Discussion on the Smart Grid and the Impacts to the Renewable Energy Implications

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ABSTRACT
The burning of fossil fuels has brought too much burden to the environment, while renewable energy can effectively alleviate this situation. However, the process of achieving power generation in the grid is limited by certain specific conditions, such as wind power, hindered by weather conditions. Therefore, these energy sources cannot always provide a stable output. Research on the more stable use of different forms of energy to generate electricity has become a problem that needs to be solved. This article will compare and analyze the results of previous research to focus on how to replace fuel generation with renewable energy generation so that it can be better connected to the smart grid. Finally, some suggestions put forward on how to make the smart grid more widely accepted. The renewable implications of the smart grid are positive in the future.

Keywords: *Smart grid; Renewable energy; Energy storage system; Implication.*

1. INTRODUCTION

Smart grid technology that uses burning fossil fuels like electrical energy is already relatively mature, and smart grid technology that uses renewable energy like electrical energy is very likely to be implemented in the future. However, experts still believe it will cause many grid integration and power fluctuation problems. In this case, energy storage technology is crucial, and researchers turn their attention to finding effective energy storage methods to achieve maximum utilization [1]. Experts recommended storing wind energy or compressed air energy storage (CAES) through batteries. To use smart grids extensively, grid companies should consider more energy saving and consumption reduction, and treat renewable energy as a unique asset class to increase the value of smart grid investments [2]. This article will illustrate key examples and further explain the ideas.

In previous studies, scientists found that the difference between the efficiency of renewable energy and the efficiency of gasoline power generation is small, and tried to replace it. On this basis, new difficulties have been identified, and in some extreme weather, the supply of renewable energy generation is insufficient. They propose that if the energy can be stored in advance, in this case a backup source is used to generate electricity, which is a possible embodiment. New questions arise, and what kind of storage is best suited. Experts have proposed many ways, but these energy storage technologies still need time to explore. The proposed large-scale energy storage system can solve this problem very well.

2. DEFINITION

2.1. Definition of smart grid

A smart grid is a large-scale power grid that provides users with different needs, connecting power stations, transmission lines, distribution networks, and load centers [2]. With the increasing demand of people, compared with the original power grid, the smart grid embodies the trend, information flow, business flow high integration of the eye-catching characteristics. At the same time, it can provide in line with the growing demand for electricity, more reliable, more in line with the original intention of users.

2.2. Definition of renewable energy

There is a growing understanding of the consequences of the environment being destroyed by compounds burned by fossil fuels. In order to slow down the deterioration of the living environment, renewable energy has received widespread attention.

Renewable energy is a source of energy that can be obtained from natural processes that can be continuously replenished. Specifically, it can refer to non-fossil energy sources such as wind energy, solar energy, hydro energy, biomass energy, geothermal energy, etc., which is a clean energy that is harmless to the natural environment or minimally harmful. Therefore, if renewable energy sources can be used instead of fuel combustion, they can effectively alleviate the pressure of environmental degradation.

3. IMPLICATIONS FOR THE USE OF RENEWABLE ENERGY

3.1. How smart grids work

To analyze the smart grid with new energy as its mode of power generation, it is necessary to understand how the smart grid works today and the efficiency of new energy generation. For a smart grid to work normally, it needs input from fossil fuels, which are used to convert fossil-burning energy into electricity. The transmission line transmits the power to the control center and works accordingly to the user's needs. Constant combustion of fuel can lead to a range of environmental pollution that is not expected, so many experts pay their attention to new energy, which is also a renewable energy source. As a kind of power generation energy, its efficiency cannot be underestimated. Commonly used gasoline generators are generally between 85 and 95 percent efficient, while the latest wind power generation is more than 80 percent efficient. Hydropower occupied 75 percent and solar power took up between 13 and 18 percent [4]. In 2011, Hossain, et al., stated that China generated 652.05TWh per year, accounting for 22.25% of the annual power generation, and Canada's annual hydropower generation is 369.5TWh, making up 61.12% of the annual power generation. Hydropower accounts for about 60 percent of Canada's electricity generation in 2021 and is expected to continue to grow in the coming decades as part of renewables, with hydropower forecasting to account for 65 percent by 2050 [5]. Taking Canada as an example, water resources have become one of the important energy sources for power generation, and it is feasible to use hydropower to replace fossil fuel combustion. It is possible to use renewable energy generation in smart grid technology.

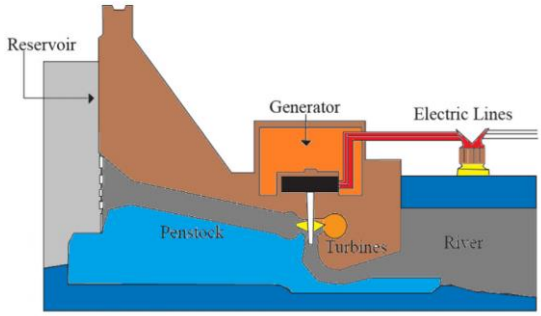

Figure 1 Hydroelectricity diagram[6]

3.2. The problem and solution of renewable energy replacement fuel

The ability to integrate renewable energy into the smart grid and make efficient use of renewable energy is a key challenge today.

Traditional Grid	Smart Grid
Mechanization	Digitization
One-way communication	Two-way real-time communication
Centralized power generation	Distributed power generation
Radial network	Dispersed network
Less data involved	Large volumes of data involved
Small number of sensors	Many sensors and monitors
Less or no automatic monitoring	Great automatic monitors
Manual control and recovery	Automatic control and recovery
Less security and privacy concerns	Prone to security and privacy issues
Human attention to system disruptions	Adaptive protection
Simultaneous production and consumption of energy/electricity	Use of storage systems
Limited control	Extensive control system
Slow response to emergencies	Fast response to emergencies
Fewer user choices	Vast user choices

Figure 2 Traditional electric grid versus the smart grid[8]

The literature on renewable energy generation indicates that not only has renewable energy generation begun to be integrated into the grid, but the share of renewable energy generation in the grid will continue to

increase [9]. The process of burning renewable energy sources is limited by some conditions, such as wind power generation is limited by weather conditions, which will cause power fluctuations, and ultimately disrupt the stability of the power grid. If the electrical energy can be stored as a backup, in the case of certain factors that undermine the stability of the power grid, the standby storage energy can be supplied in time to replenish the power, which will improve the stability of the power grid. In this case, energy storage technology is critical, and researchers focus on finding effective energy storage methods for maximum use. Ozdemir, et al also believe that energy storage is a key technical component in changing the current grid structure and operation. Venkataramani, et al pointed that energy storage technologies can be broadly divided into (i) Mechanical Energy (Pumped Hydro, Compressed Air Energy Storage), (ii) Thermal Energy Storage (Latent Heat & Sensible Energy Storage), (iii) Superconducting Magnetic Energy Storage, and (iv) Electric Chemical Energy Storage (Batteries, Fuel Cells). Experts recommend storing wind by battery or Compressed Air Energy Storage (CAES) [1].

However, the former depends on specific geographical characteristics and environmental conditions, while the latter gives more heat in the process of compression. These two ways are not ideal, so the technology is not widely used. There is no denying that CAES is still a promising technology. Venkataramani, et al describe the future application of CAES, Alias, et al published a paper named Compressed Air Storage for Power Generation, in which they discuss the integration of renewable energy systems and CAES in 2010 as a viable solution for reliable large-scale power generation. Hossain, et al conducted a CAES review and concluded that this technology could provide more stable performance at low wind speeds, even better than the Superconducting Magnetic Energy Storage system, Flywheel Energy Storage system, etc. These experts analysis of the performance of this technology makes people full of positive hope for the future of this application. In spite of this discussion in terms of time, the research results are all over the last 10 years. It belongs to the research which is both not out of date and still have some limitations or lacks by the time. Therefore, this energy storage technology still needs time to explore. However, there is no denying that these experts all have high hopes for the future of this technology. Gu, et al, the installation of a large-scale energy storage system (ESS) in the power system can significantly improve the flexibility and reliability of the power system. “Another difficulty is how to properly determine the capacity allocated to each service of ESS”[12]. And the smart grid can solve this problem very well.

3.3. Promote the smart grid of renewable energy

It is a prerequisite for the large-scale adoption of smart grids that study how to monitor, evaluate, adjust and automatically control various forms of energy through the smart grid. It is important that output the electric energy required by users and commercialize the smart grid on the basic to attract more businessmen to invest. Early in 2015, wind turbines in Denmark generated about 42 percent of the country's electricity consumption. By adopting a variety of smart grid technologies, effectively integrating wind forecasting into its grid operations, and effectively delivering electricity to users in Denmark and surrounding countries, Denmark can continue to improve its wind deployment [2]. However, this mode of power grid operation cannot fully meet the needs of the power industry. Economically, the costs of T/D facilities associated with centralized generation can no longer be increased through the economies of scale associated with increased generating capacity. In 2011, potential improvements in Thailand's smart grid will increase the possibility of renewable energy being incorporated into public utilities. Revise the tariff mechanism to accommodate and encourage the implementation of smart grid systems; Establish a competitive retail market to develop services, such as time-of-use pricing and demand response, etc [13]. RedFlow Company surveyed utility-owned smart grids and smart cities trials in Australia on March 1, 2012 solstice on May 31. They will reduce peak demand, network reliability, and peak price of energy supply in the pilot area, combined benefits between consumer, retail, and network sectors, bulk storage, and optimization of renewable energy value. In 2018, Zame, et al suggested improving the coverage and efficiency of the new energy smart grid. From the above examples, as early as 10 years ago, people had the intention to apply the new energy smart grid to the market and promote it. Nowadays power grid is still dominated by fuel power generation, indicating that the pilot area has not reached the ideal expectation. This technology still needs the support of the government and the promotion of the market.

4. CONCLUSION

This essay briefly introduces the basic ways of working on the smart grid. The implications of the smart grid are positive. Then a comparison between the advantages and disadvantages of fuel power generation and new energy generation. The results show that the new energy generation can be the main power supply operation, and the fossil fuel generation can be the auxiliary power supply operation. However, these methods will be accompanied by the emergence of new problems and new solutions, such as unstable energy storage problems and the CAES method to solve the

energy storage problem. Due to the smart grid technology with traditional energy as the power has been relatively mature, it will bring great benefits to mankind to realize the smart grid technology with renewable energy as the power. For example, businessmen can use new energy as capital to invest in the market and promote economic diversification. The limitation of this essay only explores the transmission efficiency of new energy sources in ideal circumstances. If we want to achieve smart girders in the real market, there is still a long way to go. In future studies, if large-scale energy storage technology can be applied on a large scale, it will be a huge progress.

REFERENCES

[1] Venkataramani, G., Parankusam, P., Ramalingam, V. & Wang, J. “A review on compressed air energy storage – A pathway for smart grid and polygeneration”, Renewable & sustainable energy reviews, vol. 62, 2016, pp. 895-907.

[2] Zame, K.K., Brehm, C.A., Nitica, A.T., Richard, C.L. & Schweitzer III, G.D. “Smart grid and energy storage: Policy recommendations”, Renewable & sustainable energy reviews, vol. 82, 2018, pp. 1646-1654.

[3] Hossain, M.S., Madlool, N.A., Rahim, N.A., Selvaraj, J., Pandey, A.K. & Khan, A.F. “Role of smart grid in renewable energy: An overview” Renewable & sustainable energy reviews,vol. 60, 2016, pp. 1168-1184.

[4] The World Energy Council, London, “1992 World Energy Information Survey”, 1992

[5] Arbuckle, E.J., Binsted, M., Davies, E.G.R., Chiappori, D.V., Bergero, C., Siddiqui, M., Roney, C., McJeon, H.C., Zhou, Y., Macaluso, N. & Pacific Northwest National Lab. (PNNL), Richland, WA (United States). "Insights for Canadian electricity generation planning from an integrated assessment model: Should we be more cautious about hydropower cost overruns?", Energy policy, vol. 150, 2021, pp. 112-138.

[6] John P. “Renewable Energy: Hydropower”. <http://www.dlese.org/library/catalog_ESA-000-000-000-045.htm>, ESA-000-000-000-045. Environmental Science Act. (ESA21) Acc (22.10.13).

[7] Kunal991. “Wind turbine plants or basic working of wind turbine plants using analysis of working of wind turbine plants”. 2013.

[8] Tuballa ML, Abundo ML. “A review of the development of smart grid technologies”. Renew Sustain Energy Rev 2016: 710–25.

[9] Revel, D. Smart grids and renewables– A guide for effective deployment, Veille énergie climat. 2014.

[10] Ozdemir, E., Ozdemir, S., Erhan, K. & Aktas, A. “Energy storage technologies opportunities and challenges in smart grids”, IEEE, 2016, pp. 1.

[11] Alias, K., Azhar, A., & Azhan, A.R. Compressed Air Energy Storage for Power Generation. 2010.

[12] Gu, C., Wang, J., Yang, Q. & Wang, X. “Assessing operational benefits of large-scale energy storage in power system: Comprehensive framework, quantitative analysis, and decoupling method”, International journal of energy research, vol. 45, no. 7, 2021, pp.10191-10207.

[13] "Orga Systems offers smart metering expertise to EU-funded program", Total telecom, [Online] Available at: <https://www.eco-business.com/zh-hans/press-releases/orga-systems-offers-smart-metering-expertise-to-eu-funded-program/>. 2012.

[14] Grid, O. S. Smart Grid, Smart Cities R510 Case Study - Redflow Limited. 2012.