The Vanadium Flow Battery Technology of Rongke Power

Recommendations on Dissemination

Beijing Energy Club
北京国际能源专家俱乐部

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Energy storage is the precondition of a low-carbon society and transition of energy consumption, and sees great application opportunities in the era when wind, solar and other renewables gain remarkable development and distributed microgrid and smart energy system are advocated in many countries.

Energy storage is believed to be one of the twelve disruptive technologies that will shape the economy in the future. According to the prediction made by world renowned consultant McKinsey & Co., energy storage will contribute USD1 trillion to world economy as of 2025.

Energy storage is applicable to various processes of electric system. In power generation, it can be applied to conventional generation technologies to provide intermittent power supplies such as solar and wind power with auxiliary services including frequency regulation, peak shaving and spinning reserve so as to stabilize voltage and current and improve the synchronization efficiency of clean energy. In transmission and distribution, it is a flexible regulator that de-peaks and regulates frequency. At user end, it stores renewable energy and provides uninterrupted power supply, responds to demands and lights up remote areas and islands. As an important part of distributed power supply and smart grid, the technology plays a critical role in the energy Internet.

Energy storage is of great significance to the development of clean energy. In recent years, China has experienced rapid development of clean energy and tops the world in terms of total and annual increment of wind and PV installed capacity. Consequently, it is particularly important to perfect the allocation of highly intermittent and fluctuant renewable energy in power grid, reduce wind and PV curtailment, and use renewable resources to the largest extent.

In China, grid operation defects can be solved by pumped storage and peak shaving by thermal power. However, pumped storage involves huge works such as civil engineering, wiring, transformation, and reaches users via power grid. If, in the future, the battery has sufficient capacity and is installed in large cities or nearby substation, it would greatly reduce investment in power grid and play the role of pumped storage plants. In conclusion, it is the trend to develop new energy storage technology adaptive to large scale electric projects. In the west and northwest parts of China rich in wind and solar resources but with poor power grid and small load, wind and PV curtailment can be solved by energy storage facilities technically and economically

applied to large projects. In addition, UHV transmission would be more effective and economical if regulated by the technology.

Chinese government attaches great importance to the development of energy storage. The *Recommendations of CPC Central Committee on Formulating the Thirteenth Five-year Plan for the National Economic and Social Development* promulgated in October 2015 requires that "f**ocus should be placed on the development of energy storage and smart grid,** and efforts be made to develop distributed energy and promote energy-efficient and low-carbon electric regulation". The *Guiding Opinions on the Development of "Internet + Smart Energy*, jointly issued by NDRC, Ministry of Industry and Information Technology and NEA in February requires to "**develop multiple types of energy storage products and systems featuring large capacity, low cost, high efficiency and long life span, including electric power, heat, cold and clean fuel storage; build energy storage plants with appropriate scale for centralized energy power generation bases, achieve coordinated operation of energy storage system and new energy and power grid.**" The *Thirteenth Five-year Plan for the National Economic and Social Development of the People's Republic of China* published in March sets forth that "new generation IT, biotechnology, spatial information intellisense, **energy storage and distributed energy**, high-end materials and new energy automobile should be rated as strategic new industries". The *Action Plan for National Energy Development Strategy (2014-2020)* identifies nine priority innovation areas including distributed energy, smart grid, new generation nuclear power, advanced renewable energy and **energy storage** as well as twenty priority innovation objectives including modern grid and large-capacity energy storage. **Energy storage** is one of the ten priority areas identified in *China Manufacturing 2025*. **Advanced energy storage technology**, **including synchronization of renewable energy, distributed and microgrid, and energy storage applied to battery-driven automobiles**, is one of the fifteen key tasks specified in the latest version of the *Energy Technology Innovation Action Plan (2016-2030)* promulgated by NDRC and NEA.

On April 23, 2016, Beijing Energy Club launched its Clean Energy Technology Assessment and Dissemination (TAD). Its first project was the evaluation on the Vanadium Flow Battery Technology of Dalian Rongke Power Co. Ltd. (Rongke Power). The evaluation was made by experts including Mr. Yang Zhenguo, Advisor of Grid Energy Storage Program of U.S. Department of Energy and former Chief Scientist of the Energy Storage Program of Pacific Northwest National Laboratory, Lai Xiaokang, Director of Institute of Electrotechnics and New Materials of China Electric Power Research Institute, Mr. Ying Guangwei, General Manager of Guodian Nanjing Automation Co., Ltd. and former President of Huadian Electric Power Research Institute, Mr. Zhang Qiping, Chief Engineer of State Grid Corporation of China, Li Junfeng, Director of National Center for Climate Change Strategy and International Cooperation (NCSC), and Mr. Zhai Yongping, Chief Advisor on Energy Technology of Asian Development Bank. Former Secretary-General of Ministry of Science and Technology Mr. Shi Dinghuan, Counselor of the State Council and Vice Chairman of the Honorary Board of Beijing Energy Club attended the meeting and gave comments.

Mr. Zhang Huamin, Vice President and Chief Engineer of Rongke Power presented on Rongke's independently developed VFB technology. Mr. Wang Zhiming, Vice President of State Grid Liaoning Electric Power Supply Co., Ltd., discussed the application of the technology in the local power grid. They were followed by intensive discussions among the experts.

The panel of six experts made evaluation from four perspectives: technological attractiveness, market potential, policy support and HSE (see separate report), and gave the following recommendations concerning dissemination of the technology:

I. State and Government Policies

First, the *Plan for the Development of Energy Storage Technology during the 13th Five-year Plan Period* should be formulated as soon as possible to make an overall plan for and specific requirements on the development of the technology. Formulation of the Plan should take into account the opinions and recommendations from related industries—automobile, cellphone, electricity, among others.

Second, more demonstration projects should be carried out and the *State Policy Guidance on Demonstration of Integrated Application of Power Generation, Storage and User* should be prepared to include energy storage in the overall energy system, enhance the integration effect of power generation, storage and user, improve the overall efficiency of the electricity system so as to make comparison between various energy storage batteries and tap their respective benefits and values. Moreover, demonstration and commercial operation platforms should be built for large capacity energy storage technology to explore effective business models.

Third, the *Provisional Plan for the Quota System for Renewable Energy and Green Energy Storage Technology* should be developed to set up appropriate quota systems for green energy storage technologies such as wind power + energy storage, wind and PV power + energy storage, distributed + microgrid + energy storage, large grid + energy storage. Specifically pilot and demonstration projects can be carried out in representative provinces/regions covering the grid (100MW energy storage plant), power generation side with renewable energy (e.g. wind/solar + energy storage) and users side (smart micro grid).

Fourth, pilot projects should be carried out and economic incentives given to make energy storage the alternative backup power source for diesel engine. The new energy supply model, i.e. renewable energy, multi-generation by gas-fired generation unit, geothermal pump, energy + grid power supply, should be taken into consideration in the energy supply plans for new urban areas (e.g. the co-capital of Beijing) or industrial parks. The pilot project of solar and energy storage should be carried out with island development, especially for the South China Sea project.

Fifth, research should be made on policies in favor of the development of energy storage in China. Considering that breakthroughs are to be made in the energy storage technology and cost and the market mechanism to be shaped in a short term, it is recommended to take available foreign policies as reference. China may adopt such subsidy policies as demonstrative electricity price (subsidy per kWh), construction subsidy (subsidy per KW), priority synchronization and full-amount electricity acquisition in order to support the development of the energy storage industry.

Sixth, within the framework of the overall reform of electricity pricing mechanism, the market mechanism should be established and perfected for the energy storage industry and sustainable business models be fostered. China is a latecomer, who has started to stress energy storage in the past five years. Industrial policies and operation mechanisms were in place in North America and Japan 20 years ago. As the State has given priority to the industry, NDRC and NEA should include the development of energy storage in the reform of electric power system. It is recommended to research and set up the pricing mechanisms for energy storage power, peak-load power, frequency-regulation and supporting services so as to boost the application and development of energy storage facilities by using economic leverages. In reference of international practices and pilot projects in China, related laws and regulations should be formulated to help investors estimate their investment in energy storage facilities and minimize risks.

Seventh, public services should be provided to support the development of energy storage technology, including setting up the test standards for and processes of energy storage products and systems, and building test centers.

Eighth, the standards for construction of wind and solar farms should be amended. It is also recommended that appropriate energy storage facilities be added to the construction of wind and solar farms.

II. Related Industries

First, the *Industrial Standards for Flow Battery Technology* should be formulated to regulate the development of the industry. China leads the world and represents a strong voice in the field of flow battery technology. NEA has approved the establishment of a committee for flow battery standards of the energy sector. If China finalizes the industrial and national standards as early as possible, it will influence the formulation of international standards.

Second, China should actively participate in formulation of international standards for flow battery technology. China has top companies in this field and is playing a leading role in preparation of the General Technical Conditions and Test Methods of Flow Battery of IEC.

Third, we should actively participate in drafting the Plan for the Development of Energy Storage Technology during the 13th Five-year Plan Period, which is now led by China Energy Storage Alliance (CNESA). Considering that the development of energy storage industry depends largely on external factors, the drafters should solicit opinions from related sectors.

Fourth, considering the critical role of energy storage technology in renewable energy synchronization and smart microgrid, electric power and other related companies should be supported to pilot energy storage technology in various aspects of power grid. Supporting services should also be provided.

Fifth, input should be intensified in the development and industrialization to further upgrade product performance and cut down facility costs.

III. Rongke Power

First, Rongke should lower the system cost through outsourcing. It may tap internal potential and introduce scaled and automated product to reduce the cost. Outsourcing is another effective approach. It may outsource services and products without core competitiveness.

Second, Rongke should cooperate with qualified partners. To focus on and foster strong core competitiveness of battery and electrolyte solution facilities, Rongke should cooperate with highly professional enterprises in producing products in each process of the application system (e.g. circulation pump, inverter, energy management system), in order to create industrial cluster in favor of the development of energy storage battery.

Third, Rongke should attach importance to the quality of supporting upstream and downstream products and technologies. Its quality products or technology shall never be applied to shabby supporting systems and damage its reputation. It should stress system integration and cooperate with strong enterprises to reinforce supporting services for energy control system, effectively solve such problems as temperature difference, halt and hydrogen emission test, and improve system reliability.

Fourth, Rongke should actively involve in national application demonstration projects and formulation of national plans, national and international standards.

Fifth, Rongke should intensify expansion of domestic market. It should, based on the pilot application in Liaoning grid, carry out pilot projects in the unfrozen regions in south China; while enhancing cooperation with the two large grids, it should pilot the application of flow battery to microgrid, smart grid, alternative for diesel engine, power supply in islands, new urban energy plan, charging stations, complementary power supply in industrial parks, including innovations in financing and loan sources. It should make long-term plans for the expansion of domestic market which, despite of the huge potential, suffers the absence or defects of energy management mechanism, price mechanism and subsidy mechanism. It may consider strategic partnership with solar and wind power system integrators, large electricity groups, large new energy power generators and local governments with application potential, in order to settle down its industrial layout as early as possible.

Sixth, Rongke should enhance exploration into mature and low-risk overseas markets such as Europe, Australia and USA, or into the markets along the B&R. It may not be strong enough to independently develop the markets, and should seek help from appropriate agents for each of the markets.

Rongke Power should also build up its marketing team to support its R&D forces.

IV. End User (Power Grid Enterprises and Electricity Users)

The end users of flow battery include power grid companies, electricity users, industrial parks, microgrid users, users of distributed energy system, and users of battery application in renewable energy circle (wind, solar, etc.). Our recommendations are:

First, they should have a clear view of the general development trend of energy and electric systems. According to DNV GL's Technology Outlook 2025 issued on April 5,

digitalization is one of the most important and influential drivers for the development of world's electricity/energy systems, and HVDC, mixed grid, energy storage technology, microgrid, smart grid and demand response are the major technical vehicles of electricity development. Large-scale energy storage technology, as its reliability improves and cost reduces, will bring revolutionary effect to the electricity system. Against the background of opening-up of the electricity market, power distributors should actively develop new services including demand response, and addition of energy storage facilities will innovatively allow electricity retailers and new energy integrator to provide differentiated services.

Second, they should use energy storage technology to explore microgrid, smart grid and demand response and gain experiences.

Third, they should make full use of the customized power and capacity of flow battery to involve energy storage system design based on their practical needs.

Fourth, as the property owner, they should pay high attention to selecting the supporting facilities (circulation pump, inverter, energy management system) of energy storage battery to secure reliable and efficient system operation.

Fifth, they should actively take part in formulation of national standards and pilot projects, access to new technology and new approaches, and seize the opportunities in the developing era.