

Bay Area communities working together for a sustainable energy future.

Electronic Tools for Energy Code Compliance

Fall 2015 Demonstration Report

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Prepared by

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Association of Bay Area Governments
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Confidentiality Note: The information collected for this report will inform BayREN efforts to provide Bay Area local governments with targeted tools and training to help comply with the California Building Energy Efficiency Standards. In order to encourage participation, project-specific data (such as building owner, occupant, project address, contractor, jurisdiction, or staff names) has been kept confidential for reporting purposes. Any questions or concerns about this confidentiality note can be addressed to BayREN by email at codes@bayren.org.

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1. Introduction

In the Fall of 2015, the Association of Bay Area Governments (ABAG) released an RFP seeking “scalable tools and support services to enhance compliance with the California Energy Code (Title 24) in a robust, consistent, and cost-effective manner throughout the Bay Area.” The work would be performed as a part of the Bay Area Regional Energy Network (BayREN) Codes & Standards program.

In the RFP, BayREN and ABAG were specifically looking for tools to be deployed under a software as a service (SaaS) model for a tablet/iPad based building inspection online application that could:

- Support building department verification of the 2013 California Energy Code, and/or CalGreen Code, and/or local reach codes.
- Interface with the Residential and Non-Residential HERS Registries.
- Have the ability to adjust to changes anticipated for the 2016 and 2019 T24 updates.
- Streamline and increase efficiencies for existing building department business practices and reduce administrative costs.
- Be supported by training materials and a technical assistance plan.

BayREN sought a two-month demonstration project of this identified Electronic Tool (E-Tool) for Energy Code Compliance, leveraging BayREN’s relationships with Bay Area building departments. Through a competitive bid process, BayREN contracted with CodeCycle to conduct this demonstration project. CodeCycle is a technology platform specifically designed to help building departments manage the complexity of building efficiency standards. CodeCycle provides a spatially oriented, data-driven platform to streamline and standardize the compliance process. The demonstration was conducted from mid-October to mid-December.

BayREN recognizes that new and existing buildings must comply with Building Energy Efficiency Standards in order to achieve energy efficiency and, ultimately, meet California energy-use reduction goals. Through this E-Tool Demonstration and future such efforts, BayREN is interested in exploring how an E-tool could make compliance with Title 24 Part 6 more achievable, in a way that paper-based resources cannot. If that is possible, the increased complexity of the code and its regular updating, along with California’s state-level move towards electronic HERS registries and repositories, makes an electronic compliance enhancement tool extremely valuable to Bay Area local governments.

The BayREN 2015 CodeCycle demonstration project indicated certain potential for E-tools to enhance energy code compliance through more efficient time management and quicker identification of potential code violations. For example, in one building that was part of this

demonstration, answering the question of whether a specific set of lighting fixtures required a dimmer depended on over 20 variables dispersed across at least 5 groups of fixtures. And that question represented but a small fraction of the lighting code compliance challenges posed in a single, small project. While status quo processes require a building department to trace the regulatory logic to answer this question, the CodeCycle product was able to determine whether a dimmer was required with the click of a button. Based upon the potential offered by other such findings highlighted in the remainder of this report, BayREN looks to further explore the potential of electronic compliance enhancement tools.

2. Demonstration Methodology

Implementation of BayREN’s 2015 demonstration project for an E-Tool for Energy Code Compliance was led by the CodeCycle team, with oversight provided by BayREN member agencies including the Association of Bay Area Governments and Contra Costa County Department of Conservation and Development.

Demonstration Overview and Objectives

CodeCycle worked with five Bay Area jurisdictions in the fall of 2015. The project is summarized as follows:

- CodeCycle analyzed 32 buildings as part of a two-month demonstration project using CodeCycle’s Title 24 commercial lighting prototype
- Buildings were analyzed in three different groups (detailed below) to achieve multiple project objectives and accommodate a short timeline
- The following building types were analyzed during the demonstration:
 - Retail
 - Office
 - Medical and dental
 - Restaurant
 - Veterinary
 - Grocery
 - Fitness center
 - Warehouse
 - Manufacturing

The objective was to demonstrate the process improvements that could come from an Electronic Tool for Energy Code Compliance for Title 24.

CodeCycle Product Overview

CodeCycle is a technology platform that makes energy standards easier to implement and enforce. Developed in collaboration with building officials and practicing engineers, CodeCycle provides an energy code compliance solution focused on the needs of building departments and their constituents.

CodeCycle’s integrated digital solutions:

- Prioritize the compliance process for building officials, directing inspectors first and foremost to those inspection areas that will save the most energy
- Present code requirements in plan-view, on a space-by-space basis
- Catch errors and discrepancies early
- Create feedback loops that facilitate consistency and communication throughout the design and construction team

CodeCycle’s platform creates a digital “chain-of-custody” of energy information that transforms the way compliance documentation is handled. CodeCycle strives to provide the right information, at the right time, located in the right room.



CodeCycle’s analytical functions differ from traditional “compliance engines” such as EnergyPro or CBECC. CodeCycle provides assistance for the significant regulatory requirements not covered by traditional “compliance engines,” assisting with mandatory measures when using the performance path and all code measures when using the prescriptive path. As of fall 2015, CodeCycle’s prototype focused on Title 24 Part 6 requirements for commercial lighting.

Specific Methodology for BayREN Demonstration

CodeCycle staff worked with building department staff from five partner jurisdictions to identify commercial projects that were permitted under the current Title 24 2013 standards and within a defined square footage range (e.g. 2,000 ft² – 100,000 ft²). Projects were placed into three analytical categories: Plan Review Buildings, Parallel Inspection Buildings, and Full Intervention Buildings (Table 1).

Table 1. Categories for Project Analysis

BayREN Demonstration Analysis Category	# of Buildings	Brief Analysis Description	What does this analysis category tell us?
Plan Review Buildings	15	These buildings were analyzed for design phase compliance issues.	The compliance issues identified in these buildings suggest the benefits that can come from improved design assistance tools combined with targeted plan check processes.
Parallel Inspection Buildings	11	This set of buildings was analyzed for compliance issues parallel to the standard inspection process.	These projects are most informative in assessing the potential long-term benefits of an E-Tool for Energy Code Compliance, as they provide an approximation of comparative outcomes with E-Tool and without E-Tool on a given project, analyzing both design phase compliance gaps and field inspection challenges.
Full Intervention Buildings	6	These buildings received start-to-finish compliance assistance.	These projects illustrate how an E-Tool can, as a system, directly inform and improve the code compliance process. Compliance improvement recommendations are sent to both the design and construction teams to be fixed, resulting in actual changes in construction practices. (e.g. on one project LPD was directly reduced and additional occupancy sensors were added.)

For more details on the demonstration categories, see Appendix A: Technical Demonstration Framework.

3. Results and Feedback

Over a two-month period, CodeCycle analyzed Title 24 lighting components for 32 commercial projects at various phases of construction.

Project analysis revealed compliance issues across various building types and sizes. Compliance issues included project plans that specified too many lighting fixtures; projects that met their overall Lighting Power Density (LPD) target but failed to install the required mandatory controls; and special credits were claimed where they were not actually allowed. Issues were highly diversified due in part to the diverse construction types, code requirements, and design teams.

Generally, BayREN sees potential for an E-Tool for Energy Code compliance to drive more consistent implementation and provide energy policy benefits far beyond direct compliance improvement. At the local level, by making energy efficiency standards easier to implement, an effective E-Tool can help accelerate code adoption processes. While at the State Level, this type of tool can provide real-time information on compliance levels to the California Energy Commission and other key stakeholders, often on a code-section by code-section basis.

Due to the short timeframe of this demonstration, a number of proxy methodologies were used to assess the potential benefits of CodeCycle specifically and E-Tools more generally. Proxy methodologies were structured to, as best as possible, approximate the benefits that could be realized in a longer-term implementation of an effective E-Tool. For further discussion of proxy methodologies, see Appendix A: Technical Demonstration Framework.

User Feedback

Nonetheless, because of the tool's short learning curve, the brief demonstration period still allowed CodeCycle staff to gather feedback from plans examiners, field inspectors, and lighting contractors on the benefits an E-Tool may offer to energy code enforcement and compliance.

Plans Examiners

Plans examiners found particularly helpful the fact that the intricate logic of the lighting standards is integrated into CodeCycle's analytics, such that even obscure code provisions are automatically assessed for compliance purposes. One plan examiner observed:

"I found this tool very helpful and quite easy to use. A lot of time is wasted during plan check in just looking up code sections. This tool will make a lot of difference."

That same benefit will be provided – in advance of plan check – to the design teams who are laying out a building's efficiency systems.

Field Inspectors

Most inspectors found CodeCycle's platform easy to use and appreciated its ability to perform comprehensive code compliance interpretation room-by-room, requirement-by-requirement, and exception-by-exception. Inspectors also recognized that by using CodeCycle they could spend their time more efficiently ensuring that a building complied with the code rather than spending time deciphering the code or deciding when, specifically, it may apply.

At an early site visit, one inspector posited:

"We could get to 100% compliance with a tool like this."

Another field inspector using CodeCycle commented that a well-designed user interface is critical to make a tool as detailed as CodeCycle work, and he mentioned CodeCycle's layout and information flow hit the mark in that respect. He stated that he would use the tool regularly if it were made available to his city.

In previous user testing, building officials summarized the value of placing code requirements directly on the building plan drawings:

“A lot of these questions [on the CodeCycle app] you see in the code but it is usually hard to connect. I like the yes / no approach [of CodeCycle] which helps inspectors understand when to ask a specific question.”

- Field inspector, during the BayREN demonstration, suggesting that many of the Title 24 questions put forward by CodeCycle would, otherwise, never be enforced

Lighting Contractors

Two different lighting contractor teams, present during building inspections, asked to test CodeCycle’s Title 24 commercial lighting prototype. Contractors found CodeCycle’s E-tool as offering a simpler path to determining code compliance compared to only being able to rely on standard compliance forms and processes.

“I’ve taken classes on how to use all of the forms, but whenever I try to fill them out I’m still confused. Your approach makes a lot more sense.”

– Contractor

Another electrical contractor, who had been considering expanding their services to include lighting design work, asked when they could have access to the CodeCycle Design Assistance Tool to facilitate Title 24 interpretation during the design process.

Being Respectful of Building Department Resources

Building departments have a daily scope of work that can far exceed available resources. Inspectors appreciate when their time is used well and when information is provided in a clear and efficient manner. The BayREN’s final report for its 2014 Permit Resource Opportunity Program (PROP) report highlighted the need for prioritized inspection information:

“Customized field inspection checklists can help plans examiners and counter staff prioritize the most critical energy features for the field inspector to review upon inspection.”¹

BayREN sees value in an E-Tool that simultaneously prioritizes inspection actions in a customized manner for each building while delivering compliance information and accountability across the whole of the energy code (not just the prioritized measures).

The CodeCycle inspection app allows users to choose how much time they have to spend during any inspection phase (e.g. plan review; mechanical/electrical/plumbing; final). This helps lead building officials define a clear time allocation for energy inspections, avoiding cases where the

¹ BayREN, PROP (Permit Resource Opportunity Program) Report and Energy Code Resource Guide, p 1 (2015)

energy code might otherwise get little or no attention. In earlier testing of CodeCycle, one field inspector observed:

“In my daily inspections, I find that energy efficiency and energy standards often get left behind. Not that I don’t appreciate them, there are just so many components to a building that time is limited and for some reason energy standards are at the bottom of the list. I think this tool will help me find time to effectively review energy standards provisions.”

4. Next Steps and Conclusion

BayREN’s 2015 Demonstration of an E-Tool for Energy Code Compliance was exceptionally short (two months) in the context of normal construction sequences (8-20 months), but showed real potential for benefit to local governments in more effective code compliance.

Because of the short timeline of this demonstration project, a number of proxy methodologies were used in this demonstration to assess the likely benefits of CodeCycle. A longer-term demonstration project or pilot project would be a logical next step to further illustrate the improved time management that can be delivered by an effective E-Tool product.

Longer-Term Demonstration

Given 2015 work with CodeCycle, BayREN would position a longer-term demonstration to allow:

- More consistent use of the inspection tool by building department staff, illustrating how the selected E-Tool would perform as a fully integrated part of the inspection process
- Usage of the E-Tool across the full construction sequence, such that design teams and contractors are also using the platform
- Sufficient project intake time to gather a larger sample size of projects, allowing for more definitive results regarding the savings potential of the E-Tool
- A greater focus on direct project interventions responding to the E-Tool’s analytics, leading to actual energy savings on affected construction projects
- Savings would verify through appropriate counterfactual comparisons

CodeCycle is already collecting unique data on the current state of design practices and compliance patterns. A more robust and longer duration project will produce more real-time data that should be invaluable to state policy makers.

Data-Driven Solutions to Help Cities Fight Climate Change

Cities are innovative leaders on climate change solutions, particularly in the Bay Area. In order to achieve ambitious building energy goals – such as zero net energy – data-driven solutions are

needed for the design, inspection, and construction community. As the BayREN's 2014 PROP report concludes:

"In all, it has not been possible for building departments to efficiently and comprehensively analyze overall energy code compliance or the opportunity to improve relative energy compliance within their building stock."²

BayREN is excited to work with Bay Area cities and technology providers such as CodeCycle to explore a technological solution to this problem. Achieving a level of comprehensive compliance with the energy standards and reach codes is a significant challenge, and it will only become more cumbersome as California increases the stringency of Title 24. Now is the time to advance digital tools that meet the needs of California's construction industry and create measurable efficiency improvements in the built environment.

² BayREN PROP Report, p. 12 (2015) <https://www.bayren.org/codes/prop-final-report>

Appendix A: Technical Demonstration Framework

CodeCycle used three different methodologies in this demonstration to assess building plans and perform field inspections. Those methodologies were designed to complement each other in deriving the best insight on the potential compliance benefits of CodeCycle within a comparatively narrow demonstration timeline (two months).

Plan Review Buildings: Design Phase Analysis of Savings Potential

Summary: These buildings were analyzed for design phase compliance issues. CodeCycle staff analyzed 15 buildings solely from a design phase perspective, referencing plan sets for projects that were already completed. This enabled staff to assess the potential for CodeCycle to identify compliance problems during the design and plan check process.

Project Identification: Non-residential new construction or renovation/retrofit from 2,000 ft² to 100,000 ft². Buildings selected for this group had already been finalized, with the final set of approved drawings used for the data input. The projects needed to be permitted under the current Title 24 2013 standards, therefore most were finalized from roughly October 2014 – October 2015.

Project Data Input: When CodeCycle is fully implemented, design teams (architects or engineers) will enter their own project data into the design assistance tool. Eventually, this integrated compliance process could become standard practice for designers, who will use the CodeCycle design assistance tool in the early stages of the design process.

For this demonstration, CodeCycle staff entered project information into the design assistance tool. The method for processing the building projects in the design assistance tool was similar for all three analyses categories.

First, a project's lighting plan sheet is uploaded to the design assistance tool online. Spaces are defined; groups of luminaires are identified. The lighting schedule for the project is also entered. The building attribute information entered is similar to information requested on Title 24 lighting compliance forms. But rather than listing attributes in a tabular format, the data is input in spatial context, with the corresponding plan drawing in view.

Then, the design assistance tool computationally determines the specific code requirements for each and every space and luminaire group. It addresses all code requirements, conducting a comprehensive space-by-space analysis to identify compliance errors. For example, if a particular luminaire group requires an occupancy sensor and no sensor is specified, the tool would flag this error in red.

Parallel Inspection Buildings: Full Compliance Analysis of Savings Potential

Summary: This set of buildings was analyzed for compliance issues parallel to the standard inspection process. 11 building projects were evaluated using the CodeCycle platform at both plan check and at field inspection, but with no interventions taking place to change construction outcomes.

Project Identification: Non-residential new construction or renovation/retrofit from 2,000 ft² to 100,000 ft². Projects for this group needed to be close to completion at the start of the

demonstration. Design information was gathered from final construction drawings. Again, all projects that met these criteria were pulled for analysis.

Project Input and Inspection Process:

- CodeCycle staff input project information into the design assistance tool, using the same method as the 'Plan Review' group described above. Compliance failures in the design were recorded but not corrected.
- Building inspectors used the CodeCycle inspection app to assess construction outcomes, after a project was finalized by the building department using a standard field inspection process. CodeCycle staff were present where possible to answer any questions about the app.
- The design parameters of the final construction drawings served as the benchmark for the field inspection process. (This ensured that the same compliance errors would not be flagged twice on the same project.)
- Data collected by the CodeCycle field inspection tool suggested which compliance issues would likely be identified and remedied using CodeCycle that otherwise might go unaddressed.

Full Intervention Buildings: Comprehensive Compliance Assistance

Summary: These buildings received start-to-finish compliance assistance. 6 buildings used CodeCycle's commercial lighting platform from plan check through final inspection, with CodeCycle's analytics driving compliance improvement throughout the process.

Project Identification: Non-residential Tenant Improvement (T.I.) projects from 2,000 ft² to 50,000 ft². T.I. projects were pulled for this category due to their inherently shorter construction timeframes. As of mid-December 2015, some of these projects are still ongoing.

Project Input and Inspection Process:

- CodeCycle staff input the design data into the design assistance tool for all projects (see method for 'Plan Review' group described above).
- Building inspectors used the inspection app at plan check and during field inspection. CodeCycle staff were present where possible to answer any questions about the app.
- The design and construction teams were directed to make changes to the project when the CodeCycle system identified compliance failures.

Analysis at Field Inspection

At field inspection, an analysis was made as to whether the building was built as it was designed. This was done using the CodeCycle inspection application. If an inspection question was answered "no", the above schedules were used to apply an energy value to the noncompliance event. In instances where the answer was "no" and a numeric input was also received – such as the count for a set of fixtures – the ratio of the observed (installed) count to the as-designed count was used to assess the energy implication of the building not complying with the plans.

Note that CodeCycle’s field inspection application enforces the prescriptive attributes of a building as-designed, not at a code minimum level. For instance, if a building is designed to perform 15% better than code per the drawings and Title 24 documentation, the field inspection application will ask questions that enforce to a 15% beyond code objective.

Appendix B: CodeCycle Product Details

“Will the designers get this information as well? That’s where these questions would be the most helpful.” – Contractor, participating in an inspection during the demonstration

CodeCycle is built around a truism of the construction industry: the earlier you catch a problem, the easier it is to fix. CodeCycle is designed, at its core, to assist building inspectors, but it does that by also providing guidance on compliance issues as early as possible to design teams and contractors.

How Does CodeCycle Work?

Design: Getting Energy Compliance Right Early

Designers (architects, engineers, or energy modelers) use the online CodeCycle design assistance tool to enter a building’s attributes in a spatially oriented format, overlaying a building’s construction drawings. Inputs from the design team are analyzed by the CodeCycle engine in real-time, flagging compliance errors, including comparative metrics like Lighting Power Density (LPD). CodeCycle’s programmatic model of the regulatory requirements runs behind the scenes to provide this automated compliance analysis.

Because the same programmatic implementation of Title 24 is applied to each building, the code interpretation process is standardized and clarified. This is a welcome advancement for building inspectors and construction professionals alike.

Construction: Guided and prioritized inspections.

CodeCycle computationally determines which efficiency elements are most important to inspect for a building to meet its energy target. CodeCycle’s prioritization algorithms also include a random component, so that less impactful measures are still checked occasionally to prevent contractors from systematically neglecting them. This prioritization drives the inspection process, making it far more efficient for building officials.

Some building officials have stated that they would actually spend more time enforcing Title 24 if they were using CodeCycle, precisely because CodeCycle uses their time more effectively and more efficiently. This is particularly true for field inspections.

Plans examiners use the CodeCycle inspection app to confirm that data submitted by the design team matches details on the plan documentation. Field inspectors use the app throughout construction, guided by building-specific plan drawings, answering yes/no questions that track specific code requirements. The questions are not generic – as found in most Title 24 checklists – but reflect the specific Title 24 requirements for each specific element of each specific project. This is a definitive advantage of a fully digitized platform. The tool also provides questions at a level of granularity (space-by-space) that can be readily confirmed by inspectors.