Peninsula Advanced Energy Community (PAEC)

Task 3.18: Final Energy Tracking/Benchmarking Tool Report

Building Energy Management Systems: An Advanced Energy Solution for Commercial Buildings

Prepared for

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San Mateo County, Office of Sustainability

Formed in July 2014 as a part of the County Manager's Office, the Office of Sustainability strives to improve the sustainability of the County's operations and the greater community through work in areas of renewable energy and energy efficiency; resource conservation; alternative transportation; and greenhouse gas emission reductions.

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Clean Coalition

The Clean Coalition is a nonprofit organization whose mission is to accelerate the transition to renewable energy and a modern grid through technical, policy, and project development expertise.

The Clean Coalition drives policy innovation to remove barriers to procurement and interconnection of distributed energy resources (DER)—such as local renewables, advanced inverters, demand response, and energy storage—and we establish market mechanisms that realize the full potential of integrating these solutions. The Clean Coalition also collaborates with utilities and municipalities to create near-term deployment opportunities that prove the technical and financial viability of local renewables and other DER.

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I. Introduction

The Clean Coalition's Peninsula Advanced Energy Community (PAEC), supported by numerous local governments and PG&E, will accelerate the planning, approval, and deployment of an Advanced Energy Community (AEC) within a diverse community in the southern portion of San Mateo County. The core PAEC region encompasses the cities of Atherton, East Palo Alto, Menlo Park, and Redwood City as well as surrounding unincorporated areas. The PAEC region -largely built-out yet also experiencing enormous commercial and residential growth pressure - is representative of similar regions throughout California, ensuring that the PAEC's success can be replicated statewide. The PAEC project will include the key components necessary to define an AEC: abundant solar electricity, energy storage, and other Distributed Energy Resources (DER,) low or zero net energy (ZNE) buildings, Solar Emergency Microgrids (SEM) for power management and islanding of critical loads during outages, and charging infrastructure to support the rapid growth in electric vehicles.

AEC projects can provide significant energy, environmental, economic, and security benefits, but significant barriers too often impede their planning and deployment. Finding viable sites, securing project financing, and connecting AEC projects to the grid all represent significant challenges. The PAEC project is designed to overcome these barriers and establish a replicable model that can be used by other communities across California and beyond. The results of the PAEC will inform future action by policymakers, municipalities and other governmental agencies, utility executives, and other relevant audiences.

In San Mateo County, energy consumption from County owned commercial properties represents 52% of the government operations greenhouse gas emissions.[1] To reduce emissions from County operations, it is imperative to examine how energy conservation measures can be leveraged within each building and across the County's building portfolio. Best practices used and studied in government facilities can be brought to other commercial building owners to tackle the carbon footprint of our building stock to meet California State Climate goals outlined in Assembly Bill (AB) 32.

To manage and reduce energy consumption, it must first be measured. A Building Energy Management System (BEMS) is a cost-effective tool that can be employed in a commercial building or across a portfolio of buildings to measure energy consumption. BEMS allow for the centralized control of a building's energy systems by utilizing data obtained from control and automation systems, smart meters, sub-meters and advanced sensors. Figure 1 demonstrates the breadth of systems that can be monitored with a BEMS. Data synthesized through a BEMS can be leveraged to increase equipment efficiency, manage lifecycle of systems, improve comfort for occupants and ultimately, provide utility cost savings.

[1] *County of San Mateo Greenhouse Gas Inventory,* County of San Mateo Office of Sustainability, available at http://www.smcsustainability.org/climate-change/greenhouse-gas-emissions/

Figure 1: Building Automation System Segments[2]

60% of large commercial properties in California utilize a BEMS. Whereas 22% of medium sized commercial properties utilize BEMS and merely 2% of small buildings have an active system in place[3]. There is a correlation between having a BEMS and participating in Investor Owned Utility (IOU) Demand Response (DR) programs that support energy conservation and grid harmonization. The success of a variety of energy conservation measures is reliant on being able to manage energy data from a centralized control point demonstrating the importance of employing a BEM in the pursuit of energy conservation and IOU DR program participation.

This report is intended to inform commercial building energy management stakeholders which may include building owners, executives, local governments, building tenants, facility managers, investors, utilities, and green building professionals on the economic and environmental value of employing a building energy management system for commercial buildings. The focus of this report is a deep dive into the energy management market including trends, systems available for deployment and a pro forma analysis. Systems analyzed from this report were discovered during interviews in person, over the phone, and in email and through a comprehensive internet search. This report may not include all available technologies, but aims to provide a framework for decision makers to identify an appropriate management system and better understand the marketplace.

[2] *Building Automation System Segments,* Regel Group, available at http://www.regelgroup.com/main/building-automation-systems-bas/

[3] *California Commercial Saturation Survey,* CPUC, available at http://www.calmac.org/publications/California_Commercial_Saturation_Study_Report_Finalv2ES.pdf

BEMS may also be referenced to as Building Automation Systems (BAS), Energy Management Systems (EMS), Energy Management and Control Systems (EMCS), and Building Management Systems (BMS). For this report, BEMS will be the acronym used.

II. Finding the Right BEMS

a. BEMS Functions and Capabilities

The umbrella term of BEMS covers a plethora of functions that are unique to each system. To select the correct BEMS for a particular building or portfolio of buildings, it is necessary to understand what functions are available and what needs the building occupants have. There are additional criteria beyond function to consider when selecting a BEM which will also be covered in this section.

Basic functions of BEMS have the potential to perform:

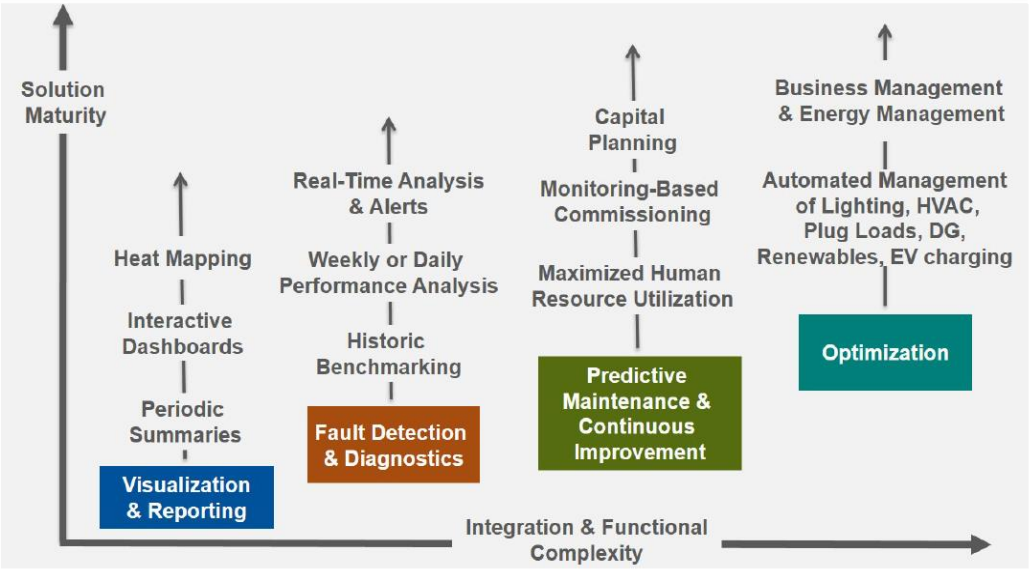
- Visualization and Reporting
- Fault detection and diagnostics

Advanced functions of BEMS have the potential to perform:

- Predictive Maintenance and Continuous Improvement
- Optimization
- Benchmarking & portfolio analysis
- Utilize a Software as a Service (SaaS) model

For a visualization of these functions, Figure 2 demonstrates the depth of offerings as a function of solution maturity and integration & functional complexity.

Figure 2: BEMS Offerings as a Roadmap[4]



(Source: Navigant Research)

b. Considerations When Selecting a BEMS

There is not a panacea for building energy management and conservation goals. A property owner must look at needs within the organization first and then examine the capabilities and features of a variety of BEMS. The below considerations can be used to inform the process of selecting a BEMS from the Table in Section III of this report. Demonstrations and consultations should be requested from top choices before selecting a system. The intent of the following factors is to inform and focus internal needs and align them to a robust BEMS.

i. Internal Factors

The BEMS an organization utilizes should take into consideration on-site limitations and needs. Factors to consider include:

- Single building/portfolio of buildings/microgrid
- Building type
- Existing equipment
- Existing sensors and meters
- BEMS or automation systems already in place
- Occupant behavior and needs

[4] *Next Generation Building Energy Management Systems,* Intel Daikin, available at https://www.intel.com/content/dam/www/public/us/en/documents/white-papers/intel-daikin-applied-next-generation-bems-white-paper.pdf

- Energy and Climate Action goals
- Dedicated staff time

ii. BEMS Factors

For maximum effectiveness of a system, a property owner should evaluate BEMS outlined in this report (see Section III: Market Ready Systems) using the following criteria to find a solution for their buildings:

- Compatible with existing sensor and automation controls
- Accessible by all stakeholders
- Robust data visualization and ability to generate necessary reports
- Reliable customer support team
- Competitive pricing
- Case studies representative of similar building types

III. Market Ready Systems

There is a robust market of BEMS that is estimated to grow worldwide to be worth $5.6 billion by 2020. This large market can be overwhelming for property owners which can lead to inaction or the employment of an inappropriate or underutilized system. The table below aims to demystify available BEMS. Property owners can leverage the below information to begin scoping the appropriate system to maximize savings, comfort and maintenance. This list coupled with the criteria allows decision makers to find the ideal solution for their building needs. In Section II: Finding the Right BEMS, the functions are given number codes that are used in the following table to demonstrate capabilities of each system.

Table 1: Available BEMS and Functions

Company	Software	Function	Website
Airdale	ACIS	1,2,3,4,6	http://www.airedale.com/web/Controls/Building-Energy-Management-BEMS/ACISTM-Building-Energy-Management-System.htm
BizEE	Energy Lens	1	http://www.energylens.com/
Building IQ	5i Intelligent Energy Platform	1,2,3,4,5,6	https://buildingiq.com/

Company	Software	Function	Website
Copper Tree Analytics		1,2,3,4,6	http://www.coppertreeanalytics.com/
Crestron	Viridian	1,2,6	http://crestron.com/products/line/fusion-enterprise-monitor-management-av-bms-room-scheduling-lighting-lights-shades-hvac-climate
DGLogik	DGLux	1,2,3,4,5,6	http://www.dglogik.com/products/dglux5-ioe-application-platform
Distech Controls	EC-Net AX EnerVue	1,2,3,4,5,6	http://www.distech-controls.com/en/us/offices-commercial-buildings/
Ecova	Ecova Platform	1,2,3,4,5,6	https://www.ecova.com/solution/energy-sustainability-management-platform/
Energy Management Systems, Inc.	EMS3	1,2,3,4,5,6	http://www.ems3.com/
Energy Star	Portfolio Manager	1,4,5,6	https://www.energystar.gov/buildings/about-us
Honeywell	Honeywell Building Solutions	1,2,3,4,5,6	https://buildingsolutions.honeywell.com/en-US/industries/commercialbuildings/Pages/default.aspx
Johnson Controls	Metasys	1,2,3,4,5,6	http://www.johnsoncontrols.com/buildings/building-management/building-automation-systems-bas
Lucid	BuildingOS	1,2,3,4,5,6	https://lucidconnects.com/solutions/building-data-analysis

Company	Software	Function	Website
Helios Exchange	Helios Exchange	1,3,4,5,6	http://www.heliosenergyus.com/energy-management-systems
Powerhouse Dynamics	SiteSage	1,2,3,4,5,6	https://powerhousedynamics.com/solutions/sitesage/
Schneider Electric	EcoStruxure	1,2,3,4,5,6	http://www.schneider-electric.com/b2b/en/campaign/innovation/overview.jsp
Siemens USA	APOGEE	1,2,3,4,5,7	http://w3.usa.siemens.com/buildingtechnologies/us/en/building-automation-and-energy-management/apogee/Pages/apogee.aspx
SkyFoundry	SkySpark	2,6	https://skyfoundry.com/skyspark/
Trend	Trend BEMS	1,2,6	http://bems.trendcontrols.com/en/solutions/trend-bems
Tridium	Niagra	1,4,6	https://www.tridium.com/en/products-services/building-automation

IV. The Financial Case for BEMS

The ability of a BEMS to save on maintenance and energy costs depends on type of system employed, how it is managed, the existing equipment, and demand charges among other factors. According to ACEEE, BEMS with predictive capabilities as well as detection can save 13-66% on energy. There is no definitive study that demonstrates the energy savings BEMS have historically achieved across commercial applications. To make the business case for using a BEMS, building owners and stakeholders must perform an assessment and evaluate savings potential on a case by case basis.

a. Calculating a BEMS Return on Investment

A simple calculation can provide an estimate of how much a building owner should expect to save when using a BEMS. Follow the below steps to determine reasonable energy savings by employing a BEMS:

1) Identify hours of operation.
2) Complete a facility audit to understand how many hours the HVAC system and lights are running at full capacity outside of the hours of operation.
3) To find the savings, multiply amount of energy consumed by equipment on reduced hours of operation (as automated by a BEMS) by utility cost. The difference between business as usual baseline and with a BEMS is the dollar savings that can be achieved through proper timing of systems will be the amount that a BEMS can save.
4) Compare savings to cost of BEMS which may include subscription, consulting, set-up, sensors and metering, and staff time.
5) Consider additional benefits of a BEMS and what value it adds to the organization like predictive maintenance, reduced demand charges, environmental and corporate responsibility, and occupant comfort.

b. Challenges Impacting Return on Investment (ROI)

While properly used, EMS can offer utility and maintenance savings, there are barriers to achieving maximum savings that property owners should be considerate of when selecting a system to ensure a ROI:

- System managers overriding BEMS to alter optimized temperature or lighting controls.
- A BEMS that is not managed by facility manager; implications include systems that are improperly programmed, not customized for facility, not well maintained, ignored alerts and nuisance alarms, and failure to act on larger energy saving opportunities.
- Faulty connection to equipment sensors or improperly placed sensors.

V. Conclusion

Commercial building operators have great potential to lead in the clean energy revolution by turning their traditional building(s) into one that reacts to occupants, alerts maintenance to system failures, and has high efficiency equipment that is automated. One of the tools a commercial building operator should employ to assist in managing their building's energy consumption is a BEMS. As described in this report there is a robust market of BEMS that go from basic visualization and reporting of energy consumption to advanced optimization and automation of systems. While there are many software

solutions, there is no panacea. Building Operators often piece together several management systems or fail to use one at all. Finding the right fit can be challenging and there is a need for education and the sharing of best practices. To make the financial case for investing in a BEMS, a recommended next step is for Building Operators to contact system providers outlined in this report for a no-cost, no-obligation consultations to provide an overview of system functions, costs, and feasibility.

Moving forward, BEMS providers, IOUs, and local governments have the responsibility to continue demonstrating the economic value of energy efficiency to increase the adoption and active use of BEMS. In addition, BEMS are in a position to catalyze the advancement of clean energy technologies by expanding offerings to include benchmarking, energy use disclosure reports, on-site renewable energy sources, battery storage, electric vehicle charging, and zero net energy compliance.