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A Plan for Increasing HVAC Compliance in California

Additional submitted attachment is included below.

HVAC COMPLIANCE AND ENFORCEMENT MODERNIZATION

A Program for Achieving Compliance in California's HVAC Industry While Laying a Foundation for the Distributed Energy Resources Grid

ABSTRACT

Bringing the HVAC industry into the 21st century is an important step towards long-term energy rehabilitation for many of California's 15 million homes and buildings. CEA presents a plan to modernize HVAC compliance and enforcement through revitalization of the HERS program; deployment of online permitting and equipment registration systems; use of advanced, embedded monitoring and diagnostic tools; and development of an HVAC efficiency program guidebook.

Prepared by: the California Energy Alliance

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Introduction

Over the past two decades, widespread disregard of California's Building Energy Efficiency Standards (Energy Standards) by HVAC contractors, municipalities, and enforcement officials have stymied California's efforts to promote energy conservation and reduce greenhouse gasses associated with buildings. This disregard has robbed home and building owners of the energy efficiency promised during purchase of new equipment. It has forced honest contractors to disobey the law to remain competitive, and it has corrupted the HERS rating system.

Fortunately, there is so much inefficiency in the current HVAC industry and in efforts to regulate the industry that savings from industry reforms will more than cover their implementation costs. Savings will come from providing rate-payers (HVAC consumers) with the actual service levels they thought they were buying, i.e. the advertised efficiency of their equipment. It will come from lower utility program costs that use real-time energy, monitoring and verification (EM&V) technology to compare costs and results on a daily basis. It will come when HVAC contractors adopt digital, software-driven diagnostic tools to self-certify their work. It will come when HERS Raters assume the role of energy efficiency expert and consultant rather than the energy verification technician.

Technology available today, if intelligently applied, could improve HVAC efficiency in California by at least a factor of two, save ratepayers enormous amounts of money in the form of reduced energy costs, provide a huge economic stimulus, resolve most of the of problematic issues in California's HVAC industry, and pay for itself in a very short period of time. Technology will resolve the inefficiency, and the gains in efficiency will pay for the technology. Additionally, a free market system will assure that innovation continues, and prices are curtailed.

In addition to resolving the most serious failings of today's HVAC industry, the solution that California regulators choose must also prepare the industry for the biggest changes to the power grid since the days of Thomas Edison, the transition to a distributed energy resource (DER) grid and a carbonless energy economy. Challenges of this magnitude require creative solutions. The answer is not simply more of what hasn't worked in the past. Time is not on our side. The ongoing economic cost to ratepayers, the environmental risk to our society, and, now, legislative mandates require a solution in months or, at most, a few years rather than decades. California is one of the few states that has the resources and capability to lead the nation to a new energy future, and it must accept this responsibility.

The approach advocated by CEA and described within this document emphasizes currently available technology and a free market system. However, the market system is a crude tool. For just and farsighted outcomes, intelligent leadership must tilt the market toward its desired end results. With respect to current waste and inefficiencies in California's HVAC industry, the role of providing the vision and intelligent leadership falls to California's energy regulators, particularly the California Energy Commission (Energy Commission) and the California Public Utilities Commission (CPUC).

The CEA represents a wide spectrum of stakeholders within the HVAC industry and hundreds of years of experience by people who have been on the front lines in the fight to reform and improve this industry. The recommendations contained in this report are a result of the hard-learned lessons from prior battles. While our emphasis is on technology, automation, and new management concepts, the solutions presented here are not intended to be disruptive. Our goal is to describe an innovative but reasonable and achievable path for accelerating the transformation of the industry and preparing it for the changes to come.

Bringing the HVAC industry into the 21st century will provide the first step towards long-term energy rehabilitation for many of California's 15 million homes and buildings. Additionally, it will lay the groundwork for the distributed energy resource (DER) power grid to which California has committed. In this report, we focus on four initiatives that we believe will deliver the market transformation long sought after for the HVAC industry and lay the groundwork for tomorrow's DER grid.

Revitalizing California's Home Energy Rating System

The Home Energy Rating System (HERS) is one of the best ideas to come out of the Energy Commission. Just imagine where we would be today had we left residential HVAC energy code inspection and verification up to 800 municipal building departments. But conditions in the marketplace and a lack of code compliance by HVAC contractors and code enforcement by municipalities have kept the HERS program from living up to its potential.

Today, both the need for the HERS program and its potential are greater than ever. We can no longer afford HVAC systems that run at less than their rated efficiency. We can no longer afford utility-sponsored HVAC programs that cost significantly more than they should. We can no longer afford the expense of HERS Raters performing a one-time test on one out of every seven HVAC installations. And, we can no longer afford costly after-the-fact EM&V that provides questionable results.

The HERS is a vital component of the state's framework designed to achieve its energy and carbon savings goals. Under Senate Bill 350, Statues of 2015, *The Clean Energy and Pollution Reduction Act*, the CEC and CPUC are legally required to evaluate and update the HERS program to ensure it continues to meet the needs of California and provide support for the bill's mandate to deliver a cumulative doubling of statewide energy efficiency savings by 2030. An evaluation and update are long overdue.

Background

Effective June 1999, the HERS regulations established requirements for field verification and testing services to show compliance with California's Building Energy Efficiency Standards (Energy Standards). The Energy Commission demonstrated foresight in transitioning Energy Standards inspection and enforcement to the private sector. The HERS program is currently run by private HERS Providers with CEC oversite. The idea of a public-private partnership may have saved taxpayers millions of dollars by avoiding development of building software and administration of a state-run program. This model could also be used for other pending HVAC initiatives such as online permitting and equipment registration.

In the HERS system, as originally envisioned, HERS Raters are intended to be agents of the building owner, not the HVAC contractor. In the system that evolved, Raters, are hired and fired by HVAC contractors whom they ostensibly oversee. A more serious impediment to the success of the HERS program is the wholesale lack of compliance to Energy Standards requirements by the HVAC industry including municipalities tasked with its enforcement. Lack of compliance has blunted the effectiveness of the HERS program, as well as corrupted it.

Some at the Energy Commission may have realized the failings of the original HERS regulations over a decade ago. A vision for an updated HERS program was revealed in 2006 when the Energy Commission initiated the Third Party Quality Control Program (TPQCP) within California's HERS regulations. The TPQCP uses computer-driven testing procedures with instant and secure data uploads to create a more accurate and tamper-proof verification system. The TPQCP also reduces costs and takes a big step

toward contractor self-certification. Unfortunately, the adopted language makes acceptance of the TPQCP optional for municipalities, which resulted in marketplace confusion that severely hindered program acceptance and growth.

Given these challenges, few people realize that the TPQCP creates the framework for a much different HERS program than we have today. One has to marvel at the ingenuity and vision of Arthur Rosenfeld who is credited with championing the TPQCP. At a 2007 Commission meeting discussing TPQCP certification, Arthur asked for electronic processes and encouraged stakeholders to automate, stating that he felt these goals could be met within 18 months. At the time, stakeholders failed to respond, but now, more than 10 years later, electronic, automated processes are widely available. With today's technology, Arthur's vision is entirely achievable.

A Future for California's HERS Program

The original HERS program is about one thing - verification. That whole purpose of the HERS program was to verify that work was done according to code. The original HERS program assumed that Raters are private inspectors who "police" the HVAC contractors. They are not allowed to assist or advise contractors. The TPQCP takes a very different approach.

The TPQCP requires both contractors and HERS Raters to use approved diagnostic testing tools. Automated wireless diagnostic tools provide accuracy unachievable with manual readings taken with traditional equipment such as pressure gauges. When contractors use modern diagnostic equipment, HERS testing essentially becomes redundant.

Contractors who participate in the TPQCP agree to use diagnostic testing equipment on every job. This exposes 100 percent of their work to a level of oversite and scrutiny impossible with the conventional HERS program. Benefits for the TPQCP contractors include the security of knowing their technicians are doing their work right. They avoid the risks of failing a HERS test and the potential penalties that entail. They are rewarded financially, because they pay a Rater to test only one in thirty jobs rather than one in seven. The proposed "acceptance testing" concept in which contractors who receive additional training and use diagnostic tools have only one in one hundred jobs HERS tested is a logical and money-saving extension of the TPQCP.

The TPQCP is a big step toward HVAC contractor self-certification, and it also facilitates a collaborative business model. A major difference between the TPQCP and the conventional HERS program is the TPQCP allows Raters to have a business relationship with contractors. TPQCP Raters can perform testing using diagnostic tools. They can also legally advise contractors, which is pervasive and illegal, for non-TPQCP Raters. TPQCP Raters can even seal ducts. This may at first seem like a conflict-of-interest, but the TPQCP standards prevent a Rater who works on a job from performing the TPQCP HERS test.

Allowing business relationships between contractors and Raters expands the role of the Rater and could completely change the HVAC industry. Envision an industry where Raters are no longer forced to serve as only test and verification officials. Imagine an industry where Raters are energy consultants to HVAC contractors, advising on the latest regulations, and training inexperienced technicians. The conventional HERS program forces HVAC contractors to perform the role of energy efficiency expert, which most of them have no interest in performing, and few do well.

In addition to diagnostic testing tools, the technology that will change the HVAC industry forever is embedded evaluation, measurement and verification (EM&V) technology. With embedded EM&V, small electronic devices are permanently installed in a building and connected to a centralized management program via local Wi-Fi and the internet. This technology provides an ever-growing number of services. Currently, available devices monitor the runtime of the HVAC system as well as the refrigerant charge. They also provide fan control, which can reduce HVAC energy use by up to 17 percent, and demand response capability.

One might wonder why we need HERS Raters once we have the capability of continuously monitoring HVAC systems for the life of the equipment. We argue that HERS Raters will fill an ever-expanding role in maintaining an ever-more technical and complex DER-based grid. To help illustrate what this new role in this new industry might look like, we have created a scenario describing a week in the life of the modern HERS Rater. Everything described below is entirely legal and possible under existing HERS regulations.

> *The first call an HVAC contractor makes after signing a contract to replace an HVAC system is to his HERS Rater. After speaking with the contractor, the Rater procures a building permit which takes ten minutes using an on-line permitting and equipment registration system. She pays for the permit through the system.*
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> *The contractor has installed a new HVAC unit along with new ducts and then notified the Rater. He says the installation is finished but he's very busy, and his crew didn't have time to do a duct test. The Rater makes an appointment with the homeowner and goes to the site. She scans the bar code on the equipment registration label with her cell phone to add the number to the HERS documentation.*
>
> *When she does a duct test, she finds 17 percent leakage. Her automated diagnostic equipment tells her the test failed. She then spends an hour in the attic sealing some ducts the HVAC crew missed and adding some mastic around the plenum.*
>
> *The local utility offers a range of incentives based on the percentage of duct leakage. The incentive includes $100 for every one percent below the legal maximum of 10 percent leakage. When the Rater runs the duct test again, the duct leakage is at six percent. The Rater and the contractor will split the $400 extra incentive for tight ducts.*
>
> *When the rater performs the rest of the required testing using her diagnostic tools, the TPQCP software tells her that the system passed all remaining tests. She uploads her data to the TPQCP platform. The homeowner is emailed a secure link where they can access HERS documents. The CF-2R automatically appears on the local building department's permitting application management screen. (The TPQCP allows a building department to close a permit with a CF-2R rather than waiting for a CF-3R, which allows the contractor to bill for the completed job and get paid.)*
>
> *The Contractor sold the homeowners an annual HVAC service contract based on the fact that the TPQCP with which the contractor works will provide continuous monitoring of their HVAC system. He explains that the homeowners can call the TPQCP customer service line to ask questions about the performance of their system or even confirm service recommendations and prices provided by the contractor.*

This type of monitoring requires equipping the HVAC system with embedded EM&V, but the contractor's crew didn't have time to install the EM&V module. The Rater installs the module, connects it to the local Wi-Fi system, and accesses the homeowner's private web dashboard. She then goes through a setup procedure to make sure the module is recording and establishes a benchmark for the system. Finally, she enters the contractor's text number and e-mail address so that he will receive alerts should the monitor detect an anomaly in the performance of the system or senses a low refrigerant charge.

Since the homeowner also signed a demand response agreement, the Rater initiates Demand Response Plan #2, which will turn off the AC compressor but leave the air handler fan running for a specific amount of time depending on the climate zone in the case of a power event. Because the module includes an open application programming interface (API), the homeowner can switch demand response providers should another company make them a better offer.

Finally, the Rater performs the health and safety inspection which includes inspecting smoke alarms, carbon monoxide detectors, and electrical connections as required by the municipality. She uses video records her walkthrough and testing. The video includes automatic time and geocoding stamps along with reduction technology.

The contractor receives a text message reporting that the tests were successful and that the HVAC monitoring, demand response, and the owner's dashboard are up and running. Attached is a copy of the CF-2R form. Also included is a note that his debit card has been credited with $200 for having achieved extra tight ducts. The $200 has been advanced by Third Party Quality Control Program.

At the same time, the municipal building department receives an e-mail that an inspection has been completed. A clerk logs into the on-line permitting system and sees the CF-2R form and the health and safety inspection video.

While she is online, the Rater sends a bill to the contractor which is generated by the HERS Provider software. She also clicks the box on her personal registry webpage indicating she will pay $10 extra to have a credit for payment immediately added to her debit card. Her debit card is credited for $740, which includes the $200 for extra tight ducts.

With the owner's permission, the Rater uses digital video to perform a solar analysis of the home. She immediately directs the analysis and the video to the local solar company along with a message that the homeowner would be receptive to a phone call regarding adding on-site solar generation.

The Rater also spoke to the homeowner about improvements to the shell of the home, particularly the fact that the attic has obvious air leaks and is poorly insulated. She suggests working out a long-term, step-by-step program that can reduce their energy bills within a budget the homeowners can afford. Again, with the owner's permission, she videos the attic and uploads it to the TPQCP platform. She then sends a text to her friend, a local home performance contractor saying that perhaps the two of them can make an appointment with the homeowners to talk about doing energy remediation work on the home.

The Rater thanks the homeowners and tells them she would like to keep in touch. She also asks if they have friends who might be interested in energy efficiency. They give her several names. Before driving off, she knocks on the doors of a number of homes on the block saying she is working with their neighbors and offers them a pamphlet of energy efficiency information. She makes appointments with one of the homeowners to return to install a free EM&V module and discuss other possible remediation work. The EM&V module costs less than $200 installed and is incentivized by the utility.

A week later, when the Rater meets with the new homeowner, she interviews them, reviews their energy bills, inspects their house, and looks over the HVAC system. She tells the owner she found nothing dramatically wrong except for a dirty filter and some closed vents, but would like to return later and do some testing of their HVAC system. In addition to the free EM&V/DR module, she offers them an annual HVAC service contract and suggests an automatic air filter, which will also increase the size of their return duct. When they accept the service contract, she programs her own phone number and e-mail into the system. When she gets an alert or an alarm, she'll either stop by herself or call one of the HVAC contractors in her network to make a service call. Stopping by will give her another chance to catch up with the homeowner and speak to them about the utility incentive for efficient hot water heaters that just came out.

Recommendation

The scenario described above is entirely legal under the current Energy Standards. There is no technology described in this scenario that is not available, or at a minimum, adaptable now. This is just one possibility of how a much more automated and efficient HVAC industry may work.

However, one regulatory shortfall that cripples the TPQCP is still in place. Municipalities can refuse to accept the TPQCP results. Consider the language under the current Energy Standards regarding TPQCP testing for residential alterations (RA 2.8):

*"Third Party Quality Control Programs, as specified in Section RA2.7, **may** also be used with alterations, and shall be limited to "closed" sample group sizes of thirty dwelling units or less.*

*When a Third Party Quality Control Program is used, the enforcement agency **may** approve compliance based on the Certificate of Installation prior to registration of the Certificate of Verification, where data checking has indicated that the unit complies, on the condition that a Certificate of Verification will be submitted. if the required HERS verification procedures determine that re-sampling, full testing, or corrective action is necessary, such work shall be completed."*

A simple change from "may" to "shall" in the Diagnostics Section of Title 24 (RA2-8) along with other supplementary text to ensure proper interpretation, if necessary, would enable the TPQCP to live up to its expectations of being a more secure, efficient, and less expensive way to verify that consumers are getting the performance and energy savings they pay for when buying a new HVAC system. It will also make the scenario described above viable. Expanding the TPQCP to include acceptance testing would be the next logical step in promoting accountability and reducing the cost of HERS testing.

Conclusion

Improving performance and control of the millions of HVAC systems in California is necessary both in terms of reducing energy demand and implementing demand response. As everyone knows, increasing compliance is the key. When we talk of changing an industry, we are really talking about changing the

behavior of individuals. In this case, HVAC contractors, HERS Raters, and technicians. Their support is crucial to any success we may have. Changing the structure of the HERS program from confrontational to collaborative by transitioning Raters from verifiers to energy consultants will go a long way toward improving contractor cooperation and contributions. Making the building permit procurement and HERS testing more efficient and less costly is another step that will lessen industry resistance to efforts to increase compliance.

Online Permitting and Equipment Registration

California has some of the most progressive building-related energy codes in the nation, but after two decades, enforcement of these codes in the retrofit HVAC industry remains at just 10 to 20 percent. At this point, there appears to be general acceptance amongst government and industry that a statewide online permitting system that includes HVAC equipment registration is a practical, near-term solution to the compliance problem.

Significant work has already been invested in researching and reporting on the opportunities and issues in implementing online permitting. The Western HVAC Performance Alliance has led this effort and reported on its findings. This research included interviewing a number of municipalities that have implemented, or tried to implement various online permitting systems. A CEC-funded research project conducted by the Center for Sustainable Energy in San Diego has also produced a report on the topic.

General Recommended Requirements

There are numerous companies and products currently able to support online HVAC permitting and equipment registration. Industry has demonstrated successful online permitting systems that have been, to some extent, vetted by industry-sponsored pilots and CEC-sponsored studies. CEA recommends the CEC invest in expanded pilots and demonstrations in order to fully develop commercial system requirements. Once requirements are codified, any company can then apply for certification to market their system in California.

The following specific actions are needed, in conjunction with development and deployment of online permitting and equipment registration, in order to reap the full suite of benefits available.

1. Any new system specified by the State should be designed to accommodate impending technical and regulatory changes to California's energy grid. On a large scale, this should include the shift to a distributed energy resource (DER) based grid. It should also anticipate embedded EM&V (real-time monitoring) replacing conventional after-the-fact EM&V and deemed energy savings.
2. To reduce costs and speed up implementation, the CEC should adopt an administrative model similar to the one used with HERS Providers. The CEC should develop specifications for online permitting and equipment registration systems, and then certify private companies who meet the specifications to offer use of their systems to municipalities and the industry. The system should integrate with the existing HERS form registry maintained by the CEC and with all permitting systems in use today by municipalities in California.
3. All municipalities will be mandated to accept permits generated by the statewide system.
4. Specifications should include extensive use of permanently affixed equipment identification labels that could be scanned using standard equipment such as bar-code scanners or cell phones.

Equipment Registration – Deployment Concept Example

The following is a brief description of an equipment registration system envisioned by the California Energy Alliance based on members experience with online permitting and the express package shipping

business, which pioneered package tracking. The equipment registration system requires that a state-wide, on-line permitting system be in place. It is important to note that this is not a serial number tracking system. Equipment serial numbers need not be recorded. Manufacturers and OEMs need not be involved. Neither equipment information nor customer information is recorded by the distributor or the contractor other than that which is already required for HERS forms.

Most importantly, this is an auditable system. Through simple sorts of the equipment registration database, the Contractor's State License Board (CSLB) can narrow the search for unpermitted HVAC systems from many thousands of unidentifiable equipment purchasers to what would probably be a few dozen distributors or a few hundred installers.

The following scenario describes a potential implementation of an equipment registration system:

1. The CEC assigns manifests with predetermined equipment registration numbers to all HVAC equipment distributors in California. The quantity of registration numbers assigned to each distributor is based on the previous year's sales. The distributors also receive equipment identification labels corresponding to the registration numbers on their manifest.
2. A record of equipment registration numbers along with the distributor's name to whom each number was assigned is maintained in a CEC-managed database.
3. When a distributor sells equipment that requires registration, the distributor assigns one of their equipment registration numbers to the equipment sold.
4. The distributor then associates each registration number with the contractor who purchased the equipment by recording the contractor's license number next to the equipment registration number within the State database. From that point on, the contractor/buyer is accountable for the disposition of that equipment. At year's end, equipment must be either correlated with a HERS inspection or in the contractor's inventory.
5. When the contractor or their technician installs the equipment, he or she enters the equipment registration numbers on the CF-1R HERS form for the job where the equipment is being installed. (HERS forms will be modified to accept equipment registration numbers. The equipment registration system communication protocol includes an open API to allow integration with all HERS Providers.)
6. If the technician enters a registration number that has not been assigned to the contractor for whom he or she works, the number is rejected and the CF-1R form cannot be registered. (This is the step that prevents fraudulent registration numbers from being used to hide non-registered equipment.)
7. For convenience, a permanently affixed product identification label can be attached to each piece of equipment. Each label includes the equipment registration number and a digital tracking code that can be read by a barcode reader.
8. At any time, the CSLB can run a report on the disposition of all equipment registration numbers that are not yet associated with a HERS test. If the CSLB finds an unusual number of registration numbers assigned to one contractor without a corresponding number of CF-2Rs (TPQCP) or CF-3Rs (one-in-seven program), they can inquire with the contractor regarding the large inventory of uninstalled HVAC equipment, potentially triggering an audit of the contractor's facility. A penalty of $5,000 per unit for installing an HVAC system without a registration number or HVAC permit would merit a contractor's attention if multiplied by 10, 20, or 100 units. The process could be managed by the CEC's compliance enforcement office, which already handles enforcement issues related to appliance certifications.

9. The CSLB can run a periodic report on the number of equipment registration numbers assigned to each distributor but not correlated to a HERS test. If the number of unused registration numbers appears to be unusually large as a ratio to revenue or some other metric, the CSLB (or perhaps State Franchise Tax Board) can request the distributor provide an accounting of their inventory vis-à-vis the registration numbers assigned to them.

Conclusion

California is in the forefront of worldwide efforts to reduce energy demand and greenhouse gasses. The value of and need for online permitting and equipment registration systems has been made clear though industry experience over the past 25 years. We now have the opportunity to stimulate an industry that will not only solve California's compliance problem, but may well grow into yet another successful industry resulting from the marriage of California's progressive regulatory environment and its innovative entrepreneurs.

Embedded EM&V

The most common reasons for poor HVAC performance are bad system design, careless installation, lack of maintenance, or, most commonly, all three. The time-honored modus operandi of the HVAC industry is to install expensive but efficient equipment poorly, have consumers pay twice what they should for power to run it, let it deteriorate with little or no maintenance until it breaks, then install another system poorly. There's a better way.

It turns out that HVAC technology used in most homes and small commercial building is not complicated. Even with poorly designed systems, there are some relatively simple fixes that make a big difference. With air conditioning systems, two of important factors are proper air flow across the coil and refrigerant charge. Dirty filters restrict air flow and are easy to change, so should top everyone's list. Measuring and correcting refrigerant charge along with coil cleaning returns the next biggest bang-for-the-buck. Sealing ducts and enlarging return grills and return ducts would come next.

But even if we do these things, how do we know how much of a difference we've made? How do we know how well the system is running even after the improvements? And, how do we know whether the improvements we've made will last?

The answer is performance monitoring. This can include monitoring the refrigerant charge by a non-intrusive and accurate super heat/sub-cool method. It can provide an in-home display near the thermostat as described by the Energy Commission. It can monitor the general condition of the system by tracking air handler and compressor run times. Analyzing run times will give us information on how efficiently a system is running when monitoring begins. That becomes the benchmark. From that point forward, any decline in system performance will be easily detected. Any improvements made to the system can be easily measured. Degradation problem solved.

Embedded EM&V can be accomplished through small circuit boards and can be easily retrofit on most furnace or air conditioning (AC) system. The circuit boards are usually connected to a centralized management program through the internet via local Wi-Fi networks. With some systems, building owners and/or their HVAC contractors are able to track system performance on personal cloud-based dashboards and receive email or text updates on energy-use projections or when performance falters. The technology has no impact on warranties.

Cloud based systems can provide monitoring for a surprising low cost. The technology is coming onto the market at a rapid pace and will revolutionize the HVAC industry. Some of this technology includes fan control which alone provides up to 17 percent increase in system efficiency (in a properly charged HVAC system).

It's estimated that basic embedded EM&V can be installed for less than $200 per HVAC unit with volume pricing. One key to controlling installation costs is having the relatively simple modules installed by a tradesman or energy professional who is on the premises for a reason other than the installation of the module. It could be an HVAC contractor making a service call or an annual inspection. It could be an electrician, a HERS rater, or handyman. The person doing the installation can either be building his or her own client base or being paid to do installs by someone else.

In addition, monitoring can make service contracts much more effective and marketable. Over time, constant feedback can educate consumers on the benefits of a well-maintained HVAC system and the costs of poor maintenance. Monitoring will foster an on-going relationship between the building owner and the contractor or other energy professional who is monitoring the system. Ideally, the trust developed through this relationship will provide the opportunity to begin a long-term, step-by-step process of energy efficiency improvements customized to fit the values and the budgets of the building owners.

Embedded EM&V technology can solve another big issue of the times by including demand response functionality. The inclusion of demand response illustrates why the Energy Commission must set at least minimum standards for these devices. Those standards must include the requirement for an open application program interface (API) to ensure that the building owner or occupant has the capability to sell the monitoring and control of his or her appliances on the open market. Many DR devices currently being installed do not have an open API because the manufacture's business strategy is to "capture" the customer.

The benefits of embedded EM&V technology extend well beyond the building owner and HVAC contractor. Advanced embedded EM&V technology can include refrigerant charge indicators and temperature and static pressure sensors. Monitoring will potentially reduce the warranty reserves required of manufacturers because they will have the assurance their equipment is installed correctly. Monitoring and regular maintenance will prolong the useful life of most HVAC units. When enough data (aggregated, not personal) is accumulated and analyzed, we will be able to predict the benefits of various types of energy remediation work on various types of houses in various climate zones. Analysis like this will be invaluable in designing public programs to make buildings more energy efficient. Use of embedded EM&V (monitoring) will help shift the industry away from the dependence on deemed savings and toward real-time actual energy-use monitoring to measure everything from equipment efficiency to program effectiveness.

Recommendations

CEA recommends development of a state-wide strategy led by the CEC to introduce EM&V/DR technology to the market. If embedded EM&V were installed every time a service technician, HERS Rater, or energy efficiency consultant worked with an HVAC system, we could have a significant percentage of California's HVAC systems monitored, running efficiently, and set up for demand response within the next five years.

Specific recommendations include:

1. EM&V/DR technology should be required for all new and retrofit HVAC installations regulated under the Energy Standards. CEA recommends the CEC evaluate requirements for this technology as part of its forthcoming 2022 Energy Standards.
2. CEC should develop standards for EM&V/DR technology so that systems can be certified to the CEC appliance efficiency database including use of open APIs communication protocols. CEA recommends CEC develop and deploy these specifications in conjunction with adding requirements to the 2022 Energy Standards.

Conclusion

The transition to continuous HVAC system monitoring using embedded EM&V technology is absolutely necessary and long overdue. Given the inefficiency in both the HVAC and HVAC regulatory industries, we have an opportunity to harvest the rewards of increasing efficiency and use that money to shape a new industry that better fits an energy-scarce world while laying the foundation for a DER-based power grid.

When combined with a centralized command and control program, the potential for monitoring, analysis, DER implementation, and technologies yet to be developed is virtually unlimited. One company is referring to the module as “the iPhone for your home.” Doubtless, the list of benefits will grow, and prices will decline once the technology gets accepted by the marketplace.

Embedded EM&V technology provides such good value propositions for the home and/or building owners, for HVAC contractors, and for other industry stakeholders that the market may very well drive distribution of the technology once it is initiated.

Efficiency Incentives Program Guidebook

It’s been widely acknowledged for decades that California’s homes and small commercial buildings use energy very inefficiently, and that HVAC systems are mostly to blame. More than twenty years ago, California legislators instituted a tax on utility bills, in part to finance programs to improve building efficiency. This spurred an energy efficiency industry supported by these taxpayer funds.

Tax proceeds go into the Public Goods Fund (Fund), which is controlled and allocated by the California Public Utilities Commission (CPUC). For the entire history of the Fund, most of the monies have been distributed through programs proposed and administered by California’s investor owned utilities (IOU’s.) Prior to being awarded funds, the proposed utility program is evaluated based on “deemed energy savings”, which are projections of anticipated energy savings based on computer modeling, data sampling, or other paper analyses.

The utilities have the flexibility to partially or fully administer approved programs. The risk is that programs must meet deemed energy savings goals or risk the costs of unreimbursed program expenses. The reward for achieving projected energy savings is being paid for administrative overhead and operational program costs.

Lack of uniform program management guidelines has caused confusion in the marketplace and gross inefficiencies. To capitalize on the dearth of available public goods funding, utilities often hire program managers to develop utility incentive programs that have no prior technical experience in their assigned program area or lack any experience implementing a large program portfolio of any kind. Then the portfolio managers, because there is so much pressure on these programs to perform, quickly develop

programs with little or no input from experienced stakeholders, creating programs with anti-trust issues, restraint-of-trade issues, and program-by-design issues. Quality products and services are locked out of programs due to these issues, and taxpayers continue to foot the bill.

Utility programs that target HVAC systems have long focused on two specific services, or "measures". These measures are refrigerant charge measurement and correction, and duct testing and sealing, both of which have a major effect on the efficiency of an HVAC system. Both also provide the best return on investment (ROI) for services performed.

Programs are usually separated between those that focus on newly installed systems, usually called Quality Installation programs, and those that focus on tuning up existing systems, which are usually called Quality Maintenance programs. The value of these programs to the ratepayers who pay for and receive these services, is documented, but is neither readily available, nor easy to interpret. If we measure Quality Maintenance programs in terms of cost per kilowatt-hour of demand eliminated, costs between various utility programs can vary by a factor of ten or more. Obviously, some programs are very inefficient, have a large overhead, or both.

Programs requirements and administration are also inconsistent, which leads to inequities among ratepayers across the State. Some Quality Install programs abide by the law and verify that HVAC permits were procured and HERS testing accomplished in order to qualify for rebates. Other programs disregard the law and provide up to $1,000 to purchasers of highly efficient equipment while completely ignoring the quality of the installation, which is necessary to actually achieve full savings levels.

The costly inefficiencies and inequities in utility programs almost always comes down to poor management. Very often, utility managers appointed to run these programs have little to no experience running HVAC efficiency programs, or supervising the implementers, which are often HVAC contractors or energy service companies (ESCO's) who are contracted to administer the programs. Sometimes managers have vested interests in promoting certain products and/or keeping competitors out of the market. While this is a blatant restraint of trade, these are not uncommon program practices and they are tolerated by most utilities. These problems create administrative inefficiency, frustrate subcontractors, create inconsistency among programs, and ultimately drive up the cost to all participants.

Currently, many aspects of program development and management are overlooked or ignored. This often leaves utilities at risk of legal and financial liabilities and unprepared for the future. The following is a short list of topics that efficiency program managers must understand and should consider in designing or managing an HVAC efficiency program.

- Rules regarding use of public goods funds
- Standardized reporting methods
- Technical specifications for common diagnostic tools
- Specifications for common efficiency measures and other services
- Consumer outreach and support
- Methods of marketing to industry stakeholders,
- Measure loading order,
- Quality Installation and Quality Maintenance Program integration
- Data collection and security

- Data privacy
- Servicing low-income neighborhoods
- Use of online permitting and equipment registration
- Energy savings calculations and reporting
- Standardized compliance advocacy reporting
- POU's and CCA's legal responsibilities under California law
- Title 24 energy code requirements
- Potentials for benchmarking, HVAC monitoring, and fault detection
- Incentivizing long-term service agreements
- Future requirements for demand response systems
- Trends in utility system design and potential future developments
- Legal issues involving restraint-of-trade
- Contract law and liability risk reduction

Recommendations

To begin to correct these issues, CEA believes a comprehensive CEC-sponsored guidebook for managing HVAC efficiency programs is needed. The guidebook would be a direct resource that supports California's mandate under SB350, which requires the CEC and CPUC to "develop and implement a comprehensive program to achieve greater energy savings in California's existing residential and nonresidential buildings stock". Per the bill,

> *(3) The commission shall adopt, implement, and enforce a responsible contractor policy for use across all ratepayer-funded energy efficiency programs that involve installation or maintenance, or both installation and maintenance, by building contractors to ensure that retrofits meet high-quality performance standards and reduce energy savings lost or foregone due to poor-quality workmanship.*

The guidebook should be authored by a team of experienced HVAC industry stakeholders, who are selected through an open, competitive solicitation process. In addition, guidebook development should include open public forums where all industry stakeholders can provide input to the Guidebook and offer review of its material prior to publication.

The guidebook should cover virtually every aspect of running a ratepayer-funded efficiency program. It should be updated periodically and in collaboration with technical experts and other experienced stakeholders. The Guidebook should differentiate between practices that are mandated by law, and others that just reflect good business. The Guidebook should explain how to avoid conflicts of interest and restraint-of-trade issues. It should provide instruction on new technologies and management concepts. It should include CEC energy and appliance standards for regulated products such as fan controllers, demand response devices, and embedded EM&V systems. It could also provide sample contract formats and list available resources within the CEC that could help program administrators adhere to the state's mandatory performance requirements for HVAC systems.

Once complete, the CPUC could adopt the Guidebook as the best practice for all IOU HVAC efficiency programs, showing its commitment to meeting the mandates of SB350 and ensuring consumer protections are in place that deliver promised energy savings. If it proves effective, outreach to ratepayer oversight boards for publicly owned utilities (POUs) could help catalyze adoption among most POUs.

Conclusion

In a time when the CPUC is consolidating management of utility programs, guidance from the CEC is more important than ever to ensure quality programs, consistency, and equity between IOUs and POUs across the State. Clear guidelines, issued by the Energy Commission, developed by industry experts, and updated on a routine basis, will provide much needed support for utility program managers who may have no other resources on which to base their program designs. Coordination between the Energy Commission and the Public Utilities Commission on this important topic is vital to achieve sustained savings and increase compliance within the HVAC industry.