

# UZBEKISTAN LCOS LEVELIZED COST OF STORAGE



What is the levelized cost of Energy Storage (LCOS)? PSH and CAES are low-cost technologies for short-term energy storage. PtG technologies will be more cost efficient for long-term energy storage. LCOS for battery technologies can reach about 20  $\text{ct/kWh}$  in the future. This paper presents a detailed analysis of the levelized cost of storage (LCOS) for different electricity storage technologies.



Which storage technology has the highest LCoS? For all technologies the arithmetic average of costs is used. A comparison of the storage technologies shows the inhomogeneous distribution of cost structure: The LCOS of PSH and CAES is dominated by the CAPEX, in which the storage unit has the highest cost share. This explains the high LCOS of these technologies if used as long-term storage.



Does Lazard have a levelized cost of storage? Source: Lazard estimates. (1) Given the operational parameters for the Transmission and Distribution use case (i.e., 25 cycles per year), certain levelized metrics are not comparable between this and other use cases presented in Lazard's Levelized Cost of Storage report.



Which storage system has the lowest LCoS? The authors find that PSH have the lowest LCOS of 2.5  $\text{ct/kWh}$ , excluding cost of charged electricity. Adiabatic CAES (aCAES) can operate at 5.3  $\text{ct/kWh}$  and lead-acid batteries as well as H<sub>2</sub> have a cost of 15.9  $\text{ct/kWh}$ . For PSH, lead-acid battery and H<sub>2</sub> storage systems a split of cost is shown.



Why is storage efficiency neglected in LCoS metrics? Storage efficiency is implicitly neglected when the charging cost is not accounted for. LCOS metrics independent of the charging cost are most broadly applicable. Limited energy capacity might limit storage dispatchability. Limited dispatchability leads to distorted conclusions when using LCOS metrics.

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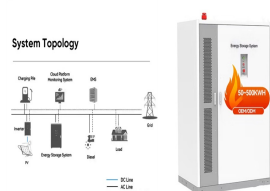
What is levelized cost of electricity (LCOE)? For conventional generation technologies, the levelized cost of electricity (LCOE) is a well-known metric. In the context of electricity storage however, such LCOE-like metrics are only limitedly applicable as the finite energy storage capacity can limit the charge and discharge scheduling decisions of the storage operator.



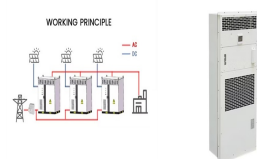
II LAZARD's LEVELIZED COST OF STORAGE ANALYSIS V6.0 3 III ENERGY STORAGE VALUE SNAPSHOT ANALYSIS 7 IV PRELIMINARY VIEWS ON LONG-DURATION STORAGE 11 APPENDIX A Supplemental LCOS Analysis Materials 14 B Value Snapshot Case Studies 1 Value Snapshot Case Studies???U.S. 16 2 Value Snapshot Case Studies???International 23



Levelized cost of storage (LCOS) is a financial metric that represents the per-unit cost of storing energy over the lifetime of an energy storage system, taking into account all associated capital, operational, and maintenance costs. This metric is crucial for comparing different energy storage technologies and understanding their economic feasibility, especially as renewable energy ???



Various levelized cost of storage (LCOS) studies addressing different research directions are available in the scientific literature [9, 13, 18]. So far, only two studies have evaluated the LCOS of second-life batteries (SLB), both from the perspective of the United States of America [14, 20]. Both studies compare LCOS of SLB with stationary



Cost are usually displayed as levelized cost of storage (LCOS). Note that there are different scales between panels. Figure 3 moves away from the concept of clearly defined applications with discrete discharge and cycle requirements to allow a more overarching view to be taken on technology competitiveness and lifetime cost variability. It

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LCOS? 1/4 ?Levelized Cost of Storage? 1/4 ?,LCOE? 1/4 ?Levelized Cost of Electricity? 1/4 ?,LCOS??? ???



The levelized cost of storage (LCOS), similar to LCOE, quantifies the storage system's costs in relation to energy or service delivered [44], [45]. Some key differences between LCOE and LCOS include the inclusion of electricity charging costs, physical constraints of the storage system during charge/discharge, and differentiation of power-related and energy ???



This article presents a Levelized Cost of Storage (LCOS) analysis for lithium batteries in different applications. A battery degradation model is incorporated into the analysis, which estimates



When the pressure drop is 15 kPa, the system achieves a power-to-power ratio (P2P), levelized cost of storage (LCOS), and exergy efficiency of 27.57%, 0.66 \$/kW???h, and 62.8%. However, this also



The aims and contributions of the presented research are as follows: 1) to present the energy storage development policies over time in China and to summarize the technical characteristics of EES in China, that is, technical maturity, energy density, power density, charge/discharge cycle, roundtrip efficiency, etc.; 2) to develop an LCOS method for evaluating ???

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Levelized cost of storage (LCOS) is a metric used to compare the cost-effectiveness of energy storage systems by calculating the per-unit cost of storing and delivering energy over the system's lifetime. It incorporates various factors including initial capital costs, operational expenses, maintenance, and expected cycle life, allowing stakeholders to assess different storage ???



LCOS: levelized cost of storage. Relative to other technologies in the analysis, electrochemical double layer capacitors, zinc, and lead-acid batteries each have low innovation implementation durations (less than 7 years) and costs (less than \$200 million). However, the average theoretical achievable LCOS of zinc and



Liquid Air Energy Storage; Levelized Cost of Storage; Economic Analysis; Waste Heat Recovery; Organic Rankine Cycle; Cogeneration. 1. Introduction In order to face the environmental challenge posed by the global warming threat due to greenhouse gas emission, the development and deployment of Renewable Energy Sources (RESs) has increased



c o n f i d e n t i a l lazar's levelized cost of storage analysis???v e r s i o n 3 . 0 i introduction and executive summary 1 ii lcos methodology, use cases and technology overview 3 iii lazar's levelized cost of storage analysis 12 iv energy storage revenue streams 19 v illustrative energy storage value snapshots 25 appendix



Levelized cost of storage (LCOS) [62]: to reflect in a simple metric all of the cost factors for energy storage technologies, levelized cost per kWh over the storage system lifetime is introduced.

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The Levelized Cost of Storage (LCOS) is predicted for different energy storage technologies from 2015 to 2050 based on trends in investment cost reductions and current performance parameters [23]



Results from a practical case study show that underwater gravity storage is a cost-efficient technology that offers payback periods of less than 10 years, mainly due to its intrinsic low capital costs estimated at around 100 ???/kWh.



Reports and studies ??? New York, Financial Advisory, LCOE, Levelized Cost of Storage, Levelized Cost of Energy. November 07, 2019. Lazard's latest annual Levelized Cost of Storage Analysis (LCOS 5.0) shows that storage costs, particularly for lithium-ion technology, have continued to decline faster than for alternate storage technologies

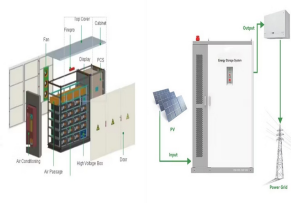


LAZARD's LEVELIZED COST OF STORAGE ANALYSIS ??? VERSION 6.0 Table of Contents I INTRODUCTION 1 II LAZARD's LEVELIZED COST OF STORAGE ANALYSIS V6.0 3 III ENERGY STORAGE VALUE SNAPSHOT ANALYSIS 7 IV PRELIMINARY VIEWS ON LONG-DURATION STORAGE 11 APPENDIX A Supplemental LCOS Analysis Materials 14 B ???



Executive Summary???Levelized Cost of Storage Version 9.0 (1) The results of our Levelized Cost of Storage ("LCOS") analysis reinforce what we observe across the Power, Energy & Infrastructure Industry???energy storage system ("ESS") applications are becoming more valuable, well understood and, by extension, widespread as grid operators

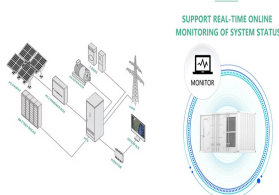
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To introduce a levelized cost of storage (LCOS), a 1-on-1 translation of the LCOE might be considered, thereby adopting its meaning in the sense that "fuel cost" becomes "charging cost" (i.e., the price at which input electrical power is "bought" by the storage facility) and "MWh generated" becomes the amount of MWh discharged and thus sold in the market. ???



costs are limited to investment cost of storage technologies only.<sup>2,3</sup> As a result, the future role of electricity storage is still perceived as highly uncertain,<sup>4</sup> despite remarkable growth in deployment for distinct technologies and applications.<sup>5,6</sup> The levelized cost of storage (LCOS) quantifies the discounted cost per unit of dis-



The levelized cost of storage (LCOS) quantifies the discounted cost per unit of discharged electricity for a specific storage technology and application. The metric accounts for all technical and economic parameters affecting the lifetime cost of discharging stored electricity and therefore represents an appropriate tool for cost



We determine the levelized cost of storage (LCOS) for 9 technologies in 12 power system applications from 2015 to 2050 based on projected investment cost reductions and current performance parameters. We find that LCOS will reduce by one-third to one-half by 2030 and 2050, respectively, across the modeled applications, with lithium ion likely to



Levelized Cost of Storage. Lazard's latest annual Levelized Cost of Storage Analysis (LCOS 7.0) shows that year-over-year changes in the cost of storage are mixed across use cases and technologies, driven in part by the confluence of emerging supply chain constraints and shifting preferences in battery chemistry. Additional highlights from



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Based on the available technology and cost parameters, LCOE and LCOS estimations are made based on LCOE Formula as given in Eq. (1). Simultaneously, the LCOS form is developed in analogy to the Levelized Cost Energy formulation where the fuel cost has been replaced by charging cost and generation electricity has been replaced by the discharged ???



II LAZARD'S LEVELIZED COST OF STORAGE ANALYSIS V5.0 2 III ENERGY STORAGE VALUE SNAPSHOT ANALYSIS 8 IV SUMMARY OF KEY FINDINGS 10 We have identified and evaluated the most common applications for new energy storage deployments???. Lazard's LCOS examines the cost of energy storage applications on the grid and behind-the-meter Use ???



Early analyses by Lazard gives results in the same direction with the LCOS of pumped storage being less than 50 % of Lithium-Ion. The most part of the LCOS of pumped storage being for charging, it does not consider that pumped storage can be coupled with solar or wind power, and it does not consider pumped storage as a solution for frequency regulation for ???



Levelized Cost of Solar Plus Storage Assumptions. This table covers the remainder of the assumptions used in the LCOS equation. I will touch upon the key variables we are benchmarking in addition to CAPEX, briefly. The first is battery lifetime. We assume that 20 percent of the battery capacity is degraded after ten years and, therefore