THE HVAC CONVENER REPORT (Appendix to the January 2008 DRAFT of the "California Long Term Energy Efficiency Strategic Plan")

Recommended Strategic Plan to Transform the Existing HVAC Industry and Achieve Additional Peak Savings, Sustainable Profitability, and Increased Customer Comfort

(NOTE: In addition to serving as the foundation for the HVAC chapter of the "California Long Term Energy Efficiency Strategic Plan," this report was subsequently edited and submitted to the California State Legislature by the California Energy Commission in June 2008 under the title: "Strategic Plan To Reduce The Energy Impact Of Air Conditioners, CEC-400-2008-010.")

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This report represents the efforts of many experts from the air conditioning industry who volunteered their time to develop detailed roadmaps or chapters to achieve different parts of the group's vision of a transformed industry. Many of these details have been trimmed as part of the final editing process but will be made available to utilities and other sector level experts who may need this additional detail to develop the final strategic plan for the CPUC. The responsibility for any errors or removal of vital ideas remains with the co-conveners of this working group, Mike Messenger and Anne Premo We also want to acknowledge the helpful editorial and writing assistance provided by Paul Kyllo of Southern California Edison and Jim Bazemore of Energy Market Innovations, Inc. Finally, we particularly want to acknowledge the contributions of the authors listed below.

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Chapter Outline for the HVAC Strategic Plan

Appendices

Executive Summary

Preface

Professionals in the heating, ventilation and air conditioning (HVAC) industry drafted this strategic planning document through a working group process with this purpose: reduce California's peak load growth while improving the business climate and level of quality workmanship in the HVAC industry The group discussed known problems in the HVAC industry as a springboard for creating a vision and a set of changes needed in the market to make progress toward the vision Subcommittees of the working group then developed specific strategies to tackle each problem consistent with the overall vision. This vision and the strategies to achieve it are summarized below.

Vision

A revitalized HVAC Industry will contribute to increased energy efficiency, reduced peak electricity usage and the capability to control peak demand by providing high quality installation and maintenance services for all cooling system installations. This goal will be accomplished by developing a brand for customers to use to recognize and ensure quality installation and by giving suppliers a profit motive to deliver higher quality installation and maintenance practices, These practices are expected to result in lower peak energy use, better comfort, higher reliability and better indoor air quality. These changes will lead to sustained profitability for HVAC trade allies as the business model changes from a commodity to a value-added service business. There are six changes needed in the structure and operation of the HVAC market to achieve this vision:

1. Consumers must learn to expect and verify quality installation practices and maintenance of their new central air conditioning (CAC) systems through the use of a new HVAC quality brand..

2. Contractors must routinely pull permits for HVAC system installations in existing homes and begin to compete for customer jobs based on their reputation as a quality provider of installation and maintenance services that maximize comfort, system performance and reliability. To achieve this goal contractors will need to agree on a universal definition of quality installation practices and support increased training and certification for all of their technicians, not just the owner of the HVAC firm

3. Building officials and CEC compliance staff must work together to ensure consistent enforcement of the current building standard requirements so that conscientious contractors are not penalized for seeking a permit and subsequent certification of quality installation practices.

4. Innovative system manufacturers must be encourages to compete to deliver reliable, high comfort, space conditioning systems equipped with features that simultaneously minimize peak energy use and overall costs to the customer. Incentives should be provided to manufacturers who work to integrate smart diagnostic systems into the original cooling system equipment to provide useful fault detection information to contractors and suggested actions to minimize usage to customers

5. Distributors of HVAC systems must work the CEC, trade organizations, and local building officials to design a new tracking data base that ensures all systems that are sold to contractors can be linked to a permit pulled for each customer address and subsequent verification of quality installation practices. Smart" diagnostic systems are available in portable or on board forms..

6. Utilities' should work hand in hand with contractor trade organizations to increase the quantity and quality of training and education programs for contractors and building officials not aware of recent changes in the building code . In addition utilities should endeavor to provide real-time

feedback to customers on the cost of operating appliances during peak time periods as part of their deployment of advanced metering systems. .

STRATEGIES

The working group recommended ten strategies to achieve these market changes. Six of the strategies are targeted at improving the level of quality controls provided at the time of HVAC installation and the quality of the maintenance delivered over the life of the system. They include:

1. Develop an industry recognized “quality” brand (similar to Energy Star) that can be used as proof of quality installation practices and high levels of HVAC technician competence.

2. Increasing the level of customer demand for quality installations through a public education campaign that explains the consequences of a poor quality installation and encourages customers to ask for the quality brand to ensure their system will perform and operate as advertised.

3. Increase the level of code compliance (and quality installations) by working with building officials to create a new, compliance tracking data base designed to create a level playing field for HVAC contractors in the replacement market.

4. Increase the number of trained technicians qualified to perform HVAC system installations that meet ACCA Quality Installation (QI) specifications and motivated to receive recognition for their “verified” quality work.

5. Obtain a commitment from local governments, state agencies, utilities, and local building departments to devote more resources to customer education, building energy inspections, and streamlining the permitting process.

6. Seek regulatory policy changes designed to encourage utilities to achieve larger scale market outcomes by estimating the energy savings achieved by the HVAC quality initiatives proposed here at the overall market level in addition to the program level.

The remaining four strategies were developed to achieve additional energy and peak savings from the development and increased market penetration of new and more peak efficient cooling systems to be installed over the next decade. They include:

7. Support commercialization of on-board and portable diagnostic and fault detection systems Stimulate existing research to integrate on board diagnostic equipment into new central air conditioning systems and to develop better portable diagnostic equipment that could be used to simplify maintenance and repairs

8. Develop new energy efficiency indicators to rate the expected performance and energy use of space conditioning systems installed in California that more accurately predict system power demands in the hot and dry climates of the southwest.

9. Accelerate Market Penetration of New Cooling Equipment Technologies by developing a “incubator” process that shortens the time elapsed between testing of an innovative new cooling concept to its proof and widespread market deployment.

10. Create a market environment that encourages builders to experiment and use whole building designs to reduce peak demands and overall customer energy bills.

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Chapter 1 Why a Focus on Revitalizing the HVAC Industry is Critical to Minimizing future Peak Electricity Demands

The CPUC and Energy Commission have decided to focus on working with the HVAC industry to reduce the energy use and increase the efficiency of its cooling system products for three specific reasons:

1. The rapid growth in the installation of central air conditioning systems over the last three decades is the primary cause of the rapid growth in peak demand in California over the last three decades. The share of total peak demand attributed to residential and small commercial air conditioning units has increased from 5% in 1976 to over 30% in 2006. (See appendix A for details) .
2. Improving the quality of the HVAC workforce by focusing on improving the quality of their workmanship is consistent with the governor's emphasis on providing more vocational opportunities and reducing the growth in GHG emissions by increasing the value provided by energy industry.
3. Much of the anticipated and forecasted decreases in peak energy use associated with the recent increases in the appliance efficiency standards for central air conditioners will not come to fruition without the use of quality control procedures currently required in the building standards but not consistently enforced .. Failure to insure quality at the time of cooling system installation results in a 20 to 30 percent increase in the peak energy needed by CAC systems to provide customers with the cooling and comfort they demand on hot summer afternoons

There are two primary methods of achieving peak and energy potential savings from current and future air conditioner installations.

1. Increasing the proportion of new and retrofit installations where quality installation practices are used and verified
2. Decreasing the peak use of new air conditioning systems by accelerating the market introduction of more efficient systems or systems designed to use thermals storage concepts to shift the energy required home to off peak periods

Table 1 presents preliminary estimates of the peak savings potential from these two broad strategies. Strategy 1 pursuit of higher quality could yield savings of up to 500 MW over the next four years while providing incentives for the pursuit of strategy 2, increased installation of thermal storage or peak shifting CAC systems could achieve savings of up to 850 MW by 2020. (Appendix B contains the assumptions and calculations used to develop these estimates.)

Table 1
Potential Energy Savings by High Level Strategy

Strategy	Potential Peak Savings (MW) by 2012	Potential Peak Savings (MW) by 2020
1. Increase quality installation practices from 10 % to 90%	500	1000*
2. Stimulate the market penetrations of alternative cooling technologies with little or no peak usage	60	850

*This estimate assumes that quality installation becomes the baseline practice by 2015 and thus no additional savings are calculated beyond 2015.

Chapter 2 A New Vision for the HVAC Industry

In our vision a revitalized Heating, Ventilation, and Air Conditioning (HVAC) Industry will deliver increased energy efficiency, reduced peak usage and the capability to control peak demand for all residential and small commercial customers by:

1. Providing high quality installation and maintenance services in response to an increased customer demands for quality certification and more consistent enforcement of existing building standard requirements. This goal can be accomplished by ensuring quality installation and service practices are easily recognized by customers and they understand the impact of high quality installations on customer comfort, system reliability and indoor air quality.
2. Providing increased opportunities for training and certification for installation and maintenance technicians. As the industry matures, Installation and maintenance of all space conditioning systems will be certified by third party verifiers and/or credible remote technologies.
3. Providing increased awareness for customers of how quality installation practices will have an effect on their home's comfort, health and safety, and energy bills.
4. Developing new cooling systems that are tailored to the needs of the local hot dry climate and the higher costs of meeting system demands during peak demand periods.

These changes should lead to sustained profitability for HVAC trade allies as the business model for installing and maintaining cooling systems changes from a commodity to a value added service business. However these changes cannot be achieved without complementary changes in the outlook of customers, building officials, local governments and electric utilities.

Overview of the Changes needed to Achieve this Vision

1. The industry and CEC need to achieve agreement on a universal definition of quality installation practices and a process to verify and then attach a quality brand or seal on all equipment that meets the specifications. The quality brand could be developed in cooperation with Energy Star at the national level or as a regional or statewide brand.
2. A significant portion of Consumers learn to ask contractors for (demand) verified quality installation and maintenance of their new CAC system. This will be accomplished by a major marketing campaign to introduce the new quality branding system and reinforce that pulling a permit for HVAC installations is not only the law, but comes with safety and quality benefits. They are made aware that their property value will not be reassessed as a result of the HVAC permit process.
3. Contractors agree to support efforts to achieve a higher proportion of quality installations by supporting increased training for their employees and development of a quality certification patch for firms with universal
4. Building officials and CEC compliance staff must work together to ensure consistent enforcement of the current building standard requirements so that conscientious contractors are not penalized for seeking a permit and subsequent certification of quality installation practices.

5. Innovative system manufacturers must be encouraged to compete to deliver reliable, high comfort, space conditioning systems equipped with features that simultaneously minimize peak energy use and overall costs to the customer. Incentives should be provided to manufacturers who work to integrate smart diagnostic systems into the original cooling system equipment to provide useful fault detection information to contractors and suggested actions to minimize usage to customers

6. Distributors of HVAC systems must work with the CEC and local building officials to design a new tracking data base that ensures all systems that are sold to contractors can be linked to a permit pulled for each customer address and subsequent verification of quality installation practices. Smart" diagnostic systems are available in portable or on board forms..

7. Utilities' should work hand in hand with contractor trade organizations to increase the quantity and quality of training and education programs for contractors and building officials not aware of recent changes in the building code . In addition utilities should endeavor to provide real-time feedback to customers on the cost of operating appliances during peak time periods as part of their deployment of advanced metering systems.

Ten strategies to achieve these changes were identified and then prioritized by the working group. An overview of these strategies and the organizations who need to be charged with achieving each one is presented in Table 2.

Table 2

Strategy	Overall Priority	Responsible Organizations
Increase the number of building permits pulled and third party quality verification for HVAC replacement and new construction installations to increase the fraction of quality controlled installations from 10% to 90% by 2012	1	CEC, CALBO, IHACI, SMACNA, and utilities
Create an industry recognized Quality Installation and Maintenance (QI/QM) Brand and launch a campaign to convince customers to demand quality installations	2	IOUs,IHACI, EPA, CEC, ACCA
Develop and/or sponsor additional QI/QM training for contractors, technicians and sales agent to increase the fraction of technicians trained and certified from 10% now to 100% by 2020.	3	IHACI, ARI, Utility training centers and CALBO
Provide funding for whole building design programs designed to achieve deep reductions in energy use, 50% in retrofit market, for cooling systems	4	Utilities, Building Performance contractors, Local governments
Develop pilot tests and or programs to encourage system performance feedback and take advantage of smart meters/Ami systems	5	CEC PIER program, HVAC manufacturers, utilities
Foster new technology incubator system that exceeds current Emerging Technology efforts	6	Utilities and Business Schools?
Recommend policy changes in the current measurement system to verify broader market effects of training/branding and education efforts	7	Utilities, Energy Division and CEC staff
Sponsor research in on board diagnostic systems and a golden carrot award for first 100,000 units sold with on board diagnostics	8	Consultants, CAC manufacturers, utilities and university research organizations
Sponsor design competitions for net zero peak demand home	9	Utilities , Building contractors and Solar providers
Develop new California Specific efficiency indicators for cooling systems that reflect California specific climates	10	Research organizations. ETTC councial and PIER

Chapter 3 Stimulating the Demand for and Supply of High Quality Installation and Maintenance Practices for central air conditioning installations

Previous reports have focused on the widespread lack of quality control in the installation of cooling systems in the residential and small commercial markets. In the past, proposals to increase quality control focused on improving the quality of supply side delivery services via training and later through, third parties verification of quality installations. However these strategies can not be successful in the long run unless the consumer learns to ask for certification that quality control practices has been verified and can easily confirm quality by looking for a simple quality brand. Currently there is no easy way for customers to determine their HVAC system meets quality requirements or recognize the increased energy use resulting from poor quality installations. The strategic planning group recognized that this one-sided focus on "forcing" more high quality practices through training would not be sustainable unless there was a universal definition of what constitutes quality installation practices and, more importantly, that customers would have an easy way to demand and recognize when quality installations had occurred.

In this chapter we explain the need for each strategy, provide a specific set of recommendations to achieve the strategy and propose milestones to track progress of each strategy.

Strategy 1. Develop a consensus of the definition of High Quality Installation and Maintenance practices needed to secure the quality brand

It is important that the industry develop a consensus recommendation on the processes and measurements needed to verify quality installation practices in order for the customer to receive a high quality brand. We propose the following actions to achieve this consensus.

Recommendations

1. 1.1 The CEC and each of the electric and gas utilities who operate programs to promote the installation of more efficient air conditioning systems should adopt the following definition of high quality installation practices and reinforce its use by creating a brand that will be attached to systems that meet the requirements in this specification:

> *Quality Installation: An HVAC quality installation (QI) is one where the heating, cooling and ventilation system has been installed per a nationally-recognized standard (ANSI/ACCA 5 QI-2007; "HVAC Quality Installation Specification"), which incorporates the original equipment manufacturer instructions, applicable building and energy codes, documentation of system commissioning elements, and customer education.*

The Air Conditioning Contractors of America (ACCA) has recently developed a quality installation specification for air conditioning equipment that has become an ANSI standard. Most of the 12 requirements in this specification are similar to the optional requirements for HVAC testing in the CEC's Title 24 (T-24) building codes. Table 1 shows each of the ACCA specifications and discusses whether each requirement is currently required in California and Inspected or verified by a third party. We propose that each of these requirements must be completed and verified before a quality brand decal can be attached to a residential or small HVAC installation by a third party rater or building official.

Table 1
ACCA HVAC Quality Installation Specifications

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ACCA Requirements	Required By	Inspected/Verified By
1. Building Heat Gain/Loss Calc. *To determine peak heating and cooling capacity needed to maintain comfort in the the building.*	Manufacturer (Mfg)/Title 24/CA Mechanical Code(CMC).	Building department often does not verify if load calculation was performed or if inputs are accurate
2. Proper Equipment Capacity Selection *To determine the proper size of the equipment*	Mfg/Title 24 compliance option	Verified by third party if Title 24 performance compliance option is selected but not if prescriptive approach is used.
3. Equipment Matched to work together *Verify with the Mfg that the equipment is compatible.*	Mfg/Title 24 compliance option	Verified by third party if Title 24 performance compliance option is selected but not if prescriptive approach is used
4. Airflow across Indoor Heat Exchanger/Coil *Ensure that the correct amount of air passes through the equipment.*	Mfg/Title 24 compliance option	Verified by third party if Title 24 performance compliance option is selected but not if prescriptive approach is used.
5. Refrigerant Charge *Ensure the correct amount of Freon is installed.*	Mfg/Title 24 compliance option	Verified by third party if Title 24 performance compliance option is selected but not if prescriptive approach is used.
6. Electrical Requirements *Ensure wire sizing, voltage and amperage draw per Mfg.*	Mfg/CMC	Some requirements inspected by building department.
7. On-Rate for Fuel-Fired Equipment *Verify BTU/H input*	Mfg	Not inspected.
8. Combustion Venting System *Ensure proper sizing, design, and material of gas venting system*	Mfg	Inspected by building department.
9. System Controls *Ensure proper selection and functions of controls*	Mfg/Title24	Building department inspects residential and often does not inspect nonresidential.
10. Duct Leakage *Endure ducts do not leak*	Title 24 compliance option	Verified by third party if Title 24 performance compliance option is selected but not if prescriptive approach is used.
11. Airflow Balance *Ensure proper air flow to rooms*	Designer	Verification of airflow by a Test and Balance contractor.
12. Proper System Documentation to Owner *Documentation of How to Operate and Maintain HVAC system information*	Title 24	No Inspection or verification currently

The ACCA quality specifications above are designed to be implemented at the local level. They provide flexibility to local building departments by giving them the ability to approve an equivalent testing or measurement procedure to the procedures specified in the ACCA publication. Currently there is no inspection or confirmation required by the building department for those procedures only required or recommended by a manufacturer. The utilities and CEC will need to work together to decide who should be given the responsibility to verify that each of these requirements have been met before the quality seal can be given out.

1. The CEC should consider making the ACCA requirements mandatory for all HVAC installations as opposed to only being required when the performance compliance approach is selected.

2. The Utilities, CEC staff, and trade representatives should work together to decide who will be responsible for verifying each of the specifications has been achieved and then delivering the seal to the customer. Candidates include building officials and third party verification providers.

3. The customer education materials that complement the ACCA standard should be reviewed and coordinated with the development of the education campaign to launch the high quality brand as discussed below.

Strategy 2. Stimulate a stronger customer pull for High Quality Installation and Maintenance Practices

Customers do not currently demand verification of high quality installation practices because they assume it is already happening. They are not aware of the energy consequences of leaky ducts or improper refrigerant charge and have no easy way to verify that their HVAC system has been properly installed. The following recommendations are designed to make customers aware of the need to ask for and verify quality installation practices have been followed.

Recommendations to Achieve Strategy 2

2.1 The CEC, CPUC, and the state's utilities should work together to develop and promote the use of a state-wide Quality Installation and Maintenance (QI/QM) Brand for customers and contractors.

i) This brand should be used in at least two ways, (1) the brand or decal should be affixed to the actual equipment after a third party has certified a given installation has met the requirements and (2) the brand or decal should be available to contractors who voluntarily ensure that a high proportion, perhaps 90%, of their workers have received high quality certification from NATE or other industry groups who wish to offer the same high quality brand.

ii) EPA is working on the development of a quality installation certification for new CAC installations and it may be possible for the state to pilot test this new brand in California. The state needs to decide whether it would be better to develop a California-specific quality brand or partner with EPA to create a national high quality brand.

2.2 The utilities and industry trade allies should launch a statewide customer education campaign to introduce and stimulate the customer demand for the QI/QM brand.

iii) A well-informed customer base will be able to demand high efficiency cooling system equipment if they know what to look for and the likely consequences of not asking for the quality brand. The education campaign should include information on the likely increases in energy and peak usage if they do not ask for and verify that the quality specifications have been met through receipt of the brand. Customers should be encouraged to use an industry or a trusted third-party source (e.g. Energy Star, Consumer Reports, Edmunds, or similar group) to provide customer-focused materials that instruct on how to shop for contractors and ask the right questions before and after the installation process. The campaign should be designed to introduce the concept of a high quality brand and teach a large fraction of the residential market how to use it.

iv) The utilities and private industry should work together to develop and co-fund this customer education campaign. This effort will be most effective if all actors speak with the same voice. Cross pollination and consistent messaging are critical.

2.3 The CPUC should consider providing discounted electricity rates for those customers who sign up and possibly pay for periodic maintenance checks to slow degradation in cooling system performance and the associated increases in peak demand.

v) The California Public Utilities Commission could develop a special electricity rate for building owners and/or consumers who purchase, maintain and operate their HVAC systems in accordance with adopted energy efficiency standards. The building owner would be required to obtain a third party, functional performance evaluation every two years to qualify for the lower rate, submitting it to the utility. Under this scenario, the consumer demands a quality and efficient installation to receive a preferred price for power. This creates pull through and isolates/insulates the quality/efficiency component from the first-cost market drivers.

vi) Some argue that the cost of such a discount could not be sustained. However, consider an alternative: An “Energy Guzzler” tax similar to the already existing “Gas Guzzler” tax that is levied on automobiles that do not meet minimum standards for efficiency. Under this scenario, consumers would pay a premium until they could demonstrate an existing or newly installed / replaced system met the minimum standards for efficiency and performance. The revenue generated could be used to pay for the third party verifiers (possibly super-HERS raters) and could subsidize repairs and replacements for low income customers and seniors.

2.4 Utility programs should provide incentives to customers who demand high quality verification or ask for the quality brand after HVAC installations.

vii) A market-based incentive should be developed to support an actionable value proposition that will increase the market pull for high quality installations. The first step in developing this market-based incentive should be to commission an in depth market research study on customer buying behaviors related to contractor-provided home/building repairs. This research will characterize the behaviors of consumers, such that a proper incentive (financial and/or non-financial) mechanism can be established. In consultation with the HVAC Industry, the CEC and the CPUC should design this program to be as efficient as possible with as little administrative cost to the contractor, building owner, and the utility.

Near-Term Milestones (2008-2011):

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1. Achieve consensus on the quality specifications and who is responsible to verify their completion by July of 2008.
2. Develop the size, feel and graphics for the quality brand or seal in focus groups in the fall of 2008
3. Launch the customer education campaign and quality brand in the spring of 2009
4. Evaluate the effectiveness of the marketing campaign in convincing customers to request the quality brand by the summer of 2010.

Medium-Term Milestones (2012-2015):

1. Verify that at least 20% of customers in the HVAC purchase market have requested the quality brand after installation and seek out the brand as part of the contractor selection process.
2. Certify at least 20% of the contractors have provided high quality training for at least 50% of their employees by 2012.

Chapter 4 Stimulating the Supply of Quality Installation Services in the residential and small commercial HVAC markets

The next section describes four strategies to increase the proportion of contractors who choose to supply high quality installation services and presents recommendations to support each strategy.

Strategy 3. Achieve Consistent Enforcement of the Existing Building Standards to ensure conscientious contractors are not penalized by uneven enforcement practices

In Chapter 3, we noted that there was a fairly high level of non compliance (over 90 percent) with current building code requirements that require HVAC contracting firms to pull a permit for all replacements of CAC systems and have the system performance parameters (such as refrigerant charge, air flow, and duct leakage) measured and verified by third party raters. The significant lack of compliance with quality verification requirements and the fact that most building officials have no real way to ensure enforcement of the current building requirements are a significant barrier to those contractors who would prefer provide quality installation practices but cannot afford to due to the extremely competitive nature of this business. The bottom line is that this he strategy designed to increase the rate of compliance with the quality installation requirements in the current code was identified as one of the top three priorities of the working group.

This section of the report begins with a discussion of the reasons why a low fraction of HVAC contractors choose not to obtain a permit for the installation of new HVAC equipment, identifies what can be done to address these reasons by creating a more level playing field, and then provides some recommendations for improving and modernizing the entire permitting process
The working group identified four key reasons why the rate of pulling building permits for HVAC installations is so low:

- Many contractors perceive takes too much time and money to pull a permit for an HVAC replacement and some contractors are still unaware that a permit is required.
- Many contractors refuse to incur the costs of pulling a permit in a market where the majority of contractors will not pull a permit, in order to gain a cost advantage in a market where the low cost bid usually wins
- Many building officials are unaware of the recent change in building requirements that require third party verification of quality in HVAC installations, and as such, do not require a permit.
- Many building officials are never notified when an HVAC replacement job has been completed.

Recommendations to Achieve Strategy 3

3.1 The CEC and CALBO should work together to make it easier for contractors to obtain a building permit by pursuing the following actions.

- Convene a California executive-level task force composed of local government officials, CALBO, CEC representatives and utility executives to develop and then propose a new HVAC permitting system that will make it easier to obtain a permit, ensure higher levels of compliance at the contractor and technician level, and build a new quality control tracking system that matches serial numbers to CF6R forms.

  .The task force should work with CALBO and other regional representatives of the building departments to determine the best way to fund pilot tests of a new system and then develop funding mechanisms to help building departments with limited funding. . The task force should also explore whether changes in laws or regulations would be needed to implement the new data base

- Encourage building departments to issue HVAC replacement permits online and or allow permits to be issued at the supplier level.

  Placing permits on line would require a significant increase in funding or personnel for some Building Departments to develop and set up an online permitting system. There would be a significant initial outlay of money to accomplish this so the benefits would have to be made clear to each building department through an analysis of both increased revenue from more permit pulling and energy savings. CEC staff and or utilities should work with local building departments to estimate the local loss of revenue resulting from current situation where a significant number of building permits are not being requested and design a program to increase number of permits and thus revenues. The group should also consider the feasibility of enforcing penalties and fines for contractors who choose not to pull a building permit.

3.2 Create a level playing field for contractors by ensuring that all new HVAC replacement installations pull a permit and have received the necessary quality control checks.

- Create a new compliance tracking mechanism that matches equipment serial numbers to CF6R forms and third parties who perform quality verification.

  Our proposal to improve the existing building permitting process is presented in Appendix C. The CEC should work with representatives from IHACI and building officials to review and discuss this proposal and make improvements consistent with building officials comments and needs. A pilot test of a revised data base system should be implemented for two or three building departments in 2008 with the goal of developing a revised data base that could be used for all building jurisdictions. The pilot test should be designed to test if input into the data base systems are secure, that the new system would actually be an improvement over the existing permit system and that maintaining the new systems will not overwhelm building department personnel resources. The Utilities and CEC should hire an independent contractor to evaluate the new permitting system and estimate if there are any energy and peak savings achieved by the improvements to the permitting system.

  The local Building Department should be the main player in taking the necessary steps to making it easier to obtain a permit through this new electronic data base. Without the active cooperation of the Building Department in developing systems to issue permits online, tracking equipment through the suppliers, working with the utilities or the California State License Board (CSLB) will not happen. There are some Building Departments that have implemented ways to make obtaining a permit easier. Using these departments as a model to motivate others to follow in their footsteps may be a good idea. Utilities or CEC should work with CALBO to highlight the benefits of modern permitting systems in the trade press and local newspapers.

3.3 Simplify the building code in 2011 by changing the current quality control requirements for HVAC systems from optional compliance options used in the performance compliance path only to mandatory measures that would be required for all homes.

  The current requirements for ensuring quality HVAC installations: testing for HVAC duct leakage, refrigerant charge and air flow across the coil can be traded off for higher efficiency measures as part of the building performance compliance process. Building officials and energy analysts recommend that these quality control procedures be made mandatory for all HVAC installations, since without these checks energy and peak usage of the cooling systems can increase by 30 to 50% above the level of expected usage from a given system. Changing this requirement will require amending the next generation of the building codes.

- Set up a pilot program that sends customers an email reporting the results of the quality verification process and or provides them with a quality seal to affix to the equipment after it has been verified by a third party. In theory this should increase the market pull for more quality by customers and help support the building code official's effort to increase the number of permits pulled and proportion of quality installations.

- Investigate ways to reduce the costs of obtaining contractor business licenses for multiple jurisdictions. Contractors report that some Business licenses are too costly. Some contractors avoid pulling permits because they will have to buy a business license for new jurisdictions. This issue would have to be worked out between the State and the City government organizations. CALBO should be asked if they are willing to assist in pursuing any of these three strategies.

3.4 Increase the penalties for contractors who choose not pull permits for the replacement and installation of space cooling systems in California or those who operate without a license.

- CEC staff should work with building officials to determine if the possibility of new and significant fines for not pulling permits should be instituted after the positive market pull approaches outlined above have been tested. The state may also want to investigate the possibility of fining Building Departments that consciously do not enforce energy codes.

- Local governments should establish fines for contractors working without a permit. The fines should be graduated, and increased over time as a function of the number of times a contractor is caught working without a license. The system should not emulate the current system where the penalty is all or nothing, pull the contractor's license or take no action.

- Utility efficiency programs should not provide contractors or customers with a rebate for more energy efficient cooling systems unless proof is provided that a permit has been obtained and quality has been verified. SMUD has run a very successful air conditioning program that does not make an incentive payment until proof of quality certification for each system is provided.

- Utilities should consider and develop programs to increase the level of compliance with the quality requirements of T-24, thereby increasing the anticipated peak and energy savings achieved by installation of new CAC systems. For example, utilities may want to co-fund efforts by local Building Departments to either update their computer permitting systems, allowing permits to be downloaded online and to possibly increase their staff to provide support for the new systems.

Near-Term Milestones (2008-2011):

1. Increase fraction of contractors pulling permits from 5% now to 50% by 2010.
2. Deploy at least five pilot tests of the new compliance tracking system by the summer of 2010

Medium Term Milestones (20012-2015)

3. Increase fraction of contractors pulling permits from 50 to 90 percent by 2012.
4. Ensure deployment of the new compliance tracking system to at least 50% of all building departments by 2014.

Strategy 4. Increase the number of HVAC contractor technicians and sales representatives who take training courses and meet new certification requirements consistent with the proposed definition of high quality and branding requirements

Enhanced education and training of the HVAC Industry contractors, building inspectors, technicians, installers, sales representatives and third-party verifiers is required to achieve the dramatic improvements in the installation quality necessary to achieve energy efficiency from new central air conditioning systems. Certification of a quality installation is dependent upon a culmination of training at clearly defined levels of knowledge, skills, and abilities.

The overarching strategy for training is to dramatically increase the number of certified technicians and installers according to industry approved examinations by working with trade associations to ensure contractors are willing to pay for training for their employees and to achieve certification of higher levels of performance. . We envision expansion of the number of examinations provided and administered by the Air Conditioning and Refrigeration Institute (ARI) and North American Technician Excellence (NATE).

The training support will be delivered by providing utility incentives that will reduce the cost of attending the training and support programs to ensure technicians achieve the long term training goal of ensuring 100 per cent of all technicians have achieved the Industry Competency Standard (ICE) or North American Training Excellence (NATE) Certification (after two years of experience) by 2020.

However, achievement of the increased level of training activity is dependent on the establishment of a Quality Installation Brand and strengthening. It will be difficult if not impossible to convince HVAC firm owners to expand their training budgets without a stronger customer demand for quality and strengthened contractor licensing requirements.

Defining the Problem

National organizations such as NATE report that a small percentage of existing technicians and installers have completed industry sanctioned certification. A preliminary study of utility bills by NATE shows that certified installers and technicians achieve 10% better field adjusted energy efficiency (with error band of +/- 5%) than work completed by individuals without certification.

A severe shortage of such qualified individuals in “green collar” jobs has become an epidemic that will only get worse as the “baby boom” generation rapidly approaches retirement. The U.S. Bureau of Labor Statistics estimates that the number of jobs in the HVAC (and refrigeration) industries will grow by 29% between now and 2014. In addition, the industry needs an estimated 27,000 new skilled workers annually to replace technicians who retire. Overall, this means that the industry needs a total of 35,000 new technicians a year.

California labor market information indicates that in 2004 there were 17,500 HVAC technicians working in the state. This is expected to increase to 22,200 technicians by 2014. Of the current technicians in California, it is estimated that less than 10% are NATE certified (1,152 technicians and 150 installers). Approximately 135 new technicians receive NATE certification each year.

California HVAC contractor licensing is conducted at the “company” level, not at he individual technician or installer level. Therefore, the person controlling the quality of installation is often not likely to be trained, certified or aware of the critical need to get installation details right. Field adjusted energy efficiencies can either approach manufacturer ratings with “quality installations” or be diminished by as much as 50% with typical efficiency deficits of 30% due to poor quality installation.

Recommendations

1. Support new and existing training programs of all kinds that prepare Installers and Technicians for Certification (ICE for entry level or NATE after two years) with an ultimate goal of 100% certification by 2020.

    The certifications should rely on the Industry Competency Exams (ICE), the Air Conditioning and Refrigeration Institute exam, or Quality Installation training, following ACCA Q/I Standards with a test, and the curricula should include:

- NATE Installation
- NATE Service
- NATE + Efficiency Analyst Exam

The ICE exams measure competency with industry-developed standards of basic HVAC concepts and practices. ICE is the entry-level exam developed, supported and validated by the HVAC equipment manufacturers and major industry trade associations. NATE (North American Technician Excellence) is the leading certification program for experienced technicians in the HVAC industry, and is the certification program supported by HVAC equipment manufacturers and industry trade associations.

2. Develop and/or recognize "train the trainer" programs that provide quality instructor training to bona fide HVAC QI/QM Training Programs. The goal for HVAC training programs will be to attain NATE Certification for 100% of the technicians installing HVAC in California.

To ensure that all HVAC training programs are accredited by the State of California or recognized by equivalent national accreditation organizations, qualification standards for teaching at HVAC schools must be set. The Partnership for Air-conditioning, Heating, Refrigeration Accreditation (PAHRA) is the industry-developed, managed, and supported program for the programmatic accreditation of HVAC education and training programs. All public and private secondary and post-secondary HVAC programs are eligible to apply for PAHRA accreditation. Industry-sponsored Scholarship Programs are also available.

Qualification standards for HVAC trainers must also be set. Examples of these standards are the SMWIA/SMACNA International Training Institute's Standards for instructors and the community college standards for instructors.

3. Ensure that training is a continuous process rather than a once in a lifetime certification.

There are numerous annual changes and specifications attached to the HVAC industry and its installations. Continuous certification will be needed to ensure that two other recommendations from this report, HVAC QI Branding and HVAC Compliance, are upheld.

The public needs to learn more about the economic consequences of poor quality installations and the part that un-certified workers play in that issue. Customers also lack information about a contractor's workforce quality, other than by word of mouth. With a continual certification process, contractors would be able to differentiate themselves as certified by the industry and the State to perform a quality installation. Some certification information does exist at the NATE web site, where a customer can locate contractors who employ certified workers.

HVAC Contractor licensing should include certification and re-certification every two years in conjunction with license renewals. However, it is too soon to regulate this effort until the critical mass of certification infrastructure is in place. It is important to begin with infrastructure development in support of training leading to certification, and then consider offering incentives for early certification accomplishment.

4. Develop new training courses to enable sales reps to sell HVAC systems based on system performance rather than SEER ratings.

Sales representatives are the first contact for the customer and, at times are the only resource available to provide information to them. It is important that the sales representative provide factual information and is able to address technical and economic issues facing the customer. The training should address the economic drivers of quality installation and cost benefits to consumers following a standardized curriculum. Communications training should also include the concept of “SEER-FA”, which stands for field-adjusted seasonal energy efficiency ratings reflecting installation quality.

5. Bolster Community College HVAC vocational education programs.

   There is a shortage of technicians in the HVAC labor market. Industry sources suggest there is a need for an additional five to ten thousand technicians to keep up with demand. Bolstering vocational training at the Community College level will help address this shortage. To support the training effort, it is important to update community college and vocational school facilities to address equipment changes and to expand the current curriculum. Schools with PAHRA accreditation can be eligible for equipment donation.

   An industry “Adopt a School” challenge by manufacturers is recommended to support instructors, recruit students, and increase certification emphasis. Incentives would encourage ties to bona fide apprentice training programs. In addition, support for other educational and training programs offered by Private Vocational Schools, Unions, and trade associations (ACCA, RSES, SMACNA).

   In addition to the certifications outlined above, training should also incorporate the “building versus HVAC system” concept as a standard course element so that the influence of the building envelope and whole house performance is understood in the context of quality HVAC design, specification and installation.

6. Recruit and encourage trainees to be certified

   It is important to enlist installers and technicians in the certification efforts. One recommendation is to take a holistic approach to attracting new HVAC employees by improving the impression of quality HVAC work with linkage to “Green Collar” job programs. Equating the certification process for an "HVAC Professional" with green careers could provide an attractive career path to some. A mentoring program is also recommended, to include field training help beyond the classroom.

   One barrier to recruitment is that technicians and installers are not aware of the training opportunities available to them. A web-based clearinghouse showing all training calendar offerings in the State, identifying all facilities and certified trainers would be valuable for recruitment efforts.

7. Encourage all affected stakeholders to provide funding for increase training and certification

   All stakeholders should contribute to this training and certification effort. Utility Public Goods Charge and Gas Surcharge-funded programs should provide funding to support upstream training for trainers, standards curriculum packages, standards development for instructors and schools, underwriting of NATE certification programs, and sales training. The CEC should request additional funding to support this effort.

   Public Education officials at the junior college level should provide more funding for HVAC training as a “Green Collar” job program yielding sustainability. The Governor’s emphasis on rekindling Vocational Education should focus on the positive impacts of reducing peak demand and increasing reliability by supporting courses to foster higher levels of of HVAC installation quality. The State should not only increase current vocational funding, but also needs to provide for additional HVAC training facilities, instructors and recruitment, and should also encourage pre-apprentice training in high schools and trade schools.

   All training funding at the Contractor and Technician level should require matching funds from industry sources. The industry should provide matching funds for all apprentice and journey level training and upgrade training. The industry should support certification with dealer incentives, warranty provisions, and educational campaigns

The CPUC and the CEC should establish a regulatory mechanism to credit utility education and training programs with a specific amount of energy savings pre trainee based on the results of early evaluations of the effectiveness of these programs. Utilities must be assured that there is agreement on a legitimate level of ex ante savings per certified contractor in order to justify expansion of HVAC training for licensed contractors by bona fide training providers and training for HVAC Sales Persons and Building Department personnel. Energy savings can be quantified by measuring the increases in the percentage of contractors meeting the Code and multiplying this by the *ex ante* savings estimate per household developed in Chapter 4.
Staging and Milestones:

Near-Term Milestones (2008-2011):

- Develop an industry agreement on what skills need to be taught to perform and certify quality installation by spring of 2008 and what types of workers need to be trained by September of 2008.
- Develop new training curricula, platforms and institutions to perform training by 2009.
- 15 % Certification by end of 2011

Mid-Term Milestones (2012 to 2014):

- 35 % Certification by end of 2014

Long Term Milestones (2015 to 2020):

- 70 % Certification by end of 2017
- 100% Certification by end of 2020 with certification of technicians and installers required as an HVAC License element with continuing education requirements.

Strategy 5 Obtain a commitment from local governments, state agencies, utilities, and local building departments to devote more resources to customer education, building energy inspections, and streamlining the permitting process

Recommendation

1. Form partnerships with Green cities to help improve their building departments ability to verify quality installations and reduce their energy usage.

   Many cities in California have taken the initiative to develop sustainable development policies to reduce their energy and carbon footprint. We suggest that the utilities and state agencies form a coalition to convince local governments of the need to upgrade the quality and performance of their building departments in certifying compliance with new building codes to help achieve their sustainable development and energy reduction goals.

Near-Term Milestones (2008-2011):

- Enlist at least 10% of all local jurisdictions to participate in the building department improvement program by the summer of 2008
- Fund pilot programs to reduce the cost and increase the coverage of local building departments by the spring of 2009
- Publish the results of this pilot test by the summer of 2010

Strategy 6 Seek regulatory policy changes designed to encourage utilities to achieve larger scale market outcomes by estimating the energy savings achieved by the HVAC education, training and enforcement efforts.

Recommendation

1. Seek policy changes in the current planning and evaluation system that will allow utilities to get credit for the energy and peak savings associated with training/ branding and education efforts

The CPUC should require that utilities conduct an evaluation of the market effects and resulting energy savings per household caused by branding, education and training programs designed to increase compliance with the HVAC quality control provisions of the CEC building standards.

In the interim before this evaluation can be completed, utilities should work with the CPUC Energy Division (ED) staff to develop *ex ante* estimates of the energy and peak savings provided by increasing the level of compliance in these markets as a function of house size and HVAC system capacity. This will require the utilities to track changes in the fraction of quality installations that occur in this market and the energy and peak savings per installation. We recommend the use of similar methodology, similar to the one used in this report, that estimates energy and peak savings of 20 % and 15%, respectively. The current situation of 5 to 20 percent of the systems installed being certified for quality installation practices should be designated as the baseline condition from which savings or impacts should be measured, not the ideal of 100 % compliance with the code. This is because the current level of compliance will not change without concerted programmatic initiatives to change the structure of the demand and supply side of this industry.

Near-Term Milestones (2008-2011):

- Develop proposed changes to the EM&V system and request their adoption by the CPUC by mid 2009
- Execute and EM&V study to estimate the potential savings from the utilities proposed energy efficiency programs for education, training and increased enforcement By mid 2010.

Chapter 5 Strategies to increase the efficiency of new space conditioning systems Installed in California over the next decade

The average efficiency of units sold in California has been trending up from 10.3 in 1999 to 11.2 SEER in 2005.[1] Recent federal standards increasing the minimum efficiency from 10 SEER to 13 SEER have in effect resulted in an immediate 23 percent increase in the rated efficiency for new equipment. However, there is still room for improvement. A significant reduction in peak usage can be achieved by deploying higher efficient technology and commercializing new technologies and making sure they are properly maintained over their system life, This chapter will discuss several strategies identified by the HVAC planning committee to address increasing the efficiency of space conditioning systems.

Strategy 7 Support commercialization of on-board and portable diagnostic and fault detection systems

In 2006, a technology roundtable was convened in Oakland to discuss critical HVAC technical and research issues. The group issued a list of 10 consensus recommendations to "improve the operating efficiency and field performance of air conditioning systems." Five of these recommendations addressed system diagnostics:

- The industry should develop a minimum standard for onboard diagnostics functionality for all units. It could take the form of a universal plug point for all manufacturers with a universal protocol for data requirements and data analysis.

- Manufacturers should look into creating a standard for specification of designated sensor mount locations for field testing. Manufacturers should mark appropriate locations for technicians to attach sensors. At least one manufacturer has a product with sensor mounting locations marked.

- There is a need to prioritize in-field diagnostic approaches based on benefit-cost of the energy savings, cost to diagnose/repair, and the frequency of occurrence of faults. This might be determined by review and analysis of existing field experience.

- There is an immediate need for benchmarking existing diagnostic and repair protocols. While there are a number of commercially available diagnostic tools, there are no underlying benchmarks from which to gauge the consistency of the tools currently used in the field. There is a need to create a national standard. The research for this standard could be undertaken by ASHRAE and/or ARI.

- There is a critical need to gather protocols and data, and post them to a common place. The collection of data should allow researchers and practitioners to examine the quality of the data including sensor and instrument types, accuracies, measurement uncertainties, and testing methods. ARI could provide this information hosting service.

Many HVAC OEMs currently offer on-board diagnostic equipment (e.g. Carrier Infinity) that integrates with their higher end systems while others offer hand-held systems (e.g. Field Diagnostics Service Assistant) that work with all systems. However, at this time none of these systems are widely used by customers and/or contractors. Supporting further commercialization of diagnostic systems that automatically collect data and alert customers and contractors when a fault or negative performance trend is detected by the system will result in energy benefits by ensuring that systems continually operate within design specifications. Such systems will:

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[1] Itron, Inc. *California Residential Efficiency Market Share Tracking*, August 2006, pp 3-10

- Provide customers with real-time performance and servicing information directly at the thermostat.
- Provide contractors the ability to download fault detection and diagnostic information during a service visit
- Communicate with the new smart meters and receive pricing signals and/or integrate with utility demand response programs; and
- Integrate with in-home automation and utility smart grids.

Recommendations:

1. Conduct consumer market research to establish the requirements of diagnostic systems that can communicate with customers, owners, occupants, contractors and utilities;

2. Enhance customer and/or contractor demand for onboard or hand-held diagnostic systems. A market needs to be created and product development costs need to be reduced in order to have private industry invest in such systems.

3. Sponsor research to determine the degree of performance degradation in unitary, packaged and split systems;

4. Provide financial support through PIER and/or Emerging Technologies programs for development and testing of fault detection and diagnostic systems into their cooling equipment and benchmarking energy savings resulting from their use;

5. Provide legislative and regulatory support for the development and piloting of standard diagnostics protocols;

6. Partner with manufacturers to develop sensing and communications functionality in HVAC equipment that integrates with warranty and service agreements with customers;

7. Make the 2008 diagnostics requirements prescriptive for the 2011 Title 24 building standards and providing compliance credits for the next generation of diagnostics that incorporate Monitoring Based Commissioning (MBCx); and

8. Utilities should consider funding a program that will provide cash incentives to the first 100,000 CAC systems brought to the market with on board diagnostics integrated into the cooling systems and or thermostat.

Strategy 8. Develop new efficiency performance metrics to promote development of advanced cooling systems customized to the hot dry climates of California

Current HVAC appliance performance testing is conducted to national standards established by the American Refrigeration Institute (ARI). Standard ARI ratings for SEER are conducted at a maximum temperature of 82 F and treat dehumidification as equal to sensible cooling. In the hot dry climates of California, outside air temperatures over 100 F with 35% relative humidity is common. The current ARI standards provide inaccurate assessments for peak period performances.

Peak energy use is further amplified by the natural tendency of designersand contractors to provide a larger capacity system than necessary, resulting in excessive and inefficient cycling of the compressor. Increased cycling of a DX A/C system reduces overall efficiency through cycle start-up losses [JP19] occurs until cold liquid refrigerant returns to the evaporator coil. “The results of oversizing single speed units are increased electrical peak and, in some cases, increased energy consumption.”7

These conditions call for a different performance metric for use in California. The metric of interest is the sensible capacity divided by the watt draw of an air conditioner. When addressing hot climates this is known as PEERs (Peak Energy Efficiency Ratio – sensible).

It is envisioned that measures of cost effectiveness will more accurately reflect avoided costs associated with technologies and processes that reduce the causes of electrical system peak. These avoided costs mirror the marginal nature of peak. Technologies that reduce the cause of peak are attributed the full marginal avoided cost of transmission, distribution, generation, and market cost escalation, while base energy consumptions are valued at base values equal to or less than the annual average costs.

As concluded in the ACEEE report, it is time to reconsider the importance of SEER ratings. The Method of Test does not reflect field conditions, particularly the pressure drops from ductwork and high performance air filters, and the effect of pressure drops on fan power. A fan power metric (e.g., W/cfm or cfm/W) is needed, too. Equipment optimized for real-world conditions will be more efficient in actual use. The single national standard does not serve well in hot-dry and hot-humid climates. Large efficiency and comfort improvements may be possible from optional regional standards that respectively give credit for very high temperature performance and improved humidity control. Regional standards could be implemented within SEER[2].

Recommendations to achieve this strategy

1. Investigate a new efficiency metric for residential and non-residential air conditioning systems (“A/C units”) that appropriately rates performance in hot and dry California climate zones, pursuant to AB2021 (short-term)

2. Explore modifications to equipment efficiency ratings as recommended by ACEEE[3] and others.

3. Review the CPUC’s “Total Avoided Cost Model” and Title 24’s Time Dependent Valuation (TDV) calculations to assess their applicability for use as a performance based platform for market incentives.

4. Initiate a proceeding, solicit expert opinion, conduct public workshops, etc. to discuss, propose and adopt a method for rating and reporting individual unit performance in hot dry California Climate Zones during periods of extreme high temperatures.

5. Following development and adoption of the new metric, various parties in the State, including the Legislature, CEC, and CPUC should take the necessary steps to accelerate the adoption and use of the new metric.

Strategy 9. Accelerate Market Penetration of New Cooling Equipment Technologies

Since equipment ratings for smaller equipment are done on a national level, manufacturers have no incentive to develop equipment that performs differently for California’s hot and dry climate zones (a similar situation exists for hot humid climates typical of the Southeast). For any significant energy

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[2] Can SEER Be Saved? Harvey M. Sachs, American Council for an Energy-Efficient Economy, Hugh Henderson, CDH Energy , Don Shirey, III, Florida Solar Energy Center; Steven Nadel, American Council for an Energy-Efficient Economy, Daniel W. Jaynes, Ohio State University; 2006 ACEEE Summer Study on Energy Efficiency in Buildings.

[3] Improving Central Air Conditioner Performance Ratings: A Review of Seasonal Energy Efficiency Ratings, Harvey M. Sachs, American Council for an Energy-Efficient Economy, Hugh Henderson, CDH Energy , Don Shirey, III, Florida Solar Energy Center; Steven Nadel, American Council for an Energy-Efficient Economy, October 2007.

reductions to be realized in California, equipment performance must be addressed by stimulating the commercialization of new equipment technologies that perform optimally in the south western region.

There are a myriad of institutional barriers to the successful introduction of new technologies with the potential to reduce peak and improve energy efficiency in California. As noted above, the reliance on the existing national metric is problematic. In addition, the time from innovation/invention to implementation is extremely long due to the need of protecting Public Goods Funds from being wasted.

The HVAC planning committee envisions a new system where new technologies are introduced and integrated into the market and provides as much as 30% of the savings and peak reductions within the Utility portfolios. These technologies are fast-tracked into the market with due diligence to provide years of opportunities that would otherwise be lost. The technologies introduced and implemented through the system include a mix of proprietary and non-proprietary technologies selected solely by cost effectiveness.

The system of fast-tracking new technologies that address our basic peak problem is not technology specific. Any technology that appears cost effective and accomplishes the task will have access to the system. At the present time, there are known technologies that might fall into this category.

There are alternatives to and modifications to the standard DX systems that are in various stages of development. These technologies can be deployed and result in significant reductions in energy use and peak load. Table 5-1 provides an overview of some technologies with a qualitative assessment of their availability, energy impacts, cost and market potential.

Table 5-1
Overview of Alternative Technologies to Traditional Vapor Compression Systems

	Near Term (2007-08)	Mid Term (2008-09)	Applicable Market Sector	Potential Savings (kW)	Potential Savings (kWh)
Thermal Energy Storage	N		Commercial Residential	M	L
Indirect Evaporative Cooling	N		Commercial Residential	L	L
Two Stage Evaporative Cooling	N		Residential	L	L
Hybrid Systems		M	Commercial Residential	M	M
Hot Dry DX	N		Commercial Residential	H	H
Water Cooled Vapor Compression	N		Commercial Residential	M	H
Ground Source Heat Pump	N		Commercial Residential	L	L
Advanced Roof Top Unit	N		Commercial Residential	M	M
Ductless DX	N		Commercial Residential	L	L
Residential Economizer (Night Breeze)	N		Commercial Residential	0	H
Radiant heating and cooling	N	M	Commercial	L	L
Advanced Direct Evaporative	N		Commercial Residential	L	L

Recommendations

1. There are several organizations tasked with identifying and managing emerging technology in use in California (Investor Owned Utilities, CEC PIER program, Universities, and Economic Development organizations). These organizations should be asked to expedite the development and introduction of new cooling equipment appropriate for the hot dry market. Such processes could be enhanced by making use of creative financial incentives, design competitions, innovation incubators, etc.

2. This recommendation includes allowing for a certain amount of risk in order to drive true innovation. This could include allowing the investor owned utilities the flexibility to implement an incubator designed to grow innovative energy saving programs and processes for the larger portfolio over the long term;

3. Explore integration of air conditioning equipment with solar (i.e. solar-thermal driven systems), smart metering (improved controls), etc. in support of other CEC and CPUC goals (long-term). This includes research into solar-thermal cooling systems (thermally activated systems such as desiccants, absorption systems, etc.);

4. Provide code support to facilitate the adoption of such technologies; and

5. Provide contractor/technician education and training support to ensure that the infrastructure exists to install and service new equipment per quality installation standards.

Strategy 10. Create a market environment that encourages whole building design

In addition to the equipment technologies listed in Table 1, there are design issues with the entire cooling "system" that need to be addressed. This includes developing solutions for a "whole-building" approach that improves the thermal integrity of structures, moving ducts and equipment off the roof and out of hot attics, or going ductless.

The building heat gain determines the size of the unit required to provide adequate space conditioning. By not considering the entire building as part of the HVAC system, only one part of the solution is addressed. If the size of the HVAC unit can be reduced and still provide the necessary occupant comfort, the peak load will be reduced proportionally. The goal is to support increased architect and mechanical engineer usage of the concept of designing the house as a system. This is expected to have a beneficial impact by reducing the overall heat gain and loss in a typical home environment that the HVAC system is designed to meet. Attention to whole building issues is a high priority since buildings contribute more to our carbon footprint than automobiles.

Recommendations

1. Address current cooling system design limitations by encouraging builders and contractors to adopt a "whole-building" design approach that improves the overall thermal integrity of new and existing structures;

2. Explore code-based solutions to improving thermal structural integrity and moving duct systems and equipment from roofs and attics;

3. Create a paradigm shift in current HVAC system design approaches by implementing code-based solutions to incorporate ductless, radiant heating and cooling, and ground source heat pumps into all new construction; and

4. Support improved building and system designs through training and education of builders, contractors, installers, code officials, etc.

STAGING AND MILESTONES

Near Term: 2008-2011

- Support development of diagnostic systems through PIER and/or Emerging Technologies
- Establish an industry-wide task force to oversee the development of a standard diagnostics protocol
- Conduct benchmarking research to determine energy savings potential for on board diagnostics

Medium Term: 2012 to 2014

- Manufacturers provide diagnostics systems standard on equipment
- Include prescriptive MBCx and mandatory on board diagnostics requirements in 2011 Title 24
- Continued support of system development through PIER and Emerging Technology programs

Long term: 2015 and beyond

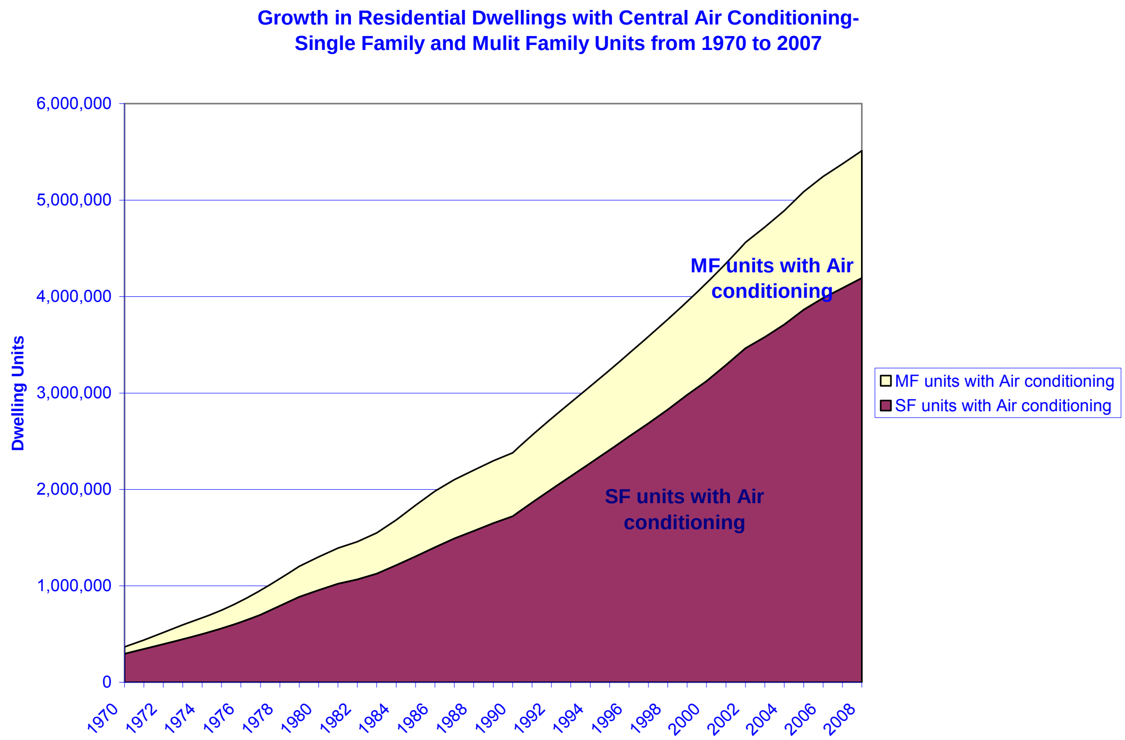
- Provide compliance credits in Title 24 for next generation diagnostics
- Manufacturers introduce advanced diagnostics technology that allows for continuous commissioning

Appendix A-
The Relationship between the Growth of Air Conditioning Units and Peak Demand in California

Central air conditioning has become a way of life in California and is now offered as a standard feature in most new residential and small commercial buildings. Over the past three decades, there has been a dramatic increase in the proportion of new homes built with central air conditioning; from 25 percent of all homes in 1976 to over 95 percent in 2007. This increase in equipment saturation coupled with a 55 percent increase in new home size (from 1,560 sq ft to 2,390 sq. ft. for new homes) over the same period has led to a ten-fold increase in the electricity capacity needed to meet this load; from an estimated 1,950 MW in 1996 to over 12,000 MW in 2006. The annual energy required to meet residential cooling load grew from 1,518 GWH in 1976 to 7,341 GWH in 2006. (Source: CAC saturations and unit energy consumption for central air conditioners in California from the 2007 CEC forecast, Glen Sharp.)

Figure 1 illustrates the growth in residential single and multifamily units with central air conditioning and the corresponding growth in peak demands over time for the three major investor owned utilities (IOUs) and Sacramento Municipal Utility District (SMUD). The graph shows there are roughly 6 million households with central air conditioning in 2006 out of a population of 12 million households served in these territories, indicating roughly 50% of all household units have central air conditioning systems.

Figure 1



Source of household and saturation data: CEC forecast for year 2007

Table 1 shows the corresponding growth in coincident peak demand associated with central air conditioning as a share of total peak demand over the last thirty years. The share of peak demand associated with residential central air conditioning has risen from 6% of total peak demand in 1976 to roughly 24% in 2007.

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Table 1

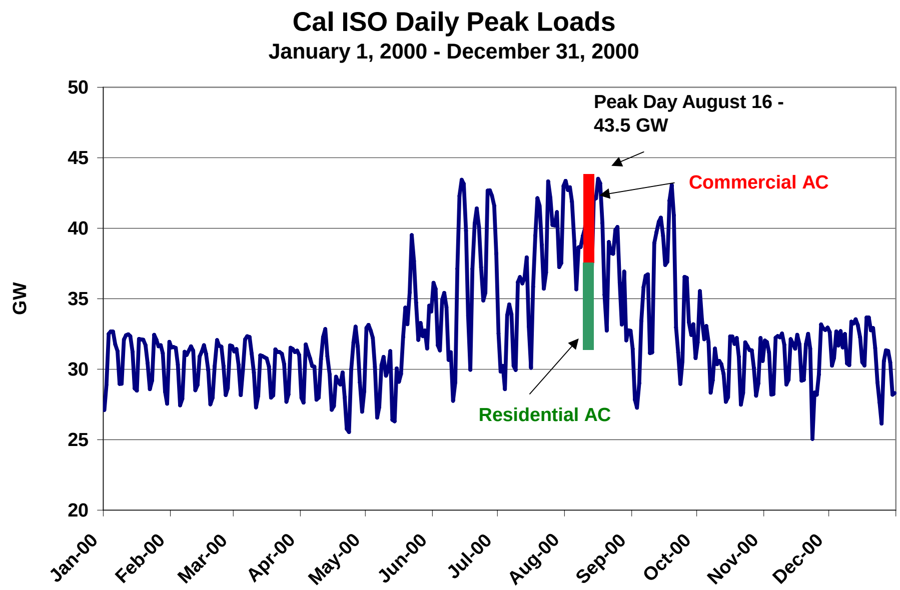
	Residential Central Air Peak MW	Total Peak MW	Residential as % of Total %
1976	1,945	32,500	6.0%
1986	4,736	39,370	12.0%
1996	8,787	50,130	17.5%
2006	14,316	60,100	23.8%

Source: CEC forecast data for households and energy use. SCE studies of coincident demand levels for households with Central air conditioners

The Relationship Between the Growth of Air Conditioning Equipment and Peak Demand

Residential and commercial air conditioners are the principal cause of electrical peak in California. This is best illustrated by Figure 2, a graph of the 2000 system energy consumption. The graph illustrates that A/C energy consumption is virtually 100% of the peak load (the difference between base consumption of 32 GW seen on most days in the graph– and the peak load of 43.5 GW).

Figure 2
Air Conditioning is the Principal Cause of Peak Electrical Consumption



Trends in the Energy use per Household with Central Air Conditioning

Energy use per household has trended down from 1975 to 1995 but began to level off in the last decade due to the rise of poor quality installation practices and increases in the size of new homes. Actually achieving the anticipated reductions in energy use associated with better thermal integrity and increases in the rated efficiency of central air conditions requires careful attention to quality installation practices. A series of reports in the late 1990's documented the need to ensure more careful testing of these parameters at the time of installation to ensure energy and peak use did not exceed the advertised system performance based on SEER and EER ratings. (Blasnik, 1997 and Proctor, 1995 and 1997)

This need for higher quality installation practices was hard to sustain in light of the rapid growth in housing starts from 1990 to 2002 and the difficulty in finding and maintaining trained HVAC technicians familiar with quality control requirements. Fewer available technicians and market pressures to build houses more quickly led to a race for the bottom in pricing for installation jobs and unfortunately installation quality since there was no visible way for homeowners to ensure their systems had been properly installed. Unfortunately the size of HVAC technician labor force could not keep up with the rapid growth in demand for new CAC systems in new construction and a burgeoning demand for central air conditioning retrofits in older homes not previously equipped with central cooling systems. As a result the quality of installations fell as fewer qualified technicians scrambled to install more systems in an overheated housing market.

Several parties called for an increase emphasis on quality control as part of the installation process and the industry responded with new certification programs and efforts to draft procedures to verify that quality installations had taken place. Despite these private market efforts, the fraction of central air conditioning jobs meeting the quality installation specifications was quite low and the CEC decided to begin to require third party testing. In late 2003, the CEC adopted changes in the building standards that required third party testing of air flow, refrigerant charge, proper sizing calculations, and potential leaks in the duct systems for central air conditioning systems under 10 tons. These changes went into effect in October of 2005. The change in the code required third party testing by HERS raters to ensure that air flow losses from ducting systems could not exceed 15% at 25 Pascals of pressure and that the refrigerant charge and air flow were within appropriate manufacturer specifications.

Unfortunately the vast \majority of contractors have chosen not to emphasize quality control and certification of quality control efforts. Recent market evaluations confirm that the proportion of homes with properly functioning central air conditions systems has continued to decline over the last ten years. As early as 1999, studies were showing that 30 to 50% of new central air conditioning installations were not being properly installed due to either lack of training for technicians or a reduction of the amount of time available to properly install the new systems, particularly in replacement jobs. (Neme, Proctor, and Nadel, 1999: Reference 1) Failure to insure quality at the time of cooling system installation results in a 20% increase in the energy needed by CAC systems to provide customers with the cooling and comfort they demand on hot summer afternoons (Neme, Proctor and Nadel, 1999). This research suggests that failure to check for quality installation results on average in a 20% increase in the peak electrical system capacity needed to meet the cooling demands of a typical single family home assuming proper sizing using Manual J[4].

Beginning in 2002, Utilities and energy agencies responded to this potential quality control program with programs that sought to increase the level of training available and standardize measurements after installation to ensure quality control.
However these programs have not yet been successful in increasing the use of quality installation processes, in part because it is still legal to replace air conditioners without getting quality verification for

[4] Details of the level of energy and peak savings that could be achieved by implementing a suite of strategies to fix these problems are presented in Appendix B.

certain building compliance options. In addition contractors report that many firms do not bother to pull a permit for replacement or installation of new central air conditioning systems in existing buildings. A recent study reported the level of compliance with the building standards requirement for quality testing and third party verification of replacement systems was 5%. (Quantec, 2007 Reference 2) We estimate that an additional 10% of the residential HVAC systems have used high quality installation practices and would have passed a quality test but are not bothering to have the quality checked or verified by pulling a permit and requesting third party verification.

Several potential reasons behind the relatively low levels of compliance with the new testing requirements have been identified:

- California Building officials may lack the staffing resources to deal with these new CAC testing requirements. In fact some contractors lament that a few building officials have told contractors that they do not have the staff to verify this new requirement.

- Many contractors simply refused to pull permits because of the additional time and expense involved in pulling a permit and the possibility that a building inspector would require additional work beyond the scope of the HVAC repair job.

- Others felt the cost of obtaining third party verification of quality installations was too high and preferred to bid the jobs without the costs of a third party verification, gambling that overwhelmed building departments would never receive notice that a permit had not been pulled at a specific address.

- Finally some contractors report that home owners have requested that a permit not be obtained because of their fear that building officials would trigger a reassessment in their home value.

Regardless of the reason, it may be rational for a contractor NOT to pull a permit if he has reasonably certain knowledge that his competitors are getting away with not pulling a permit and thus reducing the cost of their bids. Contractors who opt to do the right thing will lose out unless customers have tools to differentiate between poor quality and high quality installation and their consequences. We estimate the potential energy savings from improving on these practices in Appendix B.

References

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2. M. Sami Khawaja, Ph.D., Allen Lee, Ph.D., Michelle Levy, Quantec, LLC, Statewide Codes and Standards Market Adoption and Noncompliance Rates (Prepared for Southern California Edison, May 10, 2007)

3. Blasnik, Michael et al. 1995b, “Assessment of HVAC Installations in New Homes in Southern California Edison’s Service Territory”, Final Report.

4. Proctor, John et al. 1997, "Assessment of Energy Savings and kW Reduction Potential from Air Conditioner and Duct Improvements for New Homes in PSE&G Service Territory", Summary March 31, 1997

5. Proctor, John et al. 1995, “Southern California Edison Coachella Valley Duct and HVAC Retrofit Efficiency Improvement Pilot Project”, Draft Report, July 3, 1995.

APPENDIX B
ENERGY AND PEAK CONSEQUENCES OF THE NEW VISION-

The purpose of this section is to estimate the level of energy and peak savings that could be achieved if

1) a higher percentage of HVAC systems achieve and verify the quality specifications for proper air flow, refrigerant charge and maximum duct leakage.
2) A higher percentage of new air conditioning equipment with dramatically reduced peak requirements associated with thermal storage and other advanced cooling techniques were achieved in the medium term.

These estimates are conservative in that they do not attempt to quantify the potential savings from increasing the efficiency of new hybrid systems with lower peak requirements. Rather these estimates only attempt to estimate the savings achieved by increasing the level of compliance with current code from 10% to 90% over a multi year period.

To accomplish this task, some reasonable estimates about the consequences or loss of energy savings in the current market are needed. The baseline for these estimates includes a high level of non-compliance with Title 24.

Residential Savings Potential

Increases in Quality Installation Practice

Table 1 presents estimates of the fraction and absolute number of HVAC installations that are not meeting the manufacturer's quality control specifications for air flow, refrigerant charge and the CEC's duct sealing requirements.

Table 1 Estimated Number of CAC Installations in Residential Dwellings with Potential Energy Savings from Quality Control Improvements

Job Type	Fraction in Compliance with Bldg Code requirement for third party quality Verification	Fraction of Installations meeting manufacturer/CEC quality specifications (a)	Fraction of installations with Significant Energy/Peak Savings potential from Quality Installation Initiatives	# of Installations of CAC systems in Residential Dwellings with High Savings potential in 2006
Replacement	10%	15%	85%	337,875
New Construction	30%	50%	50%	81,650
EPA study fraction meeting specifications	NA	22% of homes had proper airflow; 28% had proper charge	NA	NA

(a) Meeting Quality Specifications is defined as insuring that air flow exceeds 350 cfm per ton, that refrigerant charge is within the manufacturer's requirements, and that duct leakage is less than 10% of conditioned air to the outside at 25 Pascals.

The compliance estimates in column 2 are derived from interviews with building officials, HERS raters and a recent study of compliance rates in residential and non residential buildings[5].

In column 3, the estimated proportion of quality replacement installations performed by technicians from the 10% verified by third parties (with permits pulled) has been increased to 15% to account for the likelihood that some technicians will perform quality installation checks or measurements on their own without confirmation by third parties. In the new construction market, we assume that an additional 20% of the technicians perform the relevant quality checks on their own. This estimate is added to the 30% which are currently using third party verifiers to check their work to yield an estimate that 50% of the CAC systems are meeting quality control requirements in new construction.

The assumption that at least 15% of technicians are performing all of the necessary quality checks when installing replacement CAC systems and may be too optimistic given that the verification process for the 10% of contractors currently pulling permits is not yet perfected. However, this estimate of 15% of installations receiving quality control and refrigerant charge and airflow (RCA) checks is probably conservative given the fact that the national study found that 22% of CAC installations had proper airflow within 5% of specifications and 28% of the CAC systems had refrigerant charge within 10% of manufacturer specifications.

The final column in Table 1 shows the annual estimate of central air conditions installations with significant potential for achieving energy and peak savings because of poor quality installations that have not been verified. The final column is simply the fraction of CAC installations with significant savings potential (column 4) multiplied by the estimated number of replacement and new construction CAC systems in 2005 (397,500 replacement CAC systems and 163,300 CAC systems installed in new homes).[6]

Table 2 shows the estimated energy and peak savings from increasing the fraction of CAC installation jobs that meet the quality installation threshold from the baseline fractions of 10 and 15% respectively derived in Table 1 to 90%on an annual basis . Savings per household estimates were taken from the low end of the range estimated in the national EPA study (Proctor, Reference 1). Per unit energy savings of 20% of baseline cooling energy usage for existing buildings and 15% for CAC systems installed with quality practices/verification in new homes were assumed. A lower fraction of 15% for replacements and 10% for new homes were assumed for peak savings impacts. Baseline energy and coincident peak energy usage were taken from the CEC's latest forecast of electricity use.

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[5] M. Sami Khawaja, Ph.D., Allen Lee, Ph.D., Michelle Levy, Quantec, LLC, Statewide Codes and Standards Market Adoption and Noncompliance Rates (Southern California Edison, May 10, 2007)

[6] Itron, Inc. *California Residential Efficiency Market Share Tracking*, August 2006, pp 3-4

Table 2
Potential Annual Energy and Peak savings resulting from an quality installation verification from homes with savings potential in 2006

Residential HVAC market	2006 CAC Installations with Savings potential (from Table 1)	Baseline energy use (a)	Baseline coincident peak use (b)	Energy Savings/ HH for CAC installs without quality verification ©	Estimated Peak Savings/ HH for CAC w/o quality verification (d)	Annual Energy Savings	Annual Peak Savings
Market type	CAC systems	kwh/HH/yr	kW /HH	kwh/yr/HH	kW/ yr/HH	MWH/yr	MW
Replacement	354,769	2,080	2	416	0.37	147,584	120
New Constr.	83,283	1,335	2	200	0.22	16,679	16
Total	438,052					164,262	136

Notes

a 30% multiplier applied to average unit energy consumption (UEC) from the CEC 2007 forecast to adjust baseline usage for homes without third party verification of quality specs

b Peak demand converted to coincident demand by reducing connected load by 50%

c Energy savings per household estimated at 20% of baseline use for existing homes and 15% of baseline use for new construction households

d Peak Savings per unit estimated at 15% of baseline for existing homes and 10% of peak usage for new construction

HH= household

These calculations suggest annual peak and energy savings of 164 GWH and 136 peak MW in the residential sector are possible. This level of peak savings is comparable to the peak savings of 166 MW reported for SCE's program portfolio in 2006. The real uncertainty in these savings estimates is how long it will it take to achieve an increase in verified quality installations from the 10 % to 15% observed today to the target of 90% quality certifications for all installations.

Energy and Peak Savings from Increasing the Efficiency of Future HVAC system Installation in the residential Sector

Table 3 illustrates the potential peak savings that could be achieved over the next twelve years if thermal storage devices were able to achieve a 6% market share by the year 2020. These estimates are based on data submitted by Paul Kuhlman of ICE energy based that derives the peak savings associated with different market shares for their product. To be conservative we have bounded these estimated market share of the thermal storage technology to 10% given that there are many other competitors in this market.

Table 3

Potential Energy Savings from the Market Penetration of Thermal Storage CAC systems in Residential and Small Commercial Markets

Year	Fraction of Market with thermal storage technology	MW Savings annual in 2007	Growth in HVAC sales	Peak Savings in MW	Cumulative MW Savings
2009	0.5%	11	1.02	11	11
2010	1.0%	21	1.02	22	32
2011	1.2%	25	1.02	26	58
2012	1.4%	30	1.02	31	89
2013	1.7%	37	1.02	37	127
2014	2.1%	44	1.02	45	171
2015	2.5%	53	1.02	54	225
2016	3.0%	63	1.02	64	290
2017	4.0%	84	1.02	86	375
2018	5.3%	112	1.02	114	489
2019	7.0%	149	1.02	152	641
2020	10.0%	212	1.02	216	857

Source: Peak Savings estimates for residential and commercial sector from Paul Kuhlman, market share estimates from Mike Messenger, CEC. Mr Kuhlman estimated potential savings of 2500 MW over five years by assuming a much higher market share of 50% for the thermal storage products.

Small Commercial Savings Potential

Table 4 shows the CEC forecast estimates of cooling energy use for the building types that can be characterized as small commercial. A gross estimate of potential energy and peak savings can be obtained by assuming peak and energy savings that could be achieved in the small commercial sector are comparable to the proportions estimated in the residential case. In the residential case, the potential peak and energy savings from increased quality installations were estimated at 2.3% of 2007 peak usage and 3.7% of 2007 energy usage. If these fractions of usage to savings are similar for small commercial buildings the potential energy savings will be 133 GWH/year and the potential peak savings will be 70 MW/year.

Table 4

2007 Cooling Peak Demand By Building Type (MW)

	Utility Service Areas								Statewide
Building types in small commercial market	**BUGL**	**PASD**	**IID**	**LADWP**	**PGE**	**SCE**	**SDGE**	**SMUD**	**Total Non coincident Peak MW ***
Small office	8	5	52	57	204	222	126	66	739
Restaurant	3	2	8	32	32	121	21	4	222
Retail	19	10	49	131	224	554	113	51	1,150
Food Stores	2	1	6	8	258	42	12	21	350
Refr warehouse	0	0	0	0	0	1	0	0	1
Schools	4	2	49	32	9	167	37	1	301
Hotel/Motel	1	1	7	40	24	160	54	4	292
Totals	37	21	171	300	751	1,266	363	147	3,055

*** Totals are non-coincident since the utility peaks occur at different dates and hours**

Energy and Peak Consequences of Implementing New HVAC Technologies and Simultaneously Reducing Building Loads through Whole Building Design

Table 5 illustrates the potential savings from existing and future cooling technologies that reduce peak usage while simultaneously addressing the requirements of the whole building by integrating design improvements to the building shell.

Table 5
Estimated Potential Energy Savings from New and Improved Space Conditioning Technologies and Improvements to the Design of the Shell using a Whole Building Approach to New and Existing Buildings

Job Type	Potential Reductions from Air Conditioning systems designed, selected, or retrofitted for their performance at Hot Dry Peak conditions	Potential Reductions from a comprehensive whole building system to reduce energy consumption through cost effective means	Potential Reductions from a metric that incorporates performance at Hot Dry Peak Conditions
Retrofit	15% to 25%	15% to 30%	
Replacement	15% to 45% (up to 90% peak reduction)	15% to 60%	15% to 25%
New Construction	15% to 25% (up to 90% peak reduction)	50% to 90%	15% to 25%

Summary of Potential Energy and Peak Savings

Significant energy and peak savings are possible if the strategies to increase compliance and quality control are successful over the next five years. The savings associated with ensuring quality installations in the residential and commercial market are estimated at 423 GWH and 300 MW per year by 2012, .Additional savings of 211 MW from the small commercial sector and 89 MW from the installation of thermal storage systems that shift 95% of air conditioning load off peak are possible by 2012. Total peak savings of 600 MW from all three strategies by the year 2012.

Proposed Metrics to Track Progress toward achieving these Energy Savings Goals

1. Near term: Achieve additional peak savings of 100 MW per year by increasing the fraction of HVAC system installations with a permit and third party verification from 10% in 2006 to 90% by 2012 for replacement systems. Cumulative annual peak savings from 2008 to 2012 should exceed 500 MW

2. Mid Term: Reduce the anticipated peak demands of new homes built in 2012 by 20% (on a per square foot basis) relative to current trends by accelerating the introduction of thermal storage and advanced cooling systems and passive design to achieve a 10% market share by 2020. Estimated Peak savings is 90 MW/year by 2012 and 800 MW by 2020

3. Long Term: Reduce the anticipated peak demands of the average new house built in 2018 by 50%, in part by ensuring that at least 10% of the new homes built in the central valley and inland southern California require no net power from the grid during peak periods. Estimated Peak savings is 1200 MW in 2020

Appendix C
Proposal for a Streamlined Permitting Process for HVAC systems

The proposed high level building enforcement task force should review to following objectives and proposal for an Improved Building Permitting System

1. Reduce the amount of time contractors spend picking up building permits at building department offices and waiting for inspections.
2. Increase the number of permits pulled and revenue received from the permits.
3. Make it easier for contractors to find third party verification providers and for third parties to send their results directly to building department.
4. Reduce potential homeowner anxiety about possibility that a visit by building official will discover new violations or reassess home value.
5. Increase title 24 compliance with HVAC installation regulations and the resulting energy and peak savings.
6. Reinforce the customer perception that it is important to ask for quality control checks via a permit to ensure HVAC systems provide high reliability and comfort over the useful life of the equipment.

Proposed New Permitting System - A Step by Step Proposal

Step 1: Contractor purchases HVAC equipment from distributor with possibility of pulling a permit at this stage.

Step 2: Distributor records equipment type, model, serial number, and name and C 20 license number of contractor who purchases equipment in a data base. This data base is forwarded on a monthly basis to the CEC (or other agencies such as building departments).

Step 3: Contractor goes online to receive mechanical permit.

Step 4: Contractor notifies Building department when work is finished, gives customer address to serial number of equipment and selects a third party rater to verify the installation.

Step 5:Third party verifier (VSP) calls customer to set up an appointment, tests equipment and sends his test results back to the contractor (with address and serial number) (if it fails or passes) and to the building department if the job passed.

Step 6: Building department officials decide whether they want to actually visit the site to confirm the work was completed (if passed) or if they are willing to delegate the job of ensuring the HVAC system is performing up to code to the third party verifier.

If the building official delegates the inspection task for HVAC systems only, the third party is responsible to send the results of the quality control check to the master data base. If the system passes, the VSP provides customer with the CAL Quality Star brand or seal. If the system fails, the information is sent to the original contractor who must revisit the home within 2 weeks, fix the problem and re-notify the VSP. In this event the VSP could be entitled to additional compensation from building department or home owner.

If the building department chooses to inspect on site, they call the home owner and set up a convenient time to inspect. If the system passes, building official or delegated VSP sends home address and pass date to the keeper of the master data base. This data base could be posted online so building officials could periodically check time lag between system installation and verification checks.

Step 7: The third party verifier sends his completed quality measurement information (air flow, refrigerant charge, HVAC duct test and pass or fail determination) back to their respective rating organizations. Each HERS rating organization is required to send their information on passes and fails by contractor name and license number to the master state database. This database is designed for contractors and consumers to know which systems have been tested and certified.

Step 8: If the job has passed, the building official or VSP (if so delegated) gives or sends the home owner the CAL Quality Star Brand sticker that he can paste on the HVAC system or in a visually prominent place. If the job fails, the contractor is notified of need to remedy situation via email, and he has an obligation to fix problem within 2 weeks and send completion information via the internet. Then building official presents homeowner with CAL quality brand.

Step 9: The CEC or other State organization will compare the list provided from Distributors and the list from HERS raters. Both these lists have equipment serial numbers on them. When it is found that sold equipment has not been inspected, then the contractor can be notified and be given a certain amount of time to pull the permit and remedy the situation. Failure to do so could result in fines.

Footnotes for the Entire Report

1 Details of the level of energy and peak savings that could be achieved by implementing a suite of strategies to fix these problems are presented in Chapter 4 after the group's vision of the new market and strategies to get there are presented in Chapter 3.
2 A specific definition of what constitutes a quality installation has been provided by the Air Conditioning Contractors of America (ACCA) and is discussed in more detail in Chapter 3, Strategy for Achieving a Consensus definition of quality , training to meet it and certifying quality at the individual and program level.
3 1. M. Sami Khawaja, Ph.D., Allen Lee, Ph.D., Michelle Levy,
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5 Can SEER Be Saved? Harvey M. Sachs, American Council for an Energy-Efficient Economy, Hugh Henderson, CDH Energy , Don Shirey, III, Florida Solar Energy Center; Steven Nadel, American Council for an Energy-Efficient Economy, Daniel W. Jaynes, Ohio State University; 2006 ACEEE Summer Study on Energy Efficiency in Buildings

6 Improving Central Air Conditioner Performance Ratings: A Review of Seasonal Energy Efficiency Ratings, Harvey M. Sachs, American Council for an Energy-Efficient Economy, Hugh Henderson, CDH Energy , Don Shirey, III, Florida Solar Energy Center; Steven Nadel, American Council for an Energy-Efficient Economy, October 2007

7 Wirtshafter and Associates , Residential Contractor Program, Market Assessment, Prepared for Pacific Gas and Electric (PGE study ID #424C, March 2000) page 4.
8 Itron, Inc. California Residential Efficiency Market Share Tracking, August 2005, pp 3-10
9 Can SEER Be Saved? Harvey M. Sachs, American Council for an Energy-Efficient Economy, Hugh Henderson, CDH Energy , Don Shirey, III, Florida Solar Energy Center; Steven Nadel, American Council for an Energy-Efficient Economy, Daniel W. Jaynes, Ohio State University; 2006 ACEEE Summer Study on Energy Efficiency in Buildings

10 Improving Central Air Conditioner Performance Ratings: A Review of Seasonal Energy Efficiency Ratings, Harvey M. Sachs, American Council for an Energy-Efficient Economy, Hugh Henderson, CDH Energy , Don Shirey, III, Florida Solar Energy Center; Steven Nadel, American Council for an Energy-Efficient Economy, October 2007

11 A quality installation is defined as one that meets or exceeds all codes, regulations and manufacturers and system component installation requirements. It includes airflow balance, duct testing and sealing, and refrigerant charge. The installation is performed by a licensed C-20 contractor - whose HVAC installation technicians are trained in the quality installation process - and the installation is verified through third party inspections that are part of the building permit process.