

Battery Storage: Benefit-Cost Analysis Framework (Preliminary Findings)

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Clean Energy States Alliance (CESA)

Clean Energy States Alliance (CESA) is a national, member-supported nonprofit for state energy organizations working together to advance the rapid expansion of clean energy technologies.



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- Applied Economics Clinic (AEC) is a mission-based non-profit consulting group that offers expert services in the areas of energy, environment, consumer protection, and equity.
- AEC's clients are primarily public interest organizations—non-profits, government agencies, and green business associations—who work on issues related to AEC's areas of expertise.
- AEC works proactively to support and promote diversity in our areas of work by providing applied, on-the-job learning experiences to graduate students.
- AEC is committed to a just workplace that is diverse, pays a living wage, and is responsive to the needs of its eight full-time and seven part-time staff.



Overview

- **Method**
- **Benefit-Cost Analysis (BCA) components:**
 1. **Cost-Effectiveness Tests**
 2. **Discount Rates**
 3. **Benefits**
 4. **Costs**
 5. **Sensitivity Analysis**
 6. **Stakeholder Process**
- **Summary of AEC BCA recommendations for battery storage**



Method



Method:

- AEC reviewed 29 battery storage BCAs, methodologies and related analyses from a variety of reputable sources, including utilities, utility commissions, state energy agencies, green banks, and research groups from around the country
- Each source was examined for the benefits, costs, or avoided costs it described, values calculated, and the methodology used to conduct the BCA—including the cost-effectiveness tests and discount rates utilized, as well as sensitivity analyses conducted and information about stakeholder engagement
- On the basis of the results of AEC’s review, we make recommendations for each of the six components of a storage BCA:
1) Cost-Effectiveness Tests; 2) Discount Rates; 3) Benefits; 4) Costs; 5) Sensitivity Analysis; and 6) Stakeholder Process



Cost-Effectiveness Tests



Cost-Effectiveness Tests:

Use the SCT as a primary cost-effectiveness test and the UCT and RIM as secondary tests

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



Discount Rates



Discount Rates:

Use a 0.1 to 2.5 percent social discount rate and 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 |



Benefits



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 |
| Environmental benefits | Wholesale market price effects |
| | Smaller land footprint than generation facilities |
| | Reducing greenhouse gas emissions and air pollution |
| Grid reliability | Reduced water consumption |
| | Fewer power outages |
| | Avoided emergency calls |
| | Peak shaving and shifting |
| | Black start capability |
| Difficult-to-monetize benefits | Reduced grid congestion |
| | Participant non-energy benefits |
| | Societal non-energy benefits (including public health and EJ benefits) |



Costs



Costs:

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

Program administration costs

- i.e. customer incentives and rebates, permit/license acquisition, interconnection agreements

Capital and labor costs

- i.e. labor, equipment, infrastructure necessary to integrate, regulate, and monitor battery resources

Program operation costs

- i.e. fixed and variable maintenance, round-trip efficiency losses, warranty fees, and insurance fees



Sensitivity Analysis



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



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

Stakeholder engagement can:

- 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 AEC 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 |

Questions?

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Upcoming report detailing best practices for energy storage cost-benefit analysis will be available from both AEC and CESA.

CESA resource library: <https://www.cesa.org/resource-library/>

