The Internet of Things (IOT) and Energy Management in the Modern Building

Better Buildings Summit
Tuesday May 10, 2016
2:00-3:15
Today’s Presenters

- Moderator: David Nemtzow, Building Technologies Office, U.S. Department of Energy
- Kevin Kampschroer, U.S. General Services Administration
- Ethan Goldman, Vermont Energy Investment Corporation
- Dr. Marina Sofos, Emerging Technologies, U.S. Department of Energy
“...the real value that the Internet of Things creates is at the intersection of gathering data and leveraging it. All the information gathered by all the sensors in the world isn’t worth very much if there isn’t an infrastructure in place to analyze it in real time.

- Wired Magazine, April 18, 2016
Why does it matter?

- Building Energy Management Systems (BEMs) attracted $1.4 B in VC Funding from 2000-2014 (26% of all investment in building energy technology).
- In 2020, about 77% of the $2.14 billion U.S. market will comprise BEMS applications, and 40% will come from buildings below 50,000 square feet.
- U.S. market for sensors and controls for BEMs will rise at a 17% compound annual growth rate to $2.14 billion in 2020.

(Source: Navigant Research)
What does it mean?

- Negotiates and transacts energy services across the meter
- Integrates and coordinates connected equipment* (load/generator/storage) for energy efficiency and financial benefits
- Supports the scalable integration of clean and efficient technologies such as PV and EV chargers
- Provides awareness, visibility, and control to serve the preferences of its managers, operators, and occupants

* Connected equipment knows how it is performing, how it could perform, and is capable of communicating that to others.
Kevin Kampschroer, U.S. General Services Administration
• Historic 1917 Building
• Last Upgraded in 1935

Plan:
• Modernization with Infill
• $161 M from Recovery Act, as Phase I
• Must Redesign for Energy Goals
• Future Funding Needed for Phase II
1800 F – Phase I

- 2,500 People → 4,400
- Eliminates 6 Leases; Saves $24 million/year
- 50% Occupancy → 85% Occupancy
- <20% Assigned Workstations
- Lockers; Booking System
- 250% Increase in Meeting/Quiet Rooms
- Telework & Mobility
- 100% Laptops; Strict Standardization
- Reduce Private Offices 90%
- Swing Space = Practice
1800 F – Phase I

- Energy down 2/3 from Baseline
- 100% Daylighting in Working Space
- LED in Hallways, Stairwells & Outside
- 100% Rainwater Capture
- New Cisterns
- Solar Direct to Computer Servers (DC to DC; No Inverter)
- 100% Solar Hot Water
1800 F – Full Renovation Renderings
Edith Green-Wendell Wyatt (Portland, OR)

- 1975 Federal Building
- Never Upgraded

Plan:
- Updating Cutting Edge ‘Green’ Design
- $133 M from Recovery Act
- Full Building Modernization
- High Aims for Sustainability and Curb Appeal
- Reoccupied 2014
• Integrated Design
• Reduced Load from Envelope
• Radiant Heating & Cooling
• Raised Ceiling (Water vs. Air: No Ducts)
• 100% Rainwater Capture & Re-use
• 70 % ↓ Water Consumption
  — Collect All Rainwater
  — Create Cistern from Firing Range
  — No Potable Water for Chillers, Flushing or Landscape
• Lighting ↓ 50%: Daylighting & Controls
• PV = 20% Electricity
• Floor Space Re-capture: Equivalent to Adding One Full Floor
# New Carrollton Federal Building

## Project Snapshot:

<table>
<thead>
<tr>
<th>Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>New Carrollton, MD</td>
</tr>
<tr>
<td>Building Size</td>
<td>1.2 million ft²</td>
</tr>
<tr>
<td>Original Construction</td>
<td>1994</td>
</tr>
<tr>
<td>Development &amp; Construction Duration</td>
<td>38 months (2012–2015)</td>
</tr>
<tr>
<td>Investment Value</td>
<td>$40.0 million</td>
</tr>
<tr>
<td>Appropriated Funds</td>
<td>$586,000 (1%)</td>
</tr>
<tr>
<td>Contract Term</td>
<td>22 years</td>
</tr>
<tr>
<td>Cost Savings</td>
<td>$2.5 Million/year</td>
</tr>
<tr>
<td>Energy Savings</td>
<td>94,588 MmBtu/year (60%)</td>
</tr>
<tr>
<td>Energy Service Company</td>
<td>Ameresco, Inc.</td>
</tr>
</tbody>
</table>

Rocky Mountain Institute, 2015
New Carrollton Federal Building

- Central Chilled-Water Plant
- Integrative Building Controls and Sensors (2,000 Occupancy Sensors)
- 11,000 LED Replacements
- 808 kW Solar PV
- Solar Canopies and Solar Thermal Heating
- Geothermal Heat Rejection
- Exhaust-to-Outdoor-Air heat-Recovery Loop
Ethan Goldman, Vermont Energy Investment Corporation
Efficiency in the Age of the Internet of Things

Ethan Goldman
VEIC
May 2016
• Mission-driven nonprofit
• Over 25 years reducing economic, environmental costs of energy
• Energy efficiency, renewable energy & transportation
• Consulting & implementation
• 3 energy efficiency utilities
Sub-metering (Old-School Data Collection!)
Smart Meter Interval Data Analysis
Gartner’s 2015 Hype Cycle
But Does It Save Energy?

CC Image courtesy of Nicolás Boullosa on Flickr.
Connected Thermostats
Connected Outlets
Controllable Plug-load Appliances

Annual cost to operate

- Water cooler / heater
- Dehumidifier
- Waterbed
- Plug-in heater
Storage
Really Large Home Appliances
HEMS Lighting Study – Participant Motivation

- Remote control
- Dimming
- Controlling single bulb on circuit
- Scheduling automatic on / off
- Correcting switch placement
- Ambient lighting (dimming scenes)
Connected Appliances - Belkin
Interoperability
Poll: is Zigbee a Standard?

[  ] Yes, has been for years.
[  ] Yes, finally!
[  ] No, but it’s close…
[  ] Never going to be.
[  ] What-bee?
Wireless Hubs
Integration Services
Data Makes Energy Decisions Tangible
Questions?

egoldman@veic.org
Dr. Marina Sofos, Emerging Technologies, U.S. Department of Energy
Interoperability and the Internet of Things – An R&D Perspective

Marina Sofos, Emerging Technologies
May 12, 2016
Marina.sofos@ee.doe.gov
What can the future look like?

BEMOSS is a Building Energy Management Open Source Software (BEMOSS) solution that is engineered to improve sensing and control of equipment in small- and medium-sized commercial buildings.

It targets to monitor/control three major loads in buildings:
- HVAC
- Lighting loads
- Plug loads
Classroom Wireless Monitoring (Alexandria, VA)

- BEMOSS core
- Plug load controller
- Environmental sensor (CO2, noise, temperature, humidity)
- Motion sensor
- Thermostat
- Power meter
The problem today
The solution

Integrating 

- Organization/Human
  - Business process
  - Interrelations
  - Issues
  - Policies
  - Communities

- Technical/Systems
  - Standards
  - Inter-connectivity
  - Compliance

- Information
  - Semantics
  - Syntax
  - Data
  - Business domains

Expected Impact:

- Reduces integration cost
- Reduces cost to operate
- Reduces capital IT cost
- Reduces installation cost
- Reduces upgrade cost
- Better security management
- More choice in products
- More price points & features

All items provide compounding benefits
It requires everyone to work together

Interoperability Layers (GWAC Stack)

Building Automation Zones (ASHRAE-Purdue model)

Management (business, enterprise)

Supervisory (facility coordination, operations)

Control (application specific control)

Devices (I/O, local control)

Building Actor Domains (Conceptual Model)

Transmission services work through market and distribution
Discussion
Thank you!

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