IoT Sensors for Monitoring and Control in Grid-interactive Efficient Buildings

Invited Speech

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3 Ds

Digitalization
De-centralization
De-carbonization
THE SMART GRID ECOSYSTEM

Smart grid: Bi-directional flows of energy, remote control/automation of power, integrated distributed energy…

Smart city: Complex system of interconnected infrastructures and services…

Smart Campus: A collection of buildings managed by the same facility manager…

Smart buildings: Intelligent building automation systems, smart devices. Grid-interactive Efficient Building (GEB)

Supported by ICT and distributed networks of intelligent sensors, data centers/clouds

Why Do We Need GEBs

• Buildings consume over 40% of the total energy consumption in the U.S. Over 90% of the commercial buildings in the U.S. are either small-sized (<5,000 square feet) or medium-sized (between 5,000 sf and 50,000 sf). These buildings typically do not use Building Automation Systems (BAS) to monitor and control their building systems from a central location.

• Result: Inefficient building operation, which causes excessive electricity usage and high peak demand.
An Open Architecture IoT Platform for Building Energy Efficiency

A Building Energy Management Open Architecture Software solution that is engineered to improve sensing and control of all IoT-enabled equipment in commercial buildings.

Monitoring and control:

Value:

Improves energy efficiency and facilitates peak load savings in buildings.

Platform supports multiple IoT devices through industry standard protocols and communications technologies.
Multiple-protocol Interoperability

Communication Technologies
- Ethernet (IEEE 802.3)
- Serial Interface (RS-485)
- ZigBee (IEEE 802.15.4)
- WiFi (IEEE 802.11)

Data Exchange Protocols
- BACnet (IP and MS/TP)
- Modbus (RTU and TCP)
- Web (e.g., XML, JSON, RSS/Atom)
- ZigBee API
- Smart Energy (SE)
- OpenADR (Open Automated Demand Response)

A Cloud-based Platform for Campus-wide Applications

- DR Event
- Pricing
- Billing
- Energy Savings (kWh)
- Peak demand (kW) reduction
- Alarm & Notifications
Users controlling buildings optimized for savings

Measured energy savings across deployments

20% HVAC Energy Savings

25% Lighting Energy Savings

Improved operations and maintenance: WiseBldg analytical platform enables operators to detect faults when devices operate outside standard thresholds enabling building operators to investigate prior to device failure.

Occupant satisfaction: spaces controlled by WiseBldg have been more comfortable due to more consistent temperature profiles and healthier air quality through consistent monitoring of environmental factors (CO2 levels, PM 2.5).

IoT Platform Deployments in Four Buildings

Building 1 – VT Classroom Building
- Location: Alexandria, VA
- Demonstration: HVAC, plug load control

Building 2 – Equipment Bureau Building
- Location: Arlington, VA
- Demonstration: Lighting control

Building 3 – VT Lab Building
- Location: Blacksburg, VA
- Demonstration: HVAC control

Building 4 – PG County Community Building
- Location: Camp Springs, MD
- Demonstration: HVAC control
Building 1 – VT Building in Alexandria, VA

Alexandria, Virginia, USA

Area: 25,000 SF
Energy: 14-25 MWh/mo.
Peak load: 61 kW

Classroom under Real-time Monitoring

- Power meter
- Environmental sensor (CO2, noise, temperature, RH)
- BEMOSS core
- Plug load controller
- Thermostat
- Motion sensor
Indoor Environmental Monitoring

Office Building, Arlington, Virginia

Office building size: 5,000 sqft
Using WiseBldg the building operator reduced HVAC consumption by 27%.

**Energy Savings from Lighting Control**

**Location:** Arlington, Virginia

**Area:** 5,000 sq ft

**Deployed Devices**
- 3 Lighting controllers
- 1 Power meter

An average energy savings of 35% was achieved through dimming control:

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<tbody>
<tr>
<td>Savings</td>
<td>33.7%</td>
<td>33.9%</td>
<td>34.4%</td>
<td>33.4%</td>
<td>35.9%</td>
<td>36.2%</td>
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**Solar PV System Monitoring and Control**

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IoT Platform User Interface

Managing Battery Storage from IoT Platform
Battery Storage Data Access from IoT Platform

Battery Storage Monitoring & Control

[Image of battery storage system and interface]

[Detailed battery status information]
Thank You

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IEEE President Election