The Home Cooling Program:
Lessons Learned in Transforming the Residential Cooling Market

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ABSTRACT

The Home Cooling Program was funded in early 1998 as a Market Transformation program by a major California utility to promote a new residential cooling technology particularly well suited to California's climate. Evaporative condensers (EC's) immerse the outdoor condensing coil in an evaporatively cooled sump, resulting in condensing temperatures as much as 30-40°F cooler than conventional air-cooled condensing units. Reduced condensing temperatures result in reduced peak load, 30% or more cooling energy savings, and more stable cooling capacity at high outdoor temperatures relative to conventional air-cooled condensing units.

The Home Cooling Program's primary goal was to introduce the infant EC technology to the marketplace and educate HVAC contractors, designers, and builders about the technology and its benefits. Key program elements included contractor training, marketing, design assistance, system commissioning, and incentives to help defray EC incremental costs. Significant market barriers were encountered, including lack of awareness, inertia, quality problems and immature market costs. Despite these barriers, nearly 500 tons of EC equipment (approximately 200,000 ft^2 of conditioned floor area) were installed and commissioned during the program.

Related technical work involved detailed monitoring of EC performance at five sites in Northern California. Results from this and other monitoring work were used in a detailed hourly computer simulation to project performance and overall economics in key regions of California. In addition, satisfaction surveys were taken from program participants, providing valuable feedback on how EC technology is perceived and the effects of the Market Transformation program. Although equipment quality problems proved to be a major hindrance, commissioning of each installation resulted in high customer satisfaction levels.

Introduction

Conventional air conditioning has become commonplace in much of the country over the last 30-40 years. The technology is well suited for warm moist climates where dehumidification is a key component of indoor comfort. However, the performance of conventional air-cooled condensing units is significantly degraded by high dry bulb temperatures experienced in the western United States. In addition attic ductwork, commonly found in the high cooling load regions of the country, is prone to significant leakage and conductive losses which further reduces the already diminished cooling system output. A 1999 study compiling results from 17 duct efficiency studies nationwide found an average energy savings potential of 17% for remediation of duct defects, with savings potential as high as 26% in hot southwestern climates (Neme, Proctor & Nadel 1999). Compounding the poor state of ducts are the problems associated with low system air flow and improper refrigerant charge often found in residential HVAC installations. All these factors conspire with the contractors desire to avoid callbacks resulting in oversized air conditioning units that still cannot maintain adequate comfort under extreme conditions when cooling capacity and efficiency is degraded the most. The local electric utility is left to meet the resulting peak load from these oversized cooling units.

A condenser technology that is not adversely affected by high ambient temperatures would be a valuable piece of the residential cooling puzzle for dry southwestern climates. Evaporative condensers meet this requirement by taking advantage of the low ambient wet bulb temperatures in dry climates to evaporatively cool water which then cools the condensing coils. Though commercially available, these systems are not widely used and neither designers, builders, contractors, nor the general public are widely aware of their existence. The Home Cooling Program (HCP) was designed as a and funded by a major California utility to "get the word out" about EC technology, begin to overcome the market barriers, and demonstrate the benefits of the technology to HVAC contractors, designers, and builders. The EC unit promoted in the HCP is a split system cooling unit with nominal capacities ranging from 2 to 5 tons. It is primarily a residential unit although there are small commercial applications for the unit.

Key HCP program elements included contractor training, marketing, design assistance, system commissioning, and incentives to help defray the incremental costs associated with new, low-volume technologies. This paper focuses on how the technology works, how well it performs (based on detailed field monitoring and simulation), key elements of the Home Cooling Program, and lessons learned during the project.

Technology Description

The evaporative condenser (EC) unit promoted in the Home Cooling Program was first introduced in 1997. An EC replaces the fin-tube air-cooled condenser coil with an immersed refrigerant-to-water helical copper heat exchanger. As shown in the exploded view in Figure 1, water is circulated through a counterflow heat exchange path in the sump containing the condenser coil, then pumped over the evaporative media, and back to the sump. A fan draws outdoor air through the wetted evaporative media evaporatively cooling the water to within 5-10^{0}F of the outdoor wet bulb temperature. The immersed heat exchanger offers significant performance benefits due both to improved heat transfer and to lower condensing temperatures than typically experienced by air-cooled condensing units.

EC's perform best relative to air-cooled condensing units when operated in climates with large outdoor wet bulb depressions. In California's Central Valley, where typical summer conditions may be 100°F dry bulb and 70°F wet bulb (30°F depression), EC's perform better than in Atlanta, where summer conditions of 90°F dry bulb and 75°F wet bulb (15°F depression) are more common. EC performance in California applications has been extensively studied over the past several years (Hoeschele et al. 1998; PG&E 1998; Proctor Engineering Group 1998) with results consistently showing peak condensing unit demand reductions of roughly 50% relative to equivalent capacity 10 SEER air-cooled units.

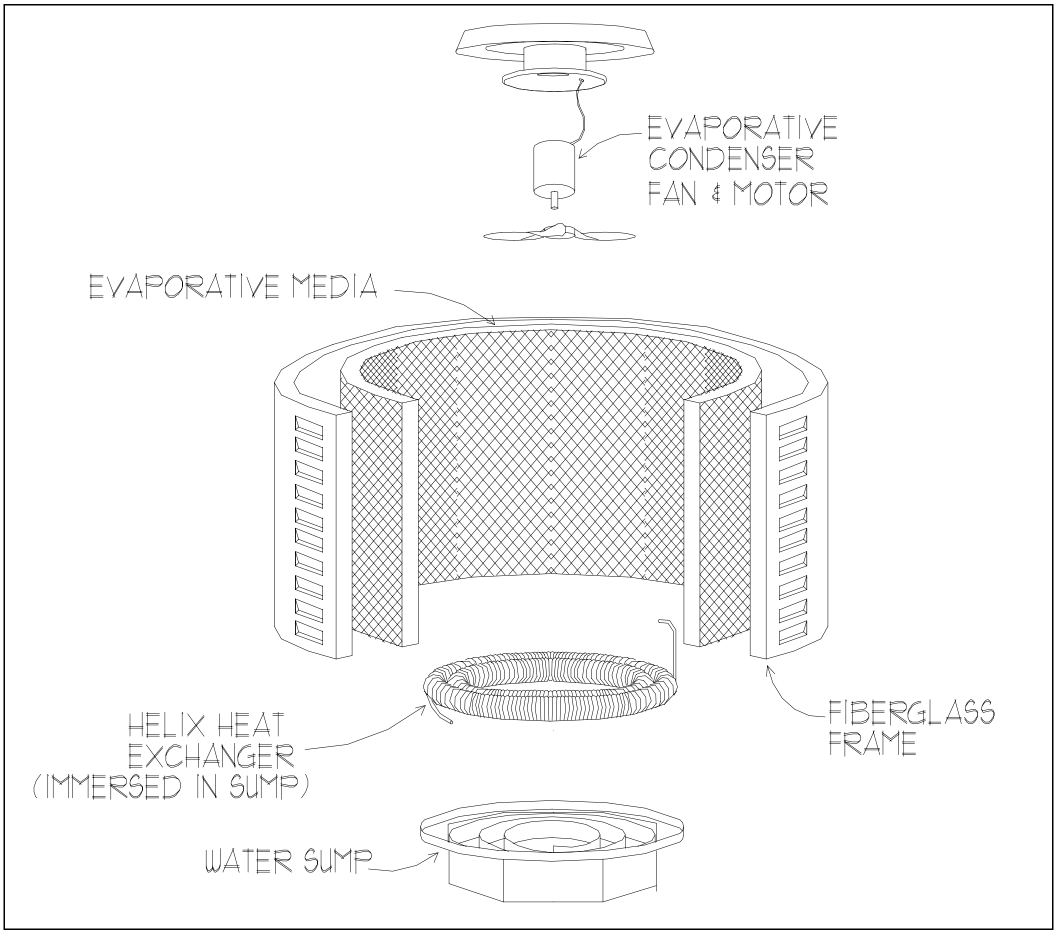

Figure 1. Exploded View of EC Evaporative Components

Methodology

1998 Field Monitoring

Parallel to the HCP Market Transformation efforts, the utility commissioned the installation and monitoring of five EC systems in existing homes throughout Northern California. The key objectives of the monitoring project were to determine in-situ operating efficiencies, assess short-term system reliability, evaluate the potential for heat exchanger scaling, and comment on the EC installation process. Performance data was used to assess the energy and peak demand savings potential of the EC.

Five houses, ranging in size from 1,800 to 2,500 ft^2, were selected as monitoring candidates. The five locations were Concord, Tracy, Davis, Auburn, and Fresno. Existing air-cooled condensing unit sizings ranged from 3 to 5 tons. The Air Conditioning Contractors of America's sizing program, Manual J (ACCA 1986), was used to calculate loads and required equipment sizes. Sizing results indicated EC capacities ranging from 3 to 4 tons, with an average 19% capacity reduction from the existing installed systems. Comprehensive monitoring of the five systems was accomplished by installing sophisticated dataloggers and sensors, with monitoring points detailed in Table 1.

Table 1. EC Monitoring Points

Monitoring Point	Use
Supply and return air temperature and RH	For calculation of system cooling capacity
Outdoor air dry and wet bulb temperature	Characterizing outdoor weather conditions
Indoor air temperature	Indoor temperature and cooling system setpoint
EC sump water temperature	Condenser "ambient" temperature
Surface mounted refrigerant line temps	Vapor compression operating conditions
EC current draw and total power	Condensing unit amp draw and demand
EC make-up water use	Water consumption data

EC Evaluation Study

A critical step in promoting an emerging technology is evaluating the benefits associated with it. In today's deregulated utility environment, long-term utility support is no longer a reasonable option. Technologies must be cost-effective from the customer perspective. To assess customer cost-effectiveness, the DOE-2.2 building energy simulation program was used to project EC and 12 SEER system performance relative to the 10 SEER unit for a range of California climates and building types. The evaluation methodology involved developing installed cost estimates for EC and both air-cooled units, utilizing manufacturer and laboratory test data to generate DOE-2.2 performance curves, and evaluating cost-effectiveness of 12 SEER and EC systems relative to 10 SEER units.

Both PG&E laboratory data (PG&E 1998) and manufacturers' performance data were used to develop performance relationships for the EC and the conventional units. DOE-2.2 characterizes residential cooling system capacity and electric input ratio (condensing unit energy input per unit of delivered cooling) with bi-quadratic functions of outdoor dry bulb temperature and return air wet bulb temperature. Four residential cases (ranging from 1,650 to 2,500 ft^2) and one small commercial office building were evaluated with the EC and two air-cooled systems (10 and 12 SEER) in six California climates ranging from mild coastal-transitional to inland Central Valley climates. Table 2 summarizes the ASHRAE cooling design information by location (ASHRAE 1993).

Table 2. Summer Design Temperatures by Climate Zone

Location	Design Dry Bulb	Coincident Wet Bulb	Design Wet Bulb
San Jose	86	66	68
Mt. Shasta	89	61	63
Santa Rosa	96	68	69
Sacramento	100	70	71
Fresno	101	71	73
Redding	103	68	70

Manual J sizing calculations were completed for each of the building type/climate combinations to determine both conventional and EC equipment sizing for all analyzed cases. HVAC cost estimates were based on information provided by a major Northern California high-volume HVAC contractor (for 10 and 12 SEER equipment) and the Northern California EC distributor. For simplicity, cost-effectiveness was based on a simple payback calculation with electrical energy savings valued at $.12 per kWh.

Home Cooling Program

The 1998-99 Home Cooling Program (HCP) was a "market intervention" program funded with public goods charge funds as "a deliberate effort by government or its agents to reduce market barriers and thereby increase the level of investment in (or practice of) energy efficient products" as defined by the CPUC policy rules. The program was managed by a major California utility and implemented by an energy consulting firm specializing in the design, monitoring, and evaluation of alternative cooling technologies. HCP's primary objective was to increase the number of residential evaporative condensers installed in the utility's service territory. The implementation team also included the Northern California EC distributor and the EC manufacturer.

Key HCP program elements included:

- **Contractor recruitment and training**. The initial program element was preparation of training and promotional materials to be used and distributed at six technical training seminars throughout Northern and Central California. Seminar invitees included building design professionals, HVAC contractors, building inspectors, and builders in market areas surrounding the six seminar sites. Seminars were conducted in late April and early May 1998. Two follow-up workshops to share experiences, identify and address issues, and provide advanced training were conducted with participating contractors in the last month of the HCP.
- **Technical and design support**. Engineering services were available to participating contractors to assist in completing Manual J loads and sizing analysis of all applications. Manual J is endorsed by the Air Conditioning Contractors Association (ACCA) and was a requirement of HCP participation. Additional technical support was provided as needed.
- **EC installation incentives.** Program funding included over $170,000 for EC installation incentives. Incentives ranged from $730 for residential and small commercial installations to $1,530 per unit for model homes. In addition to owner incentives, contractors were offered incentives of $200 per unit to complete required paperwork.
- **Quality assurance.** This element involved commissioning of each installation by a trained technician to verify proper system installation and operation. Installing contractors were called back on the job to remedy all deficiencies identified.
- **Exceptional Method Title 24 compliance application.** This element involved the preparation of an EC "Exceptional Method" application for submission to the California Energy Commission. When approved, the method will enable EC to receive an "equivalent SEER" rating and full compliance credit for its efficiency advantage under the California Title 24 energy standards.
- **Occupant satisfaction surveys, analysis and reporting.** As a market intervention effort, HCP included market research and development elements, including conducting

customer satisfaction surveys to assist the Market Transformation process. HCP participants were required, if requested, to complete a telephone survey conducted by a market research firm, 30 to 60 days after system installation.

- **Technology transfer**. HCP technology transfer elements included a workshop presentation summarizing program objectives and results, providing written summaries of objectives and results to participating contractors, and preparing this paper. The workshop was conducted at the PG&E Stockton Training Center in October 1999. Attendees included building design professionals, utility energy program managers, and a representative from the state energy agency.

Results

1998 Field Monitoring

Experiences gathered during the installation of the five monitored units clearly illustrated the following key points:

- The quality of the EC units initially installed was inadequate, with flaws in the float valve assembly, circuit board, and overall unit quality. During the course of the 1998-cooling season, the manufacturer implemented design changes to improve the unit and units in the field were retrofitted with these improvements.
- The importance of adequate contractor training is vital to the success of EC technology since certain installation requirements vary from typical air-cooled units. Although classroom training was part of the HCP, field training and improved installation instructions are critical features to achieving proper coil matching, system charging, and commissioning. Field training will be a component of follow-on EC commercialization efforts.

Monitored results for the five units were collected during a two-month period from July 24 to September 25, 1998 when all units were functioning properly. Four of the five units had steady state total capacities equal to the manufacturer's nominal ratings. (The fifth site had the improper indoor coil match.) For the four sites, average steady state EERs were only 88% of their nominal value, largely due to the high monitored indoor fan power.

A proprietary vapor compression computer model developed by Proctor Engineering Group was validated with field test data to extrapolate to full-season EC performance. Results indicate that for typical Central Valley climates, energy savings of 32-34% are projected relative to the baseline consumption of a standard 10 SEER unit, and 20-22% relative to a 12 SEER unit. (With projected Central Valley baseline usage of 1,470 to 5,530 kWh for a 2,000 ft^2 house, savings are projected to range from 485 to 1,825 kWh/year.) Monitoring data also indicated that EC capacity and efficiency was virtually unaffected by outdoor temperature, unlike air-cooled systems which exhibit significant capacity and efficiency degradation as outdoor temperatures exceed the 95°F rating condition.

Three of the five field sites exhibited small variations in outdoor heat exchanger performance due to scaling of the copper condenser coil. Two of the three sites exhibited coil degradation while one site exhibited a slight improvement in coil performance. The impact on system efficiency (EER) was estimated to be a 1.5% annual EER reduction, ranging from –3.6% to +2.5%. The coil scaling issue merits further study to better quantify the long-term impacts and determine how water quality and bleed rate affects scaling.

Overall, the field test results were very encouraging from a performance viewpoint. Favorable wet bulb temperatures common to most of California and the West, particularly at peak outdoor conditions, generate a significant efficiency advantage for the EC.

EC Evaluation

Based upon cost information collected in the evaluation project, the incremental cost to the homebuyer/homeowner versus a standard 10 SEER model was estimated at roughly $190 per ton for the 12 SEER unit and $330 per ton for the EC unit. The EC manufacturer indicates that if production volumes increase to roughly 10,000 units per year, unit costs should fall 30-40% (Bacchus 1999). If EC contractor pricing falls accordingly, the consumer cost for this technology could be comparable to conventional equipment.

Average energy savings projections for the residential and small office cases are presented in Table 3. Relative to 10 SEER, EC savings are roughly 5 to 6 times higher than those projected for 12 SEER equipment. Percentage savings for the residential and small office cases are nearly identical with little variation among the different climate regions.

Table 3. Projected Cooling Energy Savings (%) Versus 10 SEER

System	Residential		
Type	New Construction	Retrofit	Small Office
12 SEER	7%	7%	6%
EC	35%	35%	34%

Table 4 presents simple payback ranges for retrofit cases relative to a 10 SEER condenser, which is currently the most common EC installation application. A payback range is shown to reflect expected variations in savings due to varying usage patterns. In all cases, the EC is a better payback option than the 12 SEER with paybacks as favorable as 6 to 9 years for the hot Fresno climate. Paybacks at this level should be sufficient to slowly grow the EC market. If this growth helps contribute to the potential 30-40% volume manufacturing price reduction, EC paybacks could fall by more than a factor of five, spurring widespread application in the Fresno climate and more temperate climates. Demonstrated reliable operation over an extended period is the key to realizing this scenario.

Table 4. Projected Retrofit Simple Paybacks (years)

	System Type	
Location	12 SEER	EC
Santa Rosa	40-106	15-28
San Jose	34-112	17-38
Redding	23-48	8-11
Sacramento	28-66	11-18
Fresno	15-30	6-9
Mt. Shasta	53-150	25-44

Home Cooling Program Accomplishments

Nearly 160 EC units, accounting for a total of 495 tons of installed cooling capacity, qualified for incentives during the HCP. Of that total, 42% (206 tons) were new construction applications including 148 tons in a West Sacramento apartment complex, and the remaining 58% (289 tons) were retrofits. In terms of geographic distribution, nearly 58% were installed within 50 miles of Sacramento, with nearly all remaining units installed in and around Bakersfield (the hotter, southern end of the Central Valley).

Professional and trades exposure and training. Six recruitment and training sessions introduced the technology to 53 HVAC technicians, contractors, design professionals, builders, and building officials. All participants were provided with training manuals including marketing and promotional materials. Although classroom training included a full-scale EC unit on display, it is essential that further training efforts be based in the field where installation contractors are most comfortable. In addition to the contractor training, a 35,000-piece direct mail campaign was conducted by the EC distributor. Throughout the duration of the program, participating contractors were conducting their own sales and marketing efforts. HCP direct mail efforts targeted 180 builders, 60 design professionals and developers, and 50 multi-family developers.

Public information. Press releases were distributed to newspapers throughout the target market areas. The exposure generated appeared significant based upon the volume and geographic diversity of resulting inquiries.

Contractor interest. Contractor interest generated by HCP was substantial with the program attracting reputable participating contractors in major California cooling markets including Bakersfield, Stockton, and the greater Sacramento area. These three contractors alone accounted for 154 units. Five other contractors installed one or more units. Representatives of 27 different HVAC firms were introduced to EC at the HCP seminars.

Market response. The number of units installed through HCP and the level of customer satisfaction experienced indicates substantial market potential for EC, provided reliable units are offered and the technology is sufficiently supported until it achieves a self-sustaining market position. Even with HCP incentives, market resistance was encountered.

Manufacturing quality assurance. A valuable feature of the follow-up workshops with contractors were quality improvement suggestions offered first-hand to the manufacturer by HVAC technicians with recent experience installing and servicing the units.

Energy Savings. Energy savings for units installed under the program are impressive. For the 495 tons of EC installed, annual savings of over 200,000 kWh and 452 peak kW are projected (average of 1,266 kWh and 2.8 peak kW per unit). Savings were based on monitored EC peak demand (kW per ton) and projected EC and conventional system annual efficiencies for the climates and equipment vintages (retrofit applications) where EC's were installed. Savings of this magnitude are impressive in the residential air conditioning market.

Customer satisfaction. 88% of new EC customers (59 out of a total of 67 respondents) expressed overall satisfaction with the technology and 78% said they were very satisfied. 97% stated that EC cooling was "as or more comfortable" than conventional air conditioning, and 78% said "more comfortable". A key factor contributing to the high customer satisfaction rating was the detailed field commissioning performed as part of HCP. Satisfied customers are good advertising, and professional market research documenting customer satisfaction will facilitate increased exposure in the future.

Implementation Barriers

Implementation of the EC technology faced barriers both typical to new technologies and unique to the EC. Specific hurdles included:

Inertia - Market resistance in the model home market sector proved insurmountable. Despite the $1,530 per unit incentives offered for model homes, formidable resistance was encountered both among homebuilders and HVAC subcontractors. Builders indicated that they were selling all the houses they could build under current market conditions, and that customers were not asking for more energy efficient houses. They also expressed valid reliability and warranty concerns about a product and manufacturer they had never heard of. The HCP experience suggests a successful EC campaign in new construction will require a comprehensive and substantial promotional effort.

Quality problems. Prior to HCP, EC units had been installed only in climates with little or no potential for freezing. Recognizing the possibility for supply water line freeze potential in many northern California climates, the manufacturer developed an automatic drain/fill control which would drain the sump periodically to prevent mineral buildup and potential freeze damage. Unfortunately, the routine was not thoroughly field tested, and as a result caused numerous operating failures in units installed early in the program. At least one contractor who was aggressively participating early in the program discontinued his involvement due to product quality concerns. The commissioning element of HCP provided resources to assist contractors in correcting the deficiencies of the installed units. The commissioning efforts enhanced credibility of the technology, and probably avoided its withdrawal from Northern California. Quality control feedback to the manufacturer resulted in changes in the manufacturing process. Although quality issues were promptly addressed by the manufacturer, previously installed units will be closely monitored during 2000 to confirm that the completed retrofits resolved all problems. This is essential in expanding the customer support for this emerging technology.

Lack of awareness. For 60% of the program participants, the HCP was their first introduction to EC technology. Most buyers are reluctant to choose a technology they are hearing about for the first time from the salesperson. HCP worked to overcome this barrier through newspaper articles and direct mail.

Immature market costs. The EC unit suffers from high incremental cost, largely due to low manufacturing volumes which affect both labor and material costs. The HCP incentive effectively countered this barrier.

No SEER rating. Designers, builders, contractors and the general public have come to rely upon SEER ratings to compare air conditioning systems. The lack of a SEER rating is detrimental to EC technology. Once accepted, the “equivalent SEER” application completed as part of HCP will increase EC acceptance and market position in the building industry.

Lessons Learned

The “chicken and egg” syndrome. For new technologies to succeed, they must perform well and be cost-effective. To be cost-effective, a technology needs to be produced in sufficient volumes to benefit from both labor and material economies of scale.

Commissioning is key. The last thing that an emerging technology needs is to get a black eye from the early adopters who are critical in overcoming market inertia. Commissioning every unit installed in the HCP was essential in insuring the unit would perform properly. The high customer satisfaction results attest to the value of commissioning.

Utility support is essential. Utility financing of Market Transformation programs is an essential component to getting new technologies off the ground. Once monitoring and evaluation results convinced the utility that EC's were an important tool in combating peak load growth, HCP funding provided sufficient support to the early commercialization effort.

Contractor field training should be required. Although contractors were trained in the nuances of EC installation in classroom sessions, field interactions with contractors proved much more valuable. Working with the installers in the field is the most effective way to get key points across.

It's easier to say "no" than "yes". Many (heavy) doors must be pried open to sell a new technology. The following case study is a prime example of what the HCP was up against.

The West Capital Courtyard multi-family project is a perfect illustration of the range of obstacles encountered by a "new technology" such as EC. This 72 unit new construction project located in West Sacramento is a low-income housing project developed by the West Sacramento Housing and Development Corporation (WSHDC). As one of 50 multi-family developers contacted in the HCP, the head of WSHDC was the only one who expressed interest in the EC technology.

One of the first questions posed by the developer was "Could you give me the names of other multi-family projects where EC has been installed?" The answer to this question was "No. This project would be the very first multi-family project with EC's." This induced a certain reticence on the part of the developer, despite his earlier enthusiasm for the technology. After a few philosophical discussions about developing affordable housing and the challenges associated with the introduction of beneficial technologies like EC, the developer's reticence transformed into an insatiable quest for more information about, and endorsements of EC. The most challenging request was for endorsements from his general contractor and sub-contractors since <u>none</u> of them were familiar with EC.

A rapid-fire series of meetings and phone calls ensued with the project's general contractor, construction manager/owner's representative, mechanical engineer, civil engineer, plumber, and HVAC contractor. None of the market actors was enthusiastic about the prospect of a change in product specification and learning to install (and to some degree warrant) a new product. It was only because of the owner's dogged insistence that his team persisted in considering including EC in the project. Barriers that arose included:

- The mechanical engineer insisted that the indoor coil manufacturer provide a written endorsement of the match-up of the indoor coil and the EC condenser.
- The HVAC contractor insisted on applying his normal mark-up to every dollar of incremental cost for the EC.
- The developer insisted that they would not pay any incremental cost for the EC.
- The plumber quoted an excessive charge for providing water connections to the units since he had won the job on low bid and now was presented with a change order.
- The general contractor requested that the building department pre-approve EC.

- To overcome these obstacles:
- The coil manufacturer was convinced to send a (highly unusual) written endorsement of the coil and condenser match-up.
- The maximum number of incentives was applied to the project and a portion was redirected to the distributor to "buy-down" the HVAC contractor's price for the EC units.
- The HCP implementor agreed to manufacturer distribution water manifolds to simplify the field water connections and completed the water connections in the field to reduce the incremental plumbing charges.
- West Sacramento Building Department pre-approval for the EC was obtained.

Once all objectives were overcome, the developer announced that he also required the approval of his lenders. Although assistance was offered to talk to those involved, this was declined. At that point, the fate of the project depended upon the developer's ability to justify his request to the lenders and gain their approval. Fortunately, he was successful and the units were installed.

Conclusions

The Home Cooling Program can clearly be deemed a success, since it overcame equipment quality control problems, achieved high satisfaction levels from the customers surveyed, and demonstrated significant energy and demand savings.

Efficiency. Prior laboratory and manufacturer performance results were field-validated.

Economics. Computer models based on actual performance data indicate that the EC is the more cost-effective upgrade option relative to 12 SEER equipment in all climates modelled. Paybacks as short as six years are projected at current EC pricing levels. Economics should improve as volume increases and production costs decline.

Comfort. Customers were impressed with the comfort provided by their EC unit. On the hottest days, EC units will provide more cooling than conventional air-cooled units.

Contractor interaction. The need for contractor training and field follow-up after EC installation was paramount to a successful program. It proved to be very beneficial to have commissioning technicians working with the installers in the field.

Sizing. HVAC contractors are reluctant to complete Manual J equipment sizings for a variety of reasons. This is particularly true in retrofit applications where contractors will nearly always install the same size cooling system as the unit being replaced. As contractors become more comfortable with EC's and the overall quality of duct installations improve (less leakage), the need for Manual J load sizing and Manual S equipment sizing will increase to insure properly sized units are installed.

Market Strategy. For EC's to go "main stream", a broad contractor network must be built. Competing contractors within the same market represent a healthy trend leading to higher product visibility and more competition.

Field tests. New products and new models should be thoroughly field-tested to find and remedy the "bugs" before product launching.

Sales to Developers or Builders. To sell a new product such as EC to a homebuilder or multi-family developer, all the decision-makers (architect, mechanical engineer, developer, general contractor, subcontractors and project superintendent) must buy into the product.

Education and showcase installations, such as West Capital Courtyard, are both important tools in gaining acceptance.

Incentives. Before the EC market fully matures, it is necessary to have the ability to shift cash incentives upstream to leverage their effect in multi-unit projects. Incentives paid directly to homeowners also add credibility to a new technology by demonstrating that support beyond the manufacturer and HVAC contractor exists.

Residential potential. There is no apparent limit to the potential for high quality evaporative condensers in the residential market. Although EC energy savings (and customer payback) varies with climate and usage, EC peak shaving capabilities are substantial in virtually all markets, and the reduction in peak demand can be very valuable to the electric utility in areas with transmission and distribution limitations.

Commercial potential. Simulation results suggest significant EC market potential due to higher cooling loads per ft^2 and the greater likelihood of equipment downsizing. Potentially viable EC configurations include the currently available split system, similarly configured rooftop packaged units, larger engineered systems, and hybrid systems which efficiently pre-cool buildings at night.

Future Programs

The potential for evaporative condensing technology is quite large. However, the technology is far from entering the mainstream market and needs further support to accelerate the penetration rate, which would allow price reductions to occur. To build on the momentum of HCP, a follow-on program was recommended and has been approved. This program will include field training and commissioning elements, which proved valuable in HCP. In addition, further outreach to manufacturers, distributors and HVAC contractors is needed to spread the word about this technology. Manufacturing quality should be monitored and improved and the possibility of getting a major HVAC equipment manufacturer involved should be explored. Advertising in target markets with active EC installers, such as the Fresno/Bakersfield area, is necessary to prime the pump. With further support, evaporative condensing technology can contribute to significant peak load reduction and comfort improvements, particularly in the high growth inland areas of California and the southwest.

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