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<td><strong>Docket Number:</strong></td>
<td>21-IEPR-06</td>
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<td>Building Decarbonization and Energy Efficiency</td>
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<td>Presentation - Determining the Value of Demand Flexibility in Utility Planning</td>
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<tr>
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<td>S1.2E Natalie Mims Frick, LBNL</td>
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<td><strong>Filer:</strong></td>
<td>Raquel Kravitz</td>
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<td>Public Agency</td>
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<td>10/4/2021</td>
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Determining the Value of Demand Flexibility in Utility Planning

Natalie Mims Frick
October 5, 2021

Presented at California Energy Commission’s Grid-interactive Efficient Buildings (GEB) and Load Flexibility Workshop
The Value of Grid-Interactive Efficient Buildings Panel

This presentation was supported by the U.S. Department of Energy’s Building Technologies Office under Lawrence Berkeley National Laboratory Contract No. DE-AC02-05CH11231.
Introduction

The State and Local Energy Efficiency Action (SEE Action) Network offers resources, discussion forums, and technical assistance to state and local decision makers as they provide low-cost, reliable energy to their communities through energy efficiency.

**Grid-interactive Efficient Buildings (GEBs):** *Introduction for State and Local Governments*, by Lisa Schwartz and Greg Leventis - Describes GEBs in the context of state and local government interests; trends, challenges, and opportunities for demand flexibility; and actions state and local governments can take, in concert with utilities, regional grid operators, and building owners, to advance demand flexibility.

**Issues and Considerations for Advancing Performance Assessments of Demand Flexibility from Grid-interactive Efficient Buildings**, by Steve Schiller, Lisa Schwartz and Sean Murphy - Summarizes current practices and opportunities to encourage robust and cost-effective assessments of demand flexibility performance and improve planning and implementation based on verified performance.

**Determining Utility System Value of Demand Flexibility from Grid-Interactive Efficient Buildings**, by Tom Eckman, Lisa Schwartz and Greg Leventis - Describes how current methods and practices that establish value to the electric utility system of investments in energy efficiency and other distributed energy resources (DERs) can be enhanced to determine the value of grid services provided by demand flexibility.
Focuses on methods and practices for determining the *economic value* of demand flexibility to *electric utility systems*

- This value provides the basic information needed to design programs, market rules, and rates that align the economic interest of utility customers with building owners and occupants.

- Jurisdictions can use utility system benefits and costs as the *foundation* of their economic analysis, but align their primary cost-effectiveness metric with *all applicable policy objectives*, which may include *non-utility system* impacts.

Provides guidance to state and local policy makers, public utility commissions, state energy offices, utilities, state utility consumer representatives, and other stakeholders on how to improve consistency and robustness of economic valuation of demand flexibility to electric utility systems.
Scope of Valuation = Electric Utility System

Grid-interactive efficient buildings with demand flexibility can provide grid services that:

- reduce generation costs, and/or
- reduce delivery (transmission and distribution) costs

Declining costs and increasing levels of storage and other DERs provide opportunities for utilities to incorporate demand flexibility into grid planning, operations, and investment decisions alongside other options for meeting electricity system needs.

To do so, utilities need to be able to evaluate multiple resource portfolio options in an organized, holistic, and technology-neutral manner and normalize solution evaluation across generation, distribution, and transmission systems.
Lack of parity in cost-effectiveness analysis in planning

For most utilities, economic valuation of DERs as utility system resources generally is not equivalent to such valuation for utility-scale generation resources and traditional transmission and distribution system solutions.

This lack of parity in cost-effectiveness analysis limits the selection of demand flexibility for achieving state energy goals including reliability, resilience, security, and affordability.
Traditionally, the economic value of energy efficiency, demand response, and other DERs has been determined using the “avoided cost” of conventional resources that provide the identical utility system service.

The underlying economic principle of this approach is that the value of a resource can be estimated using the cost of acquiring the next least expensive alternative resource that provides comparable services (i.e., the avoided cost of that resource).
The primary task required to determine the value of demand flexibility based on avoided cost is to identify the alternative (i.e., “avoided”) resource and establish its cost.

Methods used to establish avoided cost vary widely across the United States due to differences in:
- electricity market structure
- available resource options and their costs
- state energy policies and regulatory context
There is no single economic value of DERs for utility systems.

- The value of a single “unit” (e.g., kW, kWh) of grid service provided by EE and other DERs is a function of:
  - the timing of the impact (temporal load profile),
  - the location in the interconnected grid,
  - the grid services provided,
  - the expected service life (persistence) of the impact, and
  - the avoided cost of the least-expensive resource alternative providing comparable grid service.

- EE and DER valuation methods and practices should account for these variations.
Primary Methods for Valuing Energy Efficiency and other DERs*

- **System capacity expansion and market models**
  - *Most prevalent practice* – Reducing the growth rate of energy and/or peak demand in load forecasts input into the model, then let it optimize the type, amount, and schedule of new conventional resources (generation, transmission or distribution)
  - *Less prevalent practice* - Directly competing DERs with conventional resources in the model to determine DERs’ impact on existing system loads, load growth, and load shape—and thus dispatch of existing resources—and the type, amount, and timing of conventional resource development

- **Competitive bidding processes/auctions:** Use “market mechanisms” to select new DERs, currently limited to energy efficiency (EE) and demand response (DR)

- **Proxy resources:** Use the cost of a resource that provides grid services (e.g., a new natural gas-fired simple-cycle combustion turbine to provide peaking capacity) to establish the cost-effectiveness of DERs (i.e., determine the amount to develop) that provide these same grid services

- **Administrative/public policy determinations:** Use legislative or regulatory processes to establish development goals (e.g., Renewable Portfolio Standards and Energy Efficiency Resource Standards)

*Also used for utility scale resource options analysis*
Some Example of Current Gaps and Limitations

- Not using *accurate load shapes* to determine time-varying value
- Not accounting for *distribution and transmission system capacity impacts*
- Not accounting for variations in *interactions between DERs*
- Not accounting for variations in *interactions between DERs and existing and future utility system resources*
Using inaccurate load shapes impacts evaluation of DERs as resource options — both energy and peak impacts.

- Assumed Residential Lighting Load Shape Levelized Value of Annual Energy Savings = $75/MWh
- Metered Residential Lighting Load Shape Levelized Value of Annual Energy Savings = $56/MWh
GREAT NEWS! New load shapes available THIS MONTH
Register for the webinar [here](#)!

Residential and Commercial End-Use Load Profiles

Before End Use Load Profiles Project

Source: Elaina Present IEPEC
Not accounting for all substantial utility system impacts undervalues demand flexibility

<table>
<thead>
<tr>
<th>Region</th>
<th>Distribution</th>
<th>Transmission</th>
<th>Generating Capacity</th>
<th>DRIPE</th>
<th>Avoided RPS</th>
<th>Carbon Dioxide Emissions</th>
<th>Risk</th>
<th>Reserves/Ancillary Services</th>
<th>Energy</th>
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Failing to analyze the potential interactions *between* DERs may result in selection of higher cost resource strategies.
Failing to analyze the potential interaction between DERs and the existing and future utility system may result in less than optimal resource strategies.

**Impact on Amount and Timing of CCCT Development of Alternative Levels of DER Development**

- Acquire EE <= No Demand Response, Acquire EE @ <= Long Run Avoided Cost
- Acquire EE @ <= Short Run Market Price w/Demand Response
- Acquire EE @ <= Long Run Avoided Cost w/Demand Response

Source: Northwest Power and Conservation Council, 7th Power Plan
Enhanced Valuation Methods - Seven Considerations

1. Account for *all electric utility system economic impacts* resulting from energy efficiency and other DERs
2. Account for variations in value based on *when* savings from energy efficiency and other DERs occurs
3. Account for the *impact of distribution system savings* on transmission and generation system value
4. Account for variations in value specific *locations* on the grid
5. Account for variations in value due to *interactions between DERs providing demand flexibility*
6. Account for benefits across the *full expected useful lives (EULs)* of the resources
7. Account for variations in value due to *interactions between DERs and other system resources*
Applicability of Enhanced Valuation Methods to Distribution, Generation, and Transmission Planning Analyses

<table>
<thead>
<tr>
<th>Enhanced valuation methods to account for:</th>
<th>Distribution System Planning</th>
<th>Generation Planning</th>
<th>Transmission Planning</th>
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<tbody>
<tr>
<td>1. All electric utility system economic impacts resulting from demand flexibility</td>
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<td>●</td>
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<tr>
<td>2. Variations in value based on when demand flexibility occurs</td>
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<tr>
<td>3. Impact of distribution system savings on transmission and generation system value</td>
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<tr>
<td>4. Variations in value at specific locations on the grid</td>
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<tr>
<td>5. Variations in value due to interactions between DERs providing demand flexibility</td>
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<td>6. Benefits across the full expected useful lives of the resources</td>
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<td>7. Variations in value due to interactions between DERs and other system resources</td>
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● most applicable, ○ least applicable
Select Resources


Natalie Mims Frick, Snuller Price, Lisa Schwartz, Nichole Hanus, and Ben Shapiro. Locational Value of Distributed Energy Resources


Natalie Mims Frick, Juan Pablo Carvallo and Margaret Pigman. Time-sensitive Value of Efficiency Calculator. (forthcoming)

Alan Cooke, Juliet Homer, Lisa Schwartz, Distribution System Planning – State Examples by Topic, Pacific Northwest National Laboratory and Berkeley Lab, 2018


Berkeley Lab’s research on time- and locational-sensitive value of DERs

U.S. Department of Energy’s (DOE) Modern Distribution Grid guides

Regional distribution system planning trainings for PUCs and state energy offices: Southeast, New England, MISO footprint, West, Mid-Atlantic

Berkeley Lab’s Future Electric Utility Regulation reports

Berkeley Lab and NREL’s End Use Load Profiles for the U.S. Building Stock project
Natalie Mims Frick
nfrick@lbl.gov
808-987-0389

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BACKGROUND SLIDES
### Summary of Valuation Enhancements and Implementation Guidance (1)

<table>
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<tr>
<th>Valuation Enhancement</th>
<th>Guidance</th>
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<tbody>
<tr>
<td>1. Account for all electric utility system economic impacts resulting from demand flexibility</td>
<td>Prioritize enhancements for analyses used to derive the value of primary utility system benefits.</td>
</tr>
<tr>
<td>2. Account for variations in value based on when demand flexibility occurs</td>
<td>Develop and use hourly forecasts of avoided energy and capacity costs in combination with publicly available load shape data for DERs to value demand flexibility.</td>
</tr>
<tr>
<td>3. Account for the impact of distribution system savings on transmission and generation system value</td>
<td>Model and calculate distribution system-level impacts (i.e., locational impacts and associated economic value) first so that results can be used to adjust inputs to analysis of bulk transmission and generation system values.</td>
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### Summary of Valuation Enhancements and Implementation Guidance (2)

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<td>4. Account for variations in value at specific locations on the grid</td>
<td>Initiate a distribution system planning process that includes: (1) hosting capacity analysis to estimate generating DER capacity limits and identifies demand flexibility that can mitigate limits, (2) thermal limit analysis to estimate locational value of non-wires solutions, (3) energy analysis to quantify marginal distribution system losses, and (4) systemwide analysis of the avoided cost of deferred distribution capacity expansion.</td>
</tr>
<tr>
<td>5. Account for variations in value due to interactions between DERs providing demand flexibility</td>
<td>Start accounting for interactions between DERs. Basic analysis can assume that deployment of multiple types of DERs does not impact the existing or future electric grid in a way that alters avoided costs. Such basic analysis does not require the use of system capacity expansion models.</td>
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## Summary of Valuation Enhancements and Implementation Guidance (3)

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<tr>
<td>6. Account for benefits across the full expected lives of</td>
<td>As a first step, use the EUL of DERs providing demand flexibility to calculate their economic value. However, because demand flexibility is largely based on controls, the dispatch of which is determined by the combined impact of grid operators and owner/occupant responses, EULs may be more a function of rate and program design, compared to EULs for traditional energy efficiency measures. Uncertainty regarding EULs for demand flexibility may be best addressed through program design.</td>
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<tr>
<td>the resources</td>
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<tr>
<td>7. Account for variations in value due to interactions</td>
<td>Use distribution, transmission and generation capacity expansion modeling, supplemented as necessary with other methods described in section 4 of this report, to determine the impact of widespread deployment of demand flexibility for grid services. Implementing this enhancement will require customization of commercially available capacity expansion models.</td>
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<tr>
<td>between DERs and other system resources</td>
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### Implementation Resources (1)

<table>
<thead>
<tr>
<th>Valuation Enhancement*</th>
<th>Implementation Resources</th>
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</table>
| 1. Account for all electric utility system economic impacts resulting from demand flexibility | • National Efficiency Screening Project, [National Standard Practice Manual](#)  
• EPRI, *The Integrated Grid - A Benefit-Cost Framework*  
• EPA, *Assessing the Multiple Benefits of Clean Energy – Resources for States* (particularly Section 3.2.4) |
• Smart Electric Power Alliance, *Beyond the Meter: Addressing the Locational Valuation Challenge for Distributed Energy Resources* |
| 3. Account for the impact of distribution system-level savings on transmission and generation system value | • PNNL, *Electric Distribution System Planning with DERs – Tools and Methods (forthcoming)*  
• Smart Electric Power Alliance, *Beyond the Meter: Addressing the Locational Valuation Challenge for Distributed Energy Resources* |
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| 4. Account for the locational economic value of demand flexibility                    | • Smart Electric Power Alliance, Beyond the Meter: Addressing the Locational Valuation Challenge for Distributed Energy Resources  
• Benefit-Cost Analysis Handbook developed for New York’s REV process  
• California’s Locational Net Benefits Analysis Tool (and user’s guide)  
• ConEd’s Benefit Cost Analysis Handbook recognizes DER benefits for avoided distribution capacity infrastructure and provides methods to quantify location-specific marginal costs that the system defers or avoids by opting for non-wires solutions. |
| 5. Account for interactions between DERs providing demand flexibility                  | • Frick et al., Berkeley Lab, A Framework for Integrated Analysis of Distributed Energy Resources: Guide for States  
EPRI, The Integrated Grid - A Benefit-Cost Framework                                                                                                     |
| 6. Account for potential variations in the timing and/or amount of the electric grid service provided by demand flexibility over the expected lives of the DERs | • EPRI, The Integrated Grid - A Benefit-Cost Framework                                                                                                                                                                  |
| 7. Account for interactions between DERs providing demand flexibility and existing and potential conventional grid resources supplying comparable services | • Berkeley Lab, A Framework for Integrated Analysis of Distributed Energy Resources: Guide for States  
• EPRI, The Integrated Grid - A Benefit-Cost Framework                                                                                                      |