Best-In-Class: Demonstrating Scalable Operational Efficiency through Optimized Controls Sequences and Plug-and-Play Solutions

A research and demonstration project funded by an Electric Program Investment Charge (EPIC) grant from the California Energy Commission (CEC) to address innovative, pre-commercial energy efficiency technologies in existing buildings.

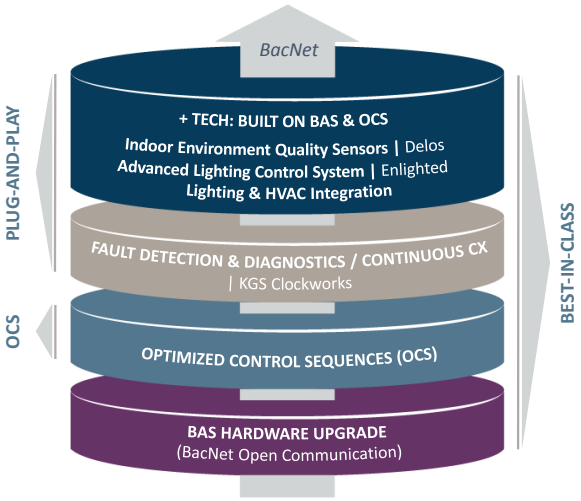
The Issue

Heating, ventilation, and air conditioning (HVAC) represents approximately 30 percent of the total electricity consumption within California commercial buildings. In most existing buildings, the building automation systems (BAS) have sub-optimal sequence of operation (SOO) programming leading to excessive HVAC energy use. Sub-optimal performance is often a function of designers and installers creating and programming SOOs ad-hoc for each building based on diffuse and fragmented information. Compounding this issue, designers and installers rarely employ fault detection and diagnostics (FDD) to ensure that the SOO are functioning properly over time.

Current standard practice contains inefficiencies throughout the entire process. Correcting these issues in the current paradigm represents another challenge. The transaction cost associated with analysis, equipment upgrades, and custom programming required to optimize SOOs, implement FDD, and reduce excessive energy cost is a real barrier for owners and operators.

The Solution

We believe there is an opportunity to address the inefficiencies in the entire value delivery chain—from design through implementation, commissioning, and testing, to ongoing system maintenance and long-term fault detection. Upgrading systems to operate more efficiently by using Best-in-Class controls and SOO presents a prime opportunity to achieve cost-effective, persistent, and measurable savings.



Using the American Society of Heating Refrigerating and Air Conditioning Engineers' (ASHRAE) Guideline 36 (GDL36): *High Performance Sequences of Operation for HVAC Systems* as a foundation, our team will layer on other plug-and-play technologies to demonstrate Best-in-Class approaches that integrate into a comprehensive solution which:

- Modernizes HVAC and building controls
- Standardizes factory programming of optimized HVAC control sequences
- Integrates advanced lighting controls
- Ensures healthy buildings through an indoor environmental quality monitoring sensor platform
- Enhances performance using advanced building analytics including FDD
- Validates savings with measurement and verification (M&V) 2.0 procedures

Developing a tested, Best-in-Class integrated solution to achieve energy savings allows commercial building owners and operators to employ this approach across a portfolio of buildings, while reducing transaction costs.

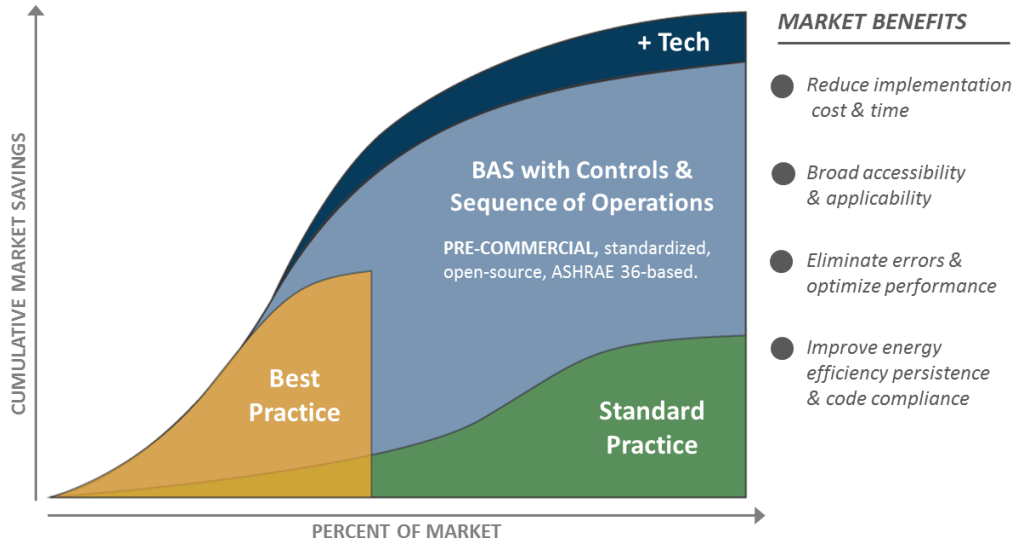
We assert that the market is ready for this type of breakthrough approach to capturing persistent operational savings. Team partners have matched the CEC grant funds for this work nearly 1-to-1, including commitments from several major BAS manufacturers.

The Benefits

The proposed Optimized Controls Sequences and Plug-and-Play strategies in this project include a comprehensive approach to accelerating market adoption of building controls retrofits and advanced software and sensor solutions. Anticipated benefits include:

- **Lower Costs**: Deploying a streamlined and integrated approach to implementing OCS will reduce first costs and immediately reduce operating costs for building owners and operators.
- **Compressed project schedules:** Standardizing SOOs through GDL36 will reduce control upgrade/retrofit implementation time.
- **Greater Reliability:** Advanced controls that are capable of responding to price or grid conditions can facilitate participation in load management programs that help provide greater grid reliability, while also providing a potential revenue stream for building owners and operators.
- **Environmental Benefits**: In addition to the substantial energy savings and reduced greenhouse gas emissions, Best-in-Class controls will offer superior indoor environmental quality for building occupants.
- **Economic Development:** Successful demonstration of project results will drive new market competition for cutting-edge technology development and deployment at the state level. At the local level, project funds spent on demonstration sites will support local economies. We are targeting demonstration sites located in economically and environmentally disadvantaged communities.

Project results will accelerate and support a cost-efficient and technically-sound shift from today's standard-practices (and even best-practices) to a Best-in-Class controls and OCS solution for existing buildings.



The Project Scope

This project demonstrates a large-scale application of a Best-in-Class integrated approach and helps accelerate the market adoption of installing OCS and Plug-and-Play solutions for the commercial building sector.

Guideline 36 Validation & Enhancement

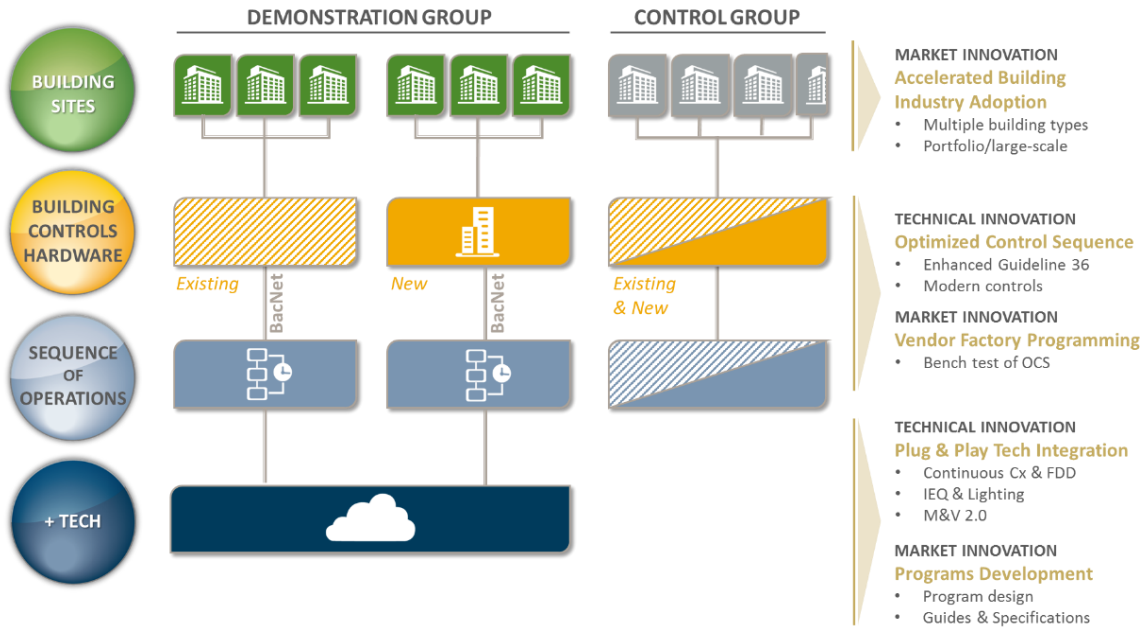
The promise of GDL36 is that the standardization of controls sequences will allow manufacturers to program and centrally test the controls logic and then distribute to installers; thereby, reducing cost and risk of errors inherent in the current practice. We are working with BAS manufacturers to develop a standardized validation process (automated functional testing) through bench-scale testing. We are also developing additional advanced controls sequences and expanding the equipment addressed in GDL36 based on new research and simulations.

Design Guides and Specifications

The team is developing a best practices guide and functional specifications for building owners and operators, portfolio property management companies, and engineering and controls firms. The guide covers all aspects of project delivery including manufacturer certification for OCS, technology performance specifications, retrofit financial analysis, criteria for design and implementation teams, implementation, and verification. The specifications provide guidance on future FDD and continuous commissioning software analysis features and capabilities, organizational operational practices, high-value data (points and frequency), and other best practice recommendations for integration. Guides and specifications may inform future program designs to replicate the solutions demonstrated in this project.

Demonstrations

A leader in California's medical community, Kaiser Permanente is providing several demonstration sites for this project. Kaiser has an immediate interest in scaling successful results across its network of medical office buildings throughout California. During this project, our team is applying the OCS Plug-and-Play solution to several building sites with both existing and new building controls to examine both market and technical innovations, as compared to a control group of similar building sites.



Utility Program Design

The development of our Best-in-Class solution has the potential for direct incorporation into new utility program designs and program measure work papers. Incentive programs that inform and incentivize building owners and operators, as they proceed with facility HVAC controls improvements, expedite the pace of moving any new or emerging technology from study to market. Specific utility program design recommendations based on our results will include:

- Program and project level cost-effectiveness calculations
- A preliminary retrofit savings calculator for engineer use for project design
- M&V guidelines including recommended level of measurement, adjustments for non-routine events, and minimum time horizons for the baseline and post-installation periods
- Persistence of savings over two-year test period
- Comparison of demonstration sites to a control group of sites without intervention
- Incentive value threshold investment analysis to include market size, savings potential, and influence on cost barriers for facility owners/operators

The Team

The research team for this project is composed of Taylor Engineering and Integral Group, two leading MEP firms; Lawrence Berkeley National Laboratory (LBNL), a national research leader; and TRC Energy Services, a national leader in efficiency program implementation and emerging technology research. Additionally, innovative product vendors including Enlighted, KGS Buildings, and Delos Living, and large BAS manufacturers including Alerton (part of Honeywell), Automated Logic (part of UTC), Distech, Johnson Controls, Siemens, and Trane, who will provide project and technology support.

The CEC has granted our team a budget of nearly $3,000,000, along with a match funded budget of an additional $2,773,750. With over $5.75 Million in funds to support the program, we expect an outstanding set of results that are easily transferable to a variety of existing building types and locations in California and beyond.

We have scheduled software validation & optimization and field demonstrations for completion in early 2021, with results compiled and finalized by the end of 2021.