Delivering Improved Operational Control to Small- and Medium-sized Buildings

An advanced control system, now in testing, is designed to make buildings more energy efficient, reduce carbon emissions, extend equipment life, support power grid operations, and save money.

Pacific Northwest National Laboratory (PNNL) and its research partners are readying an efficiency and grid services solution for a key, underserved segment of the nation's commercial buildings sector: small- and medium-sized buildings (SMBs).

The solution—a low-cost central control system for structures without building automation systems—will more effectively manage heating and cooling, hot water, connected lighting, and potentially other building functions. It will be interoperable, user-centric, and retrofittable.

The system's impact could be significant. Researchers estimate that not only will SMB owners and managers save money and equipment life, but broad deployment of the tool could potentially deliver overall source energy reductions between 2,000 and 2,500 trillion Btus annually with commensurate emissions reductions. The system also could help the grid mitigate heavy electricity demand, which provides flexibility that enables increased integration of clean energy.

THE NEED

The vast majority of commercial buildings in America are SMBs (less than 50,000 square feet). These smaller buildings represent about 60 percent of the commercial sector's total energy consumption and often lack adequate control infrastructure for improved energy efficiency and demand flexibility. Studies have shown smaller buildings may use up to 25 percent more energy than they need.

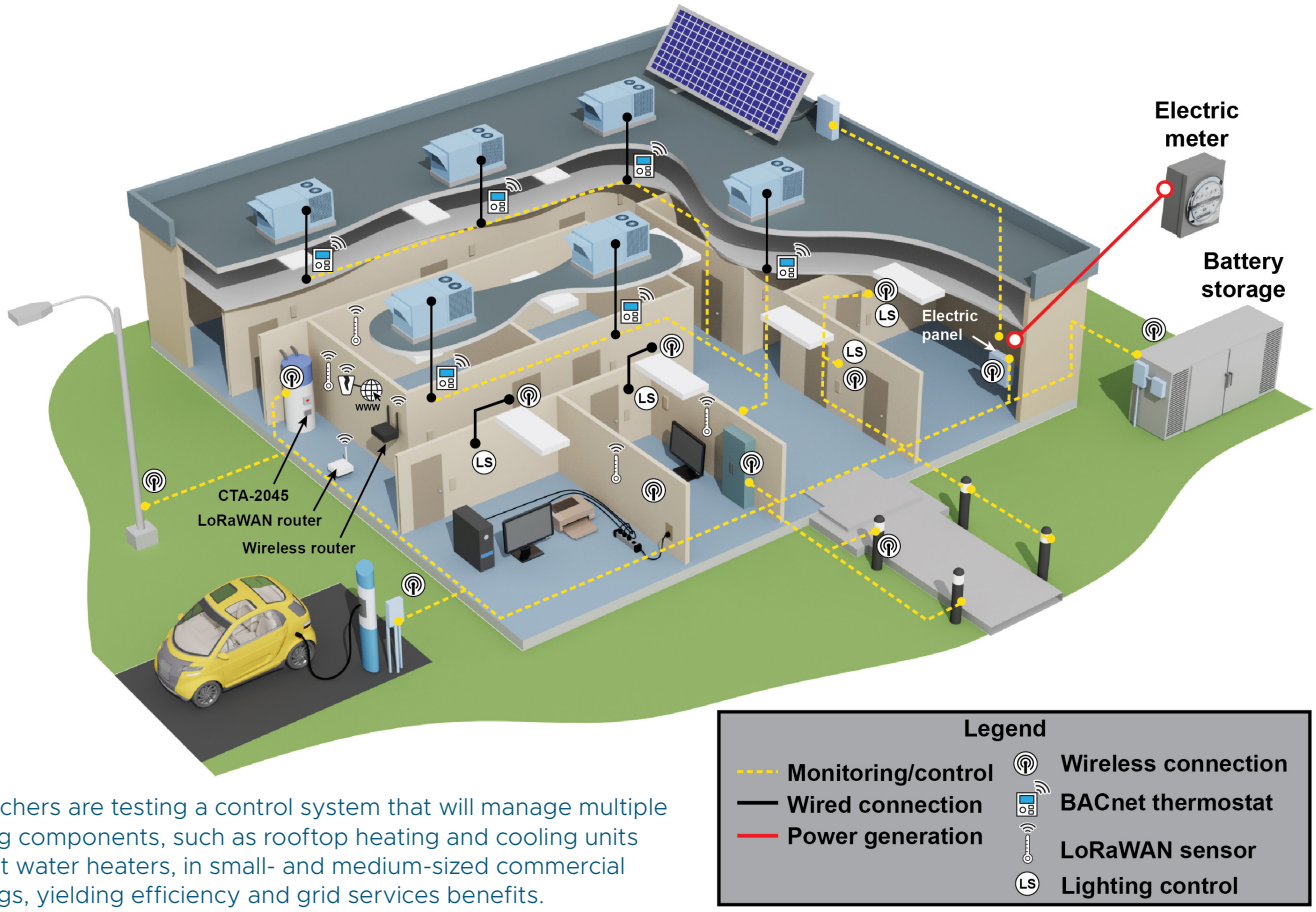
PNNL and its partners seek to provide building owners and managers with an easy-to-install, economical, and coordinated control solution that contributes a range of benefits to SMBs and society.

CONTROL SYSTEM CHARACTERISTICS AND STATUS

The system is not a solution-in-a-box. Rather, it's composed of software and hardware components than can be readily installed in a given building. The centerpiece of the system is the Eclipse VOLTTRON™ software platform that houses and deploys technologies that tune building operations and manage building systems in a manner that saves energy and supports power grid resilience.

Staff at PNNL have completed the software, while PNNL is partnering with Oak Ridge National Laboratory (ORNL) on hardware reference design development, which includes ORNL's low-cost wireless sensors. Two additional project partners, Edo and Intellimation, support testing and validation of the system in the field.

The control system will support only SMBs that don't possess building automation systems and initially will manage rooftop heating and cooling units, hot water heaters, and connected lighting. The project team hopes to extend the technology to include other end uses, such as energy storage and solar panels.



Researchers are testing a control system that will manage multiple building components, such as rooftop heating and cooling units and hot water heaters, in small- and medium-sized commercial buildings, yielding efficiency and grid services benefits.

SOFTWARE COMPONENTS

The Autonomous Energy Management Software system includes:

- The Eclipse VOLTTRON™ distributed control and sensing software platform that, among other functions, deploys two types of technologies to building systems:
  - Energy efficiency technologies that remotely manage set points, dead bands, setbacks, schedules, and optimal starts
  - Grid services technologies that manage peak loads, offer price-based controls, and mitigate winter and summer peaks (Intelligent Load Control)

HARDWARE COMPONENTS

- Low-cost, off-the-shelf computational resource
- Preferred communication protocol:
  - BACnet for connected thermostats
  - Modbus for battery and solar photovoltaics
  - Vendor-specific application programming interfaces for connected lighting
  - CTA-2045 (EcoPort) for hot water heaters and pool pumps
  - BACnet or Modbus whole-building power meter
- Low-cost wireless sensors, using LoRaWAN protocol, to be placed in all spaces served by a rooftop unit
- TCP/IP using standard wireless communication to integrate devices with the Eclipse VOLTTRON™ platform

DEPLOYMENT TIMELINE

Researchers expect to test the software and hardware in fiscal year 2024.

The control system is scheduled to be deployed in several buildings participating in the Department of Energy (DOE) Connected Communities projects in Spokane, WA, and Salt Lake City, Utah.

DOE's Building Technologies Office is funding the control system work and the Connected Communities projects.

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