The Challenge of AC Early Replacement

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ABSTRACT

Energy efficiency professionals have long shown interest in central air conditioner (CAC) early replacement (ER) programs, where existing, low-efficiency air conditioners are removed before the end of their effective useful lives and replaced with new standard-efficiency or high-efficiency units. Unfortunately, in-depth analysis shows that there are significant challenges to cost-effectively designing such a program in the residential sector within the rigorous regulatory framework governing such programs in California and elsewhere.

The principal data source that informs this paper is a 2011 report created by Energy Market Innovations, Inc. (EMI) on behalf of Southern California Edison (SCE), which explored the viability of a Residential Central Air Conditioner Early Replacement program in a disciplined and thorough way. That report and this paper utilize dynamic modeling that accounts for variables such as CAC unit characteristics, average CAC usage, projected participation rates, climate zone impacts, and policy-driven factors. This paper succinctly analyzes a number of modeled scenarios.

We conclude that despite enormous energy and demand savings potential, a residential CAC ER program in California is not cost-effective within existing market and regulatory constraints. Certain assumption changes could move a potential program in the direction of viability, but these options also face viability challenges.

The analysis supports a broader trend showing that cost-effective HVAC program opportunities beyond ER have faded in some utility contexts. It suggests that utilities and state energy commissions may want to review their overarching policies to continue achieving significant HVAC energy savings. This paper concludes with a brief discussion about some forward-looking, big picture ideas.

The Concept of "Early Replacement" in Energy Efficiency

"Early replacement" (ER) is a type of energy efficiency (EE) program that pays customers an incentive to deactivate low-efficiency equipment and replace it with new standard or high-efficiency equipment.[1] Programs for early replacement are not uncommon in the energy efficiency setting, although such programs are not always titled as such. For example, a commercial lighting program is rarely called "early replacement" even though the goal is for customers to replace inefficient lighting fixtures before they burn out (PNNL 2006). The "early replacement" title seems to be used more frequently for large appliances, where replacement is a more significant financial and logistical challenge for a customer. Over the past decade, the demand for more aggressive energy efficiency savings has encouraged some utilities to explore

[1] Note: "Early retirement" denotes programs where existing equipment is discontinued before the end of its useful life (e.g., refrigerator recycling programs). "Early replacement" has two parts: the early retirement of old equipment and the replacement of the equipment with a new unit. In some cases this new equipment is at the level of code and in other cases it is high-efficiency.

early replacement programs featuring larger equipment, namely central air conditioner (CAC) units.

In non-residential building operation and maintenance sectors, organizations routinely replace equipment before failure, based on factors such as reduced energy consumption and operating costs, reduced pollution, or increased productivity. This is often executed without incentives, since there is often a clear and compelling business case to do so without the need for external influences. Residential customers have been less inclined to engage in early replacement, due to a lack of awareness, the smaller energy impacts of common home devices, and the high initial costs of new equipment.

Early replacement of CAC systems can result in significant energy savings where existing equipment is less efficient than the local energy code—calculated for the time-period corresponding with the remaining useful life (RUL) of the old unit. This is especially true if replacement units are high efficiency (and part of the savings extends past the RUL). An early replacement program that installs only standard efficiency units instead of new high-efficiency units could thus result in significant lost opportunity for energy efficiency savings. This is particularly so when equipment has a long effective useful life (as do CACs), because once a new unit has been purchased, buyers are very unlikely to replace it with another higher efficiency unit during its life. In the case of CAC units, this stasis can literally last for decades, limiting long-term energy efficiency program administrator savings. The authors of this paper agree with many efficiency program planners and support ER programs that require new high-efficiency units vs. ER with new standard units.

Examples of Recent CAC ER Programs

On the surface, CAC ER programs are attractive—they represent a considerable amount of energy savings and peak demand reduction—and this allure is evidenced in many utilities' recent implementation of ER programs. Even through most of the analysis contained in this paper focuses on California, the following non-California programs shed light on the types of designs that utilities are exploring. A key consideration of this paper is how realistic application of elements from these programs would be at Southern California Edison (SCE), since many of the allowable program parameters are distinct to the various utilities' regulatory settings.

Notable recent ER programs across the United States include:

- **Ameren Illinois, "Act on Energy" Program** – The program offers a $600 incentive to customers who replace operable CAC units of up to 10 SEER[2] with new units of 14 SEER or higher. For a reduced incentive of $110, customers may replace units with those that have a SEER higher than 10.

- **Dayton Power & Light, Heating and Cooling Rebates** – This program offers an incentive of $400 when the new unit is above 13 SEER, and $600 dollars for units above 16 SEER. Without a qualifying trade-in, customers only receive $200 and $300, respectively. To qualify, the old unit

[2] Seasonally-adjusted Energy Efficiency Ratio – A common rating for CAC that is calculated by dividing the cooling output in Btu (British thermal unit) during a typical cooling-season by the total electric energy input in watt-hours during the same period.

must either be functioning or reparable for less than $1,000. There is no age limit for a functioning unit, but reparable units must be less than 20 years old.

- **Kansas City Power & Light, "Cool Homes" Program** – To qualify, customers must first have their old, functioning CAC unit tuned up by a qualifying contractor. At that time, if the field-tested EER[3] level is below 8 after the tune-up, the customer qualifies for incentives of $650 for a 14 SEER model and $850 for a 16 SEER model.

- **Long Island Power Authority, "Cool Homes" Program** – In this program, only CAC systems that need less than $1,000 of repair and are less than 20 years old qualify for the program. The incentives for new units are $500 for a 14.5 SEER unit, $600 incentive for a 15 SEER unit, and $700 for a 16 SEER unit. The program will install new units at a minimum of 14.5 SEER, with no maximum age for a functioning unit.

- **Xcel Energy, Colorado High Efficiency AC Program** – Xcel operates a "Trade-In Rebate" (early replacement) within its High Efficiency Air Conditioning Program suite. To qualify, an old CAC unit must have a SEER level of 12 or less, and either be functioning or need less than $750 of repair. The new unit must be at least 14 SEER.

SCE's Experience with CAC ER Programs

During the 2004-2005 program cycle, SCE offered an early replacement program through the third-party implemented Innovative Designs for Energy Efficiency Activities (IDEEA) program. The ER program, titled "AC Energy Hog Roundup," was promoted exclusively in Climate Zone 15 (a low desert climate, with resulting high cooling demands) and targeted the replacement of inefficient residential central air conditioners before their useful life ended. This program was met with limited success, replacing 183 units, which was short of its stated goal of 244 units. The evaluation (Quantec 2007) of this program highlighted a number of issues with the program including a high level of free-ridership, lack of customer participation due to financial constraints, and unreliable screening of equipment eligibility based on field measured EER.

Based on what was learned from the 2004-2005 program, SCE launched another third-party residential early replacement program in 2006-2008. This program estimated nameplate EER based on equipment vintage and set program qualifying value limits for both existing CAC EER (≤ 10), and replacement EER (≥ 12). The evaluation of this program concluded that ex post savings fell short of ex ante estimates based on technical calculation discrepancies.

Ultimately, after several years of offering such programs, SCE suspended its early replacement offerings due to lack of customer participation and focused its attention on quality installation for equipment replaced on burnout.

Explanation of SCE's CAC ER Viability Assessment

The principal data source that informs this paper is a 2011 report created by Energy Market Innovations, Inc. (EMI) on behalf of Southern California Edison (SCE), which explored

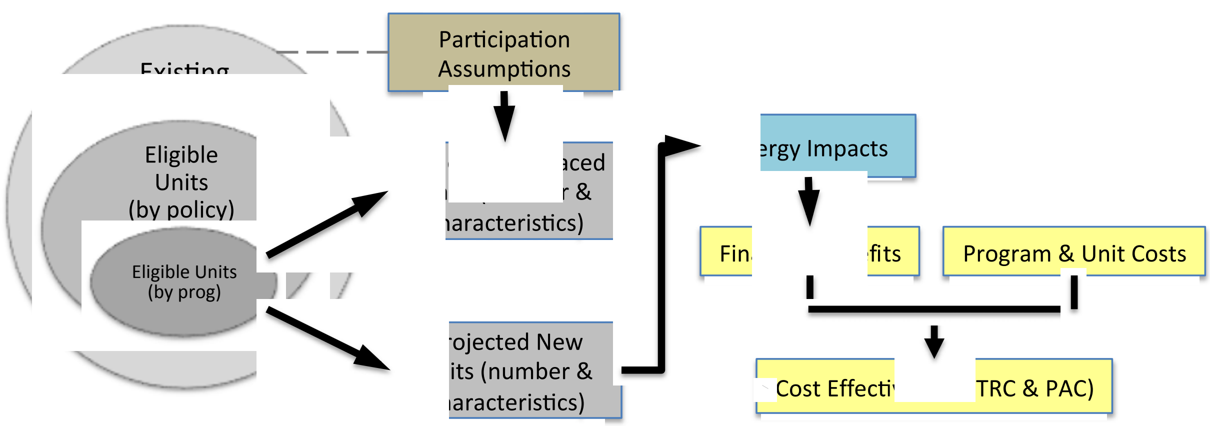
[3] The Energy Efficiency Ratio (EER) of a particular air conditioner is the ratio of output cooling (Btu/hr) to input electrical power (watts) at a given condition—usually a 95F outside temperature and an inside temperature of 80F and 50% relative humidity.

the viability of a Residential Central Air Conditioner (CAC) Early Replacement (ER) program in a disciplined and thorough way. During the project, EMI referenced CPUC policy decisions, the best available industry literature, and other ER programs. The crux of the project focused on inputting this research data into an Excel-based Monte Carlo simulation model that supported an examination of multiple program design scenarios and variable sensitivities. This model provides a conceptual representation of a prospective CAC ER program and is described below.

Model Overview

EMI's CAC ER viability assessment relies on a computer model that employs an econometric framework to evaluate key outcomes. At its core, the assessment is performed by cost-benefit analysis that incorporates assumptions from the best available input data and calculation methods—including those for program participation, unit technical attributes, energy and demand impacts, and financial impacts. The "ER Viability Assessment Model" employs the general structure shown in Figure 1 below, the elements of which are explained later in this section. This model works both with common static values, but also has dynamic simulation functionality (Monte Carlo analysis, driven in this case by Oracle's Crystal Ball® software program). This analysis shows program planners not just one result, but a weighted range of potential possibilities.

Figure 1. ER Viability Assessment Model Structure



EMI (2011). "Residential Central Air Conditioner Early Replacement Program Viability Assessment."

Eligible CAC Population. EMI constructed a profile of the CAC market to offer a modeled approximation of the existing population of units, from which eligibility and participation numbers are drawn. This population profile was derived from the California Statewide Residential Lighting and Appliance Efficiency Saturation Study (CLASS; RLW Analytics 2005), California Residential Appliance Saturation Study (RASS; KEMA 2010), and Weibull survival functions[4] fit to a CAC unit. From the territory population approximation, subsets of eligible units were identified by policy (e.g., existing unit age), program (e.g., min SEER of new units), and geographic (e.g., climate zone) constraints. These factors restrict eligibility for ER to a relatively small subset of the population so that the maximum energy impacts can be achieved.

[4] Weibull Survival Function – A continuous probability distribution that gives a distribution of failure rate over time.

See **Figure 2** below for a graphical depiction of which parts of the estimated CAC unit population might be targeted for a potential ER program (vs. a potential standard equipment rebate program or quality maintenance program).

Figure 2. Approximate Population of CAC Units in SCE Territory, Highlighted by the Potential Programs that Could Best Serve Them

			SEER Distribution												
Year Installed		Age	4	5	6	7	8	9	10	11	12	13	14	15	16
1976	176	36	14	28	15	74	24	11	12						
1977	277	35	21	44	23	116	37	17	19						
1978	442	34	34	69	37	185	59	26	30						
1979	604	33	47	95	50	253	81	36	41						
1980	699	32	54	110	58	293	94	42	47						
1981	1,048	31	81	165	87	440	141	63	71						
1982	1,120	30		87	176	93	470	150	67	76					
1983	2,144	29		167	337	178	899	288	128	145					
1984	3,565	28		277	561	297	1,495	479	213	242					
1985	4,371	27		340	688	364	1,833	587	262	296					
1986	6,059	26		471	954	504	2,542	814	363	411					
1987	8,921	25		693	1,404	743	3,743	1,199	534	605					
1988	11,752	24			913	1,849	978	4,930	1,579	703	796				
1989	16,117	23			1,252	2,536	1,341	6,761	2,166	965	1,092				
1990	16,045	22			1,246	2,525	1,335	6,731	2,156	961	1,087				
1991	20,572	21			1,598	3,237	1,712	8,630	2,764	1,231	1,394				
1992	23,287	20				1,809	3,665	1,938	9,769	3,129	1,394	1,578			
1993	30,251	19							18,621	5,964	2,657	3,008			
1994	43,837	18							26,984	8,643	3,851	4,359			
1995	52,896	17							32,560	10,429	4,646	5,260			
1996	67,831	16							41,754	13,373	5,958	6,746			
1997	70,911	15							43,650	13,981	6,229	7,052			
1998	95,143	14							58,566	18,758	8,357	9,462			
1999	113,409	13							69,809	22,360	9,962	11,278			
2000	123,301	12							75,898	24,310	10,831	12,262			
2001	122,716	11							13,356	67,317	21,561	9,606	10,876		
2002	146,326	10							15,925	80,269	25,710	11,455	12,968		
2003	152,402	9							16,586	83,602	26,777	11,930	13,506		
2004	171,454	8							105,539	33,804	15,061	17,051			
2005	213,817	7							23,270	117,292	37,568	16,738	18,949		
2006	227,445	6										116,643	51,968	58,834	
2007	239,960	5										147,708	47,310	21,078	23,863
2008	251,213	4										154,635	49,529	22,067	24,982
2009	261,111	3										160,728	51,480	22,936	25,967
2010	269,632	2										165,973	53,160	23,685	26,814
2011	276,844	1										170,412	54,582	24,318	27,531
2012	282,968	0										174,182	55,790	24,856	28,140
			252	2,544	9,399	15,497	20,450	32,702	562,738	508,865	184,933	1,218,066	420,119	197,775	157,297
			0.01%	0.08%	0.28%	0.47%	0.61%	0.98%	16.90%	15.28%	5.55%	36.57%	12.61%	5.94%	4.72%

Standard Rebate (after burnout)

ER

QM

EMI (2011). "Residential Central Air Conditioner Early Replacement Program Viability Assessment."

Participation Rate. In parallel, EMI estimated likely participation rates as a function of installed unit costs, based on assumptions derived directly from a variety of secondary sources (e.g., Nadel & Geller 1996, Mosenthal 1999, Datta & Gulati 2009). The number of customers qualified and likely to participate was estimated from the population estimates discussed above, as were the average characteristics (age and efficiency level) of outgoing units and incoming units impacted by the program. Standard free-ridership assumptions were integrated into the model, devaluing participation at the financial impact level.

Energy Impacts. Market and participation information are required to calculate the difference in annual energy use between old units and new units (over the appropriate measure period). Energy (kWh) and demand (kW) impacts of existing and proposed CAC systems were drawn directly from the 2008 version of the Database for Energy-Efficient Resources (DEER 2008), which at the time of the report was California's standard source of deemed savings by efficiency measure for all IOU energy efficiency programs in the state. The database has since been updated to a new version, but the impact assumptions do not affect the outcome of the analysis.

Financial Impacts. From energy and demand impact values, financial benefits were calculated using tables from the E3 Calculator (Energy & Environmental Economics, Inc. 2011). IOU planners use this Excel-based tool to determine the dollar value of avoided energy costs (generation, transmission and distribution) and environmental impacts (CO_2).

In the model, EMI weighed financial benefits against costs to both SCE and customer participants to determine program cost-effectiveness. The process of estimating the benefits is straightforward, using the tools described above per SCE's program planning norms. The process of estimating program and participant costs was more challenging. Accurate determination of participants' CAC system installed costs was difficult because of the absence of centralized information sources and due to competition-driven secrecy within the upstream and midstream HVAC industry organizations that establish equipment retail prices and installation costs. The inclusion of ER program participant costs into the Total Resource Cost (TRC) tests was complicated due to the calculation of "incremental" costs applied to the new unit per CPUC guidelines (CPUC 2008). This method accounts for the present value of units that would have been purchased naturally at the end of the current unit's life.

The final element of the conceptual program schema is the "cost test" bottom lines: the TRC and Program Administrator Cost (PAC) ratios (Eto et al. 1995). Both ratios use the same numerator, the financial benefits from the deferred energy use and demand. Their denominators are different, however—the TRC includes both program costs and incremental participant costs, while the PAC includes only program costs (incentive payments do not cancel out in the PAC test as they do in the TRC test). Both cost tests are widely applied metrics of utility program cost-effectiveness. When they are over 1.0 (i.e., when the benefits outweigh the costs), the program is nominally cost-effective.

Table 1 displays the decision parameters that program planners can change in the CAC ER viability model. The values contained in the yellow cells of **Table 1** represent the "base case" set of parameters that EMI established based on common designs of other programs. This paper does not explain the subtleties of each variable due to space constraints, but its authors encourage interested readers to get in contact for a copy of the report.[5] There are a few design elements we will note here: 1) the period being modeled is 2013-2014, which is the new California IOU extension period for the 2010-2012 program cycle.[6] 2) Old units can only be 10-12 SEER given a) that the current code is 13 SEER, b) the 1992-2006 code was 10 SEER, and California policy will not allow units over their prescribed effective useful lives (EUL)—15 years—to be replaced *early*. 3) New units can be 14-19 SEER. As SEER rises, energy efficiency increases, but so does average unit cost, which keeps gains in cost effectiveness very modest.

[5] *Contact information to be provided in final report.*

[6] EMI updated its modeling to account for the new program cycle, but left other modeling assumptions unchanged from the original 2011 report.

Table 1. Program Parameter Cells in ER Viability Assessment Model

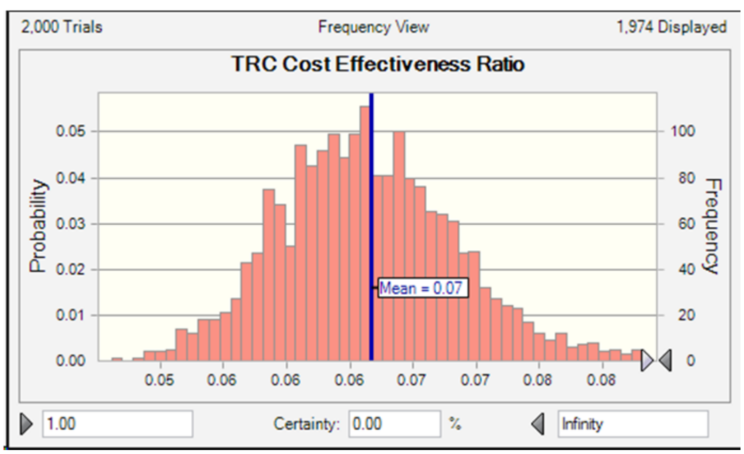
SCE Decisions						
Program Years: [pulldown menu]	**Customer Incentive Amount:** [$100-1,000]	**Max SEER for Replaced Units, 2013-2014:** [10-12]	**Min SEER for New Units, 2013-2014:** [13-19]	**Max SEER for Replaced Units, 2015-2020:** [10-13]	**Min SEER for New Units, 2015-2020:** [14-19]	**SEER Dist. of New Units:** [1] Basic [2] QI prog. shape
Prog Cycle 1 (2013-2014)	$700	10	15	13	17	1
Policy-Involved Decisions					**Manufacturer-Involved Decisions**	
Acceleration Measure Life: [pulldown menu]	**Replaced Unit Age Minimum:** [1-7]	**Replaced Unit Age Maximum:** [8-15]	**SEER Corr. Factor:** [1] Exclude [2] Include		**DR Factor:** [1] Exclude [2] Include	**Installed Unit Cost Reduct:** [Percent Reduction]
Basic DEER (5 Years)	5	15	2		1	0.0%

EMI (2011). "Residential Central Air Conditioner Early Replacement Program Viability Assessment."

Model Results

After significant analysis, the report determined that a prospective CAC ER program in SCE's territory would *not* be viable with a mass-market approach. This is less a testament to technical, market or programmatic barriers, than to the economic constraints prescribed by the California policy framework. Specifically, the Total Resource Cost (TRC) cost-effectiveness ratio in Monte Carlo modeling very rarely achieved over—much less approached—a 1.0 value (with 90% level of confidence), meaning that, in most scenarios, the cost of implementing the program was greater than the benefits. A path to viability would not be easy, but could include dramatically reducing participant costs or engaging in other novel approaches discussed later in this paper. It is unclear how willing efficiency programs would be to accept a program TRC of less than 1.0 since such decisions may often be made at the portfolio-wide strategic planning level.

Figure 3. Sample TRC Results based on Modeled Monte Carlo Simulations



EMI (2011). "Residential Central Air Conditioner Early Replacement Program Viability Assessment."

Utilizing the model, EMI identified five primary program scenarios during the assessment project. Attaining a TRC ratio above 1.0 is by far the most limiting factor of a prospective ER program, since there are a number of scenarios where the PAC is greater than 1.0, participant numbers are high, and kWh and kW savings projections are impressive. While SCE's tolerance for a non-cost-effective program is not clear, SCE staff indicate that the portfolio *may* accept around a 0.85 program TRC.

The five scenarios represent distinct sets of assumed program design options, summarized in Table 2. Note that results displayed show the mean values of Monte Carlo result ranges.

Table 2. Five Modeled Scenarios Modeled in EMI's ER Viability Assessment Model

Estimated Average Outcomes	1. Base Case	2. SCE Design Maximizing	3. SCE Design Maximizing Plus Policy Changes	4. SCE Design Maximizing Plus Manuf. Cooperation	5. Full Optimization with CZ 15
Climate Zones	All SCE	All SCE	All SCE	All SCE	CZ 15 only
TRC Ratio	0.16	0.08-0.18	0.20	1.09	1.35
PAC Ratio	0.77	1.16	1.46	1.63	2.10
kWh Impact	185 million	100-195 million	143 million	382 million	19 million
kW Impact	30,000	23,000–31,000	23,000	188,000	6,500
Participants	33,000	20,000–25,000	26,000	94,000	3,000
Program Cost	$25 million	$10-18 million	$11 million	$39 million	$1 million
Manuf. Unit Cost Reduction	0%	0%	0%	48%	43%

EMI (2011). "Residential Central Air Conditioner Early Replacement Program Viability Assessment."

Each of the scenarios represented above is briefly explained below:

1. **"Base Case"** – The basic set of parameters, as suggested by research of osher ER programs. Its parameters are shown in Table 1 above. Like with the next two cases, TRC levels do not approach 1.0.

2. **"SCE Design Maximizing"** – This is similar to the base case scenario, but SCE optimizes the TRC ratio by changing only the parameters over which it has full control. This amounts to an incentive level of approximately $400 and a new unit minimum SEER of 14. Other parameters (such as minimum unit age for replacement) have little impact on TRC.

3. **"SCE Design Maximizing Plus Policy Changes"** – SCE optimizes its own parameters (summarized in #2 above) and engages in policy conversations that hypothetically change additional parameters influenced by the regulator. This includes the parameters from the previous scenario, but changes the calculation of ER "measure life" to be consistent with a "survival function"[7] related to the outgoing unit as opposed to a more basic alternative (i.e., five years no matter the age of the outgoing unit). This measure life design element sets the acceptable age of old units, which provides more favorability with respect to modeled energy impacts. With a survival function, roughly 47% of units are forecasted to live beyond 15 years. The same analysis estimates that 23% of units will live longer than 20 years and that 2% will be functioning after 30 years. The application of a survival function would likely require the CPUC's approval even though DEER has posted a paper acknowledging the approach (Welch and Rogers 2010).

[7] A survival function is a continuous probability distribution that depicts device failure rate over time (in addition to other phenomenon within many other disciplines).

4. **"SCE Design Maximizing Plus Manufacturer Cooperation"** – SCE optimizes its own parameters (as in Scenario 3) and teams with manufacturers to bring other parameters into play. The key variable in this scenario is the cost of CAC units. Program planners can model scenarios where one or more HVAC manufacturing companies would partner with SCE to offer program participants a guaranteed number of units at significantly discounted prices. Such collaboration is not out of the realm of possibility according to some industry experts, especially in a post-recessionary era. Lower participant costs decrease the denominator of the TRC ratio and therefore increase the modeled program cost effectiveness. The magnitude of manufacturer discount that would be required to achieve a TRC over 1.0 (with 90% confidence), however, seems prohibitive. The scenarios that project a TRC over 1.0 (with 90% confidence) are Scenarios 4 and 5, but this is contingent on manufacturers reducing their upstream price by 48% and 41%, respectively. With an estimated average manufacturer profit margin of 32% (DOE 2011), this seems very unlikely. The other factor that manufacturers may be able to provide is demand response functionality within eligible new units; however, demand response functionality showed relatively minor impact on the TRC based on basic modeling terms.[8]

5. **"Full Maximization in CZ 15"** – In this scenario, SCE, the CPUC, and manufacturers cooperate to create a viable program by optimizing their respective parameters in a coordinated effort. This includes a combination of scenarios #3 and #4, but centers on SCE implementing the program only in its hottest climate zone (CZ 15, low desert), which would deliver the most per-unit energy impacts. Still, the level of manufacturer discount needed (43%) to make the program viable seems unrealistic.

Conclusion & Recommendations

A central air conditioner early replacement program has the potential to deliver substantial energy savings and demand reductions, but if program planners stay true to their governing policies, it seems unlikely that such a program would be viable—particularly in California. As discussed in this paper, modeling with realistic assumptions suggests that such a program involves costs that far outweigh benefits.

In fact, most California utility HVAC programs today—both those focused on high efficiency equipment and superior service (e.g., quality installation, quality maintenance)—experience cost-effectiveness challenges due to high initial costs.[9] This underscores general concerns about the future of all HVAC energy efficiency programs, not just those that focus on early replacement.

Below, we highlight four diverse strategies that planners may want to consider if they still want to pursue a CAC ER program and as they look to the future of all HVAC programs. California's "Big and Bold" goals (CEESP 2011) and those in many other jurisdiction around the country seem to necessitate this kind of innovative thinking. These big picture reflections can provide the basis for a targeted strategic planning effort to help all industry stakeholders achieve

[8] At the time of EMI's report, the methodology for integrating EE and DR measures and programs was not complete.

[9] Based on interviews with SCE program planners.

their goals—this includes IOUs, state policymakers, upstream industry organizations, midstream industry organizations, program participants, and ratepayers.

A Measurement Approach to ER Savings

There is a wide discrepancy in a number of the usage estimates that California IOU planners employ, which introduces uncertainty into the calculation of ER program viability. For example, certain time-based variables like CAC run-time estimates (effective full-load hours, EFLH), the *true* longevity of CAC units, and how to treat remaining useful life (RUL) in ER calculations, each have multiple methods for calculation. A measurement approach to savings is the one way to effectively resolve these uncertainties. Smart meter technology will enable such measurements when fully deployed and will in turn lead to improved projected energy and financial impacts.

TRC Test Limitations

The inability for an SCE ER program to reasonably pass the TRC test is common to other attractive large appliance and "comprehensive" energy efficiency programs around the country. Many prospective programs regularly pass PAC (Program Administrator Cost Test, otherwise known as the Utility Cost Test, UCT) ratio cost-effectiveness tests, meaning that utilities themselves are getting their money's worth and are in the ballpark to compare alongside supply-side resources. Not to mention that many of these programs carry a host of utility (e.g., energy savings and customer satisfaction) and social benefits (e.g., carbon reduction, lower pollutions levels, and job creation).

This has led a number of industry professionals to question the wisdom of the TRC test as the best metric to assess programmatic viability (Neme and Kushler 2011). Instead of allowing IOUs to leverage the financial contribution of customers, the TRC test penalizes customers' willingness to invest in EE (LaBaron 2011). A key argument states that the TRC test is unduly strict because it must demonstrate that a demand-side management (DSM) program does not levy a net cost to society while supply-side resources—including renewables programs—are not subjected to this (they are simply weighed against the cost of other energy sources).

While this debate is too large to fully cover here, we recommend that utility planners and public utility commissions continue to discuss the merits of judging certain high impact programs—such as a prospective ER program—that have considerable customer support by different criteria.

Full DSM Program Integration

The complete value of demand and energy impacts for HVAC programs should be determined in order to know how much effort utilities are able to put into HVAC. This will require merging DR and EE policies to address the technical possibilities already in existence. In addition to HVAC's advantageous natural correspondence with peak loads, advanced DR capabilities can offer further opportunities. This would likely involve a control device with Zigbee Standard 2.0 technology that adjusts CAC operation based on communication signals either to a thermostat, energy management system, or directly to a smart meter. In any of these situations, CAC units would act as smart grid "enabling devices." The value of this integration to a prospective ER program needs to be researched further.

Target Capacity Constraints

In a similar vein, utilities would be well served to explore demand response that is purposefully targeted to account for the most highly grid-constrained areas within their territories. This would require better integration with the supply and distribution divisions of the utility, but would offer specific business benefits when weighed against the cost to build new distribution circuits.

Other projects have been successfully focusing on grid-constrained areas. For example, Glendale Water & Power launched an ice storage project in 2010, which shifts cooling loads by freezing water during off-peak hours and using the ice as a source of cooling during peak hours—it is also an example of projects/programs where a number of different entities contribute to make DSM programs work (IceEnergy 2010). Even though a prospective ER program is conceptually quite different, the strategy of a highly targeted approach could make economic sense. The non-mass market aspect of such a program would introduce implementational challenges, but this barrier can be solved through targeted marketing and operational efforts.

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