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Air Conditioning, Peak Demand, And Public Goods Funds

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Public Goods Fund Revenue

Residential customers are the largest supporters of public goods funds. As shown in Table 1, approximately 40% of the electric PPP revenues were collected from residential customers. Residential and Small Commercial customers provide the lion's share (over 85%) of the gas PPP revenues (Table 2).

Table 1. Electric PPP Collections by Sector (1998-2002)[1]

	PG&E[2]	SCE	SDG&E
Residential	42%	37%	39%
Commercial and Industrial			
Small	12%	43%[3]	13%
Medium	27%		43%[4]
Large	12%	11%	3%[5]
Agricultural	5%	1%	1%
Public Authorities		6%	
Street Lighting	1%	1%	1%

Table 2. Gas PPP Collections by Sector (1998-2002)

Sector	PG&E	SCG
Residential	65%	56%
Small Commercial	22%	29%
Large Commercial	3%	12%[6]
Industrial	9%	
Other		3%

The distribution of these funds for the public good should represent an equitable distribution of the funds considering the contribution of each sector to the funds. While we are not suggesting that the breakdown of services exactly parallel the revenue, it seems clear that the sectors with the highest contribution should receive a substantial share of the services.

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[1] blueConsulting, Inc. *Financial and Management Audit of Utility Public Goods Charge Energy Efficiency Programs from 1998 through 2002.* Prepared for the California Public Utilities Commission. July 2004 Volume III.
[2] non-CARE
[3] Combined Small and Medium
[4] Combined Medium and Large Commercial
[5] Industrial
[6] Large Commercial and Industrial

Peak Electric Consumption is the Critical Feature and Weak Point of the California Electrical Infrastructure

The summer of 2004 had seven record setting peak load days (all over 44,000 MW). In spite of moderate temperatures, California ISO set a new system peak of 45,597 MW on September 8, 2004.[7]

The California Energy Commission concludes[8]:ISO Peak demand records were set 7 times in spite of average weather conditions.

- Peak demand was at a level projected for 2006.
- Insufficient reserves were available in Southern California on September 10, 2004.
- Southern California: Available capacity does not satisfy operating reserves under hot weather conditions (10% probability).The situation in 2006 and beyond is worse as shown in Figures 1 and 2.

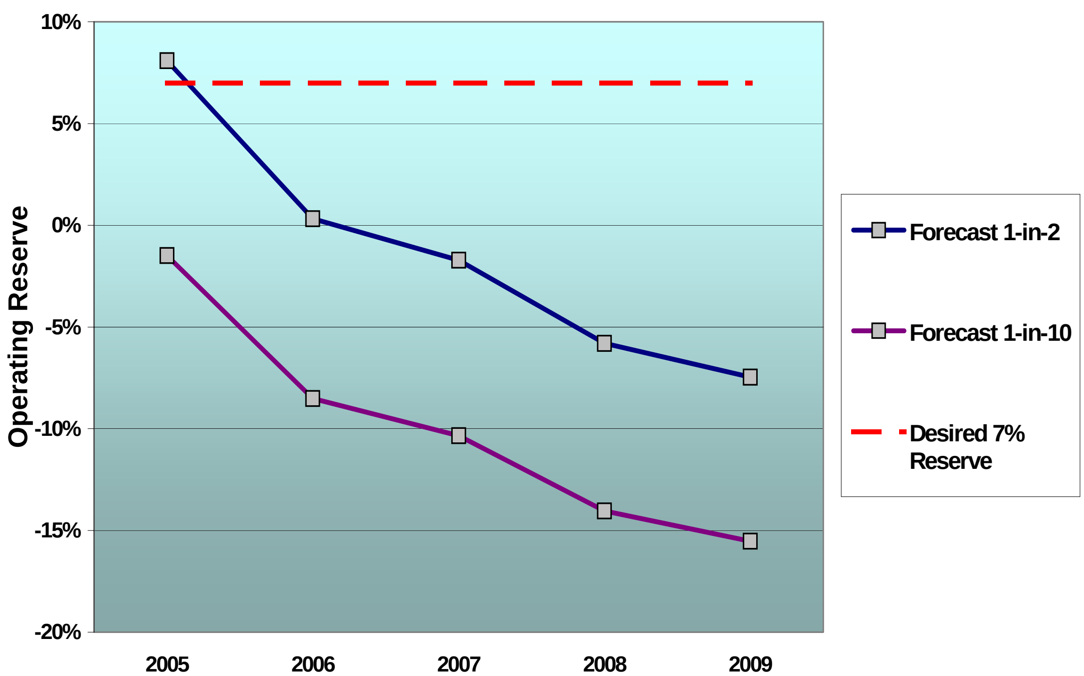

Figure 1. 2005-2009 Reserve Southern California

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[7] *ISO Outlook Summer 2005 and Beyond* Presentation to the Senate Energy, Utilities and Communications Committee, February 22, 2005 by Jim Detmers, Cal ISO

[8] *California's Electricity Situation: Summer 2005* Presentation to the Senate Energy, Utilities and Communications Committee, February 22, 2005

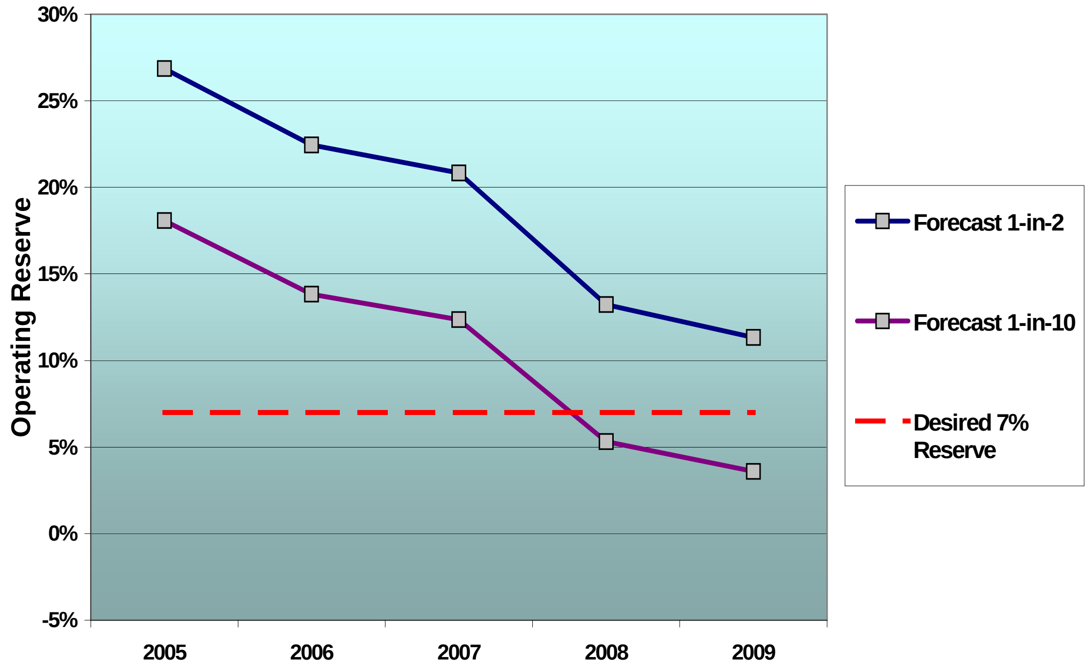

Figure 2. 2005-2009 Reserve Northern California

Inadequate peak reserve is a very expensive proposition. When the reserve margin narrows the cost of electricity increases. It makes the State vulnerable to predatory practices and endangers the productivity of the millions of workers in our state's economy. When outages occur the losses are incalculable.

Providing the infrastructure for high peaks that swing more than 60% above the base usage is an economic hardship on utility ratepayers and the State's economy.

Demand side peak reduction is not only possible it is necessary to reduce the negative effects of these huge swings in electric consumption.

The most economical (also efficient and low polluting) production of electric power would be a constant load. Every opportunity should be explored to make the State's load shape move toward that ideal. Moving toward a more constant load requires that programs concentrate on reducing consumption in end uses that create the undesirable peak.

The critical end uses are those where the peak consumption is significantly larger than the average consumption.

Central Air Conditioning Responsibility for Peak

The end uses with the highest ratios of peak load to average load[9] are: Residential Air Conditioning 3.5 to 1 and Commercial Air Conditioning 2.6 to 1. All other end uses have a ratio of less than 1 to 1.

> **California's electric peak demand is almost completely caused by summer-time air conditioning loads that show sharp peaks.**
>
> *2002-2012 Electricity Outlook Report*
> CEC, February 2002 P700-01-004F

The percentage of peak load caused by air conditioning is displayed in Figures 3[10] and 4[11]. In some hot residential areas central air conditioning, window air conditioning, and evaporative cooling account for over 60% of the peak load[12].

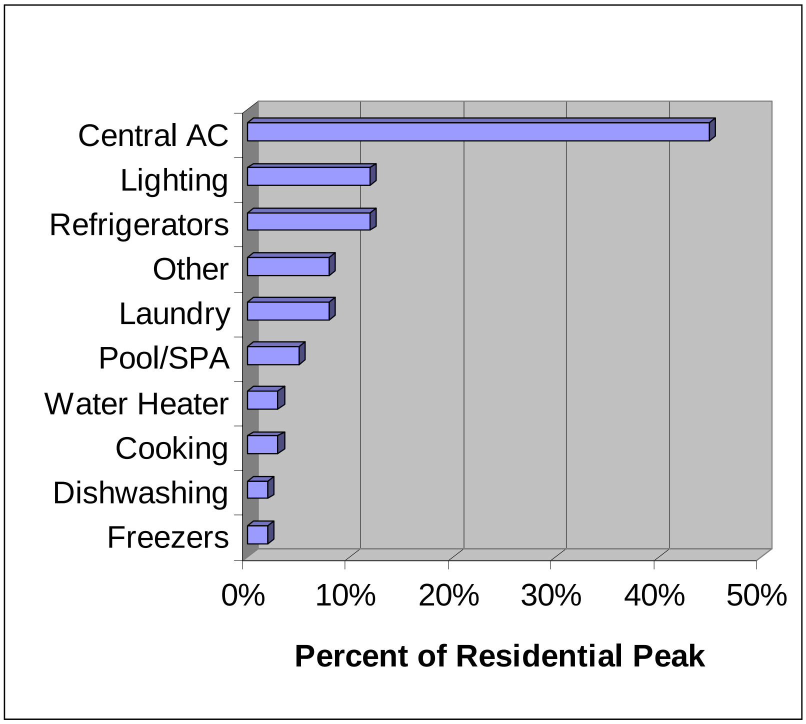

Figure 3. End Use Breakdown of Residential Contribution to Peak

Residential Air Conditioning is responsible for approximately 7,500 MW of peak electrical load[13].

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[9] Percent of Peak Load/Percent of Total Annual Consumption

[10] *CSRSES* (above) Prepared by Kema-Xenergy Inc. April 2003. Figure E3

[11] *California Statewide Commercial Sector Energy Efficiency Study.* Final Report #SW039A. V. 1 Kema-Xenergy, Inc. Prepared for PG&E Prepared by Kema-Xenergy Inc. July 2002, Figure E3

[12] *Targeted DSM to Delay T&D Expenditures at the Paradise Substation.* Proctor Engineering Group, Ltd. July 12, 1993 report to Pacific Gas and Electric Company

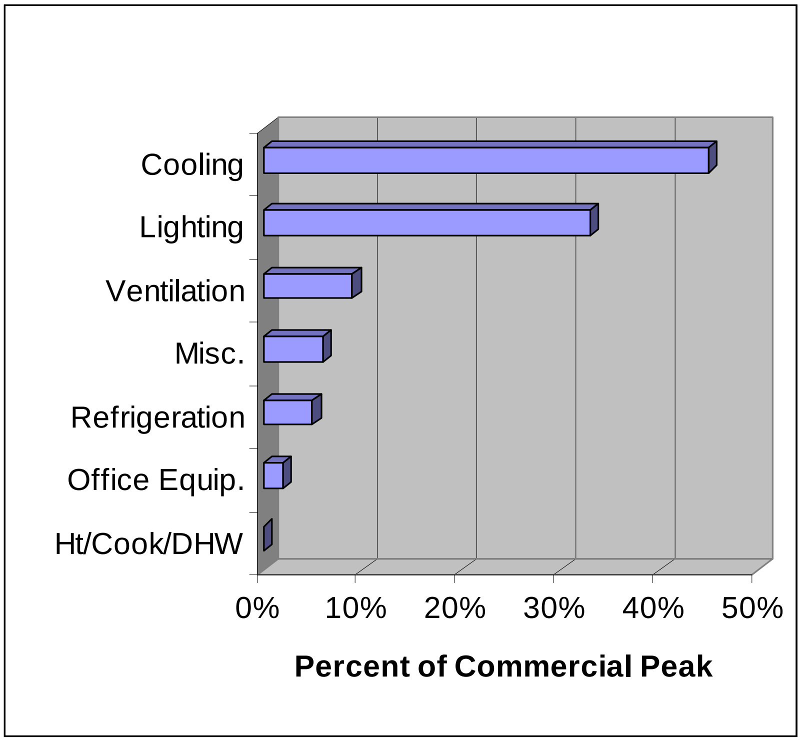


Figure 4. End Use Breakdown of Commercial Contribution to Peak

Commercial Air Conditioning is responsible for approximately 8,500 MW of peak electrical load[12].

[13] *Final IEQ RFP* 500-02-501. California Energy Commission. Page 16

Potential Peak Reductions

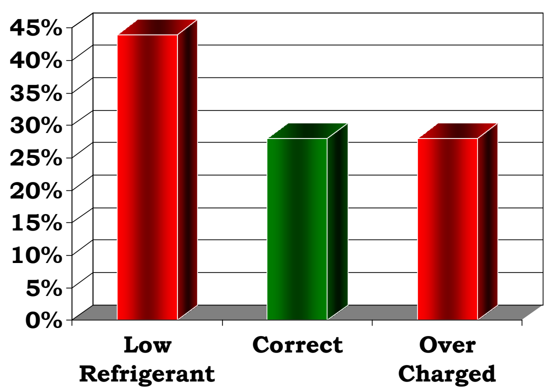
Air Conditioners have a very high potential for peak load reductions. Some of the available measures are shown in Table 3.

Table 3. Applicable Residential and Small Commercial AC Measures

	Applicability		
Measure	Existing AC	Replacement AC	New Construction
1) Efficient Operation (Commissioned Charge Airflow)	X	X	X
2) Verified Duct Sealing	X	X	X
3) Removal of DOGS (Old Ineff. Central AC)	X		
4) Removal of DOGetts (Old Ineff. Window AC)	X		
5) Economizer Commissioning	X	X	X

1) Efficient Operation of Air Conditioners – Verified Refrigerant Level (Charge) and Airflow

Air conditioners, both newly installed and existing units suffer from incorrect refrigerant charge and low airflow. The percentage of units with incorrect refrigerant levels varies only slightly between new units and units in the field for two or more years. Overall 70% to 75% of the residential air conditioners fail to meet the manufacturers' refrigerant charge specifications[14].



The largest (36,940 units) and one of the most recent commissioning projects of both residential and commercial air conditioners found that 66% of the units failed to meet the manufacturers' specifications[15].

Both low refrigerant and overcharge are also responsible for compressor failures (by different mechanisms).

Figure 5. Residential and Small Commercial Refrigerant Level (36,940 units)

[14] Neme et al. 1999, *National Energy Savings Potential From Addressing HVAC Installation Problems,* Vermont Energy Investment Corporation Prepared for the United Stated EPA.

[15] Proctor and Downey.2003. *Innovative Peak Load Reduction Program CheckMe!® Commercial and Residential AC Tune-Up Project* for the California Energy Commission.

Low airflow across the evaporator coil of an air conditioner reduces the sensible capacity. Sensible capacity is exactly what is needed in hot dry peak conditions such as those in California. Low airflow also causes durability problems for air conditioners and gas furnaces.

Commissioning[16] Residential and Light Commercial air conditioners has an energy savings of 11% to 13%[17]. Residential and Commercial air conditioners use the same technology and suffer from the same problems of incorrect charge and low airflow.

2) Verified Duct Sealing

A 1989 analysis of homes in the Pacific Northwest[18] showed that homes with duct systems used 27% more energy for heating than homes with direct heat (baseboards). Since that time there have been over 100 studies, articles, and professional papers[19] documenting the losses from duct systems and the energy savings from sealing them.

Twenty-five to forty percent of the cooling (and heating) never makes it into the home[20]. Typical duct systems lose that much energy between the air conditioner

[16] *V2 "Commissioning" here refers to both making sure newly installed and existing units are properly functioning. The peak reduction due to obtaining correct refrigerant charge varies with the situation. Newly installed package rooftop air conditioners are presumed to come from the factory with the correct refrigerant charge. For residential units, the peak reduction depends on how the particular household controls their air conditioner and how it is sized relative to the load. (See Peterson, G. and J. Proctor, "Effects of Occupant Control, System Parameters, and Program Measures on Residential Air Conditioner Peak Demands", Proceedings of 1998 ACEEE Summer Study, Vol. 1, pp. 253-264).*

[17] *2001 DEER Update Study*. Final Report Xenergy Inc. Prepared for the California Energy Commission Contract Number 300-99-008 August 2001

[18] Parker, D. S. 1989. "Evidence of Increased Levels of Space Heat Consumption and Air Leakage Associated with Forced Air Heating Systems in Houses in the Pacific Northwest." *ASHRAE Transactions,* Vol. 96, Part 2. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Atlanta.

[19] Including: Palmiter, L. and P.W. Francisco. 1994. "Measured efficiency of forced-air distribution systems in 24 homes." *Proceedings of 1994 ACEEE*;
Cummings, J. B., J. J. Tooley, N. Moyer, and R. Dunsmore. 1990. "Impacts of Duct Leakage on Infiltration Rates, Space Conditioning Energy Use, and Peak Electrical Demand in Florida Homes." *Proceedings of the ACEEE 1990 Summer Study on Energy Efficiency in Buildings,* Volume 9, pp. 9.65-9.76. American Council for an Energy-Efficient Economy, Washington, D.C.
Neme et al. 1999, *National Energy Savings Potential From Addressing HVAC Installation Problems,* Vermont Energy Investment Corporation Prepared for the United Stated EPA.
Blasnik, Michael et al. 1995. *Assessment of HVAC Installations in New Homes in Southern California Edison's Service Territory.* Final Report to Southern California Edison from Proctor Engineering.
Proctor, John et al. 1995. *Southern California Edison Coachella Valley Duct and HVAC Retrofit Efficiency Improvement Pilot Project.* Final Report to Southern California Edison.

[20] *Better Duct Systems for Heating and Cooling.* 2001. John Andrews, Brookhaven National Laboratory Report BNL-68167 Prepared for United States Department of Energy January 2001.

and the registers. Similar results have been found on small and large commercial duct systems[21].

Like homes in the rest of the United States, California homes have leaky ducts. Figure 6 displays measured duct leakage from 1210 California homes tested at .10 inches of water column (25 pascals). Note that 7% of the duct systems (the RH column) are so leaky that this standard test is invalid.

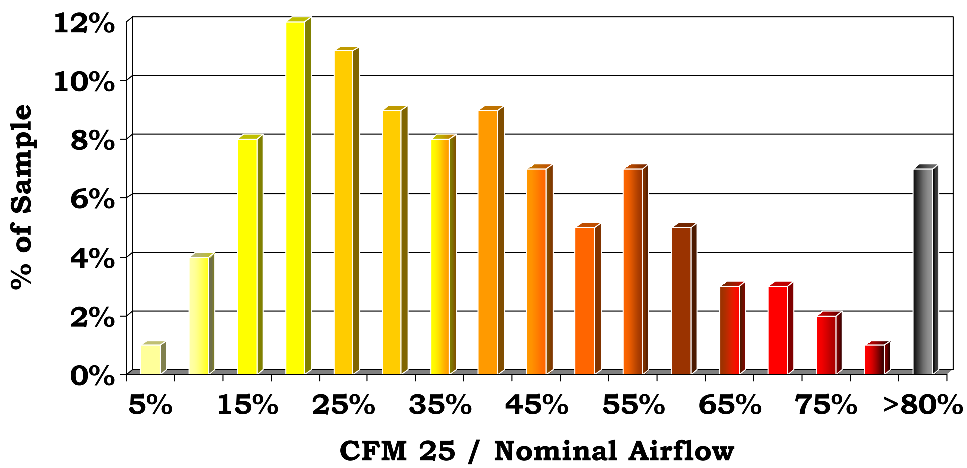


Figure 6. Duct Leakage in California Residences

Duct sealing saves energy and reduces peak watt draw. The average savings from a compilation of studies is 17%[22]. Studies include pre- post-retrofit energy consumption measurements as well as calculations using ASHRAE Standard 152[23].

These energy savings numbers are different from the estimates in the 2001 DEER Update Study. Having studied the reference material for the 2001 DEER Update Study, we can find only one study where the savings were in the low range of

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[21] Fisk, W.J., et al. 1998. "Duct Systems in Large Commercial Buildings: Physical Characterization, Air Leakage, and Heat Conduction Gains." LBNL Report, LBNL-42339. and
Delp, W.P., et al.1997. "Field Investigation of Duct System Performance in California Light Commercial Buildings." LBNL Report, LBNL-40102.

[22] Neme et al. 1999, *National Energy Savings Potential From Addressing HVAC Installation Problems,* Vermont Energy Investment Corporation Prepared for the United Stated EPA. V2 Duct sealing peak reductions increase with outside temperature for an air conditioner that is cycling on peak. However for units that are not cycling, the peak reductions vary from 0% to 25%.

[23] which has been verified through field tests including: Siegel, J., J. McWilliams, and I. Walker 2003. "Comparison Between Predicted Duct Effectiveness from Proposed ASHRAE Standard 152P and Measured Field Data for Residential Forced Air Cooling Systems" in *ASHRAE Transactions, 2003, ASHRAE Winter Meeting* CH-03-7-4. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Atlanta. and
Proctor, J. 1998. "Verification Test of Standard 152P" in *ASHRAE Transactions* 1998, Vol.104, Pt 1

DEER. That study evaluated a program that had only a 19% sealing rate. This is much lower than the general 50% sealing rate found in other programs with tight standards, verification, and enforcement.

The amount of duct sealing needs to be sufficient to save the energy and reduce peak. The 17% average savings occurs when the program has tight standards that are actively enforced. The current specification being considered by Pacific Gas and Electric is an example of a specification that includes minimum sealing criterion, verification, statistical analysis, and enforcement.

Duct sealing save peak electrical consumption. Figure 7 shows the peak reduction (V2) from a home monitored in Phoenix that was alternately tested with a supply leakage of 16% and 2% as well as a return leakage of 11% and 3%.

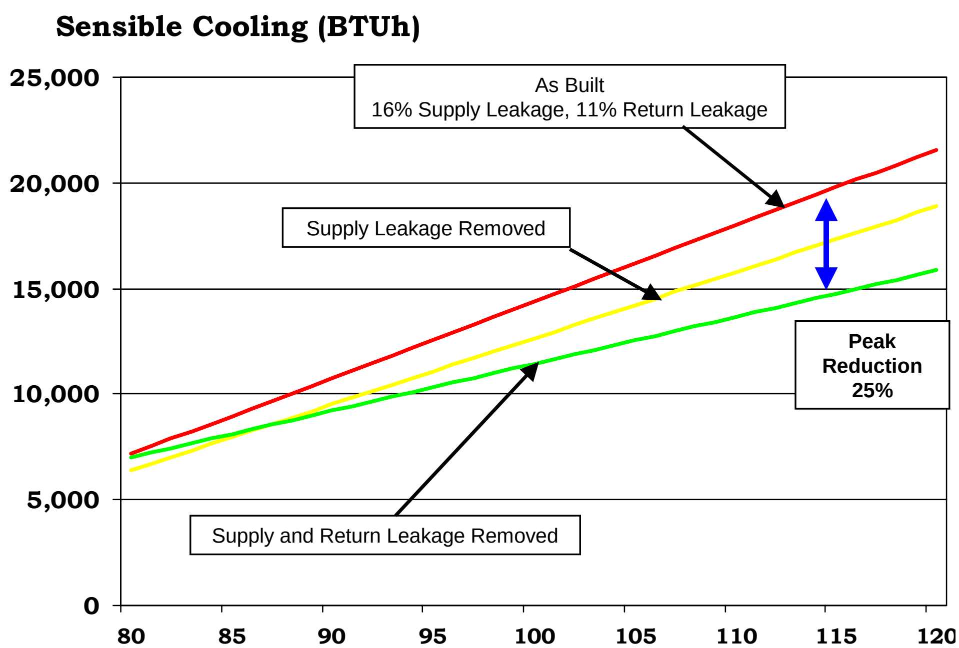

Figure 7. Monitored Peak Reduction from Duct Sealing[24]

ASHRAE Standard 152 provides proven estimates of energy savings and peak reductions for changes in duct systems. Table 4 shows the electric and gas energy savings for a typical duct system in Sacramento CA. V2 This table has a 14% of

[24] Proctor, J. 1997. "Field Measurements of New Residential Air Conditioners in Phoenix, Arizona" *ASHRAE Trans*., 1997, Vol.103, Part 2, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Atlanta.

airflow reduction in duct leakage because a 14% of airflow is proposed as the minimum duct leakage reduction for utility incentives.[25]

Table 4. Applicable Residential and Small Commercial AC Measures

	Duct Efficiency		Savings
	Pre-Repair 15% Supply Leakage 15% Return Leakage	Post-Repair 8% Supply Leakage 8% Return Leakage	
Electric Cooling Season	60.4%	70.4%	14.2%
Electric Cooling Peak	45.8%	58.8%	22.1%
Gas Heating Season	69.5%	75.4%	7.9%
Gas Heating Peak	65.3%	71.9%	9.1%

3) Removal of DOGS

DOGS are old inefficient air conditioners that continue to run and escalate peak year after year. These air conditioners have an EER less than 7[26] at standard ARI conditions. These are both old units that began as inefficient units and also those that have non-repairable problems that now perform at less than EER 7. The percentage of existing low performance units is variously estimated between 10% and 20% of the air conditioners in California. Figure 8 shows the percentage of DOGS based on longevity studies and appliance saturation surveys.

[25] V2 Title 24 has the following duct leakage percent of airflow defaults (Supply Leakage + Return Leakage): New Construction not tested 22%; New Construction sealed and tested 8%. Existing Units sealed and tested 17%

[26] V2 the EER of 7 or less may occur because these units had an EER at that level when new, or they may have that efficiency because they have unrepairable problems now.

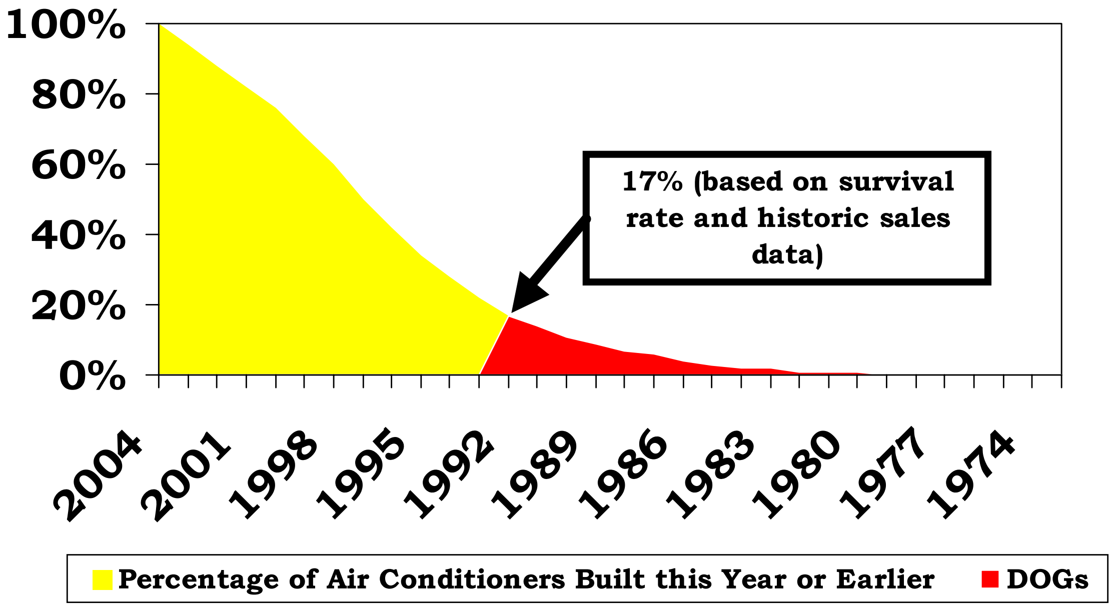

Figure 8. Percentage of Low Efficiency DOGS in existing AC Population

A replacement bounty on low efficiency units (similar to the bounty on old polluting cars) has the highest potential for effective peak reduction of all the programs studied. Peak reductions of 1.67KW or more[27] are possible. This type of program was proven practical in the PG&E Model Energy Communities Project.

This type of program provides opportunities to leverage manufacturers rebate programs such as the Carrier Corporation's Old/New program that provides a $100 rebate when a 30-year-old unit is replaced with a new Carrier Unit.

4) Removal of DOGettes

Similar to central air conditioners, a number of wall/window units are operating at very low efficiencies. Like the DOGS, a bounty on DOGettes with recycling at the retail store has been an effective peak reduction program in other states (e.g. New York).

5) Economizer Commissioning

Commercial air conditioners larger than 6 tons in California are required to have airside economizers. These economizers are very susceptible to improper installation and maladjustment. Some of these units have a constant opening in

[27] A change from EER 6 to EER 10 Average 3 ton unit. Residential diversity factor 0.7. Peak reduction = 0.70 * 3 * 12000/6/1000 – 0.70 * 3 * 12000/10/1000 = 1. 67KW

excess of the minimum ventilation air requirement. These units have a high peak watt draw because they are pulling in very hot outside air at peak.

Commercial AC economizers should be inspected and commissioned to ensure proper operation.

Existing Air Conditioners

Each of the five measures listed above can be easily implemented with a statewide program that supports continued contractor infrastructure growth. There is no interaction between Title 24 and these measures except that the technicians that are trained and gain experience on existing will be able to apply these measures to replacement and new construction air conditioners.

Replacement Air Conditioners

In the 2005 Title 24 sealed ducts, verified refrigerant charge (or TXV) and verified airflow is a prescriptive requirement on replacement air conditioners and furnaces in some climate zones V2. These requirements can be avoided in a number of ways:

- the local building department may not require building permits on AC replacement V2
- when building permits are required, homeowners and contractor may fail to pull permits subsequently the Title 24 requirements are not enforced V2
- installation of a higher efficiency air conditioner or furnace.

We contend that it is not the intention of the CEC in Title 24 or of the CPUC in approving Public Goods Programs to produce a Catch 22 where peak reductions are not implemented because one entity or the other has implemented a standard or a program.

It is essential that the specifications within Title 24 for replacement air conditioners be supported and enhanced by CPUC programs. Enforcing the new Title 24 rules is an appropriate use of public goods funds and has been approved as a statewide program in 2004-2005. Part of the program should be that a building permit must be pulled V2.

New Construction Air Conditioners

Title 24 includes requirements of independently verified charge/TXV and duct sealing in residences[28]. It also has compliance options of verified high efficiency air handling, verified duct design, verified correct sizing. ALL THESE MEASURES ARE TRADEABLE IN PERFORMANCE STANDARDS. Without the support of utility

[28] V2 Duct sealing is also a prescriptive requirement in some commercial applications.

programs these opportunities available at installation will be lost. It is incumbent upon us to provide an effective program to accomplish the application of these options V2.

Residential and Small Commercial Sectors are Underserved

These sectors provide vast opportunities for peak reduction that will save California ratepayers and utilities millions and millions of dollars.

The Commercial and Residential sectors make up 73% of the electric peak load[29]*. These sectors provide approximately 80% of the PPP Funds. Given the high goals the Energy Plan it is essential that they be served with more than lighting programs or other programs that do not directly address the peak potential of these sectors.*

There are proven programs to produce these peak reductions through commissioning existing and new HVAC systems (ducts and economizers included), and through identification and replacement of low efficiency units. One statewide program alone, started on short notice commissioned 36,940 units in less than two years.

Statewide Potential

Simply put, the achievable potentials from these programs exceed 600 MW in the residential sector over 5 years and over 700 MW in the commercial sector in the same timeframe.

[29] *California Statewide Residential Sector Energy Efficiency Study (CSRSES).* Final Report #SW063. V. 1 Kema-Xenergy, Inc. Prepared for PG&E Prepared by Kema-Xenergy Inc. April 2003, Figure E2