A Tale of Two Programs: An Analysis of Residential Early Retirement HVAC Programs

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ABSTRACT

As utilities move from low-hanging to harder-to-reach savings, an early retirement HVAC program may be a viable and needed option. Such programs, however, have not been widely implemented; therefore, evaluation results and literature demonstrating overall effectiveness and program design considerations have not been widely available. In this paper, we identify a few key considerations for designing an early retirement HVAC program.

We found that how a program defines early retirement impacts the measure and overall program savings. It is also critical to understand how different definitions impact overall program characteristics for planning purposes. Simpler definitions not requiring minimum SEER requirements appear to retire older, more efficient units than those imposing a SEER requirement. An early retirement program may or may not pass all or some of the various cost-effectiveness tests. Utilities and implementers should investigate ways to include other measures, or combine appliance and HVAC programs into a single, equipment-type program. Finally, HVAC contractors provide a main, driving force for these program designs.

Introduction

In this paper, we identify a few of the key considerations for designing an early retirement HVAC program. Specifically, we outline general program and equipment characteristics, ways to define what equipment is classified as early retirement, and cost-effectiveness considerations. We use primary data gathered in two residential early retirement HVAC evaluations: Dayton Power and Light (DP&L) Residential HVAC Rebate Program, and the Ameren Illinois' Heating and Cooling Equipment Program. Both utilities offer incentives for a wide range of equipment measures, from central air conditioners to mini-split heat pumps. This paper focuses on electric equipment only, and specifically, two measure groups: central air conditioners (CAC), and air source heat pumps (HP).

HVAC Early Replacement Overview

A typical residential HVAC program targets homeowners in the market for new air conditioners or heat pumps. The standard approach for calculating residential HVAC measure savings has been to determine the delta between the baseline unit (typically Federal or State standards) and the high-efficiency equipment installed. This difference represents savings that can be claimed by the sponsoring utility. The logic behind this method being the homeowner was going to replace their old unit due to pending circumstances (e.g., the unit failed) and has been presented with two options. Option one is to go with a unit meeting minimum-required standards, and option two is to choose a unit that exceeds those standards.

An early retirement program targets homeowners not in the market for new equipment, informing them of the value of early retirement. This value derives from installing higher-efficiency

equipment at present, circumventing immediate and imminent repair costs, and leveraging the utility incentive. An early retirement program also targets contractors, utilizing early retirement as an option when confronting a repairable system. The contractor can offer a logical sales proposition, such as: "Pay me $4,000 net of rebate for a brand new system, or pour another $1,000 for a repair into this old, inefficient system that will break down again in couple of years." The key difference between early retirement and standard program design shifts the homeowners' decision to retire their inefficient, working HVAC equipment forward in time. Rather than waiting several years until a unit has a catastrophic failure, the homeowner moves their investment to the present.

Two key program drivers are used to motivate homeowners to realize the advantages of immediate action: a tiered incentive structure; and developing well-trained contractors to provide homeowners with the necessary information to make a potentially large financial decision. Both DP&L and Ameren Illinois have set their early replacement incentives at $600 per unit, an enticing step up from the lower tier, which ranges from $110 to $300, depending on the measure and utility.

So why should a utility pay more for retiring old, working equipment? Primarily, early retirement can generate savings above those of a standard HVAC program. By design, the program shifts a central air-conditioner or heat pump purchase forward in time—given the existing unit still works and presumably has multiple years of life remaining. This redefines the accepted saving calculation baseline. Instead of using a minimum-required efficiency level as the baseline, the baseline becomes the existing unit being replaced. This moves the baseline from, for example, a seasonal energy-efficiency ratio (SEER) 13 central air-conditioner to a SEER 9, or some efficiency level below minimum requirements. Such differences can achieve substantial savings.

For example, SEER 14/15 central air conditioner savings, based on the standard calculation, generates 216 kWh in DP&L's service area. However, a working, inefficient central air-conditioner, retired before it fails, can generate 1,210 annual kWh, which can be claimed by the utility program. Similarly, peak demand savings for a new, high-efficiency central air conditioner, compared to the existing unit cited above, also increase. Other reasons for including early retirement measures in a program portfolio may be the utility seeks deeper changes in the market, or this marks the next generation in a long-running program.

Program Energy Saving Achievements

Just a few years ago (in spring 2009), DP&L and Ameren Illinois launched their residential HVAC programs. DP&L serves approximately 450,000 customers, and Ameren Illinois serves 1.23 million customers. DP&L is an electric only utility, while Ameren Illinois also provides natural gas service. Ameren Illinois, as a natural gas provider, offers incentives for gas furnaces. Conservation Services Group (CSG) serves as the program implementation contractor for both utilities. Both programs offered incentives for early and replace on failure units. In 2010, the DP&L program total realized gross savings of 9,400 MWh, and Ameren Illinois total realized gross savings of 10,489 MWh. The similarity in realized savings, despite very different market sizes, begs an explanation.

For the DP&L program, CSG launched a single HVAC equipment program into a market concentrated around a single, relatively large geographic area. The task was very focused, both geographically and programmatically, and benefitted from the concentrated efforts of all parties involved: DP&L, CSG, and HVAC contractors. In contrast, the Ameren Illinois contract included launching multiple programs simultaneously across a wide geographic area with multiple population centers. These programs included lighting, appliance recycling, appliance rebates, low-income gas, HVAC, and demand response. To this end, it is not surprising, given the demands of launching multiple programs simultaneously that balancing staff resources for any single program would be impacted by the larger priority of delivering multiple programs.

Defining Early Retirement

While the compared programs were similar, a fundamental difference occurred in how each utility defined early retirement. DP&L required existing equipment be in working order, regardless of age, or be less than or equal to 20 years old and repairable for less than $1,000. Ameren Illinois required units be in working order, and the existing unit SEER to be 10.0 or lower. In both instances, HVAC contractors captured existing equipment characteristics, and CSG had final authority to determine what would be considered early retirement. An Internet search for other early retirement programs indicated these two definitions have been utilized in other programs across the country, although SEER level requirements ranged from 8 to 12. All units must be in working condition.

Early retirement measures comprised the majority of each utilities' measure mix (Table 1). Early retirement measures also represented almost all DP&L program savings and 66 percent of Ameren Illinois savings.

Table 1. Early Retirement Equipment Participation and Savings

Utility	Early Retirement Participation (Percent of Total Program)	Early Retirement Realized Savings (Percent of Total Program)
DP&L	89%	94%
Ameren Illinois	77%	66%

As program requirements, participating HVAC contractors had to capture the year of the existing unit being replaced. These data could be collected for most units (Table 2). When combining measures into two groupings, average equipment age in the early retirement group was 21 years old for the Ameren Illinois program. However, the replace-on-burnout group average age was four years less (17 years old). Taking an average across early retirement and replace on burnout equipment vintages, DP&L were very similar, at 19 and 21, respectively.

Table 2. Average Age of Existing Equipment

Measure	Average Age of Existing Equipment	
	Ameren Illinois	DP&L
CAC – SEER 14/15 Early Retirement	22.0	20.5
CAC – SEER 16+ Early Retirement	21.9	20.4
Air Source HP – SEER 14/15 Early Retirement	20.7	18.2
Air Source HP – SEER 16+ Early Retirement	18.7	18.6
CAC – SEER 14/15 Replace on Burnout	18.1	22.7
CAC – SEER 16+ Replace on Burnout	17.0	25.0
Air Source HP – SEER 14/15 Replace on Burnout	16.0	17.7
Air Source HP – SEER 16+ Replace on Burnout	16.0	17.1

Differences in equipment average ages can be explained by reviewing how the utilities defined early retirement. The Ameren Illinois program required equipment with a SEER of 10.0 or less irrespective of age of the unit. This SEER rating corresponded to a 1992 Federal standard for cooling equipment manufacturers. It serves as another reason why younger unit ages did not qualify under the

early retirement category: if they were manufactured after 1992, they would have a higher SEER rating. DP&L's early retirement definition did not include a SEER requirement; therefore, it included younger vintages in both early retirement and replace-on-burnout groups.

As shown in Table 3, the average SEER of replaced units also differed between the two programs. Ameren Illinois' average early retirement and replace-on-burnout SEERs were 8.7 and 10.8. DP&L's early retirement and replace-on-burnout groups were very similar to each other, at 9.9 and 9.6. Again, these differences can be traced to the ways each program defines early retirement.

Table 3. Average Existing SEER Replaced

Measure	**Average Existing SEER Replaced**	
	Ameren Illinois	**DP&L**
CAC – SEER 14/15 Early Retirement	8.5	9.4
CAC – SEER 16+ Early Retirement	8.5	9.6
Air Source HP – SEER 14/15 Early Retirement	8.8	10.2
Air Source HP – SEER 16+ Early Retirement	8.9	10.2
CAC – SEER 14/15 Replace on Burnout	10.4	9.1
CAC – SEER 16+ Replace on Burnout	10.8	8.8
Air Source HP – SEER 14/15 Replace on Burnout	10.9	10.3
Air Source HP – SEER 16+ Replace on Burnout	11.1	10.2

As illustrated, the method for defining early retirement can impact measure mix between units that are retired early versus those considered replace on failure. While age is not explicitly part of any energy-saving calculation, it can help provide guidance as to expected SEER levels. To this end, understanding various SEER level changes resulting from early retirement definitions proves important in program planning.

No identified set industry standards or requirements determine how a utility defines early retirement. Nor are the methods used by DP&L or Ameren Illinois the right or wrong ways to define early retirement. Another method, not incorporated in either of these utility programs, is defining early retirement by age of existing units.

For instance, the recent draft Ohio Technical Reference Manual deems central air conditioners and heat pumps with an 18-year measure life. Using this definition, any unit older than 18 years would not be considered an early retirement. Any unit over 18 years would be considered replace-on-burnout. However, as shown, the way a program defines early retirement can impact the equipment considered and early retirement measure, and, ultimately, savings to be claimed. To investigate how various definitions impact measure and program savings, we used DP&L's 2010 program participation and measure level savings data. We only looked at DP&L program participation and savings to keep a like for like comparison. We analyzed the data as follows:

- By the current early retirement definition.
- Early retirement defined as units with a SEER 10.0 or less.
- Early retirement defined as units with SEER 11.0 or less.
- Early retirement defined as units 18 years or less.

After revising our early retirement definitions, we reran DP&L saving calculations using each definition.[1] We found measure-level savings increased when we defined early retirement by SEER and generally decreased when defined by age of existing units (Table 4). This varied by measure, but savings increased by as much as 20 percent in a couple instances and dropped by 9 percent in another instance.

Table 4. Average Annual kWh by Measure and Early Retirement Definition Scenarios for DP&L Program

Measure	**Average Annual kWh per Measure**							
	DP&L 2010 Current ER Definition	**n**	**SEER 10.0 or Less**	**n**	**SEER 11.0 or Less**	**n**	**18 yrs or under**	**n**
CAC – SEER 14/15 Early Retirement	1,210	351	1,276	287	1,265	301	1,097	174
CAC – SEER 16+ Early Retirement	1,342	140	1,370	122	1,359	129	1,261	56
Air Source HP – SEER 14/15 Early Retirement	3,482	146	3,544	97	3,544	100	3,313	83
Air Source HP – SEER 16+ Early Retirement	2,725*	60	3,257*	43	3,257*	43	2,790*	38
*Precision at 90% confidence was less than 20%								

By defining early retirement by SEER, measure level savings increase due to excluding newer and more efficient units from measure populations. Early retirement savings decreased when age is a requirement in all cases except for 16 plus SEER heat pumps. These new definitions shift measure level participation. For instance, when early retirement is defined as a working unit with a SEER 10.0 or less, existing units with higher SEERs no longer qualify, and are shifted to the replace-on-burnout category (Table 5).

Table 5. Participation Defined by Early Replacement Definition

Measure	**Participation**			
	DP&L 2010 Current ER Definition	**SEER 10.0 or Less**	**SEER 11.0 or Less**	**18 yrs or under**
CAC – SEER 14/15 Early Retirement	1,384	1,087	1,165	766
CAC – SEER 16+ Early Retirement	1,277	947	1,036	701
Air Source HP – SEER 14/15 Early Retirement	881	535	592	377
Air Source HP – SEER 16+ Early	513	308	339	222

[1] We used a participant billing analysis to calculate early retirement savings. This worked well for most measures; however the air source heat pump (SEER 16+) category had a small sample size and, therefore, a large error band (40 percent). This may explain why this measure realized lower savings in the over-19 years category.

Measure	Participation			
	DP&L 2010 Current ER Definition	SEER 10.0 or Less	SEER 11.0 or Less	18 yrs or under
Retirement				
CAC – SEER 14/15 Replace on Burnout	55	352	274	673
CAC – SEER 16+ Replace on Burnout	58	388	299	634
Air Source HP – SEER 14/15 Replace on Burnout	36	382	325	540
Air Source HP – SEER 16+ Replace on Burnout	27	232	201	318
Totals	**4,231**	**4,231**	**4,231**	**4,231**

However, shifting all participants who no longer qualify as early retirement participants to the replace-on-burnout category may overstate overall participation. The higher incentive, at least in part, was likely a reason for program participation. Therefore, participants no longer qualifying for the $600 incentive (just the $110 incentive) may well discontinue participation. Neither evaluation addressed this threshold; for this paper, we assumed the program would only retain 60 percent of these customers using the lower incentive amount. Participants were recategorized, and, where applicable, participation was discounted and savings recalculated, as shown in Table 6.

Table 6. DP&L Annual Savings by Different Early Replacement Definitions

Measure	Annual kWh			
	DP&L 2010 Current ER Definition	SEER 10.0 or Less	SEER 11.0 or Less	18 yrs or under
CAC – SEER 14/15 Early Retirement	1,674,640	1,387,012	1,474,006	840,302
CAC – SEER 16+ Early Retirement	1,713,734	1,297,390	1,408,413	883,961
Air Source HP – SEER 14/15 Early Retirement	3,067,642	1,896,040	2,097,794	1,249,001
Air Source HP – SEER 16+ Early Retirement	1,397,925	1,008,700	1,104,064	619,380
CAC – SEER 14/15 Replace on Burnout	11,857	45,531	35,442	87,052
CAC – SEER 16+ Replace on Burnout	27,022	108,461	83,582	177,227
Air Source HP – SEER 14/15 Replace on Burnout	41,967	267,190	227,321	377,703
Air Source HP – SEER 16+ Replace on Burnout	40,639	209,517	181,521	287,182
Totals	**7,975,426**	**6,219,840**	**6,612,142**	**4,521,808**
Average kWh per Participant	**1,885**	**1,686**	**1,744**	**1,344**

In this analysis, we found overall measure-level savings increased for early retirement measures, but total program savings decreased due to fewer participants qualifying for early retirement measures (where the greatest savings occurred). This impact level may not be the case for every utility scenario.

Many other drivers impact participation, such as how involved HVAC contractors are with a program, marketing efforts, freeridership, and current economic conditions.

Not only did different early retirement definitions impact savings, they also positively impacted program expenditures. Total incentives spent significantly decreased when SEER or age requirements were added. Total incentives decreased ranging from $334,000 to over $754,000 less than DP&L 2010 actual incentive expenditures. These cost savings may prove very important for programs strapped for cash, but they may be somewhat diminished when program administrative and marketing costs are leveraged over smaller savings results.

DP&L's current early retirement definition produced the highest level of program-level gross savings in this particular analysis. It also provided one of the simplest definitions for ensuring retired units fell within specific efficiency bounds, and, therefore, optimally offered the higher incentive.

Cost-Effectiveness

Are HVAC early retirement programs cost-effective? The answer: it depends on multiple factors, such as:

- What test does the program need to pass (i.e., the total resource or utility cost test)?
- Does each measure need to be cost-effective?
- How is overall portfolio cost-effectiveness evaluated?

If a program only has to pass the utility cost (UCT) test, it will likely be cost-effective. This is due to what inputs are used to calculate the UCT. The utility directly accrues costs and benefits valuation; therefore, this is measured by electric avoided costs, incentive costs, and administrative costs associated with the program.

However, if a program must pass the total resource cost (TRC) test, it may not be cost-effective. Again, this is due to elements evaluated in the test. The TRC valuation addresses a program's total resource benefits (measured by electric avoided costs) compared to total costs of acquiring savings (measured by total incremental costs of measures installed as well as administrative costs associated with the program). Another reason an early retirement program (or any other residential HVAC program, for that matter) does not pass the TRC test may be due to small program savings resulting from climate (reduced full-load runtimes) or participation. It is not uncommon to find central air-conditioner measures do not pass the TRC in many climates, due to the units' relatively low runtimes.

A key difference between UCT and TRC tests is the measure cost. Calculating incremental measure costs for an HVAC early retirement program differs from a typical replace-on-burnout program, as the program triggers customers to purchase energy-efficient equipment before they would naturally do so (which, presumably, would be on failure). Thus, the program shifts equipment costs to the present, which, otherwise, may have occurred several years later. The following example illustrates how incremental costs can be calculated for an early retirement program.

Assume a homeowner owns a 10-year old heat pump. Also assume heat pump's average measure life is 18 years. Finally, also assume the homeowner will purchase a high-efficiency unit when the existing one burns out (in eight years, for this example). The new unit's cost would be $4,000. If replacement occurs in eight years, that cost's present value would be:

$$(PV\ Equipment\ Cost) = \frac{\$4{,}000}{1.05^8} = \$2{,}707$$

However, if the customer purchases the new unit today, we shift costs to the present:

$$(Increase\ in\ PV\ Equipment\ Cost) = \$4{,}000 - \$2{,}707 = \$1{,}292$$

If the program design were built on replace-on-burnout, incremental costs would be the total cost of the energy-efficient unit, minus the cost of a standard SEER 13 (the measure baseline). Thus, the incremental cost is less for replace-on-burnout units. Early replacement measures, however, claim higher savings (at least in the first few years). Do these additional savings outweigh the inherent extra cost? For the DP&L program, the answer was no; the program did not pass the TRC.[2] However, the program passed the UCT and the participant cost test (PCT).

Looking closer at all DP&L program measure cost-effectiveness reveals early retirement measures not only did not pass the TRC, but replace-on-burnout measures, where incremental costs are considerably lower, failed as well. This implies, regardless of whether DP&L offered early retirement measures or just replace-on-burnout measures, the program would still not pass the TRC. This seemed odd, as almost every utility offering energy-efficiency programs has some form of residential HVAC measures included in their portfolios. Examination of other utility programs showed residential HVAC measures are typically bundled with other measures. By bundling residential HVAC measures, which may not be cost-effective by themselves, other cost-effective measures brought the overall program TRC to passing levels. For example, another program administered by CSG for Unisource provides higher equipment incentives when measures are combined with duct sealing. This better leverages program administration and marketing costs, reduces lost opportunities, and enhances comprehensiveness.

At the time of publishing this report, Ameren Illinois cost-effectiveness results were not made public. However, a recent report produced by the Energy Center of Wisconsin for Focus on Energy found early replacement of inefficient residential air conditioners in Wisconsin were not cost-effective for that climate. This study concluded that "the increased equipment cost must be offset by sufficient amounts of avoided utility energy and capacity costs" to be cost-effective. The authors of this report conclude that "residential central air conditioning units operate so few hours annually [in Wisconsin], and since new central air conditioning units are relatively expensive, the increased equipment costs becomes a prohibitive barrier."

Identifying and Enrolling HVAC Contractors

Program evaluation results for both utility programs illustrate participants primarily became aware of the program through their HVAC contractors or installer. Furthermore, in the DP&L evaluation, respondents who first learned about the program from a different source (other than their contractor) were asked if their contractor discussed the program with them: Ninety-one percent responded yes. Since contractors often shape the customer's first impression of the utility program, how did DP&L and Ameren determine how best to recruit and enroll contractors?

CSG approached both the Ameren and DP&L programs with an attitude that the most effective way to reach homeowners and to achieve favorable outcomes was through local HVAC contractors. HVAC contractors willing and able to deliver quality products and services at higher production volumes prove to be a high-value target for any successful program. Thus, the contractor recruitment process became a key, high priority. CSG's experience has also shown contractors recommended early in the program launch by equipment distributors, large retailers, and organizations such as Air Conditioning Contractors of America and The American Society of Heating, Refrigeration and Air-

[2] According to the ENERGY STAR central air-conditioning calculator, Dayton Ohio's full-load cooling hours are 947. Regions with higher full-load cooling hours may see increases in energy savings, and would likely have a different TRC ratio.

Conditioning Engineers will ultimately deliver more than 80 percent of the total program production volume.

Contractor recruitment focused on contractors with the highest ratings for quality, reputation, and production volume. The first step in procuring high-quality services was to communicate the program's value proposition to contractors identified through HVAC associations and local distributors. Additionally, larger home supply retailers in the region were interviewed to identify HVAC contractors with an exclusive relationship with big box retailers for sales and installation.

Following the initial contact, the programs implemented a community or regional approach to locate and capture HVAC contractors serving outlying portions of the utilities' service territory. Public outreach efforts, such as news releases and op-ed pieces provided by Ameren and DP&L, provided additional support to these remote recruitment activities by making contractors aware of and curious about the new program.

Finally, many smaller contractors became program participating allies due to the program's success. Grassroots demand created by the program's public outreach portion drove contractor participation in the program. The program's success and positive word-of-mouth within the contractor community served to attract additional contractors.

Conclusion

How a program defines early retirement impacts the measure and overall program savings. Specific definitions vary, even between the two utilities outlined in this paper, and a single, dominant definition does not appear to have been adopted by the energy-efficiency industry. It is also critical to understand how different definitions impact overall program characteristics for planning purposes. Simpler definitions not requiring minimum SEER requirements appear to retire newer, more efficient units than those imposing a SEER requirement.

An early retirement program may or may not pass all or some of the various cost-effectiveness tests. However, it is possible, depending on the utilities' geography; neither will a standard replace-on-burnout program for central air conditioners. Utilities and implementers should investigate ways to include other measures, or combine appliance and HVAC programs into a single, equipment-type program.

Finally, early retirement programs target a hard-to-reach market: those that do not have to immediately need to replace their HVAC systems. This design comes with a higher societal cost (both in the form of measure and incentive costs). However, as utilities begin to pick off lowing-hanging energy savings, programs beginning to achieve deeper savings levels, especially those providing significant coincident peak demand reduction, will be required. They also represent an opportunity to provide a service to customers that, it is hoped, impacts them positively and opens the door for more opportunities. To this end, early retirement programs may not need to be cost-effective in themselves, but should be reviewed in context with the overall portfolio's performance.

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