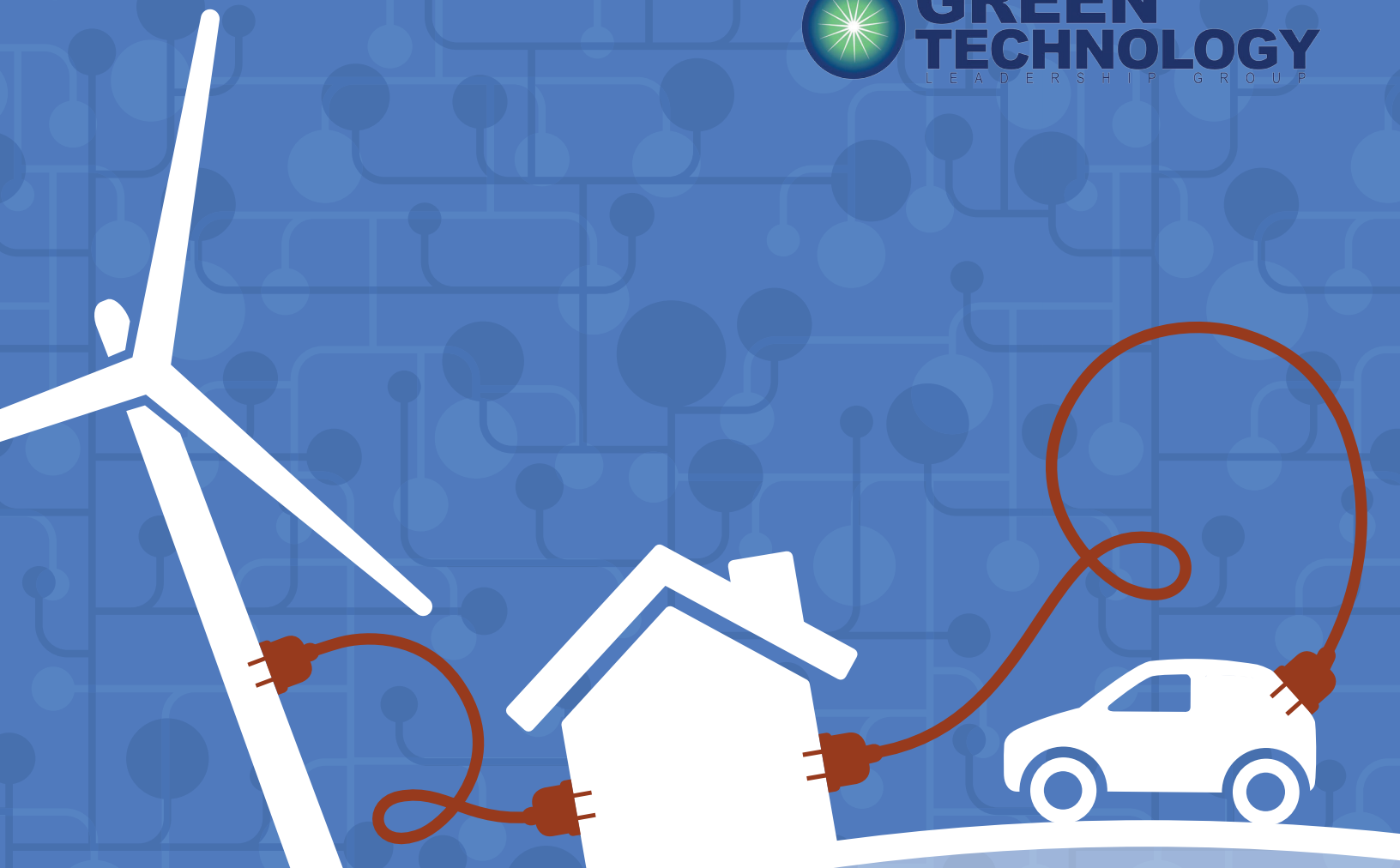
GREEN TECHNOLOGY
LEADERSHIP GROUP



SMART CUSTOMER GUIDE

Demand-side Innovation for the Electric Grid

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open energy initiative

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INTRODUCTION

Recent grid upgrades implemented by the largest electric utilities in California blended with a revolution in energy data processing and energy saving technologies have the potential to transform the way California consumers generate and use electricity, and to move us toward a cleaner, more efficient energy future. From state and national agencies, to environmental and consumer groups, there is near universal agreement that consumers, given the knowledge, motivation and tools they need to participate, can and must be a major factor in offsetting some of the critical challenges facing the electric industry: higher costs, integration of intermittent supplies, electric vehicles, and climate change.

Smart meters, recently installed on more than 80% of buildings in California, collect electricity consumption data 24 hours a day, 8,760 hours per year. This new data stream has the potential to benefit utilities and customers through more useful information, more accurate rates, and smarter technologies, which can work in harmony to enable a cleaner, more efficient, and more reliable electric grid.

Currently, most of California's electricity distribution system is at least half a century old originally built to send power one way from power plants to customers. Today more and more customers are supplying solar energy back to the grid and using electric vehicles as electric storage facilities. At the same time, installation of communication-enabled smart meters, thermostats and home area networks are growing every year. Now is the time to provide a more unified vision of where the state should go and encourage California to invest in tomorrow's intelligent energy system. Most importantly, many of the world's top companies are operating in California and can build this system and grow jobs and revenues in the process.

California's 2.0 Grid

Today is the time to focus on creating a 2.0 grid that is more customer focused. This is important as customer electricity rates continue to rise and grid reliability becomes a major concern. In addition, California needs to implement its state greenhouse gas laws that call for it to reduce its greenhouse gases by 20% below 1990 levels by 2020 and 80% by 2050. In addition, the California Long-Term Energy Efficiency Strategic Plan has a goal of zero net energy use for all new homes and commercial buildings by 2020 and 2050, respectively.

Reliability is a central concern for California. Electric supply and demand must be balanced at all times across the grid to avoid service interruptions, such as those that plagued California in the winter of 2001. Despite massive grid improvements over the past ten years, there are two recent developments that keep grid operators up at night: the rapid growth of intermittent resources and electric vehicles.

1. Intermittent resources: The California Renewables Portfolio Standard requires that retail sellers of electricity serve 33% of their load with renewable energy by 2020. Wind resources supply the bulk of this goal, but solar photovoltaic installations have been rapidly gaining ground, doubling capacity each year to surpass a 1-gigawatt milestone in 2012. As renewable resources replace

> "We've had a couple of instances where wind has run out 800 megawatts in a half hour – and that's with about 3,500 megawatts of wind on the system. If you triple that, you can triple the run-out. We need to be able to respond to that."
>
> Steve Berberich, CAISO CEO (Feb 2012)

conventional plants, demand will need to become more flexible to balance the increasingly intermittent supply.

2. Electric vehicles: Electric vehicles can be fueled by clean, local renewable energy, thereby reducing our dependence on imported, polluting, petroleum-based fuels. California's Zero-Emission Vehicle Regulation has a 9.5% electric vehicle sales goal for 2020 that increases to 22% by 2025. While this may be good news for our air and local economy, grid impacts are still uncertain. Portions of the grid are not designed to handle the huge power draws required by electric vehicles – some of which pull electricity at the rate of nearly 17 kW, or about four times the typical peak load of an entire home on a hot summer day.

Fortunately, the state is focused on enabling a pathway for how new technologies, rate reforms and the simple use of automation can cost effectively help reach state energy and environmental goals. In fact, a vision is already in place that simply needs to be implemented.

Shortly following the California electricity crisis of 2000-2001, a joint proceeding on demand response and advanced metering led by the California Public Utilities Commission (CPUC) and the California Energy Commission (CEC) spawned the large and very successful Statewide Pricing Pilot, which was designed to test the benefits of time-based pricing enabled by advanced metering. Its successful completion resulted in a PUC order for the three largest utilities to install smart meters for all customers, with the expectation that time-based rates similar to those tested in the pilot would eventually be extended to all California customers.

As the utilities worked on installing the new meters, the California agencies, now joined by the California Independent System Operator (CAISO), continued their collaboration. In 2008, they put forth a joint vision statement of a future electric grid that incorporated the information, rates and technologies that would allow electricity customers to adjust their electricity usage in response to time-varying signals from the grid. The statement read:

> "All California electricity consumers will have the opportunity and capability to adjust their electricity usage in response to time-varying signals reflecting economic, reliability or environmental conditions." (June 2008)

Since 2008, this vision has been echoed by many, perhaps most recently by Jon Wellinghoff, outgoing chairman of the Federal Energy Regulatory Commission, who said:

> "Consumers should have access to and be able to respond to five-minute wholesale prices. They should have the opportunity – not the requirement, but the opportunity – to respond to those prices and modify their loads and usages to lower their energy costs. The result would be an optimized use of the grid." (August 2013)

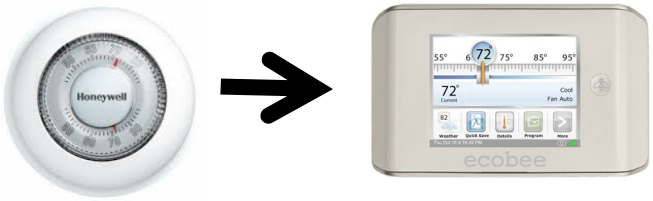
Five years after this Vision Statement and more than a decade after the end of the California electricity crisis, how much progress have we made, and how much is still left to do? Are we still on course to achieving this vision and meeting each of the hard-fought, agreed-upon goals? How can we incorporate the best minds and businesses in California to help achieve the remaining goals, while growing jobs and revenues in the process? The goal of this document is to review these questions, assess our standing, and determine whether and what course adjustments are in order.

"AIM" FOR GRID 2.0 - AUTOMATION, INFORMATION AND MOTIVATION

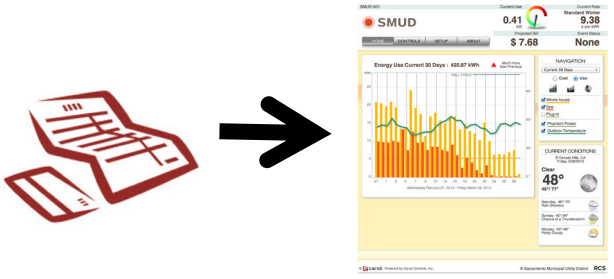
New rates, better information, and new technologies have the potential to reduce energy consumption and help balance the grid. Smarter data and devices can equip customers to conserve, make efficient purchases, and shift electricity use to times when cleaner energy is plentiful. Together, these changes have the potential to significantly reduce building energy use and GHG emissions in California. To get there, California needs to focus on using the new Advanced Metering Infrastructure (AMI) for Automation, Information and Motivation, (IMA).

AMI → AIM

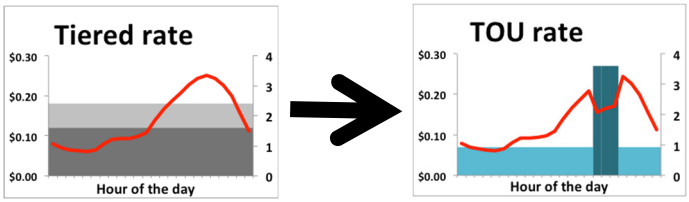
Automation – Programmable and communicating controls, such as smart thermostats and smart electric vehicle chargers, help customers schedule large loads to run when electricity is cheapest. In the long term, such smart automation has the potential to optimize needs between the customer and the grid, opening the possibility to vastly increase grid-connected battery storage and real-time supply-demand balancing.



Information – Hourly data collected by the new smart meters enable detailed, customer-specific presentations of information via bills, websites, or consumer technologies. This enhanced data presentation is expected to bring demand-side benefits under the assumption that customers with more detailed information will take action to use energy more efficiently.



Motivation – Time-varying rates enabled by AMI provide increased motivation for customers to use energy more efficiently, either by changing their behavior or by purchasing and programming automation devices that do it for them. Time-of-use (TOU) rates are designed to motivate customers to save money every day, by shifting discretional energy use to low-price periods. Critical peak pricing (CPP), in contrast, encourages deep savings only on the most critical system days.



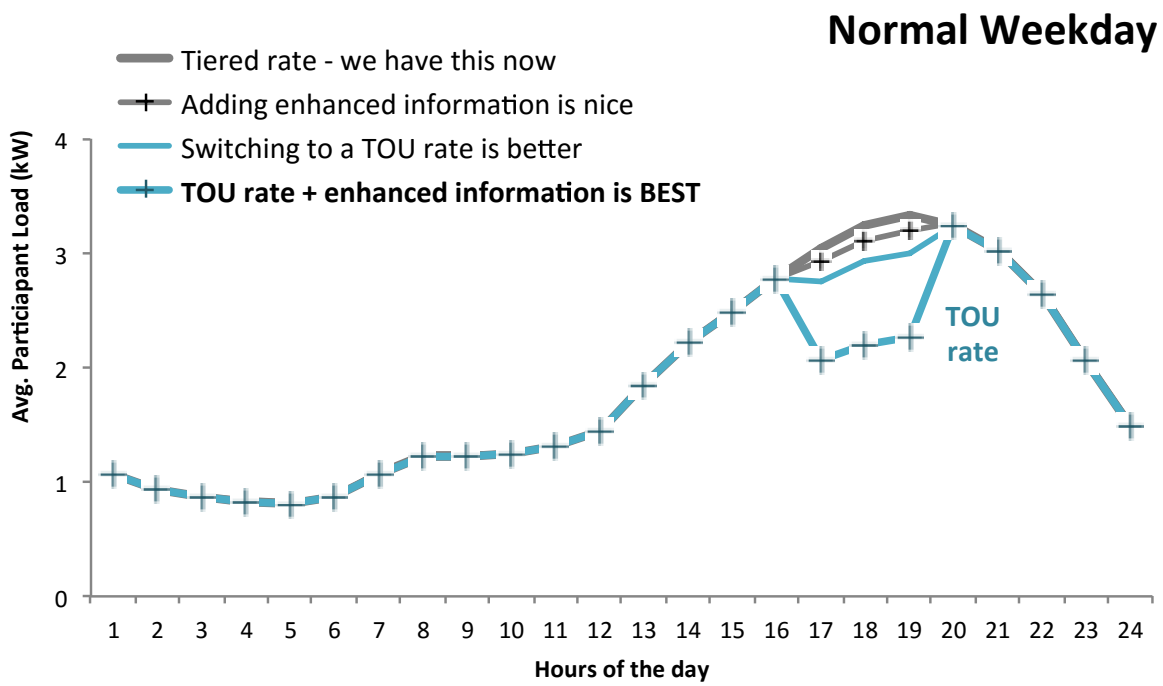
LESSONS LEARNED *from* RECENT PILOTS

Since the groundbreaking California statewide pricing pilot was completed in 2004, dozens of utilities across the nation and around the world have conducted their own field pilots to test the potential efficiency and reliability benefits of program offerings enabled by their newly upgraded grid and advanced metering infrastructure (AMI). Across these pilots were tested various forms of information display, time-varying rates, and automation devices – sometimes alone, sometimes combined with one or both of the others.

Overall, pilot results show that each of these strategies work to some extent, with considerable variation depending on factors like location, weather, implementation approach, and evaluation details. Despite the inevitable variations, one overarching and logical trend emerges: individually, these strategies have measurable positive impacts, but together, there are synergistic effects that are impossible to ignore.

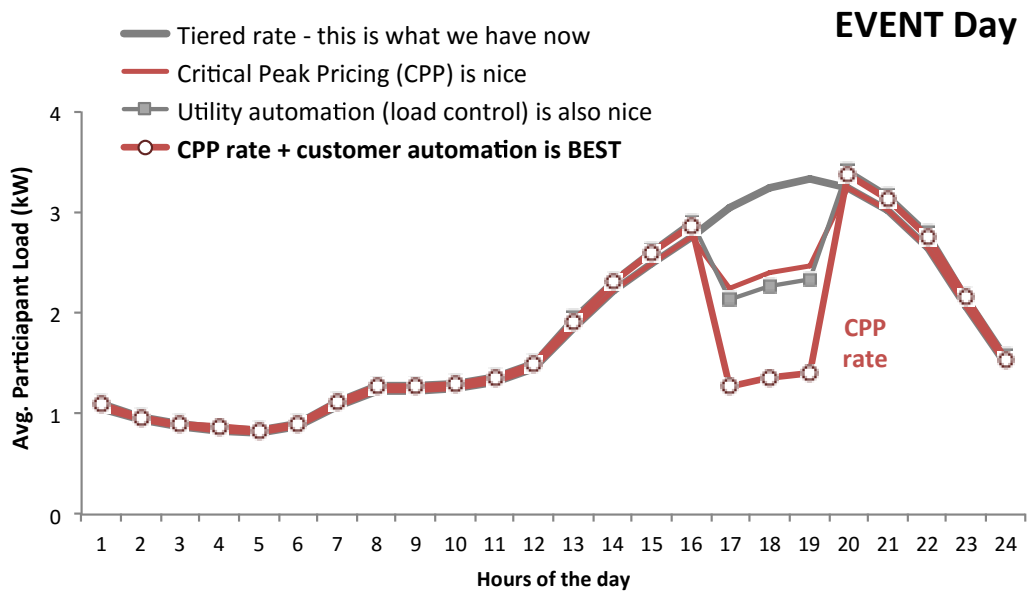
In a series of some of the best designed experimental pilots completed to date, customers in Sacramento, California, showed peak reductions of about 4% when provided with enhanced information, which included real-time energy use data and time-of-use efficiency tips (grey lines FIGURE 1). Peak reductions increased to 10% for customers who signed up for a TOU rate without enhanced information – but those who received both the TOU rate *and* enhanced information shed a staggering 30% of their load every weekday throughout the summer (blue lines FIGURE 1).

FIGURE 1: Energy savings from enhanced information and TOU rates - on a NORMAL day



These same Sacramento pilots also tested what would happen on system event days, known to customers as "Conservation Days" – when temperatures reached to as high as 110 degrees Fahrenheit. The utility notified customers by email, text and phone messages, and posted event parameters to an OpenADR server for access by smart thermostats. Under these conditions, participants on the tiered rate with utility-controlled thermostats shed about 30% of their peak load (grey line) – roughly the same as participants exposed to a CPP rate of 75 cents without smart thermostat automation. But once again, those who had OpenADR thermostats that they programmed to automatically respond to the CPP price events showed the greatest response, shedding 60% of their load when the utility needed it most.

FIGURE 2: Energy savings from enhanced information and TOU rates - on an EVENT day



The savings shown in FIGURE 1 and FIGURE 2 have the potential to significantly improve system peak efficiencies for the utility. In addition, because these participants reduced their summer energy consumption by 5%, such programs also have the potential to significantly reduce greenhouse gas emissions and customer bills relative to the standard tiered rate. [i]

With the new meters, utilities can now design electricity pricing to meet hourly system needs, promote devices that help customers respond to and benefit from these prices, and provide messages that encourage both efficiency and *time-of-use efficiency* – i.e. conservation when electricity costs more, is more polluting, or is in short supply. As some customers modify their behavior in response to the new time-varying rates, upgrade to more efficient peak appliances, and make use of home automation to avoid peak energy use, grid efficiency will be improved, carbon emissions avoided, and rates and customer bills reduced.

FEEDBACK STUDIES (INFORMATION)

Over a hundred years of user-unfriendly analog meters contributed to a lack of understanding among customers about how electricity was used in their homes and buildings. Now that we have more frequent data, customers can review current and historical energy use and costs for their homes, and compare their own data to other similar customers on devices like computers, smart thermostats, and smartphones.

Energy Use Data

The simplest way to provide new smart grid enabled information is to post hourly energy data values on customer account websites – usually with at least a 24-hour delay. One of the great advantages of this type of information program is that they can be applied more or less universally without an expensive recruitment effort. On the down side, recent California studies show that utilities can expect only about 2% savings from this type of program in the short term, and persistence of these effects over the longer term is uncertain.

Another option is to provide instantaneous demand data in "real-time" to customers, within seconds of use. Since AMI systems in California are not designed to allow real-time data to be provided over the internet, local technologies – in the form of a gateway, an in-home display, or both – are always needed for real-time data display, making such programs significantly more expensive. Studies of real-time energy use indicate slightly higher energy savings levels of between 4 and 7 percent.

In both cases, the provision of energy use data to customers is often hindered by data processing complications, data presentation complexities, and privacy and security concerns related to third party access to customer data. These barriers plus and the limited energy savings potential make the provision of real-time energy data a lower priority for California than the provision of price data and event notification.

Electricity Price Data

Studies show that customers are unaware of how much they pay for a kWh of electricity at any given time. Much of the blame for this lies with the current tiered rate structures, which make it impossible for utilities to post prices that apply to all customers, because the price for each customer depends on how much electricity they consumed since the end of their last billing cycle. Non-tiered time-varying rates don't have this shortcoming, and in fact, non-tiered rates are already posted for some commercial customers. Posting prices for residential customers would not only offer a higher level of service and education, it would also encourage the use of customer technologies designed to respond to those prices, and to system conditions.

Event Notification

TOU-CPP participants in the California Statewide Pricing Pilot responded more to the weekday peak rate than did those on the TOU rate alone. This difference can be explained by the increased customer engagement opportunities afforded by the CPP events. Event notification gives the utility unprecedented opportunity to connect with their most engaged customers – i.e. those who are willing to take part in rates or programs designed to keep the grid up and running in emergencies. Emails, texts or phone calls generated to notify customers of upcoming events can be filled with useful tips on how to best respond – and the motivated and engaged customers receiving them are more likely to take action, which

has the potential to effect their bill in a very immediate and salient way. As actions become habits, lessons learned on these event days carry over to non-event days. Customers in these programs become responsive not only to occasional short-term events, but are also more knowledgeable and better prepared to avoid peak use *every* weekday.

PRICING STUDIES (MOTIVATION)

Limited by the monthly readings of analog meters, early efforts at energy efficiency encouraged conservation through inclining block or "tiered" rates, which increased as monthly consumption increased. Proponents of these rates hypothesized that customers might conserve to avoid the higher-priced electricity later in their billing cycles. In reality, however, this theory appears to be untrue. A recent study of southern California customers showed that those on a tiered rate used slightly *more* energy than those on a flat rate, lending credence to the opposing theory that cheap energy in the early part of billing cycles *encourages* energy use for most customers, offsetting any savings that might occur in the higher tiers.

In 2006, the State of Illinois required all major utilities to provide residential consumers with access to hourly, market-based electricity prices. Since then, participants in these pricing programs have saved over $20 million on

In 2013, nearly all of California's residential customers still pay for electricity on tiered rate schedules, but this may change soon. Not only do tiered rates not save energy, they also provide no financial incentive for customers to shift load away from system peaks or towards times of clean energy production. Another major issue is that the larger users on tiered rates subsidize the smaller users, providing an opportunity for third-party electricity suppliers to pick off the overpaying high-use customers, leaving only the underpaying customers to support the default utility. With these facts in mind, the executive board of the Sacramento Municipal Utility District (SMUD) unanimously voted to abandon their default tiered rate structure in favor of a non-tiered time-of-use rate, expected to go into effect by 2017.

Such time-based pricing options may not appeal to all customers, so in most cases, utilities including SMUD will give customers non-TOU options. However, under time-varying and dynamic rates, those who can and are willing to shift energy use to better align with system needs have the potential to benefit themselves, their fellow customers, and the grid.

TECHNOLOGY STUDIES (AUTOMATION)

One of the great promises of the new grid is the ability for self-healing and automated response to short-term supply variability, introduced through intermittent renewable supplies or other unexpected loss of load events. The vision for the future involves millions of loads connected to the grid through advanced systems that automatically buffer these fluctuations without noticeable reductions in service to customers. For this to work, control systems at each participating building must work as the mediator between the needs of the customer and the needs of the grid – an issue that is at the center of considerable controversy as California hammers out the complex privacy, security and ownership issues involved.

While these issues are being resolved, however, there remain paths for moving forward without risking customer privacy or data security. Probably the best example of this is OpenADR, an open standard developed by Lawrence Berkeley National Lab and acknowledged by NIST, which has been used successfully by all of the largest California utilities for demand automation in large buildings. It works as an internet-based bulletin board where utilities post real-time and day-ahead prices or event notifications. OpenADR-compliant building automation systems are designed to retrieve this information regularly, and then respond by modifying internal building loads as programmed by the building owner. Under this system, only utility pricing and system status information is made public. Customer data is not transferred to a third party, customers maintain control of their ow n building operations, and the needs of both the grid and the customer are met.

This same system, which maintains security and privacy for commercial and industrial customers, has been proven effective for notifying residential and small commercial customers of events.[ii] Beyond a few pilots, however, OpenADR has not yet been adopted for mass-market use, where automated control of loads like air conditioning and electric vehicles could go a long way toward meeting short-term system reliability needs.

Half of the participants on SMUD's TOU-CPP rate with an OpenADR-compliant thermostat saved at least $100 in a single summer, implying an

In the near future, electric cars connected to grid-friendly chargers, such as those being designed by California-based AeroVironment, could combine publicly available information through OpenADR servers with charging needs programmed by the driver to determine the optimal charging schedule, keeping the drivers energy bills low, absorbing excess electricity when intermittent supplies are plentiful, and cutting back when the grid is running low.

Similar control algorithms are available in communicating thermostats, which use price or event information to optimize cost and comfort through small temperature adjustments within owner specified ranges. Such thermostats are already available for retail purchase from companies like Emerson, Ecobee, and Nest – however, until residential prices become available on OpenADR servers, capabilities are currently limited to manual remote control by the customer. A recent study here in Sacramento showed that smart thermostats with access to data posted on an OpenADR server helped customers cut their bills by an average of $145 over the course of the summer, while reducing energy use by 4%, weekday peak loads by more than 30%, and event peaks by almost 60%.[iii] Where utilities, rather than customers, controlled the air-conditioning response – similar to a standard AC load control program – event response was halved and non-event day peak and energy savings were non-existent. In the absence of automation, peak response was just 10% on weekdays and 26% during events.

SUMMARY *of* BENEFITS

1. Time-varying Rate

- Lowers energy use
- Improves peak savings
- Improves event savings
- Lowers customer bills
- Encourages customers to seek out enhanced information
- Encourages use of automation for peak and event response

2. Enhanced Information

- Lowers energy use
- Lowers bills
- Improves peak load shed

3. Customer Automation

- Gives customers control over their own appliances and bills
- Doubles event savings
- Lowers customer bills
- Enables reliable response to

Not all automation technologies need to communicate with the grid to benefit customers and the system. Non-communicating "TOU-ready" technologies, which are generally less expensive and easier to maintain, can help regulate regular daily system peaks. Software-based schedules in standard non-communicating thermostats can be designed to be more flexible than the current 4-period schedule required by the current California Title 24 code. With dynamic and time-of-use rates expected to be an option for nearly all California customers over the next 5-10 years, thermostats sold now should be designed to allow customers to program precooling[iv] and peak offsets – lowering target temperatures just prior to peak periods, and then increasing target temperatures during the peak, thus providing the opportunity for customers to save significantly on their electricity bills by taking advantage of cheaper off-peak pricing while maintaining comfort in their (hopefully well-insulated) homes. Likewise, timers and sensors for other end-use loads can limit energy use during high price periods.

A NEW VISION FOR THE GRID

Across a variety of entities and organizations, the stated benefits of including a more flexible demand to improve supply-demand balance vary little, if at all. Joining the CEC, CPUC, CAISO, and FERC in this vision are the Natural Resources Defense Council, the Environmental Defense Fund, and many others, who outline the expected benefits of the smart grid as:

- Maintaining grid reliability
- Presenting information that customers can use to better understand and control their electricity use
- Providing the opportunity for customers to receive direct financial benefits by shifting energy use to discounted off-peak periods
- Allowing for the increased integration of clean renewable resources by shifting electricity use to times when intermittent resources are abundant
- Lowering electricity costs for all customers by enhancing market efficiency, mitigating wholesale market power, and deferring investment in generation, transmission, and distribution

To achieve these benefits, the joint vision statement goes on to list more than thirty principles and goals focused on customer education, rates, technologies, infrastructure, markets, and further agency collaboration. Here, we outline some of the major themes and comment on progress made to date.

FIGURE 3. Major themes of California's Vision Statement

California's Vision	Progress	Notes
1. Metering Infrastructure. Provide all customers with cost-effective advanced metering systems capable of supporting hourly (or better) time-varying rates and timely customer access to energy use data.	Good	More than 80% of California buildings have such meters as of 2013.
2. Customer focus. Design all programs, contracts and tariffs to be customer-oriented, simple, voluntary, and easy for the customer to understand and implement.	Improv.	Organizations like the Smart Grid Consumer Collaborative are shedding light on what consumers want and expect. Utilities are ramping up to provide better information to customers.
3. Energy use data and education. Provide all electricity customers with timely, no-hassle access to their own energy use and cost data. Educate customers on the benefits of time-of-use (TOU) efficiencies and the actions they can take to help.	Improv.	Historical (day-old) energy data is commonly provided through password-protected accounts, however, technology problems continue to hinder the provision of real-time energy data.
4. Time-varying rates and education. Provide all customers with the option to pay for electricity according to time-of-use or dynamic rates that are revenue neutral or discounted according to risk value, giving customers the opportunity to save money by shifting energy use to discounted off-peak periods.	Improv.	Most large customers now pay according to time of use. In the residential sector, PG&E has probably made the most progress with its TOU, CPP and TOU-CPP rates (SmartRate). Utilities are updating websites and other customer communications accordingly.
5. Customer technologies. Use open standards and architectures to encourage plug-and-play compatibility with devices that receive, display, and/or respond to electricity prices, event notifications, and real-time energy data.	Needs	NIST has adopted draft standards for OpenADR and Smart Energy Profile, but SEP 2.0 is still being tested, while OpenADR services have been limited to commercial facilities despite successful residential OpenADR pilots.

CUSTOMER VISION *for the* ELECTRIC GRID

Research completed since the California vision was scripted shows that customers are interested in time-varying rates and related enabling technologies. To reflect these desires, the following customer focused goals:

FIGURE 4. The Customer's Vision of the Electric Grid

Customer Vision	Progress	Comments
1. Price data and education. Provide us with no-hassle access to the price of the electricity we are currently using in our homes, along with the near-term (24-hour) forward prices. Provide better information on the expected effects of switching to new rates based on our actual historical energy use.	Needs	The existing web sites and tariff sheets that explain customer rates are nearly indecipherable. Utilities have the ability to post non-tiered pricing in a standard format on OpenADR servers but there is no way to post tiered pricing information because it is customer-specific. PG&E does have a website showing the effects of switching to different rates.
2. **Technology support and education**. Work with vendors to develop plug-and play technologies that support our ability to automate or remotely control our own loads in response to daily TOU peaks and occasional CPP events, or to help balance the grid in real-time. Provide better information on the availability, usability, and expected effects of such technologies.	Needs	TOU-efficient and grid-ready thermostats and EV chargers are expected to be the early entrants in new automation technologies. The 3 IOUs now have websites dedicated to a handful of SEP 1.x compliant devices that show energy data. Although capable, the smart thermostats cannot be used for event automation without OpenADR event notification.
3. Customer control and education. Provide us with the information needed to make an educated choice concerning whether to give up the controls, and then require our explicit permission for utility or third-party control of our appliances.	Improv.	Customer-controlled thermostat automation has been shown to be at least as effective as utility-controlled thermostat automation. Many (not all) customers are concerned about outside forces controlling their devices.

POLICY ACTIONS *for the* FUTURE

With the enabling infrastructure largely in place, now is the time to start using our new abilities for redesigning utility-customer relationships through improved education and motivation. Once customers have the information they need and the motivation to do something about it, they will look to utilities and others for help choosing automation devices needed to manage their electricity bills and contribute to the reliability of the grid. Following is a short list of recommended policy actions that will help move us in that direction.

		ENABLES		
		Customer Motivation	Customer Information	Customer Automation
CRITICAL	Residential event notifications should be posted on utilities' existing OpenADR servers so customer devices can automatically retrieve and respond as programmed by the customer.			▯
	Utilities should post hourly electricity prices for all non-tiered rates on their OpenADR servers.[v]	▯	▯	▯
	The State should remove AB1x requirements for tiered rates, which disallow the posting of prices.	▯	▯	▯
RECOMMENDED	Develop a standard data template for electricity rates (i.e. a vCard for rates)	▯	▯	▯
	Incorporate electricity rate, natural gas, and water data in the Green Button standard.		▯	
	Determine cost-effective participation goals for the new time-varying rates.[vi]	▯		
	Develop a database of consumer devices that are compliant with utility event notification standards (e.g. OpenADR or SEP).		▯	▯
	Develop a database of non-communicating consumer devices for daily peak load shifting (e.g. TOU-ready thermostats).		▯	▯
	Offer customer rebates for utility-compliant automation.			▯

GLOSSARY

PRICING

Tiered rate. A rate with threshold kWh allowances per billing cycle, above which the price of electricity increases.

Time-varying rate. A rate that is designed to change according to the time of day. This includes static rates like time of use and dynamic rates with critical peak pricing.

Time of use (TOU) rate. A rate that changes in a predictable way throughout the day.

Critical peak pricing (CPP). The dynamic component of a base flat, tiered, or TOU rate that allows the utility to dispatch an event signal, usually 10-15 days per year, during which the peak price is significantly higher, to encourage customers to reduce energy use during that time.

EFFICIENCY

Time-of-use efficiency. The state in which customers manage the timing of their electric loads to improve economic, reliability, environmental, and societal outcomes.

TOU-efficient technology. A technology designed to enable time-of-use efficiency through, for example, programmed schedules, remote control, or automated response to price or event information.

TECHNOLOGY

Advanced metering infrastructure (AMI). A system of meters and related equipment that allows utilities to remotely collect hourly or sub-hourly energy use data from their customers.

TOU-ready device - a technology designed to enable time-of-use efficiency through programmed schedules or remote control

CPP-ready device - a technology designed to enable time-of-use efficiency through remote control or automated response to price or event information.

Grid-ready device - a technology designed to enable time-of-use efficiency through automated response to grid status.

Programmable communicating thermostat (PCT). A programmable thermostat with one or more radios that enable communications with the utility or other service provider.

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[i] SMUD's Summer Solutions Study and Smart Pricing Options

[ii] Residential OpenADR demonstration, Summer Solutions studies

[iii] SMUD's Residential Summer Solutions Study

[iv] SMUD's precooling study

[v] OpenADR servers are already installed at most utilities, but are used for commercial rates only. The same servers could be used to post non-tiered residential rates as well.

[vi] Participation rates of 20% opt-in and 90% opt-out have been shown to be achievable in the first year (SMUD 2013)