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An IoT Platform for Building Energy Efficiency Applications

Invited Lecture

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Purpose and Objectives

- Buildings consume over 40% of the total energy consumption in the U.S. Over 90% of the 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.
- **WiseBldg platform** facilitates energy efficiency applications in commercial buildings using a very simple and scalable building automation system (BAS).

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An Open Architecture Platform for Building Energy Efficiency

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

www.bemcontrols.com

Monitoring and control:

Three major loads in buildings
- Heating, Ventilation, AC
- Lighting loads
- Plug loads

Value:

Improves energy efficiency and facilitates peak load savings in buildings

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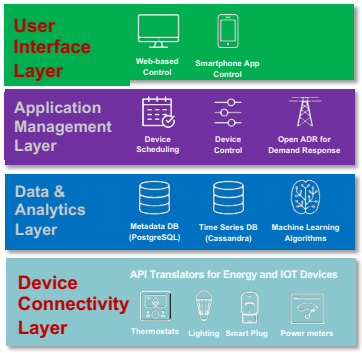
WiseBldg: Building Energy Management Platform

Platform Architecture



Overview

WiseBldg

WiseBldg (pronounced "Wise Building") is BEM Controls' powerful, low-cost, open-architecture software platform that can monitor and optimally control major electrical loads (e.g., HVAC, lighting and plug loads), as well as solar PV systems, energy storage units and other IoT sensors in commercial buildings. It is built on the DoE-sponsored BEMOSS platform developed at Virginia Tech.

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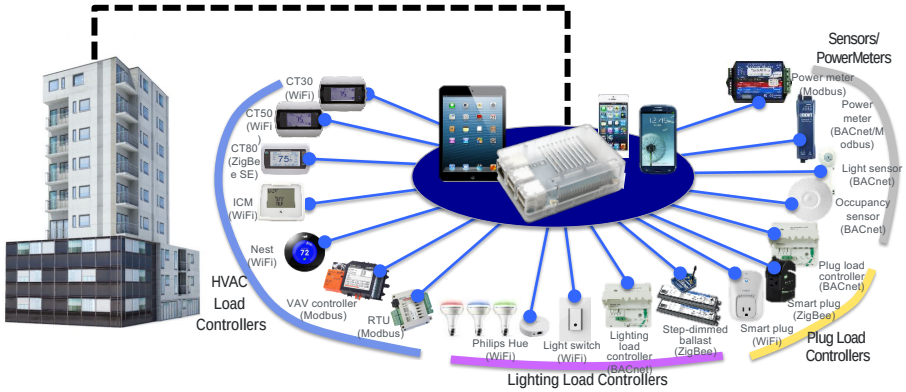
WiseBldg supports multiple IoT devices through industry standard protocols and communications technologies



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Multiple-protocol Interoperability

Communication Technologies

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

IEEE 802.3 · IEEE 802.11 · WiFi · IEEE 802.15.4 · RS-485

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)

BACnet · OpenADR · WEB · Modbus · ZigBee · Smart Energy Profile (SEP)

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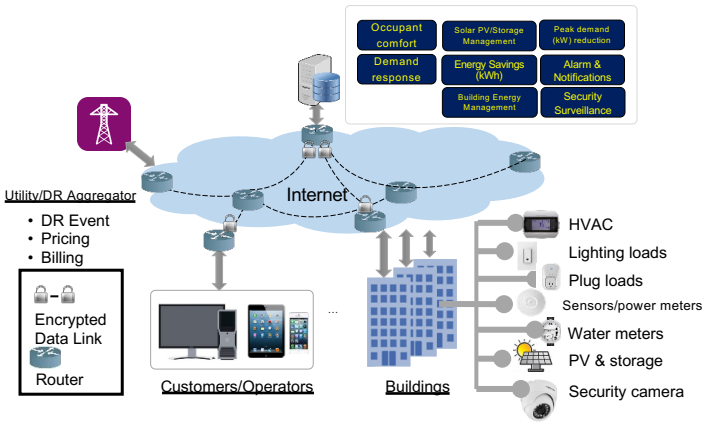
WiseBldg Platform Built by BEM Controls



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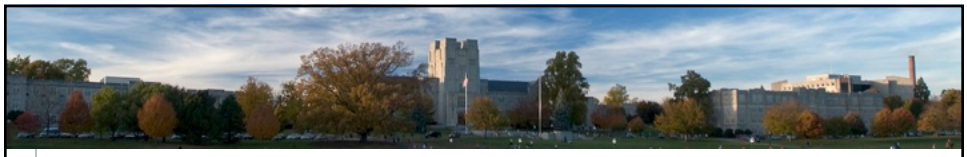

WiseBldg can make an old building smart

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Customers 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).

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WiseBldg 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

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Building 1 – VT Building in Alexandria, VA

Alexandria, Virginia, USA

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

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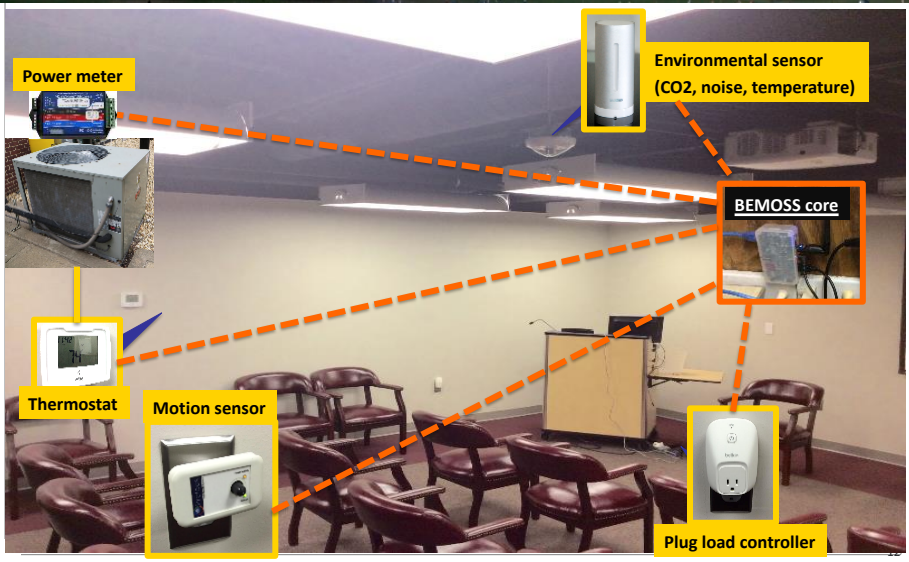
Classroom under Real-time Monitoring



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Indoor Environmental Monitoring

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Energy and Peak Savings from HVAC Control

Location: Alexandria, VA
Area: 25,000 square feet
Deployed Devices

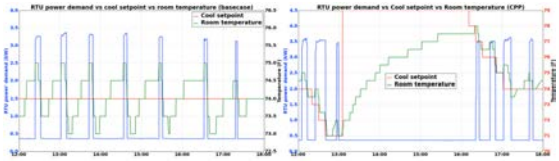
- 6 Thermostats
- 6 Power meters
- 1 Li-ion battery
- 1 Environmental sensor

Using WiseBldg, Building Operator saved 27% on HVAC consumption alone

Summer Months (June-July-August)	
Compressor consumption 2014 (Before WiseBldg)	8,340 kWh
Compressor consumption 2016 (After WiseBldg)	6,071 kWh
Average savings	**26.8% savings**

Temperature profile BEFORE WiseBldg Demand Reduction

Temperature profile AFTER WiseBldg Demand Reduction



Base case (w/o WiseBldg)

- **Setpoint:** 74 deg F
- **Energy usage** = 2.72kWh
- **Max demand** = 3.98kW

Managed by WiseBldg

- **Setpoint:** 77 deg F
- **Energy usage** = 1.42kWh
- **Max demand** = 0.5kW

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Office Building, Arlington, Virginia

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Energy Savings from Lighting Control

Location: Arlington, VA

Area: 5,000 sq ft

Deployed Devices

- 3 Lighting controllers
- 1 Power meter

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

Oct 2016	Nov 2016	Dec 2016	Jan 2017	Feb 2017	Mar 2017	Apr 2017	May 2017	Jun 2017	AVERAGE
33.7%	33.9%	34.4%	33.4%	35.9%	36.2%	35.0%	36.0%	36.3%	**34.5%**

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Energy Savings by controlling light intensity

Month	Total Measured Energy Consumption (kWh)	Total Calculated Energy Consumption without Dimming (kWh)	Energy Savings by Dimming (%)
October 2016	264.37	399.90	33.89%
November 2016	278.13	423.78	34.37%
December 2016	280.76	426.40	34.16%
Total (October-December)	823.26	1250.08	34.14%

Note: Scheduled dimming level from 6:30am to 9:00pm. Open office area A: 50%; Open office area B: 45%; Chief office's desk area: 60%; Chief office's meeting area: 50%; Conference room A: 50%; Conference room B: 45%. Lights are off after 9:00pm.

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Solar PV System Monitoring and Control

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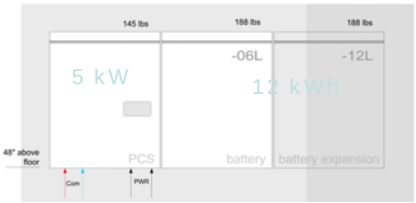
WiseBldg User Interface

Managing Battery Storage from WiseBldg Platform

Battery Cells LG Chem



Battery Storage Monitoring & Control

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IEEE President-elect Signature Campaign
Prof. Saifur Rahman
Please sign at www.ieee.org/petition
The deadline is 30 April 2020
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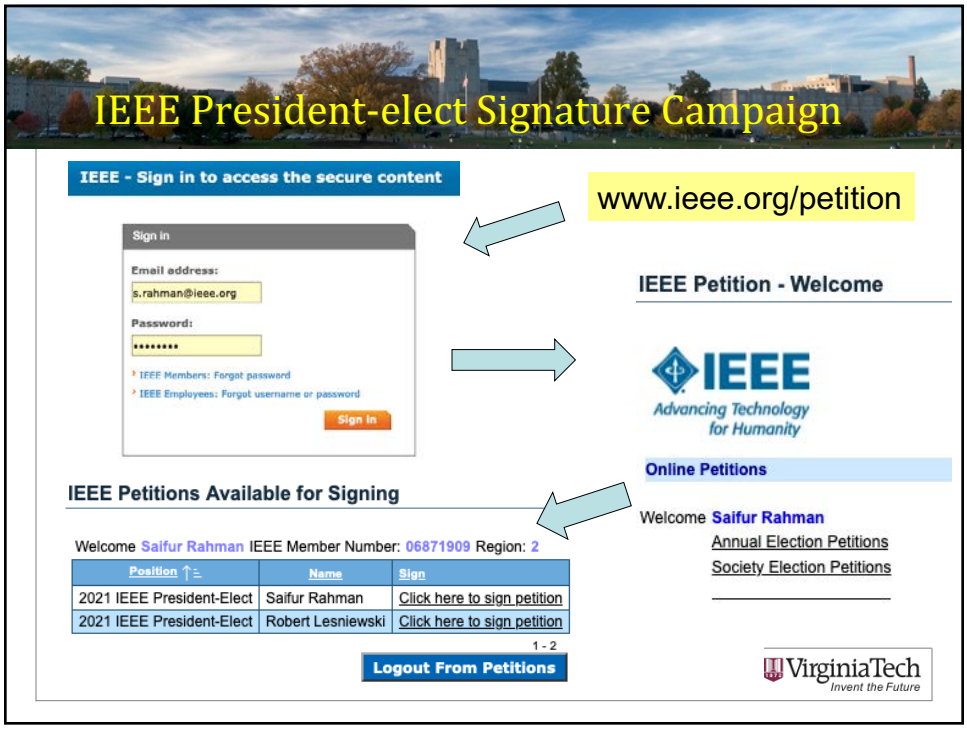
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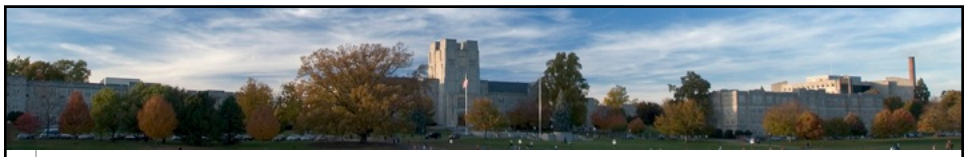

Thank You

BEM CONTROLS

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