# BUILDING DESIGN AND OPERATION

## OVERVIEW

Buildings are responsible for roughly 40% of energy consumed in the U.S. yearly. This amounts to approximately 40 quadrillion Btu and is projected to increase steadily. The magnitude of load demand and its inherently variable nature present an increasingly difficult challenge for the utility grid to meet. In addition, California's renewable portfolio standards mandate 33 percent of the state's grid mix to be provided by renewables—a level at which studies conducted at UCI APEP have shown to introduce more intermittencies than the rest of the grid can absorb economically. Energy efficiency (EE) and demand response (DR) measures have the ability to mitigate these problems by reducing building energy consumption, reducing cost of electricity, and bolstering grid stability. EE refers to the static control of load to achieve a net demand reduction. DR refers to the dynamic adjustment of load prompted by energy supply or price.

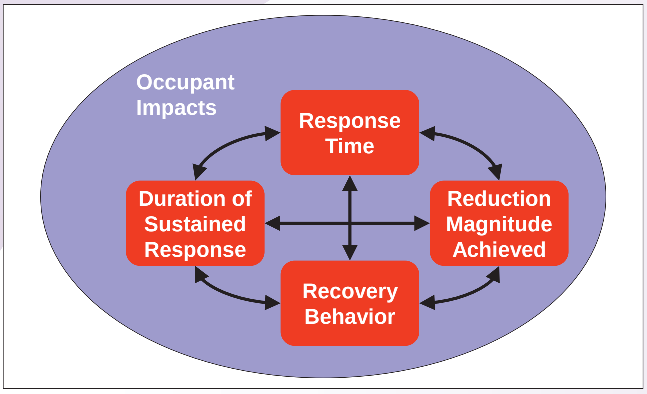
This project aims to assess the potential for EE and DR, and characterize the controllability of load demand of the UCI campus community.

## GOALS

- Understand the end-use make-up of building loads and identify opportunities for energy efficiency (EE) improvements and demand response (DR) implementations
- Establish metrics for evaluation of EE and DR measures
- Develop models to simulate EE and DR measures and characterize their performance

## RESULTS

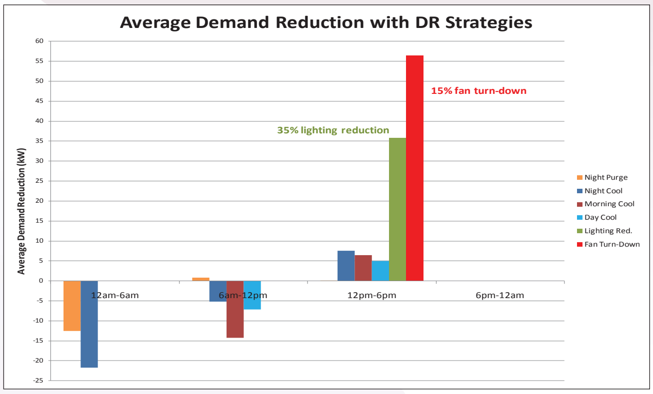
Metrics established for DR measures are shown below. Response time, reduction magnitude achieved, duration of sustained response, and recovery behavior are interrelated with all contributing to some adverse impact on the occupant. The metric for EE measures is only the reduction magnitude achieved since EE measures are non-dynamical and must not have occupant impacts.




**Evaluation metrics for demand response measures.**

## RESULTS (continued)

Models of buildings on the UCI campus have been created on the eQUEST building simulation tool and verified with metered building data. Preliminary results indicate the most substantial DR reduction is achievable via fan power reduction of the heating, ventilation, and air conditioning (HVAC) fan when zone temperatures of the building are allowed to float to 80 degrees F. These results will be verified with empirical testing on the modeled buildings.




**Average results of DR simulations in eQUEST.**

Additional models were developed from scratch by UCI APEP in the MATLAB Simulink dynamic simulation environment. These models are physical, dynamical models of a mid-sized commercial building on the UCI campus named the Multipurpose Science and Technology Building (MSTB) and its HVAC and lighting systems. These models are developed to allow increased flexibility in operational control to be implemented and, thereby, enable better characterization of the full potential for DR.

**Photo of the Multipurpose Science and Technology Building.**

## RECENT PUBLICATIONS/PAPERS


J.Q. Public, I.M. Smart (2006). This is the best project ever. J. of Prop. Power, Vol. 12, No. 3, pp. 22-222.


## PERSONNEL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