Study on the Scale of New Energy Development during the 14th Five-Year Plan Period

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Abstract. A major issue in the successful realization of energy transformation in the 14th Five-Year Plan period is to solve the problem of optimizing the allocation and coordinated development of new energy and flexibly adjusting resources. During the 14th Five-Year Plan period, if the current new energy installation distribution ratio of the eastern and western regions is still maintained, it will be very difficult to control the overall curtailment rate of the new energy in the State Grid Management area below 5%. Another development option is to further tilt the installation of new energy towards the central and eastern regions, make full use of the local accommodation space in the central and Eastern regions. It is easier to achieve the total curtailment rate of new energy within 5%, and at the same time, the total installed capacities of new energy in the whole country can be further increased. It is also suggested that during the 14th Five-Year Plan period, the curtailment rate restriction should be relaxed to 8% moderately, which not only has better overall system economy, but is conducive to supporting a larger scale of new energy development and increase the proportion of new energy generation in total power generation.

1. Introduction
In recent years, China's new energy (here only refers to wind power and photovoltaic power) has developed rapidly. In order to achieve the control target of the national average new energy curtailment rate of 5%, the whole society has made tremendous efforts and achieved remarkable results. With the acceleration of the era of "fair access" of new energy, the growth momentum of new energy is still strong in the 14th Five-Year Plan period [1]. A major issue in the successful realization of energy transformation is to solve the problem of optimizing the allocation and coordinated development of new energy and flexibly adjusting resources [2]. Rational regulation and control of the scale, spatial distribution and accommodation level of new energy development are related to the overall situation of high-quality energy development.

2. Analysis method
On the premise of satisfying a series of constraints such as non-fossil energy accommodation proportion target, power balance and peak shaving balance, and aiming at the lowest total cost of power supply in the whole society, size and distribution of new energy, flexible adjustments resources and power flow are optimized at the same time [3]. New energy accommodation indicators are designed as constraints or optimization variables according to scenarios.

Main boundary conditions: Since the 14th Five-Year Plan has not yet been decided, the main boundary conditions adopted in this study are preliminary prospects. During the 14th Five-Year Plan period, the average annual growth rate of electricity consumption of the whole society in the
dispatching area of the State Grid Corporation is about 4.5%. By 2025, the installed capacity of coal, hydropower, nuclear power and biomass in the dispatching area of the State Grid Corporation are 990 GW, 260 GW, 56 GW and 20 GW, respectively. The utilization rate of the existing and new constructed UHV channels are considered to be the designed utilization hours.

The following factors are also taken into account when setting up different scenarios [4]. First, the arrangement of power supply development and power flow should take full account of investment and operation cost. Second, the new energy should be utilized efficiently. An appropriate relaxation of the curtailment rate control target lead to a higher level of green development. On this basis, the curtailment rate should not be set too low. Third, the operation safety of power grid is increased. Under different new energy distribution and curtailment rate, the power flow scale in UHV channels can be reduced, which can appropriately reduce the operation risk of large power grid.

3. Development under the target of 5% average new energy power curtailment rate

For the new energy development scale in the 14th Five-Year Plan period, the following two scenarios are considered.

3.1. Scenario 1: the distribution proportion of new energy in the eastern and western regions continue the previous proportions of the 13th Five-Year Plan period

From 2020 to 2025, about 220 GW of new energy will be installed in the dispatching area of the State Grid Corporation, in which 100 GW will be added in the western and northern regions. The accumulated installed capacity of new energy becomes 630 GW in the dispatching area of the State Grid Corporation by the year 2025.

In order to achieve the curtailment rate target of less than 5%, the western and northern regions should add approximately 37 GW UHV channels for power transmission to central and eastern region, 120 GW flexibly adjusting resources, 3.4 GW pumped storage and 5 GW peak shaving gas power plants. The total power supply cost is more than 200 billion yuan. This development mode is not only non-economic, but also will bring more pressure to the stable operation of power grid [5].

3.2. Scenario 2: The distribution of new energy further inclines to the central and eastern regions

During the 14th Five-Year Plan period, the new installed new energy power capacity in the western and northern regions should not exceed 82 GW, accounting for less than 36% of the capacity in the whole dispatching area of the State Grid Corporation, which is about 10 percentage points lower than that during the 13th Five-Year Plan period. The overinvestment impulse should be controlled, despite of the low cost of investment and good resource conditions in the western and northern regions.

The central and eastern regions should make full use of the local accommodation space, to develop offshore wind power, decentralized wind power and distributed photovoltaics. The new installed capacity of new energy power should no less than 65 GW in east China, 43 GW in central China and 31 GW in north China (except Shanxi Province and Zhangjiakou and Chengde in Hebei Province). The overall new installed capacity in the above areas accounting for 61% of the total new installed capacity in the dispatching area of State Grid Corporation.

Compared with Scenario 1, about 5 GW flexibly adjusting resources and 8 GW UHV channels can be reduced and another 10 GW new energy capacity can be installation in the dispatching area of State Grid Corporation. The total power supply cost of can be reduced by 45 billion yuan.
4. Adjust the control target of average new energy power curtailment rate to 8%

Peak power of new energy has the characteristics of low probability and short duration. Additional costs will be incurred in order to reduce the overall economy of the system. If this part of “peak power” is reduced actively, regarded as reasonable curtailment, large investments of flexibly adjusting resources can be saved, and more new energy capacity can be installed. Adjust the control target of average new energy power curtailment rate to 8%, can support the development of new energy on a larger scale and has better overall economy of the system, compared with the target of 5% curtailment rate [6].

The new energy installed capacities in the dispatching area of State Grid can be increased by 34 GW, including 28 GW in the western and northern part, 6 GW in the central and eastern parts. The new energy generation in the dispatching area of State Grid can be increased by 28 billion kWh. The proportion of new energy install capacities increased from 28.9% to 30.1%, and the proportion of new energy generation increased from 13.2% to 13.6%. At the same time, 13 GW of flexible adjustment resource demand can be removed, reducing the total cost of power supply by 37.5 billion yuan in the dispatching area of State Grid.

Based on the above analysis, considering the potential of resources, technological progress, accommodation level and other factors, in the 14th Five-Year Plan period, it is estimated that the new install capacities of new energy in China is about 270-310 GW (including South China Grid and Inner Mongolia Grid), and the accumulated install capacities of new energy will reach 750-790 GW, which is 27.2-28.2% of total power install capacity.
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Figure 2. New installed capacity of new energy in 2025 under the overall curtailment rate of 8% in the dispatching area of State Grid Corporation

5. Relevant Recommendations
On the one hand, it is suggested that the distribution of new energy in the 14th Five-Year Plan should be further inclined to the central and eastern regions, and that the affordable access projects in the northern part of the western region should also be included in the planning scope (with high priority), so as to restrict the addition of new install capacities in the northern part of the western region.

On the other hand, it is suggested that the requirement of accommodation index should be relaxed properly in the formulation of the 14th Five-Year Plan, so as to improve the overall economy of the system, improve the growth potential of new energy installation and the level of green development.

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