Optimizing Multifamily Buildings

Multifamily buildings are very different from single-family homes. They include central HVAC systems, shared walls, shared spaces, and so on. What are the best ways to improve their energy efficiency and overall performance?

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What's the Situation?

The envelopes of multifamily buildings typically account for a smaller share of the structure's total energy use than the walls and roof of a single-family structure. Expensive to retrofit, they often have central heating and hot water systems with large distribution inefficiencies. Therefore, heating control and distribution improvements often represent the best retrofit option for the cost. Accurately modeling and optimizing these measures, however, is challenging with the tools that exist today.

Building America's Take

Fundamentally, if we are going to use modeling to justify energy efficiency upgrades, we should be as accurate as possible to ensure cost-effective solutions. But consider the complexity of modeling a multifamily retrofit. Do you model individual apartments, or the whole building? How do you input air infiltration rates? If there are central systems for space conditioning and hot water, how do you model these for individual apartments? Modeling has multiple purposes, from simple to complex. For simple use, utilities model energy measures and homes to assist in decision making for rebates. More complex is modeling for design purposes, looking at relative energy use, and there are models that are good for this—but may not successfully predict energy use. For multifamily buildings, it is critical that we have more characterization of occupancy use.

For this report, Building America looked at challenges in modeling heating control and distribution retrofits, methods used to model multifamily buildings in the BEopt energy modeling software, and gaps in our own house simulation protocol for multifamily applications, including:

- Multiple fuel systems.
- Inclusion of rules-based savings calculations.
- More flexibility with heating and cooling equipment efficiencies.
- Utility bill reconciliation.

Other Alternatives to BEopt (and MulTEA)

There are alternatives to BEopt, but none of these can do optimizations:

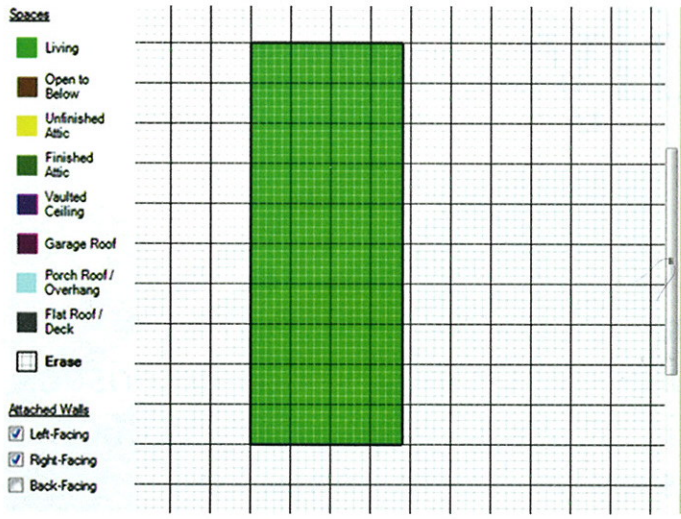
- REM/Rate (1.5 hours of modeling/apartment)
- EnergyGauge USA (1.5 hours of modeling /apartment)
- eQUEST (40 hours of modeling /building)
- EnergyPlus (>40 hours of modeling /building)

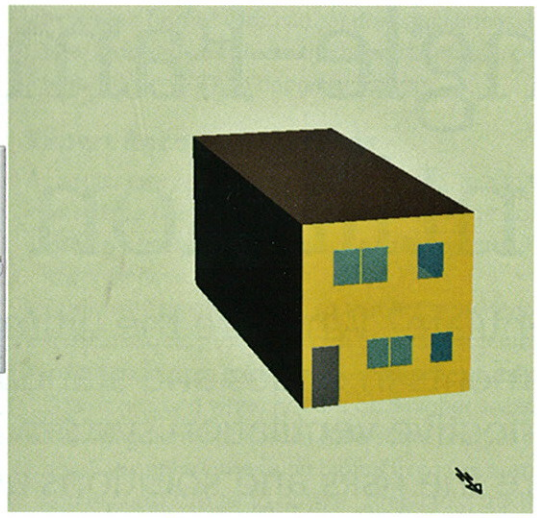
Modeling Tools

There are many energy analysis software tools out there—some do optimization, some do residential analysis, some do retrofit analysis, some come pre-packaged with options and costs, etc. Here are a some details about one of the best ones: BEopt.

To BEopt or Not to BEopt

With support from DOE's Building America program, researchers at the National Renewable Energy Laboratory (NREL) developed BEopt, the "Building Energy Optimization





Numbers Game. **The BEopt system is a relatively simple tool for simulating energy use, but it is best suited for single family or attached buildings.**

Analysis Method." This tool can simulate the energy performance of new or existing homes, analyze and prioritize various combinations of energy-saving measures, and make recommendations for optimal performance. BEopt:

- Is an hourly simulation tool (DOE2 or EnergyPlus) that has a single thermal zone (primarily used for single family).
- Has a relatively flexible building shape.
- Provides a variety of options for various Energy Efficiency measures (EEMs).
- Optimizes performance and cost based on climate region/utility costs.
- Takes into account infiltration/ventilation.

BEopt also has some significant challenges. For example, it:

- Can only currently model individual apartments and attached townhouses with slight changes in geometry (rear view).
- Can't model whole building (maximum of five bedrooms) or overlapping units.
- Can't set exposed floors and walls as adiabatic, or model partial adiabatic walls.
- Doesn't account for central mechanical and hot water systems.
- Does not include recirculation systems. These systems are very important in multifamily—where 65% of the load may be lost in distribution for hot water (*Home Energy Magazine* Sep/Oct 2012).

Recirculation energy gains

Workarounds

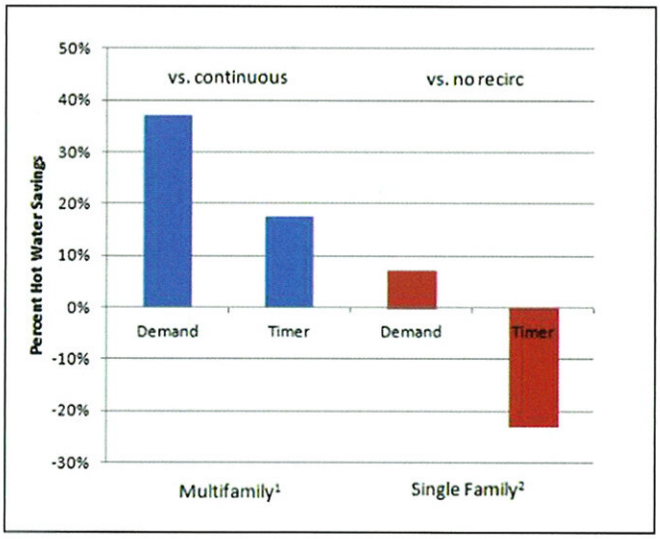
Building America researchers have come up with some workarounds for these challenges, including:

- Creating weighted R-values for walls.
- Using fake garages, attics or flat roofs with high R-values.
- Modeling central systems as individual (making conversion assumptions).

In the Works: Multifamily Audit Tool (MulTEA)

In collaboration, Oak Ridge National Laboratory (ORNL) and Lawrence Berkeley National Laboratory (LBNL) are developing a new audit tool for multifamily buildings, with a particular interest in supporting the weatherization of multifamily buildings. The tool is currently in beta form, but the desired outcome of the tool is to have:

- Handling of multiple zones and decentralized systems.
- Improved treatment of ventilation systems and infiltration assessment.
- Addressing distribution systems (pipes, ducts, tank losses).



Matters of Scale. **Hot water recirculation systems typically perform best in multifamily buildings when available on demand.**