350 kWh energy storage cost

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The battery storage technologies do not calculate LCOE or LCOS, so do not use financial assumptions. Therefore all parameters are the same for the R& D and Markets & Policies Financials cases.

The 2023 ATB represents cost and performance for battery storage across a range of durations (2-10 hours). It represents lithium-ion batteries (LIBs) - primarily those with nickel manganese cobalt (NMC) and lithium iron phosphate (LFP) chemistries - only at this time, with LFP becoming the primary chemistry for stationary storage starting in 2021. There are a variety of other commercial and emerging energy storage technologies; as costs are characterized to the same degree as LIBs, they will be added to future editions of the ATB.

Battery cost and performance projections in the 2023 ATB are based on a literature review of 14 sources published in 2021 or 2022, as described by Cole and Karmakar(Cole and Karmakar, 2023). Three projections for 2022 to 2050 are developed for scenario modeling based on this literature.

For a 60MW 4-hour battery, the technology-innovation scenarios for utility-scale BESS described above result in CAPEX reductions of 18% (Conservative Scenario), 37% (Moderate Scenario), and 52% (Advanced Scenario) between 2022 and 2035. The average annual reduction rates are 1.4% (Conservative Scenario), 2.9% (Moderate Scenario), and 4.0% (Advanced Scenario).

Between 2035 and 2050, the CAPEX reductions are 4% (0.3% per year average) for the Conservative Scenario, 22% (1.5% per year average) for the Moderate Scenario, and 31% (2.1% per year average) for the Advanced Scenario.

Projected Utility-Scale BESS Costs: Future cost projections for utility-scale BESS are based on a synthesis of cost projections for 4-hour duration systems as described by(Cole and Karmakar, 2023). The share of energy and power costs for batteries is assumed to be the same as that described in the Storage Futures Study(Augustine and Blair, 2021). The power and energy costs can be used to determine the costs for any duration of utility-scale BESS.

Definition:The bottom-up cost model documented by(Ramasamy et al., 2022)contains detailed cost components for battery-only systems costs (as well as batteries combined with PV). Though the battery pack is a significant cost portion, it is a minority of the cost of the battery system. The costs for a 4-hour utility-scale stand-alone battery are detailed in Figure 3.

Within theATB Dataspreadsheet, costs are separated into energy and power cost estimates, which allows capital costs to be calculated for durations other than 4 hours according to the following equation:

Base Year:(Cole and Karmakar, 2023)assume no variableO& M(VOM) costs. All operating costs are instead represented using fixed O& M (FOM) costs. The fixed O& M costs include battery augmentation costs, which enables the system to operate at its rated capacity throughout its 15-year lifetime. FOM costs are estimated at 2.5% of the capital costs in $/kW. Items included in O& M are shown in the table below.

The cost and performance of the battery systems are based on an assumption of approximately one cycle per day. Therefore, a 4-hour device has an expected capacity factor of 16.7% (4/24 = 0.167), and a 2-hour device has an expected capacity factor of 8.3% (2/24 = 0.083). Degradation is a function of the usage rate of the model, and systems might need to be replaced at some point during the analysis period. We use the capacity factor for a 4-hour device as the default value for ATB because 4-hour durations are anticipated to be more typical in the utility-scale market.

Round-trip efficiency is the ratio of useful energy output to useful energy input.Based on Cole et al.(Cole and Karmakar, 2023), the 2023 ATB assumes a round-trip efficiency of 85%.

Augustine, Chad, and Nate Blair. “Energy Storage Futures Study: Storage Technology Modeling Input Data Report.” Golden, CO: National Renewable Energy Laboratory, 2021. https://dx.doi /10.2172/1785959.