annual power generation (100 million kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jinshajiang hydropower base</td>
<td>8315</td>
<td>2908</td>
</tr>
<tr>
<td>Hydropower base in the upper reaches of the Yangtze River</td>
<td>3128</td>
<td>1275</td>
</tr>
<tr>
<td>Yalong River Hydropower Base</td>
<td>2883</td>
<td>1360</td>
</tr>
<tr>
<td>Nujiang hydropower base</td>
<td>2132</td>
<td>1030</td>
</tr>
<tr>
<td>Dadu River Hydropower Base</td>
<td>2524</td>
<td>922</td>
</tr>
<tr>
<td>Hydropower bases in Fujian, Zhejiang and Jiangxi</td>
<td>1417</td>
<td>203</td>
</tr>
<tr>
<td>Lancang River hydropower base</td>
<td>2560</td>
<td>722</td>
</tr>
<tr>
<td>Hydropower base in the upper reaches of the Yellow River</td>
<td>2656</td>
<td>508</td>
</tr>
</tbody>
</table>
### Part II. Business model

#### Revenue Model

The hydropower industry is a typical asset-heavy industry business model, and hydropower plant construction mainly exhibits high capital expenditures (CAPEX) during the construction period and has unique characteristics of the cash flow generation (CFO) during the post-operational period. This period includes: (1) during the depreciation period and the loan repayment period, in which the pressure of repayment of principal and interest gradually decreases as cash flow and net profit are increasing. (2) during the depreciation period
(end of debt service), during which cash flow and net profit are both at higher levels and remain stable. (3) at the end of the depreciation period, net profit remained stable after further improvement, while cash flow remained stable after a slight retreat.

During the construction phase, the cost includes engineering cost, compensation for flooding of reservoirs, basic reserve costs, and interest during construction. During the operation phase, the cost components of the hydropower plant include depreciation of fixed assets, finance costs, operation and maintenance costs, reservoir fund costs, costs for water resources, and other expenses.

After becoming operational, the revenue comes from power generation. Power generation revenue is mainly determined by two factors: the feed-in tariff and the feed-in electricity. In China, three models of hydropower pricing have emerged: hydropower plants commissioned before February 2014 still operate under the mechanism of "one plant, one price." The provincial dispatching hydropower plants commissioned after February 2014 will follow the province's hydropower benchmark feed-in tariff. For hydropower plants that are commissioned after February 2014, the cross-provincial transmission of electricity will be implemented according to the coal-fired power generation benchmark feed-in tariff in the host province. Therefore, after the implementation of West-to-East electricity transmission, the common hydropower station tariffs in Southwest China are divided into two models, namely, tariffs for external electricity transmission and feed-in tariffs for benchmarking (cost-plus tariffs are plant-specific with no need to discuss it). In terms of inter-provincially exported electricity prices, due to the implementation of a coal-fired tariff benchmark, the settlement tariff for the corresponding plant will also be different. In terms of power transmission prices, the electricity price of coal-fired electricity in the provinces where the electricity is delivered may be
higher, and the corresponding hydropower station settlement price will also be higher.

From current coal-fired electricity prices of various provinces, Guangdong (0.4530 RMB / kWh) and Guangxi Province (0.4207 RMB / kWh) have the most apparent advantages, followed by Shanghai (0.4155 RMB / kWh) and Zhejiang Province (0.4153 RMB / kWh). In comparison, it is not cost-effective to export to Jiangsu Province (0.3910 RMB / kWh). According to the Notice on Trial Implementation of Temporary Classified Benchmarking for Hydropower Stations in Sichuan power grid (Sichuan development and reform price [2015] No. 116), the benchmark on-grid price of inner diameter flow hydropower stations in Sichuan is 0.308 RMB / kWh (including 17% value-added tax, the same below). The benchmark on-grid price of hydropower stations with seasonal regulation (including incomplete annual regulation) is 0.35 RMB / kWh, while the benchmark on-grid price of hydropower station is 0.39 RMB / kWh. According to the Notice of Yunnan Provincial Price Bureau on Issues Related to Adjusting and Improving the time-varying electricity price policy ( [2013] No. 139), the electricity price of other hydropower stations in Yunnan is 0.235 RMB / kWh. This is with the exception that the electricity price of Ludila hydropower station is 0.313 RMB / kWh, the price for Jin'anqiao, Longkaikou, and Ahai Hydropower Stations which is 0.2893 RMB / kWh, and that of 11 hydropower stations such as Longjiang which is 0.27 RMB / kWh. Therefore, it can be seen from the above data that the order of hydropower price after the implementation of West to East power transmission is as follows: electricity price of Guangdong and Guangxi > benchmark price of Sichuan > price of Shanghai and Zhejiang > the benchmark price of Yunnan.

The utilization hours determines the on-grid power supply, while it depends on three indicators: the inflow of the power station reservoir, water inflow rate, and the capacity of water-saving and additional issuance. The inflow of the Jinsha
River (Yangtze River), Yalong River, and Lancang River are stronger than average. As mentioned above, the critical factors affecting the utilization hours include the inflow (fluctuation of natural resources) and water-saving capacity (joint cascade operation). In terms of incoming water, the Jinsha River (Yangtze River), Yalong River, and Lancang River all originate in Tibet, and their inflow is determined by water from glacial melting and rainfall. At the same time, Nanpan and Hongshui River only depend on rainfall. As a result, the fluctuation of incoming water from hydropower stations on the Jinsha River (Yangtze River), Yalong River, and Lancang River will be smaller. In terms of water-saving and additional water flow, due to the long main stream basin and significant elevation difference, the Jinsha River (Yangtze River), Yalong River, and Lancang River can form multiple power stations that can carry out joint cascade adjustment to smooth the fluctuation of incoming water. This process brings water-saving and an increase in the water utilization rate. Besides, with the development of high-quality hydropower resources in the middle and lower reaches of the main river basins in China, the unit investment cost (CAPEX) will gradually increase while the utilization hours will decrease.

**Financing Model**

The current hydropower industry is asset-heavy, with projects including reservoirs and dams, power plants and generating equipment, grid-tied transmission lines, and other subsidiary facilities, etc.. These have long investment, long construction period, and long investment return period. Therefore, hydropower projects are mainly developed through government or state-owned enterprises leading project development, with other enterprises participating in the implementation of each part of the project and supply chain. Under the traditional financing model, large hydropower projects mainly rely on bank loans financed by state-owned enterprises or the government. This situation leads to the problems of an unsuitable financing structure,
homogenous financing possibilities, backward financing means, and over-concentration of financing channels in banks that have led to government debt overload.

Therefore, the establishment of both new financing models, as well as the expansion of hydropower project financing channels, are not only beneficial to the development of China's hydropower industry, but it will also play a positive role in the development of the capital market and investment banking. In 2015, NEA issued the Guidance on Encouraging Social Capital Investment in Hydropower Plants to encourage private capital participation in power construction, support private capital participation in the construction of hydropower plants in the form of complete ownership, holding, or partnership. Other policies supporting this development includes liberalizing the electricity market, actively promoting electricity price reform, accelerating the implementation of competitive bidding for access to the internet, implementing bidding for project owners, and improving the electricity supervision system. The primary forms of private sector participation in hydropower projects in China are investment funds and PPP models such as TOT and BOT.

**Financing model for TOT project**

TOT (Transfer-to-Transfer) is a project that was built by the government or state-owned enterprise, and after a certain period with property rights or operating rights, will be transferred to the investor for a fee. The investor will operate the facility to recover the investment with a reasonable return after operation. Subsequently, the investor will return the project to the government or original enterprise after the expiration of the contract. Such a TOT financing model is shown in the figure below.
Figure 4 the framework of TOT pattern

It eliminates the risk during the construction of the hydropower plant, significantly increasing the efficiency and certainty of income. What's more, the stability of the revenue is helpful to the project operator in refinancing by way of operating revenue right pledge security, which helps to build the exit mechanism for social capital.

**Financing model for BOT project**

BOT (Build-Operate-Transfer) refers to the financing arranged by the government or its agencies for the construction and operation of a project, in which the investor develops the construction project and manages and operates the facility and its corresponding products and services within a specified period. It is often based on concession financing, which can reduce the government's capital investment in the initial stage of infrastructure construction.

The Hanjiang Gaopei Water Conservancy Hub Project in Guangdong Province is a BOT project with a concession period of 35 years. The total investment is
about 5.9 billion RMB, includes 3 billion RMB from the government and 1.956 billion RMB invested by private capital, with the latter one coming from the project company's funds and investment, as well as social financing of the project company. At the end of the concession, the operation right of it will be transferred to a designated unit in Meizhou.

Figure 5 BOT structural model framework
Investment and Financing Guidelines: Clean Energy - Solar

Part I. Investment Background

Solar energy, as a renewable energy source is facing the situation that further low-carbonization of world energy, and non-fossil energy is gradually becomes the world's signpost of energy development. Solar energy has consequently become one of the main tasks for clean energy development. With the first solar power demonstration project completed in 1998, China's photovoltaic industry started late. However, China is the world's fastest-growing country in new energy, and in just more than one decade, it has completed the process from the starting stage to the world's leader in new energy development. After more than 20 years of development, China's photovoltaic industry has the largest installed capacity in the world. By the end of 2019, China's cumulative installed PV power generation reached 204.3 GW, with 30.1 GW of new PV installed that year, both indicators ranked first in the world. At the same time, China is also the world's largest PV module exporter, with total exports in 2019 at 67,502.36 MW, up 65% year-on-year. Since 2013, China's share of global PV module production has remained at over 65% level, and in 2018 it reached 71.4%.

The core of the photovoltaic power generation industry is composed of photovoltaic cells, inverter, combiner box, and engineering construction. Additional core technologies include battery and inverter.

![Figure 6 Photovoltaic power generation industry chain](image-url)
Since the 13th five-year plan, China has gradually introduced a series of policies focusing on the adjustment of the photovoltaic electricity price, reduction of photovoltaic subsidies, control of photovoltaic index scale, promotion of photovoltaic parity on the grid, and the improvement of photovoltaic power generation consumption rate.

Table 5 Main PV policies issued by China in 2019

<table>
<thead>
<tr>
<th>YEAR</th>
<th>ISSUING UNIT</th>
<th>DOCUMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td>NDRC, NEA</td>
<td>Notice on Orderly Electricity Consumption Plan for Development</td>
</tr>
<tr>
<td>2017</td>
<td>NDRC, MOF, NEA</td>
<td>Notice on the development of photovoltaic and other renewable energy tariff funds clearing</td>
</tr>
<tr>
<td>2017</td>
<td>NEA</td>
<td>Guiding Opinions on the Implementation of the Thirteenth Five-Year Plan for Renewable Energy Development</td>
</tr>
<tr>
<td>2017</td>
<td>NDRC, NEA</td>
<td>Notice on the launch of the pilot market-based trading of distributed power generation</td>
</tr>
<tr>
<td>2017</td>
<td>NDRC,</td>
<td>Notice of Price Policy for PV Projects 2018</td>
</tr>
<tr>
<td>2018</td>
<td>NDRC, MOF, NEA</td>
<td>Notice on Matters Related to Photovoltaic Power Generation in 2018</td>
</tr>
<tr>
<td>2018</td>
<td>NDRC, NEA</td>
<td>Notice on Actively Promoting Electricity Market-based Trading to Further Improve the Trading Mechanism</td>
</tr>
<tr>
<td>2018</td>
<td>NEA</td>
<td>Notice on Accelerating the Work Related to the Affordable Feed-in Tariff for Wind and Photovoltaic Power Generation</td>
</tr>
<tr>
<td>2019</td>
<td>NDRC</td>
<td>Notice on issues related to the improvement of photovoltaic power generation feed-in tariff mechanism</td>
</tr>
</tbody>
</table>
Solar energy is an inexhaustible renewable energy. Since it has the advantages of sufficient cleanliness, absolute safety, relative universality, long duration and free maintenance, resource adequacy and potential price advantages, solar energy consequently plays an important role in the long-term energy strategy. Therefore, it can be predicted that in the future, with the continuous progress of photovoltaic industry technology, the reduction of cost, the stable policy support from the government, and the continuous improvement of absorption capacity, then the photovoltaic power has great development potential and will be an essential energy component in China.

Part II. Business model

Revenue Model

Revenue from PV power plant projects can be divided into subsidy revenue and electricity sales revenue. Subsidy revenue is influenced by national and local
PV power subsidy policies, and for centralized and decentralized PV power plants, their different operating models correspond to different subsidy policies. Revenue from electricity sales is influenced by factors such as generation, curtailment rate, and settlement model. The amount of electricity generated by a PV power plant is determined by the conversion efficiency of the power plant and the location of the optical resource arena. The settlement model is divided into "full grid access", "self-generation and self-use, surplus electricity to the grid".

Also, according to the Notice on Pilot Distributed Power Generation Market-based Trading, decentralized power generation projects are encouraged to trade directly with customers. The organization of market-based trading of distributed power generation, and therefore distributed PV power plant projects may also generate revenue from the direct sale of electricity. Therefore, overall, the factors can be divided into four categories: subsidy policy, PV Technology, optical resources, and market tariffs.

**Generating capacity**

(1) Sunlight resource area

Distribution of sunlight resources: Sunlight resources influence the power plant's power generation and, thus, the income of PV power plant projects. China is a vast country, where the distribution of optical resources in the country is quite different. According to the annual equivalent utilization of hours, the country is divided into three categories of solar energy resource areas. The first category of resource area is the equivalent annual use of more than 1,600 hours, mainly distributed in the Ningxia province, northwestern Gansu and Inner Mongolia. Part of the region, part of Xinjiang. The annual equivalent utilization hours between 1400-1600 hours is a category two resource area, mainly distributed in North China and part of Northwest China. The annual equivalent hours of use between 1200-1400 hours is category three resource areas with different
PV benchmark feed-in tariffs.

Table 6 Light resource Distribution in China

<table>
<thead>
<tr>
<th>OPTICAL RESOURCE</th>
<th>REGIONS</th>
<th>HOURS</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Ningxia, Qinghai (Haixi), Gansu (Jiayuguan, Wuwei, Zhangye, Jiuquan, Dunhuang, Jinchang), Xinjiang (Hami, Tacheng, Altay, Karamay), Inner Mongolia (Hohhot, Baotou, Wuhai, Ordos, Bayannur, Ulanqab, Xilingol).</td>
<td>Annual equivalent hours of utilization of more than 1600; minimum guaranteed effective hours of generation 1500</td>
</tr>
<tr>
<td>II</td>
<td>Beijing, Tianjin, Heilongjiang, Jilin, Liaoning, Sichuan, Yunnan, Inner Mongolia (Chifeng, Tongliao, Xing'an League, Hulunbeir), Hebei (Chengde, Zhangjiakou, Tangshan, Qinhuangdao), Shanxi (Datong, Shuozhou, Xinzhou), Shanxi (Yulin, Yan'an), Qinghai (Xining, Haidong, Haibei, Huangnan, Hainan, Guoluo, Yushu), Gansu (Lanzhou, Tianshui) Baiyin, Pingliang, Qingyang, Dingxi, Longnan, Linxia, Gannan), Xinjiang (Urumqi, Turpan, Kashgar, Hotan, Changji Hui, Bortala Mongolia, Ilikazak, Kizilsu Kirgiz Autonomous Prefecture).</td>
<td>Annual equivalent hours of use between 1400-1600; minimum guaranteed hours of power generation 1300</td>
</tr>
<tr>
<td>III</td>
<td>Areas other than the two mentioned above</td>
<td>Annual equivalent hours between 1200 and 1400 hours.</td>
</tr>
</tbody>
</table>

(2) power generation efficiency
In addition, the effective sunlight conversion rate also has a significant impact on power generation. The main types of accumulated crystalline silicon cells currently used in the Chinese market are as follows:

<table>
<thead>
<tr>
<th>ACRONYM</th>
<th>EXPLANATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AI-BSF</strong></td>
<td>Aluminum Back Surface Field-In order to improve the efficiency of solar cells, after the completion of the preparation of p-n junction, a layer of aluminum film is deposited on the backlit surface of the silicon wafer to prepare the P+ layer, called aluminum backfield cells.</td>
</tr>
<tr>
<td><strong>PERC</strong></td>
<td>Passivated Emitter and Rear Contact-The use of special materials to form a passivation layer on the surface of the cell as a backside emitter increases the absorption of long-wave light and increases the potential difference between the p-n poles to reduce electronic compounding and improve efficiency.</td>
</tr>
<tr>
<td><strong>PERT</strong></td>
<td>Passivated Emitter and Rear Contact-An improved version of PERC technology, with full diffusion based on the formation of passivation to enhance the effect of the passivation layer.</td>
</tr>
<tr>
<td><strong>HJT</strong></td>
<td>Heterojunction with Intrinsic Thin Layer-Both crystalline and amorphous levels of silicon are present in the cell, and the presence of amorphous silicon allows for better passivation.</td>
</tr>
<tr>
<td><strong>IBC</strong></td>
<td>Interdigitated Back Contact-Placing both positive and negative electrodes on the backside of the device reduces the shadow loss caused by partial reflection of the incident light by the electrodes on the front side.</td>
</tr>
<tr>
<td><strong>Topcon</strong></td>
<td>Tunnel Oxide Passivated Contact-An ultra-thin layer of silicon oxide is prepared on the backside of the cell, and a thin layer of doped silicon is deposited, which together form a passivated contact structure.</td>
</tr>
</tbody>
</table>
Since 2014, Chinese PV module manufacturers have been working on high-efficiency crystalline silicon such as PERC, Topcon, heterojunction, IBC, and development of thin-film solar cell technology. Each of these technologies has made significant breakthroughs. In 2019, the average conversion efficiencies of large-scale production of single-polysilicon cells were 22.3% and 19.3%, respectively. Monocrystalline cells are all based on PERC technology, with an average conversion efficiency of 0.5% higher than that of 2018, leading the company's conversion efficiency reached 22.6%. The efficiency of polycrystalline cells using PREC cell technology was 20.5%, an improvement of 0.2% over 2018. The average conversion efficiency of the metal single crystal PERC cells is 22%, which is 0.3% lower than that of monocrystalline PERC cells. The average conversion efficiency of N-PERT/Topcon cells is 22.7%, and that of heterojunction cells is 23.0%. According to CPIA, the N-type cell is expected to be one of the leading development directions of PV module cell technology in China in the future.

![Figure 7 Development trend of domestic battery cell mass production conversion efficiency from 2008 to 2019](image)

The development trend of photoelectric average conversion efficiency of leading crystalline silicon in China is as follows:

Table 8 Trends in the average conversion efficiency of various battery technologies,
<table>
<thead>
<tr>
<th>CELL TECHNOLOGY</th>
<th>Average conversion rate %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2019</td>
</tr>
<tr>
<td>polycrystalline silicon</td>
<td></td>
</tr>
<tr>
<td>P-type BSF polysilicon black silicon solar cell</td>
<td>19.3%</td>
</tr>
<tr>
<td>P-type PERC polycrystalline silicon black silicon solar cell</td>
<td>20.5%</td>
</tr>
<tr>
<td>P-type PERC 22.3% quasi monocrystalline silicon solar cell</td>
<td>22%</td>
</tr>
<tr>
<td>P-type monocrystalline silicon</td>
<td></td>
</tr>
<tr>
<td>P-type PERC monocrystalline silicon solar cell</td>
<td>22.3%</td>
</tr>
<tr>
<td>n-type monocrystalline silicon</td>
<td></td>
</tr>
<tr>
<td>N-pert+ TOPCON monocrystalline silicon solar cell (front)</td>
<td>22.7%</td>
</tr>
<tr>
<td>N-type silicon heterojunction monocrystalline silicon solar cells</td>
<td>23%</td>
</tr>
<tr>
<td>N-type back contact monocrystalline silicon solar cells</td>
<td>23.6%</td>
</tr>
</tbody>
</table>
Electricity price

The revenue of photovoltaic power station logically depends on the price of electricity. For centralized photovoltaic power stations, the electricity selling price is implemented according to the benchmark set by the state. For decentralized photovoltaic, three forms are adopted, namely "full grid access", "self-generation and self-use, surplus electricity to the grid," and "Direct Electricity Transaction". Since the 13th five-year plan, China's renewable energy scale has continued to expand, the technical level has been continuously improved, and costs for development and construction have been continually reduced. According to statistics, the average construction cost of photovoltaic power stations put into operation in 2017 is 45% lower than that in 2012. To this end, China has issued a series of policies since 2018. On the one hand, it has gradually reduced the price subsidy for photovoltaic power stations, and started auction subsidy work for photovoltaic power generation in 2019. On the other hand, it has promoted the construction of several PV power station affordable online pilot projects in areas with excellent resource conditions and guaranteed consumption market.

Since 2018, the price of photovoltaic power generation has changed from the benchmark price and full guarantee designated by the NEA and NDRC to the joint policy approach by the Ministry of Finance (MOF), NDRC, and NEA and other relevant government departments. In this way, the financial department determines the amount of subsidy, the price department sets a price ceiling, and the energy sector determines the competition rules. Next, the enterprise determines the subsidy intensity, the market determines the construction scale, and the power grid consumption capacity determines the project owners. In this way electricity price subsidies and overall scale is subsidized through a nationwide competitive allocation.

(1) full grid access
In terms of full grid access, NDRC, MOF and NEA co-issued Notice on Matters Related to PV Power Generation in 2018 (531 New Deal), lowering the benchmark feed-in tariff of PV power generation. It also lowered subsidy standards for decentralized PV in the model of "self-generation, self-consumption, surplus power to the grid". Launched in April 2019, the Notice on Improving the PV Feed-in Tariff Mechanism issued by NDRC is the latest PV feed-in tariff mechanism guidance document. The document reduced the intensity of PV subsidies, including changing the centralized PV power plant benchmark feed-in tariff to a ‘guiding price’. In 2019, the guiding prices of newly added centralized photovoltaic power generation projects included in the annual scale management of financial subsidies in class I-III resource areas are determined as RMB 0.40 (tax included, the same below), RMB 0.45 and RMB 0.55 per kWh respectively, for industrial and commercial distributed photovoltaic power generation projects. The "Full grid access" model shall be implemented according to the guiding price of a centralized photovoltaic power station in the resource area. For "full grid access" model, the guiding price of a centralized photovoltaic power station in the resource area is used. The subsidy standard for household distributed photovoltaic power generation is adjusted to 0.18 RMB per kilowatt-hour.

(2) Self-generation and self-use, surplus electricity to the grid

"Self-generation and self-use, surplus electricity to the grid" is mainly used for decentralized PV projects. From 2019, the new policy will manage the industrial and commercial and household decentralized photovoltaic projects separately. For industrial and commercial distributed photovoltaic power generation projects, the total power generation subsidy standard of "Self-generation and self-use, surplus electricity to the grid" model is adjusted to RMB 0.10 per kWh. At the same time, according to the Notice on the construction of wind power and photovoltaic power generation projects in 2019 issued by the national
energy administration the total subsidy budget for the construction of photovoltaic projects in 2019 is 3 billion RMB. This is including 750 million RMB for household photovoltaic projects and 0.18 RMB per kWh of fixed electricity subsidy.

(3) Direct Electricity Transaction

For the purpose of nearby consumption of clean energy resources, improving energy utilization efficiency, and reducing energy waste of remote power transmission, in October 2017, NDRC and the NEA issued Notice on Carrying out Market-oriented Trading Pilot of Decentralized Generation. This policy officially proposes that decentralized projects can achieve "Direct Electricity Transaction ". This Notice introduces two typical types of direct transaction models for distributed generation:

- The qualified decentralized generation projects directly provide point-to-point power delivery to end consumers nearby and generate power sales income deducted by "over grid fees" for electricity transmission services provided by grid companies.

- The distributed solar power plant entrusts the grid company to sell electricity, and the power grid company will transfer the remaining power sales revenue to the distributed solar power plant after deducting the "grid fee" (including power loss) at the final power sales price.

Figure 8 Point-to-Point Power transaction
The Notice also requires that the subsidy for "power sale by partition wall" of photovoltaic power generation should be reduced based on the local decentralized photovoltaic power generation subsidy standard. This is set at no less than 10% within 20MW and no less than 20% within 20-50MW.

Power curtailment rate of solar power plants

The "curtailment" of solar energy refers to the waste of electricity generated by a solar power plant that cannot be consumed by the power grid. Curtailment will lead to a negative influence on the revenue of solar power plants and is also one of the main factors affecting solar power generation.

In 2020, the biggest challenges for photovoltaic power generation will come from the space consumed and the curtailment rate. In 2019, the rate in China accounted for 2%, with a year-on-year decrease of 1%. The problem of photovoltaic energy consumption is mainly concentrated in the northwest provinces. The total power curtailment in such regions is accounted for 87% around the nation. The rate of Tibet, Xinjiang, and Gansu were 24.1%, 7.4%, and 4.0%, respectively, which were significantly higher than the national average level. In 2018, NDRC and NEA issued the Action Plan for Clean Energy Consumption (2018-2020), which put forward the target of less than 5% curtailment in 2020. Therefore, in some areas with limited consumed space, the approval and grid connection of new photovoltaic power generation projects may not be possible, and competition with wind power for consumed space may also arise in 2020.
Financing Model

At present, debt financing for centralized PV power plants in China mainly takes the form of bank project financing, financial leasing, and asset securitization.

(1) Project loan

Project loan is the most widely used financing tool in China's financing market. Photovoltaic power generation projects can apply for loans from banks or trust schemes within 70% of the total investment for their project construction. Although most of the banks in China are currently offering PV loan products, the existing PV loan products mostly have a duration for 3-5 years, with even the longest at no more than ten years while requiring matching with appropriate collateral. Commercial loan forms are heavily mismatched with PV project cash flows and are subject to collateral restrictions, which make project financing support even harder.

Policy loans have a longer duration and lower interest rates compared to commercial loans. Photovoltaic power generation projects are one of the main takers of policy loans due to their climate-friendly and significant ecological and environmental benefits. For example, in 2016, China Development Bank provided Jinko Solar's 50MW photovoltaic power generation project in Yangjia Village, Lianhe Township, Hengfeng County, Jiangxi Province, with project loans totaling 320 million RMB over 15 years. 2018 Lightway Green New Energy Co. and its wholly-owned subsidiary Baoding Ltd. received a 15-year loan of 70 million RMB from China Development Bank Hebei Branch for the development and construction of the first 9.645MW decentralized PV power plant in Baigou, Hebei Province, which is expected to cover the electricity consumption of 3 million people in the area.

(2) Financial leasing

The development and operation of photovoltaic power plants are similar to
operating properties with stable cash flow, making them suitable for the introduction of financial leasing. This model can optimize the operator’s asset-liability structure and profit-model while improving leverage to maintaining a high credit rating. The introduction of financial leasing in the financing of domestic power station operators can significantly help private enterprises to break through the financing bottlenecks in the field of distributed power stations.

There are two forms of financial leasing, direct leasing, and sale-leaseback. The latter one is the most common form of a PV power plant financial leasing. The financing model of direct leasing is presented in the form of the following examples. Company A has an existing 20MW new PV plant and is expected to solve the funding problem during the construction period through financial leasing. Company B can provide financial leasing and purchases the PV power generation equipment from the supplier (10% of the equipment is paid by Company A) and then leases the equipment to Company A. The lease is for 3+5 years, with quarterly payments and interest only for the first two installments. In the third year, Company A can choose whether to continue the lease or purchase the power plant.

The risk control requirements for this model: (1) Company A provides full and irrevocable joint and several guarantee liability for the entire period; (2) The leaser’s power station charging right and all proceeds under the project are pledged to financial leasing company B, and 100% equity of the photovoltaic project is pledged to B; (3) Company A purchases property insurance on the power station and names Company B as the first beneficiary. The transaction structure of direct leasing is relatively complex, involving three parties: the owner, the leaser, and the supplier, and there should be multiple suppliers for the same project and leads to a more complicated transaction structure, and this transaction model has stringent requirements for upfront project conditions. Hence there is a low penetration rate of use in China.
The sale-leaseback model applies to photovoltaic power stations that have been put into operation.

For example, company A sold its three grid-connected decentralized photovoltaic power stations to financial leasing Company B through sale-leaseback. They did so, providing a financing amount of 90% of the total project value, and signed a sale-leaseback contract with an agreed leaseback period of 8 years. During the period, the rent was paid on schedule according to the contract, and the power station was repurchased according to the agreement after expiration. The project risk control requirements are the same as those of direct leasing.
(3) Equity financing

In PV power plant projects, equity financing is mostly seen in common operation models of PV power plants. For financial leasing companies with strong professional capabilities, they can participate in the operation of PV power plants through the form of equity participation. The company can provide developers with the design, installation, and maintenance of the system, and by collecting leasing fees from customers, it can ensure the efficient operation and revenue security of the PV project. This model requires the project owner to accept a partial transfer of operating rights, resulting in a change of control of the project. Therefore this model is seldom taken by listed companies.

In addition, large Chinese PV construction and development companies, with their strong creditworthiness and specialization, obtain financing through public equity offerings to invest in PV power plant projects. JinkoSolar, which was listed in May 2020, is a market entity covering the upstream and downstream PV industry chain.
Investment and Financing Guidelines: Clean Energy- Wind Power

Part I. Investment Background

Wind energy is a renewable source of energy that has extraordinary climate and environmental benefits. In comparison to fossil fuel-based electricity generation, wind-generated electricity does not only reduce carbon dioxide emissions, but it also reduces other air contaminants such as sulfur dioxide and nitrogen oxide and reduces resource consumption.

According to the U.S. Energy Commission, an average of 1 GW of wind-generated electricity can reduce an additional 750-1000t carbon dioxide, 7.5-10t sulfur dioxide emissions, and 3-5t NOx emissions.

Policy Development

China's wind power utilization started in the 1980s, however, it was in the "Eleventh Five-Year Plan," where the country began to support grid planning related to wind power development and the construction of wind power access systems in the".".

<table>
<thead>
<tr>
<th>Year</th>
<th>Policy name</th>
<th>Policy content</th>
</tr>
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<tbody>
<tr>
<td>2006</td>
<td>Renewable Energy Law</td>
<td>Beginning of the subsidy policy of &quot;fixed electricity prices&quot; for renewable energy power and determine the wind farm investors, developers, and on-grid electricity prices by implementing wind power concession bidding projects and</td>
</tr>
<tr>
<td>Year</td>
<td>Description</td>
<td>Details</td>
</tr>
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<tr>
<td>2008</td>
<td>The Notice of the Ministry of Finance on Adjusting the Import Tax Policy of</td>
<td>This policy promotes the development, production, and independent innovation of wind power enterprises' new products by levying and retreating import tariffs, importing value-added environmental taxes first and then converting the tax refund from state investment into state capital.</td>
</tr>
<tr>
<td></td>
<td>High-power Wind Turbine, Its Key Components and Raw Materials</td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td>Notice of the National Development and Reform Commission on Perfecting the</td>
<td>Implement benchmark on-grid tariff policies based on concession bidding.</td>
</tr>
<tr>
<td></td>
<td>Policy of On-grid Electricity Prices for Wind Power Generation</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>Air Pollution Prevention Action Plan of the State Council</td>
<td>The development of renewable energy, such as wind power and solar energy, is listed as an essential measure to prevent and control air pollution.</td>
</tr>
<tr>
<td>2014</td>
<td>Energy Development Strategic Action Plan (2014-2020) of the State Council</td>
<td>This policy proposed the vigorous development of wind power. By 2020, the installed capacity of wind power will reach 200 million kilowatts, and the on-grid price of wind power and coal power will be equivalent.</td>
</tr>
<tr>
<td>2016</td>
<td>Guiding Opinions of the National Energy Administration on Establishing the</td>
<td>This policy proposed studying and improving the system plus mechanism to promote the development and utilization</td>
</tr>
<tr>
<td></td>
<td>Target</td>
<td></td>
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</table>
### Guidance System of Renewable Energy Development and Utilization

of renewable energy, establishing a green certificate trading mechanism for renewable energy power.

### Letter of the National Energy Administration on Soliciting the Notice Opinions on Establishing the Assessment System of Non-water Renewable Energy Power Generation Quota for Coal-fired Thermal Power Units

This policy required enterprises to complete their quota targets by self-constructing non-water renewable energy projects or purchasing green certificates of renewable energy and electricity.

### The 13th Five-Year Plan for Energy Development of National Energy Administration

This policy proposed to vigorously develop decentralized wind power, giving priority to the development of decentralized wind power in the central, eastern regions and the southern regions, promoting the technological progress of low-speed wind turbines and offshore wind power.

## Market Entities

The development of wind power station requires the engagement of multi-industry market participants throughout all the stages. The wind power industrial chain can be separated into three major categories, site development, engineering construction, operation, and maintenance. Each link corresponds to the main market for: a) Manufacturers of raw materials for various parts of wind turbines and wind towers, including iron and steel (wind turbine thick plate, alloy steel, pig iron, scrap steel), glass fiber, carbon fiber, resin, anti-corrosion paint, glue, etc. b) Components of wind turbine manufacturers; c) the wind farm developer, Chinese turbine OEMs, wind tower manufacturers, and construction
contractors.

Figure 12 Wind Industrial Chain
Part II. Business Model

Revenue Model

In China, wind power is the earliest new energy source to achieve grid parity. The Thirteenth Five-Year Plan for Energy Development clearly states that the price levels and subsidy standards for wind power and photovoltaic power generation will gradually be reduced. China's wind power has been going through a subsidy rollback during the 13th Five-Year Plan period and has been transitioning to grid parity by 2020. Since wind power exploitation will be much more difficult for developers, the need for their expertise in wind power development is also increasing. At present, wind power income can be divided
into two categories, the first is revenue generated by the direct sale of electricity, and the second is the income generated by the sale of green electricity trading certificates.

**Green electricity trading certificates**

The green electricity transaction certificate identifies the difference between the price of renewable energy electricity and the price of conventional electricity. To determine the electricity generated by renewable energy and to trade it for profit, this mechanism can be divided into two types: compulsory trading mechanism and voluntary subscription mechanism.

<table>
<thead>
<tr>
<th>Year</th>
<th>Policy name</th>
<th>Policy content</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>Notice of the National Development and Reform Commission, the Ministry of</td>
<td>This policy required the establishment of a voluntary subscription system for renewable energy green power certificates and attempted to trade green power certificates nationwide. This served to issue green power certificates for renewable energy generated by onshore wind power and photovoltaic power generation enterprises (excluding distributed photovoltaic power generation). According to the market subscription situation, starting from 2018, the renewable energy power quota assessment and green power certificate compulsory constraint transactions will begin in due course.</td>
</tr>
<tr>
<td>2019</td>
<td>Notice of the National Development and Reform Commission and the National Energy</td>
<td>This policy clarified that the relevant provincial energy authorities will organize and carry out the construction of wind power and photovoltaic power generation projects without state</td>
</tr>
<tr>
<td>Administration on Actively Promoting the Work of Unsupported and Affordable Internet Access for Wind Power and Photovoltaic Power Generation</td>
<td>subsidies in conjunction with the resources, consumption, and application of new technologies in the region. This encourages the obtaining of benefits through green certificates and cheap internet access projects that can obtain reasonable benefits through green certificate transactions.</td>
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<tr>
<td>Notice of the National Development and Reform Commission and the National Energy Administration on Establishing and Perfecting the Guarantee Mechanism for Consumption of Renewable Energy Power</td>
<td>This policy required that the proportion of renewable energy and electricity to be achieved should be in accordance with the provincial administrative region's regulations on electricity consumption. People can voluntarily subscribe to the green power certificate for renewable energy, electricity, and the equivalent amount of renewable energy. Electricity corresponding to the green certificate is recorded as the consumption amount.</td>
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</table>

Since 2017, China has established and operated a voluntary subscription market for green power trading certificates and adopted a listing trading mechanism to promote transactions. Renewable energy power generators first apply to the Renewable Energy Information Center according to the on-grid power, and then issue green certificates with certification marks according to the power generation type, on-grid time, and project name. Each green certificate represents 1MWh of renewable energy power. In the green card trading market, the suppliers are wind power and photovoltaic enterprises, while the green card subscribers are more diversified and can be either individuals or enterprises. Green certificate suppliers can sell green certificates on the China Green Certificate Subscription Platform and the buyer and the seller determine the subscription price through negotiation or bidding. The subscription price
must be higher than the subsidy amount of the renewable energy electricity price that corresponds to the certificate. After selling the renewable energy green electricity certificate, the corresponding electricity will no longer enjoy the national subsidies from the renewable energy electricity price additional funds. The Green Power Certificate will be delisted on the trading platform after the Green Certificate Subscriber completes the subscription and may not be sold again.

Figure 15 Green Power Certificate Transaction Issuance Mechanism

As of February 2020, according to data from the Green Certificate Subscription Platform, 2,170 subscribers in China have claimed a total of 36,439 green power certificates. The wind power industry has issued a total of 23,315,779 certificates. In terms of the transaction price, since July 2017, the transaction price of the wind power green certificate reached a maximum of 330 RMB, a minimum of 128.6 RMB, and an average of 177.4 RMB.
Centralized wind farm

The main source of revenue for centralized wind power plants is revenue from electricity generation. Revenue from electricity generation depends on the electricity price of wind power stations and online electricity. In terms of electricity price, on May 24, 2018, the National Energy Administration issued the "Notice on relevant requirements of wind power construction management in 2018", specifying the provinces (autonomous regions and municipalities directly under the Central Government) that have issued wind power construction plans for 2018 and offshore wind power projects with identified investors can continue to promote the original scheme in 2018. Beginning in 2019, the newly approved centralized onshore and offshore wind power projects in all provinces (autonomous regions and municipalities) will be allocated and determined through competition. Centralized wind power projects have formally moved from the "benchmarking" to the "competitive feed-in tariff" stage.

In July 2019, the National Development and Reform Commission (NDRC) issued a Notice on Improving Wind Power Feed-in Tariff Policy, clarifying that in 2019, the newly approved onshore wind power guidance price for class I-IV resource areas, in accordance with the plan and included in the annual scale
management of financial subsidies, will be adjusted to ¥0.34, ¥0.39, ¥0.43 and ¥0.52 per kWh (tax included). The 2020 guide price was adjusted to ¥0.29, ¥0.34, ¥0.38, and ¥0.47 respectively per kWh. While as of January 1, 2021, the new approved onshore wind power projects will all be on par with the Internet without subsidies from the government. This means that during the 14th Five-Year Plan period, China's wind power will enter a new period of market-led development.

The amount of electricity on the grid is determined by wind resources and the rate of wind abandonment. According to the National Energy Administration, in 2019 the number of average hours of wind power utilization in China was 2,082 and regions with high average wind power utilization hours are Yunnan (2,808 hours), Fujian (2,639 hours), Sichuan (2,553 hours), Guangxi (2,385 hours) and Heilongjiang (2,323 hours). In 2019, the country abandoned 16.9 billion kWh of wind power, a year over year decrease of 10.8 billion kWh, with an average wind abandonment rate of 4%, which was down three percentage points on a year over year basis. Among them, Xinjiang is an area where the wind abandonment rate exceeds 5% (14.0% abandonment rate and 6.61 billion kWh) along with Gansu (7.6% and 1.88 billion kWh) and Inner Mongolia (7.1% and 5.12 billion kWh). These three provinces (regions) accounted for 13.6 billion kWh of abandoned wind power and in total, accounted for 81% of the nation's abandoned wind power (from 2019 wind power grid-connected operational situation, National Energy Board).

In terms of wind resources, there are three main regions in China that have relatively abundant wind energy resources. The first is the "southeastern coastal area" with its coastline length exceeding 18,000 kilometers where both winter and summer monsoons are highly pronounced. The impact of both land and sea winds at the same time in this area, especially at the sea surface, creates very little resistance, leading to strong wind force. The second region is
the "northeast and northwest," the western parts of Liaoning, Jilin, and Heilongjiang in the northeast of China, and the entire northwest of Inner Mongolia, together with the eastern part of Xinjiang, is the region with richest wind energy resources in China, due to its proximity to China's North, which is a significant consumer of energy and is therefore currently the focus of China's wind power development. The third region is "northwestern Tibet," which is located in the northwestern part of the Tibetan Plateau, which has a high altitude and flat terrain. Living in such an arid climate, the surface vegetation is so sparse that it cannot block the wind so its power is relatively strong. However, due to the high altitude of the Qinghai-Tibet region, the thin atmosphere, and the low energy density of wind, it is more challenging to utilize.

**Decentralized wind power plants**

In April 2018, to promote the development of decentralized wind power and regulate the construction and management of decentralized wind power projects, the National Energy Board issued the Interim Administrative Measures for the Development and Construction of Decentralized Wind Power Projects, which opened the prelude to the large-scale development of decentralized wind power projects. Large scale wind farms and decentralized wind farms are quite different in terms their business models. The most significant difference between the two is between the customer structure and project implementation. Decentralized wind power projects refer to wind power projects that generate electricity for self-use or online and are balanced and regulated in the distribution network system. Not for large-scale long-distance transmission, the power generated from them is connected to the distribution network and consumed nearby. With the elimination of subsidies for centralized wind power projects, coupled with policy support to encourage distributed energy, the future market for decentralized wind power will be concentrated in large quantities of small wind power development operators.
In China, revenues from decentralized wind farm projects depend on the amount of electricity generated and the price of electricity as well. Unlike centralized farms, the power generated from decentralized is fully purchased by the grid company; however, centralized power has two forms of electricity sales include "self-generation and self-consumption, with surplus electricity going to the grid" and "full-grant." Full feed-in refers to the purchase of electricity by grid companies under the benchmark feed-in tariffs approved by the state for various types of power generation. In October 2017, NDRC and the National Energy Board jointly issued the "Notice on Launching Pilot Distributed Power Generation Market-based Trading" (NDRC Energy No. [2017] 1901) to encourage direct transactions between distributed power generation projects and customers and to organize the marketization of distributed power generation trades. This offers a huge potential for innovative trading models for distributed wind power sales. In July 2019, the NDRC issued the Notice on Improving the Policy of Feed-in Tariff for Wind Power," which clarifies that the feed-in tariff for decentralized wind power participating in distributed market-based trading is to be determined by the power generators and that the power users directly negotiate the formation, and do not enjoy state subsidies. Decentralized wind power projects that do not participate in the distributed market-based trading will implement the guiding price of the resource area where the project is located. However, some provincial and municipal-level finances still provide subsidies for offshore wind power, which are fully covered by local finances. For example, on June 8, Shanghai issued the "Special Fund Support Measures for the Development of Renewable and New Energy Sources (2020 Edition)," which mentioned that the incentive for offshore wind power is ¥0.1/kWh for five years.

**Financing Model**

The core of the centralized wind power plant business model lies in the
development and operation of the site, and it presents characteristics such as large upfront investment, long payback period, and a gradual decrease in subsidies. Large-scale wind power projects usually require the development entity to access locations suitable for wind power, as well as have powerful capital and debt financing capabilities. At present, most of the domestic large-scale offshore and onshore wind farm development subjects are large central and state-owned enterprises in the power generation industry or the traditional energy industry. For example, the five main power generation central enterprises are: Guodian, Datang, Huaneng, Huadian, SPIC, and other state-owned energy companies include: CGN, CECEP, CR Power, CTG and so on. At the wind farm operation stage, the market participants are more diversified, and also include private and foreign enterprises, such as Goldwind Technology, Siemens Gamesa. The latter two types of enterprises are mostly involved in the wind turbine and components manufacturing and other upstream and midstream industries. In China, the financing of wind power projects can be divided into three main categories according to the methods: bank loans, lease financing, and bond financing.

**Bank loan**

Bank loans are currently the most common method of financing wind power projects in China. Since many domestic wind power construction projects use foreign equipment, foreign equipment suppliers will cooperate with domestic investors to finance loans abroad, mainly for equipment purchases and other processes.

The financing of wind power projects by multilateral financial institutions is an example. In September 2017, the 246MW Phase II of the Putian Pinghaiwan offshore wind power project received a project loan of 2 billion RMB from the BRICS New Development Bank for the construction of offshore wind farms. The project expects to bring about 900,000 tons of carbon emissions reduction per
Domestic loans can be divided into policy bank loans and commercial bank loans. Financial funds provide long-term low-interest loans to wind power projects through policy banks and government funds, etc. Commercial bank loans refer to commercial financial institutions or trust plans, which provide financing services for wind power projects at market-based interest rates and corresponding maturities.

In recent years, with the rapid development of green finance in China, as a green industry, the wind power industry has received greater green credit support from financial institutions. More innovative green financial tools have gradually also been used to support the development of clean energy, such as carbon emission credit financing and CDM financing mechanisms.

The Donghai Bridge 100 MW Offshore Wind Power Demonstration Project is the first offshore wind power project in China and a key construction project in Shanghai. It is of considerable significance to promote energy conservation and emission reduction. The total investment of the project is 2.365 billion RMB, with a concession period over 25 years, which expects to save 100,000 tons of standard coal and reduce 200,000 tons of carbon dioxide emission per year, as a result, the benefits of energy-saving and emission reduction will be very remarkable. In this project, Pudong Development Bank led the formation of a total of 1.892 billion RMB of syndicated loans, providing the project company with 18-years of project financing. At the same time, since the East China Sea wind power project is a Clean Development Mechanism (CDM) project, it can generate a steady annual income by participating in emission reduction trading. It has already been approved by the United Nations to register for CDM trade. The Pfizer Bank has specially designed a CDM receivable pledge guarantee program to pledge CDM receivables to the syndicate as a significant supplementary guarantee method. The project successfully implemented an
innovative financing method by combining syndicated financing and a CDM receivables pledge, which is a successful way of pledging carbon emission rights in the world. Therefore making this a useful first attempt at business.

**Lease Financing**

Lease financing can be divided into three forms: direct leasing, sale and leaseback, and vendor leasing. In China, direct and sale and leaseback are most commonly used for decentralized wind power projects and small and medium-sized wind power developers. They are generally used to address the needs of the wind power industry when credit funds cannot cover the financing gap. According to statistics, for the cost of wind power station projects, wind power equipment accounted for 75% of the total, while the operation and maintenance costs accounted for a small proportion. Therefore, the lease financing is an essential means of solving the shortfall in the initial equipment purchase funds for small and medium wind power projects.

With the advent of the era of grid parity, wind power project development is gradually transitioning to diversified and market-oriented, and the efficiency of lease financing of wind power equipment is gradually manifested. The advantage being that it can leverage more social capital to participate in the construction of wind power projects.

In October 2018, Jinke Real Estate Group Holding Subsidiary Hami Huarang East Jinxia Wind Power Co. used its legally owned 30 wind turbines and related equipment located in Area C of the second Jingxia Wind Farm in Hami, Xinjiang as the subject of a sale and leaseback agreement with Chongqing Yinhai Finance Leasing Co., Ltd. to carry out a lease financing transaction, with the total financing amounting to 300 million RMB at an interest rate of 5.757575% with an eight-year term. The appraised value of the subject is 364 million RMB. At the same time, Jinke also provided a guarantee for the matching funds. The lease financing transaction effectively revitalized the stock assets of the wind
power station and broadened the financing channels of the wind power project.

**Bond financing**

Bond financing refers to the means of debt financing for the wind power industry where subjects carry out direct financing in the form of a public offering or private placement. Due to the high requirements for the bond issuer, this financing model is mostly used by large wind power industry enterprises. In recent years, with the rapid development of the green financial market in China, the support for bond financing for wind power enterprises has become stronger. According to the sporadic statistics available on the issue, since 2016, the total amount of publicly issued green bonds used for wind power projects has been greater than 16.17 billion RMB, and more than 18 bonds were issued to raise funding for wind power projects.

In March 2020, the Guangdong Electric Power Development Co., Ltd. (GED) applied for the issuance of publicly traded green renewable corporate bonds, which was approved by the National Development and Reform Commission. It was agreed that the company should issue no more than 4 billion RMB of green bonds. There are two kinds of bonds, one is the default issuance amount of 3 billion RMB, of which 1.875 billion is used for raising investment projects and 1.125 billion is used to supplement working capital. Every three interest-bearing years are taken as a repricing cycle, with renewal options attached. The default issuance amount of the second one is 1 billion RMB, of which 625 million RMB is used for raising investment projects. Of that amount, 375 million is used for replenishing working capital, and every five interest-bearing years is a repricing cycle with a renewal option. The funds raised were 800 million RMB for the Yangjiang Shaba offshore wind power project, 1 billion RMB for the Zhuhai Jinwan offshore wind farm project, 700 million RMB for the Guangdong Yuedian Zhanjiang Wailuo offshore wind power project phase II. A supplementary 1.5 billion RMB was also raised working capital, providing financial support for the
company's wind power industry layout, optimizing the company's energy structure, and realizing green and high-quality development.

Recently, the financing models of the wind power industry have gradually diversified and the scale has also gradually rose. However, at present, China's wind power industry is still facing the problem of a single financing structure, mismatched financing periods, and a large financing gap. With the gradual maturity of wind power technologies, the gradual alleviation of wind abandonment problems, and support from Chinese energy authorities for new energy policy, the increasing profitability is expected to help wind power projects obtain more diversified and multi-level financial services.
Investment and Financing Guidelines for Green Transportation

Part I. Investment Background

Transportation harms climate change. The transportation industry is one of the major sources of carbon emissions. It is estimated that the transportation industry accounts for nearly 91% of the total carbon emissions around China in 2019, making it the second-largest emission source. Within the transportation industry, road transport is the primary source with a accounting for 82.7%\textsuperscript{2} of the total carbon emissions in 2015. It is estimated that ‘China’s road transport would make up a quarter of the global carbon emissions by 2020.

Climate change has a direct impact on transportation. Climate change will lead to more extreme weather and climate disasters such as high temperatures, heatwaves, droughts, sea level rising, heavy rain, blizzards, freezing weather, severe tropical storms, thunderstorms, and dust storms. The normal operations of roads, navigations, and aviation will be significantly affected. Transportation and ground facilities will be damaged to different degrees. Therefore, reducing carbon emissions has become one of the most urgent challenges for the development of the transportation industry.

\textsuperscript{1} World Resources Institute, China Road Transport 2050 Zero Emissions Path Study, 
http://www.wri.org.cn/sites/default/files/20191202-%E4%B8%AD%E5%9B%BD%E9%81%93%E8%B7%AF%E4%BA%A4%E9%80%9A%E9%A2%86%E5%9F%9F%E6%8E%92%E6%94%BE_fin.pdf

<table>
<thead>
<tr>
<th>The Impacts of Climate Change on the Transportation Industry</th>
<th>Heavy Rain</th>
<th>Blizzards</th>
<th>Severe Tropical Storms</th>
<th>Rising Temperatures</th>
<th>High Temperatures</th>
<th>Sea Level Rise</th>
<th>Droughts</th>
<th>Heavy Rain</th>
</tr>
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<tr>
<td>Railways destroyed by the floods. Submerged highways and bridges.</td>
<td>Blocked roads and paralyzed transportation.</td>
<td>Cause traffic jams or interruptions; Ships are suspended, and airports are closed, badly damaging the transport facilities.</td>
<td>Normal driving is affected, vehicles are easily damaged.</td>
<td>Overheating vehicles, tire deterioration, railway track deformation, road expansion due to overheating, flight delays.</td>
<td>The transportation on coastal highways and railways are impacted; original transportation plans being disrupted, influencing the normal operation of transportation systems. The infrastructure of underground tunnels and low-lying places are eroded and destroyed by the sea.</td>
<td>Wildfires take place frequently, massive forest fires directly threaten the safety of transportation infrastructure and the operation of transportation facilities, leading to blocked roads; River levels are lower and influence transportation along the rivers; Impact on the integration of transportation systems.</td>
<td>Impact on the normal operations of highways, railways, and flights, which lead to traffic jams or even interruptions; Many ground and transportation facilities are badly destroyed; Mountain landslides</td>
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and mudslides happen frequently and lead to landslides on highways and railways; Floods caused by heavy rains lead to the destruction of the airstrips and other infrastructure.

| Tropical Storms | Interruption of highways, railways, navigations, and aviation lead to a number of malfunction in infrastructure; Increased risk of bridge stability; Destruction of non-restricted area facilities, such as terminals, navigation devices, their boundaries and signs; Traffic jams caused by trees on the road blown down by the typhoons. |
| Snow | Slippery railway tracks, interrupted transportation, blocked coaches and trucks; Heavy snow, icy roads, and freezing rain greatly reduce friction between vehicles and roads; Fog leads to low air visibility and making drivers prone to traffic accidents. |

“Green "Transportation’ rises as a response to this background. It is a people-oriented environmental transportation, which aims to reduce traffic congestion, reduce environmental pollution, mitigate and cope with climate change, and promote social equity. In accordance with the 12th Five-Year Plan, the Ministry of Transport will focus on building a green urban transport system. It will be consist of public transport (including routine city bus, large-capacity bus rapid transit, and large and medium-capacity of rail transit, etc.), non-motorized transport (walking and bicycle transport), and new-energy and environmental-friendly vehicle transport. Based on efficient and intelligent transport management, this system could achieve the coordinated and sustainable development of urban transport, urban land-use, and urban spatial expansion. With the rise of emerging transport in recent years, the definition of non-
motorized transport has expanded across a broader scope to include e-scooters, e-bikes, and similar.

Figure 17 The Structure of China’s Urban Green Transport Network
Since the establishment of the concept and framework of Green Transportation, national ministries have successively issued several policies to help the construction and development of urban green transportation.

Table 12 The Developmental History of Chinese Green Transportation Policies

<table>
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<tr>
<th>RELEASED UNIT</th>
<th>DOCUMENT NAME</th>
<th>YEAR</th>
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<tr>
<td>Ministry of Transport</td>
<td>Implementation Opinions on Accelerating the Promotion and Application of New-Energy Vehicles in the Transportation Industry</td>
<td>2015</td>
</tr>
<tr>
<td>Ministry of Transport</td>
<td>Guiding Opinions on Implementing Green Road Construction</td>
<td>2016</td>
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<tr>
<td>Ministry of Transport</td>
<td>Green Transportation Standards System (In 2016)</td>
<td>2016</td>
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<tr>
<td>Ministry of Transport</td>
<td>Notice on Issuing Implementation Plan of Promoting Ecological Civilization</td>
<td>2017</td>
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<td></td>
<td>Construction in Transportation</td>
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<tr>
<td>Ministry of Transport</td>
<td>Opinions on Comprehensively and Deeply Promoting the Development of Green</td>
<td>2017</td>
</tr>
<tr>
<td>Ministry of Transport</td>
<td>Notice on the Plan of Specific Project of Pollution Prevention and Control from Ships in the Yangtze River Economic Zone</td>
<td>2018</td>
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<tr>
<td>Ministry of Transport and other 12 ministries</td>
<td>Green Traveling Action Plan (from 2019-2022)</td>
<td>2019</td>
</tr>
<tr>
<td>The Central Committee of the Communist Party of China, The State Council</td>
<td>Outline for Building a Transport Powerhouse</td>
<td>2019</td>
</tr>
<tr>
<td>Ministry of Industry and Information Technology</td>
<td>Development Plan of New-Energy Vehicles Industry (from 2021-2035)</td>
<td>2019</td>
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</table>

The construction and development of the urban green transportation system needs a lot of financial support. During the 13th Five-Year Plan period alone, the related funding demands for the infrastructure construction of green transportation was estimated to be about 3 trillion RMB. This included 627.1 billion RMB for routine urban public transport, 2.240 billion RMB for urban rail transit, 132 billion RMB for new-energy infrastructures, and about 20 billion RMB for urban public bicycles.

Since the large-scale promotion of new-energy vehicles in 2009, the new-energy vehicles industry and related services, like vehicle sales, battery production, after-sales maintenance, and other services in China, have made remarkable progress. However, the development of its charging infrastructure has always been a problem that needs to be addressed. According to the “Development Guidelines for Electric Vehicles Charging Infrastructure (2015-2020)” issued by the National Development and Reform Commission (NDRC), the country will give priority to the development of charging infrastructure in public service sectors such as public transport, rental, sanitation, and logistics. During the 13th Five-Year Plan period, the total required investment in charging infrastructure will reach 132 billion RMB in China. In September 2017, the
National Development and Reform Commission (NDRC), the National Energy Administration, the Ministry of Finance, the Ministry of Science and Technology and the Ministry of Industry and Information Technology (MIIT) issued a joint notice on “Strengthening the Promotion and Application of New-Energy Vehicles and the Incentives for the New-Energy "Vehicles’ Charging Infrastructure during the 13th Five-Year Plan ” period'. Based on this notice, the government will provide special funding for the construction and the operation of charging infrastructure for provinces (or the cities) with relatively complete charging infrastructure and a large scale of the promotion and application of new-energy vehicles. According to the central financial subsidy policy, the central government will provide a maximum of 35.9 billion RMB of subsidies for the construction of new-energy "vehicles' charging infrastructure within five years (2016-2020), as calculated based on the highest subsidy benchmark for each province. Therefore, the total investment gap for the construction of new-energy "vehicles’ charging infrastructure is 96 billion RMB during the 13th Five-Year Plan period.

Part II. The Business Model

Revenue Model

The urban green transportation network is mainly composed of three sectors: urban public transport, charging infrastructure for new-energy vehicles, and urban public bicycles. Among these sectors, charging infrastructure for new-energy vehicles and urban public bicycles are the two most important aspects of the urban green transportation network.

Urban Public Transport

In general, urban public transport has the nature of quasi-public goods. In the
early stage, the primary revenue source of urban public transport systems was composed of the ticket revenue, government financial subsidies and advertising revenue. Among these sectors, government financial subsidies accounted for an extremely high proportion thus reducing its ability to sustainably operate.

In recent years, bus companies developed new business segments to actively increase revenue. The main fields include maintenance, customized buses, tour buses, driving schools, advertising, and other tertiary industries, which improves the ability to sustainably operate the bus company. For example, a fully state-owned public enterprise, Beijing Bus Group has pioneered the “Diversified Bus Service” in China, leading the transformation and upgrade of urban public transport models. Since its first launch in 2013, Beijing Bus Group has formed an innovative brand of customized bus services including business buses, a special bus line for quick and direct trips, a special bus line for vacation trips, a special bus line for leisure travel, and special bus line for medical treatment and other services. There are 334 routes in total, which cover major residential areas, workplaces, and transport hubs in Beijing, carrying a total of 17.233 million passengers. These additional services not only provide diversified, differentiated, and high-quality public transport services to passengers but also lay a solid foundation for the capital to build a “Bus City”.

By expanding its business lines, the Beijing Public Transport Group has innovated its profit model, built a value-added service system, organically combined its production with operation, asset management, and capital management, diversified its operations, gradually reduced its dependence on government subsidies, enhanced its profitability, and overall improved its management capability sustainably. Taking the urban bus group funded with private capital as an example, Beijing Xianglong Bus Passenger Transport Co., Ltd., was the first non-government joint-stock urban bus passenger transport enterprise in Beijing approved by the municipal government. It purchased 34 operating vehicles and opened three lines at the start of its operations and now...
it has six branches with more than 3,600 employees, 907 operating vehicles, and 23 operating lines, and it transports more than 200 million passengers annually. Xianglong Bus focuses on providing high-quality all-round services for passengers. By speeding up the development of new lines and increasing the intensity of vehicle renewal and improvement, it gradually adopts modern intelligent management systems, improves the content of scientific and technological management, and realizes self-development from self-financing, self-management and self-financing.

![Development of Diversified Businesses](image)

Figure 18 The Innovation of the Revenue Model for Urban Public Transportation Systems

**Charging Infrastructure for New-Energy Vehicles**

The development of China’s new-energy vehicles’ charging infrastructure industry mainly relies on the local government subsidies and the joint construction of social capital. At present, the industry mainly relies on the charging infrastructure manufacturers, the charging infrastructure operators, and the internet platform. There are also some other participants like power enterprises, landowners, and consultants. Among these participants, the infrastructure operators hold the most important role with the responsibility of
connecting the upstream infrastructure manufacturers with the downstream users. Since 2014, the government has opened the charging infrastructure market more broadly to society, with private enterprises having taken part in the field. However, from the perspective of the structure of charging infrastructure investments, state-owned enterprises still dominate the industry. Since the market for charging infrastructure operation is still in its initial stage, the business model is not mature and stable yet so operators mainly rely on charging service fees and government subsidies to recover their costs. However, operators have started to explore diversified revenue models actively, such as packaging charging service fees with other value-added services (such as new-energy vehicle rentals, parking space operations, and new-energy vehicle sales, etc.) and packaging charging service fees with charging APP operations.

Figure 19 The Model of China’s New-Energy Vehicles’ Charging Infrastructure Industry

Urban Public Bicycles

With the rise of more transport methods, public bicycle transport has developed into a broader scope to include not only the traditional urban public bicycle system but also emerging transport such as e-scooters and e-bikes. The urban
public bicycle system can be divided into two categories: the first is the public bicycles with docks and the second is the public bicycles without docks. The former mainly relies on government operation and maintenance. Taking the Chinese listed bicycle system service company Yonganhang Technology Co., LTD as an example, a bicycle system service company’s revenue streams can categorized as follows: (i) system sales revenue, (ii) system operation service revenue, (iii) revenue from user payments for the shared bikes, and (iv) advertising revenue. System sales refer to the overall sale of public bicycles and the operation and maintenance system, including providing the relevant equipment required by the third party to operate the bicycle system and the installation and debugging of the equipment for the whole system. The system operation service revenue refers to sales from the public bicycle system operation services and service revenue from repairing bicycles, temporary dispatching, and other follow-up services during the usage.

Bicycle sharing without docks is an emerging rental model arising from the Internet economy, such as the current mainstream bicycle-sharing company Hello Travel. Its revenue model can categorized into basic revenue, deposit revenue, advertising revenue, and revenue from the realization of big data. The shared bike rental and advertising revenue models are similar to that of docked bicycle-sharing. The local government is responsible for regulating and coordinating shared bikes. For example, in 2018, the Shanghai Transport Commission established Measures on the Administration of Internet Bicycle Rental in Shanghai to regularize and monitor the shared bicycle market.
Financing Model

There is always a conflict between the vast investment demands of urban green transportation and traditional investment and financing models. Green transportation infrastructure has always been dominated by government investment. It primarily relies on funding from the government or the financial platform and credit of the government. And the investment recovery mainly depends on green transportation operating revenue and government financial subsidies. With the increasing demand for green transportation funding and the growing burden of government debt, the traditional model of relying on government investment can no longer support the development of green transportation. There is an urgent need to develop new financing models to solve the industry’s capital problems.

The Entities for Raising Finance

The financing ability of green transportation is closely related to the nature of the entities that raise finance. Investors of urban green transportation include the government, state-owned enterprises, mixed-ownership enterprises, and private enterprises. Currently, the government and state-owned enterprises are still the main impetus for the construction and development of urban green
public transportation infrastructure in China. Mixed-ownership enterprises investing in green transportation infrastructure is still in the early stages.

State-owned enterprises are the main entities raising finance for the development of green transportation in China. As the green transportation industry is still in the early stage of development, the profitability model within the industry is not yet clear. And in considering risks, the social capital is still lacking enthusiasm for participation. Therefore, the industry currently relies more on government investment to promote the development of the entire green transportation industry through government financial allocations and subsidies. The Green Public Transportation System Demonstration Project in Qingdao is an example of one that aims to replace old diesel buses with electric buses. In this project, the local government provides special financing and purchases the franchise service on behalf of the three major state-owned bus operating companies. The government investment in the transportation industry was a form of establishing an investment and financing platform called the Transportation Investment (TI) Group. It's core function is to invest and finance in transportation infrastructure. Currently, due to the public service attributes of public transportation, most bus companies are state-owned enterprises, and the government contributes all or part of the capital to set up bus companies.

Private enterprises and mixed-ownership enterprises gradually participating in
the development of green transportation in China. In recent years, to reduce financial pressure, the central government began introducing social capital to invest in public transport and encouraging local governments to actively guide social capital to participate in planning and constructing the green transportation industry. There are three main methods through which social capital participates in green transportation construction. The first one is through establishing mixed-ownership enterprises through PPP in cooperation with the government. For example, the urban rail transit project is represented by Beijing Jinggang Metro Co., Ltd. The second method through occupying the market in industries with lower access thresholds by private enterprises. For example, the investment and operating entities of shared bicycles are mostly private enterprises, represented by mobike and Harrow bicycles. The third method by letting private enterprises participate in the marketization phases of certain industries. For instance, private enterprises have contracted some urban bus routes to Beijing Xianglong Bus Passenger Transport Co., Ltd.

**The Financing Methods**

From the perspective of the financing methods, green finance greatly supports the financing of green transportation. In recent years, under the promotion of the National Development and Reform Commission, the Ministry of Finance, the People’s Bank of China, the China Bank Regulatory Commission, and the Green Finance Committee of the China Society of Finance and other departments, the green transportation infrastructure project is listed as the main sector supported by several green financing tools. Those tools mainly include special funds for green construction, green credit, green bonds, green ABS, and green lease financing. The corresponding supporting and encouraging aspects include the process and speed of approval, financing terms, financing costs, and others.
In terms of Green Credit, all the major banks have already been involved in this business, having launched a series of products to date. In the statistics of Central Bank's green credit, urban bus transport projects and urban rail transit projects are both in the scope for green credit. In terms of Green Bonds, according to “The Catalogue of Projects Supported by Green Bonds (the 2015 edition)” issued by the Green Finance Committee of China Society of Finance, urban rail transit, urban and rural public road transport, new-energy vehicles, and other industries all meet the criteria for green bonds. Green bonds can be issued to finance new projects or refinance existing ones. In terms of Green ABS, at present, Nanjing, Hohhot, Changde, and other cities in China have begun using asset securitization financing by pledging the rights to the revenues generated from public transportation fees.

Financial leasing is widely used in asset-pledged financing, especially with the purchase of buses, electromechanical equipment for rail transit, and other aspects. This model has a relatively significant advantage in its application in rail transit projects. The locomotives, signals, automatic ticket sales, and check system of urban rail transit are fixed assets with high collateral value and
removability. These require large amounts of capital that about a third of the total rail transit investment. Lease financing can be used for these equipment in terms of financing assets to reduce the initial lump-sum investment.

The PPP Model has a long history in the construction of urban roads and rail transit. In recent years, it gradually expanded into the new energy field. In 2016, the National Energy Administration issued a “Notice on Actively Promoting the Model of Cooperation between Government and Social Capital in the Field of New Energy,” which clarifies that electricity and new energy projects fall into the PPP extension coverage. In practice, new energy PPP projects are mainly applied in the construction and operation of charging docks and urban public bicycle systems. For example, the model consists of investing and supervising done by the government and constructing and operating done by enterprises. In this model, the government is only responsible for project determination, planning, and approval. Other work, like the entire bicycle public service is purchased by professional enterprises. The professional enterprises are fully responsible for the design, opening, production, construction, operation of the public bicycle system, and other related work. Generally, enterprises pay for the project at the beginning by using their own capital or through loans, and the government pays these professional enterprises in installments within a certain timeframe. Therefore, the government can break even and lighten the pressure of financial payments in the short term. At present, this model is gradually becoming the main government-led model for public bicycle system services in the going forward.

Special Funds for Green Construction is a special construction bond issued by China Development Bank and Agricultural Development Bank to the Postal Savings Bank of China. The central finance banks give a discount of 90% of the interest rate for special construction bonds. China Development Bank and Agricultural Development Bank use special construction bonds to raise funding
and establish special construction funds, which are used for project capital input, equity investments, and medium to long-term concessional loans to support project construction. Green transportation, urban rail transit projects, and the construction of electric vehicle charging docks all belong in the supporting field of special construction funds.

Figure 23 Financing and use mechanism of green special fund

Furthermore, in August 2020, the Ministry of Finance, the Ministry of Ecology and Environment Shanghai jointly initiated the establishment of the National Green Development Fund, which mainly focuses on key areas of green development along the Yangtze River Economic Belt. Investments are mostly in pollution control, ecological restoration, greening of the homeland, resource conservation with utilization, green transportation, and clean energy, thus injecting new momentum into supporting the construction of an ecological civilization.
**Investment background**

**Industry is China's leading energy-consuming sector.** China has invested a great deal of effort over the past decade to reduce its emissions intensity in the industrial sector and improve resource use efficiency. China's energy consumption intensity per unit of GDP has been declining since 2009, but the rate of decline has shown a narrowing trend since 2015, making energy efficiency improvement efforts incrementally more difficult. Industrial energy conservation and green development is faced with weak systemic energy conservation and emission reduction measures, such as insufficient attention paid to the articulation between upstream and downstream enterprises, synergistic coupling between industries, and ecological links between industry and society; prominent regional differentiation; overcapacity and tight capital chains, and insufficient intrinsic motivation for energy saving and emissions reduction by enterprises.
Industrial energy efficiency improvement is an important step in supply-side reform. At the beginning of the 13th Five-Year Plan, the Ministry of Industry and Information Technology issued the Industrial Green Development Plan (2016-2020). The core objectives of the plan are to accelerate green industrial development, promote supply-side reform, promote steady industrial growth and structural adjustment, promote energy conservation and consumption reduction, achieve cost reduction and efficiency gains, increase the effective supply of green products and services, and make up for the shortcomings of green development.

Promoting the establishment of a green production and consumption system is the only way to achieve industrial energy conservation and green development. In general, energy efficiency improvements can be made on both the production and consumption side. Energy efficiency improvements on the production side include promoting the transformation of energy-intensive general-purpose equipment, implementing energy-saving transformation projects in industrial parks, and strengthening the gradual utilization of energy in industrial parks. Energy efficiency improvements on the consumption side include vigorously promoting the use of high-efficiency energy-saving products and equipment, developing high-efficiency boilers, high-efficiency internal combustion engines, high-efficiency motors and high-efficiency transformers, promoting energy-saving electrical appliances and green lighting, and continuously improving the energy efficiency of key energy-using equipment.

Policy support for industrial energy efficiency is increasing. The 13th Five-Year Plan for Energy Development mentioned that China will implement industrial energy-saving actions during the 13th Five-Year Plan period. These actions include: improving the energy-saving standard system, vigorously developing and promoting energy-saving and high-efficiency technologies and
products, and realizing the full coverage of energy-saving standards for key energy-using industries and equipment. It will also promote a system of energy efficiency "champions" in key energy-consuming industries and a system of benchmarking and assessment.

In March 2019, the Ministry of Industry and Information Technology (MIIT) and the China Development Bank (CDB) issued the “Notice on Accelerating Industrial Energy Conservation and Green Development,” emphasizing the key role of financial and policy inputs in industrial energy conservation and green development. It also pledged to increase the support of green finance for industrial energy conservation and green development. In March 2020, the National Development and Reform Commission and the Ministry of Justice issued the "Opinions on accelerating the establishment of green production and consumption regulations and policies system" notice, proposing that by 2025, green production and consumption-related regulations, standards and policies will be further improved. This will be done through the institutional framework of incentives and constraints in place which will be established at a basic level, green production and consumption methods applied in relevant areas, key industries and key processes will be fully implemented, and the level of green development in China will overall improve development goals.

Maintaining the rate of decline in energy consumption will require more social capital to be invested in energy efficiency. To this end, the Chinese authorities have issued a series of guiding documents to encourage private capital to innovate business models for the energy efficiency industry. In May 2020, the National Development and Reform Commission, the Ministry of Science and Technology and six other departments jointly issued "on the creation of a better environment to support the healthy development of private energy conservation and environmental protection enterprises of the implementation of the views." It proposed encouraging private energy conservation and environmental
protection enterprises to further innovate contract energy management service models, according to the characteristics of energy-using units using energy trusts, energy savings guarantees, lease financing, and other new business models, in order to promote the provision of services from a single device to process energy-saving renovation, expanding regional energy efficiency.

The industrial energy-saving industry shows trends of marketization and full-chainization. Investment and financing in China's industrial energy efficiency industry can be divided into three stages according to funding characteristics. Stage 1 is the early stage of industrial development (during the 11th Five-Year Plan period), where the Government is the sole investor and financial resources are mainly invested through policy banks; Stage 2 is the industrial expansion period, when the government mainly plays a guiding role and private capital starts to enter the industrial energy efficiency industry through the guidance of financial funds; Stage 3 is the mature stage of the industry, where the government gradually withdraws, the industry as a whole realizes market operations, and private capital takes a dominant position.

China's energy companies of all sorts started to explore integrated energy services relatively late, but have shown strong momentum in business transformation. In the transformation and development path, most of them adopt the "1+N" mode, that is, one of the main businesses is focused on the energy industry's whole industrial chain service extension and development.

Part II. Business models for industrial energy efficiency

Revenue Model

The industrial energy efficiency industry includes the demand side of energy efficiency, providers of energy efficiency services, and providers of energy
efficiency equipment. The composition of revenues also differs for different market players. For energy-efficient equipment providers, their revenues consist mainly of sales revenue. The energy-saving service providers can be categorized into energy-saving consulting services, energy-saving renovation services and comprehensive energy-saving scheme services according to the specific context. Comprehensive energy-saving services refer to the integrated service including consulting, equipment provision, renovation and construction.

![Figure 25 Industrial energy saving industry chain](image)

**Technology/equipment provider model**

There are two specific categories under the technology/equipment provider model, the technology provider model and the equipment provider model. The former mainly provides energy-saving technology and consulting, that is, to provide customers with energy consumption analysis and technical services required for energy-saving solutions, and where the customers themselves have to complete the procurement, installation, commissioning, and follow-up maintenance of equipment. The latter mainly provides various energy-saving equipment and sells standardized/customized energy-saving equipment to customers on the basis of their initial technical consultation.

**Energy efficiency management solution service model**
The energy efficiency management solution service model refers to the provision of overall solutions for specific links in the field of energy conservation services, with the main feature of providing consulting services and supporting relevant testing and analysis of equipment, but it does not participate in the construction of energy conservation renovation projects. The energy efficiency management solution service model has a high technical threshold, is less risky for profitability, and generates high added value.

**Contract Energy Management Model**

Contract Energy Management Model is a business operation mode in which an Energy Savings Service Company (ESCo) signs an energy-saving service contract with a customer to provide the customer with a set of energy-saving services, including energy consumption analysis, scheme design, project financing, equipment procurement, engineering construction, equipment installation and commissioning, personnel training, energy-saving confirmation and guarantee, etc. In exchange for this, it recovers its investment by profiting from the energy-saving benefits obtained by the customer after the energy-saving renovation. During the term of the contract, the energy service company shares the energy saving benefits with the customer; at the end of the contract, all energy saving benefits and energy saving equipment belong to the customer.

Contract energy management is internationally accepted and widely used by developed countries as a service mechanism to promote energy conservation using market means, which can greatly reduce the financial and technical risks of energy-saving renovations of energy-using units while fully mobilizing the enthusiasm of energy-saving renovation of energy-using units. Depending on the mode of implementation, they can be categorized into energy-saving guaranteed contract energy management, energy-saving benefit-sharing contract energy management, energy cost escrow contract energy management, and equipment leasing contract energy management.
**Energy-saving benefit sharing**

Under the energy-saving benefit-sharing model, the entire investment and risks of the energy-saving retrofit project is borne by ESCo, and after the project is completed, the energy savings are recognized by both parties, and the energy-saving benefits are shared proportionally. This model is a new business model that began to develop in China in recently, but it currently does not account for a high proportion in the country. On one hand, this model requires high financing capacity of the energy conservation service company, and on the other hand, the cost recovery and revenue acquisition of the energy conservation service company under this model usually takes more than 10 years with revenue being dependent on the operating efficiency of the partner's project. A downturn in the partner's industry, a decrease in the efficiency of production line operations, or a decline in the partner's profitability will increase the risk of the project's sustainability.

The ESCo transfers the ownership of the equipment purchased in the energy-saving retrofit to the owner, who will enjoy all the benefits of the energy savings generated in the future. However, under the energy saving guarantee model, all or part of the energy saving retrofit project is borne by the leasing company. During the contract period, the energy saving service company (ESCo) promises a certain amount of energy savings to the landlord, or guarantees reductions to the energy bill by a certain amount to the customer, and these energy savings will be used to cover the project cost. The portion that cannot reach the promised energy savings will be bore by the ESCo. During the contract period, the property rights of the equipment or assets added to the energy saving retrofit belongs to the ESCo and are managed by the ESCo (or managed by the customer's own facility manager, and the ESCo is responsible for the instruction). After the ESCo recovers all of its investment in the energy-savings project, the contract ends and the ESCo transfers the property rights
of the equipment purchased in the energy-saving renovation to the owner, and all of the energy-saving benefits generated in the future are enjoyed by the company. Therefore, this benefit-sharing scheme requires the energy-saving service company to advance capital, not only to bear the performance risk, but also to bear the financial risk associated with the customer. As a result of this, the use of energy-saving service company models is relatively small.

**Energy saving guarantee**

In the energy-efficient guaranteed model, the owner signs a separate energy-efficient equipment lease contract directly with the leasing company. The ESCo provides a full service and contractual commitment to the energy savings of the project to be able to ensure that the project is designed, installed, and repaid to the leasing company for the project-related borrowings as scheduled. The energy savings will cover all project repayments and all costs for testing, inspection, operation, and maintenance services provided to the ESCo. If the project does not achieve the promised energy savings, the ESCo is contractually responsible and financially liable for the loss. If the energy savings achieved exceed the project repayments, the customer and ESCo may share the excess benefits. As a result, energy-saving guaranteed contract energy management is more widely used by large domestic energy-saving companies (especially multinational corporations).

Under this model, the energy efficiency company is responsible for cooperating with the energy efficiency service company to complete the project and raise the funds needed for the project, therefore bearing part of the financial risk and part of the operational risk. Financial institutions form cooperative alliances with energy-saving enterprises and energy-saving service companies in energy-saving guaranteed contract energy management programs, and the funds required for the programs are usually primarily provided by financial institutions, that also bear the financial risks. Energy conservation service companies
ESCOs are responsible for the implementation of energy-saving guaranteed contract energy management (EGCM) projects and mainly bear the operational risk. The cooperation between energy saving enterprises, financial institutions, and energy saving service companies in the energy saving guaranteed contract energy management program results in a significant increase in energy saving benefits.\(^3\)

![Diagram of energy-saving guaranteed contract energy management project]

**Figure 26 Operational model of the energy-saving guaranteed contract energy management project**

**Energy hosting**

The energy cost hosting is one type of contract energy management, where the customer entrusts the energy conservation service company to carry out the energy-saving renovation, operation, and management of the energy system, and pays for energy hosting and Electromechanical operation and maintenance according to the contract. The energy conservation service company reduces the energy costs and operation & management costs by improving energy and personnel efficiency and owns all or part of the energy cost savings according to the contract.

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Energy Escrow includes both full escrow and half escrow. Full escrow: the content of escrow includes equipment operation, management and maintenance, personnel management, environmental protection standard control management, daily required energy, fuel and operating costs, etc., and finally providing customers with energy use. Semi-trusteeship: the content of trusteeship only includes daily equipment operation, management, and maintenance.

After the end of the contract period, the customer takes ownership of the energy-saving equipment by accepting donations, and all the energy-saving income generated in the future is owned by the customer, which means that the energy-saving service company assumes the technical and economic risks for the customer.

In Summary
At present, energy efficiency sharing projects are still mainstream, accounting for nearly 50% of the market share of contractual energy management mechanisms. Energy-saving guarantee projects also are growing rapidly, accounting for 40% of the market share. However, energy cost trusts are difficult to apply on a large scale because of the excessive risks borne by a single entity.

Financing Model
In the energy efficiency sector, the most common types of financing used are lease financing and energy efficiency credit.

Lease Financing
In the industrial energy efficiency industry, the lease financing model is mostly used for purchasing energy-saving equipment. According to the different financing needs of customers, lease financing companies mainly adopt two
types of models: direct leasing and sale and leaseback when intervening in contract energy management projects. Prior to the start of the construction of a contract energy management project or during the construction of the project, before completion and acceptance, the direct leasing model is generally used if there is a need for financing. A lease contract is signed between the lease financing company and the lessee to agree on the specifics of the transactions, where the lessee is generally the ESCo.

After the contractual energy management project is completed, accepted, and delivered by the ESCo to its owner, the sale and leaseback model is generally used if there is a need for financing. Under this model, the lease financing company and ESCo sign a lease contract, agreeing on the specific transaction items: the financial leasing company pays the purchase price of the leased property to the ESCo and has the ownership of the leased property; the ESCo pays rent and other payments due to the financial leasing company according to the lease contract; upon the expiration of the lease term, the ESCo retains the leased property from the financial leasing company, and the financial leasing company then purchases the leased property from ESCo.

**Contract termination:**

The leasing company is more concerned with sufficient future cash flow that the lessee's leased assets can generate. Compared to bank credit financing, under the financial leasing model, the lessee can generally achieve a higher percentage of financing, and some lessees can even achieve 100% full financing. For enterprises with large financing needs, bank loans are embodied in the enterprise's liabilities, which affects the enterprise's refinancing capacity, while lease financing can account for off-balance-sheet financing according to structural designs and arrangements. Lease financing is more flexible than rent collection where the lessor can base its decisions on the lessee's capital status, profitability characteristics, and other specific circumstances (in terms of
repayment time and amount of money combined with the actual operating conditions of the enterprise) rather than being confined to the regular, fixed amount of rent payment form.

The difficulty combining financial leasing and contract energy management projects is the uncertainty surrounding future energy saving benefits. The selection of the project, the maturity of the technology, the good or bad construction of the project, changes in energy prices, changes in working conditions, the operation, maintenance, and service of the project later, and many other factors influence it. As a new mode of intervention in the financing system of contract energy management, lease financing companies have been exploring and innovating financing solutions for contract energy management projects, and have played an active role in becoming an important financing channel for contract energy management.

**Energy Efficiency Loan**

According to the Energy Efficiency Credit Guidelines, energy efficiency credit refers to the credit financing provided by banking financial institutions to support energy-using units to improve energy efficiency and reduce energy consumption. It applies to the energy efficiency-related activities of key energy-using units, energy-saving service companies, and third-party energy-saving auditors. In December 2006, China Industrial Bank, together with one of its foreign shareholders, the International Finance Corporation (IFC), was the first in China to launch an energy efficiency loan. This loan product is designed to meet the capital needs of energy-saving technical improvement projects of enterprises and institutions, thus helping them save energy and reduce consumption. The product features an agreement that IFC will compensate loan losses on energy efficiency loans, reducing the bank's risk in the energy efficiency credit sector. The product can be used to provide credit to energy efficiency service companies as a whole, or as a project loan for individual
projects.

However, since the energy efficiency credit program is mostly used for the energy-saving renovation of enterprises in high-polluting and high-energy-consuming industries, it is classified as a polluting industry loan in the statistical system of the Climate Bond Initiative (CBI). Therefore, it requires the regulator to further improve the statistical caliber in order to support energy efficiency improvement efforts.
Investment and Financing Guidelines for Urban Renewal and Revitalization

Part I. Investment Background

China has experienced 40 years of rapid development after its reform and opening up. The urbanization rate has increased from 17.9% in the early 1980s to 58.52% in 2019, and is estimated to exceed 60% in 2020. With the rapid expansion of cities, Chinese cities have gradually entered the era of stock development. Moreover, urban renewal has become an essential driving force in promoting urban development with the gradual decline of new land construction. Accordingly, unlike mere urban reconstruction, the campaign of “green urban renewal and revitalization” focuses more on the transformation of old buildings, stock enhancement, and functional improvement, aiming to optimize the city via enhancing its quality and greenery coverage. Since the beginning of the 13th Five-Year Plan, the Chinese government issued a series of programmatic proposals on urban renewal, which mainly refer to land and spatial planning, urban infrastructure construction, ecological environment, industrial structure transformation and so on.

Table 13 National policies on urban renewal

<table>
<thead>
<tr>
<th>National Policy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Land Administration Law of the People’s Republic of China (2019 amended version)</td>
</tr>
<tr>
<td>2. Proposal of intensive savings on land usage issued by the Ministry of Natural Resources of the People’s Republic of China</td>
</tr>
<tr>
<td>3. Guiding proposal on promoting sponge city construction issued by the General Office of the State Council of the People’s Republic of China</td>
</tr>
<tr>
<td>4. Implementation of pilot work on the third batch of low-carbon cities authorized by National Development and Reform commission</td>
</tr>
</tbody>
</table>
To specify the projects, urban renewal and revitalization projects include environmental-friendly renewal of old neighborhoods, sponge city construction, low-carbon city, waste-free city, etc. The specific contents of the projects are shown in Table 2. Compared to general urban transformation and instruction, green renewal, one of the routes to accelerate dealing with climate change is to optimize climate and environmental benefits by establishing higher standards. Besides, in terms of transportation, construction, production and living, culture and other critical functional components of the city, various authorities have introduced environmental-friendly development measures accordingly, which is also an essential part of the city renewal and revitalization. Take the environmental-friendly transformation of old neighborhoods as an example. There are 40 billion square meters of old building stock in Chinese cities, of which one-third have energy saving, power saving, structural reinforcement, equipment renewal, and other transformation needs. At the same time, environmental-friendly transformation instead of shantytown transformation can achieve both urban renewal and energy-saving and emission reduction.
### Table 14 Projects for urban renewal in China

<table>
<thead>
<tr>
<th>Category</th>
<th>Projects</th>
</tr>
</thead>
</table>
| Renewal of old neighborhoods | Basics including the promotion of municipal infrastructure and public assets such as water supply, warming systems, gas supply and road pavements, external wall insulation and afforestation.  
Completion: Inclusion of heat metering, retrofitting solar water heaters, rooftop photovoltaics, and renewable energy elevators.  
Promotion: Including smart community management, wireless meter reading and online bill payment. |
| Sponge city            | Sponge cities are built to effectively control rainwater runoff, repair urban water ecology, conserve water resources, enhance the city’s ability to prevent flooding, and improve the quality of new urbanization fulfilled by strengthening urban planning and construction administration. |
| Low-carbon city        | Construction of low-carbon cities include the following aspects:  
Low-carbon energy exploitation, clean production, resource recycling and low-carbon buildings.                                                                                                               |
| Waste-free city        | Waste-free city aims to establish the urban development pattern, which includes promoting reduction and utilization of solid waste, minimizing landfill waste to minimize the baneful impact of pollutants.                               |

**Part II. Business model**

**Revenue Model**

At present, urban renewal involves mostly public investment that aims to provide public goods. Investment in public products is government-led mainly.
because of their public good attributes, i.e., indivisible utility, non-competitive consumption, and non-excludability of benefits. The payment model for urban renewal can be divided according to the nature of the product provided. Most of the projects involved in urban renewal are quasi-public or fully public goods, with very few goods not providing public welfare but requiring payment by users. Thus, in most urban renewal projects, revenues are generated from viability gap funding, the combination of government payment and user charges. Currently, among the various urban renewal projects, the environmental-friendly renewal of cities can be achieved through a user-pay model for some projects in the field of old neighborhood renovation, transportation, and low-carbon of energy, as these projects involve the operations of daily urban life.

Table 15 Overview of the business models of the urban renewal

<table>
<thead>
<tr>
<th>Contexts</th>
<th>Attributes</th>
<th>Main body</th>
<th>Operating models</th>
<th>Rewarding mechanism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renewal of old neighborhoods</td>
<td>Public welfare project symbolized for shantytowns transformation</td>
<td>Government sets out the specific construction unit in charge of shantytown transformations</td>
<td>Raising funds via issuing specialized local government bonds</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Quasi-public welfare project represented by optimization of living facilities</td>
<td>Residents</td>
<td>In some areas, private capital is allowed to participate in the construction and operation of old neighborhoods. Applying diversified operation means enriches the rewarding mechanism. However, as the profit content of the old neighborhood is necessary</td>
<td>Take user charge, those who benefited from the renewal of old neighborhoods and necessary</td>
</tr>
</tbody>
</table>
In the past two years, China has been working on urban renewal and
government intervention in the operation of these projects. Although
neighborhoods have not been fully developed, the operation is still
led by the government, and the specific construction unit is determined to carry out transformation under the leadership of the government.

| **Sponge City** | Public welfare project | PPP model is commonly used, which refers to the model where the government puts forward the essential requirements and the construction and operation objectives, whereas private capital undertakes the main construction, operation, and maintenance work. After that, the government pays according to the conditions of construction and operation. | The majority is government payment. |
| **Waste-free City** | Public welfare project symbolized for optimizing infrastructures’ green level and environmental pollution abatement. | Government sets out the specific construction unit, who is specifically responsible for the upgrading and reconstruction of infrastructure and environmental pollution abatement. | The majority is government payment. Compensation shall also be made by polluters in environmental pollution projects. |
construction. Presently, most urban renewal projects are put forward by government platform enterprises while other market entities participate in the construction and operation of the projects. With the official deployment by the government in 2020, capital markets gradually started to participate in the field of urban renewal. On August 10th 2020, Guangda Anshi successfully established a limited partnership urban renewal project investment enterprise under the support of Guangda Holdings and Guangda Jiabao, with a schemed investment scale of 4 billion RMB. It will attach measurable significance to real estate investment opportunities with urban renewal, deeply participate in the operation process of urban renewal project in stages like M&A, relocation, efficiency improvement, and value realization, to serve the development and revitalization of Chinese cities.

Take the environmental-friendly transformation of old communities as an example, the revenue from the project can be divided into three major parts: Beneficiary fees for afforestation, maintenance fund, financial aid and incremental asset gains. For retrofitting renewable energy elevators, solar water heaters, household rooftop photovoltaics, etc., which are part of a completely private product retrofit, some financial support is available, e.g., installment payments, user fees for lifts, and renewable energy equipment. Currently, there are two operating fee models for adding an elevator to a neighborhood. Firstly, the government subsidizes 100,000 RMB for each elevator, and the remaining 200,000 RMB is shared by house owners, following the principle of high-rise owners sharing more and low-rise owners sharing less; secondly, the elevator is installed free of charge by the supplier, and owners voluntarily apply for member cards to pay for the elevator.

Green upgrades to housing structures, water, electricity, roads and gas, and other supporting infrastructure can be compensated by project revenue from water and heating charges. For example, the renovation of old neighborhoods
in 2019 in Kullu, Xinjiang included the renovation of supporting infrastructure and public service facilities such as water, electricity, roads, and gas inside and outside the neighborhoods, the renovation of common areas of houses within the neighborhoods, and the energy-saving renovation of buildings. The project's debt is entirely paid for by revenue earned from water, gas, heating, and electricity.

In addition, the Building Maintenance Fund covers the cost of construction, which improves the buildings’ capability to save energy. China's Building Maintenance Fund system was initiated in 1998. According to the “Measures for the Administration of Special Residential Maintenance Funds” revised in 2007, the public maintenance fund is dedicated to the maintenance of public facilities in the community, including load-bearing walls, roofs, stairwells, elevators, etc., which are owned by the proprietor. But before the establishment of the proprietors' commission, the funds are usually held by the real estate administration departments. As statistics from the Property Maintenance Funding Research Professional Committee of the China Property Management Association show, China's inventory of collected maintenance funds exceeds one trillion USD. Moreover, according to numbers from the National Bureau of Statistics, from 1999 to 2009, more than 99 billion square meters of commercial housing were sold nationwide, the vast majority of which were new homes that year. However, at present, nearly 30 billion square meters of this batch of commercial housing have been in the repair cycle for more than a decade. By 2020, it will be phased into an industry-recognized "overhaul cycle." The maintenance fund will support the transformation of old housing as a cornerstone from 2020.
In addition, other transformations such as smart property and community management will enable the government to collect property fees, community advertising fees, parking fees, income from rental of shops, income from the transfer of state-owned land, which will flexibly fulfill the project economically. As for the revenue source, some revenues are generated from property fees, advertising, parking fees, public facilities fees (electric vehicles and EVs), and commercial rental income. For example, in Erlianhot, Inner Mongolia the source of operating revenue for the 2020 old community transformation project is the renovation of the district's Nesting Delivery-Receiving Cabinets, drinking water site fees, vending machine site fees, garbage sorting cabinet site fees as well as property and parking fees.

Urban renewal projects that are entirely public goods are temporarily not able to generate any revenue. And public investments paid for entirely by the government are prone to severe financial strain, leading to harmful results. Therefore, to utilize the role of the market in efficiently allocating resources and enhancing the capability of market-based allocation of natural resource
elements, the government issued proposals that aim to use market-based instruments to refine the public service payment system. One example is eco-products by building market-based value realization mechanisms for eco-products. “Guidance on Promoting the Reform of the Property Rights System for Natural Resources Assets in a Comprehensive Manner” issued by the General Office of the CPC Central Committee and General Office of the State Council who proposed to improve the mechanisms of property rights of natural resource assets, built a diversified input mechanism and opened up channels for transforming the value of eco-friendly products. It also proposed establishing two pilot ecological product value transformation zones in Lishui, Zhejiang, Fuzhou, and Jiangxi to explore approaches to realize the value of ecological products. This included ecological resource indicators and property rights trading, ecological industrialization and management, ecological compensation and other payment mechanisms. Through these types of bonuses, transfer payments and compensation can be made for the construction of sponge cities, urban environmental treatment, and other entirely public goods to enhance the ecological capacity of cities.

**Financing Model**

For urban renewal projects, the financing model is directly linked to public welfare. For urban renewal projects that can generate stable cash flows, such as the transformation of old neighborhoods, special government bonds, commercial debt financing, and tripartite investments are often used. For sponge city construction, street greening and other entirely public products, the project needs to be financed fully with government financial investment and special government bonds. Project financing usually needs a stable cash flow, but in practice, urban green renewal projects often lack a corresponding project cash flow and the lack of a diversified debt repayment mechanism is the main reason why the diversified project financing mechanisms are unavailable.
Take the old district green renovation project as an example, the renovation of the old district involves a wide range of areas, including energy-saving building renovation, sewage greening, and other infrastructure renovation, which is a systematic project. The cost of the project cannot be entirely covered by financial allocations. Therefore, it is necessary to establish diversified financing mechanisms and increase fund-raising efforts. Presently, local governments are still the leading party in the renovation of old communities, so the current financing channels are still based on special bond financing. In addition, financing channels include bank loan financing and enterprise funding.

At present, the combination of financial capital and special bond financing is the mainstream financing model for the renovation of old neighborhoods. Since the State Council proposed to promote the transformation of old communities, several municipals issued special government bonds to support this project. Since May 2020, there has been a surge in the issuance of government bonds for old community transformation projects, according to preliminary statistics. By the end of May, at least 15 local governments had tendered and issued special bonds for the renovation of old neighborhoods, with a cumulative issuance size of RMB 13.690 billion, mostly with maturities of 10 years or more and going up to 30 years.
Table 16 Special bonds issued for old community transformations (100m RMB)

<table>
<thead>
<tr>
<th>Municipals</th>
<th>Volume of issuance</th>
<th>Municipals</th>
<th>Volume of issuance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hubei</td>
<td>42.24</td>
<td>Shenzhen</td>
<td>2.73</td>
</tr>
<tr>
<td>Shanghai</td>
<td>26.70</td>
<td>Gansu</td>
<td>2.36</td>
</tr>
<tr>
<td>Xiamen</td>
<td>15.00</td>
<td>Inner Mongolia</td>
<td>1.63</td>
</tr>
<tr>
<td>Hebei</td>
<td>12.07</td>
<td>Xinjiang</td>
<td>1.40</td>
</tr>
<tr>
<td>Shanxi</td>
<td>12.03</td>
<td>Guangdong</td>
<td>1.00</td>
</tr>
<tr>
<td>Jiangsu</td>
<td>10.40</td>
<td>Yunnan</td>
<td>0.90</td>
</tr>
<tr>
<td>Henan</td>
<td>4.54</td>
<td>Shandong</td>
<td>0.60</td>
</tr>
<tr>
<td>Tianjin</td>
<td>3.30</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Statistics from: Zhongzheng Peng Unit: RMB

In addition, third-party investors are also attracted to renovation projects because the renovation of old communities can generate stable cash flows through the sale of state-owned assets and the transfer of income certificates. For example, the transformation of old neighborhoods in Gongshu District, Hangzhou, United Street, introduced Ping An Smart City. Zhejiang Huayue Design Co. and other private institutions invested in environmental-friendly operations and community landscaping. It directly invested in the community landscaping project, generating profit by charging parking fees and property management fees to achieve the sustainable development of the project.

Additionally, asset securitization based on the income rights of the underlying assets that generate cash flow is one of the potential financing models for urban renewal and revitalization. In 2017, China's first parking PPP asset securitization project was approved, with the asset backed securities (ABS) using parking fee rights as the subject matter and transferring the concessions of the nine parking lots included in the project scope for 12 years, with a total size of more than RMB 300 million.
However, Chinese asset securitization currently has specific requirements for the underlying assets, which has hampered the ABS financing model to some extent. In April 2019, the China Securities Regulatory Commission issued "Questions and Answers on Asset Securitization Regulation (III)." It clarified that the cash flows from infrastructure toll rights that can be used as basis for issuing ABD products could come from the following three types of situations: Government and private capital cooperation (PPP) projects, infrastructure operation and maintenance in industries and sectors encouraged by national policies, and debt or other rights formed by public services, including education, healthcare, and other public services. However, property service charges and commercial property rentals (excluding housing leases) that lack substantial collateral may not be used as sources of cash flow for the ABS's underlying assets.
Investment and Financing Guidelines for Water Management

Part I. Investment background

The impact of climate change on the world's water resources is significant. In 2008, the Intergovernmental Panel on Climate Change (IPCC) published a special technical report on Water under Climate Change. The report systematically examined the impacts of climate change on water systems, including areas such as freshwater supply, wetland ecosystems, human settlements with water resources, water supply, and health and sewage treatment, etc. The 2010 World Bank report noted that climate change will disrupt the functioning of urban water and sewerage services while increasing the cost of water and sewerage, which has already posed a threat to urban water systems. In recent years, the frequency of floods and droughts in China has increased, with droughts in the major agricultural areas of the northern region expanding, while the Yangtze River and other major river basins in the south have had more frequent periods of extreme flooding. Additionally, the occurrences of sudden man-made water polluting events and urban water supply system failures are also increasing.

Table 17 Impacts of climate change on water systems

<table>
<thead>
<tr>
<th>Type of climate hazard</th>
<th>Water resources, water supply</th>
<th>Drainage, flood control</th>
<th>Water environment and aquatic ecology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heatwave</td>
<td>Algae outbreaks caused by increased temperatures; Depletion of dissolved</td>
<td>Higher sewage treatment capacity,</td>
<td>Increased watering of green spaces exacerbates water stress. Odor evaporation from black smelly water bodies.</td>
</tr>
</tbody>
</table>
oxygen concentrations in water and quality reduction in water sources. Significant increase in evaporation and water use, leading to drought.

<table>
<thead>
<tr>
<th>Drought, reduced rainfall</th>
<th>Results in higher pollutant concentrations and lower water quality.</th>
<th>Concentration of sewage.</th>
<th>Declining water table leads to ecological damage.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short periods of heavy rainfall</td>
<td>Frequent and heavy rainfall leads to an increase in the turbidity of water sources and a decrease in the quality of water supplies.</td>
<td>Urban flooding Breach of dam and burst embankment.</td>
<td>Wetlands, Landscape damage, Soil erosion.</td>
</tr>
</tbody>
</table>

Under this shock, adaptive management of water resources can be understood as the adaptation of urban and rural water resources to climate change and climate resilience. The system carries out activities such as construction and upgrading, including flood and drought control, water supply and storage, etc.

A systematic and comprehensive study on the climate resilience of water resources has been developed in China for a long time. However, at the project level, climate resilience of water resources is mostly integrated into general urban water supply and drainage, except for climate-resilient cities.

For this end, capacity-building for the climate resilience of water resources will include the following areas.
In terms of adaptive management of water resources in response to climate change, 2009-2013 was the research phase in this area in China, while from 2017 onwards, China started to gradually move into the pilot practice phase.

The representative event of the research phase was the launch of the ACCC project. Adapting to Climate Change in China (ACCC) is a tripartite project between China, the UK, and Switzerland, officially launched in September 2009, ending in December 2013 with a total funding of more than 6 million dollars.

<table>
<thead>
<tr>
<th>Adaptive Water Resources Management Project</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sewage treatment</strong></td>
<td>Resourceful use of effluent from wastewater treatment plants: recycled water collection and supply systems are used to create a supplementary urban water source, and decentralized drainage reduces environmental impacts. Reducing the carbon footprint of wastewater treatment: reducing CH$_4$ and N$_2$O emissions through the Food Chain Reactor.</td>
</tr>
<tr>
<td><strong>Urban water supply</strong></td>
<td>Regional &quot;net-zero&quot; water use: regional minimization of out-of-basin water transfers by reducing building and municipal water use, maximizing the use of recycled water, and reusing rainwater locally.</td>
</tr>
<tr>
<td><strong>Sponge city</strong></td>
<td>Alleviate urban flooding, increase drought resilience, reduce urban heat island effect, and reduce energy consumption for treatment as well as distribution of water. Involves: Community drainage systems: rain gardens, recessed green spaces, grassed trenches, permeable pavers, green roofs, floating wetlands, permeable tree pools. Ecological drainage systems: how to transform isolated floodplains into interconnected, well-functioning drainage network systems.</td>
</tr>
</tbody>
</table>
making it the most heavily funded adaptation policy research project in the country. The project has selected Ningxia Hui Autonomous Region, Inner Mongolia Autonomous Region, and Guangdong Province as pilot provinces and regions to address the impacts of climate change on China's agriculture, water resources, livestock husbandry, extreme weather events, as well as specific areas of impact such as disasters, human health, etc., to conduct a detailed risk assessment and to assess the impact on the environment. The results will be integrated into regional development and adaptation objectives.

The representative event of the pilot phase is the climate adaptive cities pilot. In 2016, the National Development and Reform Commission (NDRC) and the Ministry of Housing and Urban-Rural Development (MoHURD) issued the “Programme of Action on Urban Adaptation to Climate Change,” with the goal of achieving universal integration of climate change adaptation-related indicators by 2020 Urban and Rural planning systems, construction standards, and industrial development plans. By 2030, it hopes to achieve the capacity for cities to cope with flooding, drought and water shortages, heat waves and strong winds, and freezing disasters, while significantly enhancing other issues and comprehensively improving the ability to adapt to climate change. The Notice on Pilot Work for the Construction of Climate Adaptation Cities (referred to as the "Notice") published in 2017 has listed Hohhot, Dalian and other 28 cities as piloting areas. The Notice pointed out that by 2020, the infrastructure for adapting to climate change in these areas will be strengthened, their adaptive capacity will be significantly improved with increased public awareness, and a number of demonstrative cities in at internationally advanced level will be created. Therefore, it will form a series of replicable city norms while spreading their experiences to other areas.

Part II. Business model

As for the business model, the design of existing projects for adaptive
management of water resources under the impacts of climate change will be guided by the principles of comprehensiveness, consistency, applicability, flexibility, and quantifiability. Therefore, in the design of existing water resources management projects, climate change may not be the most important limiting factor in the development goals, but it can be integrated into the planning process to fully consider all of its risks. Water resource management projects for the adaptation to climate change can therefore still be considered in the context of water projects in general.

**Sewage treatment**

The treatment rate and effect of urban domestic sewage fundamentally affect the realization of energy savings and emission reductions. According to the "National Urban Sewage Treatment Plan and Recycling Facilities Construction Plan during the 13th Five-Year Plan Period," by 2020, other policies and regulations in China will achieve full coverage of sewage treatment facilities, with the urban sewage treatment rate reaching 90% and county towns no less than 85%. Additionally, it includes the completion of 125,900 kilometers of new sewage pipe network, 50.22 million cubic meters of new urban sewage treatment facilities, and 42.2 million cubic meters of upgraded urban sewage treatment facilities. Therefore, the water industry will be full of large business opportunities in the future. At the same time, attracted by the current situation of water treatment in China and the prospects identified by the development plan, foreign capital industry giants have entered the sewage treatment market in China. This has brought fierce competition to domestic environmental protection industry companies and many traditionally backward enterprises are facing the threat of being eliminated. Therefore, it is necessary to discuss the business model of urban sewage treatment plants in China.
Revenue Model

At present, water supply and sewage treatment are the most mature industries in urban water resource management. The sewage treatment cost in China mainly adopts the mode of two streams of revenue and expenditure, that is, the income from sewage treatment projects can be divided into two sources: user payment and policy subsidy.

Figure 28 Charging patterns of sewage treatment projects

User payment means that the government separately disburses the sewage treatment fee from the collected water fee and then pays it to the sewage treatment company. The main basis is the “Administrative Measures for The Collection and Use of Sewage Treatment Fees,” which states that "for units and individuals using public water, their sewage treatment fees shall be collected by the public water supply enterprises entrusted by the competent Urban Drainage Department when collecting the water charges, and the amount of sewage treatment fees shall be separately listed in the invoice."

The essence of the standard for the sewage treatment fee is "government pricing," which needs to carry out the cost supervision, expert argumentation, collective review, and other pricing procedures of sewage treatment enterprises in accordance with the law. According to the “Notice on The Formulation and Adjustment of Sewage Treatment Charging Standards ([2015] No. 119)” issued by the NDRC, Ministry of Finance(MOF), and MoHURD in 2015, it is required that "by the end of 2016, the charging standard for municipal sewage treatment
should be adjusted to no less than 0.95 RMB per ton for residents and no less than 1.4 RMB for non-residents in principle, it should be adjusted to no less than 0.85 RMB per ton for residents and no less than 1.2 RMB for non-residents in the city. "Driven by this requirement, many cities have successively adjusted their prices. By the end of January 2019, the sewage treatment fees of 36 large and medium-sized cities in China have been basically adjusted to 0.95 RMB per ton or above.

At present, the price adjustment cycle of most sewage treatment projects in China is 3 to 5 years, and the adjustment of sewage treatment fees lags behind. As shown in Figure 2, with the constantly improving sewage pricing mechanism, the cost of industrial sewage treatment has increased significantly since 2018. However, the cost of sewage treatment for residents’ domestic water rises slowly. In the future, it is necessary to further shorten the adjustment period of the sewage treatment fee to make it better cover the costs.

Figure 29 Historical trends in sewage pricing

Source: Wind, open source collation

Since the fees collected from the users are far from enough to cover the cost of sewage treatment, most of the shortfall in sewage treatment costs currently relies on financial subsidies. The subsidy is included in the sewage treatment service fee paid by the government, that is, government sewage treatment
service fee = sewage treatment fee + local financial subsidy. The unit price of sewage treatment service is stipulated in the Franchise Contract signed by the local government and the sewage treatment enterprise. When the price adjustment mechanism is triggered by a change in indicators such as electricity, labor, and pharmaceutical costs, the sewage treatment enterprise can apply for adjusting the sewage treatment service fee.

Additionally, due to the increasing requirements for environmental protection, the cost of sewage treatment is also increasing. On April 2nd 2015, the “Action Plan for Water Pollution Prevention and Control” published by the State Council and the “Pollutant Discharge Standards for Urban Sewage Treatment Plants” issued by the Ministry of Environmental Protection on November 4th 2015, proposed that “from July 1st 2016, the newly built urban sewage treatment plants shall implement class a standard. As of January 1st 2018, the existing urban sewage treatment plants in the sensitive area [2] will implement the first level A standard." In order to meet the requirements of higher effluent quality, sewage treatment plants need to replace the original sewage treatment equipment, which increases the cost of chemicals or power and can even cause cost inversion. Since the gap of sewage treatment revenue and expenditure is bore by local government, the difference between the sewage treatment fee standard and service fee increases, further pressuring local financial expenditures.

Under this model, the primary way to increase the revenue of sewage treatment plants depends on cost control and technological innovation because of the relatively stable water price and treatment capacity. In recent years, with the marketization of sewage treatment, the cost price has become more and more transparent and the operation cost has gradually increased. However, the technological innovation of sewage treatment is slow and there is little room for increasing the revenue of sewage treatment in a short timeframe. Therefore, in
order to further improve the sewage treatment cost sharing mechanism, incentivizing and restraining mechanisms and dynamic adjustment mechanisms for charging standards can solve the current revenue dilemma of sewage treatment projects. Thus, relevant Chinese departments have issued a series of relevant supporting policies.

In 2015, the "Notice on Formulating and Adjusting Charges for Sewage Treatment" clearly stated that the charges for sewage treatment will be formulated and adjusted according to the principles of "paying for pollution, fair burden, cost compensation and reasonable profit," and furthermore account for factors such as water pollution prevention, control situation, and social and economic affordability in various places. Therefore, in the future, sewage treatment fees will be priced differently depending on the polluting degree of various subjects according to the principle of "whoever pollutes, pays."

In June 2018, the National Development and Reform Commission issued the "Opinions on Innovating and Perfecting the Price Mechanism for Promoting Green Development," which proposed speeding up the construction of a pricing mechanism covering the cost of sewage treatment and sludge disposal to generate a reasonable profit. This promoted the marketization of sewage treatment service fees, gradually realizing the basic coverage of urban sewage treatment fees for service fees and clarifying the goal that the standard of urban sewage treatment fees will be roughly equivalent to the standard of sewage treatment service fees by the end of 2020. Ultimately, this was aimed at easing the disparity between the continuously increasing pressure of local fiscal sewage treatment expenditures and the operating efficiency of sewage treatment enterprises.

In April 2020, the National Development and Reform Commission, the Ministry of Finance, the Ministry of Housing and Urban-Rural Development, the Ministry of Ecology and Environment, and the Ministry of Water Resources jointly issued
the “Guiding Opinions on Improving the Policies Related to the Sewage Treatment Charge Mechanism in the Yangtze River Economic Belt,” which clearly stated that the sewage treatment charge adjustment mechanism will be improved and the differentiated charge and payment mechanism will be implemented. Moreover, economically developed areas such as Shanghai, Jiangsu, Zhejiang, Hubei, and Chongqing located in the Yangtze River Economic Belt will become important experimental areas for the reform of the sewage treatment pricing mechanism.

Financing Model

Sewage treatment belongs in public service, so all sewage treatment enterprises in China are led by the government. According to the "Notice on Deepening the Cooperation between Government and the private sector in the Field of Public Services" issued by the Ministry of Finance in 2016, the government introduced private capital participation in investment through PPP models and gradually liberalized the sewage treatment market. With the opening of China's urban sewage treatment market and the implementation of the charging policy, several mainstream government-enterprise cooperation (PPP) models, such as build-own-transfer (BOT), toll-operate-transfer (TOT), and custody operation, have gradually formed in China's sewage treatment. PPP mode, that is, the cooperation model between the public and private sector, is an optimized project financing and implementation model developed in public infrastructure construction and a modern financing model with the cooperation concept of "win-win" and mutual benefit for all participants. The typical structure is that local departments or places sign contracts with special purpose companies formed by successful bidders through procurement. The special purpose companies are responsible for the financing, construction, and operation of sewage treatment plants.

**BOT Model**
The government will sign a franchise agreement with the successful investor through public bidding and grant the investor the right to construct and operate the sewage treatment plant. During the franchise period, the investor will charge the facility users appropriate fees to recover the project financing, construction, and maintenance costs, to obtain reasonable returns. After the franchise period ends, the investors will hand over all the project assets to the government.

Case of BOT Mode Case: Harbin Taiping Wastewater Treatment Plant

During the construction and operation of Harbin Taiping Wastewater Treatment Plant, in order to alleviate the financial pressure of the local government and improve and avoid many drawbacks brought by the model of a single local investment, the previous payment method of centralized payment was changed and installment payment was adopted. At the same time, after considering all factors comprehensively, Harbin Water Supply and Drainage Group decided to introduce a market competition mechanism and build the Taiping Wastewater Treatment Plant by adopting the BOT investment financing mode, which will be delivered to Harbin after 25 years of operation. In February 2004, the bidding for the Taiping Wastewater Treatment Plant was completed with Tsinghua Tongfang-North American Environmental Consortium won the bid. The project started in May 2004, was completed and put into operation in December 2005, and has a franchise period of 25 years.

TOT Model

By means of public bidding, the government entrusts the operating rights of the completed sewage treatment plant to the successful bidder, followed by the successful bidder paying a certain fee as the construction fund building the sewage treatment plant for the government. During the franchise period, the investors will generate the income and return all the equipment and facilities of the sewage treatment plant to the government after the contract expires.
Case of TOT Mode Case: Xuzhou Yaozhuang Wastewater Treatment Plant

Xuzhou Yaozhuang Sewage Treatment Plant is the first urban sewage treatment plant built in the Huaihe River Basin. On December 30th, 2003, Anhui Guozhen Environmental Protection and Energy Saving Technology Co., Ltd. and Xuzhou Municipal Public Utilities Administration reached a transfer agreement: Guozhen obtained the management rights of the Xuzhou Wastewater Treatment Plant for 30 years by TOT at a cost of 160 million RMB. The Xuzhou Yaozhuang Sewage Treatment Plant has become the first sewage treatment plant in the Jiangsu Province to transfer its management rights by TOT. Since Anhui Guozhen Environmental Protection and Energy Saving Technology Co., Ltd. obtained the management rights of Xuzhou Wastewater Treatment Plant in TOT mode for 3 years, Xuzhou did not have to be concerned about working capital and solved the problem of "being short of money" in Xuzhou.

O&M Model

The municipal sewage treatment plant is invested by the government and entrusted to a specialized operating company for operation through bidding after completion. The operator is responsible for the operation of the project during the contract period. In the process, there is no transfer of property rights for the sewage treatment plant between the government and the operator, and the operator does not pay any franchise fees to the government.

Case of Trusteeship Mode: Eight County Wastewater Treatment Plants in Heze, Shandong Province

In December 2003, Heze City and Shandong Province Enterprise Trusteeship Management Co., Ltd. (hereinafter referred to as "Shantuo") formally signed a contract, and the sewage treatment plants in eight counties of Heze City were
handed over to Shantuo for construction, operation, and management. It is rare in China to manage municipal engineering projects throughout the entire process, which undoubtedly has the meaning of "breaking the problem" for the challenge of construction and operation of urban sewage treatment plants.
Water Supply

The urban water supply system is an important infrastructure to ensure the health of urban residents and is an important guarantee in the field of research on how to deal with climate change.

In April 2004, the State Council issued the "Notice on Promoting Water Price Reform to Promote Water Conservation and Protection of Water Resources," which stated that the virtuous development of water supply units should be combined with the construction of water-saving facilities, reasonable compensation of water supply unit costs, the development of water-saving project construction, and the promotion of water-saving technologies. It requires the combination of the water price formation mechanism reform with the management system of water supply units reform. This was done to promote corporate management and industrialization, strengthen the cost constraints of water prices on water supply units, and strive to play the fundamental role of market mechanisms in the allocation of water resources.

In December 2010, the State Council issued the "Decision of the Central Committee of the Communist Party of China and the State Council on accelerating water conservancy reform and development," encouraging qualified local government financing platforms to broaden water conservancy investment and financing channels through direct and indirect financing. The key to market-based financing is to have a reasonable and stable return and to improve the system of the paid use of water resources. Therefore, the meeting proposed implementing the water price standard and charging system, requiring that the water supply price be reasonably determined before the construction of the project. It reached an agreement with the water supply object on the water price standard, water consumption, water fee collection, and dynamic adjustment mechanism, effectively reducing the project operation risk and stabilizing the investment expectations of market entities. Furthermore,
it was to establish a reasonable return mechanism to promote private investment entities to obtain a reasonable return that matches the capital invested. It encourages the use of various equity and debt investments and financing tools to optimize the equity structure of project operators, reduce financing costs, and extend the repayment period, to effectively increase the scale of market-based financing.

In December 2011, the State Council issued the "Twelfth Five-Year Plan for National Environmental Protection." By the end of 2015, the environmental safety of drinking water sources in urban and rural areas was effectively guaranteed and water quality was greatly improved. This strictly protected drinking water sources by completing the examination and approval of the urban centralized drinking water source protection zones and banning the illegal construction of projects and sewage outlets in water source protection zones. Thus, this promoted (i) environmental improvement, (ii) the restoration and standardization of water source areas, (iii) strengthened the supervision of toxic and harmful substances in the foreign exchange water area of the water source protection zone, (iv) centralized drinking water source areas in cities above the prefecture level to carry out the full analysis of water quality on a regular basis, (v) developed the environmental information disclosure system for drinking water sources, (vi) and strengthened the risk prevention and emergency early warning.

Revenue Model

The price of the urban water supply is set by the local price bureau in accordance with national guidelines. The city water company charges residents according to the water price set by the price bureau. According to the "Urban Water Supply Price Management Measures," water supply implements a two-part water price or a stepwise water price that combines a capacity water price with a measured water price. As such, the capacity water price is determined
by the water plant's fixed asset investment scale, annual water supply capacity, and average user water consumption; the measured water price is determined by the water plant's fixed asset investment scale, annual water supply capacity, and the actual water consumption of users. In addition, the stepwise metered water price is currently only used for urban residents' domestic water, and is priced according to the actual domestic water consumption.

The "Urban Water Supply Price Management Measures" document stipulates that the average level of reasonable profitability for water supply companies should be 8 to 10% of profit on net assets. The specific profit level shall be determined by the competent price department of the municipal people’s government after soliciting the opinions of the city’s water supply administrative department at the same level and based on its different funding sources. For companies that rely mainly on government investment, the profit margin of the company’s net assets shall not be higher than 6%. For others, it mainly depends on corporate investment, the price of the water supply for financing the construction of water supply facilities, including the use of loans, the introduction of foreign capital, the issuance of bonds or stocks, etc., and the profit margin of net assets during the loan repayment period shall not exceed 12%. At the end of the loan repayment period, the price of the water supply shall be determined according to the average profit rate of net assets specified in this article.
Figure 30 Total revenue and profit of water production and supply owner's business (100 million RMB) (2015-2019)

Source: Wind, IIGF collation

Figure 31 CPI of aquatic products and PPI of water supply (previous year=100) (2015 to 2019)

Financing Model

In terms of investment and financing in the water industry, due to the nature of water categorized as a public good, investment and construction will inevitably
rely and be lead by government finance. In the early 1990s, the non-public sector of the economy began to enter the field of urban public utilities, which to a certain extent, made up for the investment gap in urban and rural water services.

**BOT Model**

Under the BOT model, the government grants the water enterprise a certain period of concession rights through bidding, and the project is transferred back to the government after the expiration. The BOT project of Plant B of the Sixth Water Supply Plant in Chengdu is China’s first urban water supply BOT pilot project. It was jointly invested by General Water Group of France and Marubeni Co., Ltd. of Japan, which put it into operation on February 11th 2002. General Water-Marubeni Water Supply is responsible for its operation and management. In accordance with the relevant provisions of the "Concession Agreement for BOT Project of the Sixth Water Plant B Plant in Chengdu, Sichuan, People's Republic of China" signed on August 11th 1999 between the Chengdu Municipal People's Government and Chengdu General Water-Marubeni Water Supply Co., Ltd. And with the arrangements of the Chengdu Municipal Government, on August 10th 2017, Chengdu Xingrong Group Co., Ltd., as the designated recipient of the Chengdu Municipal Government, officially took over all the assets and operation and maintenance management of the project from the project company at the expiration of the concession period.

**Sino-Foreign Joint Venture Model**

Cooperative investment mode refers to the transfer of a portion of the shares of a water enterprise to obtain financial and technical support from a foreign-funded enterprise, so as to achieve a win-win cooperation between the two parties. This approach closely links water supply companies with foreign-funded companies, and the operating conditions of water-supply companies directly determine to a certain extent whether foreign-funded companies can be
profitable. Therefore, foreign-funded enterprises will invest advanced technology, management concepts, facilities and equipment, etc., to water enterprises to enable water enterprises to better operate and be managed.

In 2002, the General Water Company under the French Vivendi Environment Group invested 760 million RMB to acquire a 5% stake in Shanghai Water Pudong Co., Ltd. formally establishing Shanghai Pudong Vivendi Water Co., Ltd. in the Shanghai Pudong New Area. This is the first company in China to implement a Sino-foreign joint water company.

**Asset Securitization**

Asset securitization refers to the issuance of asset securities on the basis of a specific portfolio of assets and cash flow, and through a certain method to increase the credit of the securities, so that enterprises can obtain financing and greatly improve their liquidity. At the present, asset securitization has not been widely used in water related companies. Water related companies should strengthen the application of this financing method to promote the development of corporate financing.

**Sponge city construction**

Revenue model

A sponge city refers to the strengthening of city planning and construction management, effective control of rainwater runoff, restoration of urban water ecology, conservation of water resources, enhancement of urban water-logging prevention capabilities, and the improvement of the quality of new urbanization. Currently, the sponge city, as an absolute public welfare infrastructure project, does not have a stable source of market-oriented income as it is all invested in by the government and paid through fiscal budget funds.

According to the central financial sector for the pilot of sponge city construction
plans, the amount of investment in pilot projects range from 2.7 billion to 21 billion, totaling about 30 billion-RMB and accounting for an average of 8.4% of GDP, which is a moderate level of financial support for national demonstration projects. The central financial administration is providing a three-year financial subsidy for the construction of "sponge cities," which is divided into three levels - 600 million RMB per year for municipalities directly under the central government, 500 million RMB per year for provincial capital cities, and 400 million RMB per year for other cities. In addition, those that adopt the PPP model to reach a certain percentage of projects will be rewarded 10% according to the subsidy base.

However, for the PPP capital profit model in the construction of sponge cities, whether it is project financing or mixed with capital funds, it’s profits are generally divided into several parts: first, the ratio of capital return for the investors’ (central, state-owned, or private) profit is an agreement where bids are usually under 7%. For banks, the proceeds are fixed sign-offs with the PPP company’s rate of return and the difference between the interest rate of the loan and the interest rate negotiated by the government as two parts of the profit. The second area of profitability is that qualified companies can take part in the sponge city, working in its construction to make a profit. And the third area of profitability is that many PPP projects contain operations, and so there may be some operating costs for their operating period profits.

**Financing model**

Sponge city have strong financing requirements. According to the "13th Five-Year Plan," if a sponge city in 2020 accounted for more than 20% of urban areas, its built-area will exceed 60,000 square kilometers. If, according to the unit construction cost of 150 million to 190 million RMB per square kilometer using conservative estimates, by 2020 the total investment scale of the corresponding sponge city will reach two trillion RMB in volume. In addition, in only using the
first 16 sponge city construction pilot cities as an observation, according to planning data, construction investment is 1.11 RMB per square kilometer with an average investment of 320 million RMB per square kilometer, the total capital requirement for all pilot city construction projects would reach hundreds of billions of RMB. As of June 2020, three years of sponge city construction resulted in 2,581 PPP projects with the total project investment exceeding 4416.1 billion RMB.

Various local governments actively innovate investment and financing models, for example, Fuzhou has already packaged seven independent PPP projects in accordance with different water systems. These PPP projects ranged from 1.1 billion to 2.4 billion RMB and have been contracted to several of the country's leading water companies, who have spearheaded the partnership with City Hall. The construction companies formed a consortium to research, design, finance, and execute the project. Ultimately, private(?) capital will be paid based on performance.

(Private) capital is still an important financing channel for the construction of sponge cities. Due to the large capital requirements for sponge city construction, the role of central and local financial subsidies is minimal, four-fifths of the capital funding will still need to come from private capital or institutional support. Thus private capital has become an important channel for investment and financing in the construction and operation of sponge cities. From the end of 2014, as the PPP model began to gradually grow, many environmental protection companies began to expand in business volume, with a planned investment volume of PPP projects of over 8 trillion RMB. However, as most of the sponge city is a public utility form, non profit generating, and with a long investment cycle, private capital will remain very cautious in fields with these investment characteristics. It is important to promote the construction of sponge cities to not only to take PPP, government procurement, and financial subsidies,
etc., but also for eligible projects in the scope of support to benefit from the Special Building Fund.

In China's economic downturn, various regions began to explore the PPP diversified financing model and support economic incentive policies. Most of China's existing sponge city construction PPP projects use the BOT model, and based on this innovation, developed a "BOT+EPC" model. In this model in the construction phase, the "BOT+EPC" model was adopted, with the private company financing the project through debt. The project company is responsible for the design, construction, and operation of the sponge city construction work and then handed it over to the government. The operating revenue comes from government payments and the agreed payment for watershed management based on the project performance evaluation. In the "PPP+ financial loan" model, government direct financing is used, with the central financial subsidy fund and local financial fund as the channel for financing; for other supporting operational facilities, the "PPP + financial loan" financing model is adopted to establish the project company, the main part of the fund is obtained through the loan from private financial institutions, and the remaining part is contributed by the government and private capital proportionally. In the operational stage, the profits mainly come from revenues from the operating facilities. In the "PPP+ABS" model projects are done through asset-based financing and securitization to obtain low financing costs. In the "TOT+ROT+BOT" model project are done through the overall package of stock projects for the construction company, grant them franchises to invest, construct, and operate new projects. Finally, in the "TOT concession" model the government signs a long-term franchise agreement with the project company, which adopts achievement assessments and pays for efficiency. Additionally, there is also project financing. Generally, state-owned enterprises usually look for some policy loans from banks such as China Development Bank, Agricultural Development Bank, or commercial loans. Currently, there is
a trend of the insurance industry developing in the field of asset securitization following PPP projects in sponge cities. Overall, the volume of transactions is still dominated by policy and commercial loans.

Table 19 Application of different financing models in sponge city construction

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<td>PPP+EPC</td>
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<td>Joint construction between the government and the private sector par loans or other financing methods. The government will pay for performance.</td>
<td>PPP+ funds: Provincial and municipal key projects PPP+ bonds: the government issues bonds for projects with weak profitability, the project company issues special bonds or project yield bonds for projects with fine profitability PPP+ loans: the government has loan repayment ability, the shareholders of the project company have loan repayment ability, the project has loan benefit</td>
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At present, it seems that from last year to this year, PPP have been more accepted by the government. For PPP, the NDRC and MOF have issued a series of documents and also gradually improved the entire PPP market, including the opaque PPP financing process, with more emphasis on
technology + capital model, etc. With the need for new urbanization and modernization of governance, the introduction of PPP to the construction of sponge cities will be mainstream in the future. However, currently the sponge city construction investors consortia are led by large state-owned enterprises, central enterprises with private enterprises in a relatively junior position. In addition, as the PPP policies and regulations are still undeveloped, and the system of involving the private sector in the construction of sponge cities still has challenges, including mechanisms to deal with such issues as cost increases and financial risks. These issues have yet to be addressed by the government and other authorities.
The Europe-China Eco Cities Link (EC-LINK) Project is funded by the European Union in cooperation with the Ministry of Housing and Urban-Rural Development (MoHURD). Implemented by the Chinese Society for Urban Studies (CSUS) and the European Consortium led by GIZ.