



Turbo Expo

Turbomachinery Technical Conference & Exposition

ASME IGTI *Cycle Innovations: Energy Storage* Committee Tutorial of Basics

Grid-Scale Energy Storage Systems and Technologies

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Abstract

The deep penetration of variable renewable energy sources such as photovoltaic and wind power imposes significant ramp requirements on non-flexible baseload systems. In addition, much of the baseload and peaking generation plants are fossil-based and generate significant CO₂ emissions. Grid-scale energy storage technologies are needed to cost-effectively store energy during periods of high renewable generation and discharge power when renewable sources are unavailable. At large scale or moderate storage durations greater than 3-4 hours, turbomachinery-based energy storage systems that decouple generation capacity (power) from the storage capacity (energy) have the potential for competitive economics compared to electrochemical batteries.

This tutorial provides a comprehensive overview of various energy storage systems and technologies for grid-scale applications with a focus on turbomachinery-based solutions or integration of turbomachinery with other storage technologies such as batteries. A brief background on the need and markets for energy storage is provided, but the majority of the tutorial focuses on specific technologies including pumped hydroelectric storage, compressed air energy storage, thermal energy storage including pumped thermal, flywheel energy storage, chemical energy storage including hydrogen, ammonia, or synthetic natural gas, integrated energy storage with other systems, and other novel or early-stage concepts. Topics include typical system layouts, working principles, expected performance, research gaps, current research projects, pilot or demonstration systems, and technology gaps.