Prepared for:
San Diego Gas & Electric

1999 SDG&E Upstream HVAC Program & Training Baseline Analysis Report

Final Report, August 25, 1999

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INTRODUCTION

Proctor Engineering Group (PEG) was retained by San Diego Gas & Electric (SDG&E) to establish a baseline for the residential air conditioner replacement market in SDG&E's service territory. This report details the findings of this investigation, which was designed to establish the status of the existing HVAC infrastructure within SDG&E's service territory. The goal of the investigation was to establish a baseline from which the SDG&E 1999 Upstream HVAC Program started. Specifically the investigation focused on the process by which replacement air conditioners are currently sold and installed, and barriers to influencing the market to choose higher SEER, properly sized and installed equipment.

The SDG&E 1999 Upstream HVAC Program encompassed two strategies. The first strategy has the goal of influencing the market by providing an incentive for distributors to stock higher efficiency air conditioners. This program is available to distributors that sell HVAC equipment within SDG&E territory for residential and commercial uses. The incentive covers package and split system air conditioners both air cooled and water or evaporatively cooled.

The second strategy involved providing training for the installing contractors on the proper sizing, selection, installation and commissioning of air conditioners and duct systems. The goal of the training is to not only inform the contractors of the proper design, sizing and installation of air conditioners but to get them to change the way that they design, size, and install systems.

The current air conditioning replacement market involves four prime actors; homeowners, manufacturers, distributors, and HVAC contractors. SDG&E is concetrating their efforts to change the market by incenting the distributors to stock higher efficiency air conditioners with the anticipation that these incentives will be passed on to both the contractors and homeowners in the form of lower cost high SEER air conditioners. The level of incentive is established at $20 per ton per SEER point upgrade for residential air conditioners. The minimum SEER level to qualify for the program is SEER 12.

The study included contacting the players involved in the process leading to the replacement of a central air conditioner. The goal was to establish how the current infrastructure operates and barriers that exist to transforming the market. This report presents the results of this investigation and the baseline from which program impacts can be judged.

METHODOLOGY

Proctor Engineering Group has been intimately involved in the promotion of energy efficient air conditioners over the last ten years. The bulk of these efforts have been concentrated in the residential air conditioner market in the State of California. The primary emphasis of this work has been both the installation of new high efficiency equipment that is properly sized and commissioned and effective service of existing equipment.

This experience has provided us with an in-depth knowledge of the existing air conditioning market infrastructure and the barriers faced in increasing the market share of energy efficient system and systems that are correctly sized and installed.

This knowledge served as the base from which the existing interrelationships were built. The relationships were then fine tuned by contacting distributors and contractors and questioning them on the interrelationships.

The current air conditioner design and installation procedures in use in SDG&E service territory were established using two means.

First, PEG used their extensive experience in working with contractors in the field. This experience includes both surveying installation contractors and examining their written procedures for installations and start-ups. PEG has also gained a great amount of insight by performing ride-along observations to see how installations are really performed by the installation technicians in the field and comparing those observations to the written procedures of the company or manufacturer.

Second, PEG completed surveying of all installation contractors attending the SDG&E sponsored trainings. Each training included a survey of current installation procedures. The survey was administered previous to the presentation of the training materials to prevent any bias that might be caused by the materials covered in the training session and the contractors willingness to admit their actual performance is less than optimal.

The number of actors involved in the process were estimated using several approaches. These included contacting trade associations, licensing bodies, and using internet and phone directory listings. Cross checks were used to ensure all actors readily accessible to the general public were recognized but, not counted more than once. For example, several installation contractors and distributors advertise in several of the means checked for existing actors. Addresses and phone numbers were used as a check to ensure none of these actors were counted more than once.

Potential Market

The potential market for the 1999 Upstream HVAC Program is all SDG&E customers who will buy central air conditioning systems in 1999. Proctor Engineering Group used data from the San Diego Gas and Electric Company 1998 Home Energy Survey to estimate the number of homeowners in three categories: Category 1 - new construction, Category 2 - first time installation into an existing home, Category 3 - replacement of existing central air conditioning units.

Replacements

The survey indicated that 1.7% of SDG&E's 1,049,173 residential households replaced their air conditioner in the 12 months prior to the 1998 survey. This projects to 17,836 replacements. There is some potential for overestimation in that some customers may report a new AC installation as a replacement. However, the survey number is in agreement with an analysis of the number of air conditioners reported in the SDG&E service territory, their ages, and expected life.

New Construction

The survey indicated that 45.6% of the homes purchased after 1986 had air conditioning that "Came with the dwelling". For this group of customers, the average reported age of the air conditioner was 7 years. This corresponds closely to the projected average age of 7.83 years if 45.6% of the units were installed at the time the house was built. Based on 11,541 new households per year in 1995, 1996, and 1997, the lower limit is 5263 new construction installations per year. This is the lower limit because the penetration of central AC in residential new construction has been increasing over the last 10 years. It is therefore likely that the penetration rate for homes constructed in 1995, 1996, and 1997 is higher than the 45.6% reported for years from 1986 through 1998. Proctor Engineering Group estimates that the new construction installation rate in 1995, 6, and 7 was 55% or approximately 6000 households per year.

Some homes have more than one air conditioner. It is estimated that the average is 1.1 ACs per AC equipped household.

The upper limit is the increase in central AC households in SDG&E service territory (minus the first time installations on existing homes).

Growth in Households With Central AC

Prior years SDG&E surveys, quoted in the 1998 survey provide a basis for estimating the growth in residential air conditioner households year by year. Proctor Engineering Group constructed a model using data from the age of residence, and trends in central AC saturation. This model assumes that changes in survey methods have only a small effect on the data. The model also contained some smoothing of the AC saturation data for years prior to 1995 as shown in Figure 1.

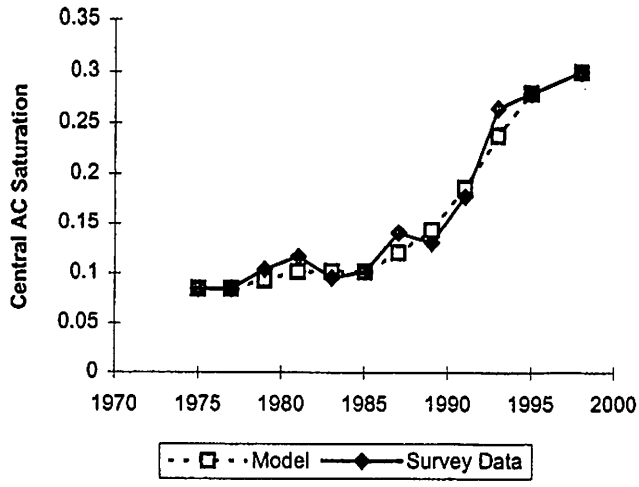

Figure 1. Air Conditioner Saturation by Year

Figure 2 shows the annual increase in new central AC households (new homes and first time installations on existing homes) and the annual growth in households over the period from the 1975 survey to the 1998 survey.

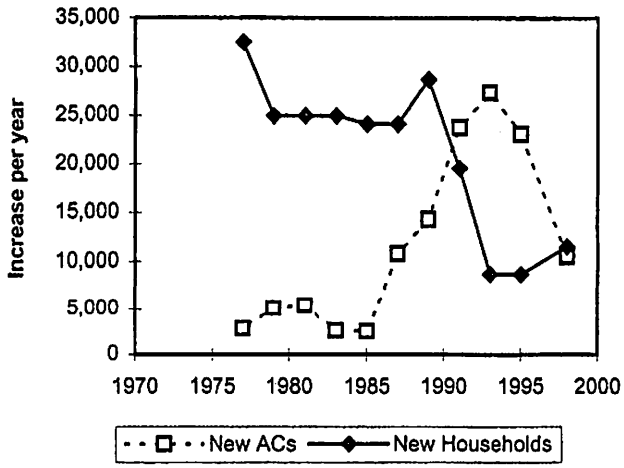

Figure 2. Annual Increase in Air Conditioner Households

The estimated average growth for 1995, 1996, and 1997 is 10,576 households with central ACs per year. This growth in residential air conditioner households combines Category 1 and Category 2. This statistic (combined Categories 1 and 2) shows a very significant rise in the 90's peaking early in the decade. At the same time, the number of new households was dropping. It appears that new installations on existing households were very common early in the decade and are now declining.

This statistic is split between new construction and first time installations on existing housing.

First Time Installations on Existing Households

One estimate of new installations on existing households is available from the survey data. Data show that 7.7% of 1,049,173 households purchased a new AC "that did not come with the dwelling". These air conditioners were purchased over the residents' occupancy in the dwelling which averaged 9.9 years. This calculates to a purchase rate of 8190 per year over the last 10 years. This is likely to be an overestimate since the period covered included the spike in the early 90s.

A second probably more accurate estimate is the difference between the total new installations and the new installations on new construction (10,576 - 6000 = 4576). PEG estimates that the annual first time installations on existing households in 1995, 1996, and 1997 were 4576 per year.

Table 1 presents a breakdown of the estimated number of air conditioners installed annually by category.

Table 1. New Air Conditioners Installed Annually by Category

Category	Annual Installations	Annual ACs
Category 1 -- New Construction	Lower limit 5263 households Upper limit 10,576 households Estimate 6000 households	6600 based on 1.1 per home
Category 2 -- First Time Installation in Existing Homes	Upper limit 5313 households Estimate 4576 households	4800 based on 1.05 per home
Category 3 -- Replacements	17,836 households	17,836
Total	28,412 households	29,236

MARKET BASELINE

Characterization of Market

The residential AC replacement market is currently characterized by SEER 10 systems that are not properly sized to meet the true cooling load of the house. Previous PEG research has demonstrated that the average air conditioner is oversized compared to the industry standard of Air Conditioning Contractors of America (ACCA) Manual J. The current market has proven largely unsuccessful in promoting SEER 12 and greater equipment.

The air conditioning replacement industry infrastructure is a fairly simple process, with little outside influence. Currently the market is driven by the homeowner and the installation contractor. These two prime actors determine the demand for air conditioners in the residential market. The manufacturers and distributors do little to influence the market. They simply provide the equipment that is being demanded.

Homeowners typically do not upgrade their air conditioner until there is a problem. Most times it takes a significant problem with a substantial repair price to motivate the homeowner to replace their air conditioner. The air conditioner replacement industry is built on slim margins and least cost bidding. While it's true that some installation contractors will push higher efficiency equipment to some extent, they still routinely suggest the customer choose the base SEER 10 system due to the fear of pricing themselves out of the competition with their competitors.

Contractors' margins are not significantly increased on higher efficiency equipment. In fact, some contractors report that the higher efficiency equipment comes with a higher nuisance complaint rate which reduces their profit. When a homeowner purchases a high efficiency piece of equipment, they expect to see a reduction in electric cost. Many consumers believe they can compare their utility bill from one month to the next or from year to year to determine if they are saving money with their new system, not realizing that weather effects and other variables need to be taken into account. They then complain to the contractor, causing them to visit the house free of charge to ensure that the system is operating as the contractor believes it should.

The performance of residential air conditioners is significantly below design performance. The average performance decrement has been estimated in field studies to be 17% or more. This is equivalent to a 12 SEER air conditioner operating at 10 SEER. This decrement is due to improper sizing and installation of new air conditioners. The primary problems are oversized systems, incorrect refrigerant charge, and incorrect air flow across the inside coil. These problems can be avoided by relatively minor changes in the infrastructure. At this point in the market, the barriers to these minor changes prevent proper operation of all but a few air conditioners. In short, the contractor has little motivation to bring the air conditioner to its full capacity and efficiency. The homeowner has no way of determining whether the installation technician's work was successful (short of, "Does it blow cold air?").

Figure 3 shows the process for the replacement air conditioner infrastructure and the lines of influence.

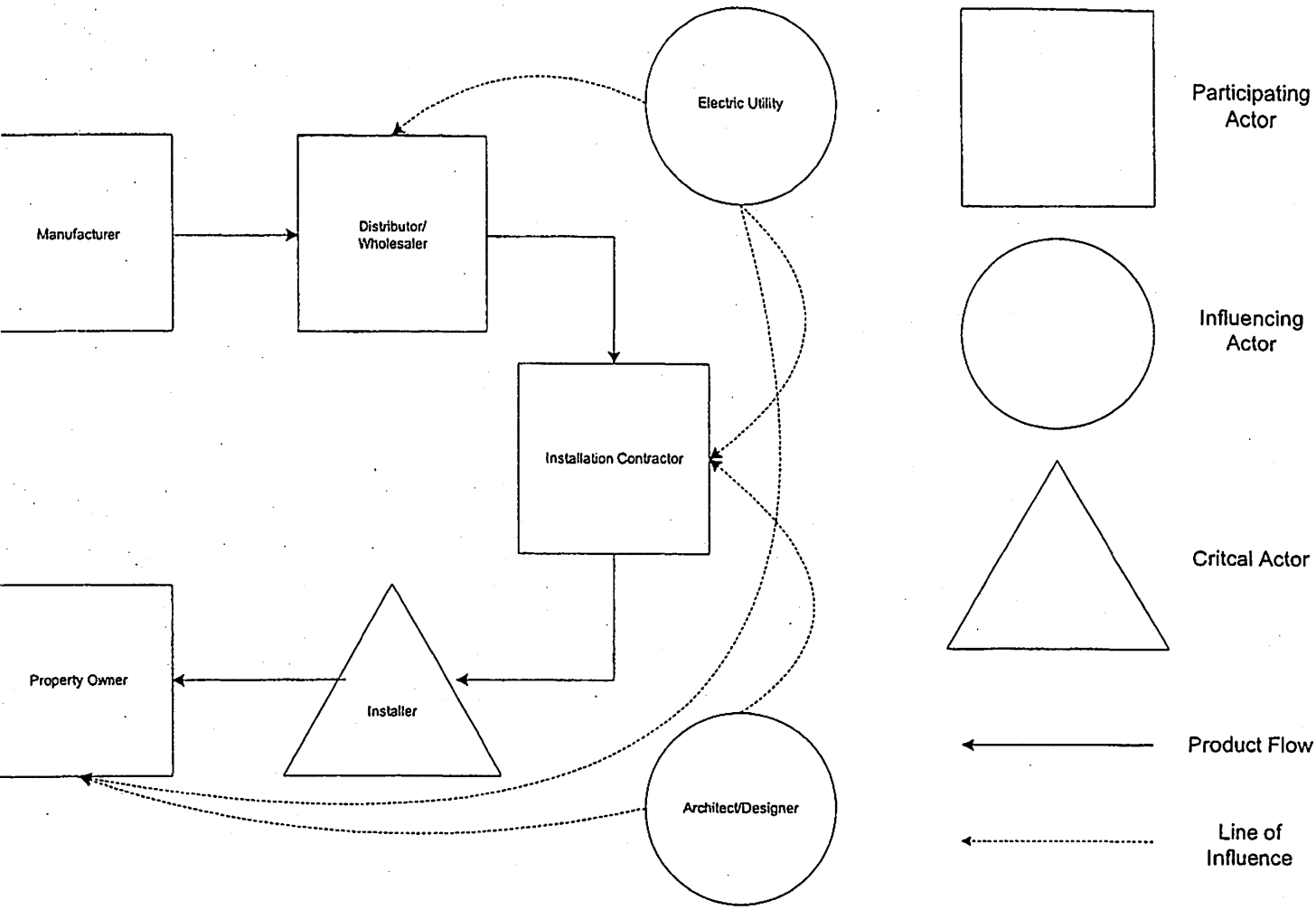

Figure 3. Replacement Air Conditioner Market Actors

Several actors are involved in the replacement air conditioner market.

The manufacturer typically has little to do with the market other than supplying the product. Typically manufacturers do not put major effort into trying to influence the market towards higher efficiency equipment but rather put their efforts into gaining a greater market share. Manufacturers make sure they are able to meet the demand of the market. At this time the demand of the market is for the base SEER 10 system.

The distributor/wholesaler can have a large impact on the market. However, under the existing infrastructure, distributors provide little influence. The distributor tries to maintain as little inventory as possible while not having so little that their customer has to wait for the product to be ordered. The inventory that the distributor does stock is based on the demand that they see. In the residential market there is currently little demand for high efficiency (SEER 12>) air conditioners. The vast majority of air conditioners stocked by distributors are the base SEER 10 systems. The distributors are reluctant to stock large quantities of SEER 12 and higher systems out of the fear that they will be left with an inventory that doesn't move. There is little motivation outside of incentives supplied by outside influences (i.e., utilities) for the distributor to stock anything other than what the contractors demand.

The contractors are the lynchpin in the process of getting wider acceptance of the high SEER air conditioners. The contractors perform the actual sales of the equipment and are therefore in the position to educate and sell the homeowner on the benefits of the high SEER equipment.

The contractor is, first of all, interested in the economic viability of their business. Market share, revenue per transaction, and profit are their primary motivations. The replacement air conditioner provides them with the opportunity to achieve an advantage over their competition. In general, air conditioner replacements are the largest profit margin item the contractor has. Service calls are not the contractors profit makers. The profits come from selling replacement parts and from selling a replacement air conditioner. The system works as it is for the successful contractor. In the absence of a market disruption, they see no need to change it.

Unfortunately, the contractors are reluctant to push high efficiency equipment very hard due to their belief that homeowners are not willing to spend the additional money for the high SEER equipment (approximately $540 for a 3 ton unit). Installation contractors want to ensure they close the deal for the replacement equipment and therefore push the least cost option in the belief that their chances of completing the sale are increased.

The last actor is the homeowner. The homeowners do not readily see the benefit of the higher SEER equipment and therefore tend to base their decision on first cost, comfort, and trust. The homeowner is, first of all, interested in obtaining reliable comfort from their air conditioner at a reasonable price. They may be interested in reduced energy costs, convenience, and environmental considerations, but these considerations are secondary.

The homeowner is ill equipped to judge the performance of their air conditioner or the claims of the installation contractor, their sales staff, or service personnel. Their baseline is past experience (and studies have shown that a properly operating residential air conditioner is the exception rather than the rule). The homeowner treats a replacement air conditioner as a commodity. That is, that all is equal except price. At the same time the homeowner is mistrustful of the many contractors, feeling that they will "get ripped off". They intrinsically know that there is an issue of quality, but they have no effective means of determining quality.

With the mild climate in SDG&E's territory, the homeowner has little incentive to upgrade to the higher SEER equipment due to the infrequent use and low associated operating costs.

All of these market actors have uncertainties that need to be addressed:

- The manufacturer isn't sure if the market will respond to the increased production of high SEER equipment.
- The distributor isn't certain if the market will respond with a demand for high SEER equipment. The distributor also has organizational practices that need to change. They are used to having the market drive their stocking practices, not being a market driver.
- The contractor doesn't know if the customer is willing to pay the additional cost of high SEER equipment. They fear losing market share. They also have organizational practices that will need to change. Not only in their sales staff but also in their installation and service practices.
- The customer isn't sure if the high SEER equipment is worth the additional investment. There is a significant level of effort that must be put forth by the homeowner to understand the benefits of a high SEER air conditioner and there is a high degree of uncertainty in what they are told by the contractor.

Estimate of Market Actors

Distributors

The number of wholesale air conditioning distributors in the SDG&E service territory is fairly small compared with other regions of the State. The distributors are very protective of the sales quantity numbers. This makes it difficult to quantify the larger actors from the smaller actors. It is estimated that there are 7 major actors accounting for the majority of the distribution in the SDG&E territory. These distributors typically distribute the equipment of only one manufacturer, although a couple carry two manufacturers. All of the major manufacturers are represented, including, Trane, Carrier, York, Lennox, Rheem/Ruud Goodman, and Janitrol.

The overall number of distributors is more difficult to quantify due to the way that the local infrastructure is set. For example, Trane, a major manufacturer does not work through a local major distributor. Instead they have allowed several installation contractors to act as smaller distributors, plus they allow installation contractors to place orders with their major distributor in Sacramento, who then arranges for the contractors to pick up the equipment at a local warehouse in San Diego.

It was thought very likely that there are distributors that are not accounted for that play a role in the distribution chain in SDG&E's territory. The chances are high that some of the contractors deal with distributors in outlying areas, for example, Orange County or Riverside counties. The distributors in these areas deal in much higher volumes so their incremental costs are lower. They are therefore able to pass these savings on to the contractors. This investigation confirmed this suspicion. It is estimated that the overall percentage of the units obtained outside of the SDG&E territory represents a small portion of the overall sales within the territory.

Installation Contractors

There are currently 609 contractors located in San Diego County that hold C-20, Warm-Air Heating, Ventilating, and Air Conditioning contractor licenses with the California Contractors State Licensing Board.

Of the 609 contractors located in San Diego County that hold C-20 licenses, 302 actively solicit business by placing adds in the Pacific Bell Yellow Pages or through internet listings. All contractors advertising in the four Pacific Bell Yellow Pages in the San Diego area and on the internet were tallied and cross referenced to eliminate duplication, or cross advertising. The four Yellow Pages examined were; San Diego, East County, North County Inland, North County Coastal.

Homeowners

Purchase and installation of residential air conditioners fall into three categories. Category 1 is new construction. Category 2 is a first time installation into an existing home. Category 3 is replacement of existing central air conditioning units. Using data from the San Diego Gas and Electric Company 1998 Home Energy Survey, Proctor Engineering Group was able to estimate all three of these categories for the years 1996 through 1998. These results are displayed in Table 1.

Table 1. New Air Conditioners Installed Annually by Category

Category	Annual Installations	Annual ACs
Category 1 -- New Construction	Lower limit 5263 households Upper limit 10,576 households Estimate 6000 households	6600 based on 1.1 per home
Category 2 -- First Time Installation in Existing Homes	Upper limit 5313 households Estimate 4576 households	4800 based on 1.05 per home
Category 3 -- Replacements	17,836 households	17,836
Total	28,412 households	29,236

The total number of installations is estimated at 29,236. This consists of 6600 in new construction, 4800 in first time installation in existing homes, and 17,836 replacements of existing equipment.

The methodology leading to these estimates is detailed in the methodology section.

MEASUREMENT PLAN

Proctor Engineering Group has devised a measurement plan for this project with the input and cooperation of San Diego Gas and Electric Company. The research questions to be addressed are:

1. What are the current practices of contractors attending the SDG&E training sessions with respect to residential AC equipment sizing and installation?

2. Do the attendees intend to change their practices as a result of their participation in the training sessions?

3. Do the attendees actually make a change in their practices over the course of two to three months?

4. Is there evidence that any changes are sustainable?

5. What barriers continue to reduce the adoption rate of the improved practices?

Proctor Engineering Group will administer an initial survey prior to the start of each training. This survey will address the current practices of the contractors.

After two to three months, the contractors will be given a post-training survey to establish their new practices. These mailed surveys will be followed by phone interviews to broaden the information for the evaluation.

These statistical data will be supplemented by direct observation of some of the contractors and the interchanges during telephone support.

Changes will be evaluated based on a near census of participants. Since a full census is unlikely due to non-response, the results will be presented with a 90% confidence interval using a finite population multiplier.

Data will be analyzed to determine if any particular groupings are present that were predictive of change or of non-response.

This approach will provide a comprehensive picture of the training, it's effects, and methods of improvement.

A draft and final report will be prepared for SDG&E at the conclusion of the program.

TECHNICAL REFERENCES

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