

Hybrid energy storage systems using vanadium redox flow batteries for extending application scenarios

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Vanadium redox flow batteries (VRBs) have been applied in versatile energy storage situations with various scales. Their applications, however, are still limited in some scenarios, such as low temperature, black starts. Combining VRBs with different energy storage techniques to form a hybrid energy storage system can efficiently increase the application flexibility and reliability. Lithium ion batteries, especially those with high power characteristics, can serve as a complement of VRBs that mainly provide high energy. In this presentation, we will discuss the choice of lithium ion batteries that match with VRBs. The lithium ion battery has the features of high power density and operation at temperature as low as $-40\text{ }^{\circ}\text{C}$. The lithium ion battery can launch the pumps of the VRB systems at low atmosphere temperatures. Meanwhile, operation of the lithium ion battery can heat or cool part of the electrolyte to start the VRBs, and VRBs can then retain the temperature in the range of $10\sim 40\text{ }^{\circ}\text{C}$ to guarantee high energy efficiencies. The proposed hybrid energy storage system provides an application perspective for wide temperature environments with fast response and improve operation efficiencies of VRBs.

Matching high power batteries with high energy batteries

- 1 / System of batteries with complementary strengths
- 2 / Extending working hour of each cycle
- 3 / Reduce the pump loss

Self-developed BMS for hybrid energy storage systems

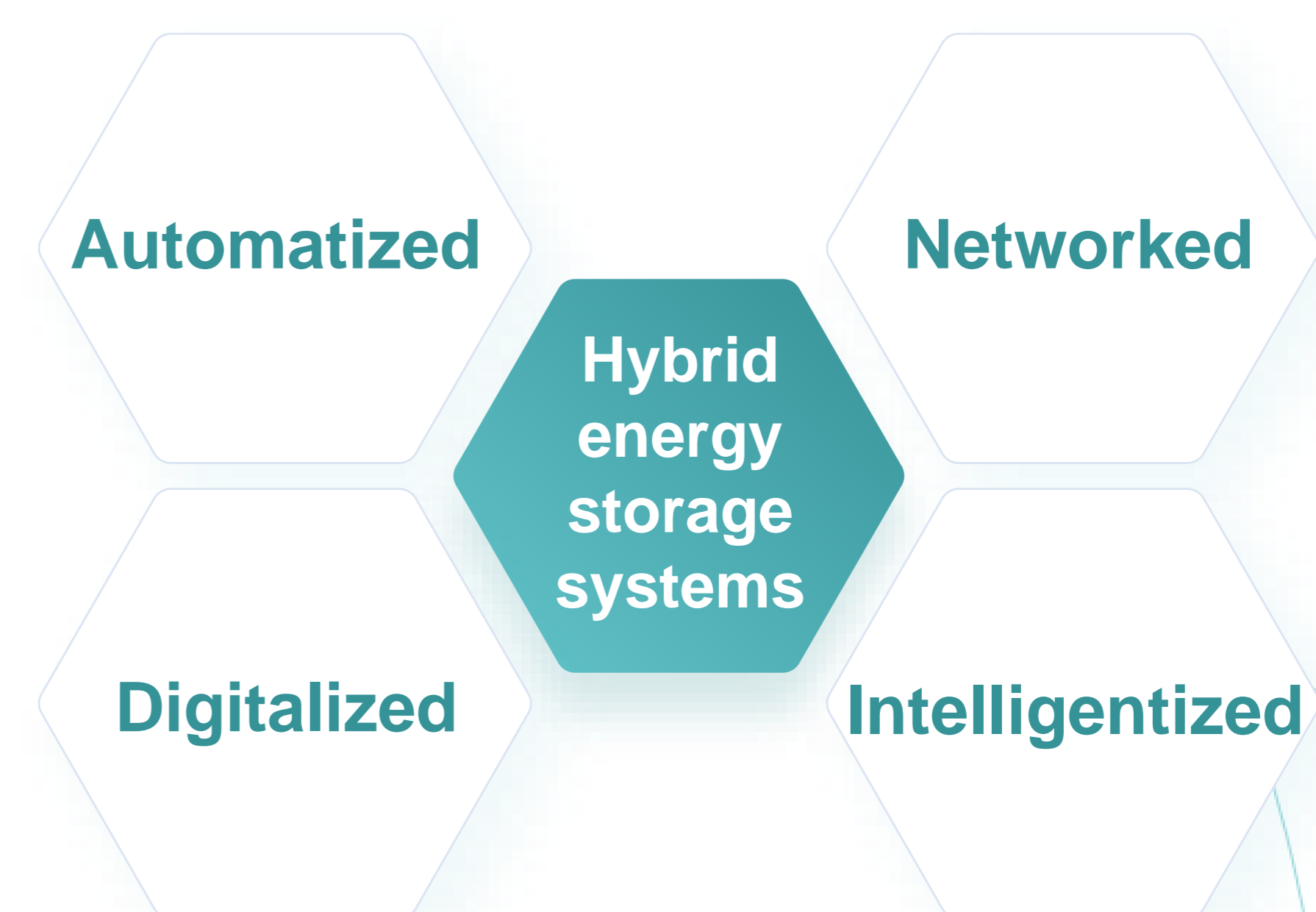
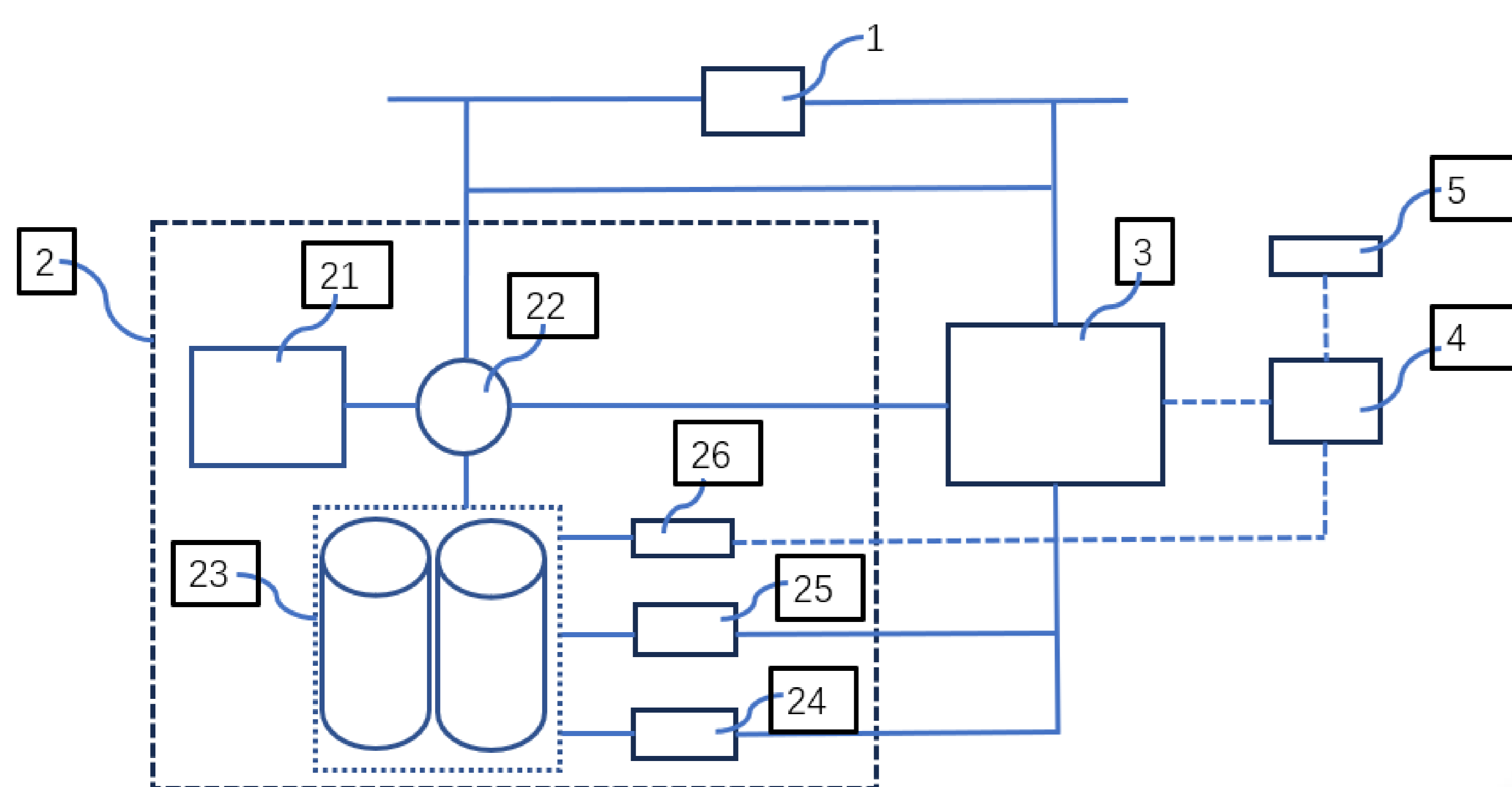
- 1 / Real-time data to optimize the dispatch of batteries
- 2 / Quickly respond of hybrid energy storage systems
- 3 / Extending application scenarios

AI assist EMS for hybrid energy storage systems

- 1 / AI-controlled system
- 2 / Real-time data to optimize the thermal management
- 3 / Optimizing the operation conditions

Hybrid energy storage systems

overall system performance and lifetime improvement



Efficiency

Lifespan

Economy

Safety

1: grid; 2: VRBs; 3: lithium ion batteries; 4: management systems; 5 and 26: temperature sensors; 21: stacks; 22: pumps; 23: tanks; 24: heating system; 25: cooling system

