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A Look at PNNL VOLTTRON™ Use Cases

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VOLTTRON™ 2016

Outline

- Why do we need VOLTTRON™?
- Benefits of VOLTTRON™
- List of VOLTTRON™ Use Cases
- A Look at a Selected Use Cases

U.S. Building Resource Consumption

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40%

Primary energy consumption

38%

Greenhouse gas emissions

9%

Total world consumption

Nearly 75% **Electricity consumption**

Opportunity to Reduce Building Energy Use, Carbon Footprint and Increase Grid Reliability

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20% to 60%

Building and equipment efficiency

20% to 30%

Operating efficiency

15% to 30%

Distributed renewable energy generation

VOLTTRON™ Domain

30% to 80% Reduction in building energy consumption and carbon emissions is possible

VOLTTRON™: Key Benefits and Primary Use Areas

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- 3 Key Benefits:
  - Cost-effective – Open source software (free to users) and can be hosted on inexpensive computing resources
  - Scalable – Can be used in one building or a fleet of buildings
  - Interoperable – Enable interaction/connection with various systems/subsystems, in and out of the energy sector
- 3 Primary Use Areas:
  - Building Efficiency – To help control building energy system performance
  - Building-Grid Integration – To support “beyond demand response” approach and integration of distributed energy resources into the grid
  - Transactive Control – To support a scalable, distributed control mechanism for transacting information about systems, loads and constraints to deliver user specified services

Example VOLTTRON™ Use Cases

- **Building Automation System (BAS) for Small/Medium Size Buildings (SMB)**
- **Deploying Energy Efficiency (EE) and Grid Services with SMB**
- **Secure Data Collection from BAS in Support of Third Party Cloud Analytics**
- VOLTTRON™-based Cloud Analytics
- **Deploying Energy Efficiency and Grid Services for Large Commercial Buildings**
- **“Re-tuning” Mandates (New York, Seattle, etc.)**
- Interoperability Platform for Commercial Buildings
- **Interoperability Platform for Homes**
- Enabling “Smart” Building for “Smart” Cities

BAS for Small/Medium Size Buildings

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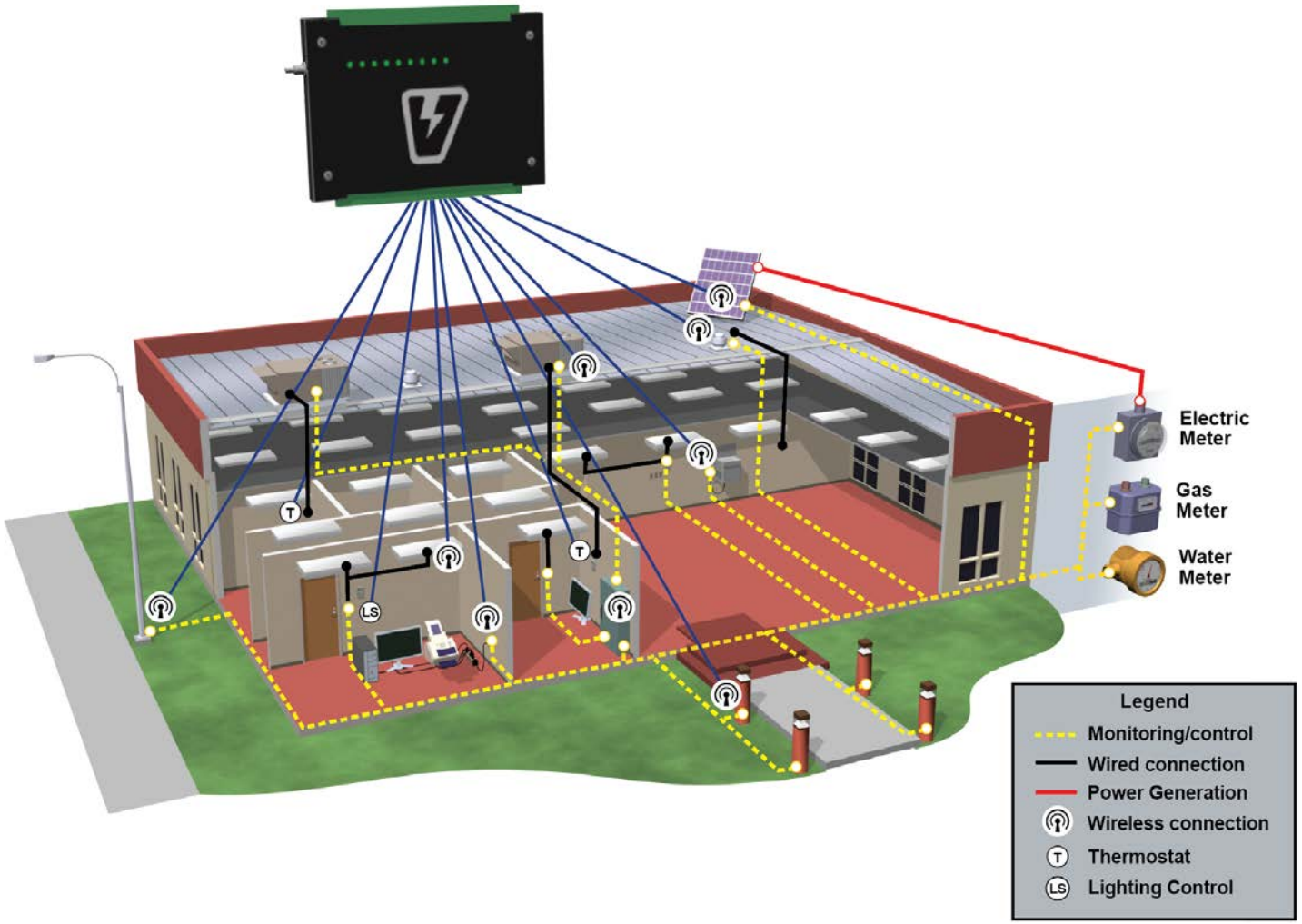

EE and Grid Services for SMB: What

- Energy Efficiency Service
  - Extract set points from monitored data – to enforce set point controls and detect local overrides by occupants
  - Extract schedules from monitored data - to enforce persistence in schedules and detect local overrides by occupants
  - Extract compressor ON/OFF cycles, without power measurement
  - Identify economizer problems with minimum set of monitored points
- Grid Services
  - **Intelligent load controls**, transactive controls, mitigation of short-term imbalance in supply and demand

Grid Service: Intelligent Load Control

- Traditional Utility Rate Structure
  - Demand charge (15 min or 30 min average or rolling-average)
  - Typically based on a 30-day billing cycle
  - Traditional demand response programs
  - Time-of-use and critical peak pricing
- Transactive Energy
  - Dynamic rates (15 min or 60 min), real-time pricing as well as day ahead
- Either Case
  - Intelligent Load Control (ILC) can help manage peak or energy consumption target

ILC: Traditional Utility Rate Structure

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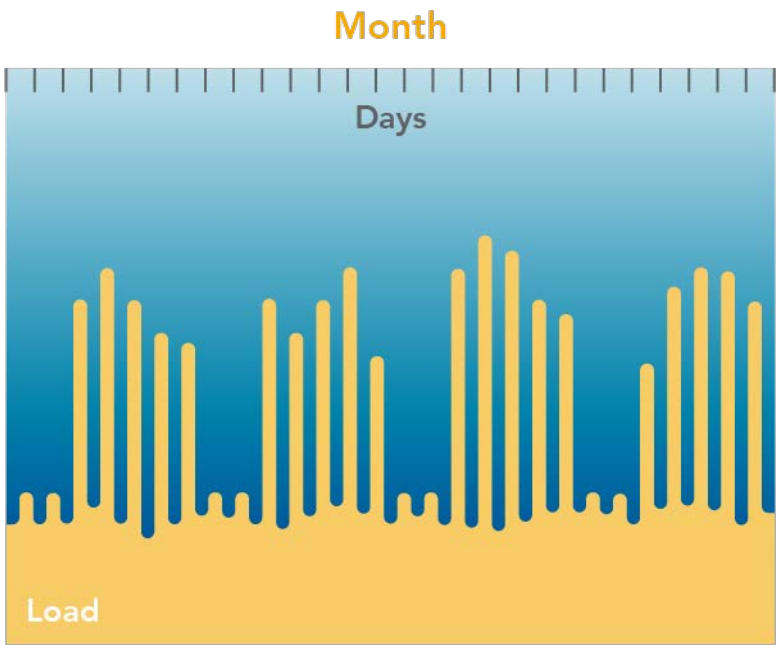
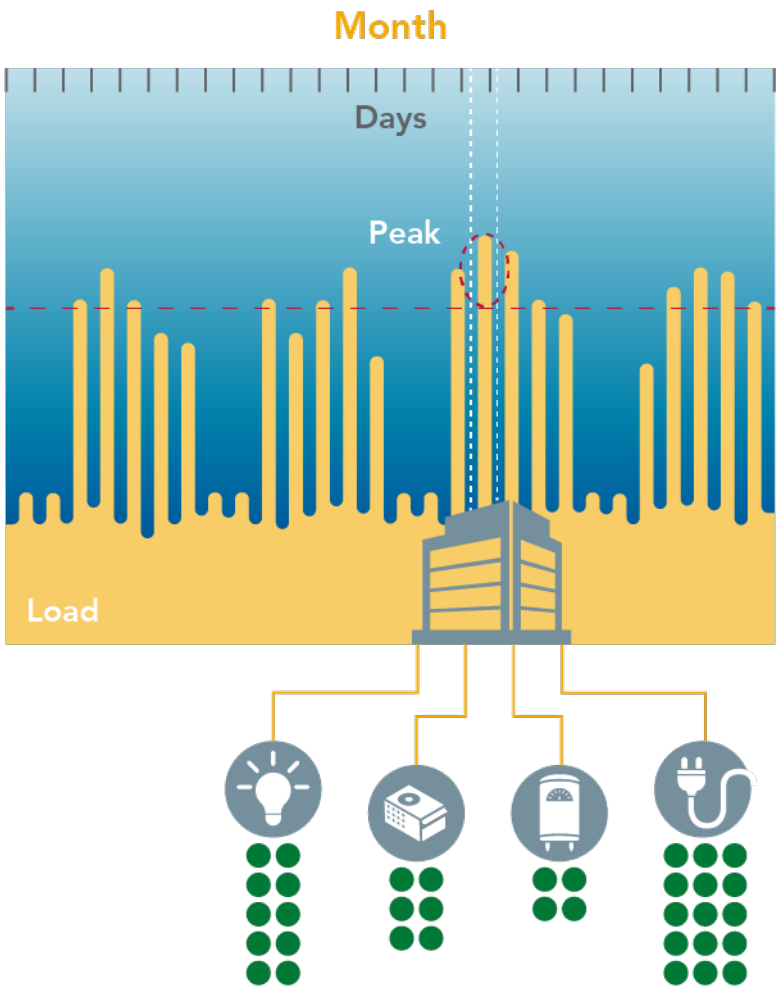
Forecast the Load for the Next Billing Cycle

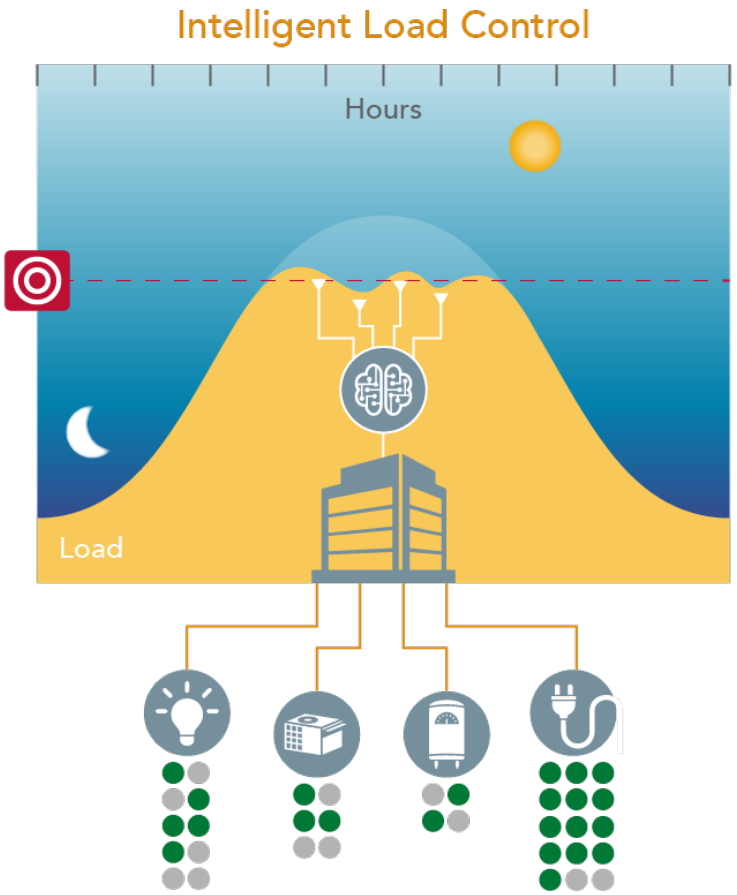


Establish the Target Peak



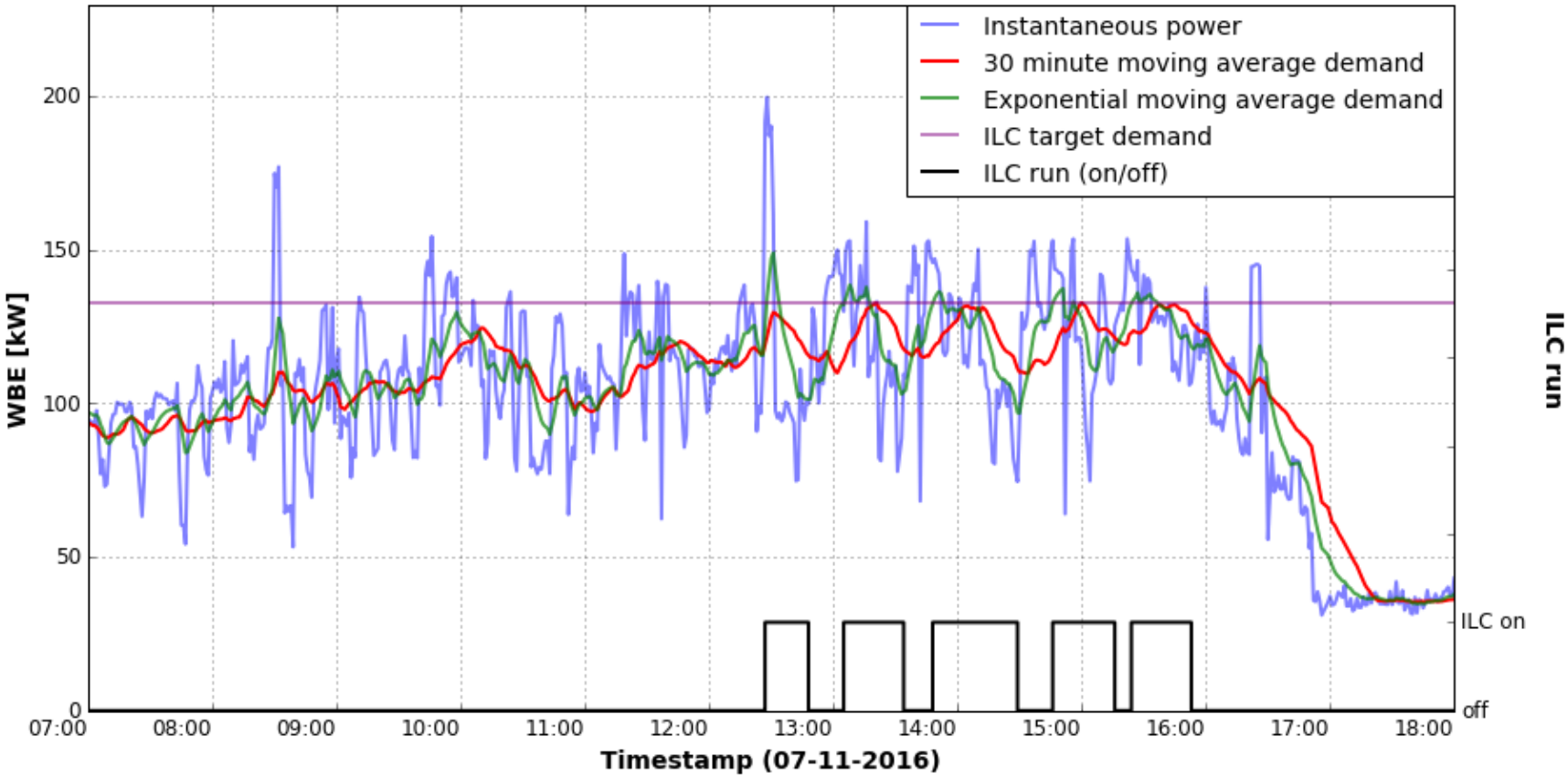
ILC: Manage Power use to a Target

- Deployment on PNNL campus building shows ILC can manage or reduce peak electricity demand by controlling heat pumps
- Without impacting occupant comfort

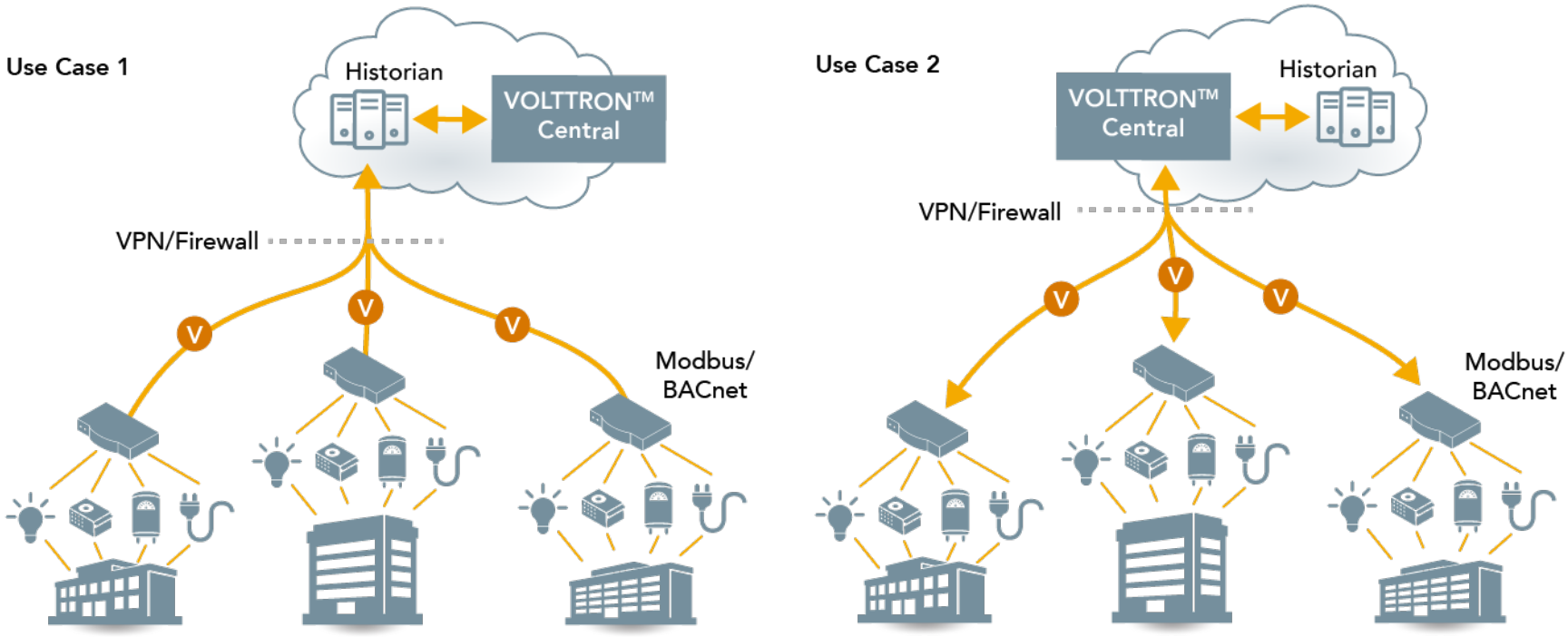


Kim W, and S Katipamula. 2016. "**Development and Validation of an Intelligent Load Control Algorithm**." Submitted for consideration for Energy and Buildings.

ILC: July 11, 2016

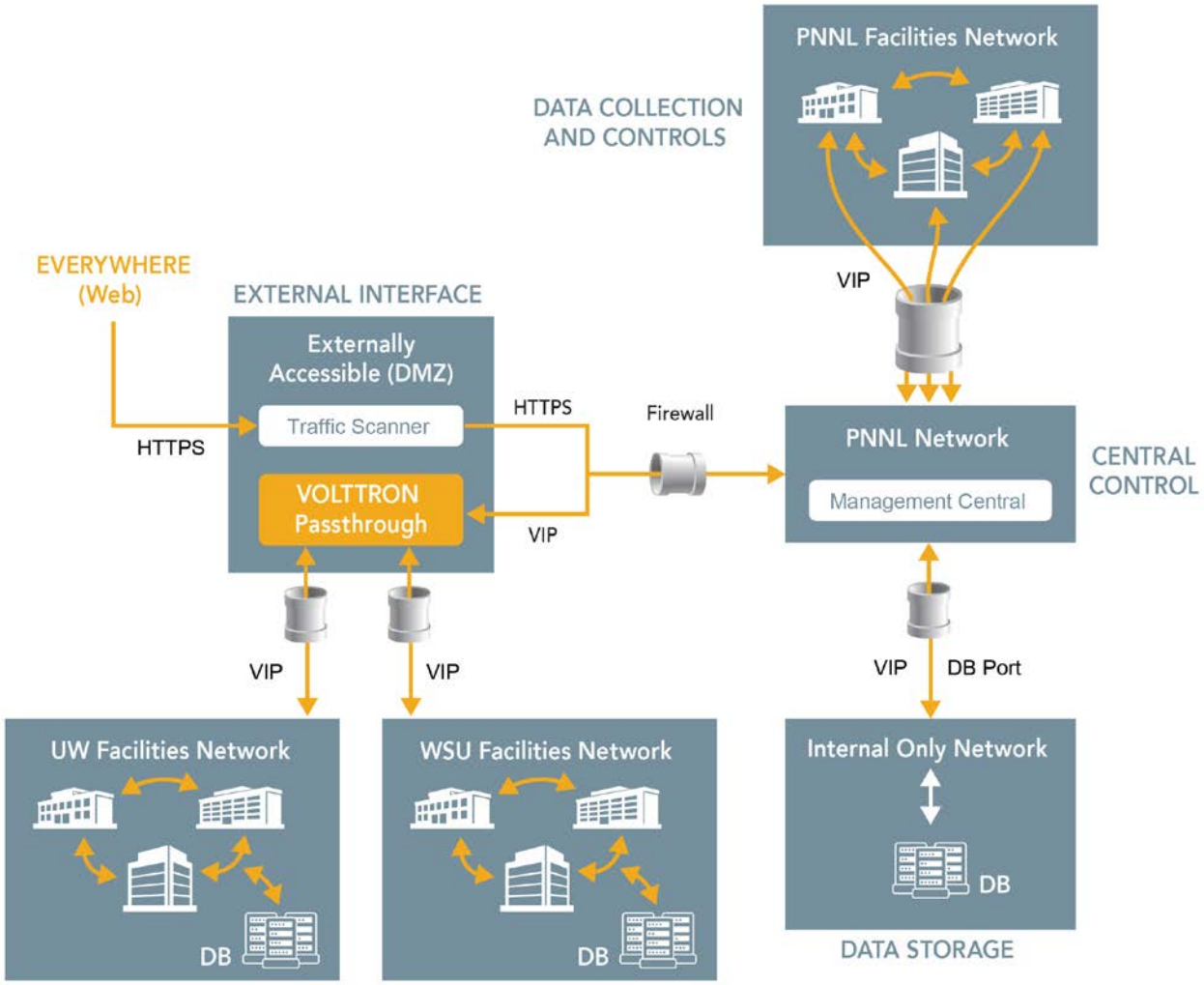


Secure Data Collection from BAS in Support of Third Party Cloud Analytics

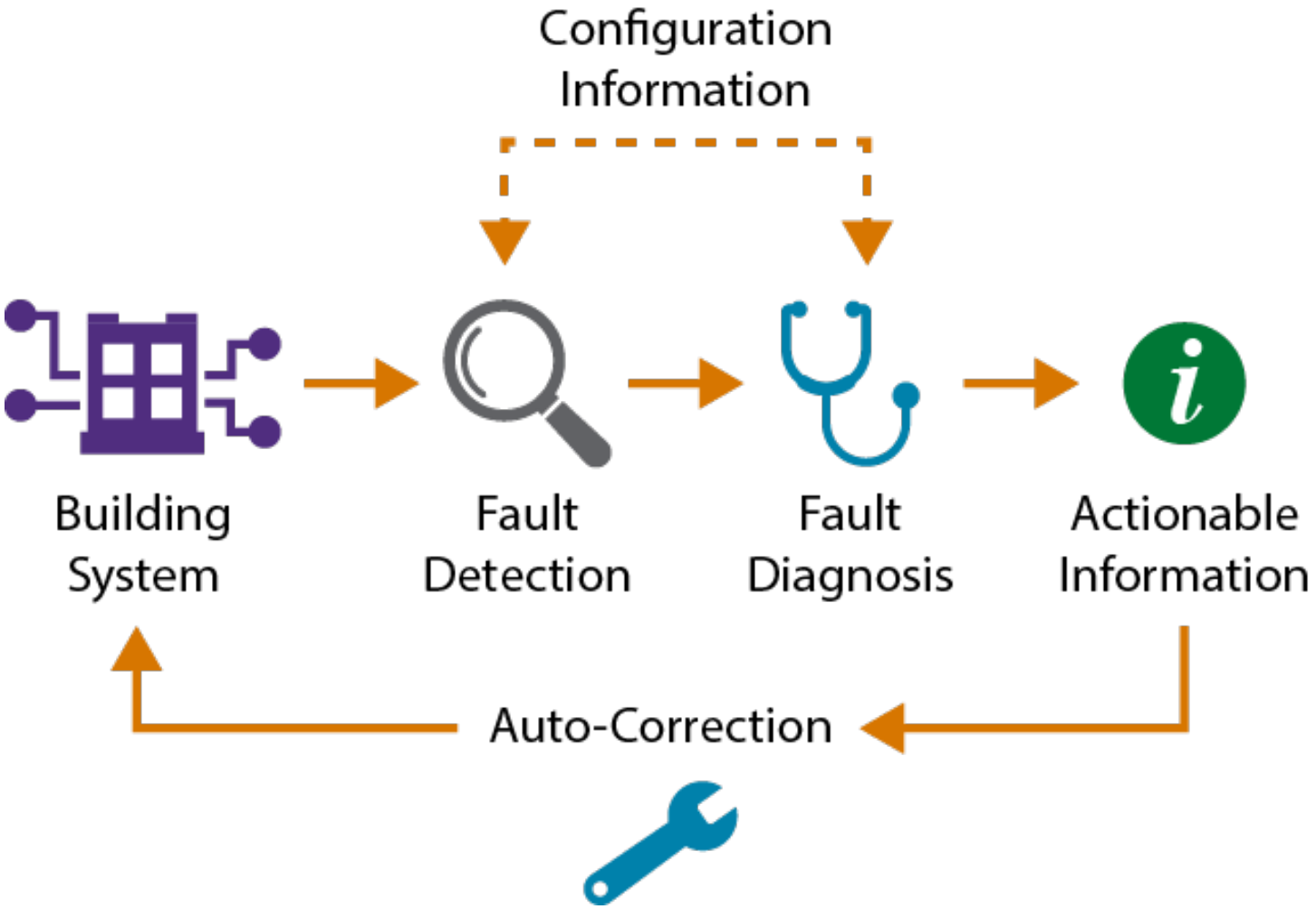


- Access to data from other devices
  - WiFi, Zigbee, proprietary devices thru API calls

Secure Data Collection at Campus Scale



Energy Efficiency Services for Large Commercial Buildings: What



Energy Efficiency Services for Large Commercial Buildings: How

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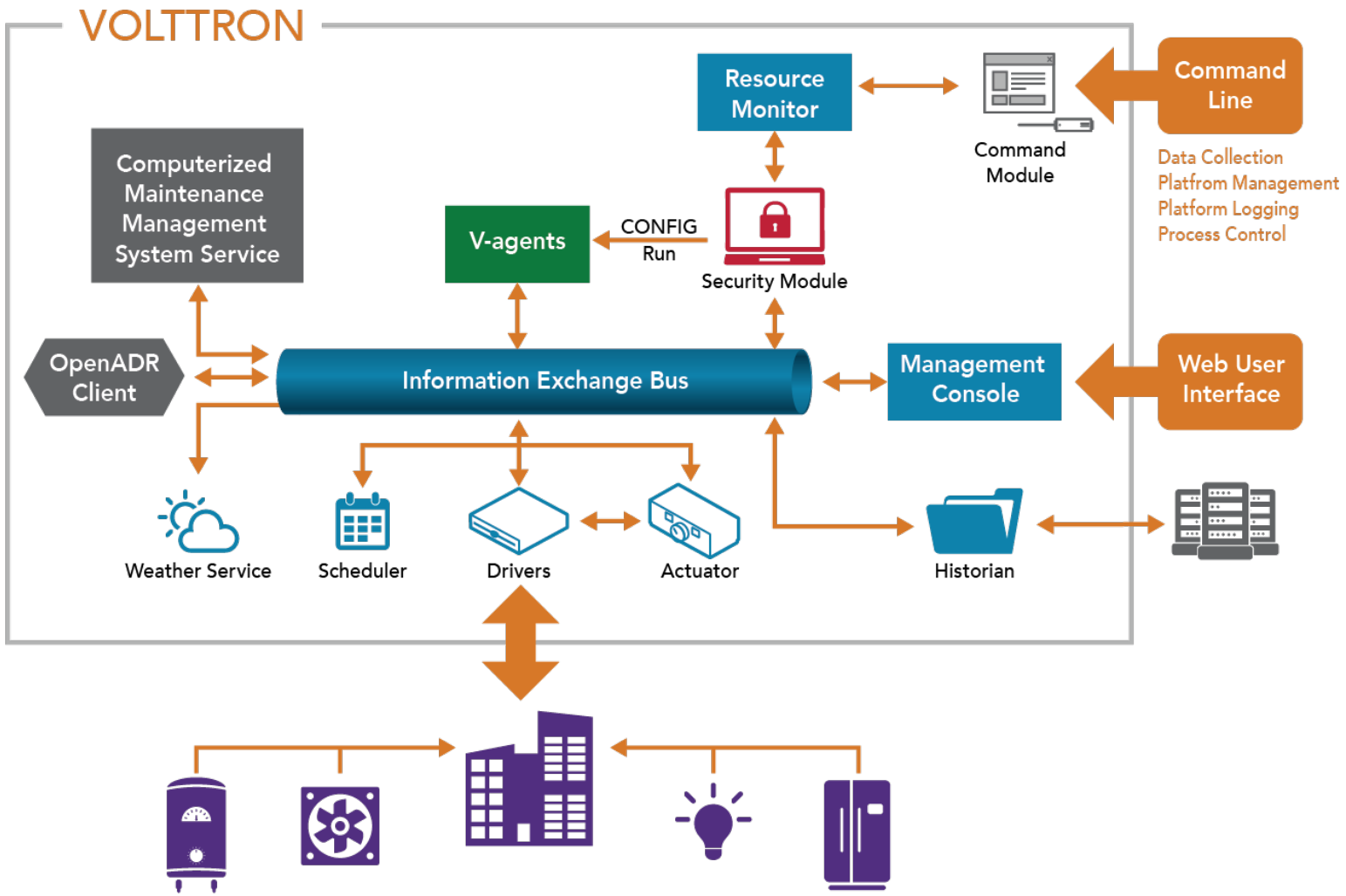

Energy Efficiency Services for Large Commercial Buildings: Result

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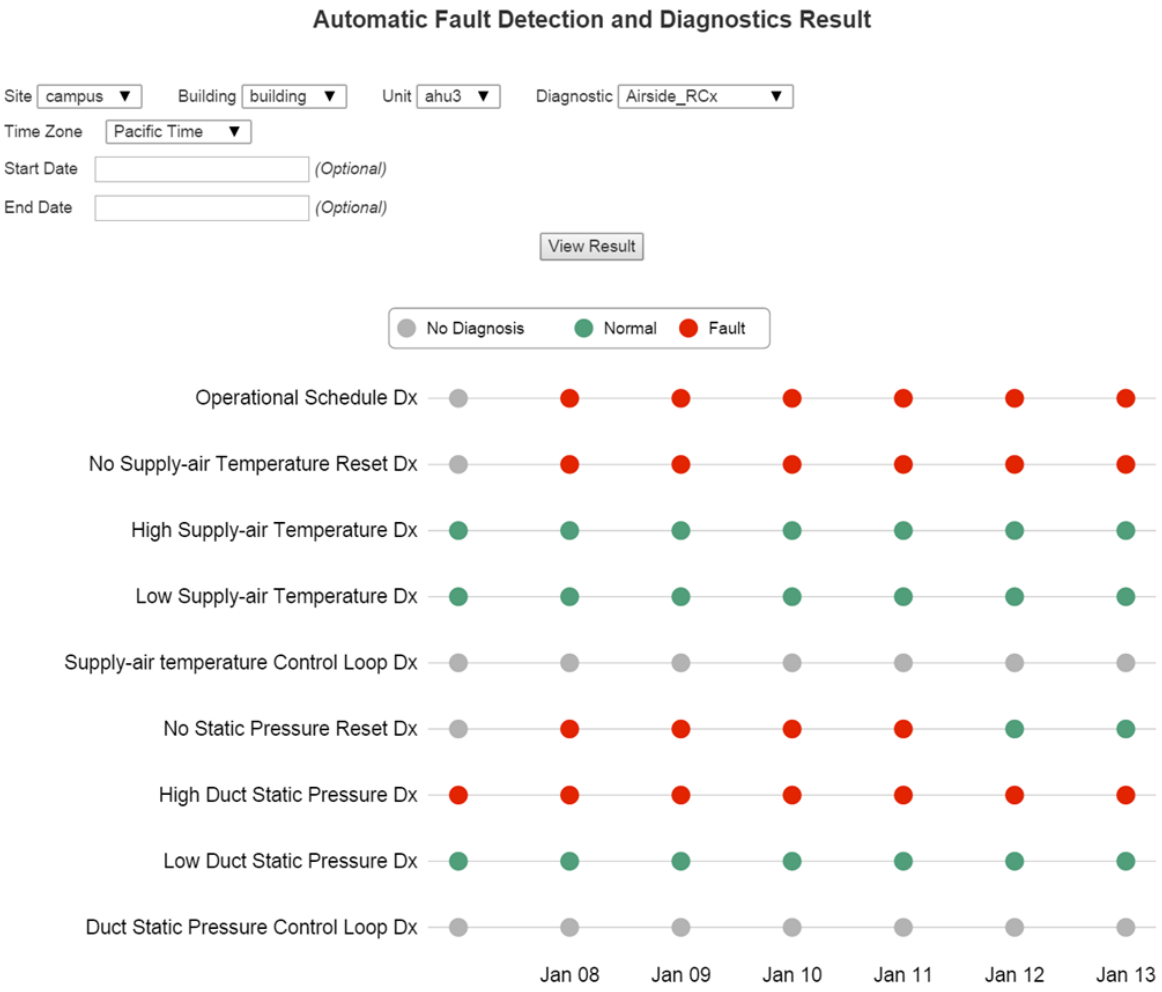


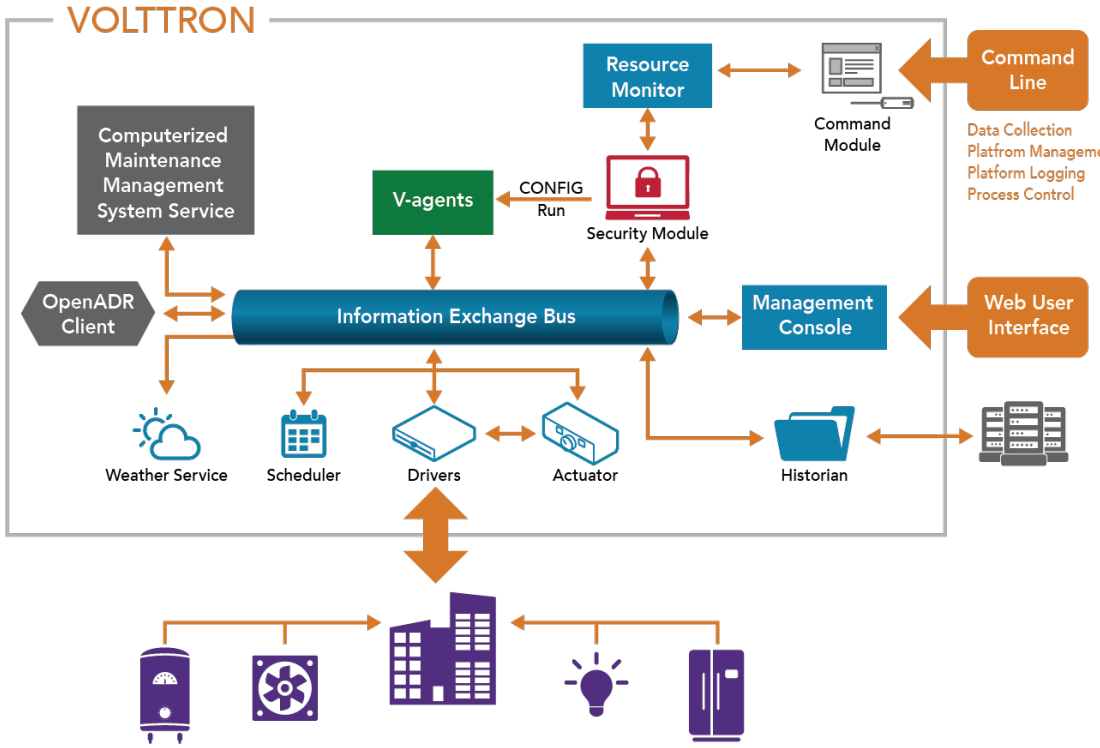
Katipamula S, RG Lutes, G Hernandez, JN Haack, and BA Akyol. 2016. "**Transactional Network: Improving Efficiency and Enabling Grid Services for Building**." Science and Technology for the Built Environment 1-12. doi:10.1080/23744731.2016.1171628

20% to 30%

Operating Efficiency

Supporting “Re-tuning” Mandates

- Support Mandates/Executive Order to periodically retro-commission building systems
- Support various city mandates to periodically retro-commission buildings
- More cost effective, systematic and also ensures persistence of energy savings on a continuous basis



Katipamula S, K Gowri, and G Hernandez. 2015. "**Automated Continuous Conditioned-Based Maintenance for Commercial Buildings**." Accepted for publication in Science and Technology for the Built Environment

Interoperability Platform for Commercial Buildings and Homes

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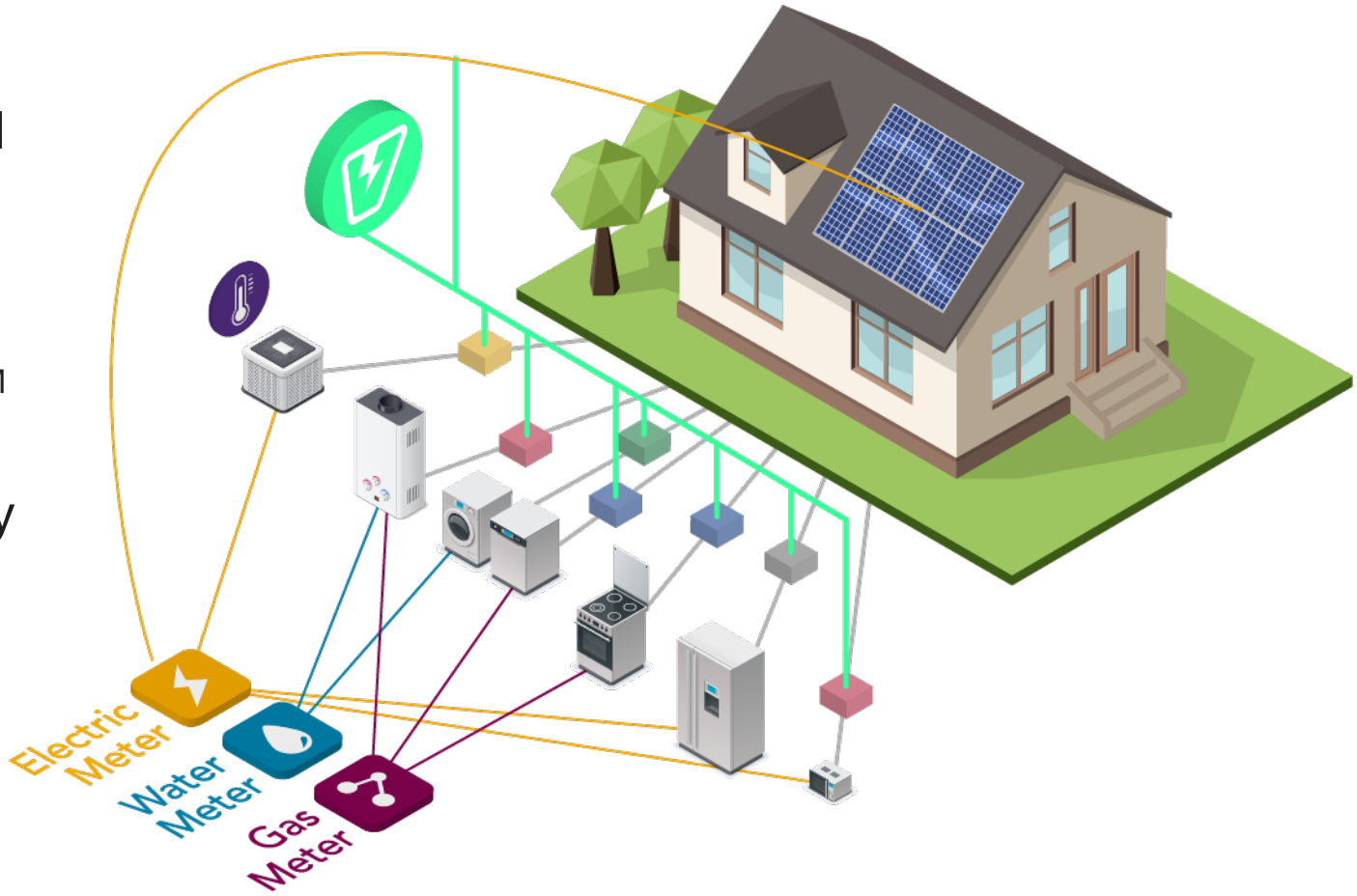
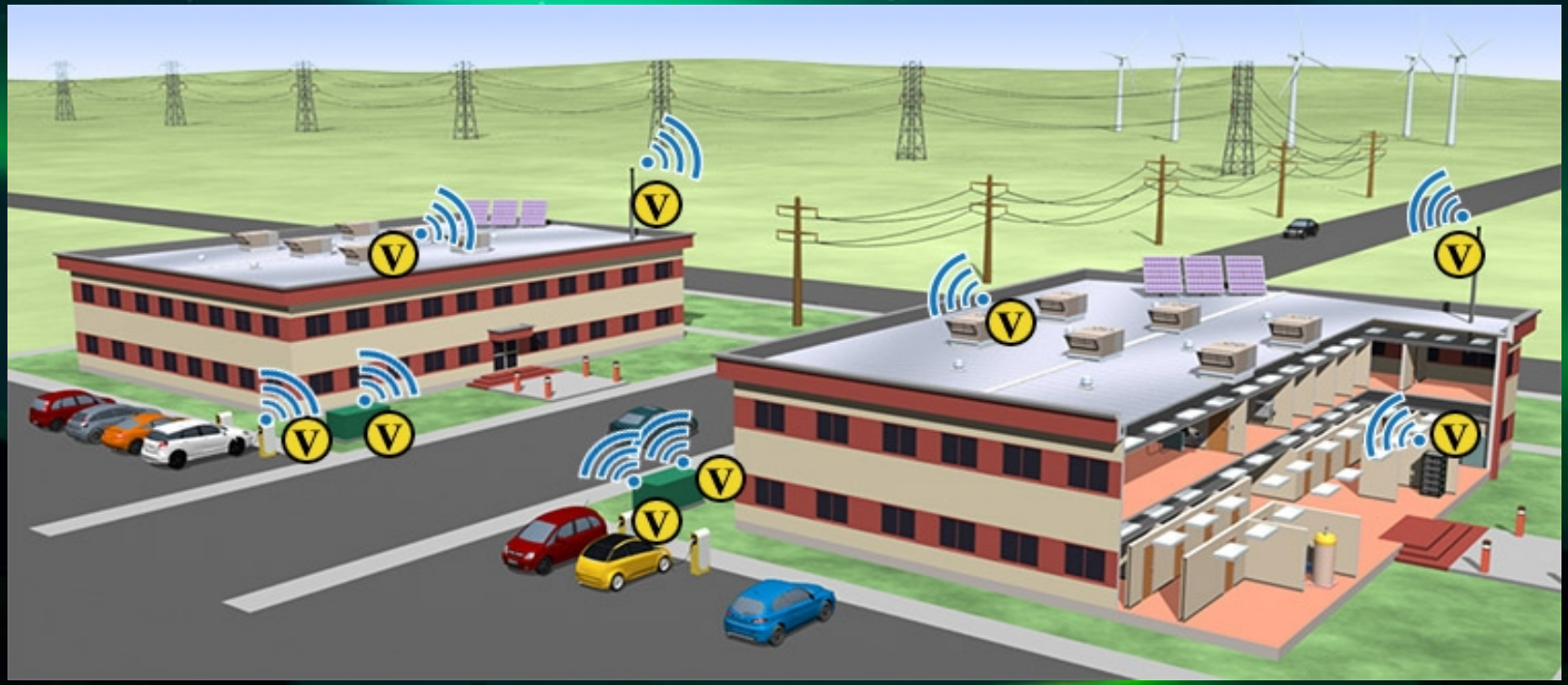
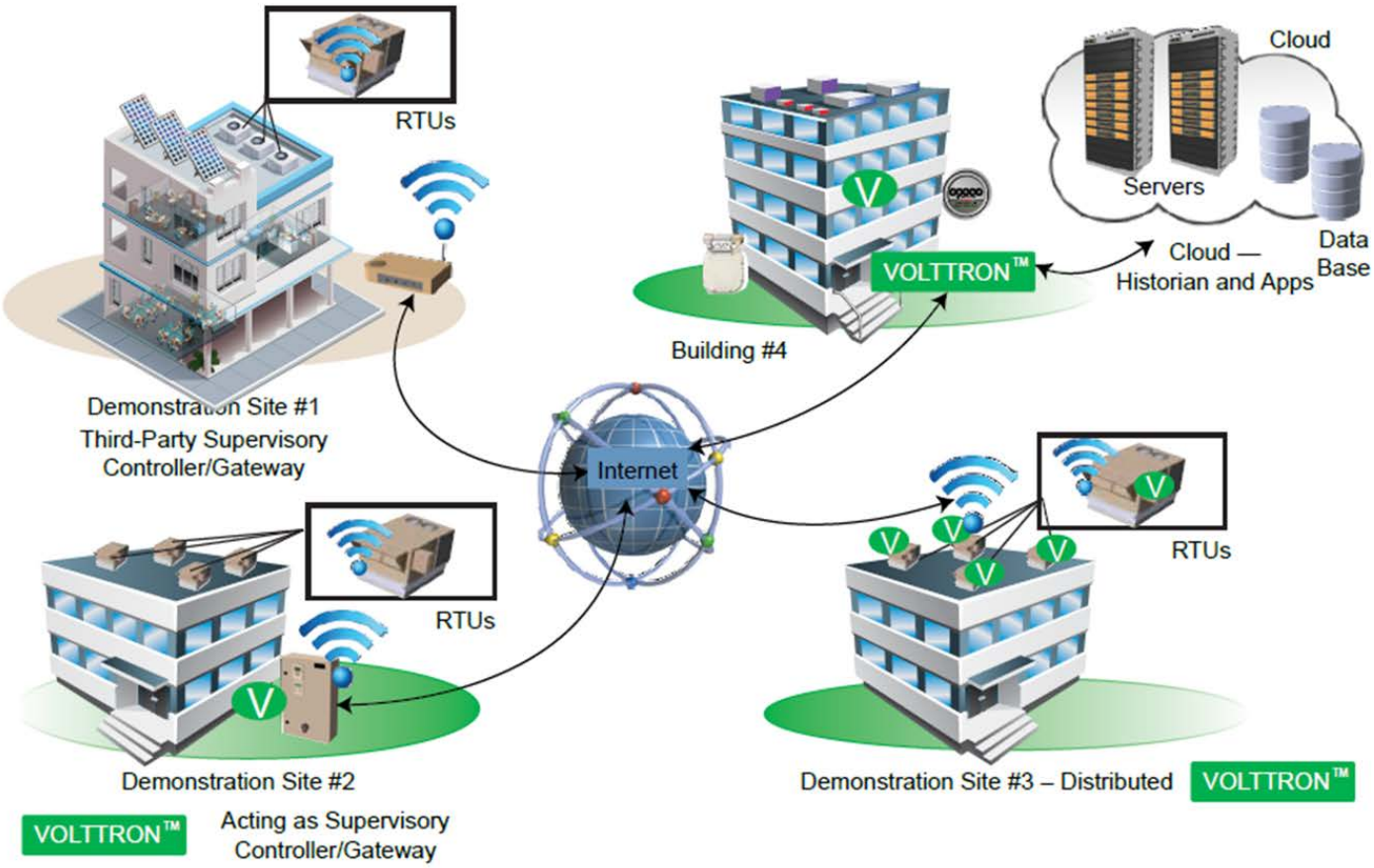
- On the home front lot of standards and alliances but none are dominant
- VOLTTRON™ can be an interoperability platform



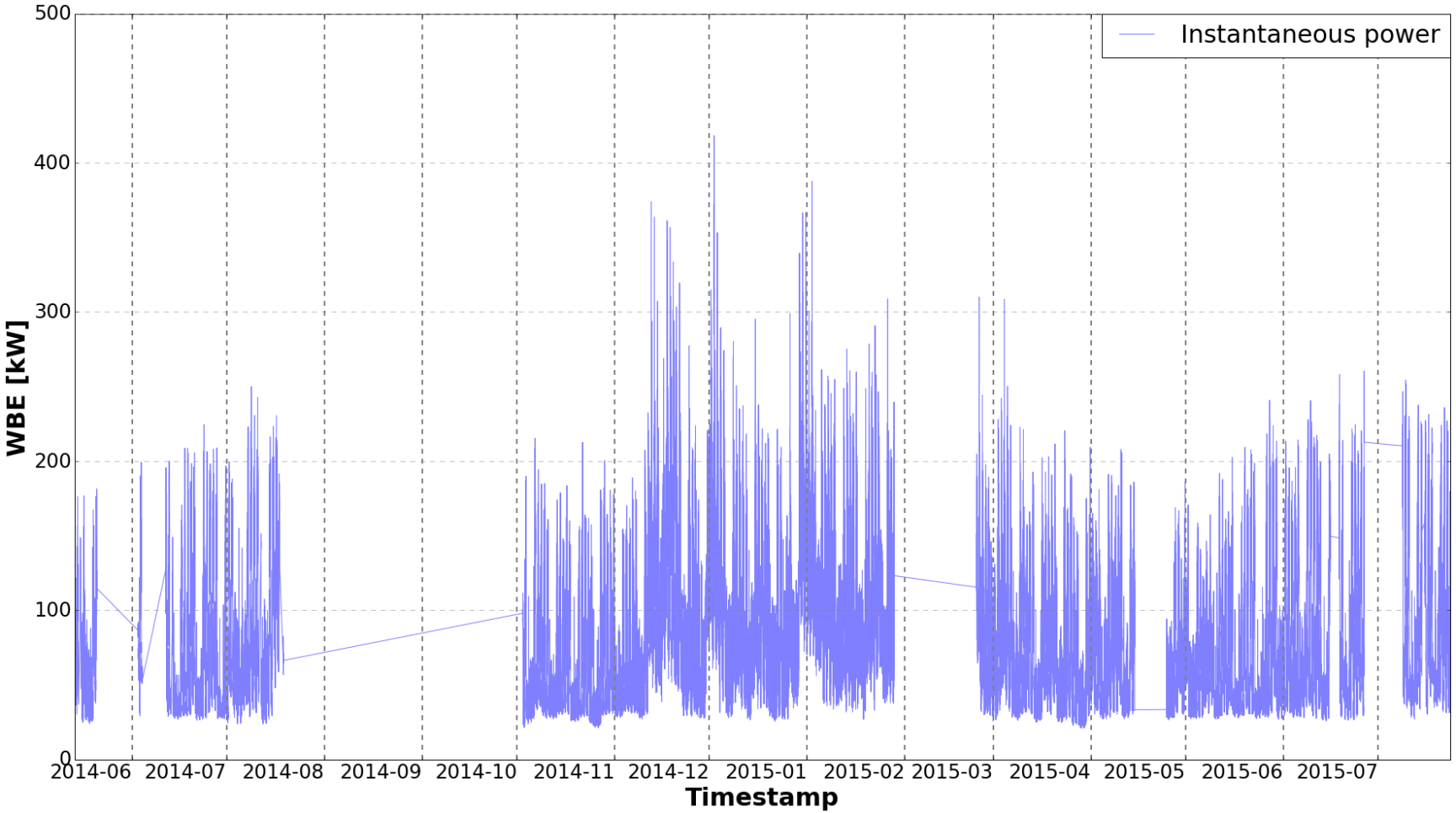


For More Information: http://volttron.pnnl.gov
http://bgintegration.pnnl.gov/volttron.asp and volttron@pnnl.gov
https://github.com/VOLTTRON/volttron/wiki

Cloud Analytics



Whole-Building Electricity Consumption



Whole-Building Electricity Consumption (last 12 months)

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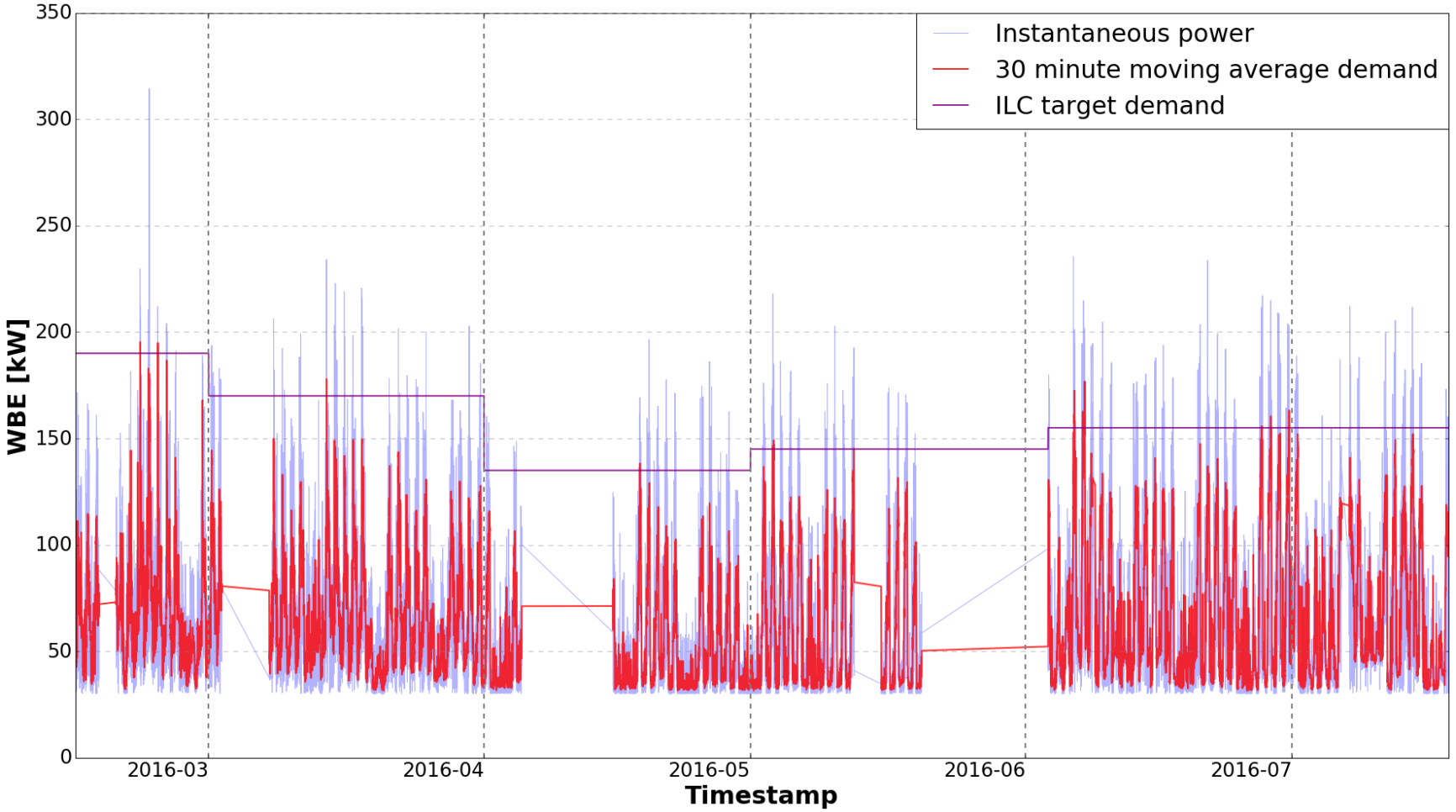

Whole-Building Electricity Consumption – July 2016

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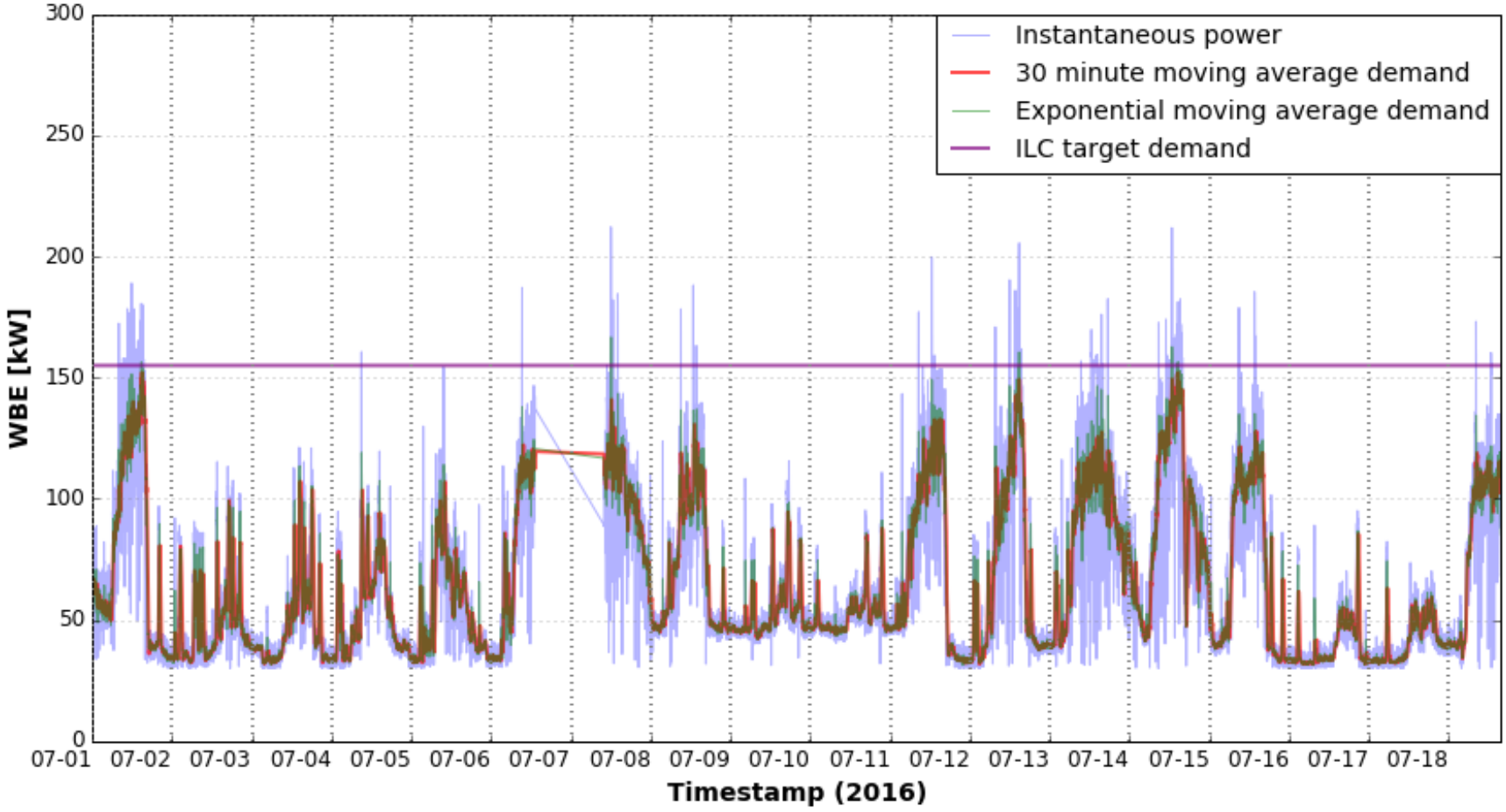

ILC: July 11, 2016

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System model	Room type	Capacity [tons]	1ST ILC start time: 12:28 PM	2nd ILC start time: 01:06 PM	3rd ILC start time: 01:49 PM	4th ILC start time: 02:47 PM	5th ILC start time: 03:25 PM	The number of Curtailment
HP1A	Manager office	2						0
HP1B	Office	2						0
HP2	Manager office	2						0
HP3	Kitchen	7.5	O				O	2
HP4	Shop	7.5		O	O		O	3
HP5	Shop	4						0
HP6	Shop	25	O	O	O	O		4
HP7	Shop	7.5			O	O	O	3
HP8	Office	20						0
HP350	Office	2						0
Sum			2	2	3	2	3	