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## Technology and Costs

# TECH 2019S12: Flow Batteries for Large-Scale Energy Storage

**Flow Batteries for Large-Scale Energy Storage is one in a series of reports published as part of Nexant's 2019 Technoeconomics – Energy & Chemicals (TECH) program.**

## Overview

Integration of large-scale energy storage has become a key enabler to the entire renewable power generation value/supply chain. Battery energy storage systems (BESS) are modular and allow commercial and industrial (C&I) facilities with a wider range of behind-the-meter (BTM)/non-dispatchable scenarios and potential for front-of-the meter (FTM)/dispatchable scenarios. The objective of this TECH report is to address key questions with respect to flow batteries:

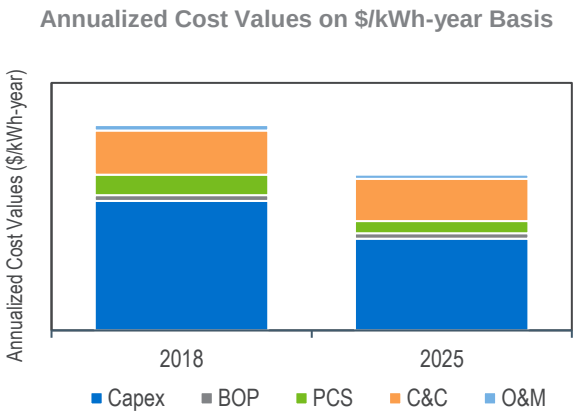
- What are the key drivers and motivating factors for BTM end-users for incorporating flow batteries in large-scale energy storage?
- What are the most likely market trends, scenarios, and opportunities for BESS in next 5-10 years in United States and globally?
- What are the strengths, weaknesses, opportunities, and threats (SWOT) for flow batteries?
- What are the current costs and projected techno-economics of flow batteries in terms of levelized cost of storage (LCOS) and total installed cost?

## Commercial Technologies

Flow batteries have much to offer both by exploiting utility time of use (TOU) rates and/or with BTM self-generation from solar photovoltaics (PV) and/or wind energy. Flow batteries can be competitive with Li-ion types and present little or no risk of fire or explosion, but toxicity hazards vary among the types as a function of electrolyte chemistry. Flow battery based BESS provide "re-chargeability" along with much deeper cycling achieved by two chemical components dissolved in liquids contained within the flow battery and most commonly separated by a membrane. Different categories of flow batteries include redox, hybrid, and membrane-less.

## Process Economics

With performance improvements and cost declines, flow battery energy storage is a technology to be reckoned while overall performance is expected to continue to improve, and costs are expected to continue to fall. Cost metrics for flow batteries are typically described in two standardized ways, namely, cost per kW and cost per kWh based on two types of electrical power architectures (e.g. DC coupled or AC coupled). The cost per kWh is typically described in LCOS or total installed cost.




## Commercial Overview

Growth in BESS will likely not occur uniformly throughout various countries globally and in United States since growth will vary based on legislative policy and regulatory framework support, local system characteristics, and end-consumer demand. Important challenges remain developing sustainable business and financing models, warranties, integrating flow batteries in large-scale energy storage, and other related market factors. Flow batteries, especially redox, are competitive and offer a viable option today in terms of cost, performance, calendar and cycle life, and technology maturity. Based on the findings, results, and case studies in this TECH Report, ***the future outlook for flow batteries for large-scale energy storage is good.***

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