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Determining the Value of Demand Flexibility in Utility Planning

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Presented at California Energy Commission's Grid-interactive Efficient Buildings (GEB) and Load Flexibility Workshop

The Value of Grid-Interactive Efficient Buildings Panel

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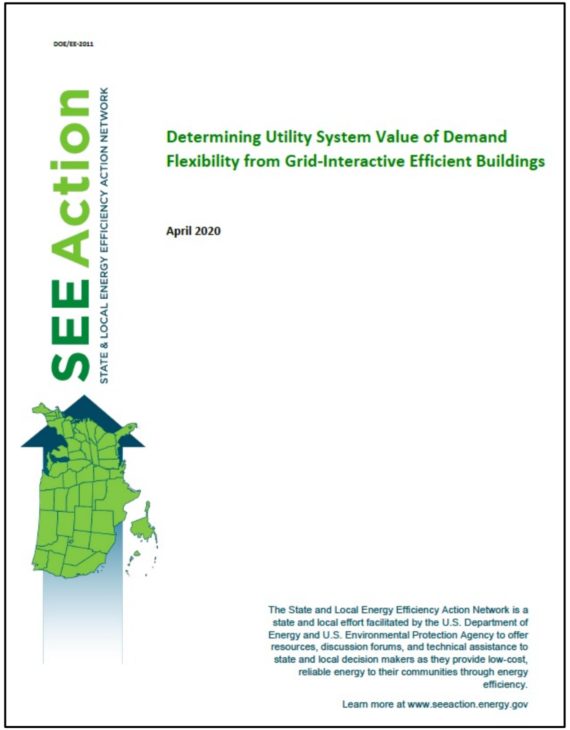
Introduction

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

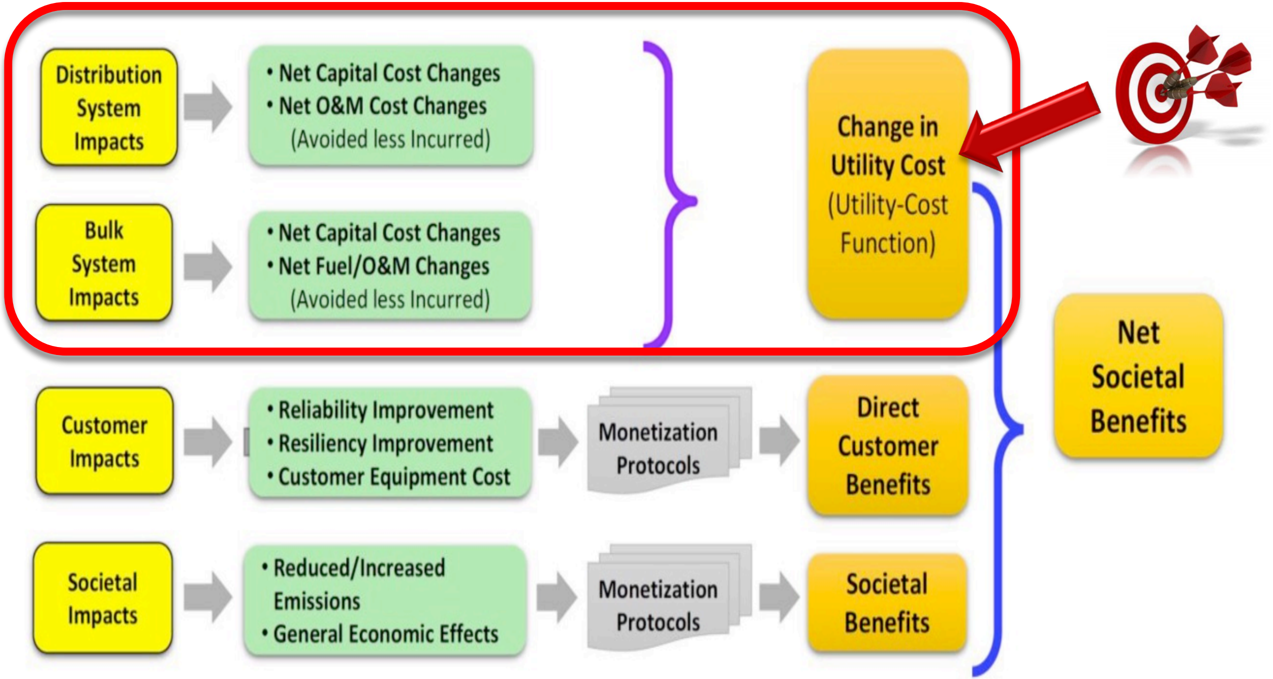
Determining Utility System Value of Demand Flexibility from Grid-Interactive Efficient Buildings, by Tom Eckman, Lisa Schwartz and Greg Leventis - Describes how current methods and practices that establish value to the electric utility system of investments in energy efficiency and other distributed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



SEE Action Report on Demand Flexibility Valuation

- 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*

Graphic: EPRI. 2015. *The Integrated Grid: A Benefit-Cost Framework*

Planning Challenges (1)

Limited analytical capacity

- 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.

Planning Challenges (2)

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.

Value = Avoided Cost

- 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).

Primary Valuation Task

- 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*

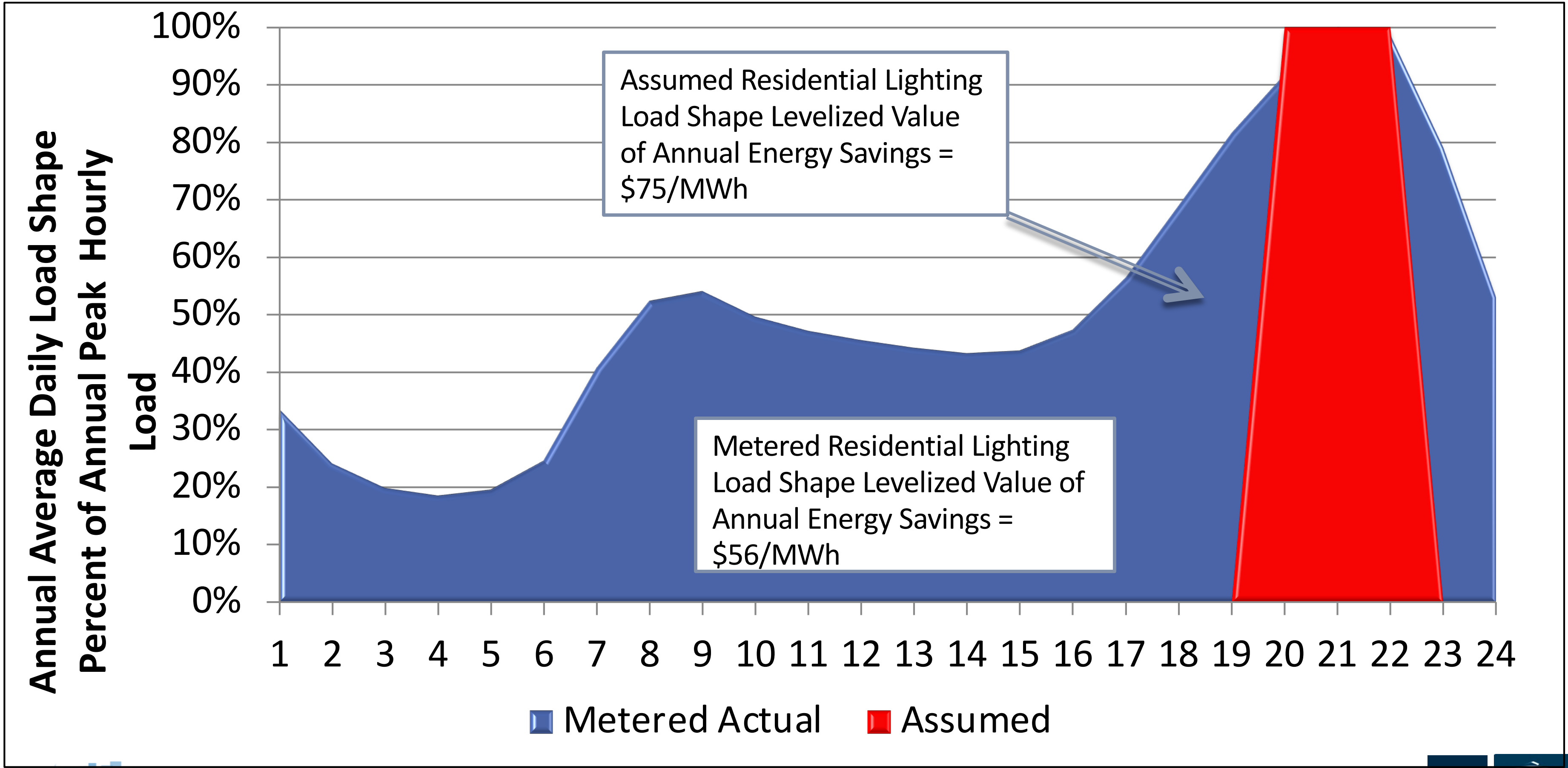
- **System capacity expansion and market models**
  - *Most prevalent practice* – Reducing the growth rate of energy and/or peak demand in load forecasts input into the model, then let it optimize the type, amount, and schedule of new conventional resources (generation, transmission or distribution)
  - *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*

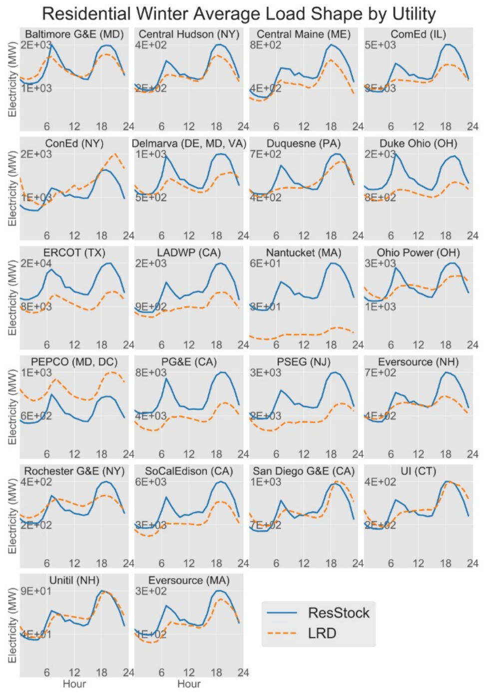
Using inaccurate load shapes impacts evaluation of DERs as resource options — both energy and peak impacts.



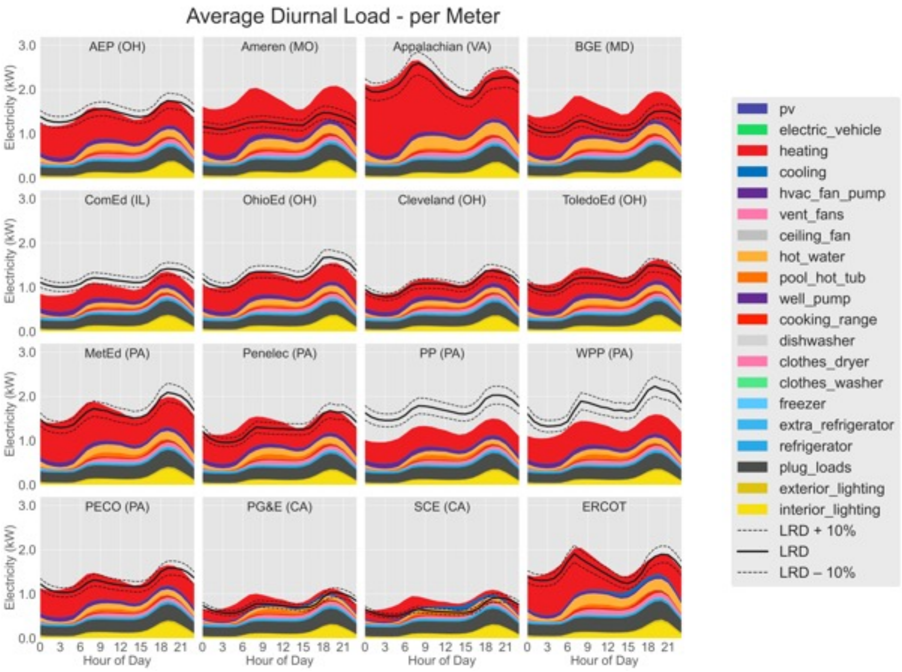
GREAT NEWS! New load shapes available THIS MONTH
Register for the webinar here!

Residential and Commercial End-Use Load Profiles

Before End Use Load Profiles Project

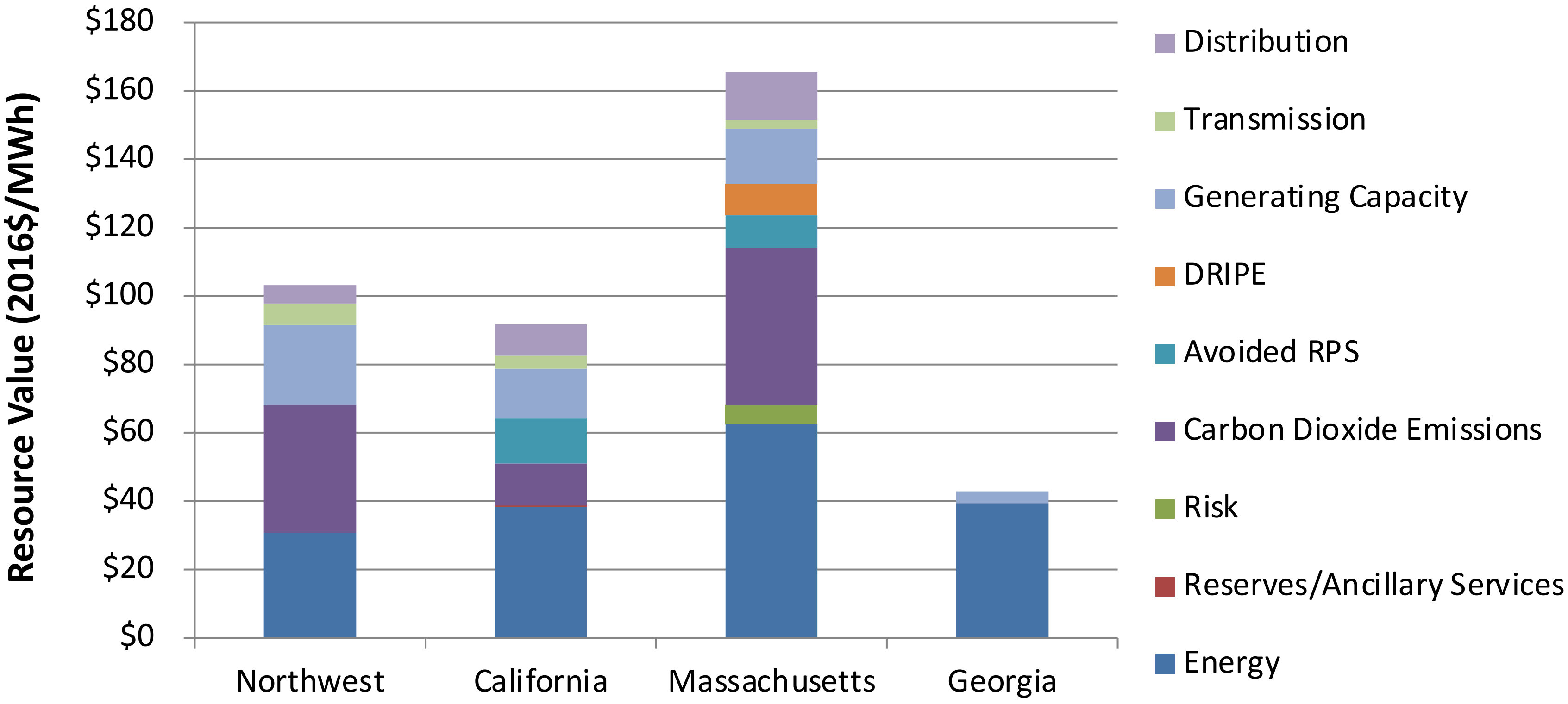


Current

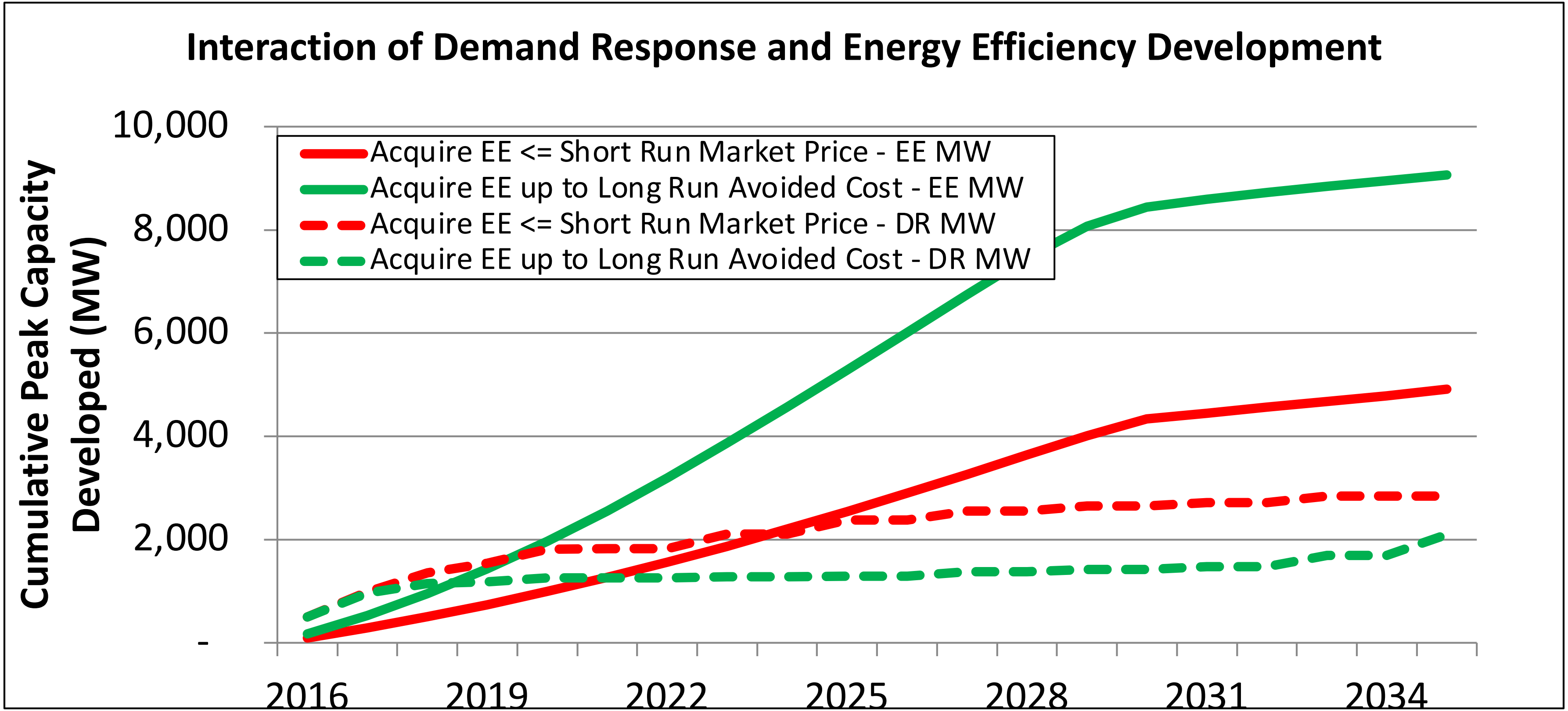


Source: Elaina Present IEPEC

Not accounting for all substantial utility system impacts undervalues demand flexibility

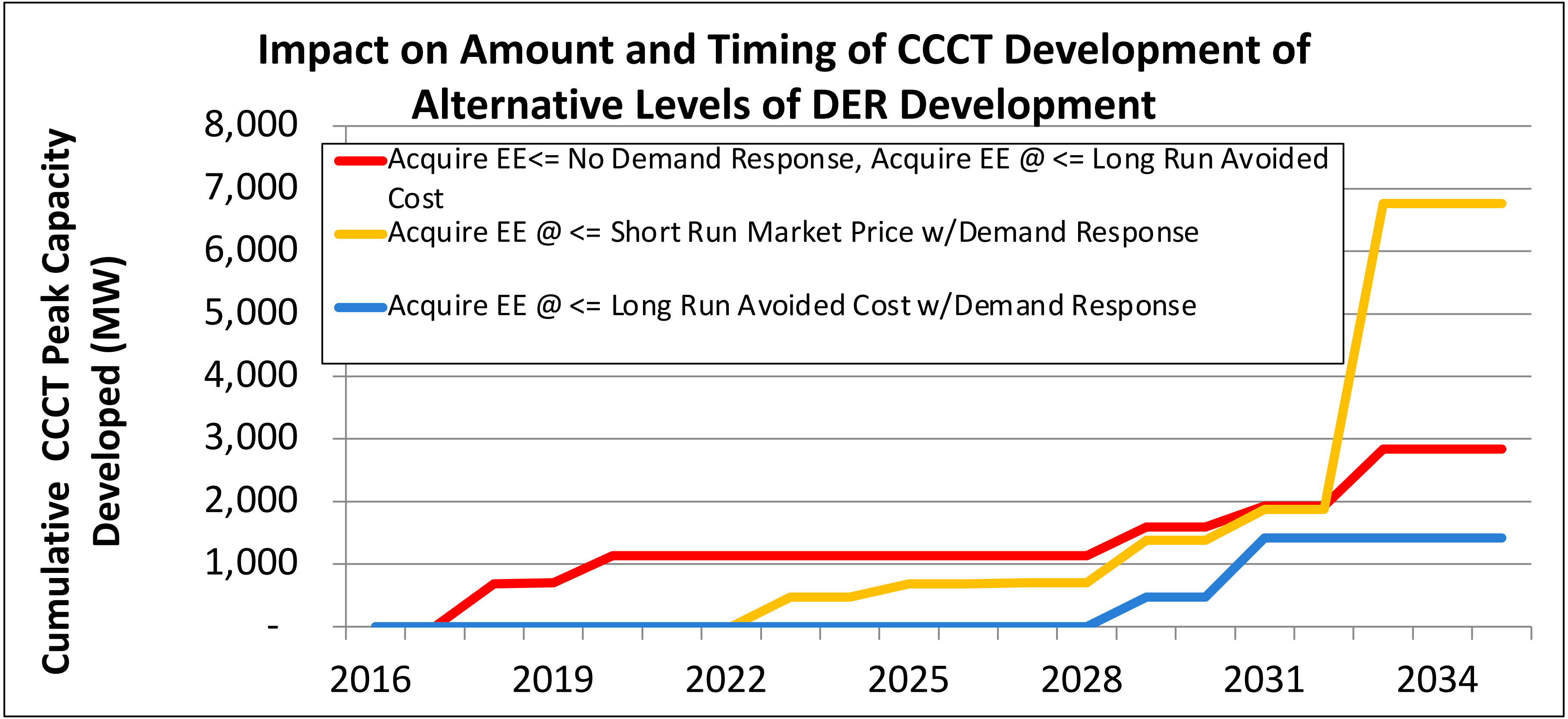


Failing to analyze the potential interactions *between* DERs may result in selection of higher cost resource strategies.



Source: Northwest Power and Conservation Council, 7th Power Plan

Failing to analyze the potential interaction between DERs and the existing and future utility system may result in less than optimal resource strategies.



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

	Distribution System Planning			Generation Planning		Transmission Planning	
Enhanced valuation methods to account for:	**Hosting Capacity (for distributed generation capacity)**	**Energy Analysis (loss estimation)**	**Thermal Capacity (peak capacity)**	**Capacity Expansion Modeling**	**Market-Based Mechanisms**	**Capacity Expansion Modeling**	**Congestion Pricing Analysis**
1. All electric utility system economic impacts resulting from demand flexibility	●	●	●	●	●	●	●
2. Variations in value based on when demand flexibility occurs	●	●	●	●	●	●	●
3. Impact of distribution system savings on transmission and generation system value	◔	●	◑	◑	◑	◑	◑
4. Variations in value at specific locations on the grid	●	●	◔	◔	◔	●	●
5. Variations in value due to interactions between DERs providing demand flexibility	●	◕	●	◕	◕	◕	◕
6. Benefits across the full expected useful lives of the resources	◑	◑	●	◑	◑	●	●
7. Variations in value due to interactions between DERs and other system resources	◕	◑	●	●	●	●	●

● most applicable, ◔ least applicable

Select Resources

U.S. Department of Energy. 2021. A Roadmap for Grid-interactive Efficient Buildings. Prepared by Andrew Satchwell, Ryan Hledik, Mary Ann Piette, Aditya Khandekar, Jessica Granderson, Natalie Mims Frick, Ahmad Faruqui, Long Lam, Stephanie Ross, Jesse Cohen, Kitty Wang, Daniela Urigwe, Dan Delurey, Monica Neukomm and David Nemtzow

Natalie Mims Frick, Tom Eckman, Greg Leventis, and Alan Sanstad. Methods to Incorporate Energy Efficiency in Electricity System Planning and Markets. January 2021.

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 Lisa Schwartz. Quantifying reliability and resilience impacts of energy efficiency: Examples and opportunities (forthcoming).

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

Juliet Homer, Alan Cooke, Lisa Schwartz, Greg Leventis, Francisco Flores-Espino and Michael Coddington, *State Engagement in Electric Distribution Planning*, Pacific Northwest National Laboratory, Berkeley Lab and National Renewable Energy Laboratory, 2017

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

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BACKGROUND SLIDES

Summary of Valuation Enhancements and Implementation Guidance (1)

Valuation Enhancement	Guidance
1. Account for all electric utility system economic impacts resulting from demand flexibility	Prioritize enhancements for analyses used to derive the value of primary utility system benefits.
2. Account for variations in value based on when demand flexibility occurs	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.
3. Account for the impact of distribution system savings on transmission and generation system value	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.

Summary of Valuation Enhancements and Implementation Guidance (2)

Valuation Enhancement	Guidance
4. Account for variations in value at specific locations on the grid	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.
5. Account for variations in value due to interactions between DERs providing demand flexibility	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.

Summary of Valuation Enhancements and Implementation Guidance (3)

Valuation Enhancement	Guidance
6. Account for benefits across the full expected lives of the resources	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.
7. Account for variations in value due to interactions between DERs and other system resources	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.

Implementation Resources (1)

Valuation Enhancement`	Implementation Resources
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)
2. Account for the time-sensitive economic value of demand flexibility	• Berkeley Lab reports discuss data and methods required to capture temporal value of energy efficiency including *Time-Varying Value of Electric Energy Efficiency* and *Time-Varying Value of Energy Efficiency in Michigan*. More resources at https://emp.lbl.gov/projects/time-value-efficiency. • 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*

Implementation Resources (2)

Valuation Enhancement	Implementation Resources
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*