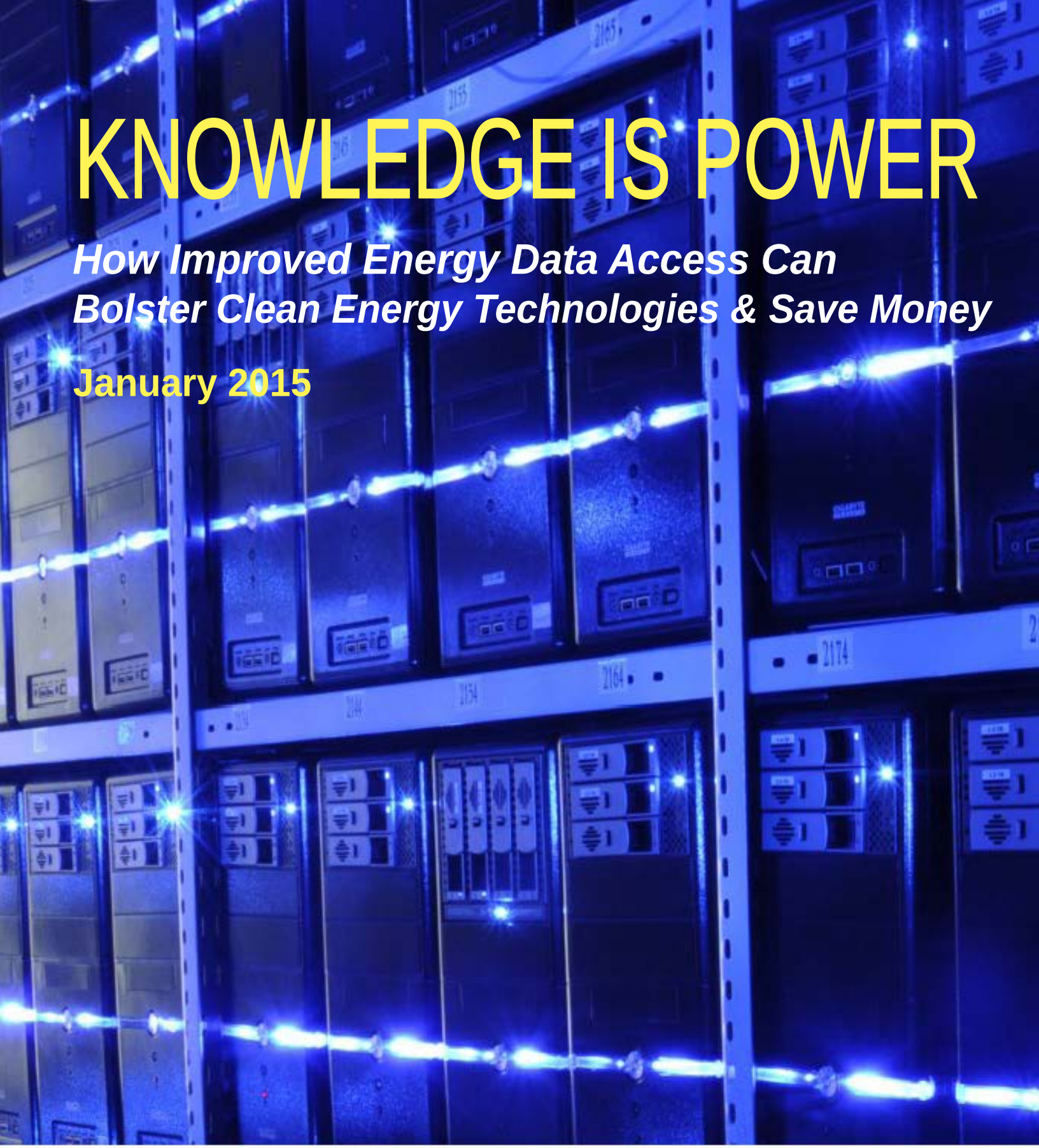

KNOWLEDGE IS POWER

How Improved Energy Data Access Can Bolster Clean Energy Technologies & Save Money

January 2015

Bank of America

BerkeleyLaw
UNIVERSITY OF CALIFORNIA
Center for Law, Energy & the Environment

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About this Report

This policy paper is the fourteenth in a series of reports on how climate change will create opportunities for specific sectors of the business community and how policy-makers can facilitate those opportunities. Each paper results from one-day workshop convenings that include representatives from key business, academic, and policy sectors of the targeted industries. The convenings and resulting policy papers are sponsored by Bank of America and produced by a partnership of the UC Berkeley School of Law's Center for Law, Energy & the Environment and UCLA School of Law's Emmett Institute on Climate Change and the Environment.

Authorship

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Glossary of Terms

Advanced Metering Infrastructure (AMI): Commonly referred to as a "smart meter," an electronic device that records consumption of electric energy, as well as other customer-level electrical parameters (such as voltage and current), in specific intervals and communicates that information to the utility for monitoring and billing purposes.

Application Programming Interface (API): A description that specifies a software component in terms of its operations, inputs and outputs, and underlying types.

Business Process Management (BPM): A field in operations management that focuses on improving corporate performance by managing and optimizing a company's business processes.

California Air Resources Board (CARB): An organization within the California Environmental Protection Agency responsible for providing and maintaining clean air, including enforcement of the state's greenhouse gas reduction law.

California End Use Survey (CEUS): a comprehensive study by the California Energy Commission of commercial sector energy use, primarily designed to support the state's energy demand forecasting activities.

California Energy Commission (CEC): An agency that reviews requests to build thermal power plants of 50 megawatts or more in capacity, and which otherwise focuses on energy policy and planning for California.

California Global Warming Solutions Act of 2006 (AB 32): California state law which sets out the greenhouse gas emissions reduction goal to be achieved by 2020.

California Public Utilities Commission (CPUC): California's agency in charge of regulating investor-owned utilities.

California Independent Systems Operator (CAISO): An independent, non-profit grid operator responsible for maintaining the reliability and accessibility of California's power grid.

Commercial Buildings Energy Consumption Survey (CBECS): A national sample survey that collects information on the stock of U.S. commercial buildings, including their energy-related building characteristics and energy usage data (consumption and expenditures).

Electric Vehicles (EV): Either fully-electric or partial battery electric plug-in vehicles with rechargeable batteries and either no or limited gasoline engine.

Energy Service Companies (ESCO): A commercial or non-profit business providing a broad range of energy solutions, including design and implementation of energy savings projects, retrofitting, energy conservation, energy infrastructure outsourcing, power generation and energy supply, and risk management.

Extensible Markup Language (XML): A markup language that defines a set of rules for encoding documents in a format which is both human-readable and machine-readable.

Federal Regulatory Energy Commission (FERC): An independent federal agency that regulates the interstate transmission of natural gas, oil, and electricity, as well as natural gas and hydropower projects.

Geographic Information System (GIS): A computer system designed to capture, store, manipulate, analyze, manage, and present all types of spatial or geographical data.

Investor-Owned Utilities (IOU): A privately owned electric company that in California is regulated by the CPUC.

Locational Marginal Pricing (LMP): A computational model for locational energy and transmission congestion prices to allow a bid-based, optimal asset dispatch of resources, managed load, and other services.

Megawatts (MW): A unit of power that is equivalent to one million watts, generally considered as able to provide sufficient power in any given moment to serve approximately 750 households.

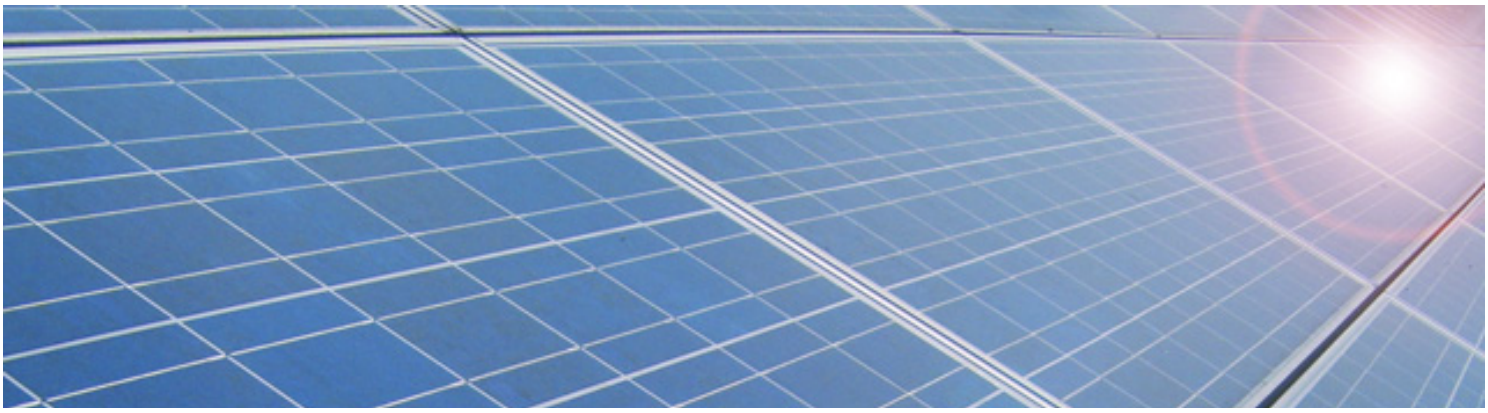
Municipal Utility: A political entity, such as a city or county government, that provides utility-related services such as electricity, water, and sewage.

Personally Identifiable Information (PII): Information that can be used on its own or with other information to identify, contact, or locate a single person, or to identify an individual in context.

Renewable Portfolio Standards (RPS): Legal requirements that a specific percentage of retail electrical power for California comes from eligible renewable energy resources.

Revenue Quality Meter Data (RQMD): Meter data meeting the standards and requirements established and maintained by the California ISO.

Western Electricity Coordinating Council (WECC): a non-profit corporation that works to assure a reliable grid network in 14 western states, 2 Canadian provinces, and northern Baja Mexico – a geographic area known as the Western Interconnection.



Introduction and Summary: A Vision for Clean Technology Energy Data

Every day, California's residents, electric utilities, government agencies, and ratepayers generate and collect energy and market data. The data can range from electricity and natural gas usage to solar panel purchases to grid infrastructure needs. New software and hardware technologies can now anonymize, aggregate, and make accessible much of the data, without compromising customer privacy.

The data could be immensely useful to a variety of audiences, including customers, policy makers, and public interest organizations, to realize both economic and environmental benefits. For example, customers could use the energy data to save money through targeted energy efficiency measures in their homes and businesses. Once customers have easier access to their energy usage patterns, as well as their real-time utility rate structures, they can work with energy efficiency companies to better evaluate efficiency investments and select the most cost-effective ones. Policy makers could use the information to target efficiency incentives to the neighborhoods or customer groups that would make the most cost-effective use of limited public funds. Public interest groups could harness data on system-wide energy usage to advocate for improved policies that help both ratepayers and the environment.

Clean technology businesses could also use the information to improve operations and increase customer benefits. Energy storage developers and other companies can use energy data access to help specific customers or customer groups reduce their energy usage at times of high demand across the system, leading to customer savings, decreased strain on the grid, and less need to build expensive power plants to meet peak demand. Electric vehicle automakers can more easily help customers determine the optimal vehicle charging time based on rate structures and price signals from the grid, thereby saving money on fuel costs. And renewable energy companies and other clean technology purveyors can identify optimal areas of the electric grid for deployment, in order to save utilities and ratepayers money.

Ultimately, expanding access to energy data can bring cleaner, more efficient power to Californians and help them save money. It could also boost emerging clean technologies, such as renewable energy, energy storage, electric vehicles, demand response, and energy efficiency measures, which will help the state meet its environmental goals in a more cost-effective manner. And all ratepayers could save money as improved energy efficiency decreases the need for new investments in polluting power plants.

But accessing and organizing the data takes time, money, and often utility resources to participate. In addition, any data disclosures must include careful procedures to protect customer privacy and security, per California law.

To develop a vision for policies that make energy data more accessible and secure, clean technology leaders and public officials gathered at the University of California, Berkeley School of Law in July 2014 for a discussion sponsored by Berkeley Law and the University of California, Los Angeles School of Law. They included representatives of companies that develop and market hardware and software solutions to improve the distribution and transmission electric power grid, as well as renewable energy, energy storage, demand response, and energy efficiency business leaders.

The group envisioned expanded energy data access for both customers and clean technology vendors, with select types of data housed at independent, secure data centers. Energy data would be bifurcated into two categories: utility-centered and customer-centered data.

They identified the following types of utility-centered data as most useful:

1. **Distribution infrastructure data,** particularly data pertaining to distribution feeder characteristics and how the utility values resources that provide renewable generation, load management, and other grid services.

2. **Transmission infrastructure data,** including from utilities, regulatory agencies, and grid operators, to identify infrastructure and resource management needs on the network.

3. **Aggregated consumer behavior data,** including real-time information on thermostat adjustments and devices in the home, to improve the implementation of ratepayer-funded efficiency programs.

4. **Aggregated customer energy data,** including data from multiple customers in key geographic or customer-type areas to help target energy efficiency policies and customer acquisition and service efforts.

"We are seeing what you can do with data, and we want to go to an even higher level, and that is taking the data from utilities and helping us further develop more rifle shot programs, including for energy efficiency and demand response. The data and the help of researchers will help us pinpoint how best to reduce the impacts of climate change."

-- Michael Peevey
California Public Utilities Commission (formerly)

They identified the following customer-centered data as most useful:

1. **Utility meter data,** available in such formats as Green Button to customers or third-party designees, ideally at intervals of 15-minute or hourly levels going back 13 months or more, to allow clean technology companies to verify energy savings after an efficiency measure has been completed.

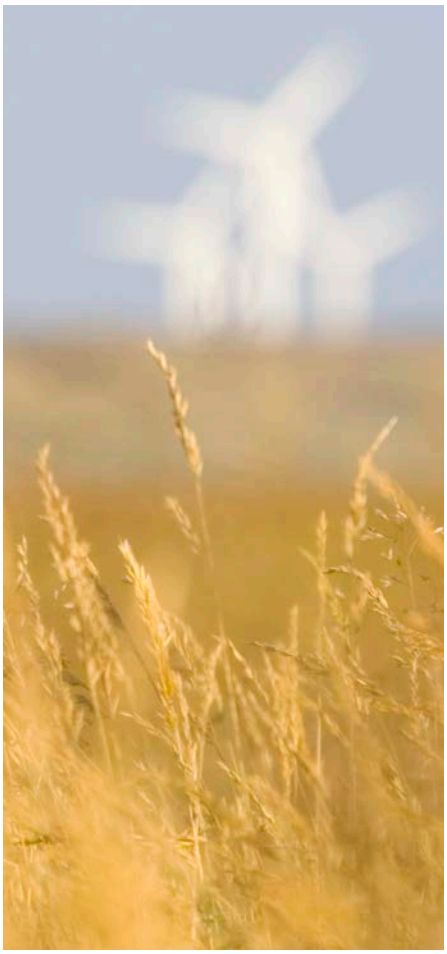
2. **Historic energy audit data** from California's commercial building stock, generated by auditors, energy service companies, and others who have assessed the on-site assets of each building and its energy efficiency potential but otherwise have not made that information easily available.

3. **"Internet of Things" data** from internet-enabled home devices, such as high-tech "smart" thermostats and appliances, which can help a customer to manage energy usage based on real-time patterns, energy pricing, and needs.

4. **Utility tariff data,** which separate a customer's charges for electricity or natural gas into fixed charges, variable charges, and taxes, in a computer-readable format to allow customers and third parties to access and analyze costs and benefits for various energy efficiency, renewable energy, energy storage, and other measures without the cost of manually decrypting the tariffs.

5. **Energy efficiency policy data** that track California's robust programs to encourage homeowners and businesses to undertake energy efficiency upgrades to save money, in order to determine measure-based savings based on efficiency projects "as proposed."

6. **Customer segmentation for each utility across usage and climate zones,** reported on annually, to inform third parties about market opportunities and to lower customer acquisition costs for all sectors.



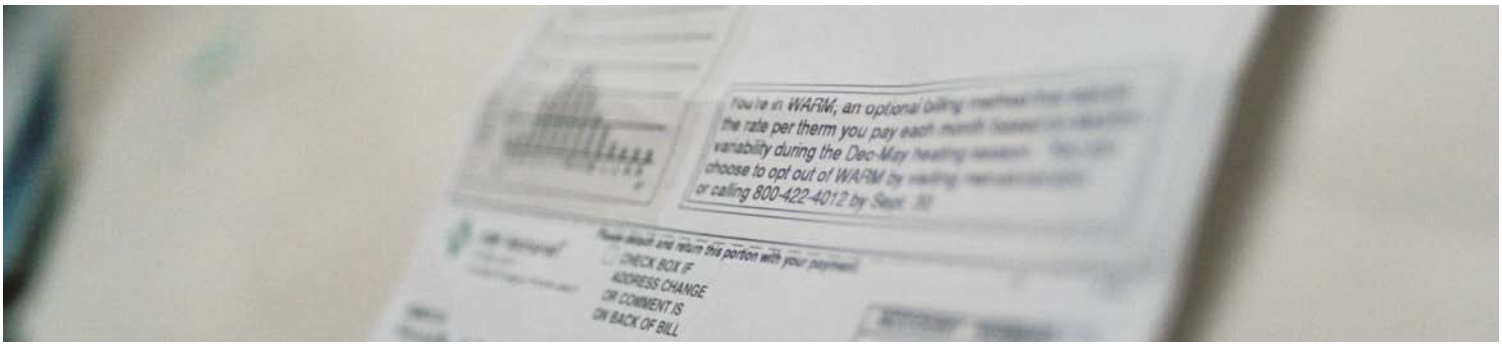
4 Key Barriers to Accessing Energy Data

1) Lack of incentives for utilities to collect and share data;
2) Lack of funding for aggregating and making that data accessible;
3) Concerns about compromising customer privacy; and
4) Fear of cybersecurity breaches.

Solutions to Overcome the Barriers

- Cost recovery mechanisms for utilities to collect and share anonymized energy and market data to researchers and the private sector
- Funding, development, and maintenance of secure energy data centers
- Creation of an ad hoc "tariff tech group" to develop a tariff engine that models costs and "what if" scenarios
- Requirement to disclose historic building energy audits
- Establishment of customers' right to improved access to their usage data through an easily organized, standardized format

The following section discusses these data needs and solutions in more depth and contains an overview of energy data and its potential value for reducing pollution, saving ratepayer money, and bolstering the clean technology sector.



The Economic and Environmental Benefits of Improved Energy Data Access

Energy Data Can Help Save Californians Money and Generate Economic Activity

Energy Data Can Help Customers Save Money through Greater Efficiency

Enhanced access to a customer's interval meter data (with readings made at regular intervals throughout each day) has the potential to save Californians money through more efficient energy consumption. Many of California's existing homes and businesses waste energy in preventable ways, such as through poorly insulated walls, air leaks in the building structure, inefficient heating and cooling systems, and outdated lighting technology. Yet building owners are often unaware of the inefficiencies. Energy data can help customers address these inefficiencies by providing insight into their usage patterns. Using these numbers, customers can work with energy efficiency businesses to identify the specific measures that may provide the most value for the least cost.

Improved data access could save California's electric utilities money by helping them to identify the most cost-effective technologies to improve existing grid assets.

These efficiency measures can bring significant savings on energy bills. The California Air Resources Board estimates that household savings from these energy upgrades, even with potential increases in energy rates, could be as much as $1,000 annually.[1] At the same time, third-party energy efficiency businesses can use improved data access to identify new customers with the greatest energy efficiency potential and to deliver better results for existing customers. According to a McKinsey & Company study, even under conservative assumptions, retrofitting existing buildings represents one of the most economical means of reducing pollution, because many efficiency measures save building owners money over a full lifecycle.[2]

Expanded Utility Data Can Lead To Cost-Effective Grid Improvements

Improved data access could save California's electric utilities money by helping them to identify the most cost-effective technologies to improve existing grid assets. New grid management technologies and optimally located resources, such as energy storage and renewable energy facilities, could help ensure better performance from assets and improve reliability. The data can also help utilities avoid unnecessary or wasteful investments in the distribution system.

Energy efficiency and "smart grid" companies can also use the energy data to help utility customers adapt their usage patterns to grid needs, such as reducing demand during periods of high stress on the grid. Referred to as "demand response," customers can employ efficiency technologies to ensure that they limit or postpone their energy usage from times of expensive rates to less-costly, off-peak times. Not only can the customers save money, but grid operators and utilities can use generating assets more efficiently, reducing pollution from dirty peak power plants and leading to savings that could be passed on to ratepayers.

Improved Energy and Market Data Access Can Boost the Economy

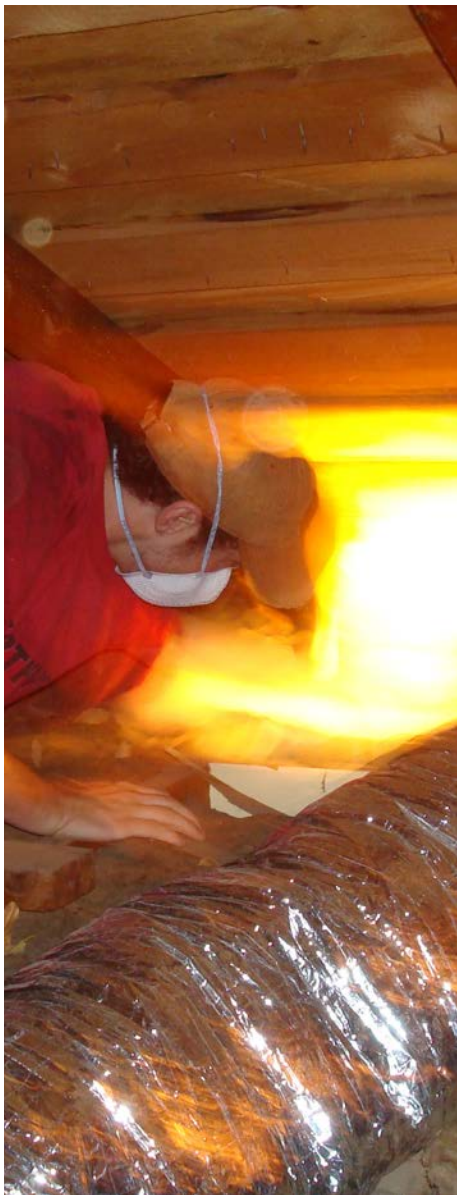
Customer and utility savings from improved access to energy data could help spur economic growth. As discussed, better access to customer energy data could result in energy efficiency improvements, which would grow the construction workforce. These "green jobs" are among the fastest-growing in the economy. According to data cited by the California Air Resources Board, California residents opened more green businesses (10,209) and created more new jobs (125,390) between 1998 and 2007 than any other state in the nation. Green jobs could account for roughly 10 percent of new jobs over the next 20 years, for a total of 4.2 million nationwide and 500,000 in California alone.[3]

In addition, according to the Rockefeller Foundation, investments in residential, commercial, and institutional energy efficiency market segments could yield more than $1 trillion in energy savings over 10 years, with more than 3.3 million cumulative job years of employment created from maximum uptake of retrofits.[4] These savings would promise a strong multiplier effect for the economy, as customers usually spend the saved money from reduced utility bills on household goods and services that involve more labor than developing fossil fuels.[5]

Other clean technology businesses could benefit from better data access, such as renewable energy developers, energy storage manufacturers, smart grid companies, electric vehicle automakers, and demand response providers. For example, data regarding rooftop solar exposure and prevalence; customer-segmented usage and bill values across income levels, climate zones, and building types; transportation expenses; and electric vehicle charging patterns would help many of these businesses better target incentives and marketing efforts to the customers most likely to save money by adopting these technologies. The success of these companies can ultimately save Californians money, such as when electric vehicle automakers save their drivers fuel costs with the cheaper price of electricity per mile compared to gasoline per mile (between one-half to one-quarter the price) and reduced maintenance costs.[6] These types of clean technology purchases can reduce energy costs for residents over the long term.

Energy Data Access Can Lead to More Cost-Effective Public Policies

Policymakers have developed a host of incentives to encourage Californians to invest in clean technologies, such as rebates for energy efficiency upgrades and renewable energy, electric vehicle and energy storage purchases. However, they often lack data about where the greatest needs and opportunities are among the state's residents. For example, neighborhoods with older buildings and more extreme weather might benefit the most from increased incentives for energy efficiency measures. Other neighborhoods may have excess electricity generating capacity and commuting patterns that would make them well-suited for electric vehicle incentives, to create more optimal demand for electricity for the vehicles. Meanwhile, electricity rates and high solar exposure in other areas, coupled with a strained distribution grid, could make solar panels or energy storage investments particularly beneficial. As a result, improved data access could make government incentives more targeted and effective and help public interest groups identify and advocate for policies to improve them. Furthermore, prospering clean technology companies that deliver energy efficiency or demand response to customers without incentives can help California achieve state policy goals without public investments.



Improved Energy Data Accessibility Can Benefit the Environment

Expanded access to key energy data has the potential to bring significant environmental benefits. These benefits include reduced power plant pollution from better energy efficiency, reduced pollution from cars and trucks from greater electric vehicle adoption, and a decarbonized electricity supply from more renewable energy, balanced by resources such as energy storage, demand response, and smart grid technologies that can help manage system load without increasing emissions.

All of these activities and technologies can reduce the greenhouse gas emissions that cause climate change, as well as other harmful pollutants. Without this private sector progress, the state would not be able to meet its goals under the California Global Warming Solutions Act of 2006 (AB 32) to roll back greenhouse gas emissions to 1990 levels by the year 2020 (equivalent to a 15 percent cutback from the business-as-usual scenario projected for 2020).[7] Former California Governor Arnold Schwarzenegger's Executive Order S-3-05 additionally calls for an eighty percent reduction from 1990 levels by 2050.[8]

The clean technology sectors that would be boosted by improved energy data access could help reduce emissions in the state's electricity and transportation sectors, which represent the largest sources of statewide greenhouse gas emissions (contributing roughly 58 percent combined in 2012, see Figure 1).[9] Private sector deployment of energy data-assisted technologies is necessary to help California switch from fossil fuel-based energy to integrated renewable sources and electrified transportation and achieve its climate change goals.

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Energy Data Can Enhance Energy Efficiency to Reduce Air Pollution

Because expanded energy data access can lead to improved energy efficiency, it can reduce pollution from power plants. The best evidence for this environmental benefit comes from California's 1978 mandatory energy efficiency standards for new buildings, now known as "Title 24,"[10] along with utility-sponsored energy efficiency programs and appliance efficiency standards. Due to these programs, the state has led the nation in energy efficiency and savings for building owners. While per capita electricity consumption nationwide has increased almost 50 percent since the mid-1970s, California's per capita electricity consumption has been relatively flat.[11] As a result, according to the California

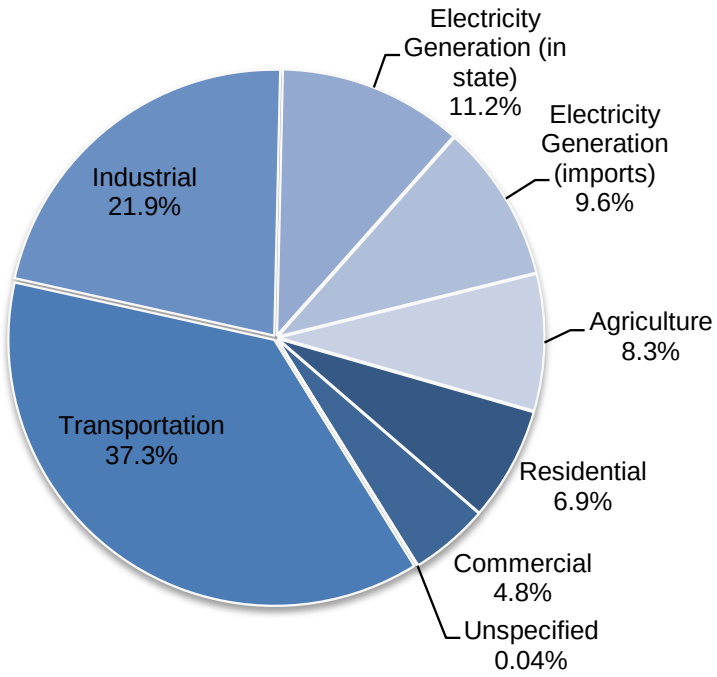


Figure 1. California's Greenhouse Gas Emissions by Sector (2012)

Source: California Air Resources Board

Energy Commission, California's building and appliance standards have averted the construction of 15 large power plants[12] and their attendant pollution (the standards have also saved consumers more than $74 billion in electricity and natural gas costs since 1977[13]).

California will need more efficiency upgrades to continue this trajectory and meet greenhouse gas goals, which better energy data access could help enable. Because 75 percent of the existing housing stock and 5.25 billion square feet of commercial space was built before Title 24, these buildings represent a greater portion of the demand. For example, the energy requirements for space heating, cooling, and water heating in buildings constructed during the 1970s (pre-Title 24) use more than double the energy permitted for comparable systems in houses built in 2005.[14] As a result, the California Air Resources Board, the agency responsible for implementing AB 32, stated in its scoping plan that "expanding and strengthening existing energy efficiency programs as well as building and appliance standards" are key elements of the overall strategy to reduce statewide greenhouse gas emissions.[15]

Reducing energy use from inefficient buildings through improved energy data access could be particularly important as California's anticipated population growth places additional strains on the state's energy infrastructure and ability to meet its greenhouse gas and other air pollution reduction goals. Currently, nearly 70 percent of the state's population lives along the coast. But some predictions indicate that inland areas, including the San Joaquin Valley, the Inland Empire in Southern California, and the Sacramento area, will house nearly 40 percent of the state's population – more than 20 million people – by 2040. Population growth in hotter inland areas will change the pattern of energy use, as the hot summers will generate more peak demand for air conditioners.[16] As a result, energy use will probably continue to outpace existing energy efficiency measures. Overall, without greater efficiency measures, the California Energy Commission projects electricity use in the state to increase 1.2 percent annually with peak demand growing at a rate of 1.3 percent per year.[17] Expanded energy data access to enable efficiency measures will therefore be crucial for meeting state environmental goals.

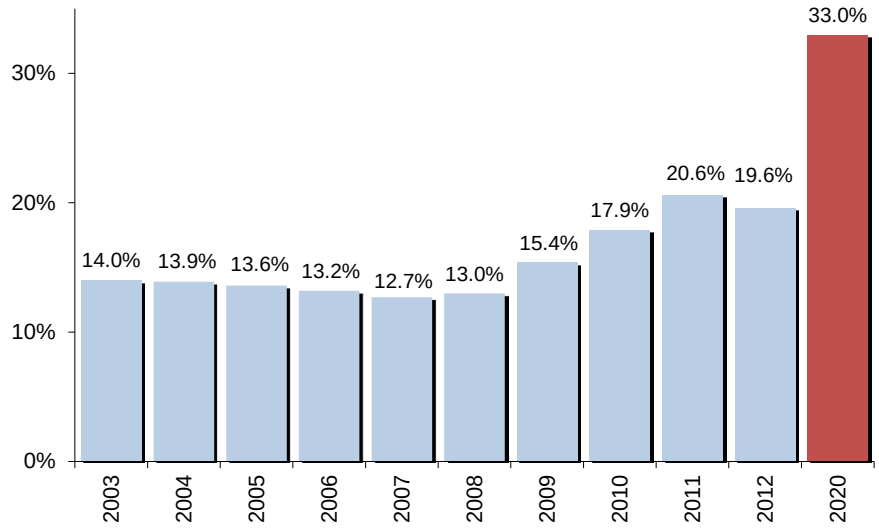


Figure 2. California's RPS Progress

Source: California Public Utilities Commission

Energy Data Can Help Decarbonize the Electricity Grid through Better Siting of Renewables and Energy Storage

Better energy data access can help decarbonize the electricity grid by facilitating optimal deployment of renewable energy and energy storage resources, among other clean technologies. California is making significant progress requiring and deploying renewable energy, although not necessarily in the most optimal locations. Governor Jerry Brown significantly expanded the state's renewable portfolio standards (RPS) program[18] in 2011 by signing Senate Bill X1-2 (Simitian, 2011), which broadened the program's scope to include all utilities (including municipal) and increased the renewables target to 33 percent by December 31, 2020.[19] And in 2013, the governor signed AB 327 (Perea), which authorizes the California Public Utilities Commission to increase the renewable procurement beyond the 33 percent ceiling and its interim targets, if necessary.[20]

California is on course to meet both its intermediate and 2020 renewables targets (see Figure 2). Between 2003 and 2013, the state's utilities deployed 7,267 megawatts of new renewable generation in commercial operation, including 2,769 megawatts in 2013 alone. The California Public Utilities Commission forecasted that the renewable portfolio standards program would generate 2,721 megawatts of new renewable capacity in 2014.[21]

Better energy data access can help decarbonize the electricity grid by facilitating optimal deployment of renewable energy and energy storage resources, among other clean technologies.

However, many of these generating assets may be located in suboptimal sites along the grid. Renewable energy developers will therefore need access to grid and customer data detailing electricity capacity and usage in order to site these resources most optimally.

In addition, integrating this surge in variable renewable energy will require several management technologies and practices, including well-situated energy storage assets

Storage Grid Domain (Point of Interconnection)	**2014**	**2016**	**2018**	**2020**	**Total**
Southern California Edison					
Transmission	50	65	85	110	310
Distribution	30	40	50	65	185
Customer	10	15	25	35	85
Subtotal SCE	**90**	**120**	**160**	**210**	**580**
Pacific Gas and Electric					
Transmission	50	65	85	110	310
Distribution	30	40	50	65	185
Customer	10	15	25	35	85
Subtotal PG&E	**90**	**120**	**160**	**210**	**580**
San Diego Gas & Electric					
Transmission	10	15	22	33	80
Distribution	7	10	15	23	55
Customer	3	5	8	14	30
Subtotal SDG&E	**20**	**30**	**45**	**70**	**165**
Total - all 3 utilities	**200**	**270**	**365**	**490**	**1,325**

Figure 3. California's Energy Storage Procurement Targets

Source: California Public Utilities Commission

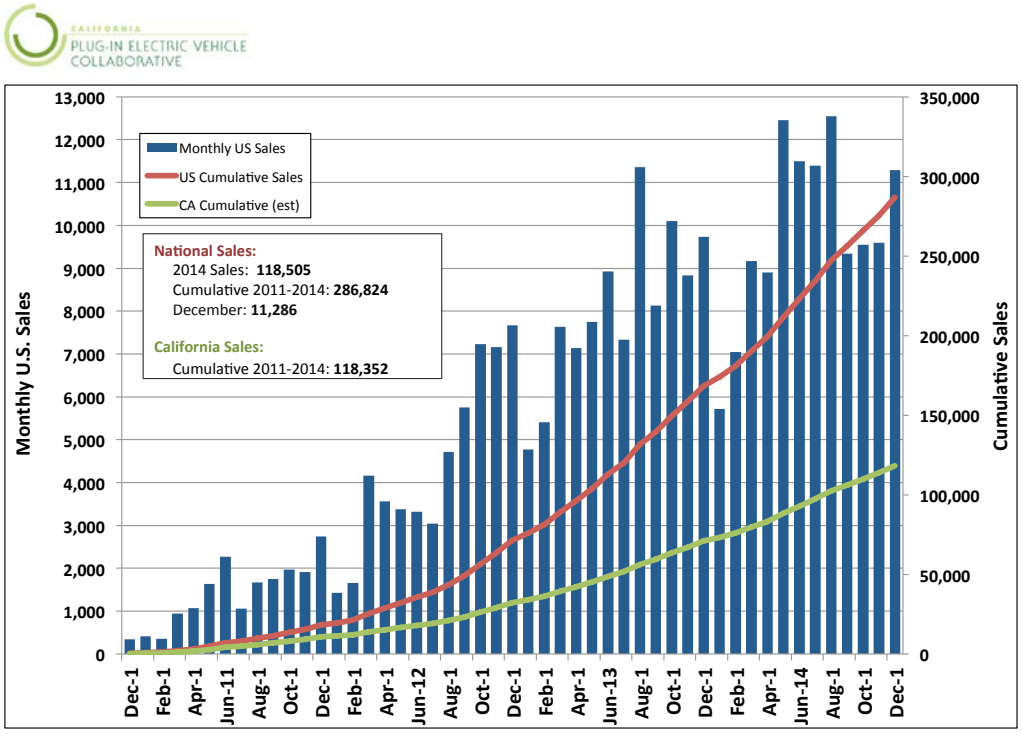
that can capture surplus renewables for dispatch during times of peak demand, demand response (discussed previously), and an integrated renewables network across the western region.

Electric utilities are now in the market for these technologies, particularly energy storage. AB 2514 (Skinner, 2010), the nation's first state law calling for grid-scale energy storage, required the California Public Utilities Commission to determine procurement targets, if any, for "viable and cost-effective" energy storage systems to be achieved by 2015 and 2020 for investor-owned utilities and by 2016 and 2021 for municipal utilities.[22] On October 17, 2013, the California Public Utilities Commission approved Decision 13-10-040 adopting mandatory energy storage procurement targets for California's three largest investor-owned utilities of 1,325 megawatts by 2020, as well as for the state's retail electric service providers and community choice aggregators (see Figure 3).[23] Given state policies on energy storage, access to energy data for optimal deployment will become even more critical to cost-effective adoption of these technologies.

Energy Data Can Increase Electric Vehicle Adoption to Reduce Pollution

Increased access to energy data could also encourage greater adoption of electric vehicles and improved deployment of the charging infrastructure necessary to support the vehicles. With better data access, automakers could potentially market their products more efficiently, and charging infrastructure providers could better locate their equipment for optimal benefit to the consumer and utilities (see recent sales figures in Figure 4).

More electric vehicle investment from these measures could dramatically improve California's environment. The vehicles reduce air pollution, saving lives and significant health care costs.



Note: Approximation assumes CA sales are 40% of national sales.
Reference: www.hybridcars.com

1/7/2015

Figure 4. California's Electric Car Sales

Source: California Plug-In Electric Vehicle Collaborative

California Public Utilities Commission Decision on Data Disclosure

On May 1, 2014, the California Public Utilities Commission approved Decision 14-05-016 requiring utilities to provide access to certain energy usage and usage-related data (such as billing data, program participation data, and account information) to local government entities, researchers, and state and federal agencies. The decision provides access to data that can help advance energy policies related to energy efficiency, energy conservation, demand response, and grid reliability, while examining specific data requests (called "use cases") to identify data that should be released for the public interest.

The conditions of access vary by recipient:

- For the University of California and other non-profit educational institutions, certain covered information, including personal information, may be accessed for research purposes, provided that the institutions conform to the data request procedures outlined in the decision and sign a non-disclosure agreement.
- For local governments, utilities must provide annual, quarterly and monthly usage and usage-related data where the data request meets certain requirements, in particular with respect to aggregation and anonymization.
- For federal and state government entities, utilities must provide energy data as requested to fulfill these entities' statutory obligations. This includes data requested by the California Department of Community Services and Development to meet its statutory obligations under the Low Income Home Energy Assistance Program.
- For any of the above parties, access is generally allowed if requested pursuant to a statutory obligation.

Any disclosed data must be sufficiently aggregated and anonymized and exclude personally identifiable information, such that an individual customer cannot be re-identified.

The decision also requires utilities to disclose certain energy data that is of interest to the public and sufficiently aggregated without requiring a non-disclosure agreement. Specifically, utilities must disclose, on a quarterly basis: (i) the total monthly sum and average of customer electricity and natural gas usage by zip code and customer class (residential, commercial, industrial or agricultural), and (ii) the number of individual customers in the zip code by customer class.

Pursuant to the decision, any disclosure of data must comply with privacy and data protection requirements under the California Public Utilities Commission Code and California law. In particular, subject to certain exceptions, any disclosed data must be sufficiently aggregated and anonymized and exclude personally identifiable information ("PII"), such that an individual customer cannot be re-identified. The transfer of data that includes PII or that can, in combination with other available data, be linked to a particular customer requires the consent of the customer.

In addition, the decision outlines specific procedures, in particular how different entities must request data, how utilities must respond to such requests, and how disputes must be resolved. Among other things, it requires the formation of an "Energy Data Access Committee" to advise utilities on process improvements and best practices (including for the review of aggregation standards) and to help resolve disputes that may arise between utilities and data requesters.

UCLA Pilot Study on Energy Data

Preceding the energy data decision at the California Public Utilities Commission, the energy data study of the California Center for Sustainable Communities at UCLA built on various data sets (including on energy consumption, socio-demographics, climate, building characteristics, embedded energy, solar resources), GIS mapping and statistical analysis to help inform energy efficiency, renewable energy and climate change policies and planning. In particular, the study aimed to use these data to improve the evaluation and targeting of existing energy policies and programs, the structuring of energy rates, and the identification of future climate issues, while also contributing to increasing public awareness regarding energy consumption.

To that end, the study assembles and connects various information sets for energy policymakers and planners, including, for example, on the drivers of energy, the energy profiles of buildings, the reliability of forecasts, and the accuracy of greenhouse gas emissions mapping. To date, the study has notably enabled the creation of (i) sample energy consumption use statistics and (ii) an interactive map of electricity use in Los Angeles, displaying monthly energy consumption in kilowatt hours at the census block group level between January 2011 and June 2012.[26] The study authors are in the process of complementing the research with additional data (e.g. natural gas data, solar resources) and analyses, such as to assess climate vulnerability.

"Another important user of data is government – the work [at UCLA] is creating an incredible resource for local governments and state agencies, which otherwise might lack the technical and financial resources to do that kind of data analytics."

-- Louise Bedsworth
Governor's Office of Planning and Research

In addition, they can help reduce greenhouse gas emissions significantly, as the state's transportation sector accounted for over 37 percent emissions in 2012, making it the single largest source, compared to 33 percent nationwide (see Figure 1).[24]

Electric vehicle deployment also promises to help California achieve its renewable energy generation goals. Energy and electricity tariff data platforms could enable electric vehicles to charge when it would be most beneficial to the grid, such as during times of surplus solar and wind generation. A report from the ISO/RTO Council found that if plugged in simultaneously, the estimated one million electric vehicles expected to be deployed over the next decade could have staggered car-charging times by eight- or twelve-hour periods, which would enable grid operators to use the batteries as distributed and aggregated demand response assets.[25] Electric vehicle purchases also stimulate research and breakthroughs in battery technology, which benefit grid-scale battery deployment. Overall, improved access to energy data would enable these purchases and uses by helping electric vehicle automakers and suppliers with customer acquisition efforts and siting decisions, as well as demand response charging technologies.

Progress to Date on Improved Energy Data Access

California has already taken significant steps to improve energy data access. The California Public Utilities Commission, which regulates investor-owned electric utilities, recently issued a landmark decision mandating energy data disclosure in certain instances and for specific parties (see accompanying summary). The decision requires utility disclosure of energy data by parties such as public sector entities and research universities. However, any customer data released must be sufficiently anonymized to avoid revealing personal data or enabling third parties to link customers with the data. The next phase of the proceeding may provide funding for the data acquisition effort and expand its scope. In addition, researchers at UCLA successfully launched a pilot energy data disclosure program using utility data from the Los Angeles Department of Water and Power (see additional accompanying summary). This decision-making and pilot project could form a basis for further progress to boost the clean technology sector.

California's Constitutional and Statutory Privacy Provisions Regarding Energy Data

Any policy to expand access to energy data must comply with various constitutional and statutory privacy provisions that limit California utilities' roles in releasing the data. First, the California Constitution provides each citizen with an "inalienable right" to pursue and obtain privacy.[27] Second, the California Civil Code requires utilities to secure a customer's express consent prior to sharing usage data with any third party.[28] Utilities must disclose to whom the disclosure will be made and how the data will be used. The Civil Code also requires businesses to maintain reasonable security procedures to protect the data from unauthorized access, destruction, use, modification, or disclosure.[29] Third, the California Public Utilities Code provides that customer information must remain confidential unless the customer consents in writing.[30] The Utilities Code also extends privacy protections to consumption data that is part of an advanced metering infrastructure or smart grid.[31]

"There are a lot of middle men who are stepping in to navigate the data. The question is: is this the right process, or should we have more direct data connections?"

-- Curtis Seymour SunEdison (formerly)

The level of protection varies depending on the purpose of the disclosure. For utilities using customer aggregate data for analysis, reporting or program management, they must remove all personally identifiable information.[32] For the disclosure of customer data to third parties, utilities must contractually require such third parties to maintain reasonable security procedures to protect the data from unauthorized access, destruction, use, modification, or disclosure.[33]

Within these constraints, the California Public Utilities Commission maintains significant authority to require the disclosure of anonymized energy data. Utilities may disclose data as required or permitted by law or an order of the Commission. Decision 11-07-056 was adopted pursuant to SB 1476 (Padilla, 2010) and sets out a comprehensive set of privacy rules covering disclosure of information by utilities.[34] It allows utilities to disclose customer information for "primary purposes" (i.e., for system, grid, or operational needs, or the implementation of demand response, energy management, or energy efficiency programs) without customer consent. However, they must obtain customer consent for any other purpose.[35] Any efforts to require energy data disclosure must therefore comply with these provisions. Furthermore, third parties who receive energy data from the utility at the direction of the customer are obligated to notify customers about how they will use their data and are prohibited from using the data for "secondary" purposes without informed consent.

Utility-Centered Data Needs and Recommendations

Participants at the convening at Berkeley Law wanted to gain access to specific types of energy data to plan, develop, and market their clean technology products and services. They described a number of data needs that would help illuminate where these companies could offer products and services they believe can make the grid more efficient and reliable, provide monetary benefits and savings for clean technology companies, and reduce energy use and pollution. They identified data needed at the utility level (described here as "utility-centered" data) that involves the physical infrastructure and operation of the electricity grid, at both the distribution and transmission levels. ("Customer-centered" data is discussed in the next section.)

Utility-centered data refers to data on the distribution and transmission grid, generally consisting of a high-voltage transmission system linking dispersed geographical areas and resources and a distribution system to deliver power to customers. The assets in these systems include wires, transformers, switches, and voltage regulators, among other technologies.

California and other states have made major commitments to improving this grid infrastructure in order to increase renewable energy resource integration, overall grid efficiency, reliability, and security, and to meet environmental goals. To help utilities meet these objectives, third-party clean technology leaders may need access to detailed information about electric resources, customer loads, customer usage, and specific grid assets for any given targeted grid region, particularly on the distribution side (relatively more information has historically been available regarding transmission grid resources). However, these distribution grid data are not made available, potentially hampering energy and utility policymakers, regulators, and stakeholders from understanding current distribution system conditions and potential performance improvement measures.

Key Types of Utility-Centered Data

1. **Distribution infrastructure data** from sources including utilities, the California Public Utilities Commission, customers, renewable energy developers, and independent power producers. The data could help third-party clean technology companies save utilities money and resources by making the grid more efficient, more reliable, and better able to integrate variable distributed renewable energy resources, such as rooftop solar, distributed energy storage to support variable resources, and demand response technologies to reduce system peak loads.

   Specifically, participants wanted data pertaining to real-time distribution feeder parameters, as well as how utilities value distributed energy resources related to generation, load management, and services. With access to such information, perhaps through the establishment of a distribution grid market analogous

to existing transmission grid resource markets, participants believed their products and services could help save the utilities and ratepayers the most amount of money. These products and services could realize the savings by potentially reducing either demand or the need for generating resources at key grid locations during certain times of day and by minimizing or avoiding expensive marginal charges. With sufficient distribution-level data, a system of "locational marginal pricing" (LMP) might be developed for distribution grids as it is now in use for transmission grids. This system involves a computational model for locational energy and transmission congestion prices in order to allow a bid-based, optimal asset dispatch of resources, managed load, and other services. The intent of LMP is to determine the delivered energy price at a specific location by calculating and accounting for the relevant energy and transmission congestion prices.

The participants wished to gain access to such data in order to determine how best to integrate variable renewable energy and locate and dispatch energy storage, demand response, and grid monitoring equipment assets, as well as to save money by obviating the need for them to accumulate and analyze the data on their own. The deployment of these technologies would ultimately contribute to grid efficiency and reliability and reduced costs by averting investment in inefficient generation or unneeded capital expansion. Furthermore, these technologies could reduce fossil fuel use and air pollution.

2. **Transmission infrastructure data,** including from sources such as utilities, the California Independent System Operator, California Public Utilities Commission, Western Electricity Coordinating Council, and Federal Energy Regulatory Commission. The data would help third parties identify infrastructure and resource management needs on the transmission network. As more utility-scale renewable facilities come on-line or are proposed, energy storage developers and other clean technology business leaders could use the data and evolving grid modeling and analysis software to identify optimal spots for technology deployment to support integration of more renewables and save costs by minimizing, deferring or avoiding the need for new capital expenditures. In addition, clean technology companies might be able to develop integrated transmission and distribution grid models and simulators, in order to improve understanding of the overall grid performance benefits of various strategic approaches and for design and operation of more accurate markets.

"Knowing where the transformers are that are being overloaded when you start plugging in EVs is very helpful. We make that data available, and private companies like GM and others selling EVs will step in, rather than just have utilities control that data for their rate-base calculations."

-- Aram Shumavon
Distributed Energy
Consumer Advocates

3. **Aggregated consumer behavior data,** including real-time information on thermostat adjustments and home devices. The data would help diverse third-party clean technology companies know where the greatest market potential might be in the grid network among groupings of customers. They could then focus their customer acquisition efforts – such as for deployment of electric vehicles, energy storage, rooftop solar, or energy efficiency programs – on areas with the greatest economic needs and potential grid and customer benefits.

4. **Aggregated meter data,** including data from multiple customers in key geographic or customer-type areas, would help clean technology businesses develop profiles for potential customers. Electric vehicle and related companies could better understand how consumers are charging their vehicles to provide services and technology that could improve and simplify that experience; energy efficiency companies could seek customers with the greatest waste and economic losses associated with usage; and solar panel installers could likewise find areas of greatest need for on-site generation, coupled with highest solar potential. These clean technology companies need raw data on consumption that is customer-tied and meter-specific. The data will then need to be quantified and standardized, possibly with GIS, and resources dedicated for data analyses.

Key Barriers Preventing Access to Utility-Centered Data

Lack of utility incentive to share data. The perception among many of the clean technology business leaders at the convening was that utilities lack incentive to share much of the data they seek, particularly given that competitors can use them to undercut utility revenue. Competitors here include any individual or company (other than the utility) supplying or proposing to supply power generation, load management, or other grid-related services to the utility's customers or to energy resource markets, using the utility's grid. For example, energy efficiency measures and rooftop renewable energy installations may lead to reduced customer use and revenues, and therefore reduced rates of return for utilities, while utilities continue to bear the burden of maintaining the backbone grid. These expenses and diminished revenue could lead to higher rates for utility customers unable to take advantage of energy efficiency and renewable or independent generation to reduce their utility-supplied power use. At the same time, improved usage of existing grid assets may reduce, defer, or eliminate the utility's need for new capital expansion projects on which utilities traditionally have earned a guaranteed rate of return. For their part, utilities often cite customer privacy concerns as reasons to avoid disclosing additional data.

Privacy laws defining much of the customer usage data as customer property. Ratepayers in California can access and use their own utility usage data. Because such data tend to reflect customer behavior, lifestyle, and even proprietary business energy use patterns, legislation mandates its protection as private, as discussed above. Solutions that might allow access to customer-level data through "aggregating and anonymizing" the data may still require burdensome waivers from large customer groups that may decline to grant them out of fear of privacy loss.

Cyber security and liability concerns. With an increasingly networked electric power system, utilities, regulators, and national security agencies alike fear that computer hackers can enter and disrupt power networks with adverse health, safety and economic consequences. Participants acknowledged that increased availability of utility-centered data could facilitate access and misuse for a variety of ill-intentioned purposes. In addition, cyber attacks might allow access to personal customer data, including energy usage data, which could lead to financial and property crimes. For example, attackers may be able to use energy data to determine when property owners are not at home based on real-time, on-site variation in energy consumption. For their part, utilities may be reluctant to disclose data that could subject them to liability for any damages that result from security breaches.

High expense of data management and updating. Participants noted that the utility-centered energy data could only be useful if aggregated, maintained, updated regularly, and stored in a secure but accessible database. Such a database would require a public mandate to all utilities to supply specified data, along with dedicated funding to hire expert staff to maintain, secure, and manage it. At present, no such mandate or funding exists.

SOLUTIONS

State leaders should allow cost recovery for utilities to provide data and then monitor the utilities for compliance. Given the lack of utility incentive to make customer data accessible, policymakers should direct and reward utility energy data disclosure – with proper protection for customer privacy – through mandates and by allowing recovery of reasonable costs incurred. In some instances, state legislators and/or regulators may need to require energy data disclosure, as exemplified by the previously discussed Decision 14-05-016 at the California Public Utilities Commission. The state should also ensure monitoring of utility compliance with existing energy data disclosure mandates. For example, third-party testing authorities could be contracted to verify compliance once the energy data mandate is operative.

State leaders should require more utility disclosure of assets and grid needs via utility planning documents. AB 327 requires utilities to submit plans for "distribution resources," meaning distributed generation, energy efficiency, energy storage, electric vehicles, and demand response technologies, including optimal locations for such resources. These plans could include the localized value of their distributed grid assets, plus the geographic locational value of data. Participants also noted that new hardware and software technologies could now support advanced modeling, simulation, and analysis of power grids, based on data utilities can currently access. As a result, policy makers such as at the California Public Utilities Commission could enhance the AB 327 directive to require that each utility provide a methodology and a model to demonstrate the feasibility and benefits of its plan, as well as grid scenarios and models that regulators and stakeholders could use, on a controlled-access basis, to review and analyze the proposed plans. State decision-makers should consider requiring that these features of the plans be made public.

State leaders should require and fund one or more data research centers and platforms to manage and disclose anonymized energy data. Policymakers have multiple options to implement this solution. One is to mandate and fund an aggregated, maintained, and constantly updated integrated power network database and model, with controlled regulator and stakeholder access. Data could be supplied by the utilities on network resources, customer loads, and interconnected network assets under specified grid status and load scenarios. Participants expressed a desire for granularity, accessibility, and both raw and "processed" data. They also wanted the energy data to be paired with other market data, including census information. The database should be maintained by expert staff to keep it secure and to manage access and services.

"Cloud-based storage is extremely cost effective, and it has security benefits with regards to redundancy."

-- Sandra Kwak
AutoGrid Systems

Alternatively, some participants suggested that real-time grid data could be supplied to a data center directly by third-party hardware or other vendors, rather than via the utilities. Consideration should be given to utility concerns over the continuing viability of their revenue model if proprietary grid and customer data are made available to third parties who will divert current revenues. As a result, policymakers may want to consider alternative revenue and incentive mechanisms to sustain investor-owned utilities and the current state and investor-owned utility compact model.

A third approach is for decision-makers to establish competitive, independent data and research centers, as opposed to a single center. Multiple data centers, such as at large technology companies, research laboratories, or universities, may bring down costs through competition and potentially safeguard against cybersecurity concerns by keeping the data dispersed. The data centers will also need dedicated funding for data collection and management, as well as validation of the data to ensure accuracy and quality. The funding could potentially come from ratepayer savings from improved utility efficiency. Ultimately, California's efforts with the data centers could be used nationally as a template for a federal version.

State leaders should ensure that the suggested data research center(s) contain proper safeguards to protect the cybersecurity of the grid and of individual customers. Some participants recommended that additional cybersecurity could be achieved by having the suggested database housed on market-based, multi-channel platforms that could be open to many hardware and software vendors. By creating diversity in the data platforms, they may be less hackable than a single-source, vertical vendor solution.

Customer-Centered Data Needs and Recommendations

The clean technology leaders at the convening described data needs related to customer-owned or generated (described here as "customer-centered") data that could be leveraged to help save or possibly earn customers money, while simultaneously reducing system-wide emissions. Participants defined the "users" in this instance as consumers, businesses, and public sector entities.

Key Types of Customer-Centered Data

1. **Utility meter data,** available in formats such as Green Button to customers or third-party designees. Programs like this one allow customers to send clean technology companies consolidated information on their past electricity usage in an Excel spreadsheet or in "extensible markup language" (XML) that can be machine-read. Green Button supports hourly and 15-minute intervals, which is useful for analyzing usage patterns; once a third party receives authorization, they can receive historical data dating back up to 13 months. However, participants felt Green Button should provide more historical data, such as three to four years' worth.

   Clean technology companies also need access to improved Green Button-style data in order to participate in wholesale energy markets, such as through the California Independent System Operator (CAISO). Third party-accessible data like Green Button is not considered "revenue quality meter data" (RQMD), which the CAISO requires in order to participate in the market. As a result, clean technology companies may be effectively shut out from participating in the wholesale markets, while electric utilities maintain control over "valid" data needed to access them.

2. **Energy audit data** from the many commercial building owners who undertake energy audits from third-party energy service companies (ESCOs), which analyze building energy usage patterns and identify inefficiencies that could be corrected. In turn, these energy efficiency companies rely on the audits to determine which efficiency measures to employ as well as the likely rate of return on the investment from the savings. These companies could make effective use of all available historical energy audits for a specific building (one participant recommended the last six, developed over a several-year period as a starting point). Some utilities receive the energy audit data in order to determine and verify customer rebates offered by the utility for purchase of energy-saving equipment or appliances or implementation of energy-saving measures such as insulation; the audits provide a benchmark to document savings. Participants expressed interest in having access to such data on an anonymized scale.

"Customers and their designees should have access to best available cost and use information in a standardized, machine-readable format."

-- Michael Murray
Lucid

3. **"Internet of Things" data,** from consumers using internet-enabled energy technologies to save money. These increasingly common technologies include high-tech "smart" thermostats that can communicate with the customer and other building appliances and systems, automating real time decreases or increases in energy usage based on historical patterns, energy pricing, and user needs. Third parties will want to access the data, with customer consent, to assist in identifying energy usage inefficiencies and possible returns on efficiency improvements. However, customers currently do not have an easy way to share the data they generate with clean technology companies. This situation may be due, in part, to a hesitance by the technology companies that harvest those data to enable customers to share it with potential competitors, as suggested by their reluctance to allow the installation of utility-approved hardware to measure the same data stream.

4. **Tariff data,** which determine each customer's rates, pricing, and services. Tariffs are complex, highly technical documents, typically developed piecemeal over many years in lengthy regulatory proceedings. Customers and third-party vendors assisting them often have difficulty accessing and understanding their energy tariff and knowing how to optimize their energy use within their existing tariff or by moving to a more favorable one. Participants wanted utilities to make tariff data more transparent and machine-readable. Many convening participants expressed a need for 15-minute interval usage data that can be linked to customer-specific tariff data in order to analyze costs and benefits for various energy efficiency, renewable energy, energy storage, and other measures. Participants also noted that a publicly accessible tariff engine as a web service would have the most value. Ultimately, the tariff data, coupled with real-time granular consumption data and demographic and market segmentation information, could be transformative for customer acquisition and servicing efforts. Electric vehicle customers in particular could benefit by easily programming their electricity rate schedules into the vehicle charging management system to set charging times for when it would be most economically and environmentally efficient.

5. **Energy efficiency policy data,** from California's robust suite of policies and programs, to encourage building owners to undertake energy efficiency upgrades to save money. For example, the "Energy Upgrade California" website can point customers to energy auditors and finance and rebate programs.[36] However, clean technology companies lack data on the performance of these programs in order to verify results and determine the most cost-effective efficiency measures. Existing data sets are not digitized or organized for public access. Prospective building buyers, for example, may want to access baseline data on a building's historical and projected energy performance, which may be contained in program databases. Clean technology leaders would benefit from "California Solar Initiative"-like data (i.e., "before and after" customer usage and related data from a solar rebate program) on energy efficiency. Such data could provide efficiency measure-based savings, based on projects "as proposed" and then compared to post-implementation.

6. **Customer segmentation for each utility across usage and climate zones,** reported on annually, to inform third parties about market opportunities and to lower customer acquisition costs for all sectors. For example, JBS Energy, Inc. released a report in 2002, updated in 2007 for Southern California, that details market segmentation within the three investor-owned utility territories.[37] Clean technology companies use the data to identify target markets, such as single-family homes above a certain income level within a given utility territory, as well as market characteristics such as the number of residential, commercial

and industrial customers. This information, coupled with climate zones and other demographic and market data, would be helpful for clean technology companies if made available annually for each investor-owned utility and then aggregated for state-level analysis.

Key Barriers Preventing Access to Customer-Centered Data

Lack of utility incentive to assist in disclosing additional data. The perception among many of the clean technology business leaders present was that, as with utility-centered data (discussed above), utilities lack incentive to ensure that customers can more easily share more of their data. In some instances, utilities may have direct incentives to resist opening access to data, given that the data will likely provide opportunities for third-party clean technology companies to compete with them. As a result, utilities may be directly incentivized to maintain control over their data.

"Getting usage data but not the underlying determinants makes it hard to help figure out ways to reduce usage. It would be helpful to flag missing areas, so we should study where we are now."

-- Andy Schwartz
SolarCity

High expense of data management and standardization. As discussed above with respect to utility-centered data, participants noted that customer-centered energy data ideally should be aggregated and stored in a secure, updated, and easily accessible database. Such a database would require new action and funding mandates to meet the expense of hiring staff and to make the data standardized and easily accessible for analytics.

Difficulty allowing customers to share data or opt-in to data disclosure programs. Currently, ratepayers that would like to share detailed data on their historical energy usage and tariffs have no easy option for compiling and disclosing the data in an easily accessible, readily transmissible format. Utilities have yet to enable sufficient sharing to meet clean technology objectives, despite the fact that their customers own their own usage data.

SOLUTIONS

State leaders should establish a right to improved energy data access for customers. Policymakers should clearly establish that utility customers have the right to more easily access their usage data in a simply organized, standardized format. This right should include access to derivatives of customers' personal data, typically resulting from utility-run analytics of the raw data. Customers should also be able to share or transfer those rights and their access to third-party clean technology companies. For example, clean technology companies could use this right to request a waiver from entities like the California Independent System Operator, which participants felt currently excludes these companies from accessing tariff data at sufficiently detailed intervals.

"We need to focus on consumer choices in response to data. We need to push the industrial sector to create real opportunities for consumers to make practical decisions based on consumption data."

-- Stephanie Pincetl
UCLA

State leaders should develop incentives and compliance monitoring for utilities to participate in customer data disclosure. As discussed above, policymakers should mandate utility energy data disclosure and reward compliance through financial incentives or recovery of costs. For example, demand response providers currently must pay utilities for customer meter data. However, the state could greatly improve the process by defining the ability of utilities to transfer data to third parties with specified privacy protections, by giving them incentives to participate. At the same time, the state should ensure monitoring of utility compliance with existing mandates related to energy data disclosure.

State leaders should allow the data to be accessible via an independent data center or via multiple competitive centers. By enforcing independence, the data centers would encourage third-party access and the development of competitive markets. As discussed above, one or more data centers, independent of utilities, could provide integrated, accessible customer-centered data for use by the community of third-party vendors, policy makers, and other stakeholders. Multiple centers could have the

added advantages of bringing down costs through competition and potentially safeguarding against cybersecurity concerns by distributing data across multiple platforms. Any such data centers will need expert managers, technicians, and archivists of data collection, storage, and retrieval, as well as means and personnel for validating the data and ensuring high quality.

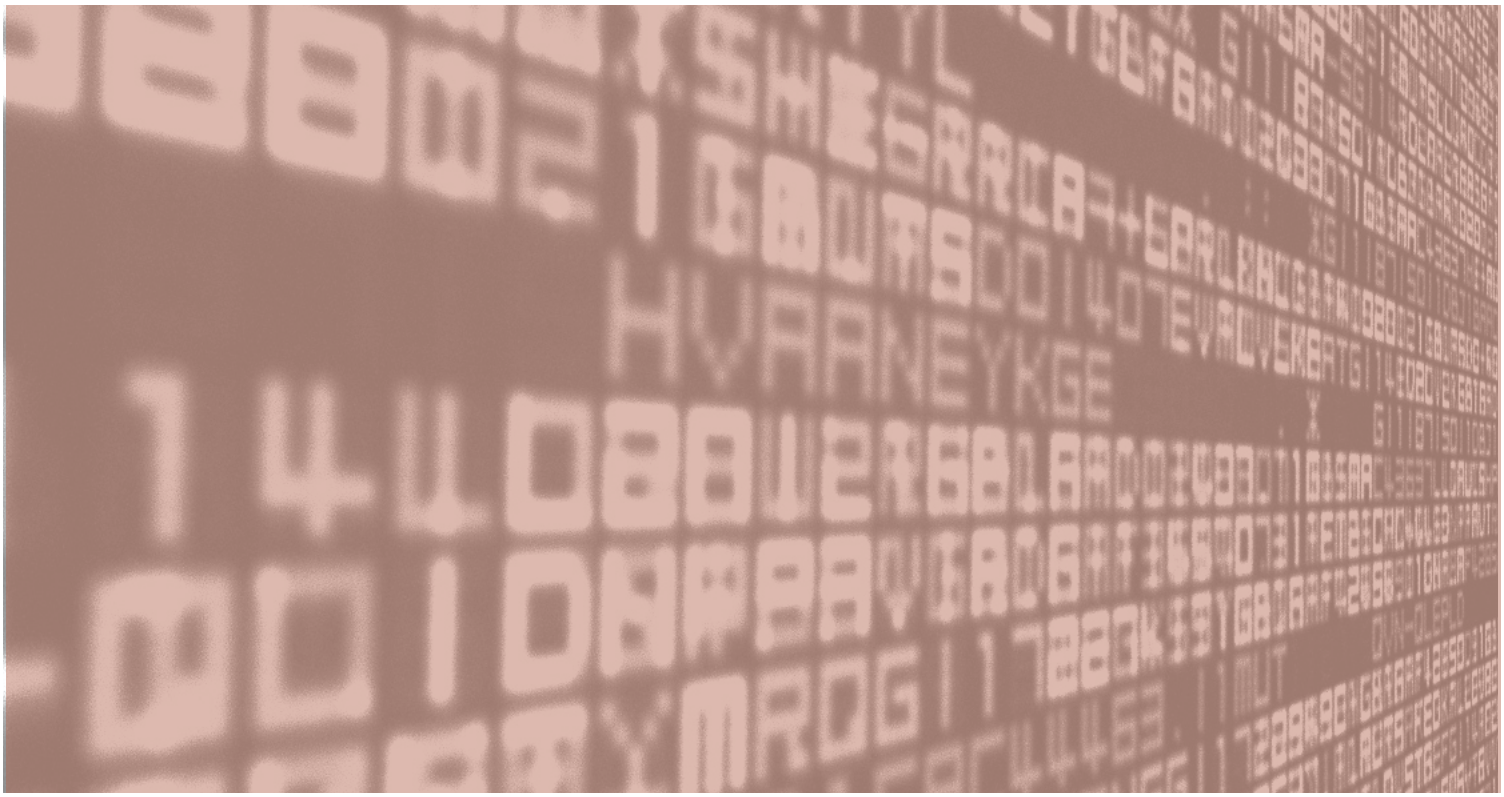
The California Public Utilities Commission should create an ad hoc "tariff tech group" to develop a web-accessible tariff engine. California customer usage data in 15-minute or hourly intervals should be reported and made linkable to customer-specific tariff data for maximum efficiency gains. The goal would be to have an application programming interface (API) to answer "what if" questions, such as "how much money will a customer save if their energy usage pattern changes from X to Y?" As rates become more complex, accurately translating energy savings into dollars becomes increasingly difficult, and yet these dollar savings represent the central determinant of customer decision-making.

"To make decisions, we need to understand the before as well as the after, and customers need to have data to change behavior. The importance of measuring and having feedback to customers directly cannot be understated."

-- Alex Keros
General Motors

The California Public Utilities Commission should require utilities to disclose customer tariff information along with existing Green Button and Green Button Connect systems. San Diego Gas & Electric developed a process for commercial customers to access cost data associated with different rate structures based on actual usage and expected changes; this transparency helped commercial customers undertake cost-benefit analyses of proposed energy efficiency measures to decide on optimal investments. However, efficiency companies need standardized tariff data in order to readily and accurately make this evaluation. Ideally, the tariff data could be linked to business process management (BPM) data and software, which can inform customers about their energy usage and cost patterns. Utilities should be required to provide training to customers for self-reporting on tariff and usage data and automating the reporting with digitized data for accessing, analyzing, and applying them.

California leaders, perhaps through the California Energy Commission, should require energy audit disclosures. Building owners should share energy audits and historical data with new owners as a part of the disclosure process on sale. The process currently is hampered by privacy concerns and the difficulty of developing formal processes to authorize disclosures, particularly if a building has tenants. California regulators could consider adopting the "15/15 rule" for disclosing energy audits, in which building or tenant data may be considered "anonymized" if the data unit has at least 15 members, with no one member accounting for more than 15 percent of the quantity measured. Regulators could encourage reporting in a manner consistent with the Commercial Buildings Energy Consumption Survey (CBECS) or the California End Use Survey (CEUS) to enable "asset benchmarking." Policymakers could also adopt New York City's policy to require retrofit commissioning for certain buildings.[38]



Conclusion: The Future of Energy Data

California is well-positioned to benefit from greater access to anonymized and secure energy data. The state has aggressive environmental goals that require significant improvements to energy efficiency, renewable energy and electric vehicle deployment, especially to achieve reductions in emissions from the transportation and electricity sectors. Increased access to energy data will boost the clean technology businesses necessary for the state to meet these goals and could also help make the state's policy incentives more effective. Ultimately, this clean technology leadership will benefit the state economically, both through savings on energy costs and the continued growth of an emerging and sustainable clean technology business sector. Energy data therefore provides the knowledge that can lead to cleaner, more sustainable, and more cost-effective power, for California and beyond.

"The work we are doing here should feed into national federal efforts, because it will be a leader for other states to emulate."

-- Jon Fortune
Sunverge Energy

Participant Bios

Tom Arnold
Gridium

Tom Arnold is co-founder and CEO of Gridium, a venture-backed energy analytics firm making in easy and simple to manage and reduce energy use based on freely available data. Prior to Gridium, Tom Arnold was the Vice President of Energy Efficiency at EnerNOC, where he led the firm's energy efficiency efforts. Tom has an MBA from the Wharton School of Business at the University of Pennsylvania and a BA in Economics from Dartmouth College. When he isn't playing with energy data models, he enjoys riding his bike and chasing after his two daughters.

Louise Bedsworth, Ph.D.
Office of Governor Edmund G. Brown, Jr

Louise Bedsworth, Ph.D., Deputy Director of the California Governor's Office of Planning and Research (OPR), was formerly a Research Fellow at the Public Policy Institute of California focusing on adaptation to climate change, transportation and air quality. She has also held positions at the Union of Concerned Scientists, Redefining Progress, and the International Institute for Applied Systems Analysis.

Tony Brunello
GreenTech Leadership Group

Tony is focused on enabling cutting-edge products and services related to energy-saving consumer electronics, energy data, green buildings and cap-and-trade markets. Previously Tony was a Deputy Secretary for the State of California overseeing energy and climate change activities in the California Energy Commission and other agencies working on renewable energy and grid planning, electronics efficiency standards, the cap-and-trade market, and other programs. Tony has extensive experience in the public and private sector working in Washington DC and around the globe with the World Bank, Pew Charitable Trusts and U.S. government. He received his M.Sc. at University College London in Resource Economics and his B.A at the University of California, Santa Barbara in Economics and Environmental Studies.

Matt Duesterberg
Ohmconnect

Matt Duesterberg is co-founder and CEO of Ohmconnect. Previously, he ran the data science division at utility meter data analytics company, DataRaker, which got acquired by Oracle in 2013. He got his start in the energy industry via finance; he traded futures for electricity flows for a small quantitative trading firm, DC Energy. He has a MS from Stanford and a BS from UVA.

Brian Fitzsimons
Qado Energy, Inc.

Brian is a serial entrepreneur and founder of Qado Energy, a distribution grid analytics platform company. Prior to Qado Energy, he founded and successfully grew innovative software companies in the Media, Publishing, and Financial Services industries. He specializes in enterprise software platform development and software as a service offerings. Over the past 25 years, Brian has built highly effective and efficient software development teams that have designed software platforms that make it easy for business and operational staff to make critical decisions. He is a pioneer in the use of XML for automated data integration, transformation, collaboration and management. He has actively contributed to global data standards development in several industries and is currently an active analyst of the IEC Smart Grid Standards, 61968, 61850 and working group 1547. Prior to starting Qado Energy, he founded and successfully exited two enterprise software companies. He holds three patents in the areas of data transformation and automation. Brian has been the keynote speaker at industry events around the world in the Financial Services, Publishing and Media markets. He holds a Bachelor of Science degree in Economics from Fordham University.

Jon Fortune
Sunverge Energy

Jon Fortune is an engineer with a career spanning electric market regulatory policy and strategy, commercial project development, energy management, and sales/value engineering. He is currently the Director of Regulatory & Energy Services for Sunverge Energy, which manufactures energy storage systems.

Mimi Frusha
Renewable Funding

Mimi Frusha co-founded Renewable Funding and helped transform PACE into a nationwide reality. Frusha is responsible for the implementation and execution of Renewable Funding's PACE, finance and technology contracts and programs. Prior to Renewable Funding, she led the development of consumer and business based finance programs for over 10 years in local non-profits such as the East Bay Asian Local Development Corporation, Juma Ventures and Inner City Advisors. Frusha holds a BA from Carleton College and a MBA from the Haas School of Business at the University of California, Berkeley. She lives in El Cerrito with her husband and two children.

Tad Glauthier
Stem, Inc.

As VP of Marketig and Business Development, Tad is responsible for defining Stem's commercial product vision. He also oversees the utility and regulatory aspects of the business. Prior to joining Stem, Tad worked at the Boston Consulting Group, where he specialized in growth strategies for the petrochemical industry. Tad graduated Phi Beta Kappa with a BA in English from Stanford University and received his MBA from the Stanford Graduate School of Business.

Richard Hammond
Energy Consultant

Richard Hammond has a background in energy, environmental, and natural resources law and policy, with emphasis on development and implementation of new policies, programs, and technologies. Since 2000, his roles with diverse energy, resource, and information technology initiatives have included assisting in funding, developing, and commercializing the GRIDiant software application suite for distribution network modeling and simulation, and real-time optimization, analysis, and geospatial display, now commercially installed at major utilities for improved grid efficiency, reliability, DER integration, asset management, and grid visibility. From 1986-2000 Mr. Hammond was a partner in an international corporate law firm based in San Francisco. He served previously as an environmental policy consultant to a major gold mining company, as a Special Assistant to the Governor of California, as Undersecretary for Resources in the State of California Resources Agency, as Senior Energy Advisor in the California Governor's Office of Planning & Research, and as Legal Counsel to the California Coastal Commission. Mr. Hammond is a graduate of Harvard College and Columbia Law School. Admitted to the Bar Associations of California and New York, he is an active member of the California Bar Association.

Udi Helman
Helman Analytics

Udi Helman is a consultant on leading-edge market and technology issues in the electric power sector, in which he has worked for over 15 years (along with another 5 years in environmental policy). Among his current roles, he serves as Chair, Market Analytics Working Group, Energy Storage Association (ESA) and is on advisory committees for studies of the integration and valuation of renewable resources and storage at the National Renewable Energy Laboratory (NREL), California Energy Commission (CEC), and California Independent System Operator (CAISO). Previously, he was Managing Director, Economic and Pricing Analysis at BrightSource Energy and before that a Principal focused on market design and policy analysis in the Market & Infrastructure Development division of the CAISO. He worked for almost 10 years at the Federal Energy Regulatory Commission (FERC) in Washington, D.C., where he worked extensively on electricity market design issues. He has published a number of papers over the years, including many in peer-reviewed journals (and also serves as a peer reviewer). He has a PhD from The Johns Hopkins University in applied economics and systems analysis.

Alex Keros
General Motors

Alex Keros is a Manager at General Motors working on advanced vehicle and infrastructure policy. He is responsible for a broad range of policy considerations and technical support for GM's advanced vehicle portfolio and their associated infrastructure—such as Chevrolet Volt & Spark EV, Cadillac ELR, Bi-Fuel Chevrolet Silverado/GMC Sierra Trucks, and Chevrolet Express/GMC Savana CNG Vans. Alex has a unique background and perspective in the automotive industry, including responsibilities for infrastructure commercialization—including electric charging, natural gas, and hydrogen. He has led technical reviews of various fueling technologies and engages regulatory agencies on the benefits and challenges of new vehicle commercialization. On the ground, he has led the design, permitting, installation and operation of hydrogen and electric charging stations in multiple regions. Most recently, Alex has been working closely with key stakeholders, such as automakers, utilities, suppliers, regulators, local officials, and advocates in order to accelerate the adoption of alternative- fueled vehicles. Alex began his career in environmental consulting where he managed the assessment and remediation of hazardous waste sites. He has extensive experience in environmental policy design and implementation. Alex earned a B.S. in Natural Resource Management and a Masters in Business Administration from the University of Michigan in Ann Arbor.

Sandra Kwak
AutoGrid Systems

Sandra is transforming the power industry with AutoGrid Systems, creating actionable intelligence out of Big Data from the smart grid. Prior to joining AutoGrid Sandra co-founded and served as President and COO of energy efficiency company Powerzoa. She has also served as CEO of a software company producing the world's first mathematically lossless video codec: SheerVideo.

Sandra was on the team at PG&E that implemented the ClimateSmart program, which offsets carbon emissions associated with electricity generation and ran a efficiency practice in California to help commercial properties meet regulation and implement cost-saving sustainability measures beyond compliance.

Andrew McAllister
California Energy Commission

Andrew McAllister was appointed commissioner by Governor Jerry Brown in May 2012. Mr. McAllister has over 20 years of technical, programmatic and policy experience in the fields of energy management, efficiency and renewable generation. Before joining the Commission, he worked at the California Center for Sustainable Energy for six years, most recently as managing director and director of policy and strategy. Previously, he worked with NRECA International Ltd. in the electric sectors of countries in Central and South America, Southeast Asia and Africa on a variety of load management, generation and utility planning projects. He was a project manager at an energy consulting firm and worked as an energy efficiency analyst at Lawrence Berkeley National Laboratory. He has published on various energy topics in academic, trade, and popular journals. Andrew studied both engineering sciences and art history at Dartmouth College and holds M.S. and PhD degrees from the Energy & Resources Group at UC Berkeley. He is a returned Peace Corps Volunteer.

Michael Murray
Lucid

Michael co-founded the commercial building energy management software company Lucid and served in various roles as its CEO and President. A LEED Accredited Professional, he has over ten years of experience with metering, building automation, energy management, and data access policy. His experience at Lucid led him to co-found Mission:data, a coalition of over 20 companies advocating for customers' access to their own usage data. Prior to Lucid, Michael specialized in Ecological Footprint applications for governments, non-profits, and corporations with Global Footprint Network. Michael holds a BA with highest honors in Environmental Studies from Oberlin College.

Terry O'Day
eVgo

Terry is responsible for developing and leading NRG EV Services (aka NRG eVgo) in California, a subsidiary of NRG Energy, the nation's largest competitive power producer. The company is investing over $100 million to build electric vehicle (EV) charging networks throughout California and is offering EV drivers solutions for public, home and workplace charging. Prior to joining NRG Energy, Terry was Executive Director of Environment Now foundation, a strategic, entrepreneurial, activist leader in California. Terry began his career in electric vehicle charging infrastructure with Edison International. He went on to co-found EV Rental Cars, which was the first rental company in the United States to offer only environmental vehicles, such as hybrid, natural gas, and electric cars to the general public. He holds an MBA from The UCLA Anderson School of Management and completed the Coro Public Affairs Fellows Program in Los Angeles. He received a BA with honors in Public Policy at Stanford University, with a thesis addressing public finance and demand management of electricity. Terry currently serves as Mayor Pro Tempore of the Santa Monica City Council, a position to which he was first elected as Councilmember in November 2010. He has been active with community organizations throughout California and Mexico; including Waterkeeper Alliance, Coro Southern California; The USC Center for Sustainable Cities, Environmental Entrepreneurs and as the Board Chair of the Coalition for Clean Air.

Michael Peevey
California Public Utilities Commission (formerly)

Michael R. Peevey was appointed President of the California Public Utilities Commission (CPUC) by Governor Gray Davis on December 31, 2002, having been originally appointed to the CPUC by Governor Davis in March 2002. In December 2008 Governor Arnold Schwarzenegger reappointed Mr. Peevey to the CPUC for another six-year term. From 1995 until 2000, Mr. Peevey was President of NewEnergy Inc. Prior to that, Mr. Peevey was President of Edison International and Southern California Edison Company, and a senior executive there beginning in 1984. Mr. Peevey has served on the boards of numerous corporations and non-profit organizations. Mr. Peevey holds Bachelor and Master of Arts degrees in economics from the University of California, Berkeley. He is married to Carol J. Liu, who served three terms representing the 44th Assembly District (La Canada Flintridge) in the California legislature and in November 2008 was elected to the California Senate to represent the 21st Senate District. They have three children.

Stephanie Pincetl
UCLA

Stephanie Pincetl is a Professor in Residence and founding Director of the Center for Sustainable Communities at the UCLA Institute of the Environment. Dr. Pincetl conducts research on environmental policies and governance is expert in bringing together interdisciplinary teams of

researchers across the biophysical and engineering sciences with the social sciences to address problems of complex urban systems and environmental management. Dr Pincetl has written extensively about land use in California, environmental justice, habitat conservation efforts, water and energy policy. Her book, Transforming California, the Political History of Land Use in the State, is the definitive work on land use politics and policies of California. Dr. Pincetl has a PhD in Urban Planning and teaches at UCLA. She worked 10 years in the nonprofit environmental justice sector and is the Faculty Director of the Los Angeles Regional Collaborative for Climate Action and Sustainability (LARC), a Los Angeles regional organization dedicated to working across jurisdictions to achieve a better future. She was instrumental in making the Institute of the Environment and Sustainability at UCLA its institutional home.

Andy Schwartz
SolarCity

Andy Schwartz is a Director on SolarCity's Policy and Electricity Markets Team where he focuses on issues and policies related to net energy metering, rate design, and energy storage. Prior to joining SolarCity in 2013, Andy worked at the California Public Utilities Commission, where he served both as an Advisor to President Michael Peevey and subsequently as a Supervisor in the Commission's Energy Division. As an Advisor, Andy covered a number of areas for President Peevey, including ongoing implementation of the state's Renewables Portfolio Standard Program and the California Solar Initiative. As Supervisor of Energy Division's Emerging Procurement Strategies team, Andy oversaw policy development and program implementation related to the state's cap and trade program, electric vehicles, combined heat and power, as well as support for emerging technologies. Andy holds a Master's in Public Policy from the Goldman School at the University of California, and a BA in Economics from the University of Colorado.

Curtis Seymour
SunEdison (formerly)

Curtis Seymour previously was Senior Director of Utility Partnerships for SunEdison in North America, where he led strategic partnerships with utilities and retail electric service providers in the U.S. SunEdison develops, finances, owns and operates solar power plants serving customers in all market segments across the United States and the world. Curtis also previously led Government Affairs for SunEdison on the west coast, and chaired the California state policy committee of the Solar Energy Industries Association (SEIA) from 2012-2013. Prior to SunEdison, Curtis worked at Q-Cells in Berlin, Germany and before that at the California Public Utilities Commission as a Commissioner Advisor and Senior Analyst.

Aram Shumavon
Kevala Energy Markets & Distributed Energy Consumer Advocates

An economist and political scientist by training, Aram Shumavon is founder and CEO of Kevala Energy Markets, the inventor and chief developer of the SPOOL geospatial energy and environmental analysis platform, founder and executive director of the nonprofit Distributed Energy Consumer Advocates, and a strategic advisor on a wide range of energy and sustainability related issues. In those capacities he has initiated and managed the development of the state and federal policy regulatory strategies and led the creation of innovative market infrastructure and policy analysis tools used by governmental entities, environmental advocates, consultants, academics, and electricity market participants. Mr. Shumavon's previous work includes more than a decade as a senior analyst and advisor at the California Public Utilities Commission where he headed the state's analysis of key wholesale electricity market design and environmental compliance efforts and led long term procurement and planning efforts focused on California's high renewables penetration future and renewables integration strategies. He has an AB in economics and public policy from the University of Chicago and has written papers on a range of subjects. A beekeeper, cyclist, skin diver, wildcrafter, musician, and visual artist as well as the father of two children, Mr. Shumavon lives in San Rafael, California.

Manal Yamout
Advanced Microgrid Solutions

Manal Yamout is currently a partner at Caliber Strategies and also at Advanced Microgrid Solutions (AMS). Manal previously served as Director of Government Affairs for NextEra Energy, Inc. where she oversaw almost all aspects of federal policy for the company including, tax, clean energy and environment, along with a myriad of issues related to the State of Florida. Prior to her time at NextEra, Manal worked as an advisor to both California Governor Schwarzenegger and Governor Brown for Renewable Energy Facilities. Manal also served as a general advisor to Governor Schwarzenegger on a wide range of issues including environmental initiatives, healthcare reform, education, as well as managing a small team responsible for producing all of the Governor's policy briefings. Prior to her time as an Advisor to Governor Schwarzenegger, Manal served as California's Assistant Secretary for International Trade. She also served as a Special Assistant to First Lady Maria Shriver and as an Executive Fellow in the Office of the Governor. Manal is proud to be a product of the California State University system, having attended California State University San Marcos and graduating with high honors with a Bachelor of Science degree in Biology. Manal graduated with honors with a Master's Degree in Public Administration from the University of Southern California.

Endnotes

1 California Air Resources Board, "First Update to the Climate Change Scoping Plan," May 2014, p. 30. Available at: http://www.arb.ca.gov/cc/scopingplan/2013_update/first_update_climate_change_scoping_plan.pdf (accessed October 18, 2014).

2 McKinsey and Company, Reducing U.S. Greenhouse Gas Emissions: How Much at What Cost? 2007. Available at: http://www.mckinsey.com/client_service/sustainability/latest_thinking/reducing_us_greenhouse_gas_emissions (accessed October 31, 2014).

3 "Setting the Record Straight on AB 32," California Air Resources Board. Citing data from "The Clean Energy Economy" (Pew Charitable Trusts), "Many Shades of Green" (Next 10), "Metro Economics: Current and Potential Green Jobs in the U.S. Economy" (U.S. Conference of Mayors). Available at: http://www.arb.ca.gov/cc/cleanenergy/clean_fs.htm (accessed October 15, 2014).

4 Mark Fulton et al, "United States Building Energy Efficiency Retrofits," Rockefeller Foundation, March 2012. Available at: http://www.rockefellerfoundation.org/uploads/files/791d15ac-90e1-4998-8932-5379bcd654c9-building.pdf (accessed October 15, 2014).

5 David Roland-Holst and Fredrich Kahrl, Energy Pathways for the California Economy, Department of Agricultural and Resource Economics, U.C. Berkeley, June, 2009, pp. 13-18. Available at: http://are.berkeley.edu/~dwrh/CERES_Web/Docs/energy%20pathways%20final%20report.pdf (accessed October 30, 2014).

6 See United States Department of Energy, "The eGallon: How Much Cheaper Is It to Drive on Electricity?" fuel savings calculator. Available at: energy.gov/articles/egallon-how-much-cheaper-it-drive-electricity (accessed October 30, 2014).

7 California Air Resources Board, "First Update to the Climate Change Scoping Plan," May 2014, p. 93.

8 Governor Arnold Schwarzenegger, Executive Order S-3-05, June 1, 2005. Available at: http://gov.ca.gov/news.php?id=1861 (accessed August 18, 2014).

9 California Air Resources Board, "California Greenhouse Gas Emission Inventory: 2000-2012," May 2014, p. 16. Available at: http://www.arb.ca.gov/cc/inventory/pubs/reports/ghg_inventory_00-12_report.pdf (accessed July 8, 2014).

10 California Code of Regulations, Title 24, Part 6.

11 California Energy Commission, 2007 Integrated Energy Policy Report, November 2007, p. 85. Available at: http://www.energy.ca.gov/2007publications/CEC-100-2007-008/CEC-100-2007-008-CMF.PDF (accessed October 28, 2014).

12 California Energy Commission, 2007 Integrated Energy Policy Report, p. 3.

13 California Energy Commission, "California's Energy Efficiency Standards Have Saved $74 Billion," available at: http://www.energy.ca.gov/efficiency/savings.html (accessed October 28, 2014).

14 Karen Douglas, California Energy Commission, Greenhouse Gas Emission Reduction through Energy Efficient Building Retrofit, Presentation to the California Assembly Natural Resources Committee, Oakland, California, December 8, 2009.

15 California Air Resources Board, Climate Change Scoping Plan, December 2008, p. 16. Available at: http://www.arb.ca.gov/cc/scopingplan/document/adopted_scoping_plan.pdf (accessed October 28, 2014).

16 California Energy Commission, 2007 Integrated Energy Policy Report, p. 3.

17 California Energy Commission, 2009 Integrated Energy Policy Report, December 2009, p. 51. Available at: http://www.energy.ca.gov/2009publications/CEC-100-2009-003/CEC-100-2009-003-CMF.PDF (accessed October 31, 2014).

18 Senate Bill 1078 (Sher, 2002) established the "renewables portfolio standard" (RPS) program to require certain retail sellers of electricity to procure 20 percent of their electricity from eligible renewable energy sources by December 31, 2017. In 2006, Senate Bill 107 (Simitian) accelerated the calendar for the RPS program to require the target to be reached by December 31, 2010.

19 California Senate Bill X1-2, Statute of 2011, Chapter 1.

20 California Assembly Bill 327, Statute of 2013, Chapter 611.

21 California Public Utilities Commission, Renewables Portfolio Standard Quarterly Report, Q4 2013, p. 3. Available at: http://www.cpuc.ca.gov/NR/rdonlyres/71A2A7F6-AA0E-44D7-95BF-2946E25FE4EE/0/2013Q4RPSReportFINAL.pdf (accessed July 7, 2014).

22 California Assembly Bill 2514, Statute of 2010, Chapter 469.

23 California Public Utilities Commission, Decision Adopting Energy Storage Procurement Framework and Design Program (Decision 13-10-040), October 17, 2013. Available at: http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M079/K533/79533378.PDF (accessed July 7, 2014).

24 California Air Resources Board, "California Greenhouse Gas Emission Inventory: 2000-2012," p. 16.

25 Lynn Doa, "Grid Operators: Electric Cars Could Add Nearly 4,000 MW to Electric Load by 2020," SNL Energy Power Daily, Mar 24, 2010.

26 Stephanie Pincetl and Jacki Murdock, California Center for Sustainable Communities at UCLA, "An Interactive Map of LA Energy Consumption," 2014. Available at: http://sustainablecommunities.environment.ucla.edu/map/ (accessed October 28, 2014).

27 California Constitution, Article 1, Section 1.

28 California Civil Code Section 1798.98(b).

29 California Civil Code Section 1798.98(d).

30 California Public Utilities Code Section 394.4(a).

31 California Public Utilities Code Sections 8380-8381. State of California Department of Justice, Office of the Attorney General, "Privacy Laws". Available at: http://oag.ca.gov/privacy/privacy-laws (accessed October 28, 2014).

32 California Public Utilities Code Section 8380(1). California Public Utilities Commission, Decision Adopting Rules to Provide Access to Energy Usage and Usage-Related Data while Protection Privacy of Personal Data (Decision 14-05-016), May 1, 2014. Available at: http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M090/K845/90845985.PDF (accessed October 30, 2014).

33 California Public Utilities Code Section 8380(2).

34 California Senate Bill 1476, Statute of 2010, Chapter 497.

35 California Public Utilities Commission Policy & Planning Division, "Data Access, Use, and Privacy," October 3, 2013. Available at: http://www.cpuc.ca.gov/NR/rdonlyres/79475EAC-B5F5-4E1A-ABAD-D260748B92D2/0/BigData.pdf (accessed October 30, 2014).

36 For more information on Energy Upgrade California, please visit: https://www.energyupgradeca.org/en/ (accessed October 6, 2014).

37 William B. Marcus, Gregory Ruszovan, & Jeffrey A. Nahigian, "Economic and Demographic Factors Affecting California Residential Energy Use," JBS Energy, Inc., September 2002. Available at: http://www.jbsenergy.com/downloads/California%20Residential%20Energy%20Use%20Economic%20and%20Demographic%20Report.pdf (accessed November 13, 2014). See also William B. Marcus & Greg Ruszovan, "Know Your Customers": A Review of Load Research Data and Economic, Demographic, and Appliance Saturation Characteristics of California Utility Residential Customers," JBS Energy, Inc. & The Utility Reform Network, December 11, 2007. Available at: http://www.jbsenergy.com/downloads/Know_Your_Customers_Paper.pdf (accessed November 13, 2014).

38 For more information on the New York City energy efficiency program, please visit: http://www.nyc.gov/html/dem/html/conservation/retrofits.shtml (accessed October 6, 2014).

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