

# **New Approaches in a Heating Dominated Emerging Technologies Program**

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## **ABSTRACT**

As a gas-only utility, Southern California Gas Company (SoCalGas<sup>®</sup>) has the highest energy-efficiency (EE) program natural gas energy savings goals of the California investor-owned utilities (IOUs), but must enable them with the smallest overall Emerging Technologies (ET) budget. SoCalGas has less than 25 percent of the budget of ET programs at peer IOUs. The SoCalGas ET program must be nimble, making every dollar count, and be highly focused in the natural gas energy-efficiency arena while leveraging opportunities and resources to have the greatest possible impact and accountability to EE's overall success.

Gadget, widget, and single end-use point-based assessments have dominated the utility's EE and ET programs in the past. Integrated solutions, community-scaled zero-net energy, codes and standards support, behavioral savings, outreach to technology suppliers, as well as contractors, are the new approaches that are gaining traction in recent years.

Cross-cutting, holistic and integrated solutions are formulated and executed today by SoCalGas ET. Since the inception of California ET programs in 2005, SoCalGas ET's deliverables are ever-increasing and span across diversified EE measures, advancing codes and standards, integrated building systems designs, zero-net energy fronts and accelerating market transformation.

With 5.6 million customer accounts and ambitious EE goals to meet or exceed, such as 25 MMth EE savings achieved in 2013, SoCalGas ET is a vital link in the pipeline between research and development (R&D), the EE programs, the markets and the customers.

## **Introduction: Regulatory And Socioeconomic Settings**

In order to achieve California's Long-Term Energy Efficiency Strategic Plan (CLTEESP) goals, the state's regulatory agencies established the statewide Emerging Technologies (ET) programs. Each of the major California investor-owned utilities (IOUs) manages its own ET program within its territory while adhering to and remaining accountable to the California Public Utilities Commission (CPUC) decisions and directives. These ET programs are designed to support the development, understanding and implementation of new and underutilized energy-efficiency and demand response technologies. The value of these programs is evident. Aggressive energy-efficiency programs in California and New York have kept per capita energy use low when compared to the rest of the country (Figure 1). Although there are significant contributing factors other than EE efforts to this energy consumption trend (Levinson 2013), an EE program is necessary for the transition into an increasingly technology- and energy-dependent society with decreasing resource availability. Such programs also have substantial impact on overall per capita consumption, especially in the industrial and commercial sector (Pickenpaugh and Balash 2009).

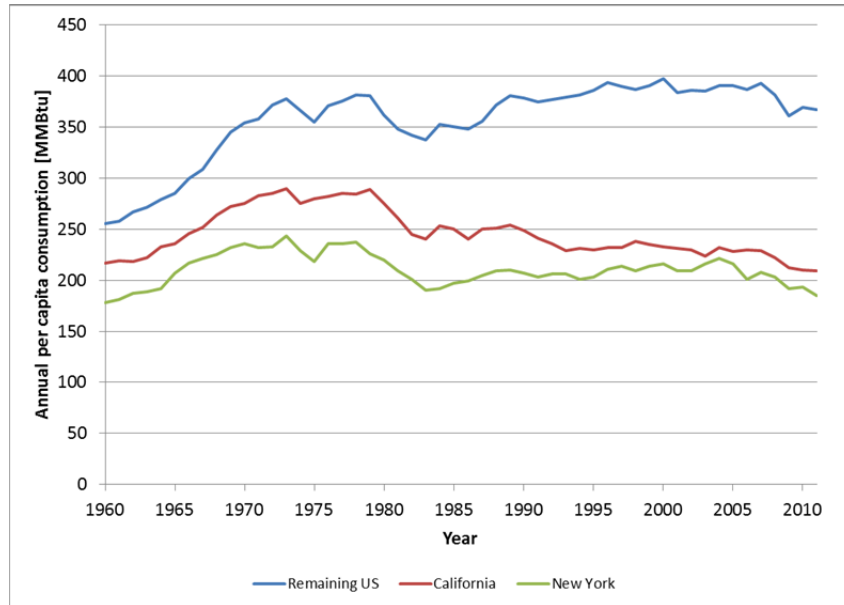


Figure 1. Per capita energy use in CA, NY, and the remaining United States (EIA 2013).

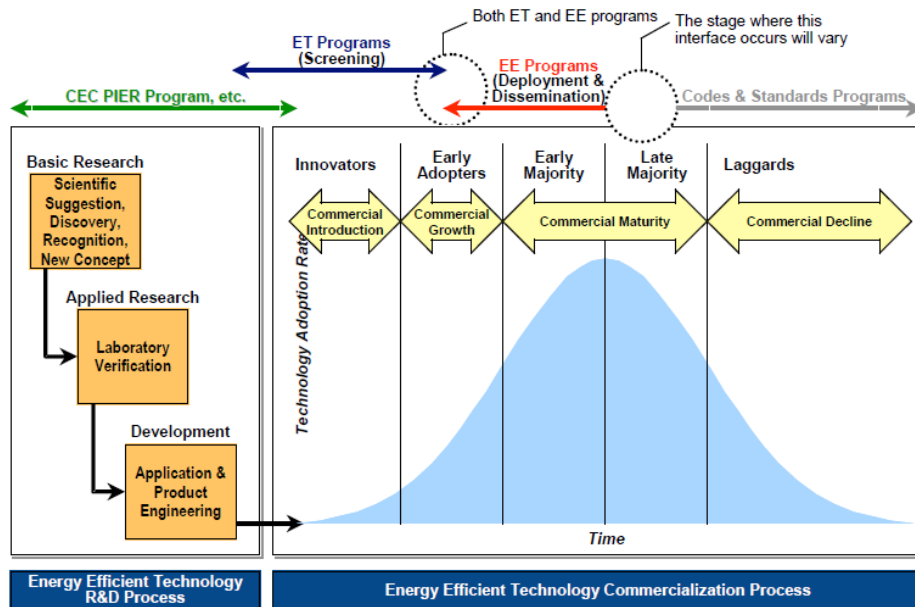
The CPUC sets EE savings goals and holds the IOUs accountable. Historical goals, achievements, and spending since the inception of the ET programs in 2005 are summarized (Table 1).

Table 1. Historical SoCalGas EE program savings summary (A. Nih, SoCalGas Regulatory Policies & Reporting, pers. comm. May 12, 2014)

Year	CPUC Savings Goals (MMth)	SoCalGas DSM Achieved (MMth)	Spending (\$MM)
2006	14.7	10.6	44.9
2007	19.3	22	51.6
2008	23.3	40.6	60.5
2009	27.2	24.2	49
2010	28.3	27.4	51
2011	29.9	37.9	58.2
2012	32.3	32.1	84.9
2013	24.1	25.4	52.8

The ET program is currently “non-resource” based under the EE program, and its direct contribution to the above is limited. However, their roles are ever-increasing and vital in ensuring the pipeline of measures are strategic for continued success in the future. ET programs generally approach these goals through technology assessments, laboratory and field studies, measurement and verification, demonstrations, market assessments and educational outreach. These projects often lead to publicly available publications, demonstrations, utility incentive and rebate programs and refinement of new technology designs. Through these methods, ET programs act as a screening process for new technologies in the energy-efficiency pipeline while

advocating for the most efficacious measures. ET programs fall in the early phases of the energy-efficiency technology commercialization process (Figure 2). In the past five years, SoCalGas ET has performed several dozens of assessments and published associated reports. With more than 5 million residential and 218,000 commercial and industrial customer accounts, SoCalGas and its ET program is a vital link between innovative EE technology and the consumer markets.



Source: Adapted from Southern California Edison

Figure 2. EE technology commercialization process (Rosenfield, Jenkins, and Shelton 2009).

In order to enable an effective and publicly beneficial EE technology commercialization process, the CPUC establishes yearly budget allocations for the ET programs of each of the major California IOUs (Table 2): Pacific Gas and Electric (PG&E), Southern California Edison (SCE; electric service only), San Diego Gas and Electric (SDG&E), and Southern California Gas Company (SoCalGas).

Table 2. 2013-2014 utility ET program budgets

	PG&E	SCE	SDG&E	SoCalGas
2013-2014 ET Program Budget	\$11,918,594	\$21,185,431	\$2,700,079	\$2,516,727

With this funding, each ET program is aiding CLTEESP through creative projects that must evolve with an ever-changing market. While each ET program evolves with continuing energy market transformation, they must also work cooperatively in order to maintain a concerted, coordinated effort that complements the others while not duplicating efforts.

As the California energy market evolves, gas utilities, the CPUC and consumers are challenged with meeting ambitious regulatory requirements and navigating changing market conditions related to natural gas:

- California greenhouse gas emissions targets (AB 32)

- South Coast Air Quality Management District Laws (e.g. electrification; NOx standard for furnaces & water heaters are reduced from 40 to 14 and 10 ng/joule in 2014 and 2007, respectively)
- CLTEESP goals and milestones in EE and Zero Net Energy (ZNE; e.g. 50% of new homes will be ZNE by 2020 and 100% by 2050)
- Natural Gas Policy Act (AB1257)
- Other traditional obstacles unique to gas technologies including vintage infrastructures, plateaued and exhausted innovations, lack of customer attentions, and the fact that lower U.S. natural gas prices translate to longer payback periods and less motivation, as compared to competing electric measures.

This list of challenges and obstacles is unique to the natural gas industry and will continue to shape EE programs in the foreseeable future. What remains to be seen, however, is how to best approach these challenges and budgetary constraints while meeting all necessary EE targets and milestones. SoCalGas ET is continuously morphing and reshaping its approach to programs and project development in order to meet these challenges and aggressive goals in the coming years for all customer sectors: industrial, agricultural, residential and commercial.

## A Unique Gas Emerging Technologies Program

Each utility ET program is unique with its own strategies and nuances and SoCalGas ET is no exception. There are several characteristics that separate SoCalGas ET from the others, encompassing financial, customer and engineering concerns.

For the 2013-2014 fiscal year PG&E has the largest natural gas ET budget and SoCalGas has the smallest, less than one quarter of the PG&E ET funding (Table 2). SoCalGas is the only one of the major IOUs dedicated to natural gas, so it does not develop electricity-focused measures. However, SoCalGas delivers more natural gas to California customers than any other utility. As a result, SoCalGas EE programs have the highest natural gas energy savings goals (Figure 3) but must enable them with the smallest overall ET budget. In 2013, SoCalGas exceeded its annual gas savings target by achieving 25.4 MMTherms/yr saved versus 24.1 MMTherms/yr targeted.

2013-14 Gas Goals	PG&E		SCG		SDG&E		Total	
	2013	2014	2013	2014	2013	2014	2013	2014
<b>Annual natural gas savings with interactive effects (MMTherms/yr)</b>								
IOU program targets	21.0	20.3	24.0	22.3	2.2	2.1	47.2	44.7
Codes and Standards Advocacy	0.1	0.6	0.1	0.9	0.0	0.1	0.2	1.6
<b>Total Gas Targets</b>	<b>21.0</b>	<b>20.9</b>	<b>24.1</b>	<b>23.2</b>	<b>2.2</b>	<b>2.2</b>	<b>47.4</b>	<b>46.3</b>

Figure 3. 2013-2014 natural gas savings targets for each utility EE program (CPUC 2012).

Additionally, while the other utilities have a vast variety of electric technologies and measures to study and encourage, SoCalGas is constrained by the fairly restrictive and limited nature of gas end-use technologies. In general, the SoCalGas end-use market is dominated by heating for various purposes, whereas electricity is used for a wide range of applications. Therefore, in order to be effective, SoCalGas ET must have especially refined criteria and

approaches to the various projects they select in order to meet their goals within the budgetary and technological constraints. Whereas electricity is highly valued in California, the economic benefit and payback of natural gas efficiency measures is limited by relatively lower energy costs. Natural gas measures must be creative and nimble in order to be cost-effective and attractive to customers.

In response to a shifting EE landscape, SoCalGas ET has been transitioning from an individual technology and widget based approach to more holistic, comprehensive solutions. This is the only way that advancing EE targets can be achieved within an increasingly restrictive environment. In the past, SoCalGas ET has focused on field and laboratory technology assessments of individual measures. While these projects continue to provide value to California, technological advancements and the acknowledgement of the coupling between all energy and utility systems has led SoCalGas ET to target bigger picture projects. In this way, the list of challenges above can be met with success.

## **Holistic Approaches to a Natural Gas Emerging Technologies Program**

SoCalGas ET has a portfolio of more than 40 current and planned projects. The portfolio is developing to increasingly include projects adhering to a holistic approach that supports and advocates emerging EE technologies. In addition to the general ET activities mentioned above, SoCalGas ET projects include the following activities.

- Scaled field installations, some as EE pilots
- Studies targeted at facilitating market transformation to accelerate adoption of existing rebate measures
- Integrated technology demonstration/showcasing in buildings and systems, using multiple measures interactive with each other
- Studies of behavioral adjustment measures
- R&D solicitations, which contribute to policy development with the California Energy Commission (CEC)
- Collaborations and leverage of funding with other utilities, industrial partners and research consortiums, in and out-of-state
- Supporting the development of California codes and standards with peer IOUs and the CEC

Each of these project categories complements and informs the others. In this manner, not only does each individual project take a holistic approach to its application and context, but the entire program is also of an integrated design with each project relevant to the others.

### **Scaled Field Installations**

One way in which SoCalGas ET continues to assess individual technologies is through scaled field installations. Single installations or laboratory studies, while valuable in early stages of technology assessment, do not reveal the subtleties and unexpected interactive effects that large-scale evaluations of measures in the field with diversified and realistic end-users provide. As such, it illuminates the barriers, benefits and conditional aspects of new or underutilized efficiency measures. For example, SoCalGas ET is currently ramping up studies of two types of

residential HVAC technologies. The participants were selected to represent the variety of conditions that would be present in the actual deployment of the technologies.

Two scaled field studies, including hundreds of smart and learning thermostats of various models (e.g. Nest<sup>®</sup>, ecobee<sup>®</sup>, Honeywell Wi-fi<sup>®</sup>, etc.), are planned for completion in 2015. While the functionality and purpose of these advanced thermostats is well understood and validated, their full potential impact on California's residential heating market remains unknown. The studies will reveal customer appreciation and rejection of various advanced thermostat strategies, energy-savings potential across conditions such as climate zone and building type and will provide important information for the development of targeted, effective EE rebate/incentive programs. Such information could allow for tailored programs that can match the best type of advanced thermostat to the appropriate customer application.

Another scaled field study example is a year-long evaluation of tankless water heater systems that serve both domestic hot water distribution and fan coil hydronic heating in 30 single-family residences (SFRs). By replacing the existing water heater and furnace with a single, high-efficiency heat source, available funds can be leveraged for increased efficiency and reduced footprint. While this type of system has been available for some time, advances in the integration of SFR space and water-heating systems has improved effectiveness and reduced delivery problems of previous designs. Preliminary modeling suggests energy savings of 30 percent are possible. This could have a large impact by saving energy in the two highest consuming residential gas end-uses by utilizing a combined system EE measure. This project is under collaboration with the Gas Technology Institute (GTI) and leverages the network of experienced contractors affiliated with the Energy Upgrade California (EUCA) program. A report of the results is expected in 2015 through the Emerging Technologies Coordinating Council (ETCC).

## **Market Transformation**

SoCalGas ET facilitates market transformation by performing evaluations and testing of various new energy-efficiency products, both incentivized and not, on customer sites. This assists manufacturers to improve new products and contributes to customer decision making in adopting the measure either with or without rebates/incentives. One example project is field testing of ENERGY STAR<sup>®</sup>-certified foodservice fryers in 17 commercial kitchens. Although a utility rebate program already exists, it has low subscriptions. Positive preliminary results show significant gas savings and even more savings in extending oil life. Thus, several restaurant owners, previously reluctant to change, plan to purchase additional high-efficiency fryers after the demonstration. The final report will be released in early 2015, which will yield information that will encourage a shift toward models that use infrared burners, pulse combustion, insulated vats and recirculation tubes to achieve equal/higher performance with less fuel. This project has great savings potential, as it targets statewide transformation of the most commonly used appliance type by the highest gas consuming customer type in California: the food service industry. Other examples include high-efficiency wall furnaces in affordable multi-family homes, the low-flow pre-rinse spray valve (PRSV), and on-demand stovetops for restaurants (Figure 4). As with the ENERGY STAR fryers, the first two technologies have existing rebates but low subscriptions. The last technology is an initial manufacturer release needing customer feedback and solid demonstration of potential of fuel savings, before work paper and rebate incentive can be recommended.



Figure 4. Four ongoing market transformation tests: high efficiency fryer, PRSV, wall furnace, and stovetop with demand control.

### **Integrated Technology Demonstration/Showcasing**

In the energy-efficient buildings of the future, domestic hot water, space heating, gas distribution, controls, process heating and all other gas, electric and water uses must be considered as a whole. This is supported by the CLTEESP zero-net energy (ZNE) targets for both residential and commercial buildings, in addition to specific codes and standards (California Title 20 & 24).

In advance of meeting those targets, SoCalGas ET is currently working on several building demonstration projects including a Laundromat of the Future, Restaurant of the Future, Smart Gas Home, a near-ZNE low income housing deep retrofit, and a commercial near-ZNE community center. SoCalGas ET is also working with new home builders to incorporate EE technologies in their offerings such as drain water heat recovery, combined hot water and hydronic heating, tankless water heaters, advanced thermostats and best practices plumbing designs.

The Laundromat of the Future project will consist of measurement and demonstration of a combination of current and emerging energy-saving technologies in a commercial, coin-operated laundromat. Installation is scheduled for the fourth quarter of 2014, and reporting is planned for the first quarter of 2016. Potential technologies include several water-heating EE measures, high-efficiency clothes washers, and high-efficiency water heaters. With the combined measures (Table 3), fuel savings would be close to 67 percent (2,560 annual therm savings from a baseline of 3,800 therms for water heating in a typical laundromat 3,500 square feet in size), excluding potential dryer efficiency measures. Note that all savings numbers are based on end-use consumption, not whole-building (facility) consumption. Typically, laundry equipment accounts for approximately 90 percent of a Laundromat's utility costs, with 35-50 percent attributable to water heating, primarily using gas-powered water heaters (Navigant 2012). Considering that 65 percent of laundromat owners feel that utility costs (which are generally 25 percent of gross revenues) are among the top problems for their business, these measures present a good opportunity for a utility rebate program (Navigant 2012).

Table 1. Laundromat of the future potential hot water measures

Equipment Planned	Payback (years)	Estimated Energy Savings
Desuperheater	2	35%
Drain water heat recovery	4.5	10%
Boiler tune-up	0.5	8%
Tank Insulation	0.8	7%
Hot water circulation demand or time clock control	0.25	5%
Pipe insulation	0.25	2%
Heat trap	0.5	1%
CEE Tier 3 clothes washer	1.5-2	30%
Condensing water heater	17	24%
Solar water heater	9	50%

The Laundromat of the Future project would also potentially include dryer efficiency measures such as modulating gas valves or thermal recycling of hot exhaust air (Table 4).

Table 2. Laundromat of the future potential clothes dryer measures

Equipment	Payback (years)	Estimated Energy Savings
Thermal recycling of exhaust heat	-	37.5%
Modulating gas valves	1-2	25%

As stated before, commercial food service customers are the single largest type of natural gas consumer in California. Therefore, SoCalGas ET is planning a Restaurant of the Future demonstration project, that would integrate multiple EE measures into a single high-efficiency establishment intended to serve as a model building (Table 5).

Table 3. Restaurant of the future potential measures. savings numbers are per appliance.

Equipment	Estimated Energy Savings
Drain water heat recovery	10%
Condensing water heater	24%
High-E salamander broiler	25%
RTU heat recovery for DHW pre-heating	35%
Low-flow pre-rinse spray valve	25%
High-efficiency fryer	50%
On-demand stove top	50%

Similar to the Laundromat and Restaurant of the Future projects, SoCalGas ET currently has Smart Gas Home and near-ZNE community center showcasing projects that use a holistic approach toward building energy savings. The Smart Gas Home project integrates advanced residential energy-efficiency measures into a home area network (HAN). In practice, such a home would inform and enable customers to make wise energy decisions while reducing gas and electric end-use consumption. Reporting is scheduled for the third quarter of 2015 via ETCC.



The near-ZNE community center project (Figure 5) has a complementary combination of solar photovoltaic and natural gas engine combined heat and power (CHP) energy generation, tankless water heaters, liquid pool covers, high-efficiency pool heaters and an energy dashboard to target ZNE status for a central gathering building for residential communities. Construction completion is scheduled for the third quarter of 2014. Reports will be available in 2015 and 2016 through ETCC.

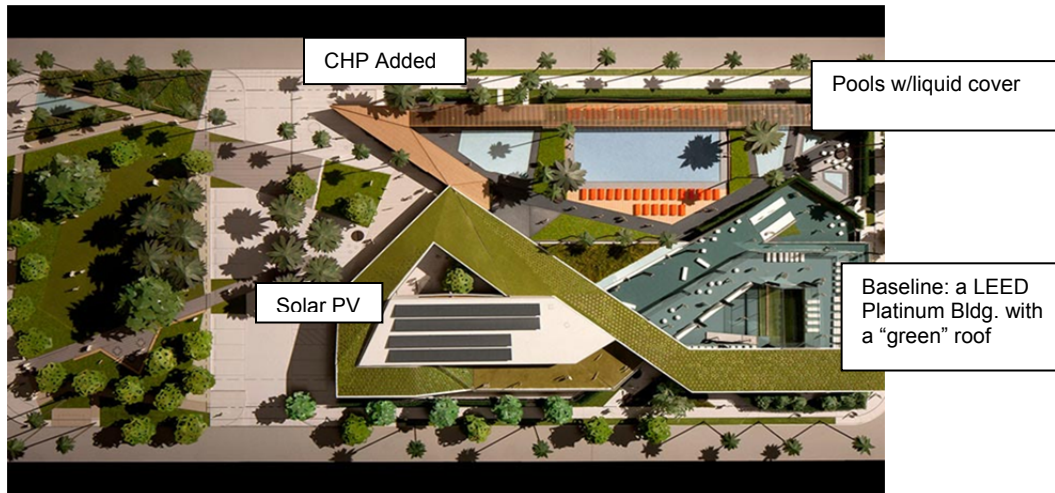


Figure 5. A commercial Near-ZNE community center design.

## Behavioral Measures and Connectivity

As the market of technological solutions and end-point applications of energy-efficiency measures becomes saturated, customer behavioral changes will be necessary for conservation. Typically, EE programs have shunned behavioral measures, but HANs, cloud-based analyses, and the availability of affordable sensors and communication devices are making conscious energy-saving decisions a more attractive target. A strong case can be made for the affordability and effectiveness of engendering conservation behaviors in customers through various creative programs, including new billable information services.

One type of technology that will help enable behavioral measures is innovative compact gas telemetry (Figure 6). Historically, only the main gas supply line has been measured, due partly to meter cost and size constraints around other appliances. The new compact and affordable flow meters enable measurement of gas consumption at end-uses such as water heaters, stoves, furnaces and burners. Equivalent to existing electrical products, a gas HAN or combined gas and electric HAN can provide occupants with a complete, real-time understanding of their energy use. Not only will HANs bring on-site gas monitoring networks into the new connected age, but will allow for behavior-based conservation through psychological impetus. SoCalGas ET has supported the development of such meters and, following safety certification, plans to demonstrate their functionality as integrated into a wireless HAN in 2014.



Figure 6. HAN-compatible compact inline gas meter.

Similar to HANs with integrated compact inline gas meters, SoCalGas ET is also studying advanced metering infrastructure on the main distribution systems. These increased gas telemetry and measurement capabilities in both buildings and main distribution networks will enable detailed research and data analysis for improved customer understanding, leak detection, theft detection, and as-yet-unknown analytics.

### **Outreach and Tools**

In general, these efforts will not be fully effective without educational outreach and publicly available materials. SoCalGas ET is an active participant in the Technology Resource Innovation Outreach Program (TRIO) and ETCC. TRIO events include symposiums and roundtable sessions which provide information to entrepreneurs and energy industry professionals on how California IOUs function, how to find solicitations and how to best enter their intellectual products and services into the California EE pipeline. Aside from supporting the administration and design of such outreach programs, SoCalGas ET also offers funding for new energy-efficiency technologies through a request for proposal (RFP) process. This year an RFP for the 2013-2014 Technology Resource Innovative Program (TRIP) from SoCalGas ET will have \$300,000 of funding to one or two emerging technology pilot projects. Meanwhile, the ETCC is a means for coordination of IOU EE members and a space for public dissemination of all final ET assessment reports for public use and consumption.

SoCalGas ET is also involved in the development of EE scoping tools in order to facilitate and streamline EE projects in industry. In collaboration with the CEC Public Interest Energy Research (PIER) program, SoCalGas ET supported the development of a suite of industrial (ETCC 2009) and residential calculator tools that estimate energy and cost savings of various EE measures. Available online, these tools let facility managers and customers quickly estimate the impacts of various available measures as the first step toward allocation of resources. These screening tools aid selection of the most cost-effective solutions and to attract otherwise uninterested customers to EE efforts. A separate tool in development will predict the commercial adoption curves of emerging technology measures. Such a tool would be invaluable in managing the start and end of measures and rebate incentive offerings.

## **Leveraging Resources through Collaboration**

Several of the above mentioned projects are collaborative efforts with research institutions, customers and other utilities. All SoCalGas ET projects and undertakings are planned with stakeholders, other utilities, regulators and customers in mind. Therefore, the SoCalGas ET portfolio is developed with a focus on collaboration with other utility systems both locally and outside SoCalGas territory.

A further case for utility collaboration specific to combined utility use is domestic hot water, which consumes electricity (for pumping), gas (for heating) and water. This water-energy nexus is a prime example of the inherent need for collaborative development of programs and conservation measures (Young 2013; Cooley and Donnelly 2013). Along these lines, a project currently in the planning stages would evaluate IT-enabled hot water use at a large number of customer sites, in collaboration with the UC Davis Center for Water-Energy Efficiency. New measurement, monitoring and messaging-based networks applied to hot water use networks can allow for statistical analysis and disaggregation of consumption patterns. This type of analytical tool is powered by the same technologies that allow gas-enabled advanced meters and HANs and can aid in transformation of combined utility consumption. Several California water utilities have deployed this technology, resulting in a preliminary prediction of 5 percent energy savings. With other large utilities, such as the Los Angeles Department of Water and Power, interested in participation, this joint opportunity is not one to be ignored.

SoCalGas ET also uses collaboration to achieve its need to be nimble and money-wise. On average, a simple widget-based test project costs approximately \$50,000, using in-house lab staff or external consultants. For a complex project that requires multiple field test sites, longer testing periods, behavioral changes, showcases and multiple interactive technologies, the budget required can be more than ten-fold larger. As a result, SoCalGas ET leverages the support of other departments within the company, negotiates direct discounts with manufacturers, seeks external co-funding partners and/or bids for CEC grants. These strategies have proven to be very effective.

## **Regulatory Support**

Finally, as a key player in the California utility market, SoCalGas can provide critical input to long-term energy plan discussions. SoCalGas ET will continue to provide insight into California's development of codes and standards, zero net energy goals, and EE plans by testing new standards, providing a gas utility perspective, services, and consumer options, and by implementing cutting-edge projects that reflect the future of buildings and gas utilities.

## **Conclusion**

As California's energy market, end-uses, and infrastructure shift with technological advances, SoCalGas ET will continue to play a pivotal role in impacting policy objectives, program offerings and market transformation toward an efficient and streamlined system. Since electricity rates are expected to rise, gas heating will likely not fall out of favor and should continue to present many opportunities as well as solutions for energy, cost and emissions savings. Customers and ratepayers deserve to have affordable gas options, and ET can fulfill the

role. SoCalGas ET, with a shift toward holistic and collaborative approaches, is gaining traction on effectively addressing these opportunities as California strives to meet its CLTEESP goals.

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