A Critical-analysis on the Development of Micro Grid in China

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Abstract. With the combination of Internet, information technology and energy, micro grid plays an important role in the adjustment of energy structure with its abundant resources and friendly environmental benefits. This paper introduces the status of micro grid and renewable Energy of the status quo, In the second part, the development status of the micro-grid is introduced in the second part. In the third part, the future development trend of micro-grid is given. The conclusion of this paper and the suggestion of micro-grid development are given.

1. Introduction
Coal is China’s primary energy structure, it is difficult to support the development of a blueprint for sustainable environmental, and urgent to improve the proportion of renewable energy in the energy consumption structure. With the reduction of conventional energy and coal resources, Micro grid will develop rapidly. Micro grid system is composed of water and electricity, photovoltaic, wind power, energy storage and other energy sources, the continuity of energy supply is more stable than that of simple photovoltaic power generation and simple wind power generation. First, the environmental pollution of fossil energy is becoming increasingly serious. Secondly, the development of renewable energy and grid connection technology; finally, the residents enhance awareness of environmental protection. Therefore, the China government pays more attention to micro grid [1-3].

In the paper [4] proposed a micro-grid operation of intelligent energy management system. In the paper [5] studied the economic operation of micro-grid with storage battery and sodium sulfur battery as energy storage equipment. In the paper [6] established a micro-grid economic model including emission costs, and analyzes the economy of micro-grid from two aspects of cost and benefit. In the paper [7], the multi-objective optimal operation of micro-grid in grid connected and islanding mode was analyzed. In the paper [8], the influence of various constraints on micro-grid economic dispatch was analyzed.

2. Development Status of Micro-grid
Micro-grid consists of gas engines, wind power and energy storage station. Big data, cloud computing, and energy unified scheduling management. In China, the demonstration project of micro grid has been carried out, the table 1 is classification and application of Micro-grid.
Table 1. Classification and Application of Micro-grid

| Types                      | Civilian micro-grid                  | Industrial and commercial micro-grid | Island micro-grid |
|----------------------------|--------------------------------------|--------------------------------------|-------------------|
| Application area           | Residential apartments               | Shopping mall, hotel, office building | Remote area and Island |
| Superiority                | Increase real estate value; reducing greenhouse gas emissions | Conducting to the safe and stable operation of the power grid | To compensate for the lack of large power grids |

Europe began to carry out micro grid’s research in 1998, which paid more attention to the construction of demonstration projects, and the Europe micro-grid project development path is clear, it focuses on solving the problem of distributed power generation [9].

Figure 1. European micro-grid structure diagram

The American Institute first proposed the concept of micro-grid, which provided power quality and reliability. Micro-grid composed of A, B and C three feeders and one bus. Micro-grid through the programmable computer controller (PCC) connected with the large power grid, by controlling the PCC state to achieve micro-grid island operation [10], micro-grid structure is shown in Figure 2.
The structure of the Japanese micro-grid allows gas turbine and other rotating power generation equipment directly connected to the micro-grid synchronous operation. Japan's micro-grid research focused on load tracking capability, power quality monitoring, power supply and demand balance, economic scheduling and island stability and other aspects of operation. Micro-grid using master-slave control structure, through the top of the energy management system unified network of distributed power management and scheduling to ensure that the power grid transient power balance, inhibit the impact of the main network, the architecture of the micro-grid in Japan is shown in figure 3.

China’s micro-grid learned from foreign countries’ experience, it focus on solving the problem of
distributed power generation. From 2010 to 2015 micro-grid demonstration projects have been completed and came into operation, these micro-grid demonstration projects have been gradually solved technical problems. Figure 4 is micro-grid control system diagram.

![Micro-grid control system diagram](image)

**Figure 4.** Micro-grid’s device control system

Energy Internet is based on the concept of the Internet and energy, it connected by a new information fusion energy WAN, micro-grid can run independently, can be exchanged flexibly in both users and generator sides.

### 3. Analysis of Development Trend of Micro Grid in China

#### 3.1 Analysis of Renewable Energy Sources

The latest assessment results show that Chinese land of 70 meters of height wind energy resources technology development amounted to 25.7 billion kWh, mainly distributed in Northeast, North and Northwest China, these areas wind energy resources accounted for more than 90% of the country.

| Wind Type     | Technology development resource |
|---------------|---------------------------------|
| Onshore wind  | 2.38                            |
| Offshore wind | 0.2                             |

More than two-thirds of China, the number of hours of sunshine land area more than 2200 hours, the annual average radiation to the solar energy on China's land area is equivalent to 1.7 trillion tons of standard coal. China has 1.308 million km$^2$ desert and the installed capacity will be achieved 50 billion kW. In addition, In China urban available area is up to 20.02 billion km$^2$, also have the ability to 2 billion kW of solar power.

China biomass resources are very extensive. Biomass resources mainly include two categories, one of various types of waste biomass generated in industry; the second is the artificial cultivation of potential biomass resources.
Table 3. Capacity of different types of biomass (billion tons)

| resources category       | Resources feature | Standard coal. | Technology can be converted to standard coal |
|--------------------------|-------------------|----------------|---------------------------------------------|
| Crop straw               | 0.72              | 3.6            | 2.16                                        |
| Forestry residue         | 0.125             | 0.72           | 0.36                                        |
| Livestock                | 1.34              | 0.56           | 0.28                                        |
| Industrial organic wastes | 4.35              | 0.16           | 0.16                                        |
| Municipal organic waste  | 0.16              | 0.25           | 0.13                                        |
| Total                    | 5.29              | 3.09           |                                             |

3.2 Energy Internet

Figure 5 describes the energy internet blocking structure, the main motivation of China’s micro grid development is to maximize the acceptance of distributed power supply, energy saving, energy efficiency improvement, and so on. Which achieves two-way energy transmission on demand and dynamic balance to achieve maximum access to new energy. Can effectively promote and realize the efficient use of energy, can absorb a large amount of distributed energy.

4. Conclusions

The micro-grid integrated with big data, cloud computing, and other information technology are a major breakthrough. The more use of information technology means to achieve micro-grid energy generation two-way transmission of information flow and energy flow. It can be seen, the application of the Internet promotes the generation of distributed energy grid-connected power generation.

Micro-grid power projects’ pre-investment is high, and the current micro-grid energy companies’ profitability is not strong, requiring longer funding period. This requires Micro-grid energy companies to broaden the financing channels for enterprises guarantee a smooth transition to maturity. On the one hand, to attract international financial capital, venture capital and other social capital, on the other hand to establish a large-scale energy fund and to form an effective financing mechanisms for renewable energy. To attract investment on the premise that a general increase in profitability of the industry, it requires government policies’ support.

The Government should set up micro-grid energy industry more stringent barriers to entry, for micro-grid energy generation companies siting, scale, investment and the expected results were evaluated for approval. By strictly limiting the number of micro-grid energy companies in the same area,
the government can be more targeted support scale enterprises, to provide enterprises with a relatively stable, suitable for the development of long-term development plan of the business environment.

Micro-Energy Network is an integrated energy system involving cold, heat, electricity, energy storage, is a very complex multi-target, multi-constraint, nonlinear, stochastic uncertainty mixed integer combinatorial optimization problems, but as it involves power supply hot / cold and Internet technology, the traditional single design professionals cannot by virtue of this professional engineering experience to meet the micro energy network planning and design requirements, so collaboration between the professional planning and design is very important.

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6. Reference
[1] China Energy Storage Alliance. White Paper on Energy Storage Industry 2015. Beijing: CNESA Annual Member Meeting, 2015.
[2] LU Zong-xiang, WANG Cai-xia, MIN Yong, et al. Overview on Micro-grid research. Automation of Electric Power Systems, 2007, 31(19):100-107
[3] Wang Chengshan, Li Peng. Development and challenges of distributed generation, the micro-grid and smart distribution system. Automation of Electric Power Systems, 2010, 34(2):10-14.
[4] Tran D, Khambadkone A M. Energy Management for Lifetime Extension of Energy Storage System in Micro-Grid Applications. IEEE Transactions on Smart Grid, 2013, 4(3):1289-1296.
[5] LIU Chunyang, WANG Xiuli, LIU Shimin, et al. Economic dispatch model considering battery lifetime for micro grid. Electric Power Automation Equipment, 2015, 35(10):29-36.
[6] Zheng Zeng, Rongxiang Zhao, Huan Yang, et al. A multi-functional grid-connected inverter and its application to customized power quality of Micro-grid. Power System Technology, 2012, 36(5):58-67.
[7] DAI Zhongfu, CHEN Tao, YU Wenjun. A Method of Considering the Stochastic of Wind Power in Dynamic Economic Dispatch of Microgrid. Power Generation &Air Condition, 2013, 153 (34):1-6.
[8] Pourmousavi S A, Nehrir M H, Sharma R K. Multi-Timescale Power Management for Islanded Micro grids Including Storage and Demand Response. IEEE Transactions on Smart Grid, 2015, 6(3):1185-1195.
[9] LIU Shilin, WEN Jinyu, SUN Haishun, et al. Progress on applications of energy storage technology in wind power integrated to the grid. Power System Protection and Control, 2013, 41(23):145-153.
[10] Lu Xun K, Guerrero J, et al. State-of-charge balance using adaptive droop control for distributed energy storage systems in DC microgrid applications. IEEE Transactions on Industrial Electronics, 2014, 61(6):2804-2815.