# Energy storage costs in 2021



## Overview

Based on our bottom-up modeling, the Q1 2021 PV and energy storage cost benchmarks are: $2.65 per watt DC (WDC) (or $3.05/WAC) for residential PV systems, 1.56/WDC (or $1.79/WAC) for commercial rooftop PV systems, $1.64/WDC (or $1.88/WAC) for commercial ground-mount PV systems.

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This battery storage update includes summary data and visualizations on the capacity of large-scale battery storage systems by region and ownership type, battery storage co-located systems, applications served by battery storage, battery storage installation costs, and small-scale battery storage.

The 2020 Cost and Performance Assessment provided installed costs for six energy storage technologies: lithium-ion (Li-ion) batteries, lead-acid batteries, vanadium redox flow batteries, pumped storage hydro, compressed-air energy storage, and hydrogen energy storage. The assessment adds zinc.

DOE’s Energy Storage Grand Challenge supports detailed cost and performance analysis for a variety of energy storage technologies to accelerate their development and deployment The U.S. Department of Energy’s (DOE) Energy Storage Grand Challenge is a comprehensive program that seeks to accelerate.

Figure ES-2 shows the overall capital cost for a 4-hour battery system based on those projections, with storage costs of $143/kWh, $198/kWh, and $248/kWh in 2030 and $87/kWh, $149/kWh, and $248/kWh in 2050. Battery variable operations and maintenance costs, lifetimes, and efficiencies are also.

This report benchmarks installed costs for U.S. solar photovoltaic (PV) systems as of the first quarter of 2021 (Q1 2021). We use a bottom-up method, accounting for all system and project development costs incurred during

installation to model the costs for residential, commercial, and.

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## Energy storage costs in 2021



### Cost Projections for Utility-Scale Battery Storage: 2023 ...

To separate the total cost into energy and power components, we used the relative energy and power costs from Augustine and Blair (2021). These relative shares are projected through ...

### Energy Storage System Costs Survey 2021

Turnkey energy storage system prices in BloombergNEF's 2021 survey range from $188 per kilowatt-hour (kWh) to $529/kWh, with the benchmark price for a ...






### 2022 Grid Energy Storage Technology Cost and ...

The second edition of the Cost and Performance Assessment continues ESGC's efforts of providing a standardized approach to analyzing the cost elements of storage technologies, ...

### Storage Futures Study: Storage Technology Modeling Input ...

The Energy Storage Grand Challenge employs a use case framework to ensure storage technologies can cost-effectively meet specific needs, and it incorporates a broad range of ...





## 2022 Grid Energy Storage Technology Cost and ...

Recycling and decommissioning are included as additional costs for Li-ion, redox flow, and lead-acid technologies. The 2020 Cost and Performance ...

## Q1-2022 U.S. Solar Photovoltaic System and Energy Storage Cost ...

Q1-2022 U.S. Solar Photovoltaic System and Energy Storage Cost Benchmarks With Minimum Sustainable Price Analysis Data File





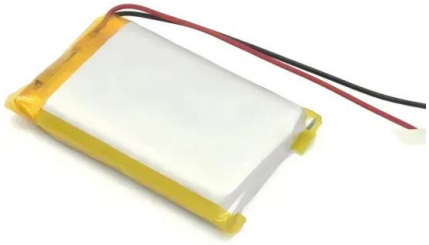

## 2022 Grid Energy Storage Technology Cost and Performance ...

Recycling and decommissioning are included as additional costs for Li-ion, redox flow, and lead-acid technologies. The 2020 Cost and Performance Assessment analyzed energy storage ...

## U.S. Solar Photovoltaic System and Energy Storage Cost ...

The National Renewable Energy Laboratory (NREL) has been modeling U.S. solar photovoltaic (PV) system costs since 2009. This year, our report benchmarks costs of U.S. PV for ...



## Cost Projections for Utility-Scale Battery Storage: 2021 Update

The projections are developed from an analysis of recent publications that consider utility-scale storage costs. The suite of publications demonstrates varied cost ...

## Solar Technology Cost Analysis , Solar Market Research

U.S. Solar Photovoltaic System and Energy Storage Cost Benchmarks, With Minimum Sustainable Price Analysis: Q1 2022, NREL Technical Report (2022) U.S. Solar ...



## NREL: US utility-scale energy storage costs grew 11-13% in Q1 ...

Energy storage costs in the US grew 13% from Q1 2021 to Q1 2022, said the National Renewable Energy Laboratory (NREL) in a cost benchmarking analysis. The research ...



## Utility-Scale Battery Storage , Electricity , 2024 , ATB , NREL

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 ...





## Residential Battery Storage , Electricity , 2024 , ATB

The National Renewable Energy Laboratory's (NREL's) Storage Futures Study examined energy storage costs broadly and the cost and performance of LIBs ...

## U.S. Solar Photovoltaic System and Energy Storage Cost Benchmarks: Q1 2021

NREL has been modeling U.S. solar photovoltaic (PV) system costs since 2009. This year, our report benchmarks costs of U.S. PV for residential, commercial, and utility-scale ...





## U.S. Solar Photovoltaic System and Energy Storage Cost ...

Executive Summary This report benchmarks installed costs for U.S. solar photovoltaic (PV) systems as of the first quarter of 2021 (Q1 2021). We use a bottom-up method, accounting for ...

## DOE ESHB Chapter 25: Energy Storage System Pricing

This chapter summarizes energy storage capital costs that were obtained from industry pricing surveys. The survey methodology breaks down the cost of an energy storage system into the ...






## NREL: US utility-scale energy storage costs grew 11 ...

Energy storage costs in the US grew 13% from Q1 2021 to Q1 2022, said the National Renewable Energy Laboratory (NREL) in a cost ...

## Utility-Scale Battery Storage , Electricity , 2023 , ATB , NREL

Current Year (2022): The 2022 cost breakdown for the 2023 ATB is based on (Ramasamy et al., 2022) and is in 2021$. Within the ATB Data spreadsheet, costs are separated into energy and ...





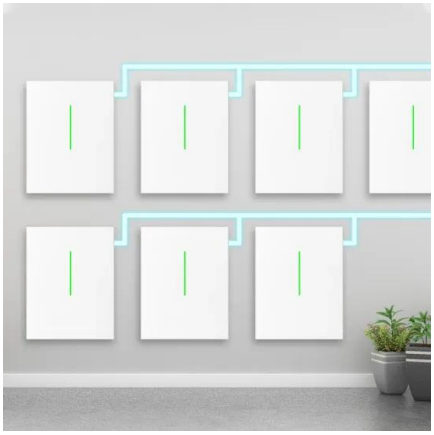

## Commercial Battery Storage , Electricity , 2021 , ATB

The 2021 ATB represents cost and performance for battery storage across a range of durations (1-8 hours). It represents lithium-ion batteries only at this ...

## Solar PV & PV+Storage Costs Keep Dropping, New ...

Standalone storage systems also saw cost declines. The 2021 PV cost benchmarks report found cost declines for PV-plus-storage and ...



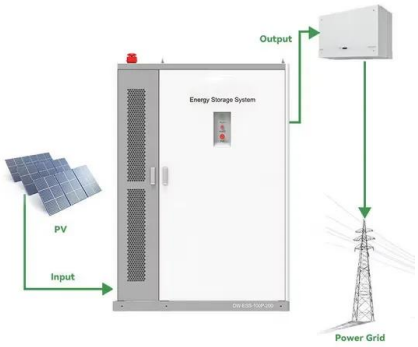


## U.S. Solar Photovoltaic System and Energy Storage Cost

U.S. Solar Photovoltaic System and Energy Storage Cost Benchmarks, With Minimum Sustainable Price Analysis: Q1 2023 Vignesh Ramasamy,1 Jarett Zuboy,1 Michael ...

## U.S. Solar Photovoltaic System and Energy Storage Cost

Our benchmarking method includes bottom-up accounting for all necessary system and projectdevelopment costs incurred when installing residential, commercial, and ...






## Storage Futures , Energy Systems Analysis , NREL

In this multiyear study, analysts leveraged NREL energy storage projects, data, and tools to explore the role and impact of relevant and ...

## Battery Storage in the United States: An Update on Market ...

Energy storage plays a pivotal role in enabling power grids to function with more flexibility and resilience. In this report, we provide data on trends in battery storage capacity ...



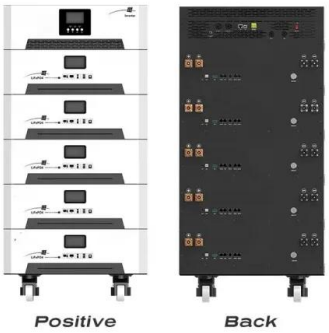
## Energy Storage Cost and Performance Database

Additional storage technologies will be added as representative cost and performance metrics are verified. The interactive figure below presents results ...



## Energy Storage Reports and Data

Pacific Northwest National Laboratory's 2020 Grid Energy Storage Technologies Cost and Performance Assessment U.S. Department of Energy's Energy Storage Market Report 2020 ...







## Residential Battery Storage , Electricity , 2021 , ATB

The 2021 ATB represents cost and performance for battery storage with two representative systems: a 3 kW / 6 kWh (2 hour) system and a 5 kW / 20 kWh ...

## Cost Projections for Utility-Scale Battery Storage: 2021 ...

To separate the total cost into energy and power components, we used the bottom-up cost model from Feldman et al. (2021) to estimate current costs for battery storage with storage durations ...



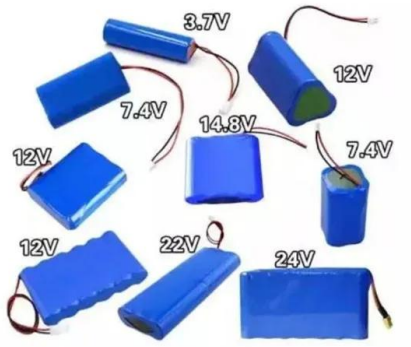


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NREL has been modeling U.S. solar photovoltaic (PV) system costs since 2009. This year, our report benchmarks costs of U.S. PV for residential, commercial, and utility ...

## Utility-Scale Battery Storage , Electricity , 2023 , ATB

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 ...






## Long Duration Storage Shot: An Introduction

The Long Duration Storage Energy Earthshot establishes a target to reduce the cost of grid-scale energy storage by 90% for systems that deliver 10+ hours of duration within the decade. ...

## Residential Battery Storage , Electricity , 2023 , ATB , NREL

Future Years: In the 2023 ATB, the FOM costs and VOM costs remain constant at the values listed above for all scenarios. Capacity Factor The cost and performance of the battery ...




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