

UNDERSTANDING RESIDENT ENERGY BEHAVIOR THROUGH BUILDING ENERGY MANAGEMENT SYSTEMS

SOLUTION OVERVIEW

Lendlease is a leading international property and infrastructure group with deep sector expertise. In the U.S., Lendlease has worked extensively with the Department of Defense (DOD), entering the Military Housing Privatization Initiative with their first project in 2001. Since then, Lendlease's work with DOD communities has grown to over 40,000 homes, 192 apartments, and, through the Privatization of Army Lodging (PAL) program, more than 12,000 hotel rooms. With locations across 25 states, Lendlease has a commitment to finance, develop, build, renovate, and operate these sites for at least 50 years. The company is focused on identifying innovative ways to reduce energy consumption to improve the quality of life for residents and their families in these communities.

After exploring various ways to reduce energy, Lendlease decided to pilot a Building Energy Management System (BEMS) at Campbell Crossing, a privatized military housing community located on Fort Campbell, Kentucky. The community features 4,456 homes for military families. The BEMS solution monitors heating, air conditioning, hot water, and other high energy consuming equipment, optimizes their performance, and reports on equipment problems before they become catastrophic breakdowns.

Each in-home BEMS system consists of a Wi-Fi gateway connected to a community system, a programmable thermostat, and a load controller on all electric water heaters. The system is designed to optimize energy consumption while enabling the residents to manage the operation of their air conditioning units and electric water heaters more easily.

The system aims to improve the comfort of Campbell Crossing residents by allowing them to view and control the temperature in their homes remotely via a mobile app. The app helps residents track their progress towards their own energy goals, as well as estimate their monthly bill. Future enhancements will allow residents to receive push-notifications that identify specific opportunities to further reduce energy consumption, or detect abnormal operation, which may indicate the need for service.

BEMS provides dashboards and operational charts for Campbell Crossing utility and maintenance managers to benchmark homes and equipment. The system alerts property management to homes that are using excessive amounts of energy, equipment that is not operating properly, and systems that may not be programmed correctly, mitigating emergency situations.

ORGANIZATION TYPE

Commercial Real Estate

BARRIER

Lack of resident energy use information and limited education related to resident energy use behaviors

SOLUTION

The Building Energy Management System (BEMS) monitors and optimizes individual home performance components based on occupancy trends, weather, and resident behavior.

OUTCOME

With BEMS installed in nearly 4,500 homes, Lendlease anticipates an average 16% reduction in electricity, saving 12 million kWh annually, and is seeking to expand the program to the rest of their portfolio.

POLICIES

As an organization committed to sustainability, Lendlease aspires to go beyond sustaining the natural environment, with a long-term goal of restoring the environment in which their projects and operations are placed.

To achieve this goal, Lendlease will:

- Employ strategies to prevent pollution and explore every opportunity to demonstrate a positive impact on the environment in all their activities and developments, as well as those of their supply chain.
- Exhibit leadership through the continual improvement of their environmental performance.
- Comply with environmental legislation, regulation, and other requirements as a minimum, understanding that sustainability is beyond compliance.
- Measure and report their performance against internationally-recognized environmental management systems and standards.
- Continue to promote and pursue a holistic approach to the design, delivery, and operation of green buildings and green precincts that exceeds best practice through innovation.

PROCESS

Each home at Campbell Crossing is equipped with connected gateway systems, programmable thermostats, and a load controller, which work together to manage and monitor energy usage efficiently. The system can determine if there are more energy-efficient ways to achieve comfortable conditions within the home. The results of the analysis are converted into reports for resident viewing via the BEMS portal.

Features of BEMS include:

- Automatic adjustment of HVAC operational parameters via the thermostat to ensure compliance with Campbell Crossing's pre-approved limits, as well as optimization of energy consumption (continuous commissioning).
- Near real-time reporting of monitored conditions related to excessive energy consumption, occupant comfort, and asset safety. E.g.:
 - Excessive run times for HVAC units - maintenance alerts generated to service HVAC
 - Cold Home Alert (49 degrees or lower) - maintenance alerts generated to prevent pipe bursts
 - Plug load monitoring - allows residents to see whether their plug load is average or high

The BEMS program creates models of key performance parameters for each home, each piece of mechanical equipment, and the major appliances monitored in that home. From these models, the system creates a performance baseline for each piece of equipment and the home itself. The baseline allows Lendlease to identify performance degradation over time. Lendlease uses benchmarking of similar homes, equipment, and appliances to help identify the worst assets on base, assets wasting significant amounts of energy, and those with imminent threat of failure. As a backup to these models, the Lendlease team has direct access to engineering tools including control charts, time-of-use data, and duty cycle charts.

The models include, at a minimum:

- Thermal shell heat transfer characteristics, including heat gain in summer and heat loss in winter.
- Energy usage profile including energy intensity, a load profile (if meter interval data exists), and forecasted energy usage from a weather-normalized historical baseline.
- HVAC efficiency characteristics, including heating and cooling by stage, run time, and duty cycle correlated with outdoor temperature, and energy use estimates from run time.
- Major appliance (HVAC and water heater) energy usage, including run time and duty cycle, time-of-use, and energy use estimates from current, voltage, and/or power readings.

In addition to the basic models and baseline discussed above, BEMS also provides analytics and alerts for each home, each piece of mechanical equipment, and major appliances in that home that detect improper equipment settings, operational parameters, and/or detection of unacceptable conditions.

OUTREACH

The BEMS solution was initially piloted in 24 homes at Campbell Crossing to understand its capabilities and potential savings. Lendlease expanded the installation to 622 homes after reengineering BEMS to simplify the system while maximizing savings and optimizing return on financial investment (ROI). With a year of data collection, the pilot project showed an average of 10 percent energy savings, which triggered the start of an ROI analysis for the remainder of the Campbell Crossing housing portfolio. The ROI required a minimum of 7 percent energy savings as

the threshold to make the project financially feasible, and with a proven 10 percent savings during the pilot, Lendlease and the U.S. Army decided to move forward with the implementation of BEMS across all Campbell Crossing housing.

Resident engagement was a key component to the success of the project; Lendlease and the property management team created flyers and informative letters to be transparent about the BEMS initiative, what it aimed to do, and how the installation process and timeline would affect the residents. The Campbell Crossing team also hosted town hall meetings where residents were briefed how they could benefit and interact with the system, as well as have their questions or concerns addressed.

One of the components of BEMS is interaction with the residents via a portal and a mobile app that displays real-time energy consumption data and how their home compares to their neighbors. Through these mediums, the residents are aware of their energy performance and what their monthly energy bill will amount to at current consumption pace. Energy saving tips and ideas are readily available through the website portal and app.

New residents receive a home orientation and walk-through, during which a Campbell Crossing team member explains the benefits and features of BEMS and how to optimize their energy consumption. An upcoming feature set to launch in early 2017 will incorporate push-notifications on residents' mobile devices if they so choose. The notifications will create alerts based on real-time consumption data.

OUTCOMES

In May 2016, Lendlease completed the installation of BEMS at Campbell Crossing, reaching a total of 4,456 homes. As of October 2016, Campbell Crossing saw an average of over 16 percent in electricity savings, amounting to 12 GWh. The project is expected to continue an average 16 percent in energy savings, with potential added energy reduction as natural gas consumption becomes monitored through BEMS. Lendlease also saw the following benefits:

Resident Awareness and Empowerment: BEMS delivers messages to residents about their typical home energy use, providing insight on sources of energy consumption. The system also offers tools for modifying in-premise equipment operating schedules and temperature set points, and for selecting the balance between conservation and costs.

Automated Energy Efficiency Optimization: BEMS is a hands-free, in-the-background service that works continuously, automatically taking action as appropriate to tune building assets and adjust equipment operations to resident behavior to reduce energy consumption.

Automated Risk Assurance: Lendlease can monitor the operating state of critical building assets continuously, providing consumers early warning of performance degradation and protection from unexpected “bump-in-the-night” breakdowns to avoid expensive emergency replacements. The early alerts provided through this service afford residents the opportunity to take preventive action for maintenance and repair versus replacement, or to make economical and scheduled replacement of equipment if required.

Automated and Manual Critical Peak Demand Response: The building management is able to react to system and resident peak demand levels in response to market signals, unforeseen events, or grid conditions.

MEASURING SUCCESS

The measurement of success hinges on a high return on investment and a short timeframe to offset the initial costs of implementation. The initial projections of the BEMS program already indicated a strong ROI; however, what made the BEMS program at Campbell Crossing an exceptional success was that the program exceeded the 7 percent minimum energy savings initially required, further increasing the ROI and reducing the payback period by more than half of the original projections. The financial savings from lower operating costs allowed Campbell Crossing to explore other energy improvement opportunities, and the reallocation of funds will be used for initiatives such as replacement of inefficient HVAC systems, improving building envelope, and creating room for piloting other innovative technologies.

A testament to the effectiveness of BEMS is the increase in resident receptiveness to the system. During the initial installation process, Lendlease faced some resistance and skepticism from existing residents. But, as residents cycle through and new residents are exposed to BEMS from day one of their stay, the system works more seamlessly and results in higher participation.

However, one of the greatest measures of success of a program is the adoption of the initiative as a “best practice,” and its replication. The BEMS program at Campbell Crossing saw a higher-than-expected energy savings in a shorter timeline, which helped promote its application at other Lendlease military housing communities. Lendlease’s largest project site in Hawaii has started the implementation of BEMS within their portfolio, and the potential outcome is expected to be equal if not greater than Campbell Crossing’s success. With the lessons learned from Campbell Crossing, the analysis and installation of BEMS has become accepted and implemented with lesser resistance both internally and externally.

TOOLS AND RESOURCES

The web portal interface on the Building Energy Management System allows residents to remotely monitor their home energy performance and make adjustments if necessary. The portal is available via web and mobile app and each provides:

- Virtual thermostat
- Energy use monitor
- Vacation mode
- Smart temperature settings

For more information on these features, view the [BEMS Portal Tools](#).