Unlocking the Power of Energy Consumption and Asset Data for Program and Policy Design

Howard Choy, Los Angeles County Office of Sustainability
Stephanie Pincetl and Sinnott Murphy, University of California - Los Angeles
Marc Costa, The Energy Coalition

ABSTRACT

Access to building energy use data has become a prominent discussion in California and the rest of the country. An important consideration is the balance between privacy concerns from greater data accessibility and the public benefit gained through research and analysis of such data coupled with building and demographic characteristics datasets. The Southern California Regional Energy Network (The Energy Network) and researchers at UCLA are embarking on a research effort which will produce analysis of customer-level energy consumption information from utilities over seven years, linked to publicly available building data (including building age, construction, size, location, use, tariff, and occupant) for all sectors and building types in Los Angeles County. This groundbreaking analysis will provide new insight on the drivers of energy consumption that can inform the energy community and shape program design and implementation, customer education and outreach, and state and local policy. The conference presentation describes the development, initial results, and intended use of the outcomes of this effort. Presenters also discuss regulatory and policy issues related to acquisition of data, presentation of results, and protection of confidential customer data.

Introduction and Motivation

California is universally seen as a leader in energy efficiency and conservation in the U.S. The state implemented appliance efficiency standards and building codes in the 1970s (Title 20 and Title 24, respectively), decoupled utility profits from the sale of electricity and natural gas in the 1980s, and mandated investment in public-benefit programs, including energy efficiency, in the 1990s. The California Energy Commission claims that Title 24 alone has been responsible for $74 billion in cumulative electricity savings since implementation, as well as the divergence of California's per capita average electricity consumption from that of the rest of the U.S (termed the Rosenfeld Effect). The state's leadership extends to climate change mitigation and adaptation as well. California adopted aggressive 2020 and 2050 greenhouse gas mitigation targets through Assembly Bill (AB) 32 The Global Warming Solutions Act (2006) and Executive Order S-3-05, signed by Governor Schwarzenegger in 2005. Ratepayers of California's investor-owned utilities have spent $2.2 billion on energy efficiency between 2010 and 2012.[1]

Simultaneously, a number of policy efforts seek to advance the achievement of energy efficiency goals, such as AB 1103 Nonresidential Building Energy Use Disclosure Program (2007) and AB 758 Comprehensive Energy Efficiency Program for Existing Buildings (2009). These, through varying mechanisms, involve both the California Energy Commission (CEC) and the California Public Utilities Commission (CPUC) and seek to achieve greater energy efficiency

[1] http://eestats.cpuc.ca.gov/ See Footnotes 9 and 10 for general comments on the footnotes.

in the state's existing buildings. While these two efforts have limited associated funding, the CPUC has an Energy Efficiency Portfolio, under which the Southern California Regional Energy Network (The Energy Network) was formed. Created by the CPUC in 2012, The Energy Network represents over 20 million people, 12 counties, 730 public agencies, and 68,000 square miles in Southern California, and is tasked with creating and implementing energy efficiency programs that address California's Long-Term Energy Efficiency Strategic Plan.[2]

The Energy Network is working to address the key barriers to achieving market transformation and scalable savings. These include a lack of access to energy and building asset data, agency coordination, and standardization and interoperability. To do this, The Energy Network is funding the creation of a regional interactive energy atlas to identify the key drivers of energy consumption in Southern California. This work leverages an emerging national data standardization and interoperability effort to support the creation of improved programs and streamlined workflows for capturing energy efficiency opportunities. We now discuss barriers to bringing programs to scale and solutions being pursued by the Network.

Barriers

Barrier 1: Energy Data

Limited access to energy data in California hinders the effective design and implementation of policies and programs and limits understanding of the key drivers of energy use. The state has not yet developed an adequate mechanism for ensuring that local governments receive the data they need from investor-owned utilities (IOUs). At present, local governments face significant delays in processing data requests, receive only aggregated data (e.g. a single value for total annual consumption within their jurisdiction), have no recourse when an IOU denies a data request, and no ability to ground-truth any data received. The most disaggregated release of data provided by an IOU in Southern California of which we are aware entailed ZIP code-level reporting of electricity consumption for Los Angeles County for a single year—though 45 percent of ZIP codes for the data request were aggregated together into a single value to protect privacy in accordance with the "15/15 guideline."[3] Even these data were only released to the County after several months and repeated interactions between County and IOU staff.

Despite many hurdles, researchers at UCLA have succeeded in collecting a seven-year census of monthly customer-level electricity and natural gas data for Los Angeles County, including data from both IOUs and municipally owned utilities. To collect these data, UCLA built close relationships with electric and natural gas utilities across Los Angeles County, the California Public Utilities Commission, the California Energy Commission, the Governor's Office of Planning and Research, and other key stakeholders to argue the need for joining high-resolution energy use data to a host of data sets describing the physical and social characteristics of the region. By partnering with The Energy Network, UCLA hopes to leverage the potential of these data to help California achieve its energy policy objectives while ensuring customer confidentiality through a robust set of physical and information security safeguards.

[2] http://www.theenergynetwork.com

[3] A guideline adopted by the California Public Utilities Commission which requires that at least 15 customer accounts are aggregated together, with no single customer accounting for more than 15 percent of total usage, in any energy use data publicly disclosed. <<Add a citation to a CPUC document describing the 15/15 rule>>

Barrier 2: Asset Data

Energy data is only one component of the information necessary to study the drivers of energy consumption; data describing physical and social characteristics of human systems are also crucial. It is, however, often difficult for researchers to acquire granular energy data due to utility company policies, State policy regulations and the time and resources involved in cleaning and analyzing large, and often messy, datasets. There has been significant recent advancement in methods that utilize such asset data to help understand patterns of energy use. One end of this spectrum is the U.S. Department of Energy (DOE) effort to evaluate the physical characteristics and as-built energy efficiency of buildings through the Building Energy Asset Score.[4] The other end of the spectrum is the virtual energy audit which relies primarily on interval energy use data and secondarily on asset information. The primary challenge here is the resources needed to collect and verify physical characteristics of a building. This challenge grows rapidly as the volume of building stock increases. If programs aimed at spurring retrofits are not well informed by the confluence of energy, social characteristics, and asset data, their market impact and cost-effectiveness will leave a margin of uncertainty and provide less leverage to policy makers.

Barrier 3: Agency Coordination

Los Angeles County represents more than 10 million people across 88 cities, a full quarter of California's population. The size and diversity of the County's service territory makes coordinated action with other jurisdictions and stakeholders more challenging, limiting the effectiveness and efficiency of regional responses to the complex and interrelated issues of demand management, clean energy integration, and climate change mitigation. Systematic analysis of disaggregated energy data across a large region over time provides an opportunity to capture significant economies of scale in data collection, processing, analysis, and results dissemination for the benefit of all local jurisdictions within the region.

Barrier 4: Standardization and Interoperability

Finally, data standardization and interoperability must be addressed. At present, significant fragmentation of workflows exists. Property benchmark, energy audit, permit, code compliance, verification, and rebate data are all disconnected, resulting in wasted time and reduced uptake of energy efficiency measures. Data standardization and interoperability would significantly reduce barriers to achieving greater energy efficiency in California. The Energy Network and UCLA are seizing the opportunity to create effective programs and infrastructure to address these challenges. We now discuss this work in greater detail.

[4] http://energy.gov/eere/buildings/commercial-building-energy-asset-score

Solutions

Solution 1: Data and Analysis

Prior each energy efficiency program funding cycle, the CPUC commissions a Potential and Goals Study to broadly identify technical, economic, and market potential for incremental, cumulative, and life-cycle savings.[5] This study helps inform IOUs and Regional Energy Networks (RENs) in program creation. In other parts of the U.S., the National Renewable Energy Laboratory (NREL) is embarking on large-scale analyses of regional energy savings potential. This utilizes a number of DOE tools to find a more granular savings potential through building modeling and simulation. Blending the two approaches together may provide more accurate and well-informed findings to shape core program design in California.

Furthermore, programs must be customized for local governments as they are playing an active role in achieving AB 32 objectives through implementation of Climate Action Plans and energy reduction targets and represent unique constituents and socio-economic conditions. This is what The Energy Network and UCLA's work linking high-resolution energy data to asset data will enable.

This analysis will leverage a broad range of datasets to increase knowledge of patterns of building energy consumption and opportunities for promoting energy efficiency. Energy data collected and processed to date include seven years of monthly, customer-level electricity and natural gas consumption spanning nearly a full census of businesses and residents in Los Angeles County, provided by the California Public Utilities Commission and several the region's municipally owned utilities. To these energy use data will be joined numerous publicly available data sets describing the physical and social characteristics of Los Angeles County. The key datasets to be joined to the energy data include building size, age, shell materials, value, and number of units from the County Assessor's Office; resident population, income, age, race, education, occupation, and proportion of rented versus owner-occupied housing data from the U.S. Census and American Community Survey; industry classification codes; and heating and cooling degree days.

Data are integrated via a relational database comprised of several individual data tables that are related using account numbers and other identifiers, diagrammed below. Geospatial attributes for each account include street address, ZIP and ZIP+4 codes, city, county, latitude-longitude coordinates, climate zone, and census identifiers. The above-described explanatory datasets are each represented by individual tables in the database and may thus be flexibly related to energy consumption data at their various spatial resolutions.

[5] http://www.cpuc.ca.gov/PUC/energy/Energy+Efficiency/Energy+Efficiency+Goals+and+Potential+Studies.htm

Energy Database Diagram

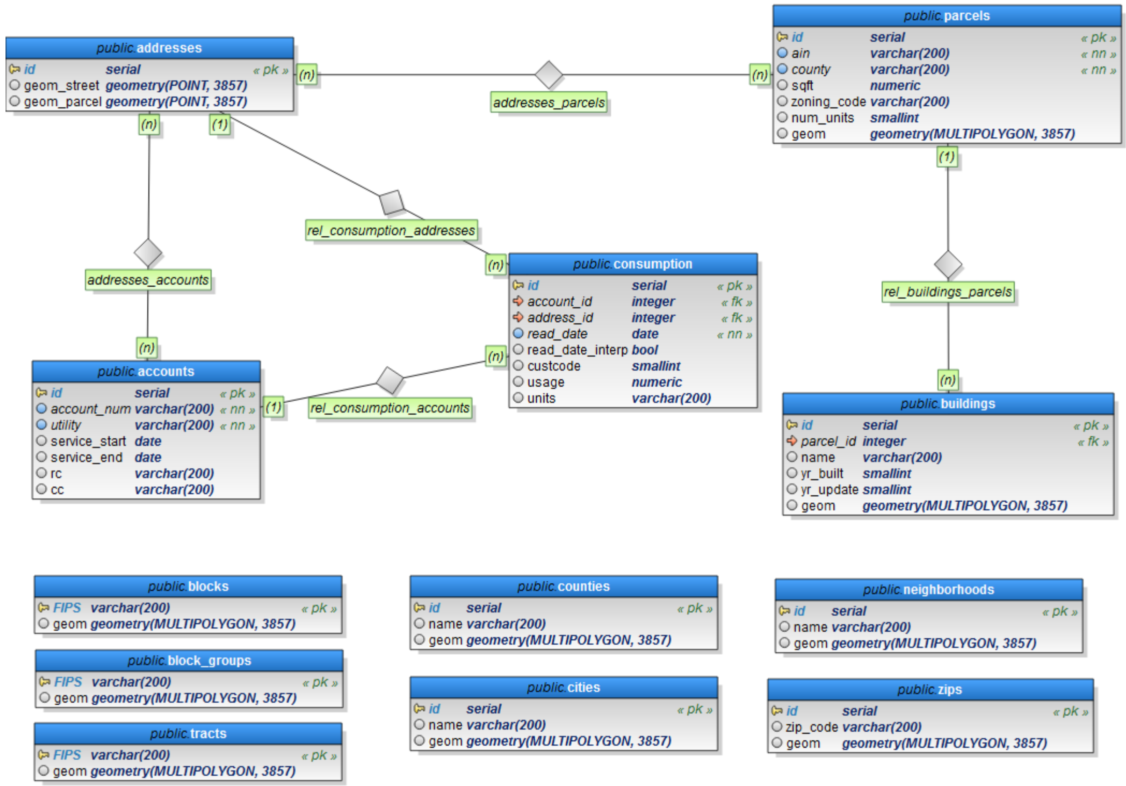

Figure 1. This diagram depicts the database structure and function serving the analysis discussed in this paper.

This database architecture will enable UCLA and The Energy Network to answer the following questions relevant to local-level policy makers:

- How much energy is consumed throughout the region and in sub-regions (e.g. by city, ZIP code, and census tract)?
- How much energy is consumed by different customer types (e.g. single-family residential; multi-family residential; small, medium, and large commercial; public buildings; etc.)?
- Which building types are the most efficient?
- Do older or newer buildings consume more energy?
- How does residential energy consumption vary across income classes?
- How much energy is consumed by industry types?
- What is the energy intensity by customer or industry type (e.g. how much energy is consumed per square foot, per building occupant, per household, per hour of operation, etc.)?
- What are the energy consumption and energy use intensity patterns over time (2005-2012) by building and industry type, and by county sub-region?

Metrics and other findings from the study will be conveyed through an interactive energy atlas, the first of its kind created anywhere in the world. The atlas will provide local governments with access to key energy consumption metrics and trends over time, undergirded by analysis of a census of monthly, customer-level electricity and natural gas data spanning Los Angeles County. This map will have a broad range of uses to many stakeholders. For example, decision-makers will be able to evaluate the most effective places to target energy investments, program managers will be able to communicate energy consumption to program participants and the public-at-large can use the tool to understand their own energy consumption.

To date, UCLA has created a pilot-scale interactive electricity mapping tool for the City of Los Angeles and begun to analyze spatial patterns of electricity use. The interactive mapping tool displays monthly electricity consumption by census block group for 18 months (January 2011 through June 2012) linked to the distribution of land uses (residential, commercial, industrial) by census block group. UCLA is leveraging this platform to create the interactive energy atlas for The Energy Network and is now adding additional energy data to span Los Angeles County for the full seven years. A screen shot of the interactive electricity mapping tool is shown below. No individual data will be released through this work, and all outputs will be aggregated to a level where individual usage patterns are protected.

Screenshot of Interactive Map

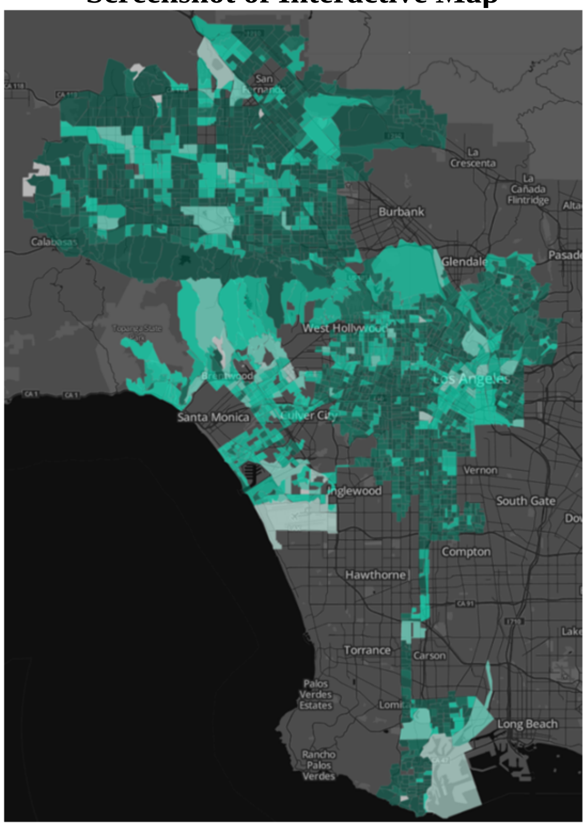

Figure 2. The picture is a screenshot of the prototype interactive map UCLA developed which shows energy consumption in the City of Los Angeles. Researchers will expand this map to include all of LA County and will update it with advanced functionality and graphics.

Solution 2: Infrastructure and Standardization

Simultaneously, The Energy Network is undertaking infrastructure and data standardization efforts to support energy efficiency programs. This effort spans the adoption of an emerging national data standardization specification and the development of a policy framework and regional tools to support streamlining of local-agency benchmarking, auditing, and online permitting activities. First, the DOE and Lawrence Berkeley National Laboratory are creating the Building Energy Data Exchange Specification (BEDES), a set of terms, definitions, units and metadata that lays the foundation for dealing with energy and asset data in a standardized way. This framework supports standardization of energy use data for auditing and permitting applications, and can thus help The Energy Network to streamline workflows for local agencies.

Second, through the City Energy Project, a policy framework and regional tools will be developed to support standardization of benchmarking and auditing ordinances across U.S. cities.[6] This will help ensure a high degree of reliability in data collected and provides an opportunity to streamline workflows. For example, NREL is currently testing the audit “use case” of BEDES, which has the potential to allow any firm conducting an energy audit to submit a report and map the findings into a standard format. It thus gives the private sector, nonprofits, industry organizations, and others an opportunity to create application programming interfaces (APIs) and programs that facilitate the exchange of building energy data. So if a facility meets criteria for both an audit and benchmarking, then data from an audit could flow into a benchmarking report without additional time needed to manually populate a separate benchmarking form. This also allows local governments to more easily verify that the audit report has been correctly completed.

Third, BEDES can support streamlining of online permitting through a code compliance and permitting use case. This facilitates the completion of energy efficiency retrofits by property owners who have completed benchmarking and auditing activities by auto-populating a permit application from an audit report. This could prove particularly useful if California Title 24 compliance forms and the XML compliance reports were mapped into BEDES. In this case, no matter what online permitting vendor is servicing a city, the BEDES framework would facilitate interoperability of data across jurisdictions, as well as with the CEC’s compliance repository. The potential of BEDES mapping to streamline these workflows across local jurisdictions, which may be served by various online permitting vendors, and to link to existing incentives is demonstrated by the figure below.

[6] http://www.cityenergyproject.org/

Mapping of BEDES Workflow

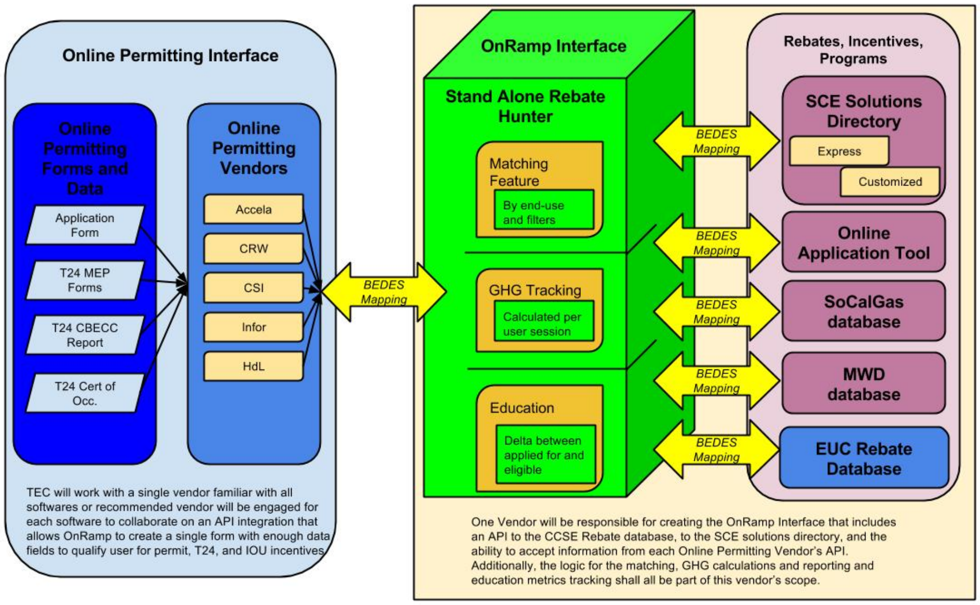

Figure 3. The figure below depicts how BEDES can streamline workflows across multiple jurisdictions.

A pilot effort to implement these solutions began in 2010 as part of the Community Energy Efficiency Project Management System (CEEPMS) in the City of Santa Monica and the City of Brea.[7] Santa Monica and Brea received grant funding from Southern California Edison to pilot the development of an energy efficiency project management system to address the gap of calculating community-wide energy efficiency improvements and related savings. The initiative was specifically designed to meet Goal 4 of California's Long-Term Energy Efficiency Strategic Plan: "Local governments lead their communities with innovative programs for energy efficiency, sustainability and climate change." While the pilot project experienced significant delays and barriers, its market potential resulted in the CPUC renewing the CEEPMS efforts through The Energy Network's 2013-2014 program cycle. The new CEEPMS product addresses the issues identified in the pilot program and is now able to work with a variety of low-cost, scalable, online permitting software packages. It also supports the CEC's AB 758 No Regrets Strategy 2.1.4: "Develop or adopt a statewide online permitting system for local building departments and contractors. Collaborate with manufacturers, distributors, and retailers to encourage contractor and consumer participation in the online permitting system and tools."[8]

Solution 3: Program Design

Finally, The Energy Network is leveraging UCLA's analysis and the infrastructure and standardization efforts described above in the design of its core programs. UCLA's analysis will support the adoption of to-code and/or above-code retrofits; this creates opportunities for city-

[7] http://energycoalition.org/cepms-cities-of-santa-monica-and-brea/

[8] Slide 58: http://www.energy.ca.gov/ab758/documents/2013-06_workshops/presentations/2013-06-25_AB758_Workshop_Fresno.pdf <<A little more info in this citation would be helpful – tell the reader who was presenting, on what, and where so they'll want to check it out>>

specific programs for meeting local Climate Action Plan objectives, yielding measurable progress toward California's AB 32 goals. EM&V impacts could be tracked from the ground up instead of top down or middle out. Local governments will be able to play a larger role in program implementation, managing variable incentives appropriate for their specific city. Through the adoption of BEDES, cities can verify compliance and manage processes for permits and rebates simultaneously.

Discussion and Conclusion

Fast forward five or ten years and imagine looking for a new job because the energy efficiency industry accomplished its vision. All new construction is net zero, retrofits are all zero energy capable, permit and code compliance are nearly 100%, unemployment decline is attributed to retrofits, and distributed generation have all contributed to meeting energy security and climate mitigation and adaptation goals. This would take considerable coordination across numerous stakeholders. Auditors, specialty contractors, local governments, property owners and investors would all need to seamlessly hand-off information about energy savings projects to encourage cost-effective, high-penetration implementation of energy savings. With this in mind, The Energy Network is building on DOE pilot programs to address barriers to data access, streamline the exchange of energy and asset information, and enable interoperability across the data lifecycle—from benchmarking to audit to permit to incentive. All of these elements combined will allow The Energy Network to advance policy and create programs that take local conditions into account.