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Today's Best Opportunities for Improving Manufactured Homes Efficiency

By Katherine Dayem, Xergy Consulting

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NRECA
America's Electric Cooperatives

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SUBJECT MATTER EXPERTS ON THIS TOPIC

Adaora Ifebigh,
Project Manager R&D Engagements
NRECA Business and Technology Strategies
Adaora.Ifebigh@nreca.coop

Brian Sloboda,
NRECA Consumer Solutions Director
NRECA Business and Technology Strategies
Brian.Sloboda@nreca.coop

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ARTICLE SNAPSHOT

WHAT HAS CHANGED IN THE INDUSTRY?

Improving the efficiency of manufactured homes and providing savings for low- to moderate-income residents remains a priority for cooperatives. Recently, government agencies and electric industry stakeholders have considered the effectiveness of whole home replacements for inefficient manufactured homes as opposed to the more traditional energy-efficiency measures on the existing homes. To that end, zero-interest loans to utilities and non-profit groups have expanded to now include whole home replacement of manufactured homes. The question then follows: *"In what situations is manufactured home replacement more cost-effective than other efficiency improvements such as weatherization?"*

Our research showed that, in most cases, home replacement is not a cost-effective means to reduce energy bills. Costs of home replacement include not only the cost of the new home, but also site preparation, transportation, and shipping costs, which are too large to be offset by resulting energy savings. Replacement only makes sense for homes with structural damage or health and safety hazards. Even at that, the cost to purchase a new home may be cost-prohibitive for someone who has long paid off the cost of their current home. Weatherization measures, however, can be a cost-effective, short payback means to improve energy efficiency and reduce energy bills.

This paper provides an update on NRECA's prior reports on manufactured home weatherization opportunities, presents weatherization efforts undertaken by several co-ops, and explores funding mechanisms that can be used to implement these improvements.

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WHAT IS THE IMPACT ON COOPERATIVES?

About 20 million people live in 6.7 million manufactured homes across the United States (MHS 2017). These homes are disproportionally weighted to the rural areas of the country, and can comprise 25 percent or more of co-op residential building stock (Cody 2011). Although the purchase price of a manufactured home is considerably less than a stick-built home, energy bills of manufactured homes can be much higher, due to inefficient heating and cooling systems and building envelopes. Unfortunately, for those who live in manufactured homes because of their perceived affordability, high energy bills can cause major financial stress.

Co-ops are impacted by high manufactured home energy use. It can lead to increased frequency of high bill complaints, risk of non-payment, and decreased member satisfaction (Cody 2011). In addition, because most manufactured homes use electric space heating and air conditioning, inefficient HVAC systems and building envelopes drive up load and contribute significantly to co-op demand peaks (Cody 2011). Co-ops that identify and assist members with energy improvements, therefore, can not only improve the manufactured homeowner's living situation, but also reduce electricity bills of their entire membership by reducing peak demand costs.

WHAT DO COOPERATIVES NEED TO KNOW OR DO ABOUT IT?

Co-ops can help their members access funding for energy reduction strategies that reduce electricity consumption and pay for themselves in a few years or less. To defer the initial cost of these strategies, co-ops can leverage low and zero interest loans, like the U.S. Department of Agriculture's (USDA) Rural Energy Savings Program (RESP), rebates, and other funding.

On-bill financing (OBF) can be used to recoup payment for the loans, especially if the post-measure cost of the loan and electricity is less than what the member was previously paying for electricity on a monthly basis. Co-ops can encourage efficiency in new homes as well, by promoting, rebating, or financing efficient heat pump HVAC systems or ENERGY STAR homes. In all cases, it is important for co-ops to remain particularly sensitive to helping members save money on a monthly and total basis, and make sure that they are not making the financial situation worse for a potentially vulnerable member.

As part of NRECA's ***Advancing Energy Access for All*** initiative, NRECA intends to explore and research ways to develop a collective, cooperative effort to improve manufactured home energy efficiency on a large scale at co-ops across the country. A goal of this effort would be to help co-ops share and expand on their collective experiences, allowing them to identify successful approaches, lessons learned, and knowledge gaps. By sharing this information widely, co-ops would have access to a broad range of information and resources to help make their programs successful.

As we discuss in this article, many co-ops have identified opportunities to improve manufactured home efficiency and positively impact the financial situation of low- to moderate-income members. Many of these opportunities are "low hanging fruit"—they are low cost, tried-and-true energy savings measures. In fact, the biggest challenge many of these co-ops face is reaching and engaging with members who are most in need of energy efficiency improvements. Although many in the efficiency community perceive commercial and multifamily efficiency measures as delivering the most energy savings for the least investment, manufactured home improvements have the potential to deliver similar results, especially if co-ops are able to share and build on their collective efforts.

Energy Reduction Strategies for Manufactured Homes

Replacing inefficient space conditioning components with a central or mini-split heat pump system has large energy savings potential.

Improving energy efficiency in manufactured homes is important to co-ops, especially those serving a large proportion of manufactured homes. Seventy-four percent (74%) of co-ops surveyed for the NRECA 2011 Manufactured Housing Survey said improving energy efficiency of manufactured homes is important or extremely important (Cody 2011). Fortunately, a variety of energy reduction strategies are available for existing homes, and a subset of these can be applied to new or replacement homes. These strategies are discussed below and summarized in Table 1.

TABLE 1: Energy reduction strategies for existing and new or replacement manufactured homes

Area of Improvement	Existing Home	New or Replacement Home
HVAC System	• Replace existing HVAC with heat pump (central or ductless) • Repair ductwork, especially crossover duct	• Install heat pump (central or ductless) HVAC system
Building Envelope	• Improve underbelly insulation and moisture barrier, protect against future damage • Air seal marriage joint(s), windows, doors • Improve attic insulation	• Promote ENERGY STAR qualified or other efficient homes.

EXISTING HOMES

Improving insulation and moisture barriers underneath the home is often the primary focus of manufactured home weatherization.

Existing manufactured homes present unique opportunities for energy savings improvements, which can be different from strategies typically used for stick-built homes. These strategies generally have low upfront costs, short payback periods, and meaningful electric bill reductions. They include: HVAC system improvements, insulation and moisture barrier improvements, and air sealing. More costly improvements, such as upgrading windows, are generally not viable for manufactured homes, as improvement costs can quickly approach the value of the structure itself.

HVAC System Improvements

HVAC improvements include replacing inefficient furnaces and air conditioning equipment with heat pump units, and repairing duct work. A large proportion of manufactured homes use electric resistance furnaces and window or room air conditioning (EIA 2013). Replacing these inefficient space conditioning components with a central or mini-split heat pump system has large energy savings potential.

Ducts in existing manufactured homes are often another source of inefficiency. The ducts are usually underneath the home, and are often constructed of flimsy material that can be damaged by animals or weather, or simply fall apart with age. In particular, the crossover duct, which connects sections of multi-section homes like double-wides, is a common source of air leakage in the ductwork. Repairing and sealing ductwork ensures that the conditioned air is delivered into the home, rather than being pumped out beneath the home.

Mini-split, or ductless, heat pumps do away with the duct issue altogether, since they move heat between paired indoor and outdoor units connected by a short run of conduit rather than through a duct system. Ductless systems can be sized to replace the central system entirely or to save cost; or can be slightly undersized and used to offset a majority of the existing central system's load.

Building Envelope Improvements

Typical manufactured home building envelope improvements include:

- Upgrading insulation to reduce heat transfer between the home and the outdoors,
- Air sealing windows and doors to reduce air transfer between the home and the outdoors (e.g., drafts into the home and the loss of conditioned air out of the home), and
- Installing a moisture barrier to reduce moisture damage and mold development.

These improvements are typically carried out to varying degrees below, around, and above the home's conditioned space.

Improving insulation and moisture barriers underneath the home is often the primary focus of manufactured home weatherization. As noted earlier, insulation and moisture barriers underneath the home can be damaged if not secured with skirting or a foundation (**Figure 1**). Upgrading or replacing insulation in the floors and adding moisture barriers reduces heat transfer from the home to the

FIGURE 1: Manufactured homes may be sited on permanent foundations (left) or on blocks with protective skirting (right). Photos courtesy of Buckeye Power

outside, and reduces moisture damage and mold growth. Then once the improvements are complete, the underbelly must be secured with protective skirting, if the home does not sit on a permanent foundation, to prevent new damage and ensure the improvements last.

Manufactured homes are often leaky, especially at the marriage joint between sections and around windows and doors.

Manufactured homes are often leaky, especially at the marriage joint between sections and around windows and doors. Loss of conditioned air from the home to the outdoors leads to increased heating and cooling loads, and decreased comfort due to draftiness. Air sealing improvements often involve an initial blower door test to assess pre-measure performance; air sealing marriage joints, doors, and windows; and confirming improvements with a post-measure blower door test.

Finally, manufactured home attics are often found to lack insulation. Adding insulation, especially when the roof is being repaired or replaced at the same time, can be another cost-effective improvement that helps keep heat inside the home in the winter and outside in the summer.

Even in new homes, significant HVAC savings can be realized by upgrading to a heat pump system.

NEW HOMES

New homes can also benefit from energy reduction measures. Home construction has improved greatly since the implementation of the Housing and Urban Development (HUD) building standards (the HUD code) in 1976, subsequent revisions to the standards in the 1990s, and the Manufactured Housing Improvement Act of 2000, which requires regular review of and updates to the HUD code (Furman 2014). This has led to tighter building envelopes and improved building construction in new homes. In 2001, the U.S. Environmental Protection Agency (EPA) began an ENERGY STAR program to recognize energy efficient homes that are at least 30 percent more efficient than a home designed to meet the 1993 Council of American Building Officials Model Energy Code and have efficient HVAC systems, water heaters, and building envelopes. Even with the improvements resulting from the HUD code, however, most manufactured homes are still sold with electric resistance heating systems. Significant reduction in HVAC energy use can be realized by upgrading to a heat pump system.

Case Studies: Research and Programs for Decreasing Manufactured Home Energy Use

Many co-ops and other utilities and organizations actively work on improving manufactured home energy efficiency to reduce electricity bills and peak demand. In this section, we highlight some key experiences that may help other co-ops address the energy use of this segment of their membership.

PROMOTING HEAT PUMPS

Central Heat Pump Systems

As noted earlier, space conditioning comprises a large fraction of a typical manufactured home's energy consumption, and is a prime opportunity for energy savings. Inefficient space conditioning not only impacts member electric bills directly, but also has potential to impact co-op peak demand, both in the summer with air conditioning peaks and in the winter with heating peaks. Promoting efficient space conditioning like heat pumps, therefore, is a priority for some co-ops (see **Figure 2**).

Figure 2: The outdoor unit of a new heat pump installed in a manufactured home
Image courtesy of Buckeye Power

The electric load of manufactured home heating contributes significantly to peak demand.

PowerSouth Energy Cooperative (PSEC), a generation and transmission (G&T) co-op serving Alabama and the Florida panhandle, and its member distribution co-ops, including Coosa Valley Electric Cooperative (CVEC), have actively promoted heat pumps for new and existing homes for more than 10 years. Manufactured homes comprise a large portion of residential building stock in the region, reaching 30 to 35 percent in several PSEC distribution co-op service territories. Most of these homes are heated with electric furnaces, which contributes a large portion to monthly energy costs in the winter. Mike Majors, Member Services Coordinator at PSEC, noted some households can spend more than a dollar *per hour* on heat. Not surprisingly, the electric load of manufactured home heating contributes significantly to peak demand. To address high bills and peak demand impacts, PSEC and its member co-ops decided they needed to provide substantial incentives and financing to encourage members to adopt heat pump technology.

Partnerships are important in educating members about and encouraging them to adopt heat pumps.

To that end, PSEC offers a $400 per ton rebate on the replacement of an electric resistance furnace with a heat pump, which covers about half the cost of the new unit and yields a payback period of about a year. In the first six months of their current program, PSEC has issued about 160 rebates. On a new home, PSEC pays the cost difference between an electric resistance and a heat pump system directly to the dealer, so that the member experiences no financial impact from the upgrade.

Realizing that partnerships are important in educating members about and encouraging them to adopt heat pumps, PSEC also provides an incentive of $100 per unit to the contractor (in the case of a replacement) or the home dealer (in the case of a new home). Barbara Edmondson, Marketing Representative at CVEC, notes that education is key to realizing energy savings. Not only do contractors and dealers need to understand and promote heat pumps, but members need to understand how to use them. As a key element of CVEC's program, Edmondson explains key maintenance and behavioral practices that can help members achieve the most energy savings. These include replacing dirty air filters to ensure that the heat pump runs efficiently, and turning down thermostat temperatures when nobody is at home to avoid heating unoccupied space.

Ductless Heat Pumps

Although, at the time of this paper, we did not learn of any co-ops promoting ductless heat pumps, this solution has been explored for manufactured homes in the Pacific Northwest. A 2012 Bonneville Power Administration (BPA) pilot retrofitted 20 homes with ductless heat pumps, offsetting the majority of existing electric furnace heating load. BPA estimated that heating costs of participating homes decreased by 39 percent (BPA 2012). More recently, an Energy Trust of Oregon pilot of 100 homes found 20 to 23 percent savings (Cadmus 2017). Another NRECA *TechSurveillance* article, ***The Business Case for Retrofitting Manufactured Homes with Mini-Split Heat Pumps: Facing Down the Inefficiency Challenge***, outlines the business case for ductless heat pumps, and steps to increase adoption of the technology (Funkhouser et al., 2016).

IMPROVING BUILDING ENVELOPES

Co-ops have also worked to improve building envelopes of manufactured homes. Buckeye Power, Inc. (Buckeye), a G&T co-op serving Ohio, self-funded a study to weatherize and improve homes, several of which were manufactured homes, in the early 2010s. According to Bernie Woller, formerly the Director of Facilities and Special Projects at Buckeye, they generally focused efforts on low-cost improvements to the underbelly of the home (see

FIGURE 3: Spray foam installed between floor joists under a manufactured home. Photo courtesy of Buckeye Power

Figure 3), improving insulation, sealing ducts, and installing moisture barriers. The cost of improvements varied from less than $1,000 to more than $3,000 per home, saved homeowners $440 to $830 per year, and had payback periods of 2 to 4 years. Buckeye performed higher-cost improvements to one home that included attic insulation and duct modifications, in addition to underbelly improvements, for a cost of over $5,000, saved about $700 a year, and had a payback period of 8 years. Buckeye also learned an important lesson: the water pipes under one of the low-cost improvement homes froze because the pipes were no longer warmed from the conditioned space. Although they successfully repaired the damage and insulated the water pipes, they decided to focus other efforts on homes with foundations that can keep pipes from freezing.

Central Electric Power Cooperative, Inc. (CEPCI), the G&T that serves South Carolina distribution co-ops, has been an active promoter of manufactured home weatherization. In 2010, they weatherized 79 manufactured homes as part of their GoodSense Program, funded by American Recovery and Reinvestment Act stimulus money (CEPCI 2012). Appropriate weatherization measures were determined for each home, and included duct sealing and repair, HVAC repair, and insulation upgrades. On average, the measures cost $5,500, saved members $670 a year, and had a payback period of 11 years (CEPCI 2012). The savings varied over a wide range, however. About 18 percent of the homes experienced a payback period of less than 5 years, and 44 percent achieved payback in 5 to 10 years. Payback periods for the remaining 38 percent of homes were greater than 10 years.

Additional weatherization in South Carolina has been carried out by the *Help My House* program, a collaborative effort between the Electric Cooperatives of South Carolina (a state-wide trade association), CEPCI, and South Carolina distribution co-ops. This program provides low-interest loans with OBF to carry out weatherization measures on both stick-built and manufactured homes. It was piloted in 2011, and included 72 manufactured homes of 125 total retrofits (Keegan 2013). Homes were initially audited with a blower door test, then contractors performed air sealing and other weatherization improvements. Afterward, home performance improvement was confirmed with a second blower door test conducted by an independent auditor. Although results were combined for manufactured and stick-built homes, they show most homes (over 80 percent) realized energy cost savings larger than the monthly loan repayment. Coincident peak demand savings were 27 percent of the June summer peak and 45 percent of the January winter peak (Keegan 2013). *Help My House* was introduced as a full program in 2013.

Jay Kirby, Vice President of Public Affairs at Santee Electric Cooperative, Inc. (Santee), noted good success with the *Help My House* program at the distribution co-op. Of the approximately 240 participating homes, about 60 of which are manufactured, Santee has had no write-offs and only had to disconnect electricity on one occasion for non-payment of the loan. Santee's experience has led them to focus on homes newer than 1992, as older homes tend to have other issues like failing roofs and leaky floors. They also require a 10-year parts and labor warranty priced into installed equipment, so that if it fails, the member is able to have it repaired.

For any particular home, energy reduction strategies undertaken will depend on the age and condition of the home, and the funds available to carry out the improvements.

Replacing an existing home with a new home cannot be justified by energy savings alone.

NEW HOME PROGRAMS

East Kentucky Electric Cooperative (EKPC), a G&T in Kentucky, offers rebates to offset the cost of upgrading from a standard efficiency new home to an ENERGY STAR qualified home with a heat pump. In early years of the program, which began in 2014, EKPC rebated the home manufacturing plant directly to cover the incremental cost of the participating member's new ENERGY STAR home. Although this allowed the member to pay a reduced up-front cost, the rebating process was slow and cumbersome, according to Josh Littrell, DSM Program Manager at EKPC. EKPC is currently restructuring the program, and plans to offer a rebate to the member of $1,150 on the purchase of an ENERGY STAR home with a heat pump. According to Littrell, most of the savings opportunity is in upgrading to a heat pump, since new homes are fairly tight, and have improved ducts compared to older homes.

Cost and Benefits of Energy Reduction Strategies

As the co-op experiences included in this article indicate, a variety of energy reduction strategies are available for manufactured homes. In this section, we make a first estimate of the cost and energy benefits of several strategies, from simple upgrades to home replacement, based on previous co-op work and other published estimates (see Table 2). These estimates are presented as (sometimes large) ranges, in part due to variability in the limited data, and in part due to site-specific factors that need additional study. For any particular home, energy reduction strategies undertaken will depend on the age and condition of the home, and the funds available to carry out the improvements. In addition, realized energy savings for that home depends not only on the improvements, but other variables, such as climate and behavior changes. Additional research and experience is needed to develop solid cost, savings, and payback period estimates. The estimates presented here are meant to start this conversation and work, rather than be a guideline on which to base program development.

Even with large uncertainties, we can begin to draw some conclusions that can shape how co-ops approach manufactured home energy reduction, and highlight areas for additional study. It is clear that upgrading an existing home's HVAC system and/or implementing weatherization measures can be cost efficient with shorter payback periods than measures for new homes. Expected energy savings for an ENERGY STAR home relative to a standard home, however, is poorly known and likely highly dependent on climate, hom e size, and occupant behavior. For these reasons, we place little certainty on the savings and payback estimated for this strategy, and recommend further study.

Replacing an existing home with a new home, however, cannot be justified by energy savings alone. The high initial cost would be recouped through energy savings over several decades at best, and not paid back over the life of the home at worst. Additional costs related to home replacement such as delivery, site preparation, and increased taxes and insurance, have not been factored to this estimate. As many co-op staff noted during interviews for this project, it takes more than energy efficiency issues to justify replacement of a house. Replacing the home would not be cost-effective unless structural repairs, a new roof, or mold abatement were necessary. Unfortunately, this situation is not uncommon; in some states in Appalachia, for example, old

TABLE 2: Estimated cost and benefits of a range of energy reduction strategies

Energy Reduction Strategy	Incremental cost ($)	Estimated savings ($/yr)	Payback (yr)
Replace electric resistance furnace with heat pump[a]	350 – 600	300 – 500	1
Improve underbelly insulation, seal and repair ducts, install moisture barrier[b]	1000 – 3000	400 – 800	2 – 4
Purchase ENERGY STAR new home instead of base efficiency home[c]	2000 – 4000	400	5 – 10
Replace existing home with new home[d]	40,000 – 80,000	700 – 1300	30 – >100

Notes and Assumptions:

a. Cost, savings, and payback estimates based on PSEC and CVEC results. Incremental cost is difference between heat pump and electric resistance furnace.

b. Cost, savings, and payback estimates based on results from CEPCI GoodCents program and BEC study results. Incremental cost is the cost of the weatherization measures.

c. Cost and payback estimates from Furman (2014). Annual savings calculated by dividing cost by payback. Incremental cost is the estimated cost difference between an ENERGY STAR and a non-ENERGY STAR home.

d. Cost estimates from Furman (2014) for single and double wide homes. Does not include delivery, site preparation, title fees, or taxes. Estimated savings based on combining savings estimates related to heat pump upgrade and weatherization (strategies 1 and 2). Payback estimated by dividing cost by savings.

homes in poor condition can make up almost a quarter of manufactured home building stock (VCHR 2016).

Financing and Funding Options

Fundamental to the success of any weatherization measure or home upgrade is members' access to financing or other funding to cover the initial costs of the upgrade. Co-ops are and should be sensitive to the costs borne by members who live in manufactured housing and make sure that members who embrace energy reduction strategies do not end up worse off from a financial perspective. In many cases, financial assistance, often in the form of low interest loans or rebates, is necessary to defer improvement costs.

TABLE 3: Energy efficiency improvements that can be financed by RESP. Common co-op measures are shown in bold type.

Category	Examples
HVAC	**Duct sealing** **Heat pumps** ENERGY STAR qualified central air systems ENERGY STAR qualified furnaces Programmable controls Economizers Air handlers
Building Envelope Improvements	**Insulation (added beyond existing levels, or beyond existing building code)** **Caulking and weather stripping around doors and windows** Door upgrades and ENERGY STAR qualified windows
Energy Audits	**Pre- and post-measure blower door tests** Whole home audits
Home replacement	Replace existing home with more efficient new home
Lighting	Efficient bulbs and fixtures Lighting controls
Other	Water heater Appliances (if attached to real property) Irrigation Renewable energy Energy storage

TABLE 4: Summary of USDA loan programs.

Program	Eligible Borrower(s)	Interest Rate	Terms
RESP	Utilities Nonprofit organizations Municipalities States	0% for the Eligible Borrower, who may relend to consumers (co-op members) at rate up to 3%.	Up to 20 years for the Eligible Borrower, who may relend to consumers (co-op members) on terms up to 10 years.
EECLP	Utilities that serve rural areas	Current direct US treasury rate for the Eligible Borrower, who may relend to at rate up to 1.5% greater than direct treasury rate	Up to 15 years.
REDLG	Utilities that serve rural areas	0% (Utility and consumer)	Up to 10 years (Utility and consumer)

The USDA offers several programs to aid rural areas. RESP, the program noted earlier that finances weatherization and home replacement, offers zero-interest loans to eligible borrowers, such as utilities, municipalities or states, and non-profits. Loan terms are up to 20 years. The borrower, be it the co-op or a government or non-profit partner organization, relends the money to members at an interest rate of up to 3 percent, to be repaid in 10 years or less. RESP has been offering financing for weatherization measures since 2016, and in 2018, expanded financing to include manufactured home replacement, if the new home "would be more cost-effective in saving energy" (USDA 2017a, USDA 2018). The program allows for a wide range of energy efficient improvements (see Table 3).

Co-ops may be familiar with other USDA programs including the Energy Efficiency and Conservation Loan program (EECLP) and the Rural Economic Development Loan and Grant (REDLG), which can be used to fund energy efficiency and peak demand reduction measures (see Table 4). Compared to RESP, EECLP has shorter terms, higher interest rates, and limits borrowing entities to utilities that provide electric services in rural areas (USDA 2013, 2017a,b). REDLG has funded energy efficiency programs such as the South Carolina *Help My House* program (Keegan 2013), with zero percent interest loans with a 10-year maximum term (USDA 2015). Of these options, RESP may be the preferred choice of co-ops. Not only does RESP provide the best rates and terms of these federal funding options, it is also most conducive to collaboration, allowing not just co-ops, but potential co-op partners like municipalities and non-profit organizations.

Once the co-op (or partner government or non-profit entity) secures funding, it issues loans to members. OBF streamlines this process by collecting repayment via a monthly charge on the electric bill. Ideally, post-measure

electricity savings is greater than the loan payment, and the member sees a smaller electricity bill after the improvements. OBF allows the co-op to assign the loan to the meter, rather than the member. If the member sells the home, the loan is passed to the new owner. This ensures that the member that pays the loan is also the member that benefits from the energy efficiency improvements.[1] Co-ops have a history of using OBF for a wide variety of energy efficiency and distributed energy programs (Keegan et al. 2016). Ouachita Electric Cooperative, a distribution co-op serving southern Arkansas, is a leader in OBF weatherization programs, offering the program for single-family, multi-family, and even commercial buildings to renters and owners (Ouachita Electric Cooperative 2017). Applied to manufactured homes specifically, OBF has been successful in the *Help My House* program in South Carolina, as discussed earlier.

Co-ops may also benefit from forging partnerships with community or advocacy groups that focus on helping low- and-moderate income families.

Co-ops may also benefit from forging partnerships with community or advocacy groups that focus on helping low- and-moderate income families. Although the roles of the co-op and the partner(s) will vary depending on the resources each brings to the table, partner groups could take on a wide range of roles, such as procuring and administering RESP financing, securing charitable contributions or other funding, and providing staff resources to identify members in need and provide them with information on the program, or perform other outreach activities. Successful partnerships include the *Help My House* program's collaboration *KWSavings*, a non-profit that oversees loan processing for the weatherization program. In another example, South Carolina co-ops have partnered with *Home Works of America*, a nonprofit organization that provides home repair services to low-income homeowners. In this partnership, *Home Works* first addresses health and safety issues, then the co-ops perform weatherization improvements.

Finally, co-ops can fund efficiency improvements through a familiar tool: rebates. This is especially popular in situations where members are replacing equipment, like furnaces, as a way to cover the incremental cost of the efficient model.

Exploring a Co-Op Collective Effort to Improve Manufactured Home Efficiency

Many co-ops like the ones highlighted in this article are assisting members who live in manufactured homes implement energy efficiency improvements. But, many more co-ops do not have programs in place that would benefit these often low-income members. NRECA is exploring opportunities to expand manufactured home energy efficiency improvement through a collective co-op effort. By working together, co-ops can leverage previous co-op experience as a resource to develop research and programs, as well as share experiences and lessons learned. Below, we outline potential components of this collective effort.

BUILDING ON CO-OP EXPERIENCE

Co-ops are already having success with existing home measures by providing financing and incentives for participating members. Although it may be difficult to use current data to make accurate estimates of savings and payback for a weatherization measure without additional pilots and experiences across the country, co-ops have shown that they can help members living in manufactured homes in a variety of ways. These include:

- Promoting HVAC system and building improvements.
- Leveraging low-interest financing and OBF.
- Promoting energy efficient new homes (ENERGY STAR homes or homes with heat pump systems).
- Educating members on efficient technologies and behaviors, and building relationships with contractors and dealers.
- Building partnerships with municipalities and community assistance programs.

[1] For a comprehensive discussion of OBF, see NRECA's 2016 *TechSurveillance* article ***Financing Member Investment in Efficiency and Solar: A Solution for Cooperatives?***

SHARING EXPERIENCE AND LESSONS

No pilot or program is without unforeseen issues or consequences. Sharing those experiences and the solutions developed can help other co-ops avoid the same issues. Co-ops interviewed for this paper shared some key lessons, including:

- Weatherization measures inadvertently leading to frozen water pipes at Buckeye.
- The decision by Santee to require a parts and labor warranty built into the cost of new HVAC equipment, so that if it breaks, the member is not hit with a large, unplanned expense.
- Education for members, contractors, home dealers, and other partners is key to success.
- Leveraging partnerships can stretch resources, allowing the co-op to do more to help their members.

No single solution will apply to every co-op, but sharing experiences will provide additional information to co-ops as they develop programs to suit their needs.

COLLECTING AND SHARING INFORMATION

Although a good amount of information has been collected by co-ops in the Southeast, because space conditioning and weatherization approaches are inherently dependent on climate zone, a broader information collection and sharing effort across the county is needed. Such questions include:

- Which homes are a good fit for measures? Are some deemed too risky for non-energy reasons (home is unsafe, home is at risk of abandonment due to financial stress)?
- What climates are central and ductless heat pump systems a viable and cost effective improvement on existing systems?
- What building envelope improvements are cost effective in various climates?
- How much do the measures cost?
- What financing structures are most cost efficient?
- What partnerships can co-ops leverage to increase accessible funding and staff resources?

Co-ops serve a large portion of low- and moderate-income households. Consequently, co-ops are uniquely positioned to be a trusted community resource that helps reduce the financial burden of high energy bills. By leveraging efficient technologies, novel financing mechanisms, and partnerships, co-ops can develop energy reduction programs that positively impact their members' lives while improving the co-op's bottom line. Working together, co-ops can collect the information and experience needed to expand these manufactured home programs, helping not just their own members, but helping other co-ops improve lives of their members too. ■

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REFERENCES

BPA 2012. Ductless Heat Pump Engineering Analysis. **Single-Family and Manufactured homes with Electric Forced-Air Furnaces**.

Cadmus 2017. **Existing Manufactured Homes Heat Pump Pilot Evaluation**. Prepared for Energy Trust of Oregon.

CEPCI 2012. **Manufactured Home Study Final Report**.

Cody, E. 2011. **Retrofitting Manufactured Homes for Improved Energy Efficiency**. Prepared for the National Rural Electric Cooperative Association Cooperative Research Network.

EIA (US Energy Information Administration) 2013. **2009 Residential Energy Consumption Survey**.

Funkhouser, E., M. McRae, and J. Folks 2016. **The Business Case for Retrofitting Manufactured Homes with Mini-Split Heat Pumps: Facing Down the Inefficiency Challenge**. Prepared for NRECA by Research Into Action, Inc.

Furman, M. 2014. **Eradicating Substandard Manufactured Homes: Replacement Programs as a Strategy**. Prepared for Harvard University Joint Center for Housing Studies and NeighborWorks America.

Keegan, P. 2013. **Help My House Program Final Summary Report**. Prepared for Central Electric Power Cooperative, Columbia, South Carolina and The Electric Cooperatives of South Carolina, Cayce, South Carolina.

Keegan, P., C. Grant, and A. Wheeless 2016. **Financing Member Investments in Efficiency and Solar: A Solution for Cooperatives?** Prepared for NRECA Business & Technologies by Collaborative Efficiency.

MHS (Manufactured Housing Study) 2017. Data accessed April 2019.

Ouachita Electric Cooperative 2017. **Opening Opportunities with Inclusive Financing for Energy Efficiency**: Report on the first year of the HELP PAYS® Program at Ouachita Electric.

USDA (United States Department of Agriculture) 2013. **Energy Efficiency and Conservation Loan Program, Final Rule**. 7 CFR Parts 1710, 1717, 1721, 1724, and 1730.

USDA 2015. **Rural Economic Development Loan & Grant Program Fact Sheet**. Accessed April 2019.

USDA 2017a. **Rural Energy Savings Program Fact Sheet**. Accessed April 2019.

USDA 2017b. **Energy Efficiency and Conservation Loan Program Fact Sheet**. Accessed April 2019.

USDA 2018. **Announcement of Loan Application Procedures, and Deadlines for the Rural Energy Savings Program (RESP)**. Accessed April 2019.

VCHR (Virginia Center for Housing Research) 2016. **Mobile and Manufactured Homes In Central Appalachia and Alabamia: Age, Condition and Need for Replacement**. Prepared for Next Step, Fahe, and CFED.

ABOUT THE AUTHOR

Katherine Dayem, PhD, Principal, Xergy Consulting. Katherine helps US and global clients investigate, analyze, and cultivate emerging clean energy resources at the grid's edge. Her research is focused on identifying impactful new ways to save energy, from product-level to building-level, and has resulted in deep energy savings through innovative utility programs and the enactment of energy-saving regulations. Her recent work has delved into a wide range of topics, including beneficial electrification of vehicles and space heating. A former member of La Plata Electric Association, she now lives in the Pacific Northwest.

QUESTIONS OR COMMENTS

- Adaora Ifebigh, R&D Engagement Project Manager, NRECA Business and Technology Strategies: **Adaora.Ifebigh@nreca.coop**
- Brian Sloboda, Consumer Solutions Director, NRECA Business and Technology Strategies: **Brian.Sloboda@nreca.coop**
- To find more resources on business and technology issues for cooperatives, visit our **website**.

DISTRIBUTED ENERGY RESOURCES WORK GROUP

The Distributed Energy Resources (DER) Work Group, part of NRECA's Business and Technology Strategies department, is focused on identifying the opportunities and challenges presented by the continued evolution of distributed generation, energy storage, energy efficiency and demand response resources. For more information, please visit **www.cooperative.com**, and for the current work by the Business and Technology Strategies department of NRECA, please see our **Portfolio**.