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An IoT Platform for Building Energy Efficiency Applications

Invited Lecture

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IEEE Student Branch, SJCE, Chennai, India, 12 July 2020

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).

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 <u>all</u> IoT-enabled equipment in commercial buildings

www.bemcontrols.com

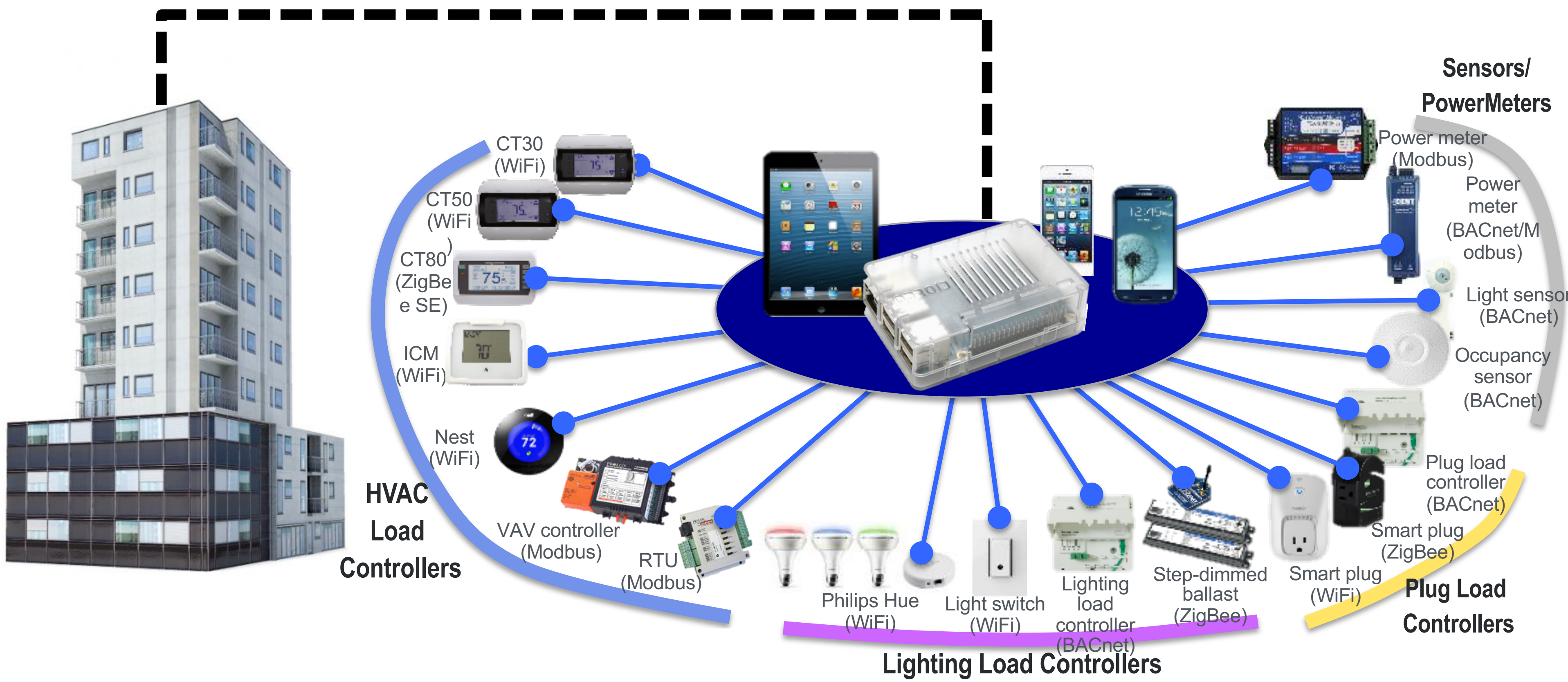
Monitoring and control:

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

Value:

Improves energy efficiency and facilitates peak load savings in buildings

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

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

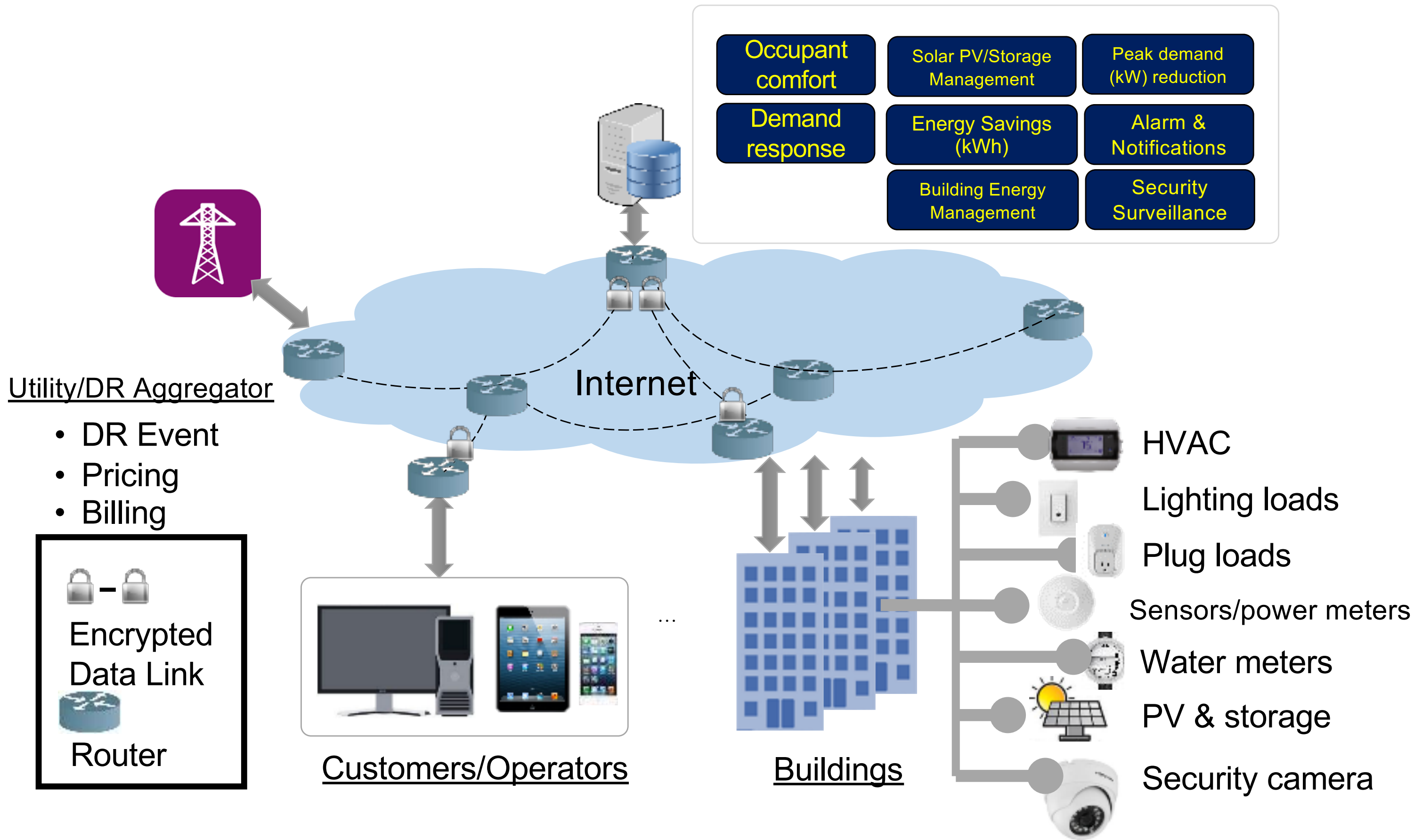
WEB

Modbus

ZigBee

Smart Energy Profile (SEP)

WiseBldg Platform Built by BEM Controls



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WiseBldg can make an old building smart

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

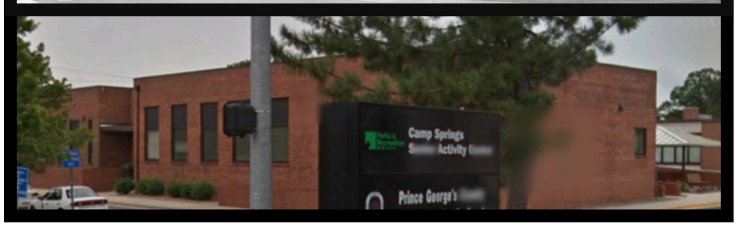
- **Location: Alexandria, VA**
- **Demonstration: HVAC, plug load control**

Building 2 – Equipment Bureau Building

- **Location: Arlington, VA**
- **Demonstration: Lighting control**

Building 3 – VT Lab Building

- **Location: Blacksburg, VA**
- **Demonstration: HVAC control**

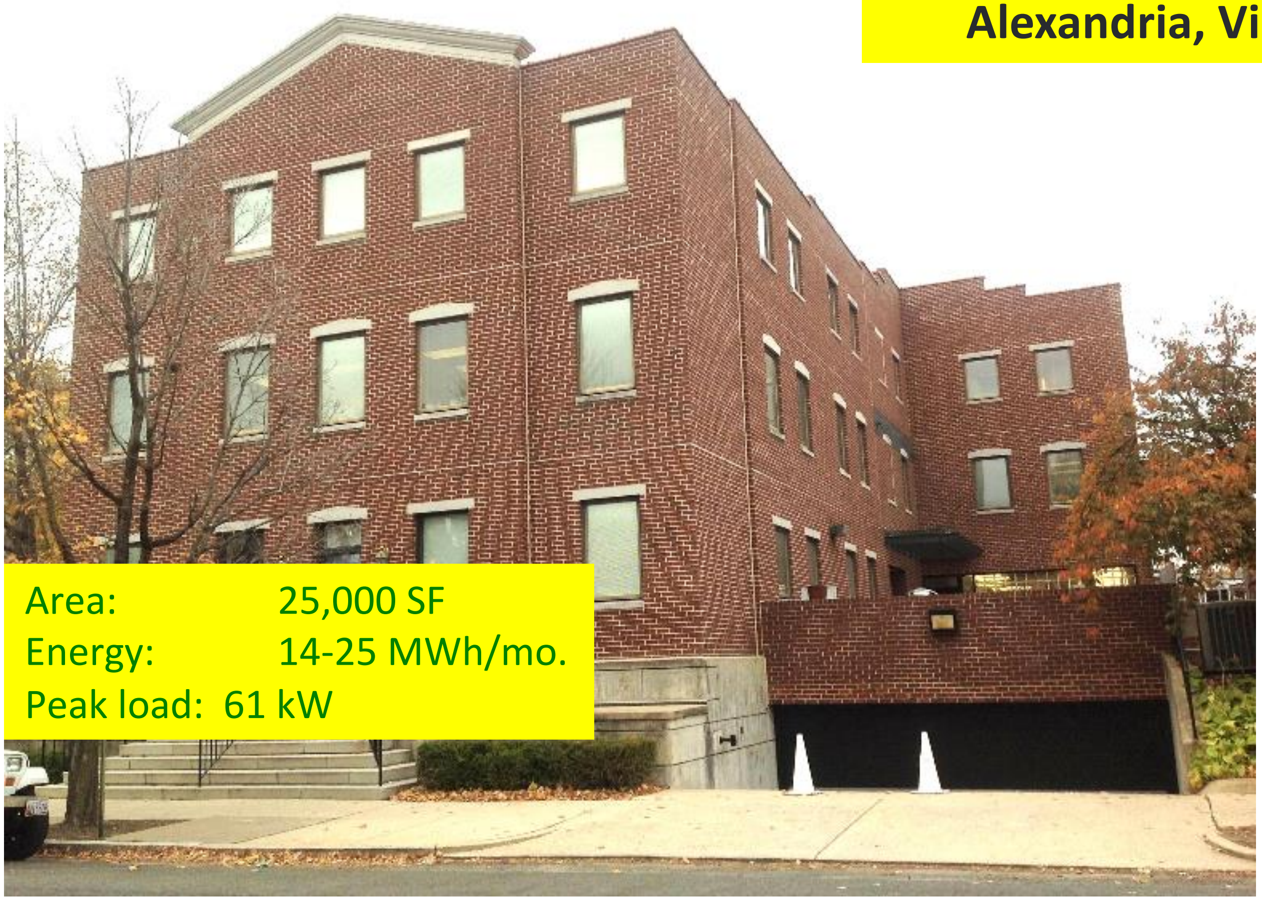


Building 4 – PG County Community Building

- Location: **Camp Springs**, MD
- Demonstration: HVAC control

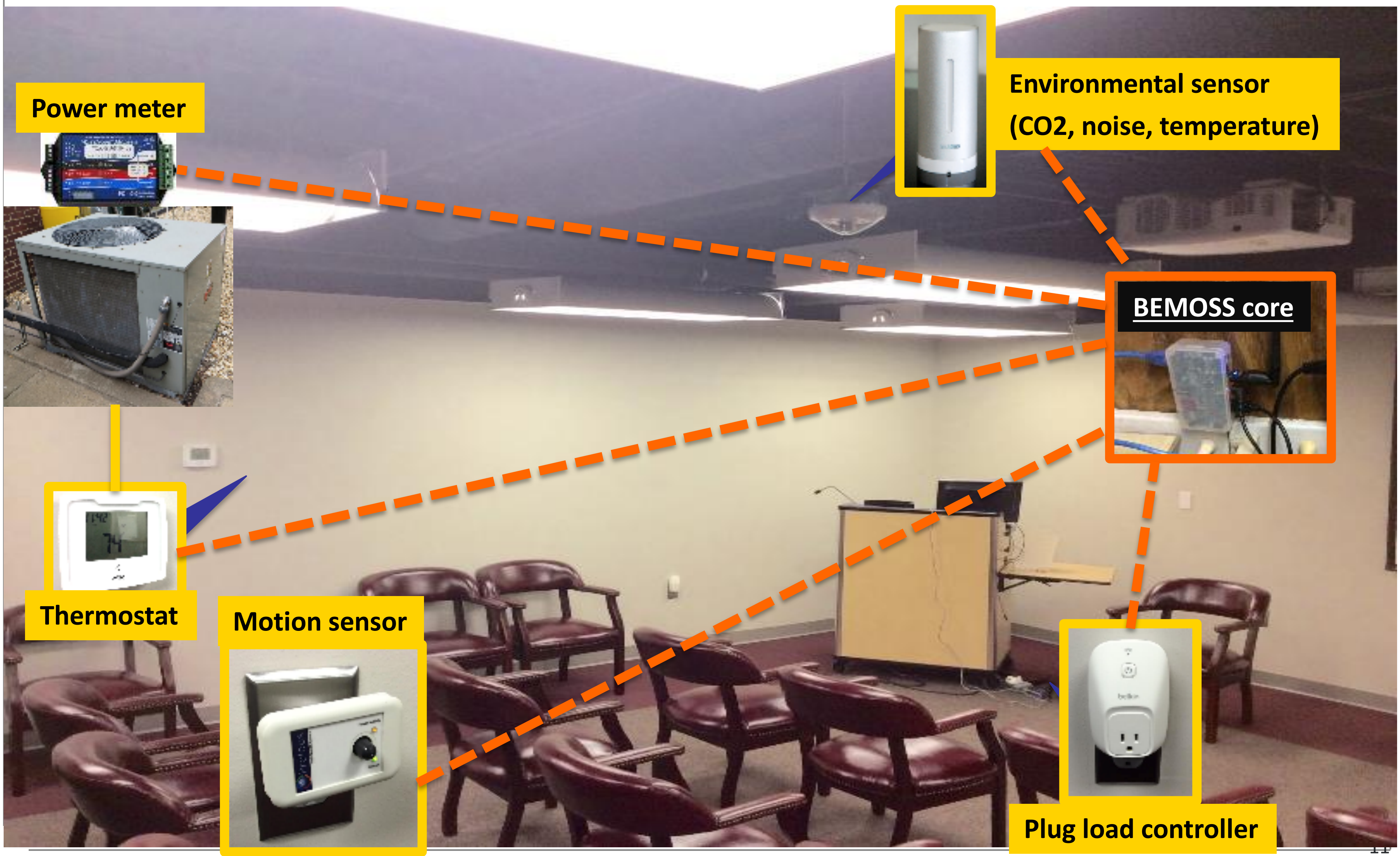
Building 1 – VT Building in Alexandria, VA

Alexandria, Virginia, USA

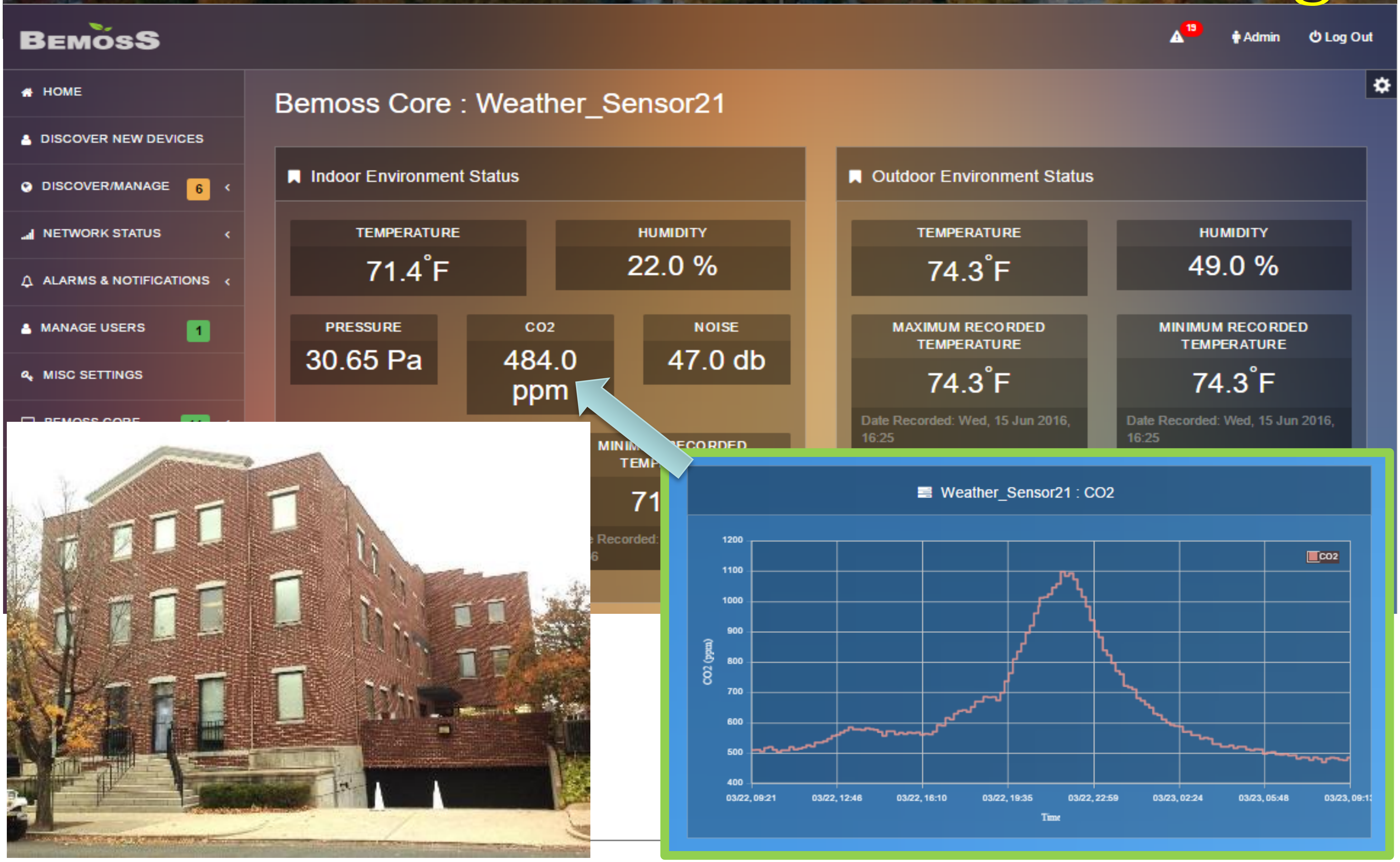


Area: 25,000 SF
Energy: 14-25 MWh/mo.
Peak load: 61 kW

Classroom under Real-time Monitoring



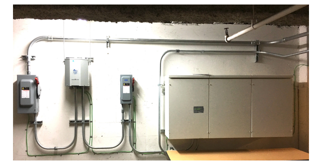
Indoor Environmental Monitoring



Energy and Peak Savings from HVAC Control

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

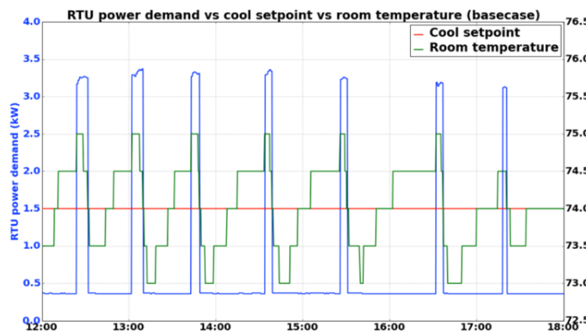
- 6 Thermostats
- 6 Power meters
- 1 Li-ion battery
- 1 Environmental sensor



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**

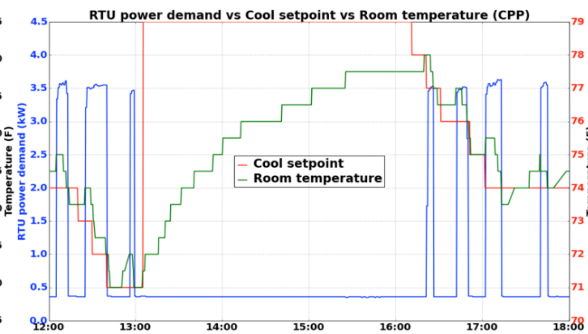
Temperature profile BEFORE WiseBldg Demand Reduction



Base case (w/o WiseBldg)

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

Temperature profile AFTER WiseBldg Demand Reduction



Managed by WiseBldg

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

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Office Building, Arlington, Virginia

Office building size: 5,000 sqft

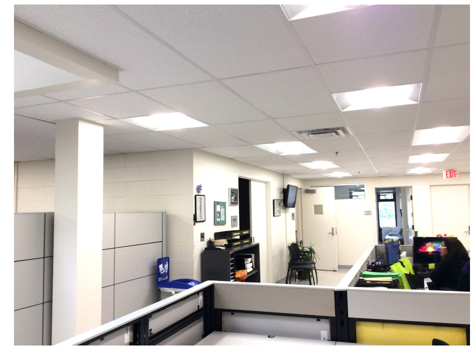
Energy Savings from Lighting Control

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%

<u>Note:</u> 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.

Solar PV System Monitoring and Control

WiseBldg User Interface

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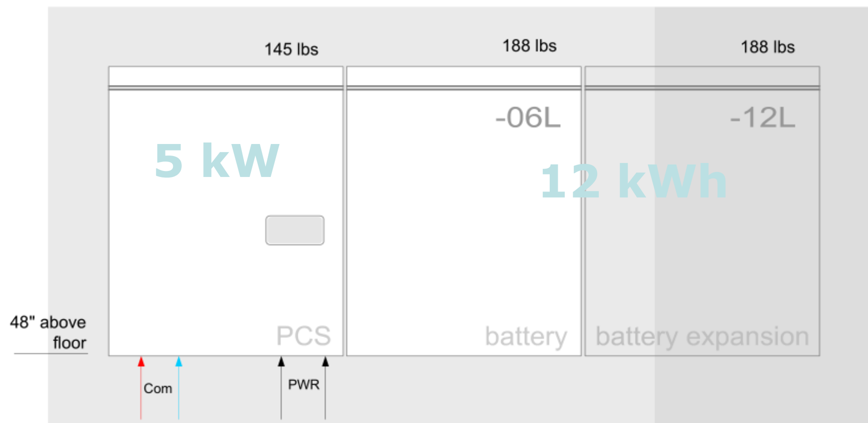
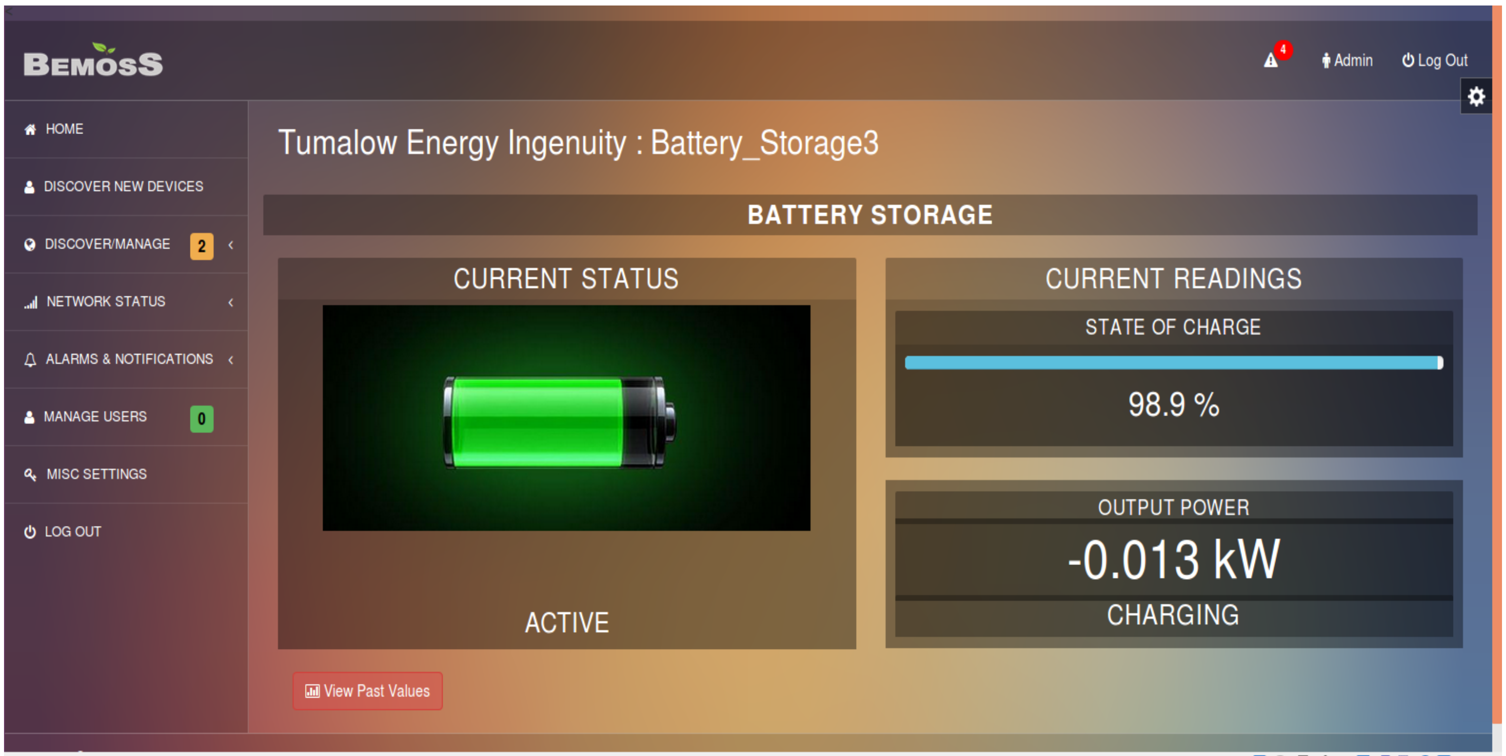
Managing Battery Storage from WiseBldg Platform

Battery Cells LG Chem



Battery Storage Monitoring & Control



BEMCONTROLS

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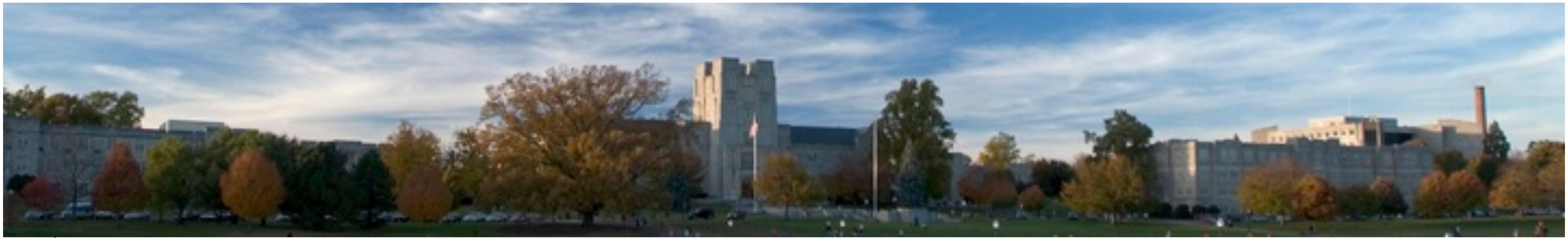
All Buildings should be Smart Buildings

Building Automation Systems (BAS) can slash power consumption and energy bills significantly, but they are too expensive for most buildings.

BEM Controls breaks through this barrier.

Our Wise Building (WiseBldg) platform is affordable and works with any existing loads to make any building smart, no matter the size or age.

www.bemcontrols.com



Covid-19 and IEEE

The COVID-19 outbreak is incredibly fast moving, uncertain and complex.

We need to ensure that we are “READY FOR RECOVERY”, when we get back to the “NEW NORMAL”. Let us enhance cooperation, collaboration and community spirit.

For this we need to make IEEE broader so that IEEE is more relevant to the work our members do regardless where they work.

We need more participation from volunteers globally in IEEE governance. A broader based IEEE will make the Institute more relevant to technologists and academics from all parts of the world.

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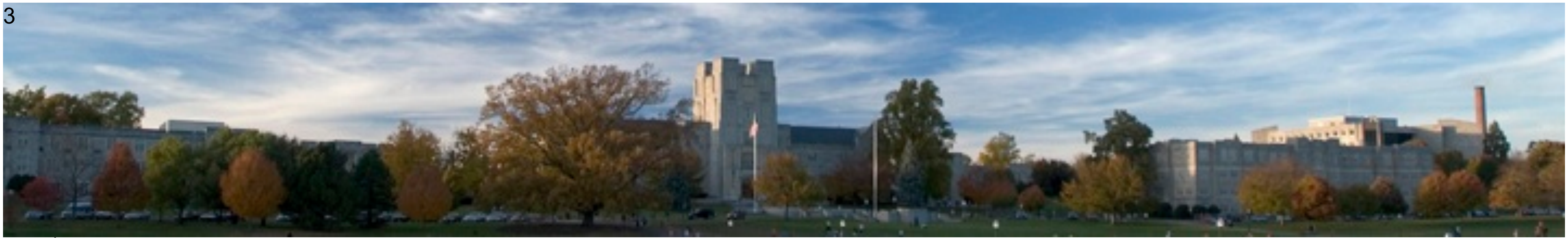

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Past-President of IEEE Power & Energy Society
Past-Chair, IEEE Publication Services & Products Board

PES accomplishments:

- PES University
- PES Corporate Engagement Program
- PES Chapters' Councils in China, India, Africa and Latin America

website: https://www.srahman.org.

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