U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Grid Facing Building Controls Portfolio Overview

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Content Overview

- Definitions and positioning
- Use cases
- Research needs
- High level intro to project portfolio
- Discussion of gaps

Transactive Control

It is not new…..

….but we do have some new problems it could help us solve.

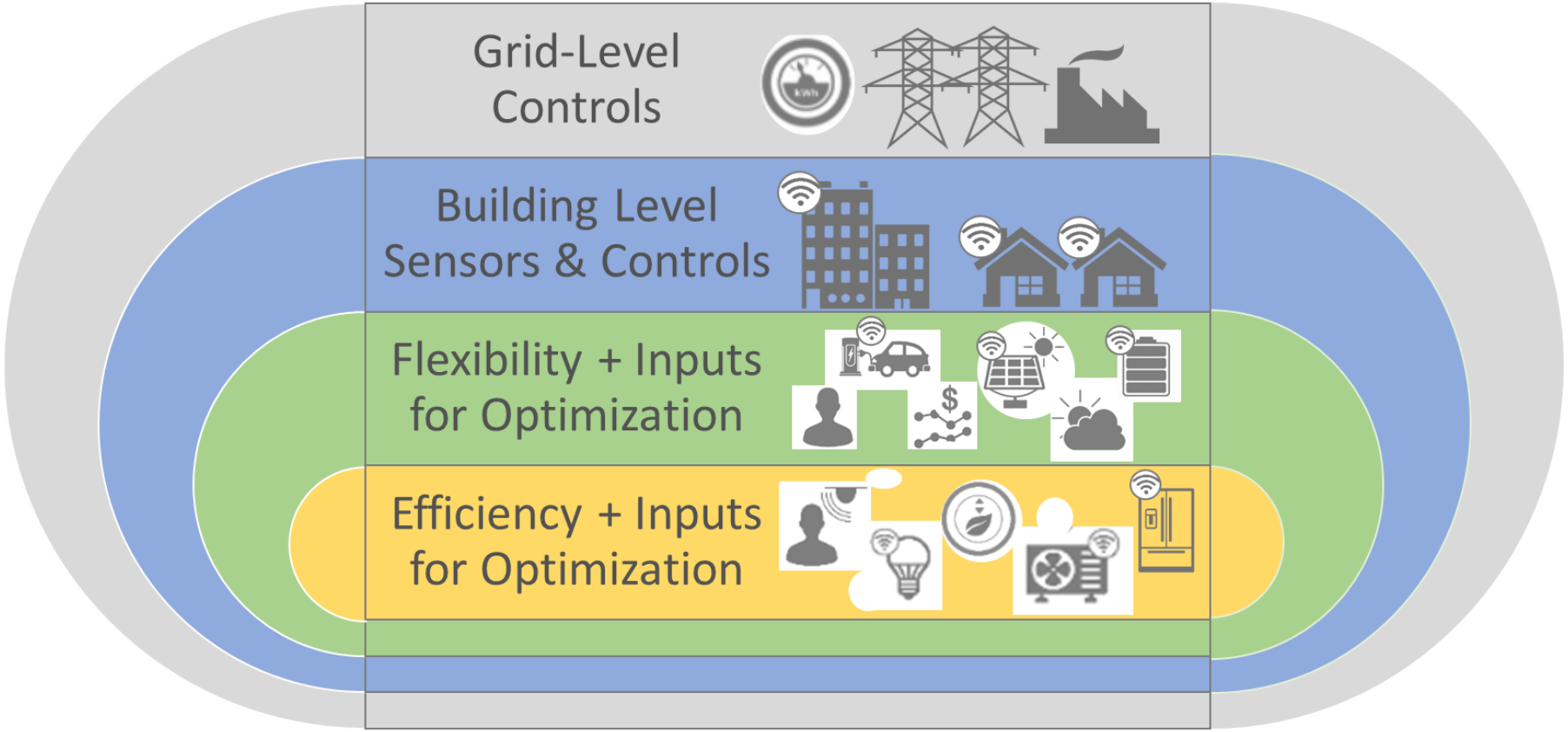
Transactive Energy

The term "transactive energy" is used here to refer to **techniques for managing the generation, consumption or flow of electric power** within an electric power system **through the use of economic or market based constructs while considering grid reliability constraints.** The term "transactive" comes from considering that decisions are made based on a value. These decisions may be analogous to or literally economic transactions.

-Definition of "transactive energy" from the Gridwise Architecture Council

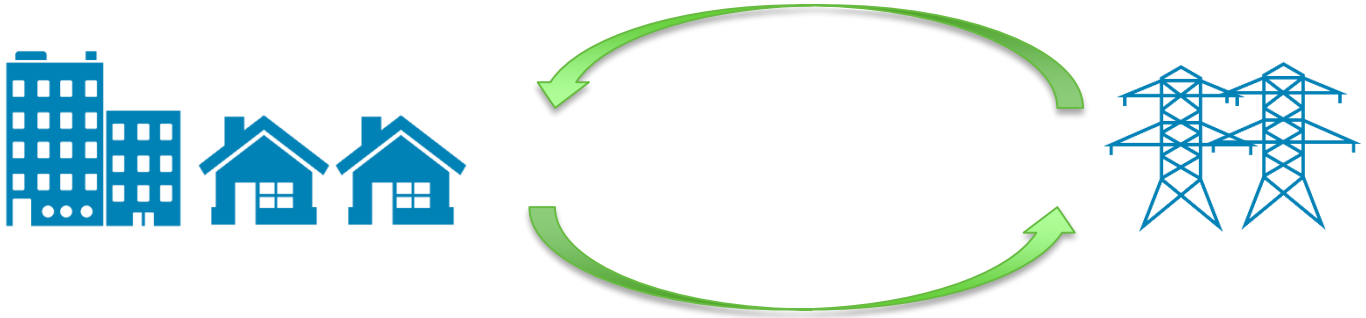
https://www.gridwiseac.org/about/transactive_energy.aspx

Transactive Control for Transactive Energy



Building Transactive Controls Portfolio Goal

Provide a transactive control system that negotiates securely with the grid to respond within a required timeframe to provide the requested service to the grid and within acceptable occupant comfort and productivity.

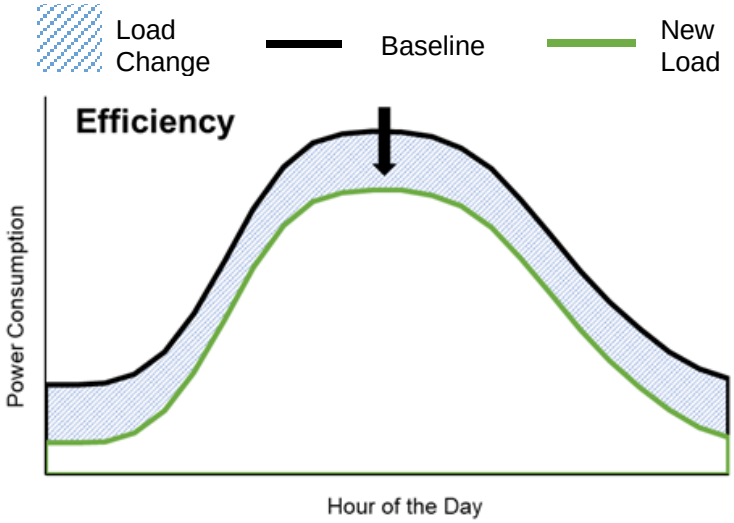


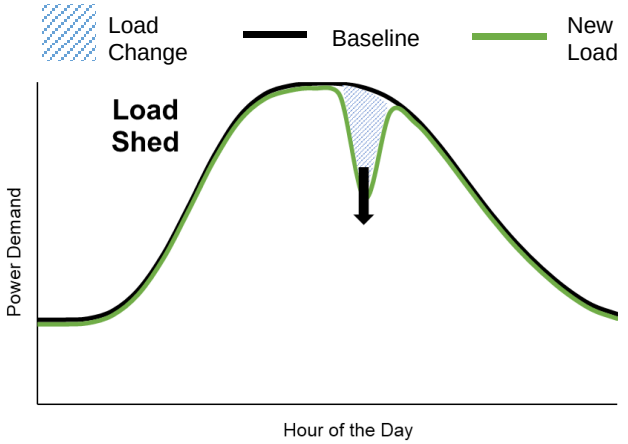
OE is developing a complementary goal to "*Provide a transactive control system that negotiates securely with buildings to request from them a defined grid service within a specific timeframe.*"

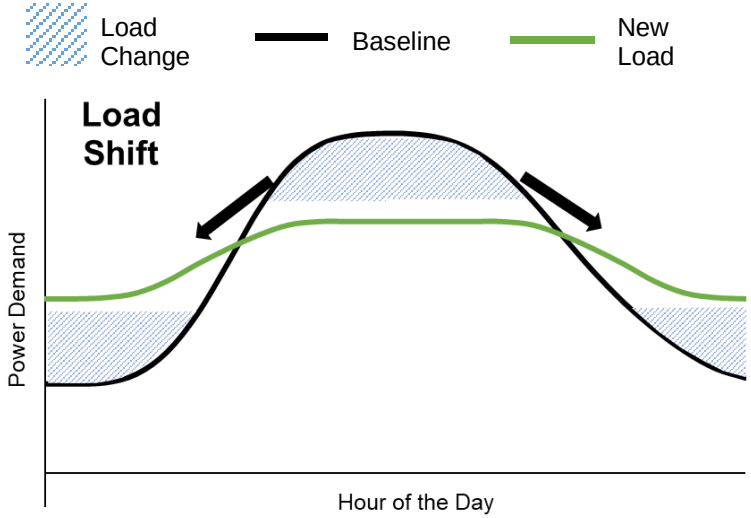
Use cases

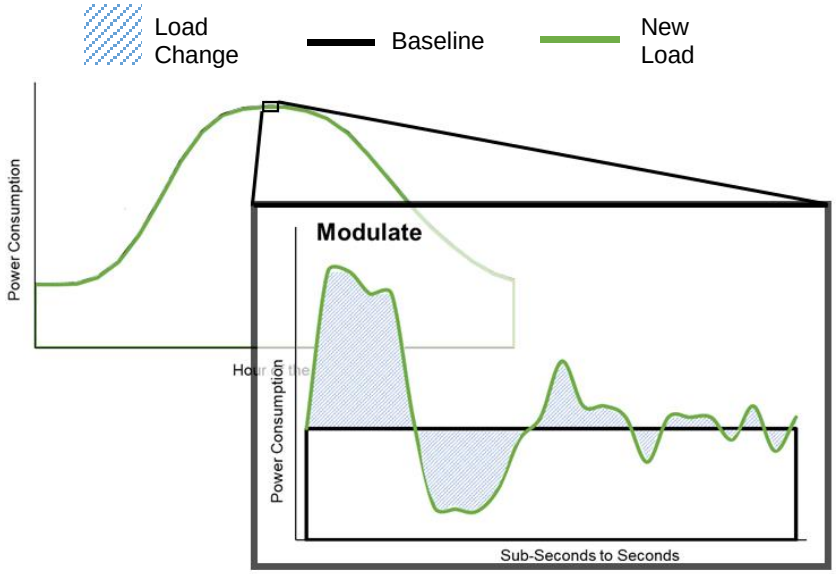
1. Reduce Critical Peak Load
2. High Penetration of Renewable Energy in Distribution Systems
3. Improve asset utilization through locational pricing
4. Reduce outage and recover time through intelligent and cold load pick up

Flexibility Modes









Priority Research Needs

1. We need to know our building needs
2. We need to characterize a buildings ability to offer grid services to participate in transactive systems
3. We need open and standard communication protocols
4. We need to ensure security of the cyber-physical system
5. We need to make sure the system is scalable
6. We need to understand the real world implementation challenges
7. We need to be able to recruit existing infrastructure for use in demand response

1. Knowing our building needs

Predictive models for building energy needs

This research question largely leverages our existing work for energy efficiency controls

Site specific weather modeling

ANL – PI: Zhi Zhou - Data Driven Weather and Energy Forecasting

NREL – PI: Rui Yang- Machine-Learning-Driven, Site-Specific Weather Inference for Building Energy Forecasting

2. Characterizing the ability to offer grid services

- ORNL – Teja Kuruganti - Smart Neighborhood
- GMLC – RDS - Teja Kuruganti - Integration of Responsive Residential Loads into Distribution Management Systems
- NREL – Tony Burrell - Behind the Meter Storage (with VTO and SETO)
- NREL – Xin Jin, AI smart communities (with SETO)
- PNNL – Draguna Vrabie - Comprehensive Pliant Permissive Priority Optimization
- LBNL - Jared Langevin - Risk-based framework for dynamic assessment and prioritization of flexible building loads

Risk-based framework for dynamic assessment and prioritization of flexible building loads (LBNL)

- **What:**
  - An open-source decision tool for commercial building operators that dynamically ranks flexible load control options based on associated risks, benefits and operator preferences.
- **Why:**
  - Commercial operators either lack the automated control resources needed to respond to DR signals on short time scales or rely on pre-determined sets of actions that do not account for changes in operational patterns and control priorities, exposing operators to substantial risks of service losses (e.g., reduced occupant comfort, productivity) which limits their participation in demand response.
- **Result:**
  - The decision making tool will facilitate broader and more effective demand-response participation in commercial buildings by removing the burden of manual flexible load prioritization from building operators while retaining their response preferences

Partners

U.S. GSA

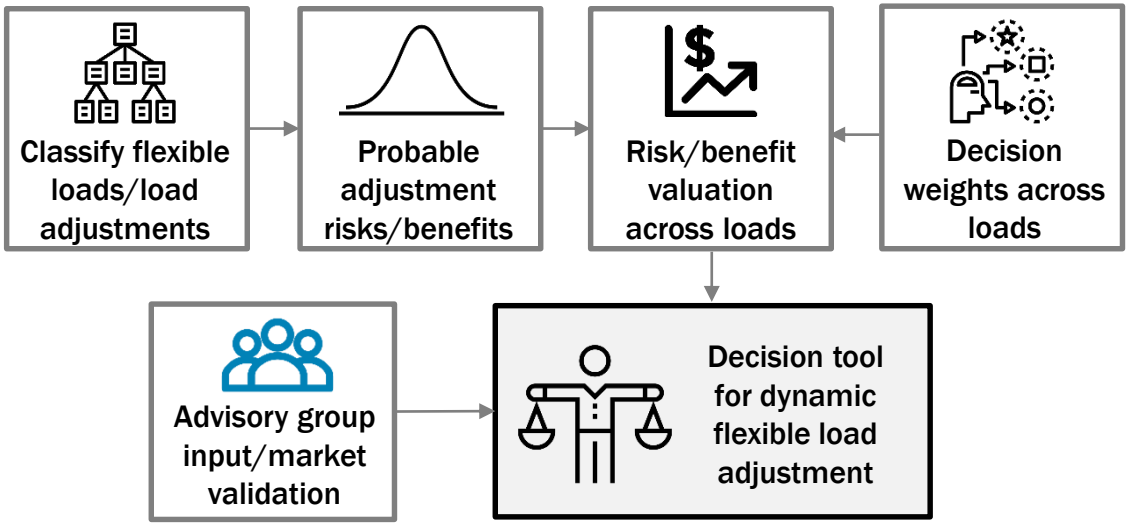
DC Office of Resilience

Deloitte Consulting

The Danfoss Group

Risk-based framework for dynamic assessment and prioritization of flexible building loads (LBNL)

- **How:**
  - Develop overall Bayesian decision network, establish scope of modeling/measurement work
  - Develop models of the demand and service impacts from flexible load adjustments for two baseline models
  - Develop models of decision-maker valuations of flexible load adjustments based on discrete choice experiments and analysis
  - Finalize the decision maker load valuation and validate tool performance
  - Publish the technical guide and results



3 and 4 Communication and security

- VOLTRON
- GAP

5. Scaling up

- ORNL – Teja Kuruganti - Smart Neighborhood
- NREL – Xin Jin, AI smart communities (with SETO)
- PNNL - Srinivas Katipamula - Scaling of Building Transactive Control and Coordination to Support Grid Operations

6. Understanding Real World Challenges

- ORNL – Teja Kuruganti - Smart Neighborhood
- NREL – Xin Jin, AI smart communities (with SETO)
- GMLC – RDS - Teja Kuruganti - Integration of Responsive Residential Loads into Distribution Management Systems

We can also leverage our AFDD work in this area.

7. Recruiting existing infrastructure

- PNNL – Nora Wang – Transactive-Control-Based Connected Home Solution for Existing Residential Units and Communities
- Gap?

GAPS

- Understanding if buildings can provide reactive power
- More work is needed in cyber physical security
- Other?