Status of Energy Modeling and Data Resources in California Energy Efficiency Programs

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Introduction

The efficient use of energy resources continues to be a critical element in the State of California's energy [1] and climate action plans[2] [3]. Californians are investing $1.2 Billion[4] a year in energy efficiency resources. Future goals include zero net energy (and carbon) buildings and a resilient grid infrastructure. California has long been a leader in developing energy analysis tools and deploying programs to meet its goals. These include building energy codes (CEC) and utility demand side programs (CPUC). A suite of building simulation tools and various supporting applications support these programs.

However, with so many programs and applications, California has been less successful in *integrating* the wide variety of tools and sharing data between them. There are many opportunities to enhance the efficiency of energy calculations supporting California's energy efficiency programs. The Open Efficiency Initiative funded this memo to survey the current landscape and offer recommendations for future integration.

Brief Background of Energy Modeling tools data applications in California

Energy efficiency analysis is heavily dependent on engineering modeling tools and associated data manipulation, storage and reporting.

Energy Efficiency Modeling and Analysis Needs

The general field of analytical modeling for forecasts can be broadly broken up into two domains 1) statistical and 2) physical[5]. Though the following is written about weather forecasting, it could just as easily apply to energy forecasting:

> In fact, up until about thirty years ago, purely statistical models were the primary way that the weather service forecasted hurricane trajectories. Such techniques, however, are subject to diminishing returns. Hurricanes are not exactly rare, but severe storms hit the United States perhaps once every year on average. Whenever you have a large number of candidate variables applied to a rarely occurring phenomenon, there is the risk of overfitting your model and mistaking the noise in the past data for a signal. There is an alternative, however, when you have some knowledge of the structure behind the system. This second type of model essentially creates a simulation of the physical mechanics of some portion of the universe. It takes much more work to build than a purely statistical method and requires a more solid understanding of the root causes of the phenomenon. But it is potentially more accurate….. Statistically driven

[1] CPUC Strategic Plan http://www.cpuc.ca.gov/General.aspx?id=4125
[2] CEC AB 758 Existing Buildings Plan
[3] https://www.climatechange.ca.gov
[4] http://www.edisonfoundation.net/iei/publications/IEI_Energy Efficiency Report_Mar2019.pdf
[5] The Signal and the Noise ISBN-13: 978-0143125082 p

systems are now used as little more than the baseline to measure these more accurate forecasts against.[6]

Both statistical (regression) and physical (simulation) models are used in the analysis of California's energy efficiency policies and programs. Statistical models use a range of data types from real projects and actual conditions such as weather and energy consumption. Physical models (often just called "energy models" or "bottom up models") use algorithms based on engineering principles, in conjunction with building characteristics and weather data. These models are then used to estimate the potential impacts of energy efficiency projects. This memo focuses on physical models and the tools[7] that are built around them.

Simple physical models, such as lighting calculators, can be implemented in spreadsheets. The most sophisticated energy models are called energy simulations. Simulation tools are capable of modeling many (if not all) of the physical characteristics required to fully describe a physical system. ASHRAE [8](140-2017) maintains standards for the criteria a model must meet to be considered a simulation model. [9]

Of the various available energy modeling simulation software packages, DOE2 and Energy Plus are the engines behind the most widely used tools in public sector efficiency programs. These simulation engines were not designed with convenient user interfaces. Additional software (eQuest for DOE2 and Open Studio[10] for Energy Plus) is available to allow a simplified interface for users, among other programming features. An additional layer of software is used to perform specific analysis.

In recent decades, both the California Energy Commission and the California Public Utility Commission have built tools based on these (and other) simulation engines for a range of energy analysis needs. The CEC utilizes Energy Plus, IES and other simulation engines to assist in Title 24 code compliance (CBECC). The CPUC uses DOE2/eQUEST in the MASControl tool used to develop DEER database values.

The DEER database actually has a history that spans both agencies.

Brief DEER History

The DEER database[11] is a core element of California's (and several other states') deemed estimates used in energy efficiency programs regulated by the CPUC.

[6] Silver, Nate. The Signal and the Noise (pp. 387-388). Penguin Publishing Group. Kindle Edition.

[7] CPUC ExAnte Review
[8] https://www.techstreet.com/standards/ashrae-140-2017?product_id=2001489
[9] https://wiki.openmod-initiative.org/wiki/Main_Page
[10] There are other vendors providing interfaces to EnergyPlus (Simergy, Trace, etc…)
[11] http://www.cpuc.ca.gov/general.aspx?id=2017

> The Database for Energy Efficiency Resources (DEER) provides a set of approved ex-ante savings estimates for use in prescriptive (deemed) programs. The DEER started as a California Energy Commission (CEC) project called the California Conservation Inventory Group (CCIG) in the early 1980s. The CCIG was created for the purpose of collating energy savings and incremental cost data on common energy efficiency measures. The CCIG coined the name Database for Energy Efficiency Resources (DEER),and agreed-upon the initial contents of the database. The database contained estimated average costs, market saturation, expected life and annual energy savings, and summer on‐peak demand reduction estimates for common residential and nonresidential demand‐side management (DSM) measures. The original intended uses for DEER were to estimate and measure program cost‐effectiveness for regulatory filings and to forecast DSM program demand reduction and energy savings potential in specific market segments and utility service territories. [12]

In 2005, the CPUC ruled to move DEER maintenance and updates to the CPUC Energy Division. ExAnte estimates and custom calculations. [13]

> The key purpose of DEER has evolved into providing a common set of ex ante savings values (i.e., deemed unit energy savings, net-to-gross values, effective useful life values, and full and incremental measure cost data) to improve the consistency of information and assumptions used in energy efficiency program planning, market analysis and benefit/cost analysis. The 2001 and 2004‐05 DEER updates were managed by the investor-owned utilities. In 2005, Commission Decision D.05‐01‐055 directed Energy Division to update DEER as part of its research and analysis in support of policy oversight. The Commission placed these activities, including DEER updates, under ED because they involve judgments that can influence either the development of performance targets or the measurement of program achievements. Due to conflict‐of‐interest concerns, management of the DEER project was transferred from the IOUs to the ED.

DEER values are based on a variety of modeling assumptions and model types. Simulations are required when modeling systems where interactions are important or detailed component are involved. DEER values are currently modeled using DOE-2, eQuest and associated tools (MASControl)[14].

CEC and CPUC Recent Developments

CEC Title 24 2013 to 2019

For many years, the CEC had also relied on the DOE-2.x simulation engines to support its primary analysis tools behind Title 24 Code compliance. However, as noted below, additional modeling demands

[12] From a CPUC report on the RTF – Pete Jacobs, 2014
[13] http://aceee.org/files/proceedings/2014/data/papers/8-1074.pdf p.8-237
[14] http://www.cpuc.ca.gov/General.aspx?id=4132

resulted in the CEC moving to EnergyPlus as the primary engine supporting non-residential compliance tools.

EnergyPlus Simulation Engine [15]

Performance compliance modelling in California for Title 24, 2008, was based on the DOE-2.1E simulation engine, which is no longer supported by U.S. Department of Energy (DOE). As a result, no significant updates on modelling features or accuracy have occurred recently. As per the California Long Term Energy Efficiency Strategic Plan, all new commercial construction will be Zero Net Energy buildings by the year 2030. To meet this aggressive goal, it was critical that the CBECC simulation engine be capable of informing and supporting decision making by the code agency. It also is important that the simulation engine used for compliance modeling be able to support building features and emerging technologies capable of reducing energy consumption in California buildings. To this effect, the CEC adopted EnergyPlus v8.0 for developing and maintaining the Standards, beginning with the 2013 code cycle.

EnergyPlus is a publicly-funded software supported by the DOE, Building Technologies Program. EnergyPlus not only incorporates modeling features of DOE-2, but also includes new modelling capabilities that were absent in DOE-2. EnergyPlus simulates loads, systems, and plant generation simultaneously, which is a different approach from DOE-2 where loads and systems were simulated separately. It is expected that adoption of EnergyPlus as the simulation engine for CBECC and Title 24 compliance will enable a broader representation of energy efficient technologies in compliance modelling since EnergyPlus undergoes continuous development for modeling algorithms to incorporate low-energy technologies.

While the CEC ultimately decided to move to EnergyPlus, it did so knowing that the transition would require additional work on the engine[16]

It should be pointed out first that while EnergyPlus achieves its purpose of incorporating the latest and most advanced methods of simulating building energy performance, it is only an engine. It is not a compliance tool which must have the user interface, preprocessor, post-processor, data libraries, and reporting tools required by CEC. Since AEC's report was released in 2005, the EnergyPlus development team has made significant progress in adding new features and enhancing existing features in EnergyPlus to bridge the gaps in EnergyPlus modeling capabilities for use in Title 24. However, there are still gaps that need to be addressed. This section of the report summarizes the important gaps under two categories: Title 24 Code Compliance Generic Gaps and ACM Modeling Capabilities Gaps. Other sections of the report prioritize the gaps and categorize the gaps under different sources.

[15] https://energydesignresources.com/media/19649858/edr_enews_093.pdf?tracked=true
[16] https://www.osti.gov/servlets/purl/944980

With the decision to adopt a new simulation engine, the CEC also required a means of standardizing the various data inputs that are required to create and operate the code compliance software. This led to the development of the Standards Data Dictionary (SDD) [17][18] and Building Energy Standards Modeler (BESM)project. While the BESM project did not produce a functioning tool, the SDD is still being used as the data model for the CEC's CBECCC software and data registry. [19]

The CEC continues to fund development and management of simulation tools under the California Building Energy Code Compliance Technical Support contract, awarded to Bruce Wilcox in Feb. 2019.[20]

The current list of approved computer compliance programs is here

https://www.energy.ca.gov/title24/2016standards/2016_computer_prog_list.html

CPUC Programs Using Simulation – Focus on DEER

From 2005 through today, the DEER21 tools and methods have been periodically updated to address changes in CPUC program requirements. [22] [23] As noted earlier, the DEER values originate from a range of modeling tools. But a primary source for weather-related measures is the MASControl tool, using DOE 2.2 and eQUEST "under the hood".

A new era for DEER? CPUC EM&V Contracts for 2019 and beyond - Group A and Group D

In 2018 the CPUC changed the contracting structure for the Evaluation, Measurement and Verification contracts that support the Rolling Portfolio Cycle adopted in D.15-10-028 [24]

Group A is focused on ex ante savings estimation, ex post EM&V, and post-evaluation savings parameter update tasks related to the for commercial and residential sector programs, as well as lighting and HVAC markets, programs and measure groups.

The Group A contractor is currently developing a work plan for using the existing suite of tools, as well as looking at ways to improve the transparency and reduce the complexity of the existing (DEER) methods. The competing imperatives of getting quick results (using the existing tools) and improving the efficiency of the process for the longer term will require parallel efforts.

[17] http://bees.archenergy.com/Documents/PAC_2013.02.27_PPT_SDD_Data_Model.pdf
[18] https://www.energy.ca.gov/2015publications/CEC-500-2015-015/CEC-500-2015-015.pdf
[19] Personal correspondence Rob Hitchcock 1/17/19
[20] https://www.energy.ca.gov/contracts/efficiency.html
[21] http://www.deeresources.com/index.php/ex-ante-database
[22] http://www.cpuc.ca.gov/General.aspx?id=4132
[23] http://www.cpuc.ca.gov/general.aspx?id=2017
[24] http://www.cpuc.ca.gov/general.aspx?id=6442455949

The Group D contract was officially signed early in 2019. Group D (aka "Custom") will be assisting the CPUC Energy Division with review of Ex Ante and Ex Post estimates for Group D Sectors: Large Commercial, Industrial, and Agriculture, and Customized Project Reviews and Strategic Energy Management.

The CPUC currently maintains a list of "approved" models to be used in custom project submittals. Again, the competing imperatives of generating timely results and improving the overall work flow will inform the work plan.

The fact that the Group A and D contracts are currently in the planning stage opens up the opportunity for a parallel process for collaboration with other stakeholders (state agencies and others), while attending to its primary responsibility, i.e. meeting the "Bus Stop" schedules of D.15-10-028. The need for improved compliance software, benchmarking data and the rapidly approaching future needs of integrating EE into other state and CPUC initiatives (Load shapes, DER, IRP, etc.) makes coordination even more important. Within the CPUC, Energy Division has taken the initiative to consider integrating EE into the newly-legislated landscape or Senate Bills 350 (SB 350)[25] and SB100.

Another possible effort worth considering is the Department of Energy effort to utilize simulation models to assist in understanding loadshape impacts on the grid. A newly formed DOE effort is [26] just one effort to characterize load shapes based on "specialized energy models".

Other CEC Energy Programs

Energy models and standardized data play a role in a number of other CEC programs. A short list follows.

Proposition 39

Beginning in fiscal year 2013-14 began a five-year program to improve energy efficiency in schools. The CEC continued development of the SDD to support the implementation of Prop 39[27]

> The California Clean Energy Jobs Act (Proposition 39) changed the corporate income tax code and allocates projected revenue to the General Fund and the Clean Energy Job Creation Fund for five fiscal years, beginning with fiscal year 2013-14. Under the initiative, funding is available annually for appropriation by the Legislature for eligible energy projects such as energy efficiency upgrades and clean energy generation at schools.

[25] Energy Division Staff Proposal for IRP at the CPUC
[26] https://www.energy.gov/eere/buildings/downloads/end-use-load-profiles-us-building-stock
[27] https://www.energy.ca.gov/efficiency/proposition39/

CEC AB 758 Existing Buildings / Benchmarking[28]

The CEC is currently developing guidance on access to a recently approved repository of customer energy usage data. They are partnering with the Department of Energy to develop and utilize algorithms for data anonymization[29].

CEC Electric Program Investment Charge (EPIC) Programs[30]

Several EPIC funded programs utilize simulation models, both as prototypes or project-specific building simulations. Many of these models could be repurposed for other program purposes, should they be made available.

Forecasting[31]

A primary responsibility of the CEC is providing forecasts for future uses of energy. Current modeling tools do not take advantage of all of the energy modeling assets available. And while AMI data will play an increasingly important role in creating accurate forecasts, energy modeling could play a much bigger role in scenario analysis.

This would require "rebuilding the pipes that connect" calibrated energy models to forecast scenarios.[32]

Opportunity for data integration and a model library.

The previous discussion has attempted to capture recent critical developments in the area of energy modeling in energy efficiency at the CEC and CPUC. The next section will review the perspectives of a number of statewide stakeholders that must interact with these programs and agencies.

Stakeholder Views and Activities

As outlined in the previous sections, developments of energy simulation tools and a supporting data ecosystem have not been coordinated across state agencies or programs. This has created a situation where those in the state who wish to, or need to, interact with similar tools in different programs must follow multiple proceedings and adapt to multiple modeling requirements. For those market participants who are only active in a single area (Example - Utility new construction programs, or Title 24 code compliance) this may not be an issue. But for any entity that is required to perform energy modeling to support a range of program requirements (Title 24 plus Savings by Design plus LEED, Benchmarking Ordinance, etc.) there is no single path. This can cause increased workloads and confusion.

Southern California Edison Roadmap and Symposia

Among the organizations active in implementing energy efficiency programs in California, and subject to regulations from a variety of agencies, the investor owned utilities (IOUs) have a special role. The IOUs in general, and Southern California Edison in particular, must comply with a range of rules and hence

[28] https://www.energy.ca.gov/efficiency/existing_buildings/16-EBP-01/
[29] https://www.energy.gov/eere/slsc/energy-data-access
[30] https://www.energy.ca.gov/contracts/epic.html
[31] https://www.energy.ca.gov/2018_energypolicy/
[32] Personal communication with Martha Brook, March 11, 2019

must maintain the ability to perform energy analysis using a wide range of tools. Furthermore, they must interact with just about every other organization in the state that deals with energy efficiency, form code compliance (using EnergyPlus) to DEER and Custom programs (using eQUEST/ DOE-2). And then they must report in a range of formats.

In order to assist the state in rationalizing this increasingly complex set of analysis requirements, in 2016 SCE commissioned a roadmap to assist SCE in making decisions around future investments in Building Energy Modeling (BEM) tools. [33] (TRC, 2017)

In addition to the roadmap, SCE hosted a series of symposia on energy modeling. The first symposium was held in September 2017 and focused on issues related to modeling and code compliance. The most recent symposia focused on a wider range of topics related to energy modeling in support of Zero Net Energy and carbon goals and programs.

California Technical Forum (CalTF)

The general process, methods and roles of players for determining energy savings values in CPUC-regulated energy efficiency programs in California have evolved over the past 20 years. The most recent changes are summarized here:

> Summary: History of Developing Ex Ante Values in California
>
> During the first 15 years of DEER, energy savings values were developed through a public, collaborative, transparent process. Starting with the 2006-2008 program cycle, energy efficiency measure parameters have not been developed through an open public process that allows for effective peer review. Unfortunately, the process for developing DEER values that has evolved out of the D.05-01-055 administrative system has become overly complex, and the underlying methodologies difficult for many industry participants to understand and utilize correctly.[3] Partly as a result of this complexity and the lack of effective stakeholder input, the current system lacks transparency and support. Furthermore, despite the best efforts of the utilities and CPUC staff, it has been difficult for these parties to collaborate effectively and in a timely manner during the workpaper development process. This in turn has led to delays, frustration on both sides, and wasted resources.
>
> The controversy and disagreements that have arisen over the values in DEER prompted stakeholders in California to seek another model for developing energy-efficiency measure parameters in California, as described below. [34]

[33] https://www.etcc-ca.com/reports/sce-building-energy-modeling-roadmap

[34] http://aceee.org/files/proceedings/2014/data/papers/8-1074.pdf

The paper goes on to describe the formation of the California Technical Forum (CalTF) and its primary technical focus on rebuilding the DEER database so as to be transparent in method and references. From its web site:

> *The California Technical Forum (Cal TF) is a collaborative of experts who use independent professional judgment and a transparent, technically robust process to review and issue technical information related to California's integrated demand side management portfolio. The Cal TF was created in 2014 by a broad group of stakeholders and is funded by participating program administrators.*

The CalTF is currently focusing in four main areas 1) finalizing and releasing the standardized, consolidated, statewide, complete and comprehensive database of California's deemed measures 2) the electronic Technical Reference Manual (eTRM) 3) finalizing and seeking CPUC review and approval of all statewide consolidated measures that will all have effective dates of 1/1/20 4) reviewing the tools that make up the analysis suite.

The 2019 Business Plan[35] includes several items related to energy modeling, including:

> "**Advance Statewide Consistent Approach to Energy Modeling"**
>
> CA industry professionals who use building simulation models will participate in meetings and will provide input to identify common goals and propose approaches to harmonizing modeling to:
>
> - Reduce inefficiencies
> - Maintain or improve modeling rigor
> - Identify what constitutes sufficient evidence such that results of a new model are reliable for savings calculations
> - Achieve consistent documentation so results are transparent and can be reproduced and peer reviewed.

The report also has a review of the status of the eTRM. Uploaded measures are expected to be available August 1, 2019.

DOE National Laboratories NREL

The Department of Energy National Laboratories, in particular LBNL and NREL, have been active players in the energy efficiency tool development and deployment activities in California for several decades. The following is but a brief set of examples, it *is not intended to be an exhaustive list.*

LBNL is the original home of the DOE 1.X and DOE 2.x series of engines. They actively support EnergyPlus (and associated modules) development. Recent collaboration (along with NREL) on the BayREN Integrated Commercial Retrofit (BRICR) program is a good example[36]. LBNL also supports the BEDES data dictionary and SEED database.

[35] CalTF 2019 Business Plan
[36] https://www.energy.gov/eere/buildings/downloads/bayren-integrated-commercial-retrofits-bricr

NREL supports tools development (OpenStudio, EnergyPlus, others) as well as deployment support for municipal energy companies (LADWP and others). As part of their deployment support, NREL harvested content from the DEER prototypes and used this data to create OpenStudio prototype models. This work was funded by LADWP and SoCalGas. NREL also supports several California market actors such as CalTF on the eTRM project[37].

Legislative Advocacy

Several important recent pieces of Legislation (AB 802 and 758, SB 350) are being implemented now, and promise to impact the energy efficiency landscape in California. Two committees in Sacramento are the assigned to this area. The Senate[38] and Assembly[39] Energy and Utilities Committees have jurisdiction over energy issues generally. The primary industry lobbying group dealing with these committees is the California Efficiency and Demand Management Council (CEDMC). CEDMC's Legislative Committee has been recently focusing on methods for streamlining ex-ante review of custom projects. The focus is on industry standard practice (ISP) and preponderance of evidence (POE), but modeling is an increasingly important tool to sort out these issues.

The California Energy Alliance (CEA) is a newly formed, member-based organization working "… to improve California's energy future and the migration toward a Zero Net Energy horizon. CEA focuses on the promotion and realization of deep energy savings, sustainable energy generation, and integration."

Among the recent legislative initiatives that CEA is following and might impact energy modeling standards:

> SB100[40] California Renewables Portfolio Standard Program:
>
> Requires a minimum percentage of delivered energy originate from renewable energy sources.
>
> SB338[41] Integrated resource plan: peak demand.
>
> "This bill would require the commission and the governing boards of local publicly owned electric utilities to consider, as a part of the integrated resource plan process, the role of distributed energy resources and other specified energy- and efficiency-related tools…"

[37] http://www.caltf.org/etrm-overview
[38] https://seuc.senate.ca.gov/
[39] https://autl.assembly.ca.gov/
[40] https://focus.senate.ca.gov/sb100
[41] https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180SB338

The Role of Cities, Regions and related Ordinances (Benchmarking)

As energy efficiency programs continue to evolve, the boundaries between municipal ordinances[42] (San Francisco Environment and BESO), IOU local government utility programs[43], Code compliance and Climate programs become less certain.

One example, BRICR (see above) is SFE's attempt to integrate data and modeling to support a range of municipal and state requirements and goals. The City of Berkeley is cooperating with SFE on a promising new tool suite that integrate data to support implementation of its Building Energy Savings Ordinance (BESO). (See OEP San Francisco Case Study) There are numerous organizations supporting local governments in these types of efforts. These could all be considered as candidates for raising awareness and on and scaling deployment of successes in using energy modeling to support energy efficiency.

Non-Resource Programs

The CPUC portfolio of energy efficiency programs. "Non-resource" programs do not "count" in utility goals calculations but are intended to guide customers to other utility incentive programs or financing. Several creative non-resource programs have successfully implemented energy modeling into program implementation procedures.

(See OEP TEC Case Study)

NGOs and other organizations

The non-profit sector has a large number of organizations that are directly involved in energy modeling and associated tools. In particular the California Association of Building Energy Consultants (CABEC[44]) and the International Building Performance Simulation Association (IBPSA [45]) would be perfect candidates for coordination and awareness campaigns.

The Efficiency Valuation Organization (EVO) is currently developing guidance on the use of simulation software to perform "non-routine adjustments, a core component of savings persistence analysis.

The California Energy Alliance is promoting the adoption of Outcome Based Codes[46], a novel approach to assuring buildings operate as designed and approved through code compliance.

A short list of these and other organizations is in Appendix I.

Third Party Perspectives

Last but not least, those firms that actively participate in energy efficiency programs must be aware of, and able to implement a wide range of tools and data interfaces. This complexity is an impediment to

[42] https://sfenvironment.org/article/san-franciscos-existing-commercial-buildings-ordinance
[43] https://sfenvironment.org/article/energy-for-commercial-and-multifamily-properties
[44] https://cabec.org
[45] https://www.ibpsa.us/
[46] https://caenergyalliance.org/outcomebased-energy-code

new actors and reduces the administrative efficiency of these programs. Implementers and modelers want consistency.

The author is aware of a project that epitomizes the lack of coordination in energy modeling between energy efficiency programs. On a single, very large project (Merced 2020 [47]) there are multiple energy models required for each building. The project requires an energy model for each of five distinct purposes, CBECC compliance, LEED compliance, Title 24 Minus 20%, Savings By Design and contractually set energy targets. Clearly, this is a less than optimal use of modeling resources and introduces uncertainty when the models do not all align. And unfortunately, this is not uncommon.

This section attempted to highlight the issues facing just a few of the stakeholders in the California energy efficiency modeling and data ecosystem. It identifies barriers that are preventing stakeholders from delivering efficient services to the industry. The next section offers some suggestions for rectifying some of the inconsistencies and confusion in California modeling and data management.

Go Forward Strategies

As described in previous paragraphs, California's use of energy modeling tools and data has been aggressive and largely successful. But California's creative experimentation has also created a very difficult landscape for market actors. There are now opportunities to rationalize the modeling and data landscape for the benefit of all users and the ultimate improvement of program delivery. All parties will benefit from a new emphasis on coordination within the energy efficiency industry on the topics of energy modeling and data standardization.

Level of Coordination – Communication - Awareness

The general challenge of coordination is not unique to California energy modeling and data. All industries face the challenge of maintaining balancing the needs/benefits of standardization against the forces/possibilities of innovation.

There is not one silver bullet solution to California's energy modeling and data conundrum. Coordination among players, both broad and narrow, is needed.

Broadening existing efforts

As mentioned in the section above on Stakeholder Activities, SCE's efforts to gather energy modeling experts to share their experience and plans via a series of symposia has been a productive exercise. Indeed, any of the major topic areas covered in these symposia, from Title 24 compliance software, to modeling requirements for future code cycles to general education of the modeling community, could be expanded into a series of future symposia.

In order to be effective, any future meetings would benefit from participation from of all major state agencies, primarily the CPUC and CEC, but also agencies [48] tasked with supporting efforts to meet the

[47] https://merced2020.ucmerced.edu/design/sustainability
[48] https://www.arb.ca.gov/cc/sb350/sb350.htm

state's Greenhouse Gas Planning Targets. A useful first step would be to identify current modeling uses and future needs from all state agencies. [49]

And it's not just models that could be shared. Many statewide actors are already involved in data collection. The CEC is actively pursuing authority to access the data needed to implement legislated goals in AB 802[50] and SB 350.[51] (See Appendix II)

The CPUC maintains CEDARS, a repository for all energy efficiency claims. The CEC supports a Proposition 39 database[52]. A logical next step is to create an inventory of all current data set and sources.

Beyond identifying overlapping and duplicative data sets, sharing information on specific policies to address PII concerns[53] [54]would be a priority.

Narrower, focused efforts to coordinate

The Open Efficiency Initiative was conceived as a project to identify obstacles to the use of advanced modeling and data in the implementation of utility energy efficiency programs. A suite of integrated OEP tools has been tested and reported in case studies. However, in conducting interviews and collecting information on existing programs that are not currently using OEP tools, it became clear that adopting the full OEP package will rarely be possible (see case studies). Yet many programs are already benefiting from individual elements of the Open Efficiency Platform. For example, the SEED database has undergone substantial development in response to users' requests and is now a fully functioning element in several cities' benchmarking programs. Building Energy Asset Score and Portfolio Manager are being used in non-resource programs now.

The various OEP components are being proven and are ready for use.

Examples of Piece-wise

The OEI case studies are helpful in understanding some of the opportunities that arise when combing OEP tools. A couple other examples are:

BRICR

The BayREN Integrated Commercial Retrofits program utilizes Open Studio/EnergyPlus, Portfolio Manager, SEED and other tools.

Sonoma County – Urban Footprint – Energy Explorer[55]

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[49] See inventory recommendation
[50] https://www.energy.ca.gov/sb350/energydata/
[51] https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=16-OIR-03
[52] http://prop39publicsearch.energy.ca.gov
[53] https://www.eff.org/deeplinks/2009/09/what-information-personally-identifiable
[54] http://www.cpuc.ca.gov/General.aspx?id=10151
[55] Sonoma County Energy Explorer https://scta.ca.gov/wp-content/uploads/2017/12/Sonoma-County-Scenarios-Presentation-11-Dec-2017.pdf

As part of an EPIC funded project, Calthorpe Analytics led a team that ran scenarios using prototype models, customized with county-sourced data.[56] This project is one of several where a set of prototype models were built for California-specific purposes.

CCAs (many and growing)

The rapid growth of non-IOU load serving entities means a new set of players are involved in providing energy and optimizing energy sources and delivery. Organizations like the CALCCA[57] could be another avenue for awareness building.

Immediate Next Steps

Outreach

There are several groups already planning to conduct coordination activities related to energy modeling. The CalTF and SCE Software Symposium are two notable examples. Member supported groups such as CEDMC and CEA are also good candidates for raising awareness and moving towards an integrated modeling environment.

The two primary state agencies, the CPUC and CEC are logical candidates to co-lead a state-sponsored effort. But there are many more potentially important participants in the modeling community that could promote the concept of integrated modeling.

CABEC[58]

IBPSA[59]

CEDMC[60]

California Energy Alliance[61]

Design community – ARUP, others

Local Government Commission

Local Government Sustainable Energy Coalition

Climate Action Plan groups

[56] https://aceee.org/files/proceedings/2016/data/papers/11_139.pdf
[57] https://cal-cca.org
[58] https://cabec.org/title-24/
[59] http://ibpsa.org
[60] https://cedmc.org/
[61] https://caenergyalliance.org/

A new entity might be conceived, the California Energy Modeling Collaborative.

Inventories

An initial project for the CEMC could be to create statewide inventories of existing activities and resources

- Inventory of Tools
- Inventory of Data Sources/ Repositories
- Inventory of Future Needs

Coordination of Planned Modeling Efforts

Irrespective of any new efforts, several activities at the CPUC and CEC are currently in the planning stages for large tasks involving modeling and data. These efforts could benefit from communication and potential cooperation.

- CPUC EM&V Contract Group A (ExAnte / DEEMED) Inform CPUC/Selected contract team of all efforts underway in California to standardize data and adopt open source tools.
- CPUC EM&V Contract Group D (Custom) Inform CPUC/Selected contract team of all efforts underway in California to standardize data and adopt open source tools.
- CEC Next generation of Compliance Software for Title 24
- CalTF 2019 Work Plan
- SCE Software Symposium 2019 Plan

Data Standardization – Create a Statewide Data Working Group

Modeling and analysis run on data. The state of California collects and maintains a wide range of relevant energy and buildings characteristics data. Efforts to harvest the data from Title 24 compliance filings, a great idea that has been around for years, have been left unfunded in lieu of other priorities. California would benefit from an effort to identify, categorize and inventory the data that is already available.

Major, operational data sets have already been developed. But they currently do not share a common scheme. The Data Working group could build relationships between SDD[62], the CalTF data spec (eTRM), DEER (READI), CEDARS and other heavily used energy efficiency specific data. The CEC's Data Lake is another opportunity. As is UCLA's Energy Atlas[63].

[62] http://bees.archenergy.com/Documents/PAC_2013.02.27_PPT_SDD_Data_Model.pdf
[63] http://www.energyatlas.ucla.edu/

Data reporting from energy models is another area of continuing interest. Charles Eley has captured the challenge well in a recent paper published at IBPSA.[64]

Finally, these issues are not confined to California. Any new data specifications would benefit from coordination to national efforts, such as BuildingSync and ASHRAE 211[65].

Conclusions

California has a long and successful record in the area of energy efficiency. It has initiated many efforts that have resulted in wide range of analysis tools and data. However, a lack of coordination has created a confusing and overlapping set of tools and methods that support EE programs. The recent SCE software symposium was a good start to bringing together experts, agencies and actors. Future meetings will benefit from a wider array of agencies and stakeholders.

Energy modeling (and supporting implementation software) is increasingly important for the planning, execution and reporting of energy efficiency activities. While it is not likely that any one tool will ever serve all the needs of such a vast enterprise, certainly better awareness of opportunities to integrate tools will benefit all.

And while there are still important issues to be worked out on the policy and privacy side, the fundamentals of data standardization can be addressed through awareness and communication between efforts.

Future efforts might adopt a longer ranged and integrated view of modeling. For instance, adopting the construct of maintaining an energy model for the life of a building is increasingly possible, and will soon become necessary.

California will benefit from broad efforts to enhance communication among these programs and narrow efforts to build bridges through standardization.

The Open Efficiency Initiative is already playing an important role in helping California, and then helping transfer lessons learned to other areas.

[64] https://ibpsa-usa.org/index.php/ibpusa/article/view/380
[65] https://www.linkedin.com/pulse/buildingsync-makes-worth-learning-what-xml-schema-jim-kelsey/

Appendix I NGOs - Other

LGC	Local Government Commission
CABEC	California Association of Building Energy Consultants
NBI	New Buildings Institute
IMT	Institute for Market Transformation
GBCI	Green Building Certification Institute
AIA	American Institute of Architects
EVO	Efficiency Valuation Organization
ASHRAE	American Society of Heating Refrigeration and Air-Conditioning Engineers
NRDC	Natural Resources Defense Council
CAECC	California Energy Efficiency Coordinating Committee
CEDMC	California Efficiency & Demand Management Council
USDN	Urban Sustainability Directors Network
CEA	California Energy Alliance
gbXML	GreenBuildingXML
UCLA	Energy Atlas
C40	C40 Cities
CPE	Clean Power Exchange

Appendix II CEC Energy Efficiency in Existing Buildings (AB 758 implementation)

Strategy 2.1 Modern, Accessible Data

The Energy Commission continues to focus its efforts on these data-related plan strategies. Good progress has been made, but there is much more planned in the coming months and years.

Data Exchange Protocols

The Energy Commission has developed standard data terms and relationships for multiple building energy- related programs over the last eight years. This standard data dictionary (SDD) has data structures and properties for defining all components of a building that are evaluated in assessing its energy efficiency. The SDD is consistent with the Department of Energy's Building Energy Data Exchange Specification, and BEDES terms are mapped to SDD terms, where appropriate.

For exchanging SDD-based data between programs or outside vendors, an Extensible Markup Language (XML) schema using the XML Schema Definition Language (XSDL) was chosen to take advantage of the benefits for expressing and validating data exchange format and content. The SDD is used to generate products for different Energy Commission programs including:

- XML schema for Title 24 residential compliance document registration.
- XML schema for Proposition 39 utility energy usage and cost data collection.
- Software data model and documentation for Title 24 nonresidential compliance.

Future programs developed at the Energy Commission will leverage SDD and allow infrastructure to share data across various programs. SDD structure will also be made available on the Energy Commission website for the public and third-party programmers to use.

Data Lake Repository

In mid-2016 the Energy Commission committed to planning, developing, and governing a multipurpose data infrastructure to store, analyze, and visualize building energy and efficiency information for the State. Leveraging the SDD architecture introduced above, the Data Lake Repository will be piloted with the following data collection, analysis, and reporting use cases:

- AB 802 Building Energy Use Benchmarking and Disclosure
- Proposition 39 schools energy use and efficiency project analysis and reporting
- Granular building energy use baselines (supported first with CPUC-shared historical consumption time series, then later with Title 20 data collection regulations)

Appendix III CPUC and other California Programs Using Simulation

This is a very brief list. A good overview of enegy modeling in CPUC programs can be found in SCE's Roadmap. https://www.etcc-ca.com/reports/sce-building-energy-modeling-roadmap

Program Tools – Savings by Design

Interview program managers from each IOU. Review Evaluations

Potential Studies

Navigant

IOU Pilot Programs

PG&E Whole Building Pilot

IOU Support

https://energydesignresources.com/media/7716866/pge169_edrbrochure_final.pdf

SoCalREN

OEI/TEC non-resource

Energy Atlas non-resource

BayREN

BRICR

CCAs

Sonoma Clean Power

POUs

LADWP