

# **Benefit cost framework for evaluating modular energy storage**





## Overview

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What are the potential value propositions for modular energy storage?

This study uses updated cost and performance information for modular energy storage (MES) developed for this study to evaluate four prospective value propositions for MES. The four potentially attractive value propositions are defined by a combination of well-known benefits that are associated with electricity generation, delivery, and use.

Why is energy storage evaluation important?

Although ESS bring a diverse range of benefits to utilities and customers, realizing the wide-scale adoption of energy storage necessitates evaluating the costs and benefits of ESS in a comprehensive and systematic manner. Such an evaluation is especially important for emerging energy storage technologies such as BESS.

Should energy storage be a value proposition?

Given the low benefit for arbitrage (relative to storage cost), the best prospects for energy storage – especially modular, distributed storage – are value propositions involving use of the MES as “capacity resources” that offset the need for other capital equipment.

Can Utility-scale battery energy storage systems improve system flexibility?

Utility-scale or grid-scale battery energy storage systems (ESSs) are emerging as one of the potential solutions to increase system flexibility.

What are electric storage resources (ESR)?

The Federal Energy Regulatory Commission (FERC) has given a definition of electric storage resources (ESR) to cover all ESS capable of extracting electric energy from the grid and storing the energy for later release back to the grid, regardless of the storage technology.



How are uncertain benefit and cost streams evaluated?

The uncertain benefit and cost streams are evaluated through a Monte Carlo simulation and then arranged through a discounted cash flow to provide a net present social value of the investment.



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### Benefit/cost framework for evaluating modular energy storage : a ...



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### Design and Evaluation Framework for Modular Hybrid Battery Energy

hybrid modular multi-level energy storage topology, which is summarized in Figure 3 and briefly explained here for the sake of completeness. The HBESS algorithm is composed



### Benefit/cost framework for evaluating modular energy storage : a ...

Figure 13. T& D Deferral, Arbitrage and Capacity Credit: 10-year Present Worth of Benefits and Costs for Various Storage Technology Types. - "Benefit/cost framework for evaluating modular ...

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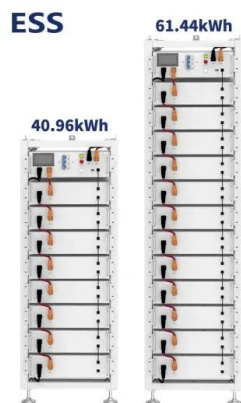
### Innovative applications of energy storage in a restructured ...

Benefit/cost framework for evaluating modular energy storage : a study for the DOE energy storage systems program. Technical Report · Fri Feb 01 00:00:00 EST 2008 · OSTI ID: 920761



### Electrical energy storage for the grid: applications and benefits

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### Modular Energy Storage Benefit and Cost for Three Emerging ...

4/8/2010 2 o Goal: high level evaluation of modular ESS benefit and cost using consistent baseso Objectives 1. update ESS cost data 2. establish framework for "generic" financials 3. concrete examples of B/C estimates for three emerging ESS value propositions



### Electrical energy storage for the grid: applications and benefits

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### A social cost benefit analysis of grid-scale electrical energy ...

The social cost benefit analysis framework is an effective tool for evaluating the publicly sponsored investment in Smarter Network Storage. A full social cost benefit analysis ...

### A stochastic cost-benefit analysis framework for allocating energy

To address the above challenges, this paper proposes a stochastic cost-benefit analysis (CBA) framework, named CBA-LL, for allocating centralized energy ...



### Benefit/Cost Framework for Evaluating Modular Energy Storage

Benefit/Cost Framework for Evaluating Modular Energy Storage A Study for the DOE Energy Storage Systems Program Susan M. Schoenung Longitude 122 West, Inc. 1010 Doyle Street, Suite 10 Menlo Park, CA 94025 Jim Eyer Distributed Utility Associates



### Economic Analysis of Bulk Hydrogen Storage for Renewable ...

o Made benefit/cost estimates based on the present value of costs and benefits, where benefit values are recently for Evaluating Modular Energy Storage. SAND2008-0978. 2008. 3. Steward, D. et al, Lifecycle cost analysis of hydrogen versus . NREL/TP-560

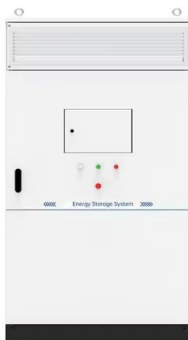


### A stochastic cost-benefit analysis framework for allocating energy

The benefits of integrating ESS in terms of distribution system upgrade cost, distribution energy loss cost, arbitrage benefit, and generation plant upgrade cost are considered. In CBA for ESS allocation, the financial objective chosen is generally maximizing net savings (NS) (also known as net present value (NPV)).

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Benefit/cost framework for evaluating modular energy storage : a study for the DOE energy storage systems program . x Close Log In Log in with Facebook Log in with Google or Email Password Remember me on this computer



### Energy storage systems cost update : a study for the DOE Energy Storage

(DOI: 10.2172/1013227) This paper reports the methodology for calculating present worth of system and operating costs for a number of energy storage technologies for representative electric utility applications. The values are an update from earlier reports, categorized by application use parameters. This work presents an update of energy storage system costs ...



### A social cost benefit analysis of grid-scale electrical energy storage

Semantic Scholar extracted view of "A social cost benefit analysis of grid-scale electrical energy storage projects: A case study" by Arjan S. Sidhu et al. DOI: 10.1016/j.APENERGY.2017.12.085 Corpus ID: 116464422 A social cost benefit analysis of ...

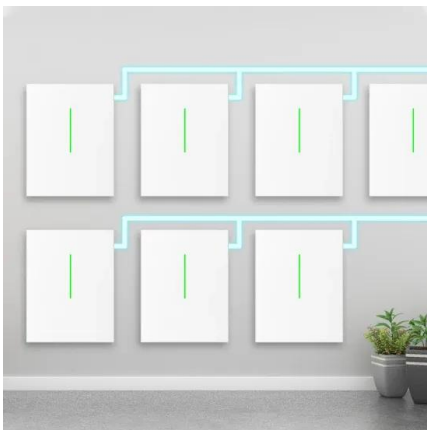


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Benefit/cost framework for evaluating modular energy storage [electronic resource] : a study for the DOE energy storage systems program Imprint Washington, D.C. : United States. Dept. of Energy. ; Oak Ridge, Tenn. : distributed by the Office of Scientific and

### Benefit/cost framework for evaluating modular energy storage : a ...

Figure 15. Peak and Critical Peak Pricing Value Proposition: Present Worth of Annual Benefits and Costs for 5-hr flooded Lead-Acid Battery. - "Benefit/cost framework for evaluating modular energy storage : a study for the DOE energy storage systems program."



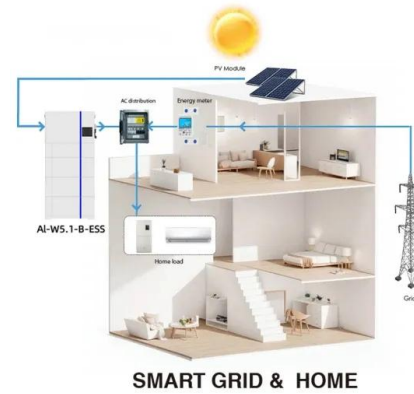
### (PDF) Battery energy storage systems for the electricity grid: UK

Benefit/cost framework for evaluating modular energy storage : a study for the DOE energy storage systems program Article Full-text available J. M. Eyer Susan M. Schoenung



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Figure 13. T& D Deferral, Arbitrage and Capacity Credit: 10-year Present Worth of Benefits and Costs for Various Storage Technology Types. - "Benefit/cost framework for evaluating modular energy storage : a study for the DOE energy storage systems program."



### Long

This report extends an earlier characterization of long-duration and short-duration energy storage technologies to include life-cycle cost analysis. Energy storage technologies were examined for three application categories--bulk energy storage, distributed generation, and power quality--with significant variations in discharge time and storage capacity. More than 20 different ...

### Projections of Levelized Cost Benefit of Grid-Scale Energy Storage ...

The levelized costs of delivered energy from the leading technologies for grid-scale energy storage are calculated using a model that considers likely number of cycles per year, application-specific expected lifetime, discount rate, duty cycle, and likely trends in the markets. The expected capital costs of the various options evaluated -- pumped hydrostorage, underground pumped ...



### Benefit/cost framework for evaluating modular energy storage

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**Benefit/cost framework for evaluating modular energy storage : a ...**

DOI: 10.2172/1028917 Corpus ID: 110864205  
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@inproceedings{Schoenung2008BenefitcostFF, title={Benefit/cost framework ...



**Uses, Cost-Benefit Analysis, and Markets of Energy Storage ...**

Energy storage systems (ESS) are increasingly deployed in both transmission and distribution grids for various benefits, especially for improving renewable energy ...



**[PDF] Economic analysis of large-scale hydrogen storage for ...**

The work reported here supports the efforts of the Market Transformation element of the DOE Fuel Cell Technology Program. The portfolio includes hydrogen technologies, as well as fuel cell technologies. The objective of this work is to model the use of bulk hydrogen storage, integrated with intermittent renewable energy production of hydrogen via electrolysis, used to ...





### Benefit/cost framework for evaluating modular energy storage : a ...

Figure 1. Annual Current and Present Worth Values for \$1 in Year 1. - "Benefit/cost framework for evaluating modular energy storage : a study for the DOE energy storage systems program." DOI: 10.2172/1028917 Corpus ID: 110864205 Benefit/cost framework for

### Benefit/Cost Framework for Evaluating Modular Energy Storage

3 SAND2008-0978 Unlimited Release Printed February 2008 Benefit/Cost Framework for Evaluating Modular Energy Storage A Study for the DOE Energy Storage Systems Program Susan M. Schoenung Longitude



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Benefit/cost framework for evaluating modular energy storage [electronic resource] : a study for the DOE energy storage systems program Imprint Washington, D.C. : United States.



### Energy Storage Benefits and Market Analysis Handbook A Study ...

This Guide describes a high level, technology-neutral framework for assessing potential benefits from and economic market potential for energy storage used for electric utility-related applications. In the United States use of electricity storage to support and optimize transmission and distribution (T& D) services has been limited due to high storage system cost ...





### Benefit/cost framework for evaluating modular energy storage : a ...

- "Benefit/cost framework for evaluating modular energy storage : a study for the DOE energy storage systems program." Figure 12. T& D Deferral, Arbitrage and Capacity Credit: Present ...

### Table 1. Parameters of Value Propositions for Energy Storage Benefit

This paper reports results of a benefit-cost evaluation of modular energy storage (MES) used by utilities to augment sub transmission and/or distribution (T& D) systems, and by utility customers to reduce utility bills and/or to reduce losses due to power problems.



### Design and Evaluation Framework for Modular Hybrid Battery Energy

In the context of the maritime transportation sector electrification, battery hybridization has been identified as a promising manner of meeting the critical requirements on energy and power density, as well as lifetime and safety. Today, multiple promising battery hybridization topologies have been identified, while there is not a level playing field enabling ...

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