Examination of Non-Lithium Battery Storage Concepts

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Abstract

This study was undertaken to inform State of Minnesota Energy Policy and is funded by the Legislative-Citizens Commission on Minnesota Resources (LCCMR). It is focused on identifying alternative energy storage opportunities for the state. Various battery storage techniques for renewable energy are under active development by various parties, and many of these technologies are geared for energy storage for 2- to 4-hour duration. Other non-battery technologies are also under active development. These do not involve electrochemical storage concepts. This report summarizes non-lithium ion battery approaches that take advantage of physical principles involving gravity, compressing air and/or carbon dioxide, using hot carbon dioxide or molten salts or flywheel systems to capture energy that can be converted into electricity when renewable energy sources are unable to provide what is required. The use of these concepts can lead to long-duration storage that can facilitate better capture of available renewable energy and potentially eliminate the need for natural gas-based peaking plants to provide a more stable electrical supply when intermittent (e.g., solar or wind) resources cannot supply the necessary electricity. Additionally, the future impact of hydrogen as a means for long-duration energy storage is considered, especially using ammonia as a storage media. It is also apparent that redox flow batteries may also be useful in supporting storage needs beyond 2- to 4-hour duration. The techniques noted do not require nickel, cobalt, or lithium resources, have improved environmental characteristics, and in most cases reduced fire hazards compared to lithium ion-based battery systems. Finally, geographic information system (GIS) analysis is applied to better understand where the technologies can be potentially adopted at specific locations in the state of Minnesota. Some technologies need very specific geologic features for ready site selection; others can be placed if suitable near-grid locations are available.