The PG&E Model Energy Communities Program: Offsetting Localized T&D Expenditures With Targeted DSM

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The PG&E Model Energy Communities (MEC) Program is a three-year pilot project designed to meet the electrical capacity demands placed on an existing transmission and distribution (T&D) system. The program is a result of a detailed and innovative least-cost integrated resource planning effort. The program seeks to demonstrate that targeted and aggressive demand-side management (DSM) is a cost-effective and reliable alternative to capital investment in T&D as a means of addressing summer electric peak load growth. The program uses DSM, with an emphasis on service, marketing, and quality assurance, as a means to offset demand, and to defer construction of a new planned substation.

This paper discusses the implementation challenges and preliminary findings regarding the largest segment of the MEC Program -- the residential retrofit direct installation component. Over a period of three years this aspect of the program will attempt to work on up to 5,000 existing air conditioned homes in the target area. In the initial 1991 phase, HVAC ductwork and building shells were tested for leakage and repaired using blower door guided techniques. When indicated by on-site evaluation, shading was installed on west facing windows and ceiling insulation was increased. On 175 air conditioners, air flow and refrigerant charge were tested and repaired when necessary.

This paper provides pre-repair and post-repair data on duct leakage, evaporator coil air flow, and refrigerant charge from units completed in the initial stages of implementation. All aspects of the program are discussed, including marketing, impact projections, program management and program modifications.

Introduction

The PG&E Model Energy Communities (MEC) Program is an innovative pilot project designed to offset increased local area peak electric demand in a rapidly growing community. The program seeks to demonstrate that targeted and aggressive demand-side management (DSM) is a cost-effective and reliable alternative to capital investment in transmission and distribution (T&D).

The MEC project is directed at a portion of California's far eastern Contra Costa County that will be served by a new substation. The program places an emphasis on public outreach, aggressive marketing, direct installation, service, and quality assurance. By actively marketing energy efficiency services and ensuring that the services are properly applied, this program is working to extend the life of existing T&D resources and to determine successful program outlines for future DSM efforts.

The largest segment of the MEC Program is the residential retrofit direct installation component. (Other components of the MEC Program include large and small commercial retrofits, residential new construction, and small commercial new construction.) Over a period of three years, this element of the program plans to work on up to 5,000 of the air conditioned homes in the target area.

The economic analysis of this project is contained in *Targeting DSM for T&D Benefits: A Case Study of PG&E's Delta District*. (Orans et al. 1991). The findings are based on local area specific avoided costs. It compares a traditional supply side investment plan with one that integrates DSM. The study shows that "high saturations of DSM programs that are carefully matched to local area costs and the timing of loads, can cost-effectively defer investment in T&D facilities. In the case study area alone, PG&E was able to create a modified forecast of demand that reduced its investment in local T&D capacity from $112.3 million to $76.4 million over a 30-year period, or by approximately 32 percent." The integrated plan results in a $35 million savings from a total resource cost perspective.

Marketing Residential Retrofit Services

The program's retrofit component is central to the project's overall success rate due to the population mix (90% residential) and area-specific peak load "drivers" (i.e., residential AC). In the initial direct mail marketing, two approaches were tested. Residents were sent either (1) a comprehensive promotional package which introduced the MEC Residential Retrofit Program and offered a variety of incentives to participate or (2) a simpler offering based upon community involvement and a sweepstakes drawing. Response to these original marketing efforts (2%-5%) were not as high as desired.

In order to attain the desired market penetration, a more direct approach was implemented in the next marketing effort. Realizing that the market might respond to a "straight to the point" explanation of the program and its benefits, subdivisions within the targeted five feeder area were selected based on target market criteria (consumption, geographic location and AC penetration) and sent a one-page letter explaining the program.

In the letter, homeowners were informed that their area had been selected for testing, and that all they had to do was schedule an appointment. This time the marketing effort provided an exceptional level of penetration -- greater than 50%.

The program delivery itself was so well received that it generated significant word of mouth referrals. Since the work done was of clear value to the customers, they marketed it to their neighbors of their own accord, without any assistance. For a period of several months in late 1991/early 1992, the program's capacity to provide services was fully subscribed by individuals who phoned in with service requests.

The initial on-site visit, scheduled through the direct marketing effort, was made by an energy specialist who conducted an energy efficiency survey and installed efficiency devices such as compact fluorescent lamps, low flow shower heads, and water heater blankets. At the time of this initial visit, AC customers were scheduled for those services that they qualified for and accepted, including duct and shell sealing, AC tune-up, ceiling insulation and sun screening. In the initial phase of the program, these services were provided at no cost to the customer. Table 1 lists the activities in the initial on-site visit.

Table 1. The Initial On-Site Visit

- Customer Education
- Bill Disaggregation
- Rebate Program Information
- Installed Items (Free of Charge)
    - Low Flow Shower Heads
    - Compact Fluorescent Lamps
    - Water Heater Blankets
- AC Customers Signed Up for Eligible Services
    - Duct Sealing
    - Shell Sealing
    - Ceiling Insulation
    - Sun Screening
    - AC Tune-Up

Program Implementation

This program requires reliable and measurable results. Traditional engineering estimates will not provide the system planners with the comfort level necessary to defer the substation. This project's success depends on real DSM impacts visible at the substation level. For this reason, great effort has gone into implementing a quality assurance system with feedback loops and data verification, as shown in Figure 1. The development of this process is described in Jacobson et al.(1992), Proctor and Foster (1986), and Proctor (1984 and 1991).

Crews are trained in step-by-step procedures to diagnose, repair, and verify the critical parameters for reducing targeted peak use. These parameters include measured duct leakage, duct location, and rated and measured air conditioner efficiency. Each crew member is well trained in their specialty. Training includes classroom instruction with experienced personnel and field experience with certified trainers.

Upon completing work at any site, data forms are returned, entered into a comprehensive data base, and checked by an expert. This expert determines which units have passed, which require further work, and which need further investigation. The process can be streamlined by the use of a computer expert system.

To guarantee accuracy, twenty percent of the completed homes are inspected in the field to ensure that the repair

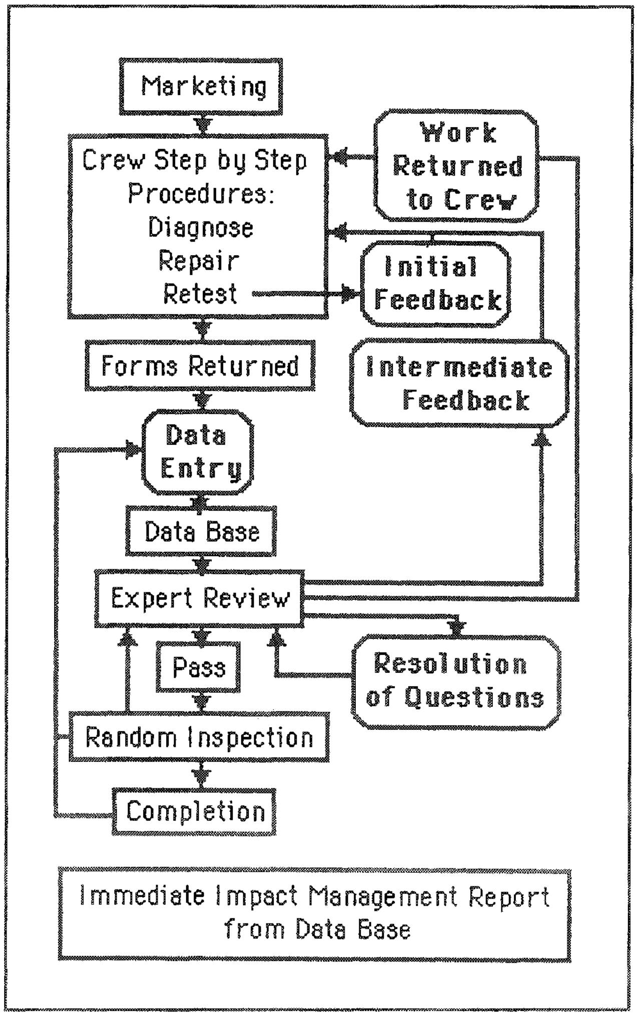

Figure 1. Quality Assurance System

work is durable and that the numbers on the forms represent the true final condition of the house. In the future, a small percentage of units should be pre-inspected to validate initial data.

The process ensures that homes requiring additional work are returned to the contractor for completion. Program staff investigate any questions that arise in the form review process and make sure that appropriate action is taken. No house is considered complete until it has passed form review by a certified expert.

Feedback to the technicians doing the work is essential for a quality product. Pre-repair testing followed by post-repair testing enables the crew to determine whether they have met the established criteria for a completed home. Face-to-face feedback with an individual certified in quality assurance is provided as a result of the form review and inspection process. Experience has shown that feedback on an individual house must take place no more than two weeks after the unit is completed for the technician to remember the home and learn from it.

When houses have passed form review and inspection, they are flagged in the database. On an as needed basis, an Immediate Impact Management (IIM) report is generated. Based on the parametric information gathered at the home, as well as the past energy use information from billing data, a projection of energy savings and peak reduction is determined. This is accomplished with a proprietary system of empirically weighted models. This information is aggregated into the IIM report.

The IIM report provides essential management information to the utility. Each report includes a graph that compares program savings (or peak reduction) to the savings that should be achievable within the parameters of the program. This graphical device makes it easy to determine when some correction must be applied to the system (the actual line will begin to diverge from the achievable line as shown in Figure 2). In addition, the report shows the most recent performance of every contractor and crew in the program. It also reports on energy, peak, and emissions impacts and projects current trends to program completion.

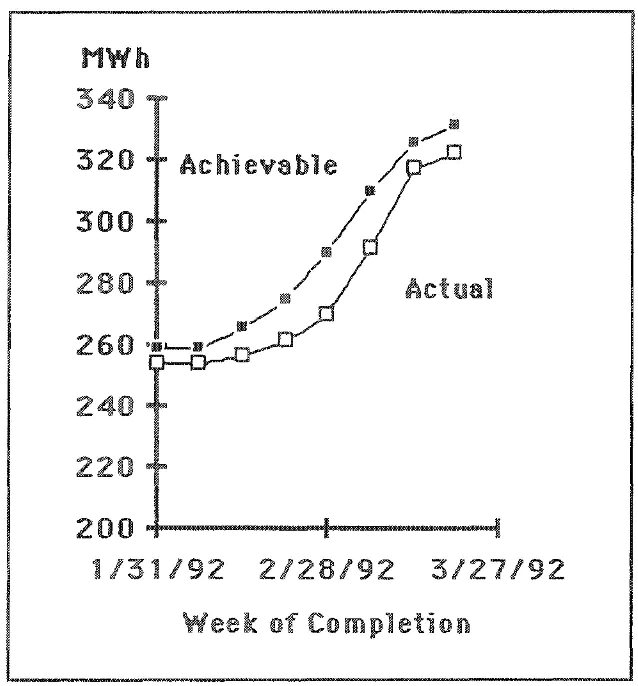

Figure 2. Actual vs. Achievable Savings

Start Up Lessons

The first six months of this energetic program are filled with lessons for future use. These lessons are being used to restructure the program for higher cost effectiveness and impact.

Marketing

For the greatest impact, efforts should be carefully targeted at AC customers with the greatest potential for peak reduction and energy savings. This can be evaluated by past consumption and localized conditions (AC penetration, age, etc.). The target marketing for this customer subgroup should be further qualified by the actual conditions found at the first on-site visit. The conditions relevant to this screening would include the capacity and efficiency of the existing air conditioning system and levels of repairable duct leakage. Large inefficient units with significant duct leakage provide the largest potential for peak reduction.

Whenever possible, in line with targeting high potential savers, the work should be concentrated into a few subdivisions at any one time. This allows the crews to work with floor plans they have become familiar with, and reduces logistical problems. Concentrating the effort into a small geographical area increases referral activity. This activity is advantageous if it brings in customers with high potential for peak reduction. On the other hand, it adds complexity if it brings in significant numbers of non-targeted customers.

Building the Infrastructure

Traditional weatherization has focused on a transactional approach, i.e., how many houses were completed, how much caulking was done, etc. This program involves more intricate, performance based, operations (such as blower door guided duct and shell sealing). As a result, additional training is required at all levels. Managers and crews with experience in these areas are not widely available. For that reason, program start-up should include hands-on experience for all crew and management personnel in attics and crawlspaces where this work is concentrated. This field experience must be accompanied by feedback from program trainers. Comprehensive development and training of management staff, as well as intensive crew training and certification, is crucial for program success.

Program management and administrative control systems, including comprehensive policies and procedures, need to be refined and expanded to guarantee program success. These systems, with their heavy emphasis on delivery and expert review, are more complex than those required for more traditional, transaction oriented weatherization programs, and need to be continually monitored and improved.

The transition to more reliable savings is substantially aided by an integrated participant database that incorporates transactional, quality control, and performance parameters. This database consists of both field measured and billing data.

Contracts

The pilot program has shown that contracts must incorporate a fixed fee structure with strict standards for quality and customer satisfaction in order to optimize success. The fee structure needs to be based on measured improvement at each site (performance), not just on the number of houses visited (transactions). Adequate performance needs to be carefully defined, and remedies for poor performance need to be prescribed and enforced. A comprehensive and effective system for field measurement of performance is essential to this type of performance contracting, and must include both pre- and post-field inspection.

Safety

Effective combustion appliance safety checks are necessary. These checks include carbon monoxide (CO) and combustion product leakage tests under worst case conditions. These tests differ from typical procedures used by utility gas service people.

At the start of this project, the combustion safety tests were done when the duct sealing crew first arrived at the house. Substantial down-time resulted, since almost 25% of the homes had pre-existing conditions which prevented sealing. Safety tests are now completed in advance of the crew visit. Crew safety training on work place hazards is also an essential element of this program.

Results

In total, over 3,000 in-home energy surveys have been conducted through the MEC residential retrofit program. To date, 8,000 compact fluorescent lamps have been installed, and over 2,000 AC homes have been provided with direct installation services such as duct and shell sealing, ceiling insulation, sunscreen, and AC tune-ups.

The First 1000 Homes (Phase 1)

Table 2 summarizes project results on the first 1000 homes.

Table 2. Results

Duct and AC Statistics (initial units)	
Initial Duct Leakage	374 cfm
Final Duct Leakage	157 cfm
Low Evaporator Air Flow (<350 cfm wet)	44%
Excess Refrigerant Charge	33%
Estimated Annual Effect from Residential Direct Installation (first 1000 houses)	
Estimated MWh Savings	245
Estimated Potential kW Reduction	568
Estimated Therm Savings (heating)	58,142
Estimated CO_2 Emission Reduction	492,066 lbs.
Estimated SO_x Emission Reduction	723 lbs.
Estimated NO_x Emission Reduction	192 lbs.

In the first 1000 homes serviced, average pre-repair duct leakage was 374 cubic feet per minute (cfm). The repair procedure was designed to accomplish duct sealing sufficient to bring the average duct leakage to 150 cfm. For these homes, technicians were able to decrease duct leakage to an average of 157 cfm.

In the same period, air conditioner testing and repairs were initiated on 175 air conditioners. These repairs were discontinued when the weather turned too cold for adequate determination of refrigerant charge. These units showed problems similar to those found in previous pilot studies (Proctor et al. 1990; Proctor 1991). Forty-four percent of the units had a wet coil air flow of less than 350 cfm per ton. This is a very high incidence of problems considering the predominance of newer AC units in the area. Incorrect charge continued to surface as a major problem. Thirty-three percent of the units were overcharged, which results in high peak usage and lowered efficiency. Twenty-three percent of the units were determined to be undercharged.

The annual savings and peak reduction potential was calculated for this initial period. These calculations showed that significant energy savings would result from the program. The efficiency improvements in the air conditioning system and building shell are intended to reduce the area peak load. This peak load occurs from 6:00 to 8:00 p.m., when a large percentage of the residences are running their air conditioners continuously. This is partially a result of resetting the thermostat to a lower temperature upon return from work. This behavior jeopardizes the peak reduction possible from efficiency improvements. When the project team performed their scheduled analysis of the initial phase, it was determined that the program should be modified to ensure that the desired reduction would occur.

Phase II Program

Additional homes will participate in the MEC program through 1994, and are expected to yield at least 8.4 MW of summer peak load reduction.

A number of changes are being implemented to ensure that target goals are met. Only the efficiency retrofits considered the most cost-effective and reliable will be used. In order to capture the potential peak reduction due to these retrofits, a program of early replacement of air conditioners with high efficiency (and often smaller) units is underway. This provides a method of mining the potential peak reduction created by efficiency improvements. In addition, a program of direct load control for AC and swimming pool pumps has been proposed.

Summary

The initial start up phase of the Model Energy Communities program has provided the project team (as well as program planners) with essential information for future improvements both within the MEC implementation scheme as well as subsequent targeted T&D DSM load deferral projects.

To date the project team has reached the following conclusions. First, programs must target those AC homes with the greatest potential for peak reduction. Second, project teams need to formulate effective fixed fee contract structures. While "time and materials" contracts allowed for rapid program implementation, design, and start up, they were less effective for performance based goals than for transaction-oriented goals. DSM programs of this nature need to address actual KW impact reduction per utility dollar spent on efficiency measures. Third, programs must implement effective expert systems with feedback loops for both management and crews.

The MEC pilot study clearly shows that while not all goals have yet been reached, the implementation of targeted and comprehensive DSM programs is an effective strategy to delay T&D expenditures. In fact, planners have identified fourteen growth sites system-wide as possible locations for future integrated least cost planning programs, and planning and funding for a "Son of Delta (MEC)" program have been initiated.

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