Study on the economic analysis model of new energy power generation under the form of grid parity

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Abstract: This paper first analyzes the influencing factors of the economy of new energy power generation under the situation of grid parity, then studies the economic analysis method based on the internal rate of return, and establishes the calculation model of the economic analysis of new energy power generation. Finally, taking the economic calculation of wind power field and photovoltaic power station in 2020 as an example. This paper studies the IRR of new energy power generation projects in different regions under parity conditions. On this basis, the paper analyzes the key issues of new energy development scale, development layout, operation consumption, market competition and so on under the situation of grid parity, and studies and judges the development trend of new energy in China in the future.

1. Introduction

With the gradual reduction of new energy benchmark price and the introduction of a series of policies and measures such as parity on grid, it marks that China's wind power and photovoltaic power generation have entered the era of parity on grid, so it is necessary to study the economic problems of new energy power generation in the era of parity on grid. Literature [1] conducts research based on the cost analysis model of kilowatt hour. It predicts the change trend of new energy and kilowatt hour cost in different countries in the future; literature [2] forecasts the kilowatt hour cost of wind power in the east central region of China in 2025 / 2030. It studies the prospect of wind power development in the east central region of China in the future; literature [3] based on the analysis of historical changes and future costs of new energy generation cost in China According to the trend analysis, the power generation cost of new energy in China in 2020 and 2030 is predicted. The future parity of new energy is analyzed; according to the literature [4], the development of new energy in China is gradually entering the "post subsidy period", and the development prospect of new energy in medium and long term is analyzed. Based on the above research results, this paper puts forward an economic analysis method and model based on internal rate of return. It studies the development trend of new energy generation in the era of parity grid access from the aspects of development scale, development layout, operation consumption, etc.

2. Economic analysis of new energy generation in the era of cheap internet access

2.1. Analysis of influencing factors

Under the condition of parity grid access, subsidies will be cancelled for new energy power generation. The economy of development and operation of parity projects will be mainly affected by the local coal
benchmark grid price or general industrial and commercial price, as well as the cost of bulk power generation, generation utilization decimal and non-technical cost.

1) Local coal benchmark feed in tariff or industrial and commercial tariff
To calculate the economy of new energy power stations, the grid price shall not be higher than the local desulfurization coal benchmark. Since there is no additional subsidy, distributed photovoltaic needs to take into account the economic calculation of local desulfurization coal benchmark and industrial and commercial electricity price.

2) Power generation cost of new energy project
Initial investment cost: including equipment cost, construction cost, financial cost, design and other miscellaneous and other expenses of new energy project. The cost of onshore wind turbines accounts for 64%, the cost of wind farm infrastructure accounts for 16%. The cost of grid connection accounts for about 11%; the cost of offshore wind turbines accounts for 51%, and the cost of infrastructure accounts for 27%. Operation and maintenance costs generally account for 5% ~ 15% of the total investment.

3) Utilization hours of power generation
The utilization hours of power generation are closely related to the power generation of new energy. The higher the utilization hours, the more the power generation of new energy power generation projects, and the higher the final income level of the projects. The actual generation hours are also constrained by the scheduling operation. The actual annual generation hours of new energy will be lower than the theoretical generation hours corresponding to the resource conditions.

4) Non-technical cost
The non-technical cost is an important factor affecting the yield of new energy projects, which is mainly reflected in other additional fees, including land tax and other fees, in addition to the initial investment cost and operation and maintenance cost.

2.2. Economic analysis model of new energy power generation
(1) Internal rate of return
Internal rate of return (IRR) refers to the discount rate when the total present value of capital inflow is equal to the total value of capital flow and the net present value is equal to zero.

(2) Calculation model
The calculation formula of internal rate of return is as follows (1):

\[
\sum_{n=0}^{N} C_n (1+r)^{-n} = \sum_{n=0}^{N} (A_n P_n + B_n) (1+r)^{-n}
\]

Where \(n\) is the year and \(N\) is the whole life cycle. \(r\) is the discount rate. When the equation that the net present value of income is equal to the net present value of cost holds, it is the internal rate of return of the project \(C_n\) is the total expenditure of the nth year. The calculation formula is as follows:

\[
C_n = D_n + R_n + V_n + W_n
\]

\[
D_n = PerInv \times Cap \times (1-a)/b
\]

\[
R_n = PerInv \times Cap \times Ope-rate
\]

\[
V_n = A_n \times P_n \times V-rate/(1+V-rate)
\]

\[
A_n = Cap \times Hour_n
\]

Where, \(D_n\) is the depreciation cost of the nth year power plant project, \(PerInv\) is the unit kilowatt investment of the project, \(Cap\) is the installed capacity of the project, \(a\) is the residual value rate of fixed assets, \(b\) is the depreciation life of the project, \(R_n\) is the annual operation cost of the project in the nth year, \(Ope-rate\) is the proportion of annual operation cost in the initial total investment.
$V_n$ is the value-added tax expenditure in the $n$th year. $V_{rate}$ is the value-added tax rate. $A_n$ is the generation capacity of the project in the $n$th year. $nHour$ is the annual generation utilization hours of the project in the $n$th year. $P_n$ is the feed in price of the project in the $n$th year. $W_n$ is the loan interest of the project in the $n$th year. $B_n$ is the income from other sources in the $n$th year. Under the condition of parity access to the Internet, $B_n$ is not included in the subsidy income.

2.3. Economic calculation of new energy power generation by province in 2020

(1) Economic calculation of wind power

According to the current unit investment cost of wind farms, it is predicted that in 2020, the unit investment cost of each province will be divided, and the economy of new wind power projects across the country will be estimated. See Table 1 for the calculation data.

Table 1. Main boundary conditions of wind power calculation by province and resource area (unit: hour, yuan / kWh, yuan / kW)

| Province     | region                                      | resource area | desulfurization coal benchmark price | hours | initial investment |
|--------------|---------------------------------------------|---------------|-------------------------------------|-------|-------------------|
| Qinghai      | Whole province                              | IV            | 0.3247                              | 1524  | 5500              |
| Sichuan      | Whole province                              | IV            | 0.4012                              | 2275  | 6000              |
| Gansu        | Jiayuguan, Jiuquan                          | II            | 0.2978                              | 2200  | 5000              |
| Mengxi       | Except Chifeng, Tongliao and Xinganmeng and Hulunbuir Other areas | I             | 0.2829                              | 2409  | 5000              |
| Liaoning     | Whole province                              | IV            | 0.3749                              | 2265  | 5500              |
| Heilongjiang | Jixi, Shuangyashan, QiTaihe, Suihua,YichunCity, Daxinganling region | III        | 0.3740                              | 2144  | 5500              |
| Jilin        | Baicheng, Songyuan                         | III            | 0.3731                              | 2057  | 5500              |
| Hebei        | Chengde, Zhangjiakou                       | II            | 0.3720                              | 2312  | 5500              |
| Tianjin      | Whole city                                  | IV            | 0.3655                              | 1830  | 5500              |
| Beijing      | Whole city                                  | IV            | 0.3598                              | 1866  | 5500              |
| Ningxia      | Whole province                              | III            | 0.2595                              | 1982  | 5300              |
| Shanxi       | Whole province                              | IV            | 0.3545                              | 1959  | 6000              |
| Guangdong    | Whole province                              | IV            | 0.4530                              | 1504  | 5800              |
| Hunan        | Whole province                              | IV            | 0.4500                              | 2053  | 6000              |
| Xinjiang     | Urumqi,Ili, Karamay, Shihezi                | I             | 0.2500                              | 2277  | 5200              |
| Yunnan       | Whole province                              | II            | 0.3358                              | 2405  | 6300              |
| Shanxi       | Whole province                              | IV            | 0.3320                              | 2196  | 6000              |
| Hainan       | Whole province                              | IV            | 0.4298                              | 1419  | 6000              |
| Guangxi      | Whole province                              | IV            | 0.4207                              | 1584  | 6000              |
| Hubei        | Whole province                              | IV            | 0.4161                              | 2159  | 6000              |
| Shanghai     | Whole city                                  | IV            | 0.4155                              | 2092  | 6000              |
| Zhejiang     | Whole province                              | IV            | 0.4153                              | 1809  | 5800              |
| Jiangxi      | Whole province                              | IV            | 0.4143                              | 1940  | 6000              |
| Mengdong     | Chifeng, Tongliao, Xing’an, Meng Hulun Buir | II           | 0.3035                              | 2250  | 5000              |
| Gansu        | Other                                       | IV            | 0.2978                              | 1969  | 5000              |
| Chongqing    | Whole city                                  | IV            | 0.3964                              | 1570  | 6300              |
| Shandong     | Whole province                              | IV            | 0.3949                              | 1971  | 5500              |
| Fujian       | Whole province                              | IV            | 0.3932                              | 2587  | 6000              |
| Jiangsu      | Whole province                              | IV            | 0.3910                              | 2215  | 6000              |
The results show that in 2020, the internal rate of return of new wind power projects in these areas is 8.3%–12.0%, which can achieve parity on the Internet. In other provinces, the internal rate of return of new projects is 3.7% – 7.6%, which does not have parity Internet economy.

(2) Economic calculation of photovoltaic power station

According to the current unit investment cost of photovoltaic power plants, it is predicted that the investment cost will be divided into provinces in 2020. The economy of new photovoltaic power plants in all regions of the country will be calculated. See Table 2 for the calculation data.

Table 2. Calculation boundary conditions of photovoltaic power stations by province and resource area
(unit: hour, yuan/kWh, yuan/kW)

| Province       | region                                                                 | resource area | desulfurization coal benchmark price | hours | initial investment |
|----------------|------------------------------------------------------------------------|---------------|-------------------------------------|-------|-------------------|
| Qinghai        | Haixi                                                                  | I             | 0.3247                              | 1464  | 3500              |
| Sichuan        | Whole province                                                         | II            | 0.4012                              | 1441  | 4000              |
| Gansu          | Jiayuguan, Wuwei, Zhangyejiuquan, Dunhuang, Jinchang                    | I             | 0.2978                              | 1336  | 3600              |
| Mengxi         | Other areas                                                            | I             | 0.2829                              | 1525  | 3500              |
| Liaoning       | Whole province                                                         | II            | 0.3749                              | 1207  | 3600              |
| Heilongjiang   | Whole province                                                         | II            | 0.3740                              | 1311  | 3600              |
| Jilin          | Whole province                                                         | II            | 0.3731                              | 1283  | 3600              |
| Hebei          | Chengde,Zhangjiakou,Tangshan,Qinhuangdao                                | II            | 0.3720                              | 1363  | 3500              |
| Tianjin        | Whole city                                                             | II            | 0.3655                              | 1136  | 3800              |
| Beijing        | Whole city                                                             | II            | 0.3598                              | 1139  | 3800              |
| Ningxia        | Whole province                                                         | I             | 0.2595                              | 1376  | 3500              |
| Shanxi         | Yulin,Yanan                                                            | II            | 0.3545                              | 1274  | 4000              |
| Guangdong      | Whole province                                                         | III           | 0.4530                              | 1097  | 4000              |
| Hunan          | Whole province                                                         | III           | 0.4500                              | 930   | 3800              |
| Xinjiang       | Hami,Tacheng, Altay,Karamay                                            | I             | 0.2500                              | 1401  | 3600              |
| Yunnan         | Whole province                                                         | II            | 0.3538                              | 1224  | 4000              |
| Shanxi         | Datong,Shuozhou, Xinzhou, Yangquan                                     | II            | 0.3320                              | 1265  | 3800              |
| Hainan         | Whole province                                                         | III           | 0.4298                              | 1001  | 4000              |
| Qinghai        | Other                                                                  | II            | 0.3247                              | 1336  | 3500              |
| Guangxi        | Whole province                                                         | III           | 0.4207                              | 992   | 4000              |
| Hubei          | Whole province                                                         | III           | 0.4151                              | 1031  | 4000              |
| Shanghai       | Whole city                                                             | III           | 0.4155                              | 946   | 3800              |
| Zhejiang       | Whole province                                                         | III           | 0.4153                              | 1045  | 3500              |
| Jiangxi        | Whole province                                                         | III           | 0.4143                              | 1031  | 3600              |
The calculation results show that in Qinghai, Inner Mongolia, Hebei, Liaoning, Jilin, Heilongjiang, Shandong and other regions in the "Three North" region, the internal rate of return of new photovoltaic power station projects in 2020 is 8.1% ~ 10.4%, which can achieve parity online. The internal rate of return of new projects in other regions is 2.9% ~ 7.6%, which does not have the economy of parity access to the Internet.

3. Conclusion

The cheap Internet leads the development of new energy into a new era. The main conclusions of this paper are as follows:

(1) The economic analysis model based on internal rate of return shows that the eastern and central regions of distributed photovoltaic are more economical than other regions.

(2) In the era of affordable Internet access, new energy will show a development trend characterized by large-scale development and economic and efficient utilization.

(3) China's new energy consumption will continue to maintain a good momentum, but we need to pay attention to the rebound of local consumption caused by possible layout adjustment.

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