SCE DRET Findings
October 2018

DR14.01: A Replicable and Scalable Near-Zero Net Energy Retrofit of Low-Income Multifamily Housing: Electric Energy Efficiency

This project evaluated technical and financial models for scalability of deep, near-zero net energy (ZNE) retrofits in existing low-income multifamily (LIMF) housing. The project was implemented at The Villages at Beechwood in Lancaster, California. This is a 100-unit, LIMF property, owned by LINC Housing, LLC, a non-profit owner and operator of low-income housing, and a partner for this project. This property was chosen, in part, because its location has a climate requiring substantial heating and cooling energy loads, and it represents a large share of the low-income market. The work took place over the four-year period from 2013 to 2016. Each unit is individually metered and billed for electricity use, however, the entire facility is master-metered for gas, with the property owner responsible for paying for all gas use.

Thirty units at The Villages at Beechwood, in Lancaster, California, were retrofitted with packages of substantial Energy Efficiency (EE) measures for natural gas and electric use, including light-emitting diodes (LED) indoor and outdoor lighting, weather stripping, smart thermostats, duct and envelope improvements, efficient appliances, deep EE measures, solar thermal, and solar photovoltaic (PV). Contractors also installed roof spray foam insulation as well as emerging technologies like aerosol envelope sealing and advanced economizers in the common area. The project identified the measures' technical effectiveness, and provided an understanding of hidden costs, such as asbestos mitigation and tenant intrusion, that act as market barriers.

This project meets the LIMF market demand for EE, and the technical and financial information, packages, practices, and methods produced in this project will be applicable to the entire existing multifamily (MF) market, making the project more important.

The overarching goal of this project is to develop, demonstrate, and document the steps and components needed by LIMF property owners to make the process of VER-related business decisions both easy and straightforward.

INTRODUCTION

Why EE at LIMF?

Low-income households typically occupy energy-inefficient housing, whether owned or rented, resulting in high energy use. A study by the U.S. Department of Health and Human Services stated low-income households can spend as much as 16.4% of their income on residential energy services, more than double what an average household spends. Inefficient buildings are typically difficult to condition properly and often have poor air quality. Low-income families are often uncomfortable in inefficient, uncomfortable dwellings, and do not have the financial means to upgrade their properties or pay higher rent for the property owners to recoup an investment in retrofitting the rental properties with EE upgrades.

This project developed, implemented, and evaluated EE retrofits in low-income housing, to improve the quality of life for these households. It was important to understand the current state of LIMF housing, and simultaneously understand customer (tenant and property owner) preferences. The team identified and applied appropriate technology interventions, including data collected from monitoring at the equipment level, in an attempt to pinpoint the impact of each EE measure.

Another significant part of the work was developing a business model around comprehensive EE and solar retrofits. The team found it essential to work with and be attentive to the occupant-customer before, during, and after installing EE improvements, as well as to plan to avoid problems and budget for the unexpected. In addition, the project also emphasized the importance of building a knowledge base of "real world" cost estimates, to provide better insights into the cost effectiveness of key EE measures.

The project started with a thorough audit of the components and construction of current structures and their energy-consuming contents, as well as occupant interviews to survey small electric appliances and behaviors, including thermostat settings (both queried and observed), where possible. Audit information, including envelope components and areas, and equipment age and efficiency ratings were used to develop building models. Simulations were used to identify the units with high energy use and retrofitted packages of EE measures.

What was done?

The project studied 30 non-retrofitted units, which provided baseline data for direct comparison with those that were retrofitted. The project had three major goals:

1. Develop deep EE retrofits and integrate renewables (PV and solar thermal) to produce a practical retrofit package that would be as close to ZNE as possible.
2. Implement the retrofit as successfully as possible and evaluate the success of the retrofit.
3. Evaluate and suggest improvements to existing financial models and associated tools that should enable scaling of these retrofits across LINCs housing portfolio as well as California's LIMF market.

The EE measures referred to as Very Efficient Retrofit (VER) installed in the tenant units included:

- Attic insulation, to place ducts in conditioned space
- Hand-installed envelope air sealing
- Duct leakage sealing and/or replacement
- Increased duct insulation
- "L" duct seals on Roof-Top Units with reflective paint
- Community-scale solar water heating
- High efficiency boilers for community water heating
- High efficiency tankless water heaters for duplexes
- Spray foam roof insulation (in one building)
- Smart thermostats
- Low-flow showerheads
- Refrigerators in select units
- Improved piping for community water heating

Photovoltaic (PV) panels were also installed as another measure to help achieve Near ZNE. 74 kW of PV was installed which reduced energy usage by 25% across the test units.
In-depth HVAC system monitoring, combined with data from the Automated Metering Infrastructure (AMI) electric and gas smart meters, was used to verify the efficacy and performance of the EE measures.

Progress Towards Near-Zero Net Energy

The installed efficiency measures were effective in delivering electric and gas energy savings to the low-income households. The average electric energy use for the units in 2013 was about 22.5 kWh/day, and the net reduction from EE equates to 5 kWh/day/unit. Since California has about seven million apartment residents, the potential for electric energy savings equates to 12.75 GWh annually.

The apartments with EE measures reduced their natural gas use by about 10%, and for the community, water heating natural gas use dropped 58%. For the community scale, this is approximately a 28% reduction in gas use, or about 14,400 therms annually (144 therms/unit).

Figure 1.

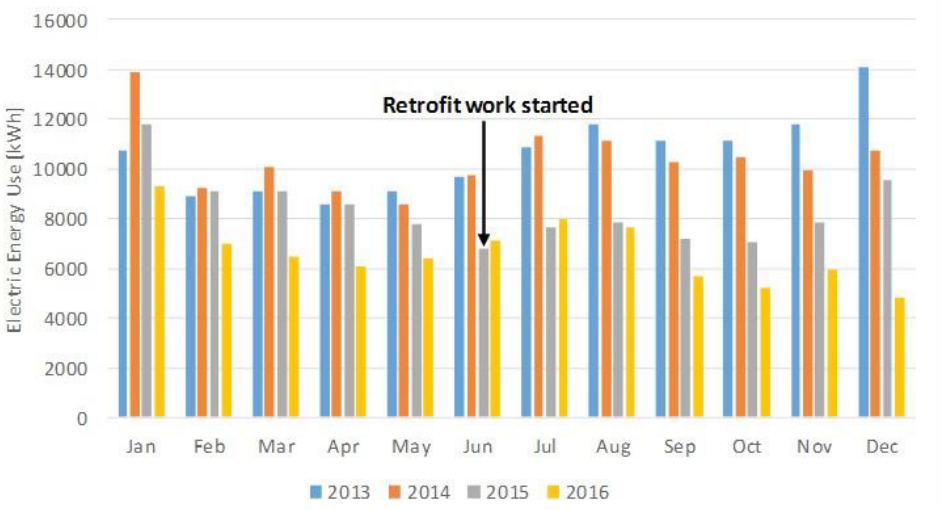

Figure 1 above shows a month-by-month comparison of four years of electric energy use. Most of the retrofit work at the common area started in May 2015, and the data shows significant energy reduction starting in June 2015 as a result of the VER package including; LED lights, aerosol sealing, re-roofing, re-ducting, smart thermostats, and economizers. This does not include the PV.

Figure 2. shows the annual energy savings from all the measures, the cost for installation and the Simple Payback. Best scenario is with all EE savings and PV savings at 23 years.

Figure 2.

	$ Saved Per Year	Rate	Cost	Simple Payback
Gas	$4,280	$0.92	$ 368,281	86
Electric	$7,194	$0.17	$ 368,281	N/A
Total EE	$11,474	N/A	$ 368,281	32
PV	$19,390	$0.17	$ 331,800	N/A
Gas + PV	$23,671	N/A	$ 700,081	30
EE + PV	$30,864	N/A	$ 700,081	23

CONCLUSIONS

What We Concluded?

Based on this research, it continues to be challenging to implement EE retrofits in existing low-income units to achieve a favorable return on investment without some rebates, incentives, or financial assistance. A LIMF owner is hard pressed to make the economic investment required for EE improvements without some additional financial help, especially for older MF units, which are more prone to have abatement issues such as asbestos, lead paint, or even mold. Mitigating these hazards adds significant cost to the retrofits, substantially increasing the payback period.

Due to the complexity of funding sources for EE measures, PV and related items, there is no single "one size fits all" scalable financial solution for funding these types of retrofit projects, though the team has identified that successful ZNE retrofits can be financed. If financing is not available in the amount needed to install a full package of measures, another option may be to fund a portion of the work, from which savings could support additional measures at a later time.

Financial institutions, such as banks and third-party financiers, do not yet trust EE to consistently deliver returns over the long term. The team recommends future research initiatives focused on developing models substantiated by data that would increase the confidence of financial institutions in EE savings, and thus unlock the capital required for scaling near-ZNE retrofits in low-income housing.

Lessons Learned

It is essential to continue encouraging and supporting energy and non-energy benefits as part of future work on affordable and low-income communities. It is important to emphasize that incentives for EE must be provided to tenants, as well as to the property owners who must invest substantial effort in implementing these measures.

Communication with residents

- Communicate the scope of work
- Set expectations about savings and bills
- Set expectations about EE technology
- Take upfront survey about occupancy
- Take survey at the completion to get feedback about results

Installation

- Contractors should be trained on specialty EE work
- Scope of work is well defined
- On-site oversite and care tracking of progress
- Look out for unknowns such as asbestos, lead paint and mold. These can lead to cost overruns for abatement
- Run a pilot as a way of learning ways to streamline future installs on a large consistent scale.

Education

- Additional effort is needed to educate tenants on how to use the smart thermostats. Very few tenants understand the capabilities of their thermostats, much less how to use them.
- Educate the maintenance crews about the upkeep of the various types of equipment.
- Educate the tenants (and all project participants), that ZNE does NOT mean there will be no utility bills.

Financing

- The team also recommends financial models, similar to those used in the solar industry, be encouraged in the EE industry, and future research be conducted to fill any gaps in the data required by financial institutions, such as private and public banks.

These Findings are based on the report "A Replicable and Scalable Near-Zero Net Energy Retrofit of Low-Income Multifamily Housing: Electric Energy Efficiency" which is available from the ETCC program website.