How utilities can evaluate the cost-effectiveness of DERs

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Steve has over 30 years of experience working at the confluence of energy, environment, and economics to evaluate and design workable solutions to our biggest energy challenges.
Lines will be muted.

Submit questions in the chat box.

We’re recording!

How did we do?

Tell us what you want to hear next.

→ Some ground rules
We design robust future-focused solutions in response to industry, policy, and environmental changes.

And we’ve been carbon neutral since 2007.

50 years of energy work

1K+ energy experts

Top 50 utilities in North America

200+ energy efficiency programs

All major federal agencies

All major energy NGOs

35+ years of climate science, impacts, and adaptation

100+ climate change experts

→ ICF’s energy + climate footprint
Today's presenters and agenda

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Director of Valuation, E4TheFuture

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Energy Engineer, Building Energy Analytics, ICF

• About the National Standard Practice Manual (NSPM)
• Case studies background
• Deep dive into case studies:
  • Residential managed EV charging in the Midwest
  • Commercial solar and storage-controlled dispatch in the West
  • Residential grid-interactive efficient buildings in the Mid-Atlantic
National Energy Screening Project (NESP) – stakeholder organization that works to improve cost-effectiveness screening practices for distributed energy resources (DERs).

NSPM for DERs:
- Comprehensive framework for cost-effectiveness assessment of DERs
- Set of policy-neutral, non-biased, and economically-sound principles, concepts, and methodologies to support single- and multi-DER benefit-cost analysis (BCA)
- Provides guidance on what inputs to include in BCA tests
  - The MTR Handbook provides guidance on how to determine those inputs to those BCA tests
  - *New* BCA Case Studies demonstrates application of NSPM and MTR Handbook guidance

→ NSPM for DERs and supporting resources
NSPM references and application
1. Recognize that DERs can provide energy/power system needs and should be compared with other energy resources and treated consistently for BCA.
2. Align primary test with jurisdiction’s applicable policy goals.
3. Ensure symmetry across costs and benefits.
4. Account for all relevant, material impacts (based on applicable policies), even if hard to quantify.
5. Conduct a forward-looking, long-term analysis that captures incremental impacts of DER investments.
6. Avoid double-counting through clearly defined impacts.
7. Ensure transparency in presenting the benefit-cost analysis and results.
8. Conduct BCA separate from Rate Impact Analyses because they answer different questions.

→ NSPM BCA principles
Cost-effectiveness testing perspectives
(and the Jurisdiction Specific Test or JST)

- Three perspectives define the scope of impacts to include in the most common traditional cost-effectiveness tests.

- NSPM for DERs
  - Regulatory Perspective
    - Perspective of public utility commissions, legislators, muni/coop boards, public power authorities, and other relevant decision-makers.
    - Accounts for utility system plus impacts relevant to a jurisdiction’s applicable policy goals (which may or may not include host customer impacts).
    - Can align with one of the traditional test perspectives, but not necessarily.
Importance of consistency

- Consistent BCA framework reduces risk of either over or under-investing in a resource (or combination thereof)
- Siloed approach to valuing different DERs can be complex and overwhelming for commissions, utilities, and stakeholders
- Allows for analysis of multiple-DER initiatives

Consistency still allows for unique characteristics of each DER

- A consistent BCA framework does not require all impacts to apply to all DERs
  - The framework accounts for differences in DER technologies and use cases
- Policy framework should be comprehensive, but all policies may not apply to all DERs
- It may not be possible to develop quantitative values for each DER.
  - Impacts may need to be addressed qualitatively due to data limitations

NSPM principle #1: Consistency in BCA across DERs
<table>
<thead>
<tr>
<th>Category</th>
<th>Type</th>
<th>Impact</th>
<th>EE</th>
<th>DR</th>
<th>EV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric</td>
<td>Generation</td>
<td>Energy generation</td>
<td>Benefit</td>
<td>Will depend if DR only shifts load or impacts consumption</td>
<td>Cost</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Capacity</td>
<td>Benefit</td>
<td>Benefit</td>
<td>Cost or Benefit if paired with demand flexibility, TOU rates</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RPS/CES compliance</td>
<td>Benefit</td>
<td>N/A if no change in sales</td>
<td>Cost (increased electricity sales)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Market price effects</td>
<td>Benefit</td>
<td>Benefit</td>
<td>Energy = cost Capacity = benefit if paired with demand shifting</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ancillary services</td>
<td>N/A</td>
<td>Benefit</td>
<td>Cost or benefit if V2G enabled</td>
</tr>
<tr>
<td>General</td>
<td>Risk</td>
<td>Benefit</td>
<td>Benefit</td>
<td>Cost due to increased electricity consumption</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reliability</td>
<td>Benefit</td>
<td>Benefit</td>
<td>Cost without DR/time shifting. V2G could great benefit.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Resilience</td>
<td>N/A</td>
<td>Benefit</td>
<td>N/A except for V2G mode that creates a benefit</td>
<td></td>
</tr>
<tr>
<td>Societal</td>
<td>Greenhouse gas emissions</td>
<td>Yes</td>
<td>N/A or could be cost depending on timing</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Public health (critical air pollutants)</td>
<td>Yes</td>
<td>N/A or could be cost depending on timing</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Economic development and jobs</td>
<td>Yes</td>
<td>N/A</td>
<td>N/A except for V2G mode that creates a benefit</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Energy security</td>
<td>Yes (for other fuels)</td>
<td>N/A</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Host customer</td>
<td>Measure costs (host)</td>
<td>Cost</td>
<td>N/A</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Interconnection fees</td>
<td>N/A</td>
<td>N/A</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other fuel (oil, propane, gasoline)</td>
<td>Yes (for other fuels)</td>
<td>N/A</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tax incentives</td>
<td>Depends on measure</td>
<td>N/A</td>
<td>N/A</td>
<td>Yes (depends on vehicle type)</td>
</tr>
<tr>
<td></td>
<td>Asset value (property value)</td>
<td>Benefit (ex. weatherization)</td>
<td>N/A</td>
<td>N/A</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Productivity (includes O&amp;M)</td>
<td>Yes</td>
<td>Potential Cost</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Low-income</td>
<td>Comfort</td>
<td>Yes</td>
<td>N/A</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Health &amp; safety</td>
<td>Yes</td>
<td>N/A</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mobility</td>
<td>N/A</td>
<td>N/A</td>
<td>Yes (depends on type of program)</td>
<td></td>
</tr>
</tbody>
</table>

→ Sample impacts and DER use cases
Benefit–cost analysis case studies: examples of distributed energy resource use cases

Three use cases covered:

1. Residential EV managed charging in the Midwest
2. Commercial solar + storage–controlled dispatch in the west
3. Residential grid–interactive efficient building (GEB) retrofit in the Mid–Atlantic

Available at: https://www.nationalenergyscreeningproject.org/resources/case-studies/

NSPM guidance application to real–world use cases: BCA case studies (2022)
# Summary of case studies JST

<table>
<thead>
<tr>
<th>Category/Type</th>
<th>EV Managed Charging Case Study 1 (JST 1)</th>
<th>Solar + Storage Case Study (JST 2)</th>
<th>GEB Retrofit Case Study (JST 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric Utility System Impacts</td>
<td>All impacts included in JST though some values are zero where impact is not relevant to the use case and/or DER</td>
<td>All impacts included in JST though some values are zero where impact is not relevant to the use case and/or DER</td>
<td>All impacts included in JST though some values are zero where impact is not relevant to the use case and/or DER</td>
</tr>
<tr>
<td>Natural Gas Impacts / Other Fuel Impacts</td>
<td>Not applicable given jurisdiction’s policies</td>
<td>Not applicable given jurisdiction’s policies</td>
<td>Included in JST consistent with jurisdiction’s policy</td>
</tr>
<tr>
<td>Host Customer Impacts</td>
<td>Not applicable given jurisdiction’s policies</td>
<td>Included in JST consistent with jurisdiction’s policy</td>
<td>Included in JST consistent with jurisdiction’s policy</td>
</tr>
<tr>
<td>Societal Impacts</td>
<td>GHG emission impacts (beyond any compliance costs) included consistent with jurisdiction’s policy</td>
<td>GHG emission impacts included given jurisdiction’s policies, however, GHG Adder included as utility system impact in addition to existing compliance costs</td>
<td>GHG emission impacts (beyond any compliance costs) and public health impacts included consistent with jurisdiction’s policy</td>
</tr>
</tbody>
</table>
Commercial solar + storage case study

Reference case
- Small commercial customers install stand-alone rooftop solar PV, customer is on TOU rate

DER case
- Small commercial customers receive a state government and utility incentive to install a BESS, so customers decide to install the BESS in combination with a rooftop PV system, customer is on TOU rate

Policy scenario
- State incentive program to encourage DER deployment, including energy storage
- Aggressive state-level GHG emissions reductions targets
- GHG adder included as Utility System Impact and also existing compliance costs to capture GHG requirements
- Host customer impacts included in JST

Utility scenario
- Investor-owned utility in a Western state that does not have an RTO
- High avoided energy and capacity costs
- Significant renewable energy, including solar PV, as part of the generation mix, in addition to grid reliability constraints (e.g., public safety power shutoffs (PSPS))
### Identification of relevant value streams

#### Electric Utility System Impacts
- Avoided energy costs
- Avoided generation capacity costs
- Avoided transmission costs
- Avoided distribution costs
- Avoided ancillary services
- Avoided environmental compliance costs (cap & trade compliance costs)
- Avoided environmental compliance costs (GHG adder)
- Avoided environmental compliance costs (GHG rebalancing)
- Reduced risk
- Program administration
- Utility financial Incentives

#### Host Customer Impacts
- Increased reliability
- Federal Investment Tax Credit (ITC)
- State financial incentive
- BESS interconnection costs

#### N/A because of JST formulation

#### Host Customer Impacts
- Depreciation tax write-off
- Operations & Maintenance (O&M) costs
- Battery Energy Storage System (BESS) net capital cost

#### N/A because of DER use case examined

#### Societal Impacts
- All societal impacts
• Modeled hourly load shape impacts of BESS system using NREL’s Renewable Energy Optimization (REopt) platform
• Baseline building assumed: 5,500 sqft small office from DOE prototype buildings
  • Existing 20 kW solar PV array
• TOU Tariff: $0.40/kWh peak, $0.21/kWh off peak
• BESS system: 14 kW, 86 kWh system
  • $41,202 per system cost

→ Modeling BESS impact with NREL ReOpt
BESS shifts grid load to off peak times
Increased reliability = ΔCLL * VoLL

- **ΔCLL (kWh):** Average change in customer lost load due to expected outages
  - Based on SAIFI, CAIDI, average BESS SOC, and average building load data; assuming no contribution from PV

- **VoLL \( \left( \frac{\$}{kWh} \right) \):** Value of Lost Load to the customer
  - Estimated as $151/kWh based on New England Avoided Energy Supply Component (AESC) study\(^1\)

\(\rightarrow\) Methodology for valuing host customer reliability improvement

• Assumed Federal Investment Tax Credit (ITC) at 26% of BESS capital cost
• State financial incentives modeled as equal to half of California Self Generation Incentive Program (SGIP) incentive levels ($175/kWh)
• Depreciation: 21% of BESS capital cost after subtracting 50% of ITC
• Recently passed Inflation Reduction Act bolsters incentives for storage

→ Incentives and depreciation
• Whether societal impacts are relevant depends on utility planning & policy
  o If planning is in line with policy, there is no need for societal valuation

• This case study valued GHG emissions from only the utility system perspective, due to policy and data inputs for utility planning data being aligned

• GHG emissions impacts were calculated on an hourly basis

→ GHG modeling: Utility system cost vs. societal cost
For this case study, assumed baseline of customer already having PV system, but alternative relative baseline is co-installation of these systems.

When modeling multiple resources, need to account for differences in measure lives.

Two ways to address this:
1. Use multiple load shapes to model the load impacts for different measure combinations
2. Annualize costs and standardize measure lives so that one load shape can be used

→ Handling measure lives and interactive impacts
→ **Customer reliability is the single largest benefit**
Sensitivity of the results: What are the most influential factors?

Value of lost load, customer minutes out
- Estimates by customer type vary significantly

BESS capital costs
- Cost of storage fallen significantly in past decade, projected to continue to fall

Inclusion of host customer impacts
- The 5 most influential value streams are host customer costs and benefits

Tax credits and financial incentives
- Without these the JST would be less than 1
Results with the host customer impacts removed
• Storage (and all dispatchable resources) have potential value in their flexibility
• No deterministic analysis will accurately capture this value without approximation, requires a probabilistic accounting methodology

→ Future research: Utilizing multiple load shapes to value flexibility
### EV managed charging

<table>
<thead>
<tr>
<th>Reference case</th>
<th>Residential customer on flat rate charging EV when they desire</th>
</tr>
</thead>
<tbody>
<tr>
<td>DER case</td>
<td>Customer receives incentive from utility for LV2 charger and switching to TOU</td>
</tr>
<tr>
<td>Policy scenario</td>
<td>Include GHG impacts in JST</td>
</tr>
</tbody>
</table>
| Utility scenario| • An IOU in the Midwest that is connected to MISO  
|               | • Relatively low avoided energy and capacity costs  
|               | • Generation mix with significant coal baseload             |

### Residential GEB

<table>
<thead>
<tr>
<th>Residential GEB</th>
<th>Residential SF home with gas furnace, central AC, and no smart devices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceiling insulation, reduced air leakage, ASHP, smart thermostat with DR program participation</td>
<td></td>
</tr>
<tr>
<td>Include host customer, natural gas, GHG and public health impacts in JST</td>
<td></td>
</tr>
</tbody>
</table>

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**Additional case studies: EV managed charging & Residential GEB**
Questions?
About ICF

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