Development and Validation of Low-Cost, Interoperable, User-Centric, Supervisory Controller Kit for Small and Medium Size Commercial Buildings

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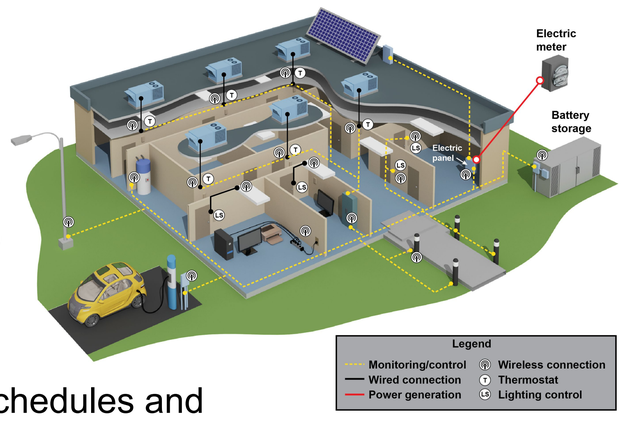
RD&D Challenge

Over 85% of commercial buildings, most of them small and medium size (SMB), lack proper control infrastructure leading to operational deficiencies and excess energy consumption.



SMBs use packaged rooftop units (RTUs) for heating, ventilation, and air-conditioning (HVAC), and are controlled by thermostats. Currently, in many SMBs:

- Set points, setbacks, schedules and optimal start are not properly configured or enforced.
- Economizer controls do not work as intended.
- Limited interaction with grid; buildings with multiple RTUs have no ability to coordinate RTU operation.
- Electrification of buildings and decarbonization of electricity generation will increase the supply-demand imbalance.

Other major end-uses, interior and exterior lighting and exhaust fans, are not controlled in an automated way.

Approach

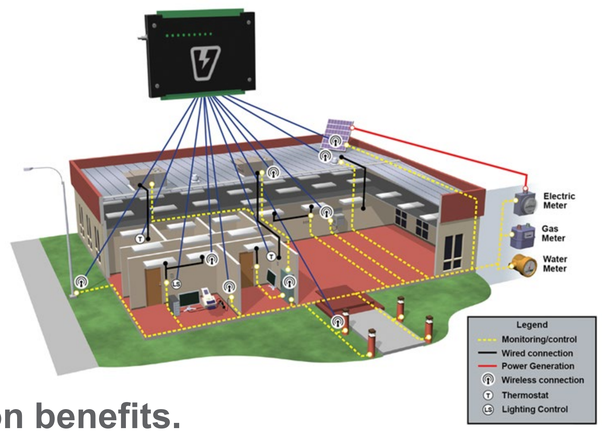
- **First year:** Working with Oak Ridge National Laboratory (ORNL) and project partners Edo and Intellimation, the SC-SMB system will be specified and developed.
- **Second year:** SC-SMB system will be tested in a laboratory environment.
- **Third year:** Working with project partners, the SC-SMB system will be tested and validated in the field.

SC-SMB System Requirements

- Must be built on off-the-shelve product (e.g., Intel NUC©, Raspberry Pi).
- Must cost between $200 and $400.
- Must provide a means to integrate building systems and allow supervisory control algorithms to indirectly (e.g., changing set points, etc.) control the systems to either improve operating efficiency or to deliver grid services.
- Preferred communication protocol:
  - BACnet for connected thermostats.
  - Modbus for battery and solar PV.
  - Vendor specific application programming interfaces (APIs) for connected lighting.
  - CTA-2045 (EcoPort) for hot water heaters and pool pumps.
- To improve comfort, low-cost wireless sensors, using LoRaWAN protocol, will be placed in all spaces that are served by the RTU.
- Must be capable of integrating whole-building electricity meter for real-time access to data.
- All connected devices will be integrated with the IoT platform via TCP/IP using standard wireless communication.

Goals

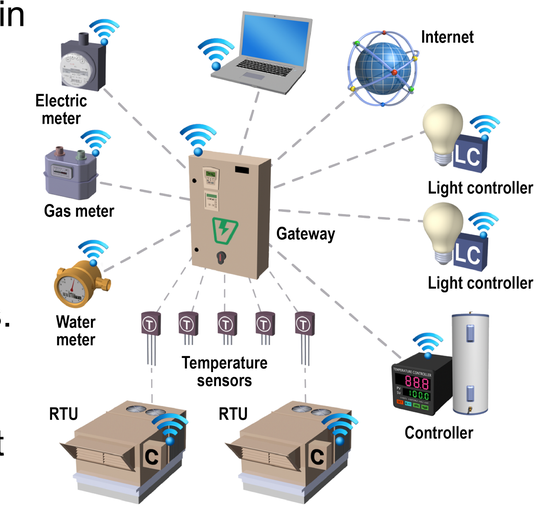
Design, develop, test, and validate a low-cost, interoperable, user-centric, retrofit supervisory controller (SC-SMB) kit that can be used to continuously optimize energy consumption and deliver demand flexibility for SMBs, including all-electric buildings, and provide a means for maximizing decarbonization benefits.



- **Reference hardware platform for buildings without automation system.**
- Initially, the focus is on managing RTUs and hot water heaters (potentially connected lighting), but extensible in the future to manage other end-uses.
- Eclipse VOLTTRON™ is used for testing and validating the reference design in the lab and in the field.

Objectives

- Cost-effectively increase energy efficiency of underserved SMB sector, leading to significant energy/cost savings for the building owners/occupants and reduction in greenhouse gas (GHG) emissions benefiting the society.
- Increase the rate-of-return (ROI) of the control infrastructure by simultaneously delivering grid services that would reduce energy cost to the owners and support increasing hosting capacity of renewables.
- Capable of hosting applications that will support multiple objectives, including reduced energy costs, improved occupant comfort, resilient operations during extreme weather events (by managing building consumption), reduced emissions, and automated load shaping.



Status

- Working with ORNL and project partners developing system requirements and implementation plans.
- Reviewed and selected BACnet/WIFI communicating thermostats for testing SC-SMB system features.
- Later this year, the SC-SMB system will be developed.

Impact

- Potential control solution for 85% of commercial buildings lacking automation system.
- Widespread deployment of the SC-SMB system will result in source energy reductions between 2,000 and 2,500 Trillion Btus and emission reduction between 2.4 and 3.0 $MMTCO_2$

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