



U.S. DEPARTMENT
of **ENERGY**

Office of Energy Efficiency
and Renewable Energy

Industry and Lab Collaborations Drive Grid-Edge Technology Innovation

Brian Walker, Ph.D.

Technology Manager, Emerging Technologies Program

Grid-Edge R&D, Validation, and Tools

Coordinated Controls R&D

Coordinated, interoperable controls and communications (from the grid through to the building end use) are necessary to improve reliability of the electric grid and to reduce costs due to custom integrations of devices.

EXAMPLE PROJECT – PacificCorp is testing a hybrid control archetype that allows grid operators to develop real-time testing and control.



Field Validations at Scale

Field validations at scale produce necessary data (device-, building-, and grid-level) for utilities to have confidence in the reliability of grid-edge technologies to provide headroom and reduce infrastructure costs.

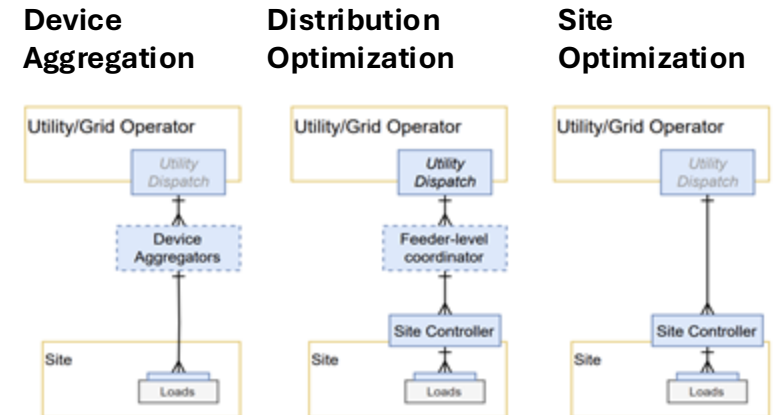
EXAMPLES – Multiple announced projects will bridge traditional models for demand response with flexible, grid services in real-world situations for utilities, grid planners, and vendors.



Tools for Technology Bridging

Grid-edge technology must be developed to operate flexibly across a patchwork of device manufacturers, building operators, grid operators, and control archetypes.

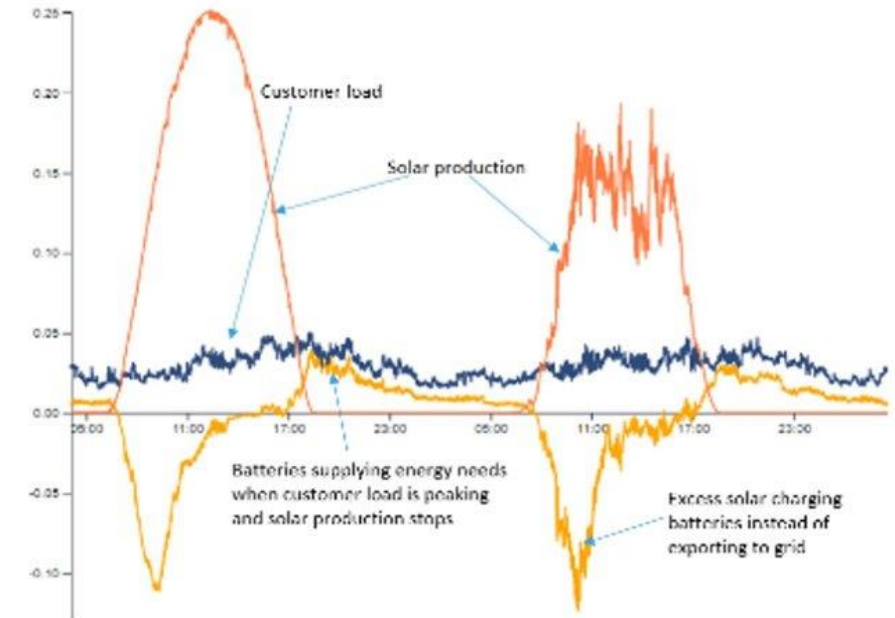
EXAMPLE PROJECT – UCI, SunPower, and Southern California Edison are partnering with KB Homes to test dynamic control of load, energy efficiency measures, and batteries to balance the local grid, provide emergency resiliency, and reduce customer costs.



What are the latest results from field integrations of buildings and devices at the grid edge?

PacifiCorp and Rocky Mountain Power have a project to develop and test a utility-managed DER control program that integrates buildings, loads, and customer experience.

- PacifiCorp is studying customer experience and baseline scalability and replicability.
- Hybrid archetype between aggregator and direct controls allows grid operators to develop real-time experience with the best systems.



Peak Load Management
(48-hour timeframe)

**Generation 1.0 (2022–2027)
(PacifiCorp & Rocky Mountain Power)**

Validating innovative grid-edge integrations in the field

Dimensions of evaluation plans (1st gen)



Building Space Constraints

Electric retrofits may require additional space for condensers or refrigerant piping depending on the system type



Infrastructure Impacts

Electrical panel and wiring upgrades are typically needed when converting to an electric system, especially if siting locations will change



Capital Cost and Constraints

The capital and cost required to retrofit the system can be significant and involve updates to building infrastructure



Project Timeline

Timelines vary depending on the scope and scale of the retrofit, so it is an important consideration for impact on business operations



Payback

Payback varies depending on electric utility rates and the ability to claim emissions savings to leverage incentives

Evaluation criteria (2nd gen)

- **Benefit-cost analysis**
- **Stakeholder benefits and experience**
- **Energy impacts of grid edge technical measures**
- **Additionality vs. industry BAU**
- **Reliability benefit**

Planned data from 2nd gen grid edge field projects



Quantity (e.g., kW, kWh) and **quality** (e.g., duration, **response time**, power quality/tolerance, persistence) of actual energy **load** and/or generation during periods of interest



Voltage and reactive power measurements and others, as required to support proposed grid services value streams



Building **occupant benefits** (e.g., cost savings, comfort and convenience improvements)



Financial costs (e.g., capital costs, energy costs, disruption) and benefits (e.g., avoided costs) for both building owners or occupants and the grid



Case studies that will include data **trends**, research questions and findings, and **promising operational practices**



Meter-based (existing buildings) and/or versus-code (new construction) **analysis**



Survey-based assessment of, e.g., occupant/customer experience, performers' regulatory and policy barriers and enablers



Measurement-based assessment of, e.g., indoor environmental conditions



Descriptive characterizations of, e.g., benefits, delivery methods



Techno-economic assessments of, e.g., **cost effectiveness benchmarked against alternative methods**

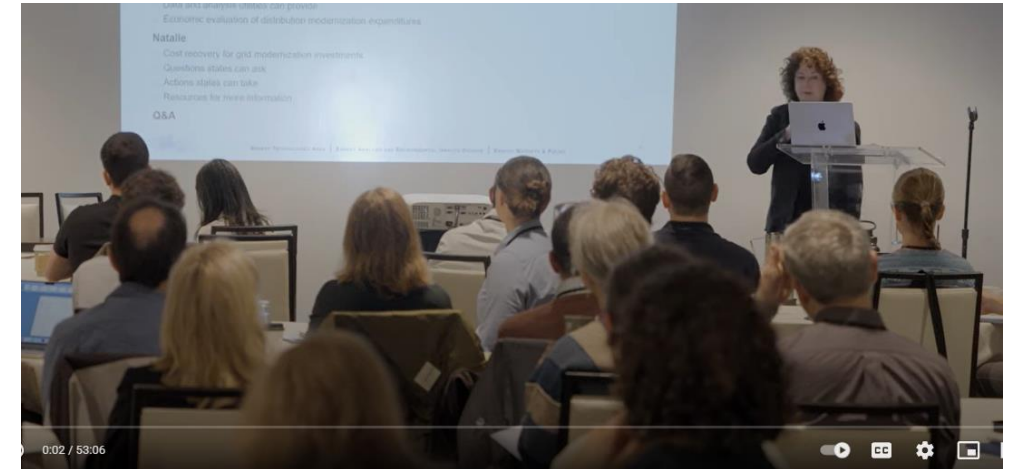
How have states prepared for needed utility investments in distribution infrastructure?

Collaborative effort provides training and education for public utility commissions, state energy offices, and state utility consumer offices: best practices for Integrated Distribution System Planning (IDSP) and new tools and technologies.

Training topics:

- New planning methods and tools
- Forecasting for electrification, data centers, and other large loads and resulting distribution upgrade needs
- Integrating DER programs and retail rates with IDSP
- Addressing uncertainty and risk, including scenario analysis
- Coupling IDSP with other planning processes
- Data that states and stakeholders can request

Plus: [catalog of state planning requirements](#)



Collaborators: NARUC, NASEO, NASUCA, EPRI, regional organizations representing state agencies

Feedback from training participants

“The training was relevant, engaging, and well-paced. We learned a great deal from the presentations and benefited from the invaluable interactions we had with the expert trainers and participants from across the country.”

– Commissioner Dr. Zenon Christodoulou, New Jersey Board of Public Utilities

“The training went a long ways toward filling numerous knowledge gaps. . . . I now have necessary tools if my office wants to push for a formal IDSP process in my state.”

“I’ve spent the last couple days . . . attending this DOE/NARUC/NASEO distribution planning and resilience training. Very impressed with the quality of the training. Definitely worth the 5-hour drive.”

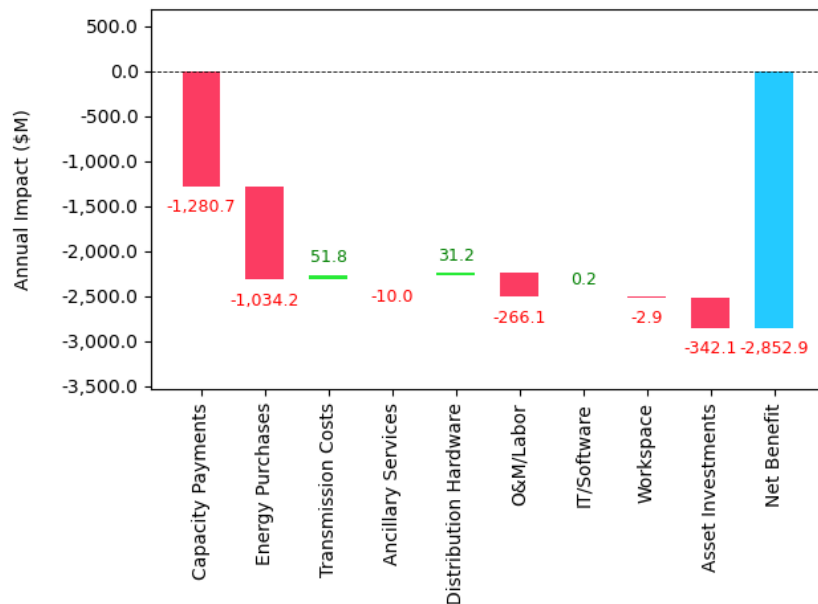
– Other state agency participants in 2024 regional trainings



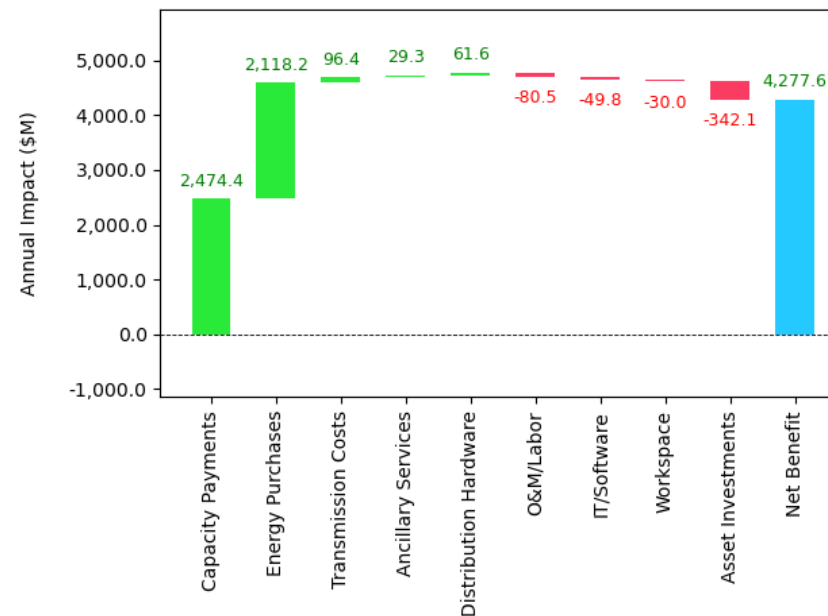
What is the impact of rate design on the physical and economic performance of the grid?

At high adoption rates, time of use (TOU) requires higher energy and capacity payments, while real-time pricing (RTP) creates substantial savings.

System Costs: TOU vs. Flat Rate



System Costs: RTP vs. Flat Rate



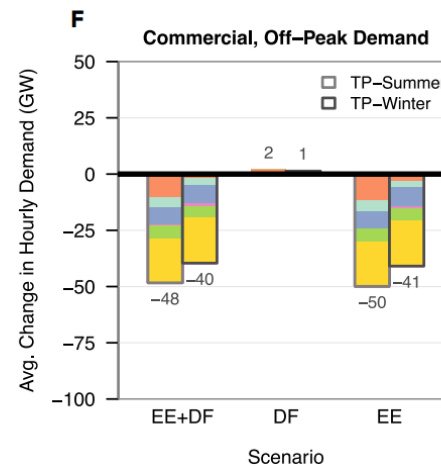
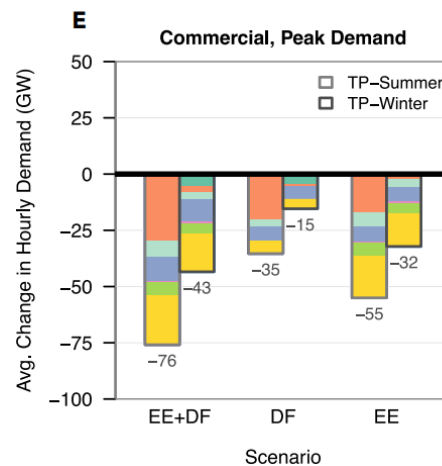
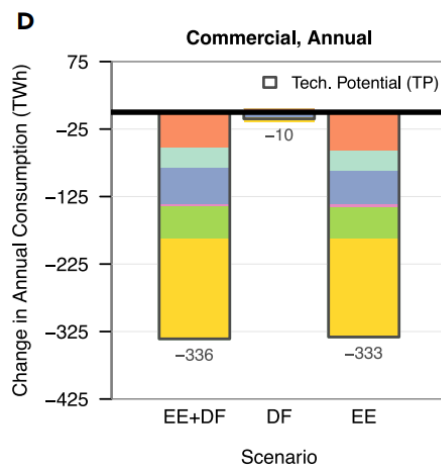
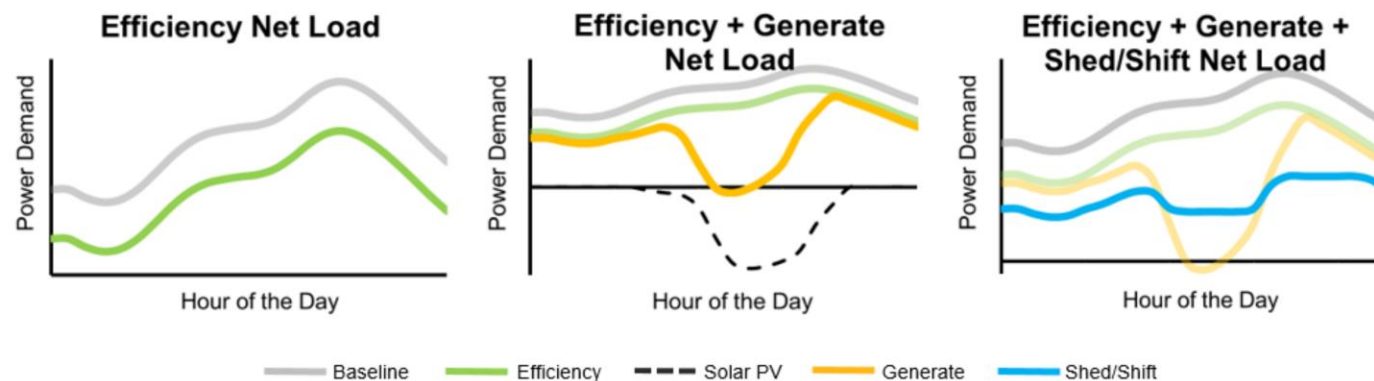
The PAVER study models increasingly dynamic rates deployed at scale on a near-term grid.

- Dynamic prices can reduce system costs for all customers.
- A wide range of rate design options exist to manage risk exposure and share savings.

Source: Publication in preparation; builds on prior work: [Distribution System Operation with Transactive \(DSO+T\) Study | PNNL](#)

What is the value of energy efficiency for demand flexibility?

Efficiency with local generation can alleviate power demands to the grid.



- Heating
- Cooling
- Ventilation
- Lighting
- Water Heating
- Refrigeration
- Office Electronics

Efficiency and demand flexibility complement one another in reducing hourly power demands.

Product level: Innovation in Connected Commercial Lighting

The L-Prize provides cash rewards for lighting industry innovation in critical areas including energy efficiency, quality, affordability, and electric grid integration

Breakthrough innovations from the L-Prize, newly commercialized:



Open standards-based miniature wireless smart sensor/controller

<https://mwconnect.us/news/mwconnect-introduces-new-compact-sensor-controller-series/>



Modular luminaire with integrated controls and breakthrough efficiency and quality of light performance
<https://www.signify.com/en-us/brands/product-highlights-new/products/ledalite/bloombox>

Prototype Phase Winning Companies

signify



lightly



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Thank You

brian.walker@ee.doe.gov



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