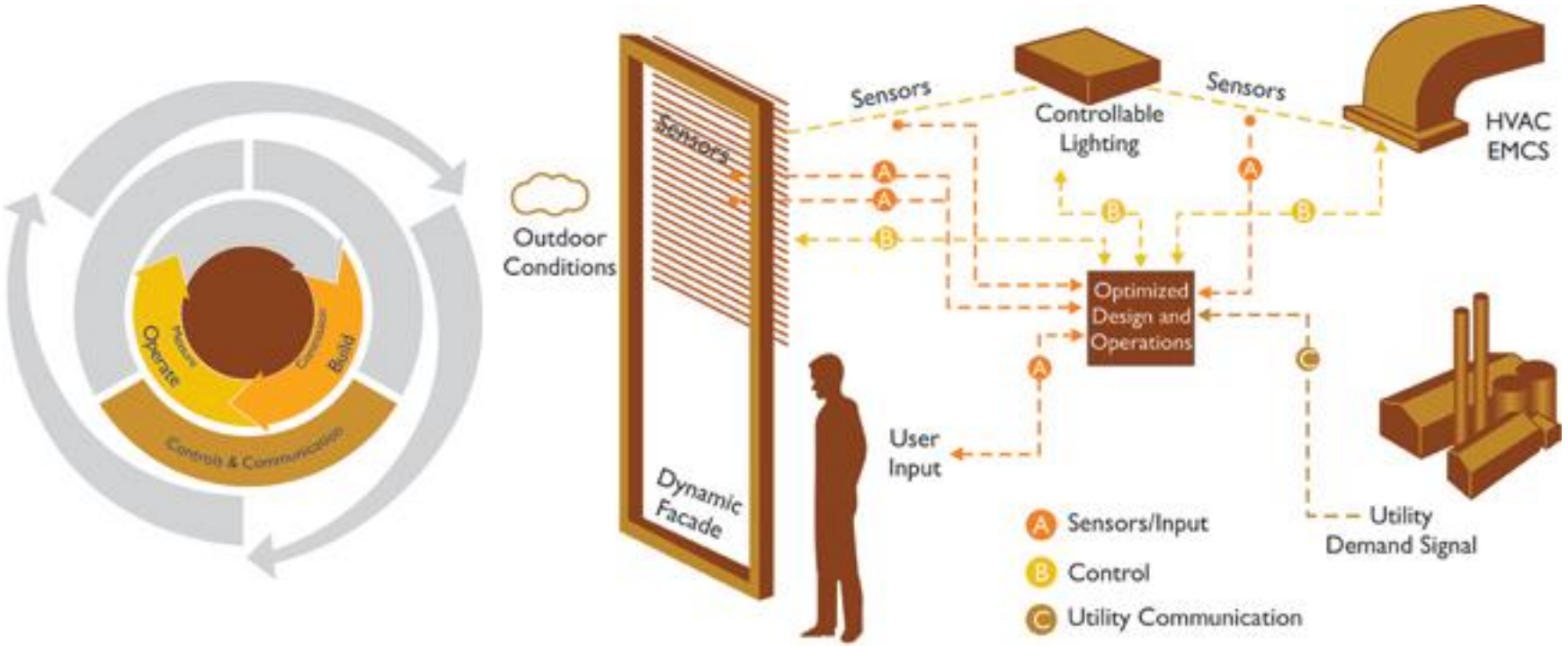
US India Joint Center for Building Energy Research and Development (CBERD) : Controls and Communications Integration

2015 Building Technologies Office Peer Review



U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

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Project Summary

Timeline:

Start date: Oct 2012; Planned end date: Sep 2017

Key Milestones

1. Pilot lighting system deployment with open control interface (Fall 2014)
2. Transactional Network Volttron integration (Spring 2016)
3. Demonstrate transaction-based controls for constrained-resource buildings in Indian office building (Summer 2017)

Budget:

Total DOE $ to date: $375K (FY13-FY15; $250k spent)

Total future DOE $: $250 K (FY16-FY17)

Target Market/Audience:

Commercial building owners and system innovators

Key Partners:

Institutional	Industry
International Institute of Information Technology Hyderabad (IIIT-H)	enLighted

Project Goals:

Develop and demonstrate:

- Transaction-based controls to manage constrained energy resources,
- Open software interfaces to allow communication and control across diverse building systems.

Purpose and Objectives

Problem Statement:

- Lack of coordination among building systems wastes energy (e.g., lighting system might turn off when space is unoccupied, but HVAC system unaware).
- Loads in buildings do not adjust to constrained energy resources in a coordinated, cost-effective way.

Solving this problem requires:

- Communications and integration across end-uses,
- New control paradigms for buildings using software-driven tools and services like Transactional Energy frameworks.

Target Market and Audience:

- Commercial building owners and system innovators.
- Small/medium buildings with inadequate controls consume ~3 Quads source energy annually in US; ~0.5 Quad savings potential.

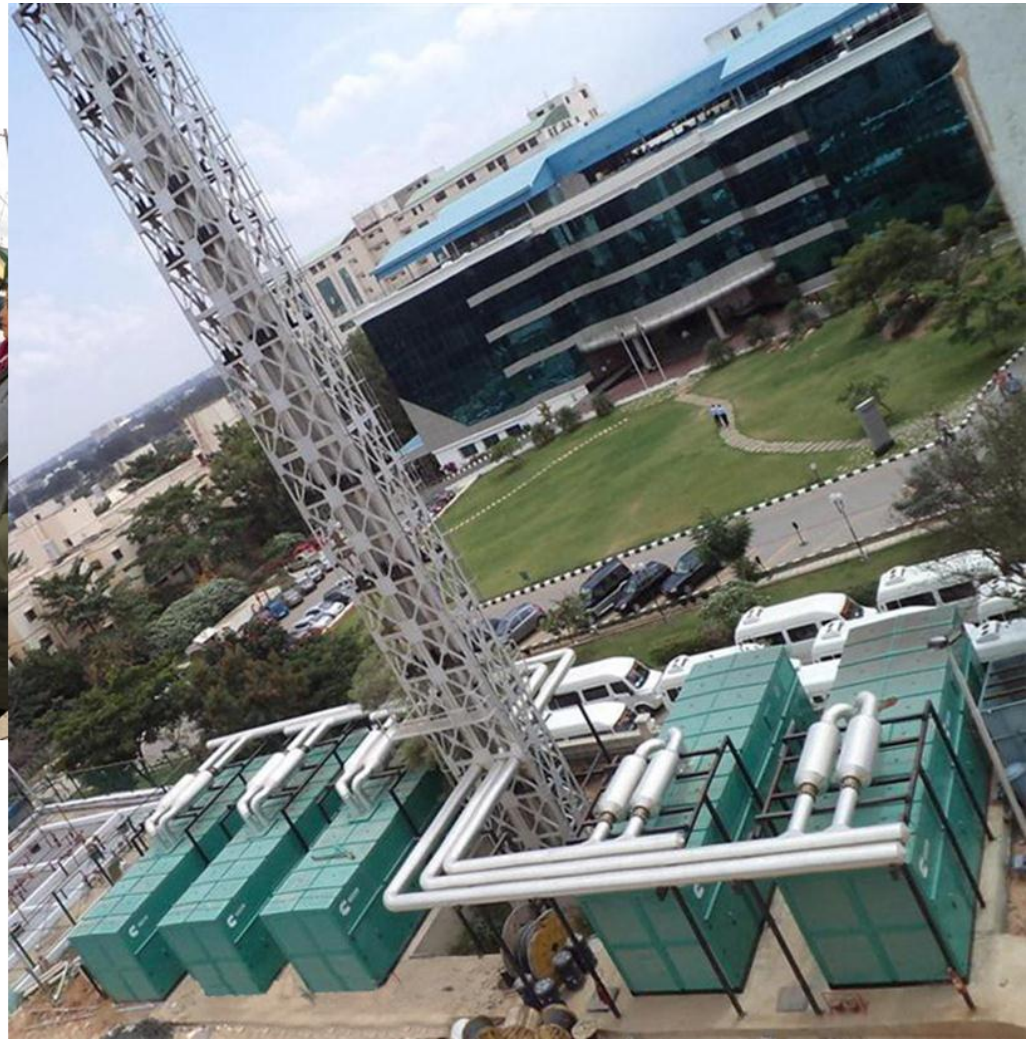
Impact of Project: This project will:

- Demonstrate an integrated workstation control system (lighting, plug loads, HVAC) in an Indian office building
- Release open-source software tools enabling unified, transaction-based control

Are Constrained Energy Resources a Problem?

NYC: Cell phone charging after Hurricane Sandy

(source: FEMA)



Bangalore: 5x1.5MW backup generators at Magna office complex

(source: Powerica)

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Approach

Approach:

Integrate commercial control systems using open-source tools

- Develop and use open data interfaces to allow communication and control across diverse building systems.
- Adapt and demonstrate integration platforms that enable new control paradigms for buildings using open-source, software driven tools.
- Demonstrate advanced plug-load management capabilities as part of platform.

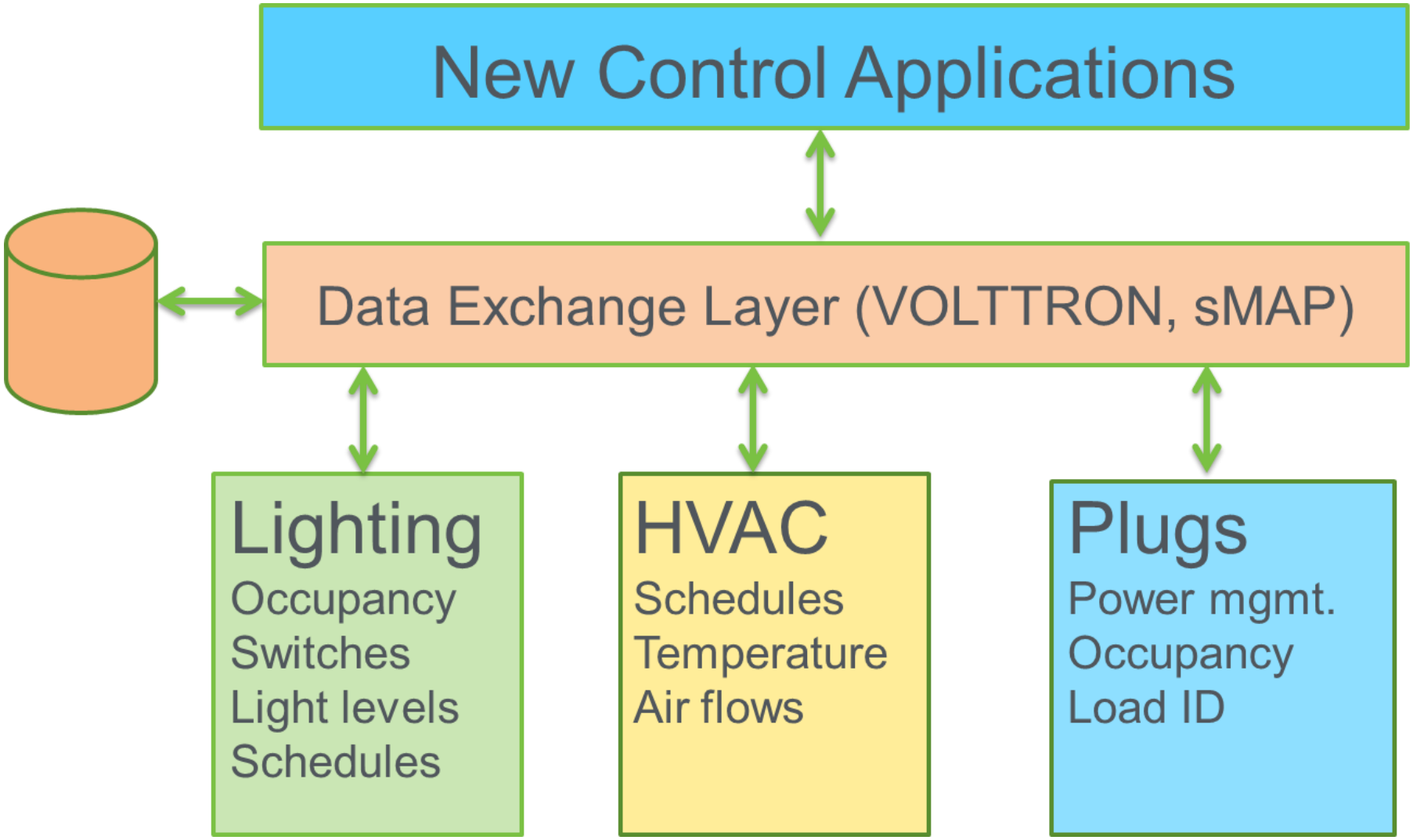
Extend Volttron transaction-based control system

- Hierarchical architecture with distributed control at workstation level, loosely coupled to neighboring workstations, aggregated to zone and building.
- Use transactional-energy principles to allocate scarce energy resources within each control realm.

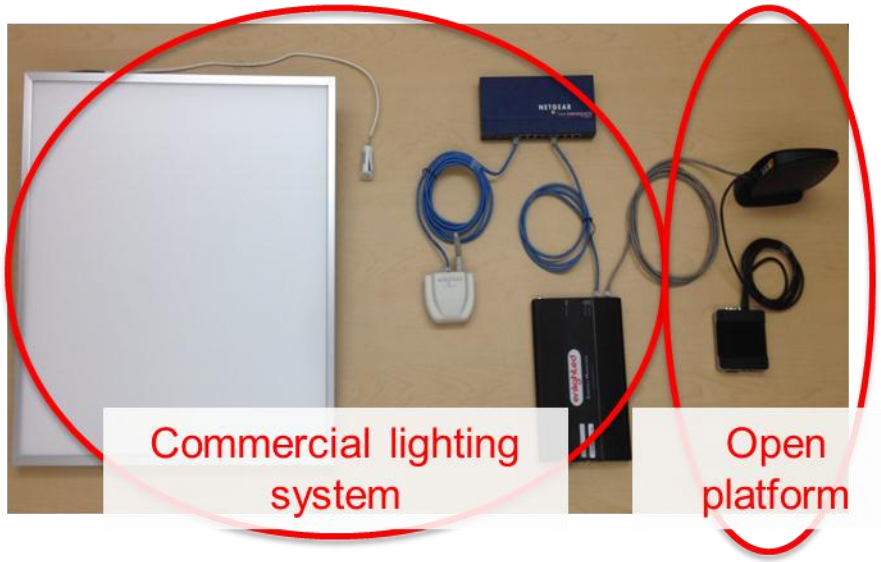
Key Issues:

- Can we integrate control of several end-uses into one, easy-to-use platform?
- Can transactional-energy principles be applied to individual workstation?

Approach: Data Integration Platform Overview

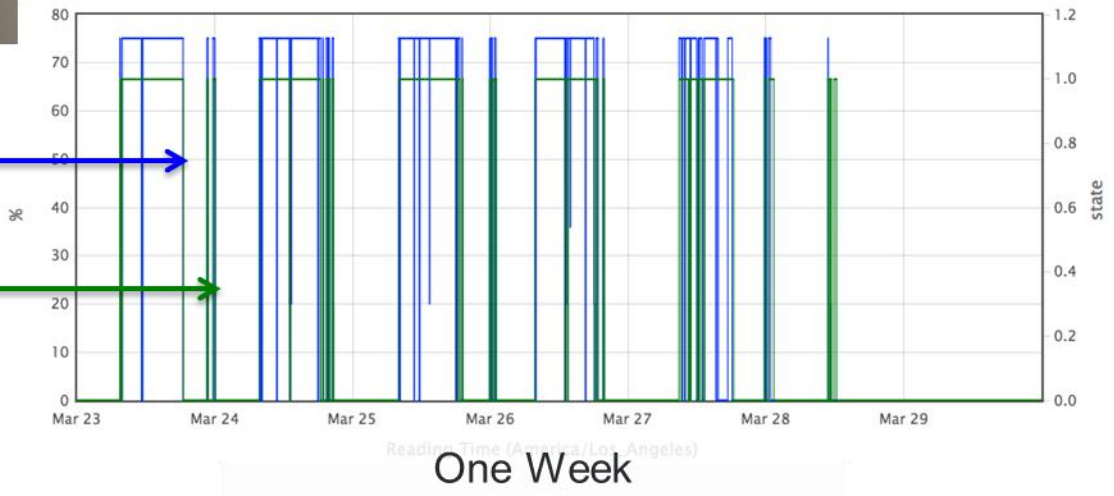


Results: Integrated commercial lighting system with open-source communication and control platform



Fixture dimming **data show energy savings during unoccupied times**

Occupancy data **now available in platform for controlling HVAC, other systems**



Progress: Integration Platform Shows Benefits

Baseline Commercial Lighting System:

Fixtures are commissioned and controlled via a web-accessible GUI where user can:

- Set lighting schedules.
- Group fixtures and set group behaviors based on integrated occupancy sensor data.
- View current projected power consumption and cumulative savings attributable to efficient behaviors.

Integration Platform adds:

- Lighting behaviors are determined by software, which is highly customizable.
- Integration with other (third party) sensors and controls is enabled.
- Fixtures can respond to whole-building schedules and other external data.

Project Integration and Collaboration

Project Integration:

- Regular calls with Indian research partners
- Joint US-India work on data exchange platform
- Collaborative work with Enlighted on lighting interface

Partners, Subcontractors, and Collaborators:

- Project is a task in the CBERD Program
- Vishal Garg, International Institute of Information Technology, Hyderabad, India
- Tanuj Mohan, Enlighted Systems, California, USA (Development Partner)

Communications: CBERD Industry Forum

Next Steps and Future Plans

Transaction-based Controls: tools are being developed for U.S. grid-integration … but have not been applied to "resource constrained" settings, such as islanded buildings during power outage

Approach: ***Extend Volttron transaction-based control system***

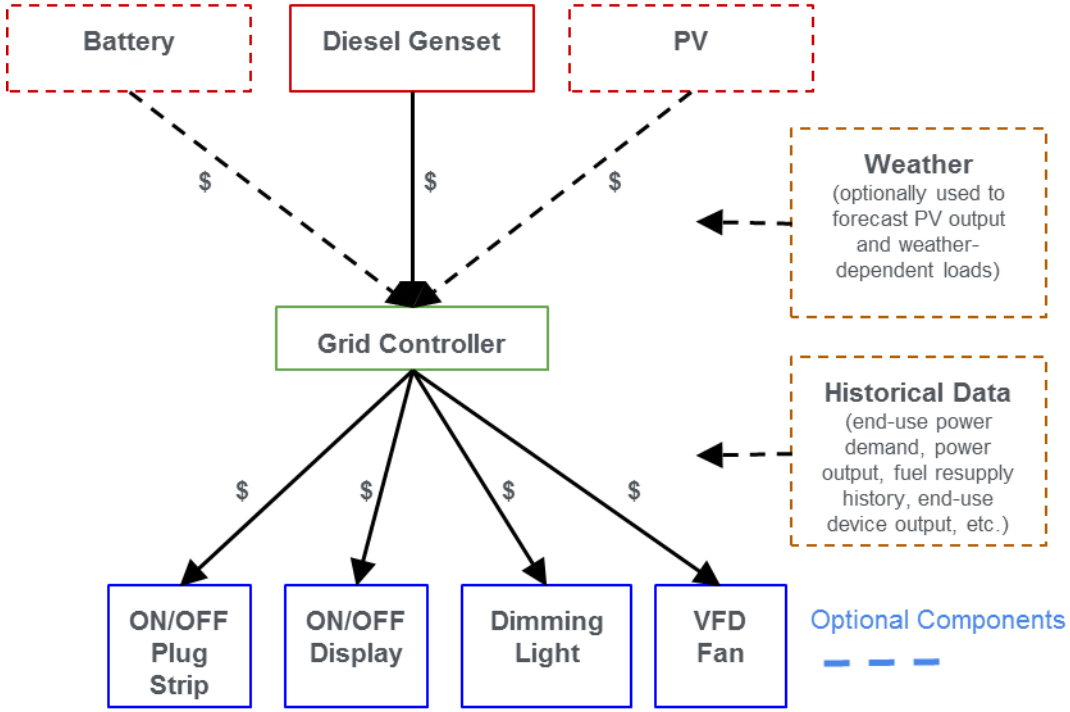
- Builds on work for BTO that uses Volttron to manage military microgrids.
- Demonstrate Volttron-based system in Indian office building

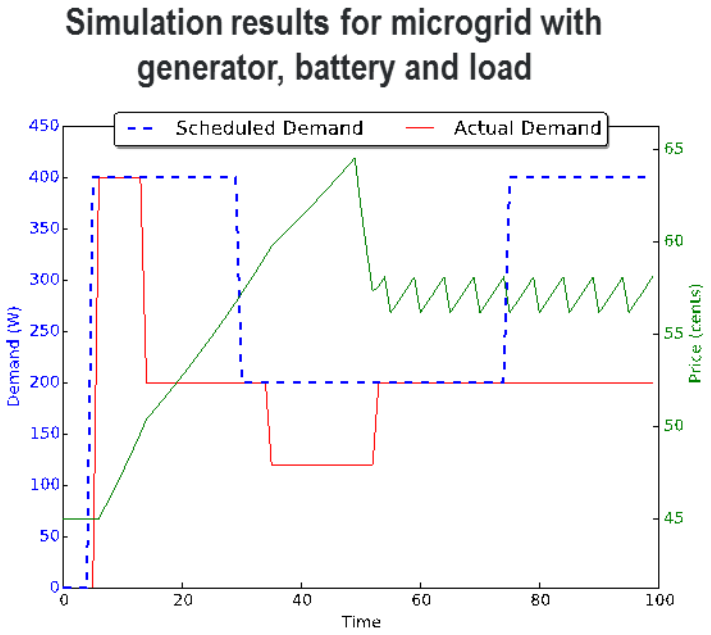
Key R&D questions:

- Can Volttron be used to manage energy and load in grid-islanded, "resource constrained" buildings?
- Is the Volttron system robust enough to handle intermittency and instability of the Indian grid?
- Demonstrate that control of many workstation-level loads can have an effect on zone and whole building.

- *Volttron is a key component of DOE's grid-integration research agenda.*
- *Advanced communication and control technologies are essential to BTO's 50% energy savings goal.*
- *This project will extend transaction-based controls to resource-constrained grids.*

Next Steps: BTO Transactive-Energy Microgrid Control Concept





- Developed to manage military microgrid; can be applied to islanded building
- Price of electricity is used to manage energy, balance supply & demand
- Supply assets (generators, battery) publish prices based on energy scarcity
- Grid controller publishes system-wide price to balance available supply & expected demand
- End-use devices adjust load based on system price & device-specific demand elasticity curves

Future Plans: Integrated Workstation Demo

- Challenge:
  - Manage loads at workstation, zone, and building level, while still giving individual occupants control.
  - Demonstrate that control of many workstation-level loads can have an effect on the zone and whole building.
- Approach:
  - Hierarchical architecture with tightly controlled “microgrid” at workstation level, loosely coupled to neighboring workstation microgrids, aggregated up to zone and building.
  - Control loads (e.g., lighting, person comfort) and laptop batteries to conduct transactions between microgrids; use findings from RPI lighting task.
  - Use power price as control mechanism, influenced by availability of grid power and local resources.
  - Volttron system used for communication and transactions.
  - Infosys very interested in workstation-level control on their campuses.

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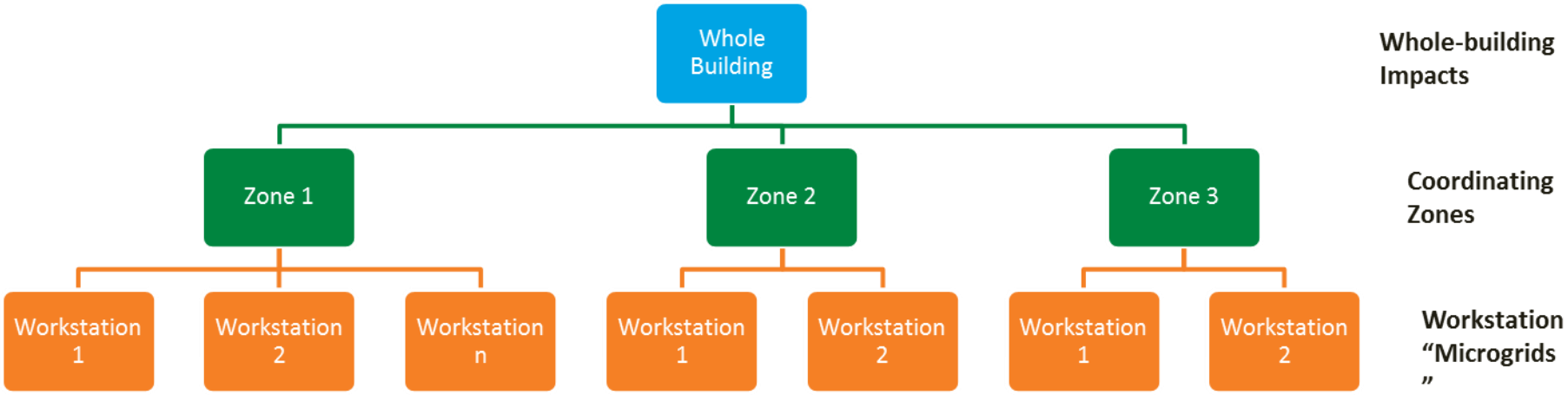
Integrated Workstation Demo: Conceptual Architecture



- Each workstation controlled independently using transational-energy methods.
- Volttron manages each workstation "microgrid."
- Independent workstations are coordinated at the zone level using price-based transactions.

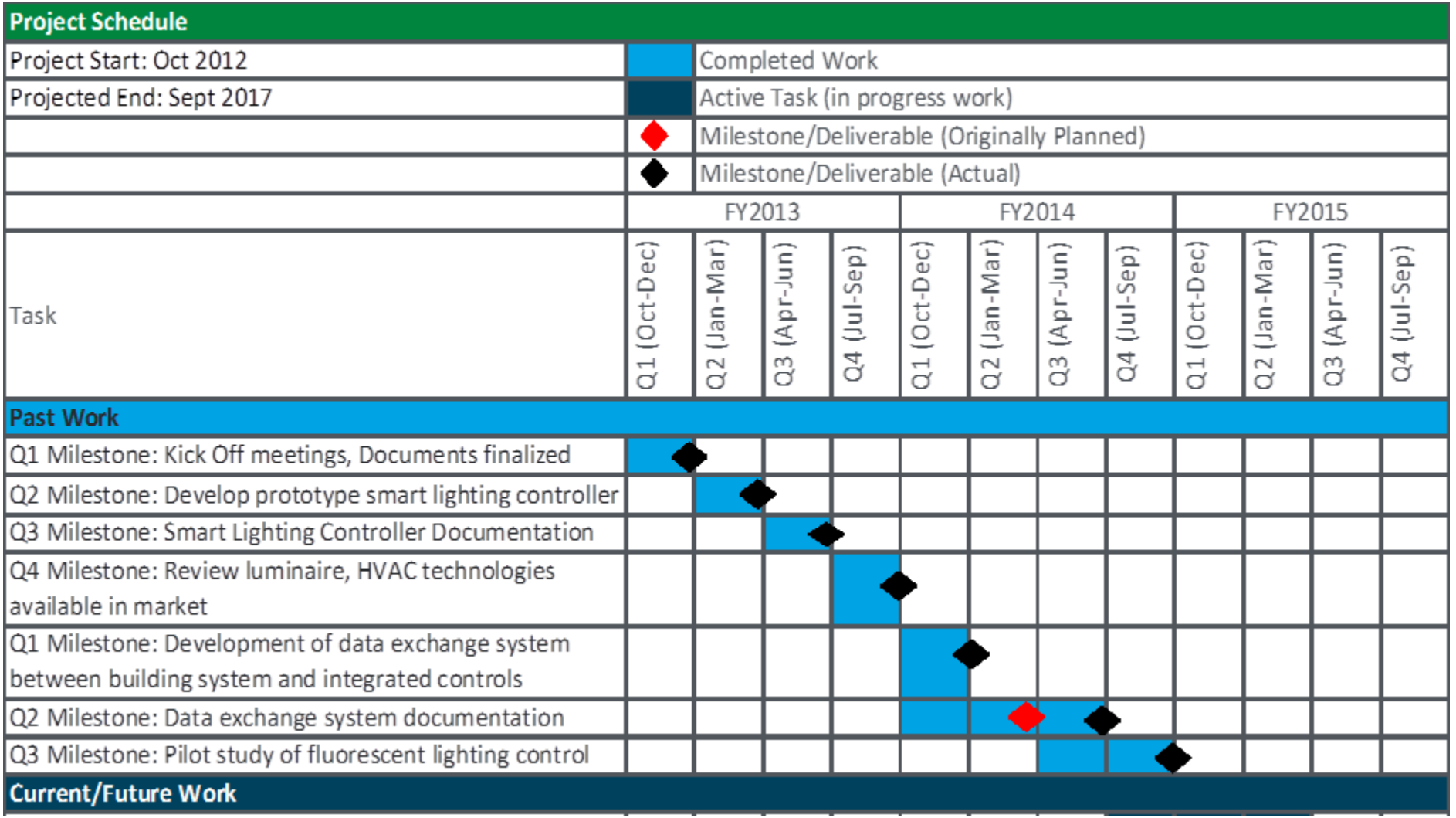
REFERENCE SLIDES

Project Budget

Project Budget: $125K per year
Variances: None.
Cost to Date: $250K
Additional Funding: $300K cost share

Budget History					
Oct 2012– FY2014 (past)		FY2015 (current)		FY2016 – Sept 2017 (planned)	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
$250k	$50	$125k	$0k	$250k	$250k

Project Plan and Schedule



Progress: Laboratory Scale Lighting Demo