
# Energy Retrofits and Building Electrification for Multifamily

## What You Need to Know to Make Your Project Successful

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## Introduction

In the quest to get to net zero, building owners and operators are moving towards electrification to cut emissions and improve energy efficiency. But as fossil fuel-burning appliances, boilers and furnaces are replaced with more efficient electric models, increased demand will put more strain on the grid, resulting in increased energy costs. At the same time, governments and utilities are accelerating efforts to move the grid to 100% renewables, which introduces more variability in electricity supply.

### So, what's a portfolio owner to do?

Aging building stock is an issue across all sectors of the built environment, but just electrifying old, inefficient buildings without addressing underlying issues doesn't solve the problem. Leaking windows, inadequate insulation and a poor building envelope leads to more energy waste. Electrifying without improving efficiency will actually increase energy costs and overload the grid. That's why smart owners and operators are doing three things:

- Energy retrofits to improve overall energy efficiency
- Electrification to move to carbon free energy
- Peak energy load management to reduce strain on the grid at critical times

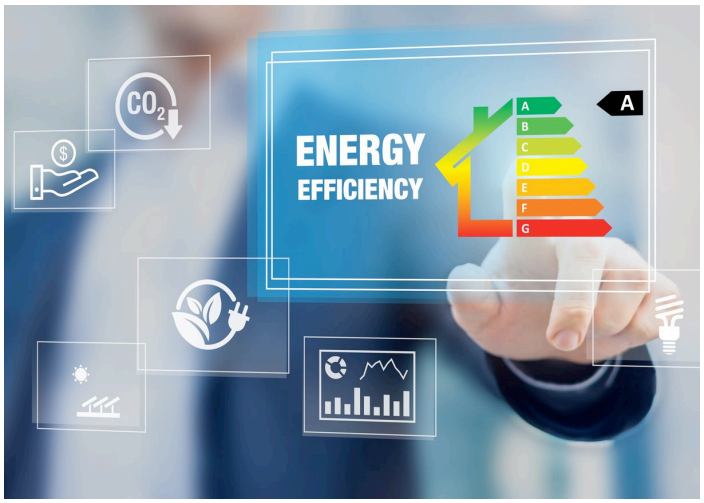
**Together, these efforts radically reduce energy consumption and carbon in operators' portfolios.**

Energy retrofits are also a huge investment opportunity, especially considering two thirds of the building stock will still be here in 2040. Increasing energy efficiency by 30% in US buildings built before 1980 would result in $1 trillion dollars of energy savings over 10 years, and require an investment of $279 billion dollars. That represents a 358% return on investment over the 10 year period.

But while there's much to gain, these projects are inherently more complex in multifamily than in other sectors of the built environment because of the age of multifamily building stock and the fact that energy information is often difficult to obtain. In addition, retrofit projects can be disruptive to residents. By implementing best practices and using a data driven approach to understanding building conditions, owners and managers can maximize the effectiveness of any energy retrofit project and make significant gains in both energy efficiency and carbon reduction in older multifamily buildings.

**Multifamily Retrofits are Challenging**

- Age of building stock
- Energy information is hard to obtain
- Disruptive to residents




## What is an Energy Retrofit?

The goal of an energy retrofit project is to radically reduce a building's energy consumption. There are three elements to any retrofit project:

- **Improve the building envelope** by sealing air leaks, adding insulation, replacing windows and taking other energy saving measures.
- **Replace some or all energy consuming equipment** including heating, ventilation and air conditioning (HVAC), domestic hot water (DHW), kitchen appliances, laundry and lighting. Because of the envelope improvements, the HVAC equipment will be smaller and less expensive to run.
- **Install active mechanical ventilation equipment** to provide appropriate air flow in the tighter building envelope. This ventilation conserves energy in the winter by transferring heat and humidity from the exhaust air to the fresh inlet air. In the summer the process is reversed.

The new mechanical systems are usually all electric; if 100% renewable electricity is purchased then the building will be net-zero in operating carbon emissions, or very close to it.

## Creating an Action Plan

All good projects start out with a goal and a well-defined plan, and in the case of energy retrofits and electrification, capital constraints often dictate that the work be performed in phases – but the good news is that the work can lead to immediate energy and carbon savings.  And time is of the essence –  a ton of carbon saved now is more valuable than one saved in the future.

## Saving Energy From the Start

Any building will immediately benefit from installing a building intelligence system connected to smart thermostats and sensors placed throughout the building and controllers connected to heating and cooling equipment. These controls can reduce energy consumption and carbon emissions by 25% by running the existing equipment more efficiently, reducing overheating and overcooling, and reducing peak energy usage.

Such a system can pay for itself through lower energy costs, but more importantly, it provides critical information that will make the next phases of the project more successful in the end.

> Smart thermostats and sensors placed throughout the building and connected to heating and cooling equipment can reduce energy consumption and carbon emissions by 25%.

## Understanding the "Old" Building

A prerequisite for any retrofit project is to establish the physical indoor conditions of the existing building and to obtain a good understanding of occupant behavior. Retrofit designs that take into account how a building operates and the preferences of the occupants are far more successful than those that don't.

The most successful retrofit projects will use the smart building platform to gather and analyze important data points, including:

### Physical conditions

- Indoor temperature
- Indoor humidity
- $CO^2$ levels
- Energy consumption
- Equipment performance

### Occupant behavior

- Thermostat setpoint history
- Window open/close behavior
- Occupancy data

## Monitoring the "New" Building

Once the retrofit work has been completed, it's important to continue and even extend the use of building intelligence to monitor and control the performance of the whole building.

**Whole building intelligence monitors the new equipment, the environment, the new building envelope and how they all work together.**

Building design is complex; retrofit design even more. If existing conditions are not well understood, post-retrofit performance may not match the design.

For example, in any retrofit project, humidity is an area of special concern. Before the retrofit, a building may have avoided high humidity problems in winter because it had high infiltration rates due to cracks and air leaks. After the retrofit, the mechanical ventilation must keep humidity and other air quality measures in safe ranges.

Temperature distribution and temperature extremes can also be a problem. Improved insulation, windows and leak sealing can make some rooms much hotter just through solar gain.

Many energy retrofits proceed in phases throughout a building so that a few residents at a time need to be relocated for anywhere from one day to four weeks.

**The data gathered through whole building intelligence can give the designers the opportunity to gain insights from post-retrofit monitoring of the first group of apartment renovations and, if necessary, adjust plans for the remaining units.**

## Controlling Energy Use and Comfort

The key driver in any energy retrofit project is the efficiency of the building and its systems, but the reality is that good design and equipment are only part of the solution. Even the most well designed, highly efficient building can waste a tremendous amount of energy due to the unintentional actions of occupants and staff.

Best practices include putting in place setpoint limits that allow staff to prevent excessive energy usage by setting a maximum heating setpoint and minimum cooling setpoint.


Image: Embue

Many building efficiency standards require operable windows, yet they can be a source of energy waste. Installing a solution with window open/close logic that uses sensors to detect when a window is opened and then sets the thermostat to a more energy saving setting (e.g. 60F in the heating season and 90F in the cooling season) can stem the tide of energy loss.

A word of caution on setpoint limits: setpoint limit and window-triggered setpoint changes can often spur complaints, backlash and even equipment damage from residents if the programs are not rolled out thoughtfully. The most successful programs include the ability to set flexible setpoint limits and incorporate policies that can easily be adjusted by staff on a property-wide or individual basis by site teams who know the community best.

Staff behavior is critical as well. Often staff will modify or override central equipment settings in an attempt to respond to resident complaints. These changes can defeat energy savings and increase energy costs. Incorporate software that logs all staff actions and can be configured to alert management if settings are changed and allow management to restore or adjust settings.

## Smart Grid and Microgrid

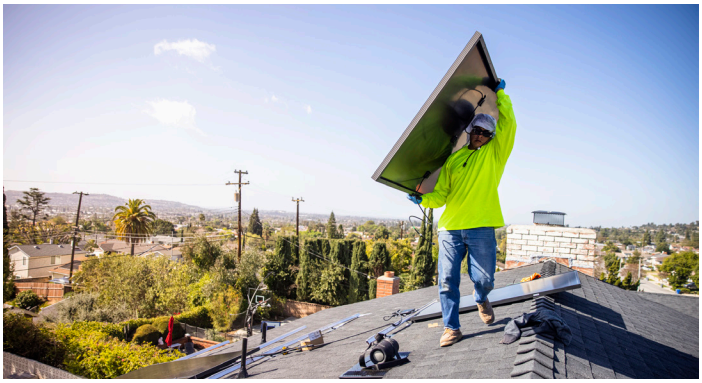
In the next few years, the grid will not be able to keep up with the pace at which buildings are electrifying and solar and wind production is growing. The smart building provides a solution here as well. The same whole building controls can shape energy load to reduce consumption when electricity demand is peaking and supply is restricted due to the variability of renewable power generation by wind and solar.

During natural disasters or power outages, smart building and microgrid controls can limit power usage to essential functions to keep residents safe. A building that has completed an energy retrofit can maintain safe indoor temperatures for hours or days with little or no energy use for heating or cooling (using the Hours of Safety Framework).

## Hybrid Electric / Gas Approach to Energy Retrofits

All retrofit projects must meet cost and practicality constraints. Sometimes the nature of the building fabric, the local climate, the financing vehicles available and the local cost of electricity make it challenging to go all electric. It's not always feasible to improve insulation to the point where an all-electric HVAC system will keep occupants warm and comfortable on the coldest few days of the year. Senior housing is a particular challenge since many older residents require higher temperatures to remain comfortable and healthy.

In such projects, one option is to leave the existing fossil fuel heating system in place, to be used on just the coldest days of the year. In these projects, however, it's critical to install software that controls both forms of heating. Most of the time the heat pump is used during the heating season, but if certain conditions are met, the whole building intelligence system will switch to using the fossil fuel heating system instead. Air source heat pumps become less efficient and more costly to run as the outdoor temperature drops.



The result is a very flexible control strategy where the decision for electric vs. fossil fuel heating can be based on outdoor temperature and its effect on heat pump efficiency, relative fuel costs or the real-time carbon footprint. of the electricity supply. The strategy can also react to winter demand response events which are becoming more common and may be triggered on gas or electricity supply.

## The Smart Whole Building Approach

In planning energy retrofit projects, selecting a technology platform that addresses the needs of the whole building will not only set the project up for success, but it can pay dividends long after the retrofit is complete. Installing a system that senses every space and piece of equipment and provides flexible controls that respond to residents, staff and the smart grid will drive operational value through energy efficiency, staff productivity and resident wellness and comfort.

## About Embue

Embue's whole building intelligence and automation platform enables multifamily property owners and managers to reduce energy usage and carbon emissions, operational waste and infrastructure risk. Embue works in any type of apartment building to automate the whole building and deliver control of the total environment, from heating and cooling systems to each individual unit, from a smartphone or web, and provides alerts to conditions that may cause problems, including mold and water leaks. Embue is based in Worcester, Mass.

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