DERConnect

A National Science Foundation User Facility for Control of Distributed Energy Resources

Distributed Energy Resources Connect (DERConnect)

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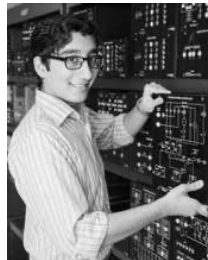
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DERConnect is a National Testbed for Autonomous Energy Grids

$$\min \sum_{\alpha=1}^{n} f_\alpha(x_\alpha(\tau))$$

$$\underline{x}_\alpha(\tau) \le x_\alpha(\tau) \le \overline{x}_\alpha(\tau)$$
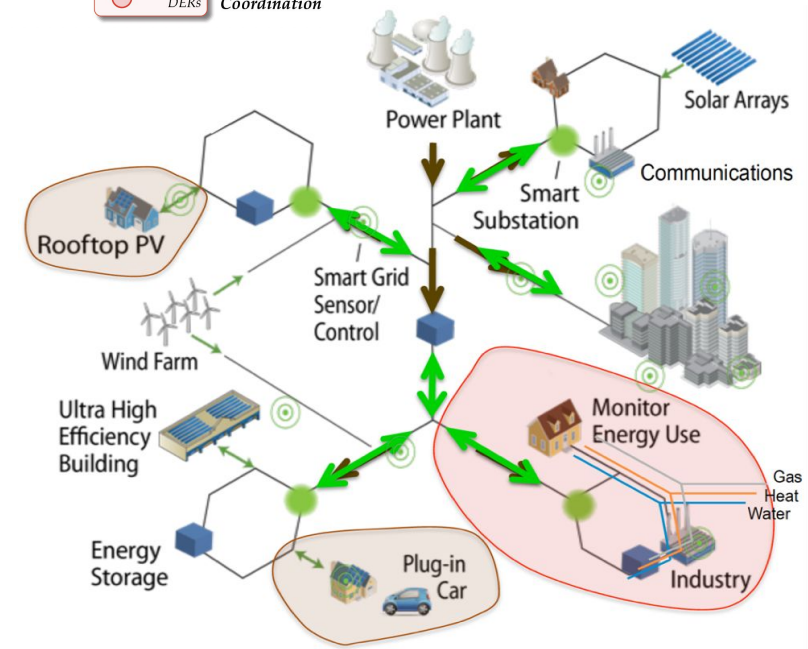
$$\sum_\alpha x_\alpha(\tau) = P_r(\tau)$$

- 2,500 actual devices. 2M simulated nodes.
- Small form factor DERs jointly serve critical power grid needs.
- Accessible nationally
- Made possible due to a number of technological advances at UCSD:
  - Integration of renewable energy sources
  - Buildings as sensory and control programmable systems
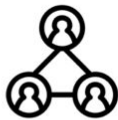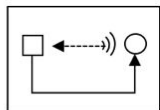 - EV as programmable systems

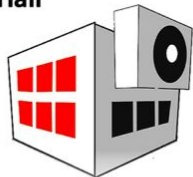Ben Kroposki, NREL
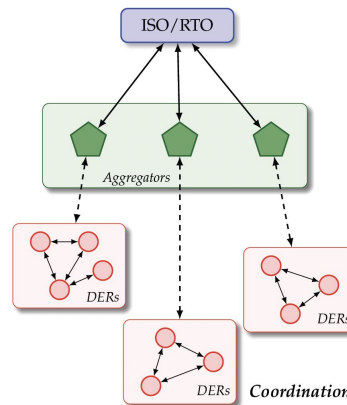
DERConnect

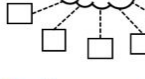Outside Users

DERConnect Core: Robinson Hall

Demand Response
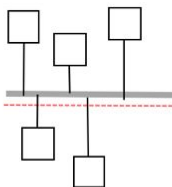
Building with Smart Control (Air Handlers, Lighting, Occupancy Sensors)
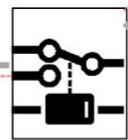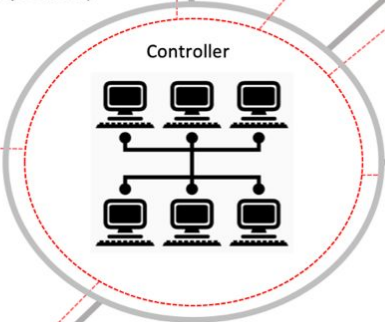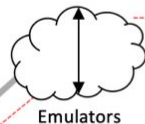
Virtual Power Plants

Real-Time Grid Simulator

US Power Grid

Controller

Emulators

Battery Energy Storage

Add-on DERs, Converters and Protective Relays

Plug and Play Connection Hub
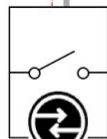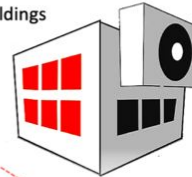
Islanding Controller

UCSD Microgrid Resources

11 Buildings

15 PV Plants with Smart Inverters

Cybersecurity

6x 500 kW Energy Storage Testpads

Smart Inverter Testing Lab

366x 7 kW
1x 75 kW
EV Chargers
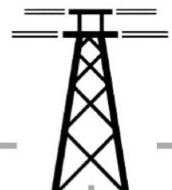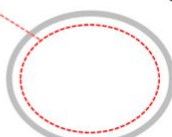
To Main Grid

Other Microgrid Resources

Power Routing
Communications

Case Study

● Tracking a frequency regulation signal with 176 DERs
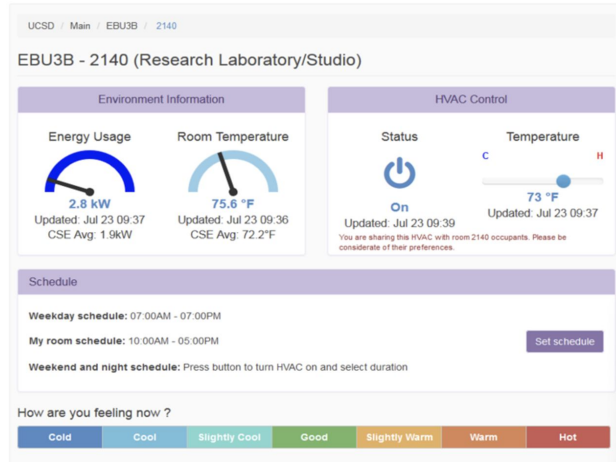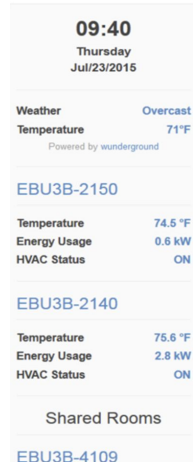● Total RMSE: **9.7%**
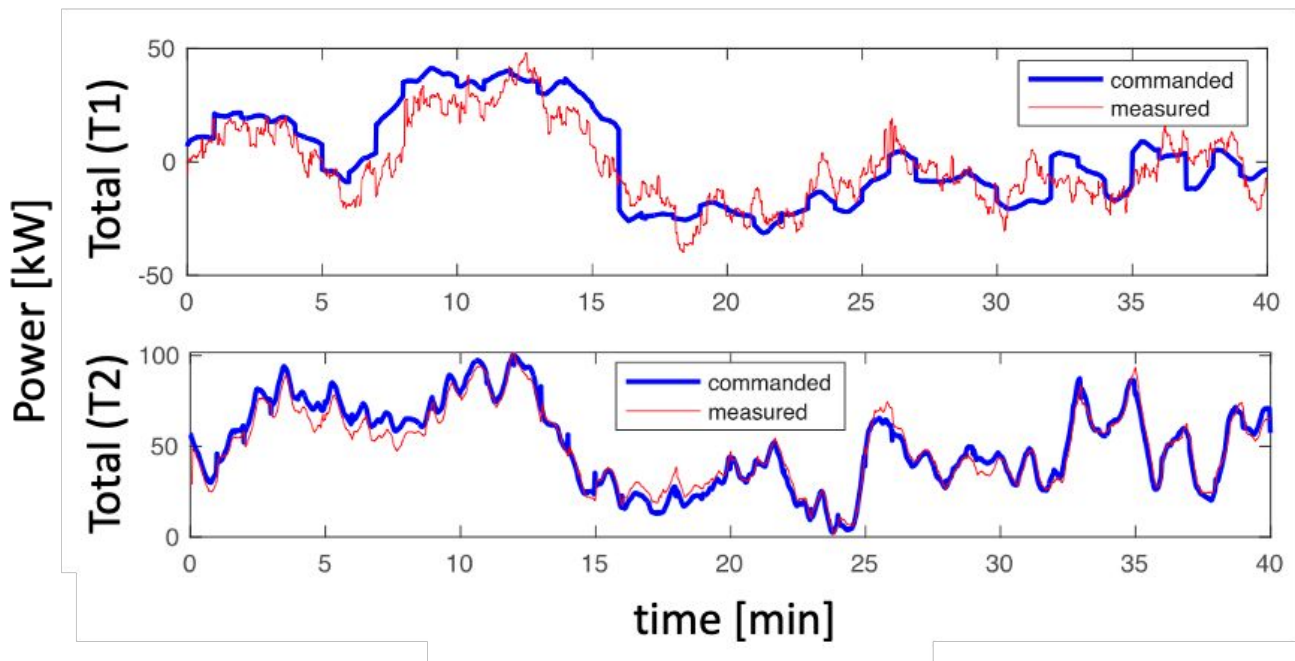
Building Operations
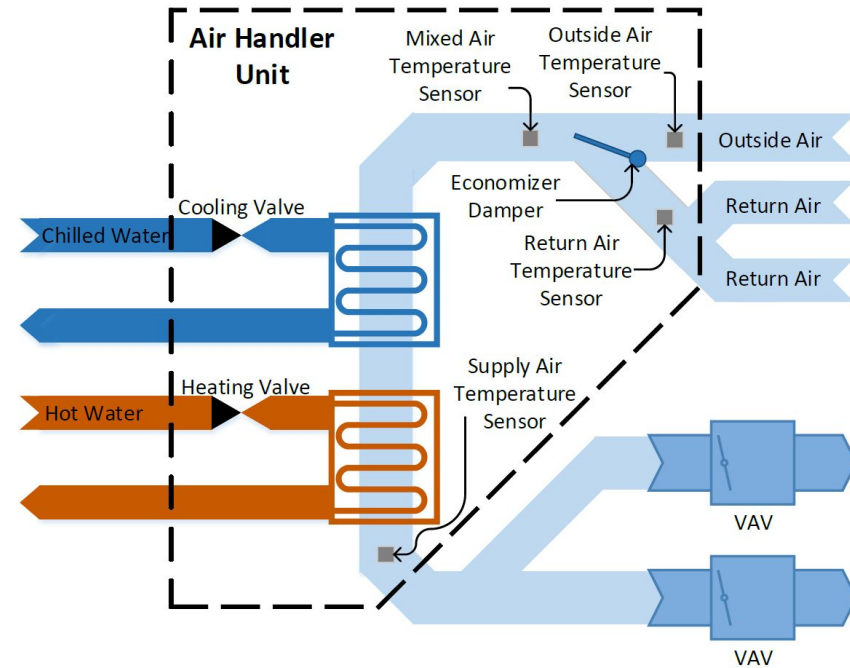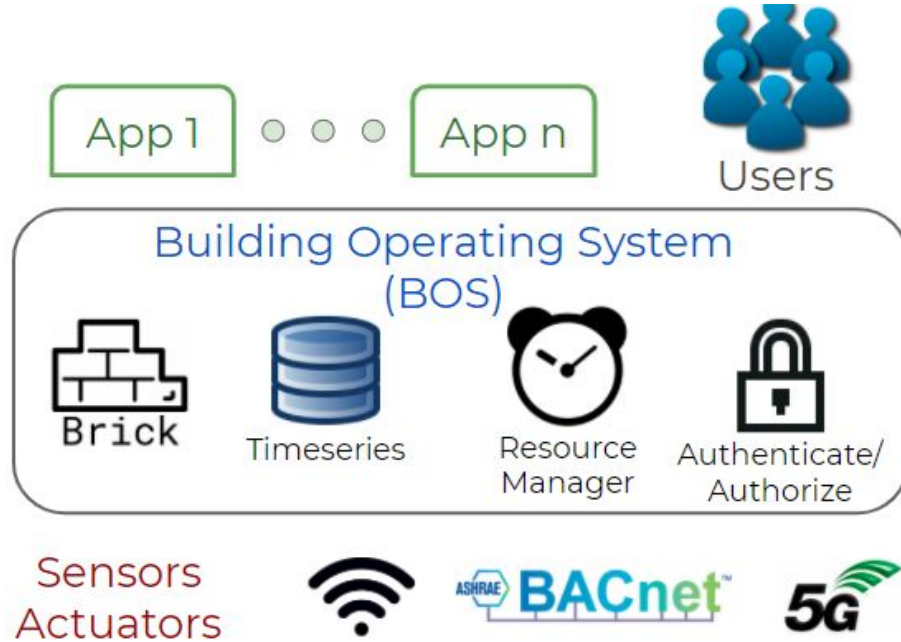
Social Science Experiments

- Negotiate the conflicts between energy savings, economics, comfort
  - Electric vehicle fast versus flex charging
  - Building air conditioning
  - Building lighting

Phase 1 – Observe
- Recruit users for research study
- Implement cloud-based monitoring
- Apply immediate charging only

Phase 2 – Learn
- Charging options:
  - Immediate charging (higher price)
  - Flexible/eco charging (lower price)
- Expose research group to various prices, to learn their choice behaviors

Phase 3 - Optimize
- Optimize price on charging menu
  - Immediate charging (higher price)
  - Flexible/eco charging (lower price)
- Maximize net profit, while managing overstay

Scott Moura, UC Berkeley

DERConnect Buildings

- 12 buildings with >$1M square feet
  - Library
  - Office Buildings
  - Lecture Halls

- Metering and control every 2 seconds
  - 155 air handlers
  - 637 individually controllable LED light fixtures and 1,384 legacy fixtures
  - 1,000 plug load controllers
  - 1,170 Temperature, humidity, occupancy, and CO_2 sensors

Energy Storage Innovation Lab

- Current capacity of 250 kW to be increased to 2,000 kW with 4x larger footprint
- Directly interface with DERConnect
- Participate in energy markets