Demand Flexibility as a Utility System Resource: Grid-interactive Efficient Buildings

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Distribution Systems and Planning Training for Southeast Region
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Agenda

- Demand flexibility and grid-interactive efficient buildings
  - Opportunities and benefits for the electricity grid
  - Demand-side management strategies to manage building loads
- Valuation of demand flexibility in electricity planning
  - Current methods and practices
  - Challenges and limitations of current practices
  - Considerations for improving valuation methods
- Assessing demand flexibility performance
  - Importance of assessing performance
  - Approaches and metrics to measure impacts
- Opportunities for states to advance demand flexibility

Thanks to Lisa Schwartz, Tom Eckman and Steve Schiller for their contributions to this presentation.

Regulatory proceedings or requirements in Southeast states related to demand flexibility*

- Improving demand flexibility
  - Storage: Alabama, Arkansas, Florida, Kentucky, Louisiana, North Carolina, South Carolina, Texas
  - Demand response: Georgia, Kentucky, Louisiana
- Increasing need for demand flexibility
  - Existing renewable resource targets: Puerto Rico, North Carolina, South Carolina
  - Transportation electrification initiatives and studies: Georgia, Kentucky, Louisiana, North Carolina, South Carolina, Tennessee
  - Net metering: Arkansas, Georgia, South Carolina
  - Community solar: South Carolina
- Valuing distributed resources: Arkansas, South Carolina, Mississippi
- Many Southeast states also have existing energy efficiency requirements, including contributions to peak load reduction: e.g., Arkansas, Florida, Georgia, Mississippi, North Carolina, Texas

* Not intended to be comprehensive. Sources: DSIRE, NCSL.

The electricity system is changing, requiring changes in grid operations and greater consideration of loads as a flexible resource.

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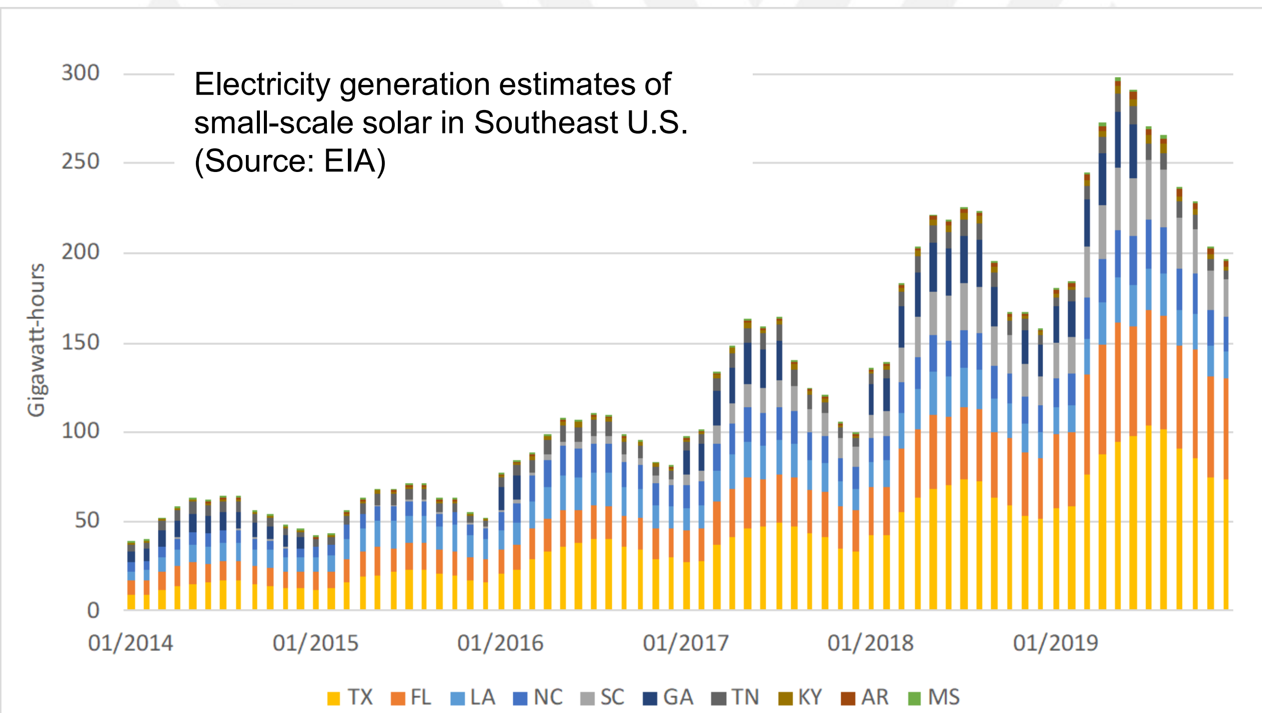
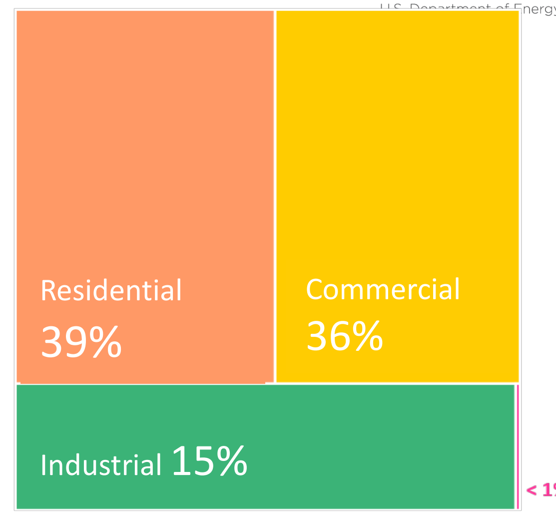
- Increasing amounts of variable renewable energy
- Growth in electric vehicles
- Buildings (residential + commercial) account for 75 percent of electricity consumption and in some regions up to 80 percent of peak demand.





U.S. Energy Information Administration (EIA), [Monthly Energy Review, June 2019](), Table 7.6

- With many adjustable loads, buildings also represent the largest source of demand flexibility.

Grid-interactive efficient buildings and demand flexibility

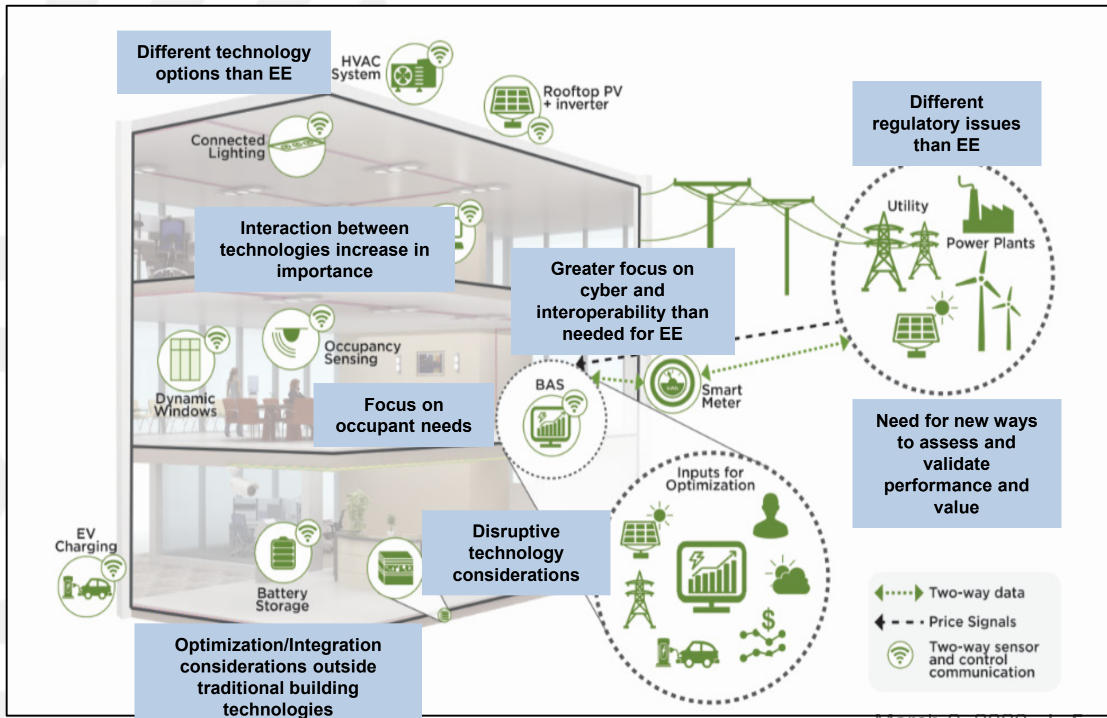
Grid-interactive Efficient Building	An energy-efficient building that uses smart technologies and on-site DERs to provide demand flexibility while co-optimizing for energy cost, grid services, and occupant needs and preferences in a continuous and integrated way

Demand Flexibility*	Capability of DERs to adjust a building's load profile across different timescales

DERs – Resource sited close to customers that can provide all or some of their immediate power needs and/or can be used by the utility system to either reduce demand or provide supply to satisfy the energy, capacity, or ancillary service needs of the grid

Smart technologies for energy management - Advanced controls, sensors, models, and analytics used to manage DERs. Grid-interactive efficient buildings are characterized by their use of these technologies

**Also called "energy flexibility" or "load flexibility"*

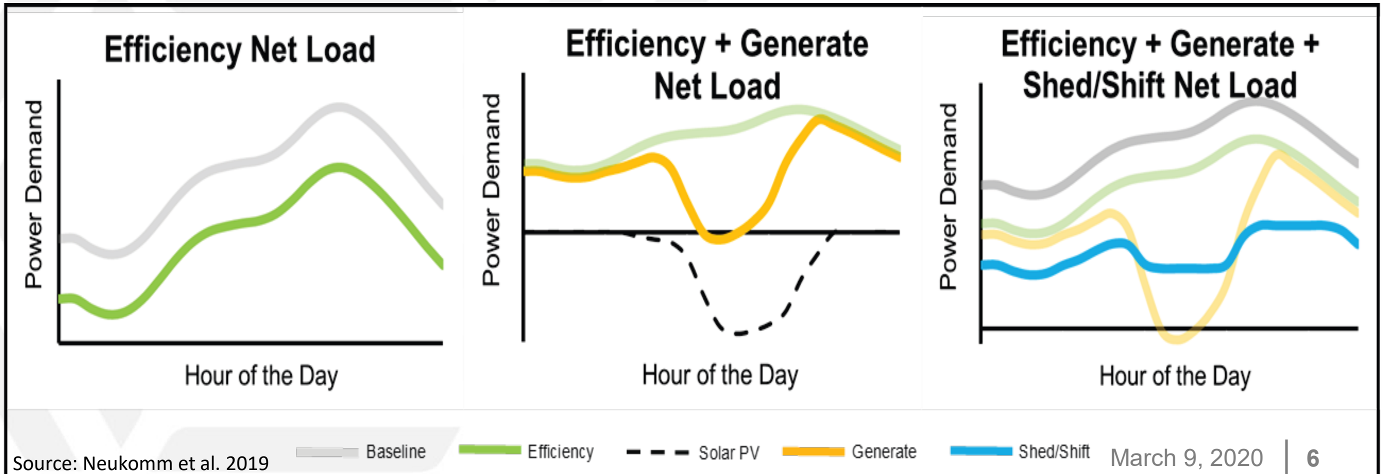


Source: Neukomm et al. 2019

Demand-side management strategies to manage building loads

- *Energy efficiency:* Ongoing reduction in energy use while providing the same or improved level of building function
- Demand flexibility:
  - *Load shed*: Ability to reduce electricity use for a short time period and typically on short notice.
  - *Load shift*: Ability to change the timing of electricity use. In some situations, a shift may lead to changing the amount of electricity that is consumed
  - *Modulate*: Ability to balance power supply/demand or reactive power draw/supply autonomously (within seconds to subseconds) in response to a signal from the grid operator during the dispatch period
  - *Generate*: Ability to generate electricity for onsite consumption and even dispatch electricity to the grid in response to a signal from the grid

Daily average load profiles for grid-interactive efficient buildings



Source: Neukomm et al. 2019

Southern Company Smart Neighborhood Initiatives

Understanding tomorrow's home today

Two first-of-a-kind smart home communities at the intersection of energy efficiency, distributed energy resources & buildings-to-grid integration and the traditional utility model

Georgia Power Smart Neighborhood™

- 46 townhomes
- Atlanta, Georgia
- Homeowner owned solar + storage
- Grid integration of solar, storage, HVAC, water heating & EV charging

Alabama Power SMART NEIGHBORHOOD®

- 62 single-family homes
- Birmingham, Alabama
- Utility owned, grid-connected microgrid
  - → 330 kW solar
  - → 680 kWh storage
  - → 400 kW NG generator
- Grid integration of microgrid, water heating & HVAC

Major Research Partners

Electric Power Research Institute and
U.S. Department of Energy's
Oak Ridge National Laboratory

Media Impact

Global recognition
50 million unique clicks
4,200 visitors

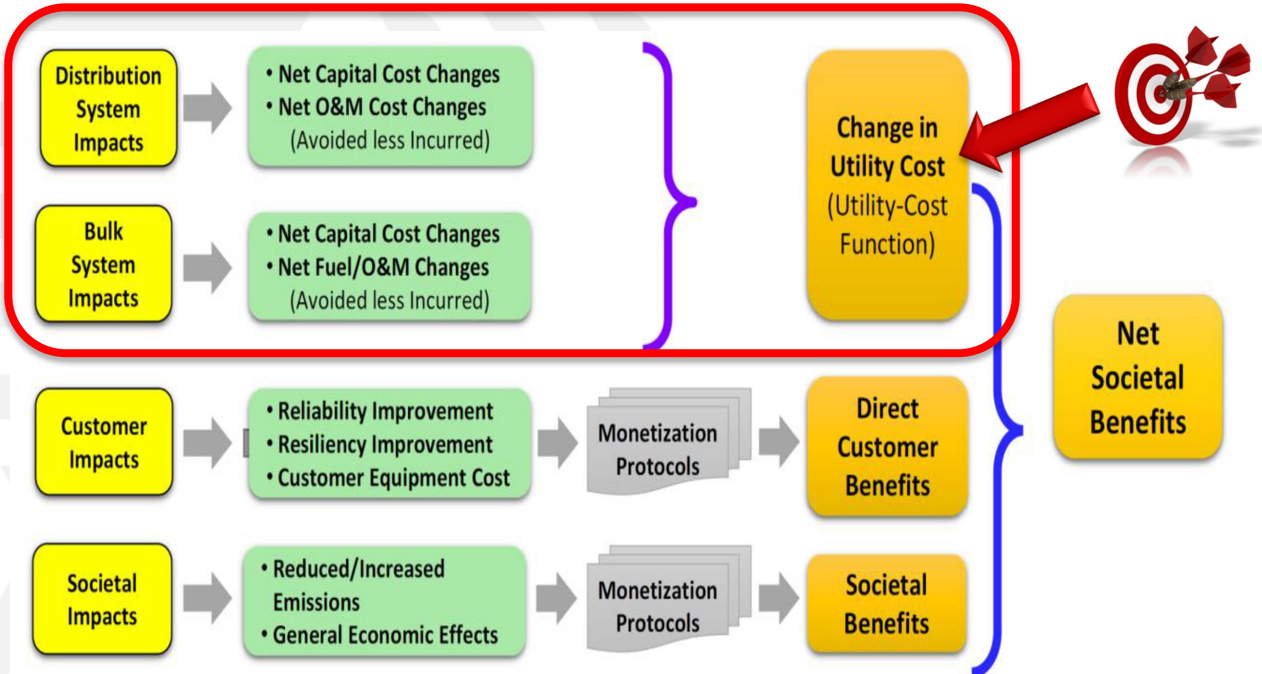
Key Results

Homes are 30-40% more efficient
EV makes up 15-20% of total usage
Successful microgrid islanding
Load shifting achieved w/lessons learned

Determining Utility System Value of Demand Flexibility From Grid-Interactive Efficient Buildings

Forthcoming report by Tom Eckman, Lisa Schwartz and Greg Leventis, Berkeley Lab

Scope of valuation = electric utility system



Source: EPRI 2015.

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

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

Example benefits and grid services that buildings with demand flexibility can provide

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Benefit	Utility System	Building Owners/ Occupants
Reduced operation & maintenance costs	✓	-
Reduced generation capacity costs	✓	-
Reduced energy costs	✓	-
Reduced T&D costs	✓	-
Reduced T&D losses	✓	-
Reduced ancillary services costs	✓	-
Reduced environmental compliance costs	✓	-
Increased resilience	✓	✓
Increased DER integration	✓	✓
Improved power quality	-	✓
Reduced owner/occupant utility bills	-	✓
Increased owner/occupant satisfaction	-	✓
Increased owner/occupant flexibility and choice	-	✓

Primary factors impacting value of demand flexibility

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- There is no single economic value of demand flexibility for utility systems.
- The value of a single “unit” (e.g., kW, kWh) of grid service provided by demand flexibility 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.
- Demand flexibility valuation methods and practices should account for these variations.

Value = avoided cost

- 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
- 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 <u>*value*</u> of a resource can be estimated using the <u>*cost of acquiring the next least expensive alternative resource*</u> that provides comparable services (i.e., the *avoided cost* of that resource).

Primary methods of resource options analysis for DERs and planning challenges

Analysis methods

- System capacity expansion and market models
- Competitive bidding processes/auctions
- Proxy resources
- Administrative/public policy determinations

Planning challenges

- Limited analytical capability
  - 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.
- Treating DERs as resource options in capacity expansion modeling is challenging.
  - Most commercially available capacity expansion models can model DERs as resource options.
  - These models require users to define the specific resource characteristics such as cost, quantity, lead times, and load shapes.
  - Modeling of DERs as resource options requires many user-defined inputs, an experienced modeler, potentially multiple model runs, and post-processing of model output.

Enhanced Valuation Methods - Seven Considerations

1. Account for *all electric utility system economic impacts* resulting from demand flexibility
2. **Account for variations in value based on *when* demand flexibility 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* of the resources
7. Account for variations in value due to *interactions between DERs and other system resources*

2. Account for variations in value based on *when* demand flexibility occurs

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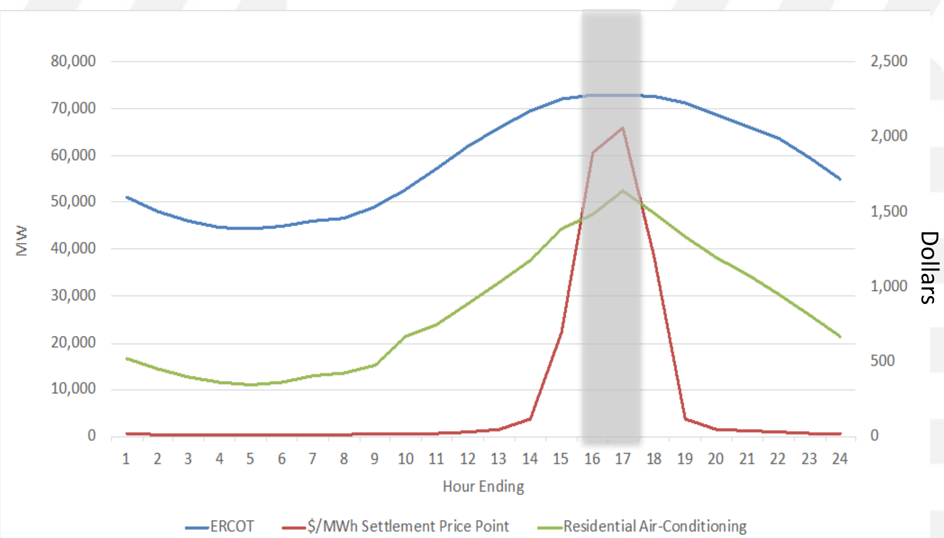
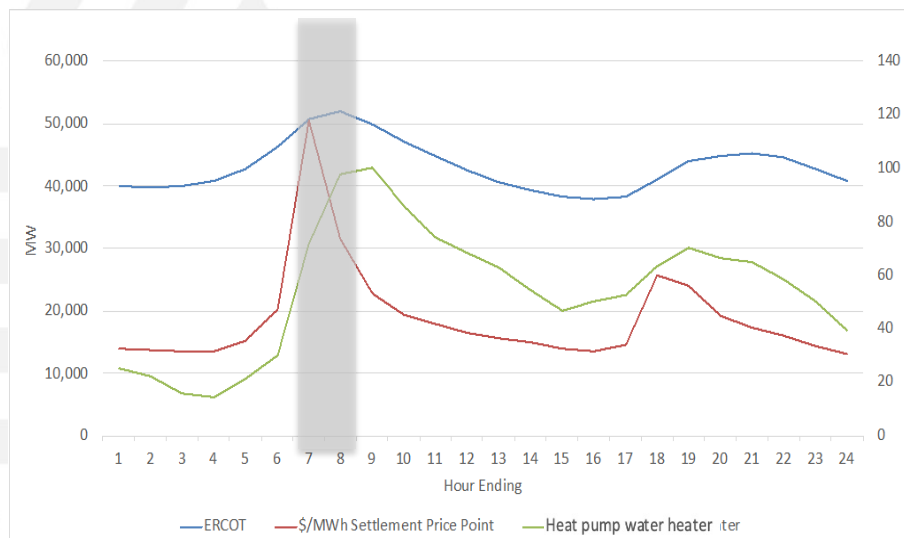
- The value of DERs that can adjust load is fundamentally dependent on the timing of their impacts.
- The impact of demand flexibility must be addressed on a more *granular time scale*.
  - The economic value of grid services that demand flexibility provides varies from sub-hourly to daily, monthly, and seasonally as well as across future years and across utility systems.

ERCOT, Monday, July 23, 2018



ERCOT, Monday, December 10, 2018



Sources: [ERCOT system](), [ERCOT price](), [Texas air-conditioning load shape]()

3. Account for the impact of distribution system savings on transmission and generation system value

Demand flexibility can be used to avoid *distribution system losses* when they are highest, resulting in reduced transmission system losses and avoided generator capacity needs (including the planning reserve margin).

Locational impacts on the distribution system and their associated economic value should be modeled and *calculated first.* Results can be used to adjust inputs to the analysis of transmission and generation system values.

Value streams have ripple effects

Ben Kellison, "Unlocking the Locational Value of DER 2016: Technology Strategies, Opportunities, and Markets," January 2016,

Calculate the localized impacts first

4. Account for variations in value at specific grid locations

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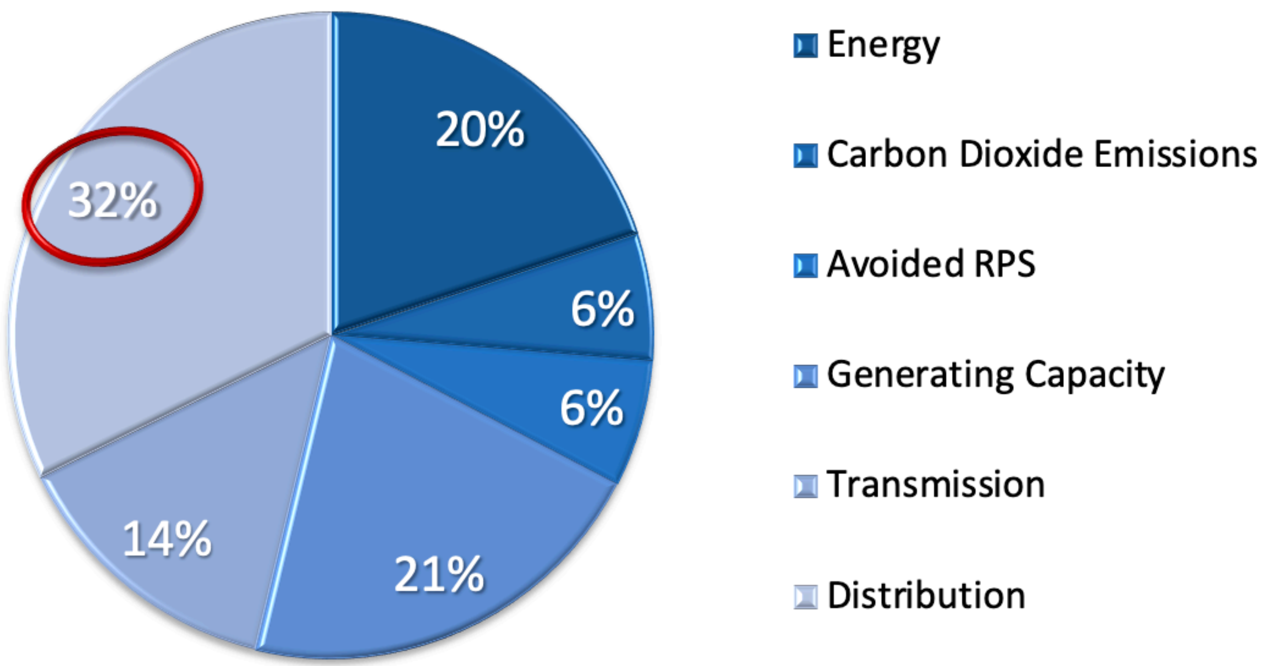
- ► The locational value of demand flexibility is highly dependent on where grid services resulting from demand flexibility occur on the interconnected grid.
- ► Locational value of demand flexibility may account for significant economic value.

Example - Relative contribution to total utility system value for energy and capacity savings from residential air-conditioning efficiency measures in California



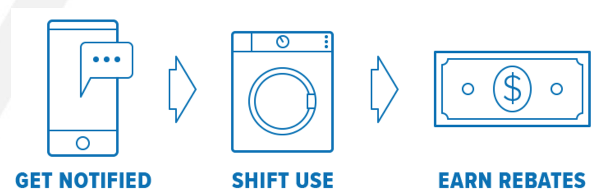
Source: Mims, et al. *Time-varying value of electric energy efficiency*. Berkeley Lab, 2017

Where efficiency and demand flexibility occur influences value.

PGE Smart Grid Test Bed

- Demand flexibility during peak events
- Systemwide, targeting 69 MW of demand flexibility in summer and 77 MW in winter to fill a 2021 capacity gap identified in Integrated Resource Plan
- Residential customers
  - Tstats, direct load control, battery storage, heat pump water heaters, EV chargers
  - Testing value propositions
  - Peak time rebate
- Small and medium businesses
  - Direct installation of smart thermostats
  - Plans to add EV charging and storage
  - Coordinating with Energy Trust of Oregon on efficiency and solar incentives

Focusing on neighborhoods served by 3 distribution substations

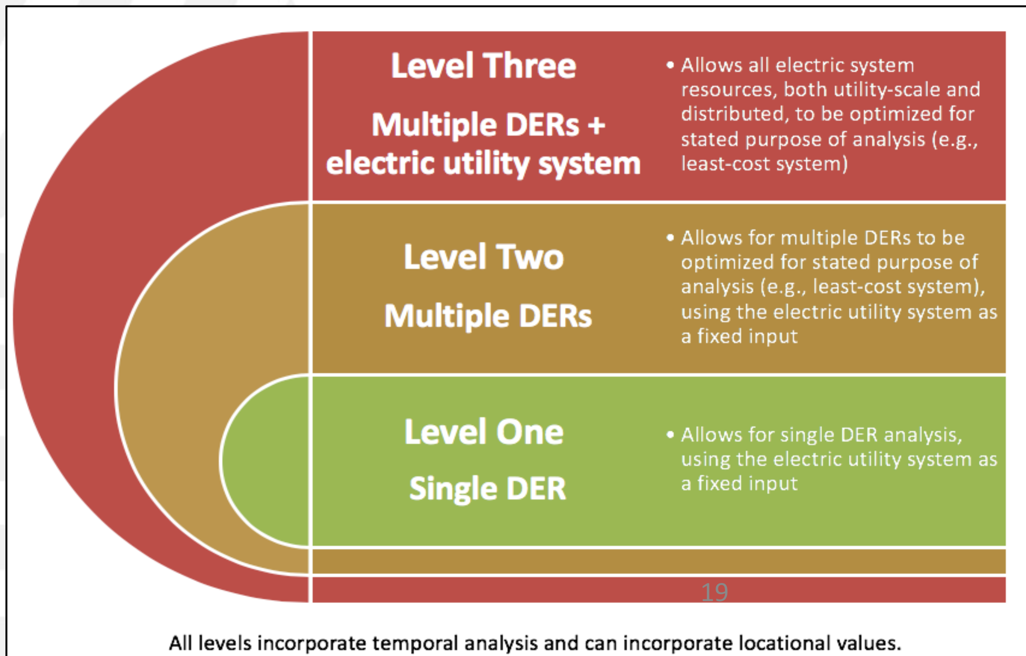


5. Account for variations in value due to interactions between DERs providing demand flexibility

- Analysis should first capture major interactions between pairs of DERs
  - Interactions can be estimated assuming that deployment of DERs does not impact the existing or future electric grid sufficiently to alter avoided cost.

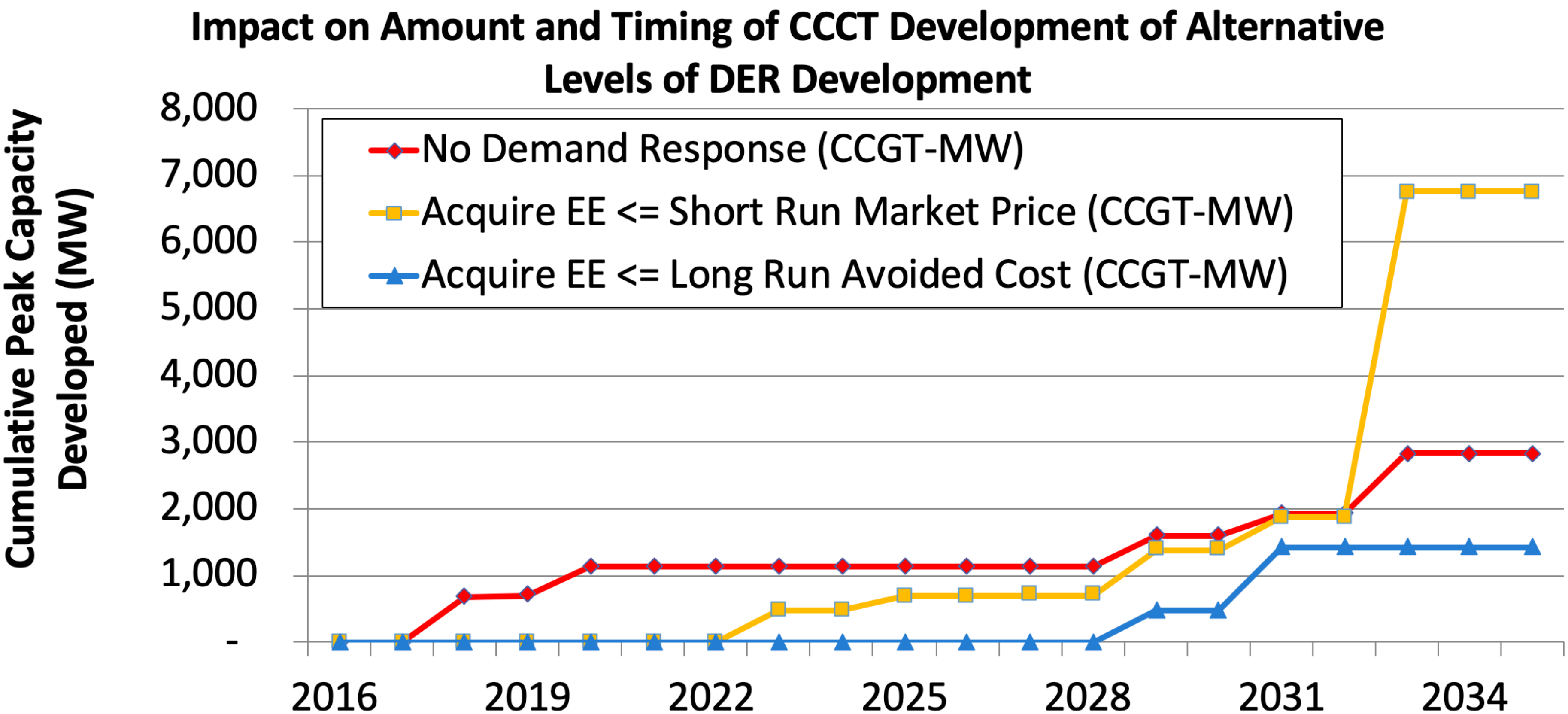
- Higher levels of DERs increases the need to address interactions of DERs with one another and with the electric grid. It is unlikely that their collective and cumulative impacts are simply additive, and they may alter avoided cost.
  - Widespread deployment of demand flexibility for grid services will change grid operations and infrastructure development, altering avoided resource costs.

Framework for addressing interactions between DERs



Graphic: Mims Frick, et al., Berkeley Lab, *A Framework for Integrated Analysis of Distributed Energy Resources: Guide for States*, 2018

Failing to analyze the potential interaction between DERs may result in less than optimal resource strategies.



Source: Northwest Power and Conservation Council, Seventh Power Plan, 2016.
https://www.nwcouncil.org/sites/default/files/rpmfinalscenarioresults_data_032816-final.xlsx

Applicability of enhanced valuation methods to distribution, generation, and transmission planning analyses

Enhanced valuation methods to account for:	Distribution System Planning			Generation Planning		Transmission Planning	
	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	◕	◑	●	●	●	●	●

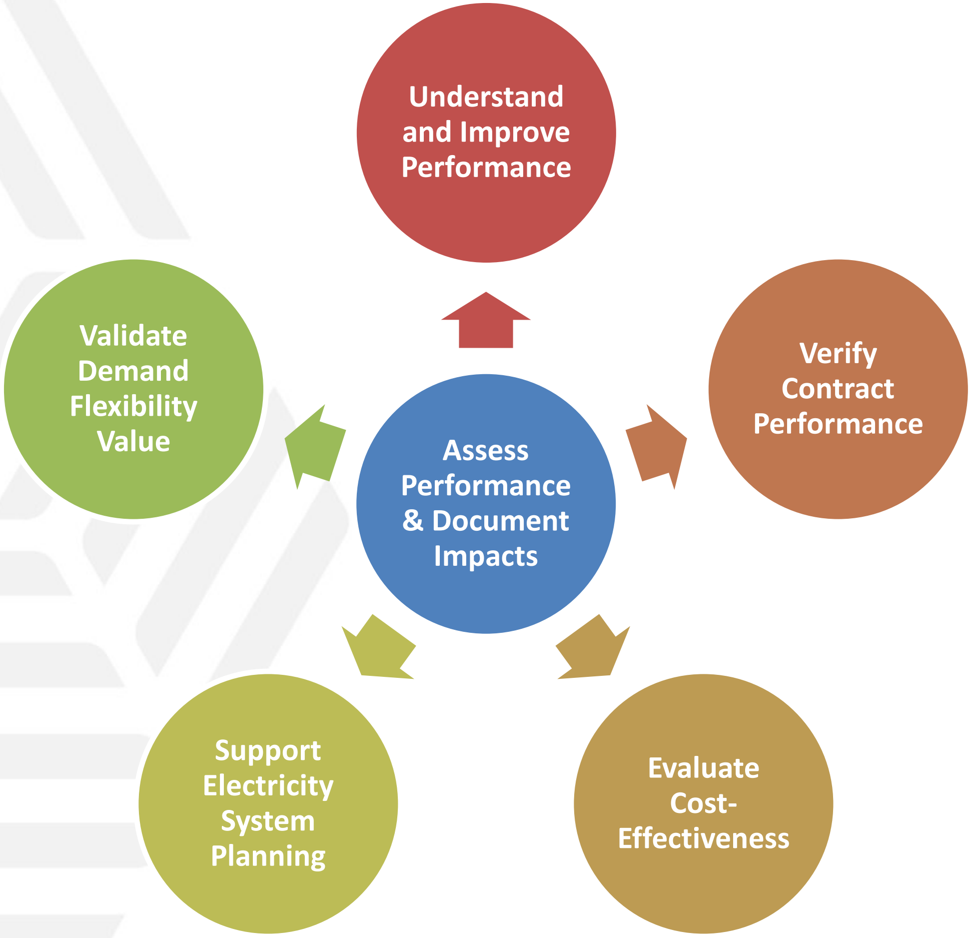
● most applicable, ◔ least applicable

Assessing Demand Flexibility Performance of Grid-interactive Efficient Buildings

Forthcoming report by Steve Schiller, Sean Murphy and Lisa Schwartz, Berkeley Lab

Performance assessments for demand flexibility provide multiple values.

- **Document impacts**: Document the energy savings of projects and programs in order to determine how well they have met their goals — e.g., has there been a good use of the invested money and time? Provide PROOF of the effectiveness of energy management.
- **Resource planning:** To support energy resource planning by understanding the historical and future resource contributions of energy efficiency as compared to other energy resources. Provide data to support efficiency as a reliable resource.
- **Understand why the effects occurred:** Identify ways to improve current and future projects and programs as well as select future projects. "You can't manage what you don't measure" and "Things that are measured tend to improve."



Five fundamental considerations define a demand flexibility assessment.

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- **Assessment objectives**–What information is the assessment intended to provide and how will the information be used?
- **Assessment boundary**–At what level will performance be assessed—whole building, building system or equipment level, by DER, and/or by flexibility mode?
- **Performance metrics**–What metrics will be assessed and how will be they defined? What data will be collected and at what temporal granularity (e.g., seconds to hours)?
- **Analysis methods**–How will metrics be calculated and with what expectations for certainty? Will baselines be used and, if so, how will they be defined?
- **Assessment implementation requirements**–What are the requirements with respect to data collection, privacy, cybersecurity and reporting? What entities will conduct the assessments? What is the duration of assessments (performance period covered)?

Determining the impacts of demand flexibility is both important and doable.

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Important

- For regulators, state energy officials, utilities and grid operators, documentation of demand flexibility performance is required to treat it as a reliable, cost-effective resource.
  - As basis for compensation (settlements) with event-based demand flexibility programs
  - For assessing the effectiveness of time-varying electricity rate schedules
- Building owners and occupants can use assessments to understand and improve demand flexibility performance and better control their electricity bills.

Doable

- Existing practices for assessing energy efficiency and demand response programs can be used, with some modification, for assessing the performance of demand flexibility. For example:
  - Measurement and verification (M&V) of air-conditioning cycling programs has been successfully conducted for several decades.
  - Whole building meters and building automation systems often can provide the necessary data.
- In a future with more sophisticated, integrated DERs and demand flexibility events becoming more common, some advances in M&V will be required. But experts do not see it as a major barrier.

Grid services that grid-interactive efficient buildings provide define the metrics that are used.

Flexibility Mode	Grid Services	Example Performance Metrics

Shed Load	Generation energy or capacity, contingency reserves, T&D non-wires solutions	• Demand (kW): For each load shed event:
		  • average amount of demand over a period of time
		  • baseline amount of demand over the same time period

Shift Load	Generation capacity, contingency reserves, T&D non-wires solutions, avoid renewable curtailment	• Demand (kW): For each load shed event:
		  • average amount of demand over a period of time
		  • baseline amount of demand over the same time period
		• Energy (kWh): Net total increase or decrease in building energy consumption during a defined period of time (e.g., shed event windows)

Modulate Load	Frequency regulation, voltage support, ramping	• Reactive power (kVAR), Voltage (V), and/or frequency (Hz) of power as measured at building interface with grid (service entrance) • Upper and lower bounds of frequency, voltage or reactive power regulation and ramping (load following)
Generate	Generation energy or capacity, contingency reserves, T&D non-wires solutions, ramping	• Power supplied (kW) • Energy supplied (kWh
Efficiency	Generation energy or capacity, contingency reserves, T&D non-wires solutions	• Demand reduction (kW) • Energy reduction (kWh

Categories of metrics

Metrics for demand flexibility may encompass four dimensions

- Quantity of demand flexibility provided
- Quality of demand flexibility provided
- Building non-energy services and occupant impacts
- Building-level and disaggregated performance contributions
  - Individual equipment or system impacts
  - Individual DER impacts
  - Individual flexibility mode impacts

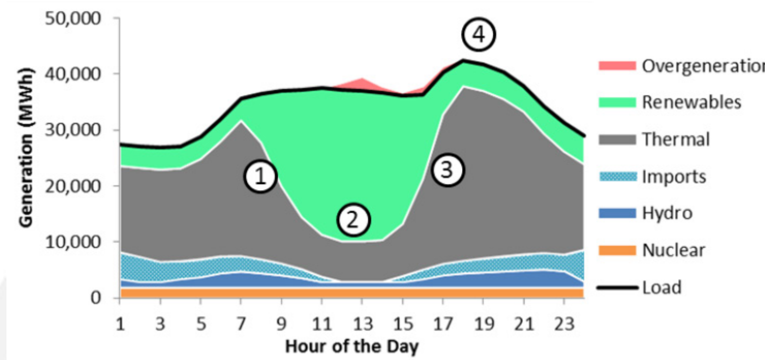
Actions states can take to advance demand flexibility assessments

- Encourage performance assessments and share results
- Adopt current best practices for demand flexibility assessments
- Support advances in assessment practices
- Improve access to data from existing utility billing meters
- Consider improvements in metering infrastructure and related standards and protocols

Opportunities for States to Advance Demand Flexibility

Demand Flexibility and State Goals

- Helps meet multiple state policy goals
  - Energy-related goals like resilience and reliability, electricity affordability, emissions, reducing energy waste, renewable energy generation, electrification, energy security, and grid modernization
  - Other goals such as economic development
- Reduces stress on grid
  - Growth in peak demand
  - Infrastructure constraints for T&D systems
  - Increasing share of variable renewable generation — utility-scale and distributed
  - Electrification of space and water heating, industrial processes and transportation



High levels of variable renewable generation increase multi-hour ramping (1, 3) and intra-hour variability and short duration ramps (1-4) for thermal power plants. Generation also may be curtailed (2). Source: Energy and Environmental Economics

- Provides higher value than traditional grid solutions with additional benefits
  - For consumers — e.g., asset value, more control over energy use
  - For society — e.g., jobs, energy security, resilience, environmental and public health benefits
- Improves building performance
  - States can lead by example

State and Utility Actions to Advance Demand Flexibility

	State and Local Governments	Utility Regulators	Utilities
1. Gather information and identify opportunities	Articulate state or local goals that demand flexibility can support Catalog existing pilots, standards, programs, procurements, policies, and regulations that address demand flexibility Establish a statewide (or municipal or county) forum to consider potential state and local targets for action	Engage with regulated utilities and stakeholders to identify benefits and opportunities related to demand flexibility for utility programs, planning, procurements and operations Identify DER requirements that may need updating	Assess achievable potential of demand flexibility for residential and commercial buildings and most cost-effective opportunities Conduct pilot projects Build on results to advance use of demand flexibility
2. Develop and implement strategies to integrate demand flexibility	Develop a roadmap with stakeholders to advance demand flexibility in support of state and local goals Conduct outreach and education about opportunities and benefits	Provide direction on utility cost recovery and compensation mechanisms for participating customers and third-party service providers Enable incentives and rate designs to facilitate use of demand flexibility for utility programs, procurements and time-varying rate options	Incorporate demand flexibility in programs, planning, procurements and operations Test incentive and rate design approaches

[1] State energy offices may perform many of these roles at the state level. Other state agencies and local governments that have policy, regulatory or program responsibilities or that operate buildings and facilities also may have roles. Public utility commissions are addressed separately in the next column.

	State and Local Governments	Utility Regulators	Utilities
3. Accelerate adoption	Regularly assess and report on progress toward metrics identified in roadmap Identify strategies to overcome remaining barriers and ways to improve demand flexibility implementation to achieve state or local goals Continue to support sharing of project and program results and best practices and provide recognition for outstanding achievements	Provide guidance for enhanced economic valuation methods Establish requirements for robust and cost-effective retrospective assessments of demand flexibility performance Continue to assess barriers and opportunities	Implement enhanced economic valuation methods Conduct retrospective assessments consistent with regulatory guidance

Source: Forthcoming report by Lisa Schwartz and Greg Leventis, Berkeley Lab, *Grid-Interactive Efficient Buildings: An Introduction for State and Local Governments*

NASEO-NARUC Grid-Interactive Efficient Buildings Working Group

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- Supported by U.S. DOE Building Technologies Office
- Inform states about GEB technologies and applications
- Identify opportunities and impediments
- Identify and express state priorities, concerns, interests
- Recognize temporal and locational value of EE and other DERs
- Enhance energy system reliability, resilience, and affordability

Inform state planning, policy, regulations, and programs

More information here. Additional states (public utility commissions and state energy offices) are welcome to join.

DOE Intends to Invest up to $42 Million into "Connected Communities"

Connected Community - a group of grid-interactive efficient buildings (GEBs) with diverse, flexible end use equipment that collectively work to maximize building and grid efficiency without compromising occupant needs and comfort.

Funding opportunity would enable regional GEB communities to share research results and lessons learned on projects that increase grid reliability, resilience, security and energy integration well into the future.

- **Demonstrate and evaluate** the capacity of buildings as grid assets by **flexing load** in both **new developments and existing communities** across diverse climates, geography, building types and grid/regulatory structures
- **Share research results** and lessons-learned on projects that improve energy affordability, increase grid reliability, resilience, security and energy integration


Photo Courtesy of Patrick Schreiber via Unsplash

What We're Looking For When the FOA is Released

- ✓ Teams of strategic stakeholders
- ✓ Sets of multiple buildings
- ✓ Multiple DER integration
- ✓ Ability and willingness to share data
- ✓ Diversity of projects (geography, building type, vintage, regulatory)

What We Hope to Achieve

- Measured impact of building as grid assets
- Solutions that address diverse grid needs that can be scaled in size and in other communities
- Input from occupants on impact and comfort level
- Demonstrated new business models for demand flexibility and DER coordination and optimization
- Online solutions center on best practices

Request for Information on Connected Communities is on its way, too, so stay tuned!

SCAN ME

We Look Forward to Your Feedback

Visit eere-exchange.energy.gov or Scan the QR Code to read the Notice of Intent:
"DE-FOA-0002249: Notice of Intent to Issue Funding Opportunity Announcement No. DE-FOA-0002206 Connected Communities"

For more information:
www.energy.gov/eere/buildings/geb

David Nemtzow David.Nemtzow@ee.doe.gov

Select LBNL Resources

- State and Local Energy Efficiency (SEE) Action Network. *Grid-Interactive Efficient Buildings: An Introduction for State and Local Governments.* Prepared by L. Schwartz and G. Leventis, Lawrence Berkeley National Laboratory. Forthcoming.
- SEE Action Network. *Determining Utility System Value of Demand Flexibility From Grid-Interactive Efficient Buildings.* Prepared by T. Eckman, L. Schwartz, and G. Leventis, Lawrence Berkeley National Laboratory. Forthcoming.
- SEE Action Network. *Assessing Demand Flexibility Performance of Grid-Interactive Efficient Buildings.* Prepared by S. Schiller, S. Murphy, and L Schwartz, Lawrence Berkeley National Laboratory. Forthcoming.
- T. Woolf, B. Havumaki, D. Bhandari, M. Whited, and L. Schwartz. *Benefit-Cost Analysis for Utility-Facing Grid Modernization Investments.* Lawrence Berkeley National Laboratory. Forthcoming.
- Satchwell, A., P. Cappers, J. Deason, S. Forrester, N. Frick, B. Gerke, and M.A. Piette. *A Conceptual Framework to Describe Energy Efficiency and Demand Response Interactions.* Lawrence Berkeley National Laboratory. Forthcoming.
- Developing and Evaluating Metrics for Demand Flexibility in Buildings: Comparing Simulations and Field Data. Forthcoming.
- Time and locational sensitive value of efficiency
  - Time-Sensitive Value of Efficiency: Use Cases in Electricity Sector Planning and Programs (2019); Time-varying value of electric energy efficiency (2017); Time-varying value of energy efficiency in Michigan (2018); Locational Value of Distributed Energy Resources. Forthcoming
- End-Use Load Profiles for the U.S. Building Stock - U.S. DOE Building Technologies Office funded project that is a multi-lab collaboration to create end-use load profiles representing all major end uses, building types, and climate regions in the U.S. building stock.
  - End-Use Load Profiles of the U.S. Building Stock: Market Needs, Use Cases and Data Gaps; End-Use Load Profile Inventory
- Hoffman, I., C.A. Goldman, S. Murphy, N. Mims, G. Leventis, and L. Schwartz. The Cost of Saving Electricity Through Energy Efficiency Programs Funded by Utility Customers: 2009-2015. 2018.
- Schwartz, L., I. Hoffman, S. Schiller, S. Murphy, and G.Leventis. Cost of Saving Electricity Through Efficiency Programs Funded by Customers of Publicly Owned Utilities: 2012–2017. 2019.
- Frick et al. Peak Demand Impacts from Electricity Efficiency Programs. 2019.
- Frick et al. Energy Efficiency in Electricity Resource Planning. Forthcoming.

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Example benefits and grid services that buildings with demand flexibility can provide

Grid Services	Potential Costs Avoided (or Deferred)
Generation	
Energy	Power plant fuel, operation and maintenance (O&M), and startup and shutdown costs
Capacity	Capital costs for new generating facilities and associated fixed O&M costs
Ancillary Services	
Contingency Reserves	Power plant fuel and O&M costs
Frequency Regulation	Power plant fuel and O&M costs
Ramping	Power plant fuel, O&M, and startup and shutdown costs
Delivery	
Non-Wires Solutions	Capital costs for transmission & distribution (T&D) equipment upgrades
Voltage Support	Capital costs for voltage control equipment (e.g., capacitor banks, transformers)