Analysis of China's New Energy Development in New Period of Renewable Energy Subsidy

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Abstract. With the rapid decline in costs, China's new energy development has entered a new period of subsidies. In order to achieve energy transition, new energy will keep playing a greater role, reflected in the installed power capacity and power generation electricity. How to improve the new energy carrying capacity of power system and promote the healthy development of new energy are still important problems, on which should be paid more attention in the future. Firstly, the changing trend of new energy generation cost has been analyzed in this paper. Then the development of new energy in the future has been pointed out. Thirdly, the comprehensive measures have been proposed to improve the accommodation capacity, and the relevant policy recommendations also have been figured out finally.

1. Introduction
At present both the installed capacity and generation electricity of new energy of China have hold the No.1 position in the world[1,2]. However owing to the rapid growth and overdependence on subsidy, the gap of new energy power subsidy keeps widening. Till the end of 2018, the accumulative gap of renewable energy subsidies in China had over reached CNY 200 billion, more than CNY 113 billion in 2017[3]. In that moment the installed capacity of wind power and solar power amounted to 160GW and 180GW and the power output registered 305.7 TWh and 118.2 TWh respectively; it was estimated that by the end of 2018 the total installed capacity of new energy power may exceed 350GW. As the new energy power generation cost plunged over the years, its competitive edge got sharpened prominently. China also has issued an array of policy documents to lower the subsidy intensity, speed up subsidy reduction, encourage the construction of new energy power projects with no need of national subsidy, and promote grid parity of wind and solar power[4]. The new energy development in China steps into a new period of renewable energy subsidy.

Firstly the paper has considered the national requirements on energy transition and development, and found out the future of new energy development in China; secondly it has analyzed the trend of cost efficiency of new energy power, forecasted the changes of costs per kWh of the electricity generated by wind and solar power in future typical level years; thirdly from the perspectives of planning, operation, market, etc. the measures to improve the new energy carrying capacity of power system have been proposed; at last, the paper also has given related advices on future new energy policies such as scientific guidance of development pace, promotion of power market construction, development of supportive policy mechanism and improvement of system flexibility, etc.

2. Development prospect of medium and long term for new energy in China
Establishing a clean, low-carbon, safe and efficient modern energy system has been the inevitable trend of energy transitions. China's energy consumption is becoming huge in scale and increasing
rapidly each year where the fossil energy still takes a large share in the energy consumption structure; as a capital- and technology-intensified industry, energy development is heavily path-dependent. Therefore, it is a thorny task to break the traditional barriers and realize energy transition. Forceful development of renewable energy including wind and solar power and sustainably increasing the share of non-fossil energy in the primary energy consumption is an important way of combating climate change, air pollution as well as environment protection [5,6]. Energy Production and Consumption Revolution Strategy (2016-2030) points out that in 2050 the share of non-fossil energy should be larger than half of the primary energy consumption, and the related estimation of various scenarios has been performed. In 2050, the new energy power generation scale will reach 2.5 TW at least, with the share of installed capacity over 52% and power generation electricity share around 30%.

In terms of new energy development mode, the centralized mode accounts for 88% of total installed capacity of new energy while the distributed mode accounts for 12%. In solar power sector particularly, about 80% of distributed PV power projects are located in East and Central China, which should be further prioritized because they are close to power load centres and facilitate local consumption. The West and North China regions have larger potential of exploring new energy resources [7,8], as a result of favorable conditions of centralized development and higher utilization level. If the new energy accommodation situation gets better, these regions will gradually enjoy the economic strength of medium- and long-term scale-up development and become another focus of future new energy development in China. Therefore, both centralized and decentralized modes will coexist in future new energy development. The former mode is suitable to the western, northern and offshore regions, while the latter one is fit for East China and Central China.

3. Trends of cost change of new energy power generation in China

3.1. Global trend of cost change of new energy power generation

Driven by the factors as declining prices of key equipment, maturing experience of project development, etc., the costs of onshore wind power and solar power has kept falling globally. In the first half of 2018, the average cost per kWh of the electricity generated by onshore wind power globally was USD 0.055/kWh, down by 35% compared with that of 2010, as shown in Figure 1(a); the average cost per kWh of the electricity generated by solar power globally was USD 0.07/kWh, down by 77% from 2010[5], as shown in Figure 1(b).

![Figure 1. Global wind and solar power cost per kWh from 2009 to 2018](image)

3.2. Domestic trend of cost change of wind and solar power generation

As the percentage of homemade parts of full wind power industry chain constantly has been increasing, and the wind power equipment technology and reliability level keep improving, the overall cost of wind farm construction will keep dropping down year by year. However, most newly-built wind farms are located in the Central and East China with higher land and construction costs, so that the per kWh construction cost in 2017 reported around CNY 8,000/kW. According to the statistic data of Ministry of Industry and Information Technology (MIIT) of PRC, the average cost per kWh of the electricity generated by onshore wind power is CNY 0.43/kWh[2]. It is initially estimated that in 2022 such cost
will drop down to around CNY0.38/kWh which would realize grid parity at generation side across China; in 2025, it will further decline to around CNY 0.35/kWh.

The technology progress, industry upgrading and scale-up market of solar power in China lead to continuous decline of solar power generation cost, where the construction cost of unit capacity plunged from around CNY 20/W in 2010 to CNY 6.6/W in 2017. In a few of enterprises enjoying strength of industry chain, the mentioned cost is even lower, reported close to CNY 5/W. It is estimated that the average solar power generation cost in 2017 was around CNY 0.52/kWh, which was more than 70% lower than the cost of 2010. In the short- and medium-term, the solar power cost still has considerable potential of decrease. It is initially estimated that in 2020 China's solar power generation cost will decline to CNY 0.39/kWh, therefore the grid parity of new energy at generation side can be realized in the Three-Norths regions (North China, Northwest China and Northeast China). If there is a further dropping to CNY 0.35/kWh, the grid party of new energy at generation side can be finished in other regions such as East China, Central China, etc. On the basis of forecast data of China Photovoltaic Industry Association (CPIA) and the actual prices of PV components in 2018, the construction costs of solar power projects in 2020, 2022 and 2025 will be reduced to CNY 4.6/W, CNY 4.1/W and CNY 3.7/W respectively.

4. Comprehensive measures to improve the new energy carrying capacity of electric power system

The new energy accommodation in large scale and high proportion is always a world-class difficult problem. Compared with foreign countries, China is confronting with more conspicuous problem of new energy utilization [7,8]. The growth rate of new energy installed capacity is far higher than that of system load and regulation capability, i.e. the insufficient regulating capacity of power system is the major bottleneck of consumption of higher-share new energy. In the meantime, the construction of domestic electric power market is underway, where the interprovincial mechanism carriers should be removed. It need to require the joint force of planning, operation, policy and other sectors to form a checklist of comprehensive measures, integrate the system regulating resources and improve the carrying capacity of new energy.

Table 1. Comprehensive measures to improve new energy carrying capacity of power system

| Operation level | Planning level | Market level |
|-----------------|----------------|--------------|
| Exclusive dispatching the whole grid | Refined arrangement of operator | Renewable portfolio standard (RPS) system of renewable energy |
| More precise in new energy power output forecasting | Peaking Regulation gas-fired power generation construction | Green certificate trading |
| Demand side response | Diversified application of energy storage | |
| Improving existing thermal power plant flexibility | Expansion of grid interconnection scale | |
| Pumped storage power station construction | National electric power market | |

In its narrow sense, the flexible regulation resources exist in each step of power system operation and are featured with direction, time scale, inherence, etc., which also involves many parts of power system operation like power source, grid and load [7-10]. In its broad sense, the flexible regulation capacity may extend beyond the power system operation to its pre-stage and mechanism. The former one includes the planning stage and relevant technology, while the latter one includes policy environment and market building. As a whole, for consolidation of flexible regulating capacity of system and protection of effective carrying capacity of new energy, planning is the prerequisite and operation is the foundation, which should be protected by policy, supported by technology and driven
by market\cite{7,9}. All the aspects should be integrated in an organic and barrier-free manner, so as to overcome imbalance between system flexibility and new energy development.

5. Policy advice on future development of new energy in China

To meet the national urgent requirement of energy transition, more higher share of new energy will be taken to the power grid. The paper has proposed the relevant policy advices on scientific guidance of development pace, promotion of power market construction, development of supportive policy mechanism and improvement of system flexibility.

5.1. Scientific guidance of development pace to impel efficient development of new energy

For energy strategy, it is necessary to find out the energy transition roadmap suitable to Chinese national conditions, especially the position and role of new energy in the energy transition. During planning development stage, it should be reasonably determined for the quantity of installed capacity and structure layout of new energy. By rolling analysis of accommodation capacity, the new energy development scale and layout in different regions and various years could be studied and estimated, which is a necessary condition for project construction scheduling of new energy. As to annual arrangement, it is the further strengthen the macro-control and adjustment of new energy industry that will play an important role. China should generally plan the new energy development as a whole, consolidate the annual investment pre-alerting and supervision system, enhance new energy scale management, and implement top-level policies design. Only that peculiar attention has paid on the policy connection and transition, the dramatic volatility of industry could be avoided.

5.2. Establish a large consumption platform and build a national exclusive power market

The establishment of the market-oriented consumption mechanism with chinese characteristics, would help realize the electric power resource allocation in a wider market scope. Building a national unified power market that not only integrates nationwide medium- and long-term transaction, spot transaction and auxiliary services, but also combines the state-level market and provincial-level market, improve the renewable energy consumption and utilization, and achieve efficient allocation of new energy power across China.

5.3. Develop supportive policy mechanism and foster a favorable environment for new energy development

It has been more importantly to put the renewable portfolio standard (RPS) into practice with scientific and reasonable indice and implementation plan. During this procedure, the responsibilities and obligations of all stakeholders should be clarified, interprovincial barriers should be broken, dynamic monitoring and assessment and appraisal of implementation result should be enhanced. Especially, the strengthened connection between the RPS policy with the existing renewable energy policies and power market construction also should be paid more attention.

5.4. Improve system flexibility and implement comprehensive policies to create favorable conditions for new energy accommodation

The flexibility power sources, such as pumped storage station and gas-fired power for peaking regulation, should be focused on construction enhancement. Meanwhile, the supporting policy mechanism should be established to motivate the flexibility improvement of coal-fired power units, with speeding up the transformation of deep peaking regulation of conventional thermal power plants. The decoupling between heat and electricity for combined heat and power plants is a vital way for system flexibility. It has been estimated that installed capacity of coal-fired power in 2035 will reach around 1.15 TW, which will ensure China's electric power balance. By flexibility reformation, the regulation capacity of coal-fired power units may amount to around 0.8 TW including around 0.5 TW capacity in “Three-North” regions. Meanwhile the scientific price formation mechanism should be set up to guarantee reasonable investment returns.
6. Conclusions
The energy transition requires forceful development of new energy. China's new energy’s role in power system is transforming from a "supplementary" power source to a "backbone" one. In the upcoming new renewable energy subsidy, the new energy power will become more cost efficient and realize grid parity. In the medium and long term, the new energy sector will have significant opportunities to embrace a bright future. The large-scale efficient consumption of new energy of higher share is a systematic issue that requires state-level attention, effective support of governments at all levels, joint efforts of all power enterprises and the care of the whole society. Scientifical guide in new energy development pace, effective promotion in construction of power market and positive development in supporting policy mechanism should be put forward. By adopting the comprehensive measures from three aspects i.e. planning, operation and policy, the new energy carrying capacity of power system could be improved, on which the new energy utilization could be implemented in a larger scope and on a higher level.

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