Battery Storage: A Benefit-Cost Analysis Framework for States

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Clean Energy States Alliance

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Celebrating 20 Years of State Leadership

Clean Energy States Alliance

The Clean Energy States Alliance (CESA) is a national, nonprofit coalition of public agencies and organizations working together to advance clean energy.

CESA members—mostly state agencies—include many of the most innovative, successful, and influential public funders of clean energy initiatives in the country.

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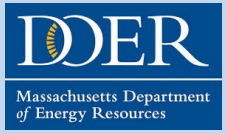

Energy Storage Technology Advancement Partnership (ESTAP)

Conducted under contract with Sandia National Laboratories, with funding from US DOE Office of Electricity.

- Facilitate public/private partnerships to support joint federal/state energy storage demonstration project deployment
- Support state energy storage efforts with technical, policy and program assistance
- Disseminate information to stakeholders through webinars, reports, case studies and conference presentations

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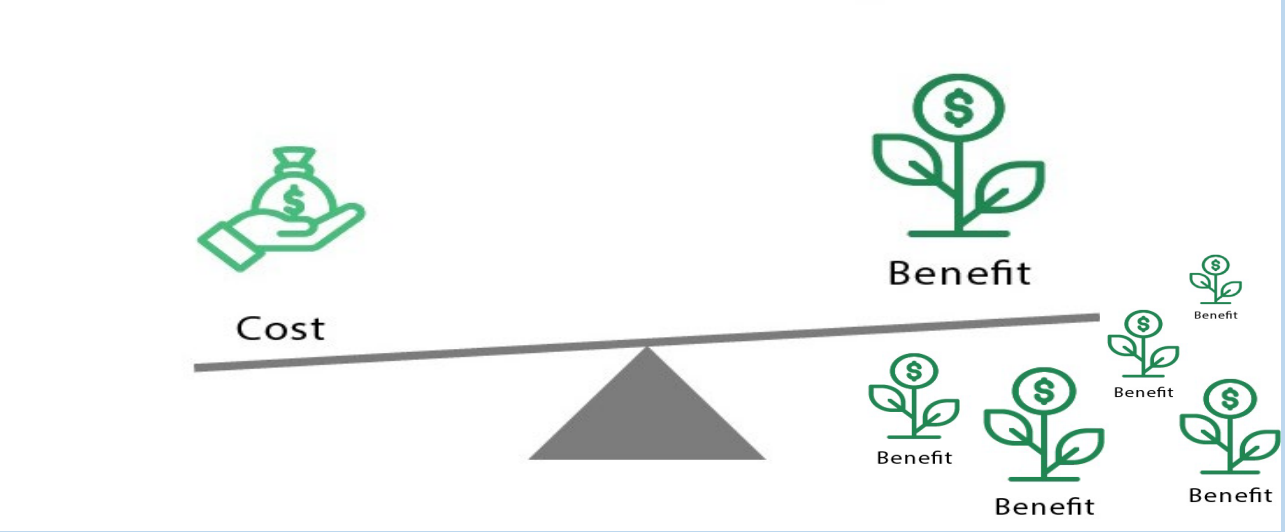
Energy storage can provide two types of benefits: Monetizable, and non-monetizable

MONETIZABLE BENEFITS	NON-MONETIZABLE BENEFITS
Reduced peak energy demand	More renewables on grid
Energy arbitrage (buy low, sell high)	Increased resilience
Capacity provision	T&D investment deferral
Ancillary services provision (example: frequency regulation)	Reduced GHG and local pollutant emissions

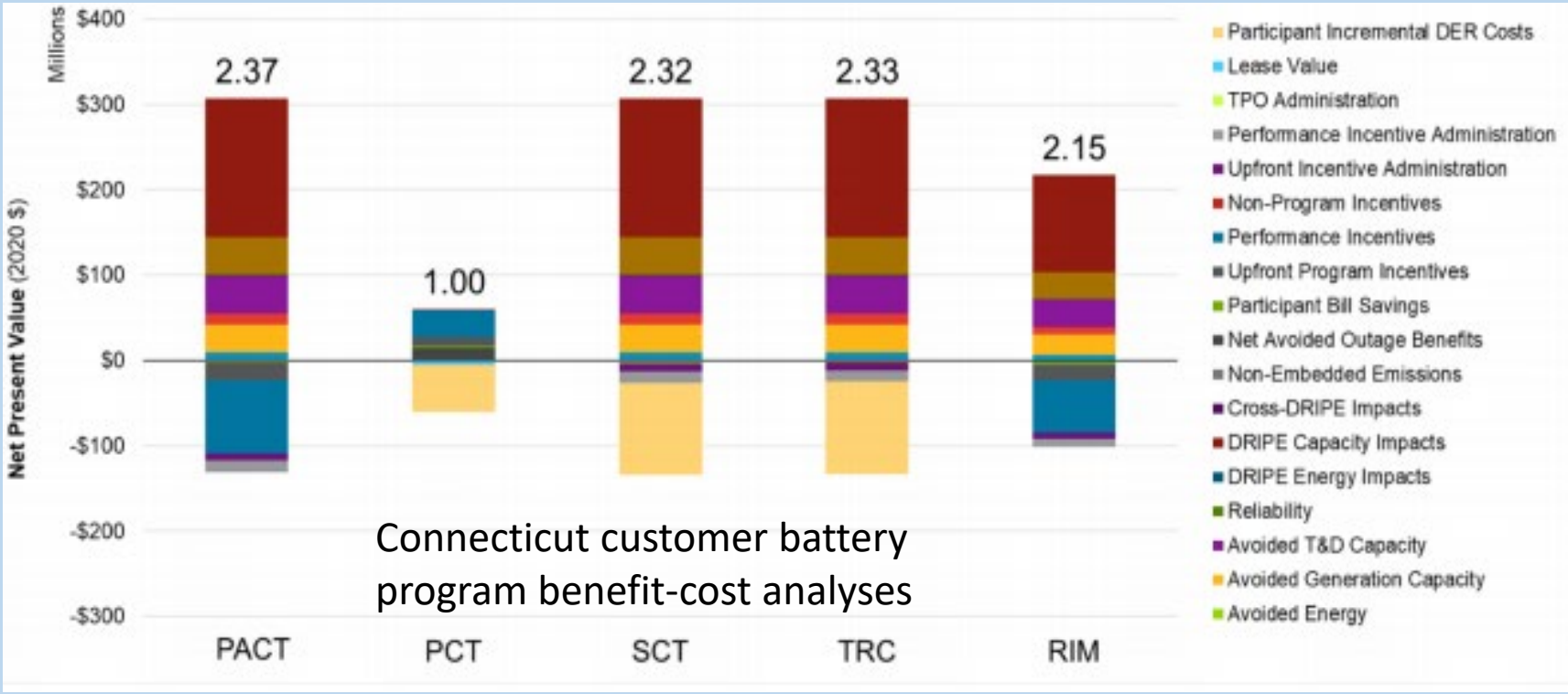
Both types of benefits have ***value***

Benefit-cost analysis of energy storage often considers all the costs, but only a fraction of the benefits (example: utility IRPs)



- **<u>Value</u> does not equal <u>price</u>.** What is valuable is not always priced or monetizable in current markets.
- Failing to assign values to the non-energy or non-monetizable benefits of storage has the same effect as assigning them a value of $0.
  Low or estimated value is better than no value at all!

Benefit-Cost Tests – Examples from Connecticut

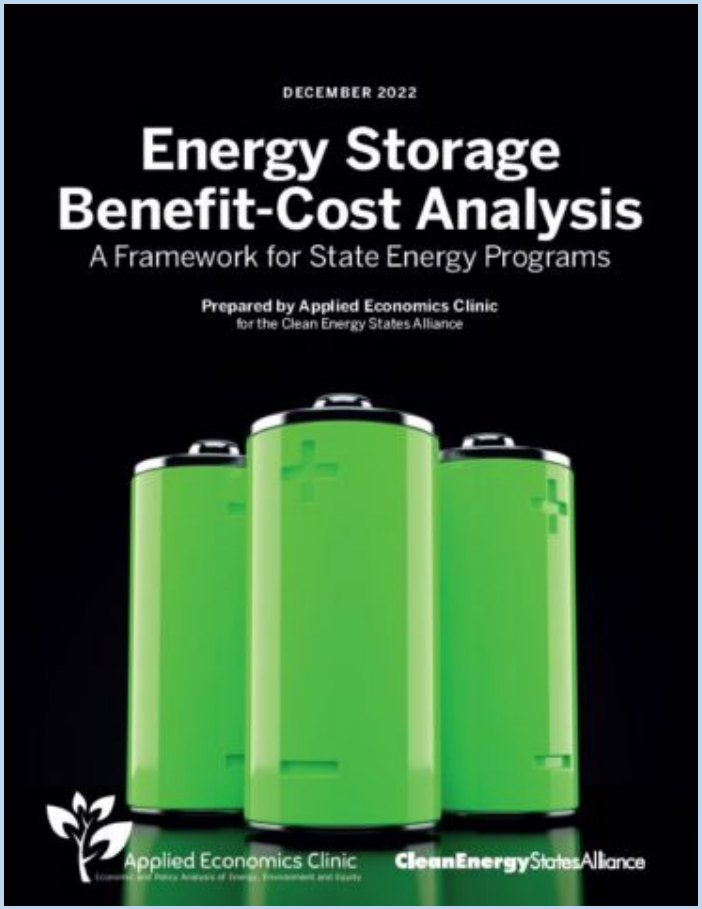


Connecticut customer battery program benefit-cost analyses

PACT = Program Administrator Cost Test **PCT** = Participant Cost Test **SCT** = Societal Cost Test
TRC = Total Resource Cost Test **RIM** = Ratepayer Impact Measure

Clean Energy Group contracted the Applied Economics Clinic to conduct research on BCAs for state distributed battery storage programs

- **Benefit-Cost Analysis (BCA) components:**
  1. **Cost-Effectiveness Tests**
  2. **Discount Rates**
  3. **Benefits**
  4. **Costs**
  5. **Sensitivity Analysis**
  6. **Stakeholder Process**
- **Recommendations for states conducting battery storage benefit-cost analysis**



Applied Economics Clinic
Economic and Policy Analysis of Energy, Environment and Equity

Method:

- AEC reviewed 29 battery storage BCAs, methodologies and related analyses from sources including utilities, utility commissions, state energy agencies, green banks, and research groups from around the country

- Each source was examined for:
  - Benefits, costs, or avoided costs
  - Values calculated
  - Methodology used including cost-effectiveness tests, discount rates, and sensitivity analysis
  - Stakeholder engagement

- Recommendations were made for:
  - Cost-Effectiveness Tests
  - Discount Rates
  - Benefits
  - Costs
  - Sensitivity Analysis
  - Stakeholder Process

Recommendations

Cost-Effectiveness Tests:

- Use the SCT as the **primary test**
- UCT and RIM may be used as **secondary tests**

Typical benefits included		Typical costs included
Societal Cost Test (SCT): Perspective of society overall		
Avoided energy Avoided generation capacity Avoided transmission and distribution capacity Reliability DRIPE energy impacts DRIPE capacity impacts	Non-embedded emissions Market revenue Avoided ancillary services Job creation benefits Net societal non-energy benefits Net participant non-energy benefits	Upfront incentive administration Performance incentive administration Participant incremental DER costs
Total Resource Cost Test (TRC): Perspective of utility system plus host customers		
Avoided energy Avoided generation capacity Avoided transmission and distribution capacity Reliability	DRIPE energy impacts DRIPE capacity impacts Market revenue Avoided ancillary services	Upfront incentive administration Performance incentive administration Participant incremental DER costs
Participant Cost Test (PCT): Perspective of host customers only		
Net participant non-energy benefits Net avoided outage benefits Participant bill savings	Upfront program incentives Performance incentives Non-program incentives	Lease value Participant incremental DER costs
Utility Cost Test (UCT): Perspective of utility system		
Avoided energy Avoided generation capacity Avoided transmission and distribution capacity	Reliability DRIPE energy impacts DRIPE capacity impacts	Program incentives Program administration costs
Program Administrator Cost Test (PACT): Perspective of program administrator (only if a distinct agency from utility)		
Avoided energy Avoided generation capacity Avoided transmission and distribution capacity Reliability	DRIPE energy impacts DRIPE capacity impacts Market revenue Avoided ancillary services	Upfront program incentives Performance incentives Upfront incentive administration Performance incentive administration
Ratepayer Impact Measure (RIM): Perspective of all utility ratepayers		
Avoided energy Avoided generation capacity Avoided transmission and distribution capacity Reliability	DRIPE energy impacts DRIPE capacity impacts Market revenue Avoided ancillary services	Participant bill savings Upfront program incentives Performance incentives Upfront incentive administration Performance incentive administration

- SCT considers the largest range of benefits
- UCT considers costs and benefits from utility perspective
- RIM tests for whether costs are shifted to other ratepayers

Discount Rates:

- Use a 0.1 to 2.5 percent **social discount rate**
- Use each utility's own WACC as a **financial discount rate**

Discount Rate	Applications	Reference
Social discount rates		
0.81%	Real discount rate for energy price levelization	NE AESC 2021
1%, 2%, 3%	NYS SCC guidelines	NYDPS 2015
1-2.5%	Intergenerational discount rate for SCT	DC CEAIWG 2021
2.5%, 3%, 5%	EPA discount rates for SCC	NYDPS 2015
3%	Residential solar PV	CT Green Bank 2020
3%	PACT, SCT, TRC	CT Green Bank 2020
3%	SCC (real discount rate)	NYSEG and RG&E 2020
3%	Real discount rate	NJBPU 2020
Financial discount rates		
6.81%	NYSEG WACC for 2018	NYSEG and RG&E 2020
7%	RIM	CT Green Bank 2020
7.18%	WACC for utility-scale solar	MN EEE 2019
7.18%	WACC for BTM solar financing	MN EEE 2019
7.48%	RG&E WACC for 2018	NYSEG and RG&E 2020
8%	After-tax nominal WACC	MA DOER 2016
9.13%	WACC for front-of-meter Li-ion battery financing	MN EEE 2019
9.13%	WACC for BTM storage financing	MN EEE 2019
10%	PCT	CT Green Bank 2020
10%	Battery energy storage system (BESS)	HI GE Energy 2017

The **discount rate** is the interest rate used to determine the present value of future costs or benefits

WACC = "weighted average cost of capital" (the cost of financing)

Social Discount Rates:

- Used to calculate social benefits and costs, such as future costs associated with present-day greenhouse gas emissions, or the social cost of carbon
- Social discount rate values typically range from 1 to 3 percent
- This values future costs and benefits as very similar in importance to current costs and benefits. Social discount rates are often used to value costs and benefits tens and sometimes even hundreds of years into the future.

Financial Discount Rates:

- Used to calculate the financial costs and benefits associated with funding a battery storage program/investment in battery storage
- A financial discount rate, typically represented by a firm's own weighted average cost of capital (WACC), reflects the rate the company must pay its investors and/or lenders, and thus the minimum rate that must be returned on its investment.

Benefits:

- Include 25 benefits for a thorough consideration of a full range of battery benefits

Benefit Category	Benefit
Consumer benefits	Lower ratepayer bills
	Lower customer energy use
	Fewer power outages and value of lost load (VOLL)
	Job creation
	Higher property values
	Enhanced value and capacity of renewables
Avoided system costs	Avoided operations and maintenance costs
	Avoided costs of environmental compliance
	Avoided capacity costs
	Avoided fuel costs
	Reduced ancillary services costs
	Avoided transmission and distribution costs
	Avoided collections and disconnections
	Reduced costs to integrate distributed renewable generation
	Wholesale market price effects
Environmental benefits	Smaller land footprint than generation facilities
	Reducing greenhouse gas emissions and air pollution
	Reduced water consumption
Grid reliability	Fewer power outages
	Avoided emergency calls
	Peak shaving and shifting
	Black start capability
	Reduced grid congestion
Difficult-to-monetize benefits	Participant non-energy benefits
	Societal non-energy benefits (including public health and EJ benefits)

Costs:

- Use up-to-date battery-specific engineering references to establish correct program costs

Program administration costs

- Includes customer incentives and rebates, permit/license acquisition, interconnection agreements

Capital and labor costs

- Includes labor, equipment, infrastructure necessary to integrate, regulate, and monitor battery resources

Program operation costs

- Includes fixed and variable maintenance, round-trip efficiency losses, warranty fees, and insurance fees

Sensitivity Analysis:

- A battery-related BCA should conduct several sensitivity analyses for 1) model calibration and 2) full model results

Model calibration: to fine-tune model results based on adjustments to input assumptions

- Fuel prices
- Capacity prices
- Power prices
- Resource adequacy event notification
- Frequency regulation
- Battery efficiency
- Renewable penetration

Full model results: to capture the uncertainty inherent to particular assumptions to arrive at a range of benefit-cost ratio values

- Social cost of carbon
- Financial discount rate

Stakeholder Process:

- Conduct an inclusive, diverse, and equitable stakeholder process from start-to-finish of a BCA assessment
- Include representatives from a wide range of stakeholders (state agencies, utilities, consumer and environmental advocates, low-income representatives, ratepayers, regulators, environmental justice communities, non-governmental organizations, government, renewable energy developers and battery companies)

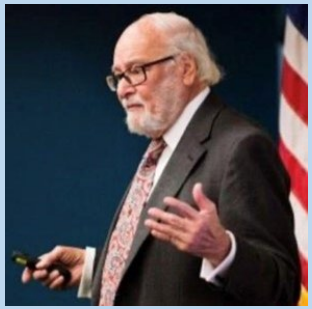
Stakeholder engagement can help to:

- Identify battery performance information/data, key market drivers, battery deployment barriers
- Develop appropriate peak load forecasts, costs and benefits, recommendations for program performance metrics and reporting
- Select appropriate discount rates
- Provide additional information and materials related to BCA analyses

Summary of recommendations

Cost-effectiveness tests	Use the SCT as a primary cost-effectiveness test and the UCT and RIM as secondary tests
Discount rates	Use a 0.1 to 2.5 percent social discount rate and each utility's own WACC as a financial discount rate
Benefits	Include all 25 benefits listed in Section VI for a thorough consideration of a full range of battery benefits
Costs	Use up-to-date battery-specific engineering references to establish correct program costs
Sensitivity analysis	Conduct several sensitivity analyses, falling in two categories. Sensitivities recommended for model calibration are analyses that can be used to fine-tune model results based on adjustments to input assumptions; and sensitivities recommended for full results presentation are analyses that capture the uncertainty inherent in particular assumptions to arrive at a range of BCR values
Stakeholder process	Conduct an inclusive, diverse, and equitable stakeholder process from start-to-finish of a BCA assessment and include representatives from state agencies, utilities, consumer and environmental advocates, low-income representatives, ratepayers, regulators, environmental justice communities, non-governmental organizations, government, renewable energy developers and battery companies

Thank You!



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Questions?

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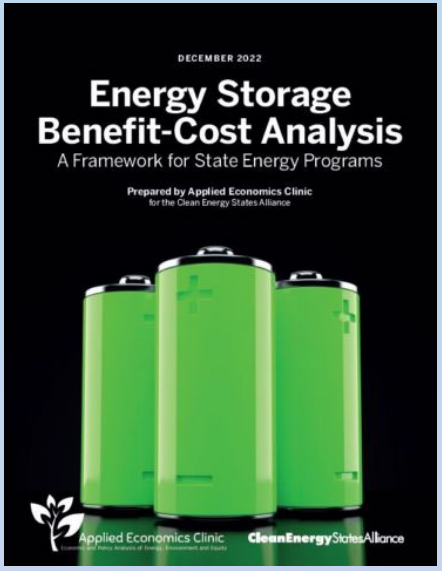

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