Electronic Code Compliance Repository: A Broad Vision Supporting a Sustainable Process

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ABSTRACT

The State of California has approximately 500 jurisdictions that are responsible for building code compliance. Each jurisdiction uses their own protocol for processing building code compliance documentation and for retention of the documentation. This paper describes the required functional elements, economies of scale and cost savings potential that are possible by consolidating all of the documentation activities at one centralized (virtual) location. The impact that a central electronic document and data repository would have on the accountability of all participants in the construction process (building designer, installing contractors, HERS Raters, and building inspectors) provides an opportunity for improved code compliance. The data mining potential of a central compliance document repository provides unprecedented capabilities to better track code compliance; to learn how the building market responds to new products and code changes; to help define current practice and best practice, and to evaluate the contribution from each 'link' in the supply chain, from designer to inspector. Additionally, the repository would enable more accurate evaluation of the new construction and codes and standards programs and could provide a platform to test and encourage adoption of new technologies or to promote early code adoption. Descriptions of the California Energy Commission's (CEC) rationale and experience in the development of the document registration procedures implemented for the 2008 Standards cycle, and the proposed implementation of a compliance document repository for the 2013 Standards cycle are also presented.

Opportunity for Convergence in the Energy Data World

There are many market actors with separate but related needs that involve the collection of data used to describe building energy characteristics and prove compliance with the energy code. These market actors – though looking at different parts of the energy code application, compliance and enforcement 'elephant' – are often seeking precisely the same bits of data. The data includes: building location and weather data, building characteristics such as the U-factor, area and orientation of windows, building appliance data such as SEER of cooling equipment or energy factor of water heater, and distribution information such as absence or presence of ducts in unconditioned space, or recirculation loops on domestic hot water systems. The data itself has great value, even apart from its initial purpose.

From building departments to regulators and policy makers, those whose jobs relate to buildings and energy efficiency share an opportunity to transform the process by which we currently look at buildings and learn more about buildings at the same time. The time is ripe to evaluate automation and data sharing to help improve the process of documenting how buildings

comply with the energy code in order to focus more time on the buildings themselves. As we move toward net-zero energy, we will need to leverage the information we gain at every turn. A central data repository provides the ability to dynamically integrate and connect the data to all market actors in the broadest sense of the word. It includes not only those who design, construct, permit and inspect buildings, but also those who design, implement and evaluate energy programs and those making policies that impact California's efficiency portfolio at large.

While an even broader scale data repository could benefit the country, and, indeed, the entire world, we will focus on the needs and benefits for a California-specific model. There is a great opportunity to share knowledge from a California-led effort and this thread should not be lost. However, for the purposes of this paper we will limit our example to California.

Convergence in Building Energy Efficiency?

When the verb "converge" was coined in 1691, it was used to describe the tendency of two lines to approach one another, as tributaries of a river flowing together. Usage in the 20th century has been broader, such as the coming together of fields of endeavor. One way to characterize convergence is the unification of functions - the coming together of previously distinct products that employ digital technologies. We see it happening in industries such as the financial services industry, where deregulation creates the potential for banks to compete with insurance companies and enabled banks to compete in the investment brokerage industry. We see it in technological devices, where the lines between phones, computing devices and televisions continue to blur. In the energy efficiency world, learning how to better share data and build compatible systems for separate purposes will provide the opportunity to exponentially increase our knowledge base and create more strategic and effective solutions to the problems and opportunities the data uncover.

Factors that Drive Energy Data Convergence

California's Strategic Plan for Energy Efficiency states, "A broad range of aggressive and continually improving minimum and higher voluntary sets of energy codes and standards will be adopted to greatly accelerate the widespread deployment of zero-net energy and highly efficient buildings and equipment. The effectiveness of codes and standards will be enhanced by improved code compliance as well as coordinated voluntary activities."[1] The California Public Utilities Commission (CPUC) and other key policy makers, program planners, as well as the design, implementation and enforcement communities all play key roles in achieving this stated goal.

Contractors are looking for ways to simplify and automate the process of pulling a construction permit. They are also looking for ways to zero in quickly on what features are best suited to be specified in a building to meet compliance requirements. Building departments are looking for ways to streamline and improve the effectiveness of plan check and field inspection. They are also looking for ways to decrease non-permitted activity and increase revenue. Third-party inspectors, including California's HERS[2] raters, TAB[3] contractors, contractors responsible for acceptance tests and others, are looking for ways to quickly know which tests are required,

[1] *California Long Term Energy Efficiency Strategic Plan*, California Public Utilities Commission, September 2008
[2] Home Energy Rating Systems
[3] Testing, Adjusting and Balancing

what the required test results are, pass/fail feedback and a way to transmit the findings electronically. HERS providers, who manage and provide quality control for HERS raters, are interested in improving automation and error checking functionality of their existing systems. They are also motivated to work with those who regulate them, the California Energy Commission, to provide data to a central data repository, which will primarily be used to house registered, legal compliance documents to be viewed by those interested in code enforcement.

The CPUC is interested in learning all it can about how to facilitate the advancement of energy-efficient design and construction practice. It is responsible for regulating California's investor-owned utilities (IOUs) including conducting evaluation studies to verify the IOUs energy efficiency savings claims and assessing compliance rates. The results of such studies help inform the CPUC on where to target future funding for energy efficiency programs and improvements in program design and implementation strategies. To assess compliance rates, the CPUC and its evaluation contractors need to access design and as built data, compliance data and energy models so that proper and efficient evaluations can be made of programs that utilize public goods charge funds.

For their part, investor owned and public utilities in California are interested in developing and underwriting an effective mix of incentive programs, education programs and code advocacy. They are interested in supporting programs that result in market transformation, including encouraging the adoption of emerging technologies, improving standard practice design and construction techniques and providing training, education and process support that addresses specific needs.

The CEC staff is interested in all aspects of making new and existing buildings more efficient. They sponsor research, development, demonstration projects and develop policy as directed by the legislature to improve compliance and move buildings toward zero-net energy.

All these market actors should benefit by having access to data that they did not previously have.

There are other drivers behind a movement toward energy data convergence besides the desire to learn from the data at work. One in particular is the need for the energy code to be customized and filtered for specific building design situations. The solution to the problem of how to simplify the application of a complex code opens the door to learn more about buildings on a global scale. A case in point is illustrated below, how solving a problem such as complexity in paper forms can drive the need for an integration solution with the added benefit of the potential to share data.

The Case for Dynamic Forms

The building design and code enforcement communities generally believe that California's Title 24 Building Energy Efficiency Building Standards are too complex, and that complying with the code is too difficult. This belief can result in a high non-compliance rate, creating lost opportunities to capture energy efficiency opportunities in California buildings. The CEC wants to continue to promote increased energy efficiency in existing and new buildings. This can be accomplished by increasing the stringency of the code. It is also accomplished by improving the rate of compliance with existing and new codes. The core challenge is to retain the ability to tighten the requirements while, at the same time, making the code appear simpler to the permit applicant and design community.

Much of the perceived complexity of the code is evident when one looks at the compliance documentation forms themselves. The forms are created by the code development team as a means for a permit applicant to provide specific references to the elements in the project design that document that the requirement is met. The forms contain fields for all possible requirements, conditional requirements, exceptions, tests and other descriptors to paint a complete compliance picture for any and all permit scenarios. Currently there are 107+ pages of forms and worksheets for residential compliance and 120+ pages of forms and worksheets for nonresidential compliance. For any given permit scenario, the majority of these forms do not apply. In addition, for any given permit scenario, certain fields on the required forms, once determined, may or may not apply. Knowing which forms to use and then understanding which parts of the required forms must be completed and which parts may be left blank is an ongoing problem and source of confusion for the end user, the permit applicant. This problem cannot be alleviated by training alone. How can one make the code appear simpler and still preserve the option to increase the efficiency by creating requirements that only apply in certain situations? By creating a dynamic forms generator like what people are used to seeing with their tax forms, e.g. TurboTax®. The filtering logic utilized by a dynamic form generator can also be used in applying the energy code so that permit applicants only have to see and respond to those questions and requirements that apply to their individual permit application and project scope. By creating a user interface that guides the applicant via a series of questions about their design, users only need see requirements to which they must pay attention.

Users must characterize their building, and that data is valuable in so many ways. It can be utilized to:

- guide the permit applicant to make wise energy decisions
- issue a building permit and prove that the energy code requirements are met
- document which field tests and inspections must be performed after construction
- assist a third-party inspector in conducting the test and collecting required field data
- assist those doing QC on the performance test to identify which addresses and features to inspect
- assist the California Energy Commission with enforcement queries and complaint investigation
- assist the CPUC to assess compliance rates efficiently (in terms of resources and time) and therefore verify IOUs' energy efficiency savings claims as well as informing policy on future funding and programmatic planning decisions
- assist utilities, researchers, agencies and others about current standard practice, appliance saturation, product choices and other market data
- help program evaluators learn more about how buildings operate, to help target which buildings and products to inspect

The need to simplify the compliance process through automation is but one driver toward energy data convergence. The benefits from effectively handling that problem are larger than the problem itself. Those working on the compliance simplification process as well as those looking at other problems and opportunities related to building efficiency should take a broad view and seek to understand how their problem and solution can be leveraged for the greater good.

Why Now?

In California, energy compliance can be documented via a simple prescriptive method or by creating a comprehensive building model. Both of these methods require the designer to describe the building, including surface types, areas and characteristics, equipment and controls. These descriptors are the key data bits that are valuable to analyze. If this data can be entered and transmitted via a cloud application, the data bits themselves can be automatically collected in a central repository. The next round of CEC-approved modeling software will have cloud capabilities. There are prescriptive compliance tools being developed that would also live in the cloud, and enable the user to send the data to a local government to obtain a permit, to the HERS provider to request an inspection, or to the utility company to request a rebate, to name just a few examples.

The technology to catalog and transmit data exists. Strategies to deal with preservation of anonymity and security also exist. Wireless handheld devices that can talk to remote databases are inexpensive and available. Yet change is difficult and in the energy efficiency world there is, unfortunately, not a lot of precedent for the scale of collaboration it would take to integrate not only the collection of data, but the process by which it is collected. Energy efficiency analysts, engineers, consultants and even policy makers tend to focus on individual problems that are solvable. Even those looking across multiple problems have little incentive to move out of the traditional 'silo with blinders' paradigm. This inertia is a major challenge and will not be easy to overcome. It will take a large scale, multidiscipline effort and must include those outside of the industry who can guide the retooling of the process.

Sources of Data

The sources of potential data to share are varied and expansive. They include:

- prescriptive compliance data submitted via electronic permitting system
- permit data shared via dedicated system or web service interface
- building performance model input and output data
- HERS registry data
- acceptance testing data, either via HERS registry or via integrated application
- data integration with manufacturer
- data integration with architect's building information modeling (BIM) digital design system

Current and Past Efforts -- the CEC Central Data Repository

Purpose and Vision[i]

Successful compliance and enforcement for the Building Energy Efficiency Standards relies heavily upon completion, submittal, and retention of compliance documentation that records the design and installation decisions, and field verification determinations made by the applicable responsible persons during the construction project. Prior to the effective date for the 2008 Standards, retention of residential energy compliance documents was not required by regulation, except that HERS providers were required to collect and retain the documents for

projects for which HERS verification was required for compliance. Without retained documentation, quality assurance and construction defect mitigation follow-up with responsible parties for the various aspects of a construction project, and research follow-up of the effectiveness of the building energy efficiency measures were not easily accomplished. It is likely that much of the energy compliance documentation required by the regulations was never completed and submitted.

The 2008 California Building Energy Efficiency Standards introduced the requirement for residential energy efficiency compliance documentation to be *registered* with a data registry (a web service with a user interface and database application maintained by a registration provider) prior to submitting the documentation to the enforcement agency. The document *registration* process requires that all information and certification signatures necessary for completing a compliance document must be transmitted electronically to a data registry where a final electronic image of the document is created and tagged with a unique registration number. Copies of these *registered* documents are made available by the data registry for printing hard copies or for downloading of electronic copies for use for submittals to enforcement agencies or other parties to the project after the registration process is complete. The *registered* documents remain stored as permanent non-editable image file records in the data registry, available for viewing/printing by authorized users of the data registry such as building officials, HERS Raters, installation contractors, energy consultants, builders and Energy Commission staff.

Data registries are privately owned business enterprises that provide document registration and document submittal services to the public for a fee. In order for retained electronic documents to be admissible as evidence in legal proceedings for enforcement of the Standards, a copy of each *registered* document is expected to be transmitted to and retained in an electronic document repository in the custody of the Energy Commission in accordance with California Evidence Code Sections 1530(a) 1 and 1530(a) 2. Improvements to compliance software and data registry software functionality for the document registration process, and development/implementation of an Energy Commission Document Repository is proposed to be completed in time for use with the 2013 California Title 24 Standards update.

Methods of Data Exchange

The 2013 update process for the California Title 24 Standards has undertaken to make improvements to the interim data exchange processes and electronic signature features utilized in the document registration processes first implemented for the 2008 Standards cycle. Development is under way (summer 2012) for standardization of data exchange transactions between compliance software tools, data input tools, document repositories, and data registries. Standardized XML schema designs will be created for each of the unique compliance documents such that all of the definition necessary to receive input data and create a formatted document image output will be contained in the data exchange element. This XML data standardization and document definition will provide the foundation for integration of innovative digital devices to streamline the documentation process. The integrity of the document standardization utilized throughout the network will be supported by use of a single point web based service to validate the data input to compliance document registration procedures, and generate the formatted document images utilized by the data registries. This single point web based “reporting engine” will facilitate ease of maintenance of the most current versions of each of the compliance documents and standardize the document formatting across the entire network.

Other Work in Progress

The proposed Energy Commission Compliance Document Repository will contain registered document images. The information that is represented on the documents will be maintained as searchable data. It is anticipated that the Document Repository will be utilized to access information for many purposes, including submittal of evidence in court proceedings to enforce the Standards, satisfying public information requests, research to better understand the penetration of efficiency measures into the housing stock, and research to determine new ways to improve energy efficiency for future Standards updates. A requirements engineering process will determine the user interface functionality the Commission will implement, and the authorities for access to the data assigned to users of the Document Repository.

The Long View – Benefits

What are the short and long-term benefits of creating a data repository that allows for integration and dynamic viewing and processing of data? Benefits include:

- Improved Code Compliance that allows for incremental code improvement
  - Applications that allow online data entry would include a TurboTax® type query interface structure that provides filtering of requirements to make decisions easier. Because the actual code lives in the back end, the code itself can be made even more stringent and conditional without the perception of additional complexity. Data from such applications can be exported to more comprehensive analysis programs such as those based on DOE2.
- Improved Code Enforcement
  - Integrated systems can provide automated error checking, including accessing other related databases such as California's appliance database. These features would ease plan checking. Such systems would also guide building departments, field staff and third party inspectors to the important and customized plan check and field inspection items that pertain to any given building.
  - Building departments would realize the benefit of additional revenue from an increase in permit activity because many types of permits would be able to be obtained remotely. Building departments would also benefit from the added efficiency provided by the automated error checking and customized inspection guides, and access to registered and certified documents.
  - Systems can include process support functionality– permit payment, status tracking, scheduling of inspections and automatic transfer of data, integration with related building department functions and processes and other related code enforcement activities
- Improved Market Characterization
  - Currently, large-scale field data collection projects are launched to obtain market data to assist in predicting the effects of energy efficiency efforts and in assessing the current state of the market. Building permit volume data by type and location and energy compliance data is also currently time consuming to obtain. An energy data warehouse (repository) would reduce the need to sponsor a separate, overlapping effort.

- Improved Impact Analysis
  - Instead of spending resources for field crews to locate and collect data from buildings, efforts can instead focus on learning from the data obtained over time via the centralized data repository. Compliance margins, frequency of prescriptive versus performance analysis, identification of measures used to improve compliance, effectiveness of targeted incentive programs and more can be learned if better data collection and sharing systems were put into place.
- Real Time definition and better understanding of Best Practice
  - Building code researchers and developers must spend time tracking standard practice so that code credits and requirements can be created to move standard practice further along the continuum. Data as simple as the average size of a typical home or the number multifamily buildings that use central water heating systems would help prioritize code efforts so that maximum savings could be achieved.
- Integration with Reach Codes, Utility Incentive Programs and Pilots by area or by measure
  - An integrated application can recognize customization criteria such as incrementally stringent codes in a particular jurisdiction or integration with national codes and reach code requirements. Systems can also coach the permit applicant by providing 'learn more' features and 'smart' suggestions for improved efficiency.
- Integration/Customization of referral to utility-sponsored training programs and other programs
  - Buildings that contain features eligible for a rebate or that contain features that have potential to be upgraded can be forwarded to incentive programs and even be automatically enrolled in those programs. In addition, targeted training opportunities can be flagged for buildings with appropriate features. For example, if a building features skylights, the permit applicant or architect could elect to receive information on best practice integration of skylight design with lighting controls.
- Integrated and dynamic role in the connection of data to all market actors and to the energy efficiency portfolio at large
  - On a high level, data can be sliced, diced and analyzed so that funds are leveraged according to highest need. Program course corrections can be made more easily and more frequently. Databases such as DEER can benefit from any cost data that may be included as optional inputs.

Where Do We Go From Here?

More needs to be learned about the various process drivers and data needs of all the stakeholder groups. This task may best be undertaken through the development of a working collaborative with representatives from inside and outside the energy efficiency industry. Representatives could include key stakeholders and data exchange experts. Together they could plan for necessary research and studies, then create a roadmap adopted by consensus, and locate funding to execute a series of integrated pilots.

It will not likely be necessary to coordinate all activities directly, but it will be necessary to develop a common data dictionary, protocols and guidelines that must be followed so that integration can be automated to the extent possible. It will also be necessary to plan and create data sharing strategies, utilizing technology such as web services, so that proprietary data can be recognized and secure transfer of data can be guaranteed.

There is a clear and obvious benefit to sharing data to the fullest extent possible. The sooner we start this effort, the sooner we can learn from and leverage the vast sets of data that pass through the energy efficiency universe every day.

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[i] Current efforts to collect and share data for code compliance in California include:

- HERS Provider Registry – view the registry videos at www.calcerts.org
- CEC Repository – view the description at www.energy.ca.gov/title24/2008standards/notices/2010-09-23_workshop/residential/Jeff_Miller_Residential_Software_Planning.pdf
- CEC Energy Efficiency Software Consortium – www.energydataweb.com/consortium/
- CPUC Energy Efficiency Groupware Application - http://eega.cpuc.ca.gov/
- Building Department www.velocityhall.com/