EZ Retrofit: Multifamily Building Energy-Efficiency Evaluation Process Just Got Easy!

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ABSTRACT

In an era of rising utility costs, multifamily owners are paying more attention to their buildings' performance. Benchmarking is increasingly a standard practice. Yet the next step – typically third party audits – is often complex and expensive.

To address these challenges, three energy and affordable housing organizations developed EZ Retrofit – a no-cost, Do-It-Yourself audit tool. The tool identifies cost-effective energy and water retrofit opportunities. It provides cost and savings estimates for each retrofit measure based on each building's characteristics and utility consumption. It enables owners to customize a retrofit scope for their individual property.

While the tool is designed to be easy, it includes powerful and customizable features, making it a unique tool in the industry. One year after the initial launch of the tool, housing owners have used the tool at more than 32 multifamily properties with 3,541 units.

This paper provides an overview of EZ Retrofit and an evaluation of properties that completed retrofits. It highlights how the tool changed perspectives on retrofit approaches. To demonstrate its applicability, the paper also compares the "Do-It-Yourself" approach with traditional audit approaches. Key findings are:

- EZ Retrofit appears to work well across a range of locations, building sizes, ages and system types.
- EZ Retrofit results for common Energy Conservation Measures (ECMs) appear mostly similar to third-party audits, but may not be suitable for complex central systems.
- The cost of using EZ Retrofit is expected to be much lower than an audit performed by a third-party, but calls for more staff time.

EZ Retrofit Approach

Overview

Stewards of Affordable Housing for the Future (SAHF) developed EZ Retrofit, a Do-It-Yourself audit tool that gives multifamily property owners and managers an easy way to identify cost-effective energy and water efficiency upgrades using a whole building approach. The idea to develop EZ Retrofit grew out of SAHF's experience commissioning audits in support of loan-financed retrofits in between capital events for its members. In some cases, the cost of the audits proved to be a high portion of the overall project costs, prompting a desire for a lower cost

option. Additionally, the types of measures ultimately recommended by the expensive audits typically seemed well suited to simpler savings calculations, not requiring more advanced engineering.

Development of EZ Retrofit was funded by a grant from the US Department of Housing and Urban Development (HUD) under its Energy Innovation Fund. ICF International served as the principal developer for the tool, which runs in Microsoft Excel. Bright Power, Inc. provided technical assistance to SAHF and applied the tool at many properties across the U.S. throughout the development period.[1] EZ Retrofit can serve as an alternative to the traditional energy audit, which reduces the soft costs associated with an energy audit by allowing property managers and building owners to perform similar analyses on their own. EZ Retrofit was designed particularly for small to medium sized multifamily properties that are a little too big for programs or services focused on single-family homes and a little too small for programs or services (often provided by Energy Service Companies) that focus on larger multifamily and commercial properties.

The tool aims to provide some of the benefits of a level II audit at a much reduced cost, relying instead on an increased investment of owner time. Based on experience in implementing retrofits under the pilot and looking at the full scope of an audit from initiation through hiring contractors, we estimate that the EZ Retrofit approach requires an additional 7 – 32 hours of staff time, while saving $5,000 - $30,000 in audit fees. Depending on third-party audit costs and the time investment in EZ Retrofit and assuming an hourly rate of $50/hour for staff time, the difference could be as small as $2,000, or more than $30,000.

Use-Cases of EZ Retrofit

EZ Retrofit initially was envisioned for use in financed, stand-alone retrofits, as a solution to the barrier of high audit costs. However, as SAHF developed the tool and worked with its members to identify pilot properties, it became clear that financed, stand-alone retrofits face other significant barriers even once audit costs are reduced, particularly with respect to taking on new debt outside a recapitalization event. At the same time, we identified a number of other scenarios for using EZ Retrofit:

- **Utility programs looking for low-cost, nationally applicable alternative to level II audits:** Utility or government programs often require audits as a way of ensuring that public funds are well-spent (i.e. that equipment purchases are actually impactful). This desire for accountability, however, can add significant costs to programs, and does not always guarantee good results. EZ Retrofit could be used by programs to have a consistent and low-cost audit approach that could be used across a variety of property types and locations.
- **Owners independently evaluating the potential for common ECMs:** For building owners motivated to reduce energy and water use, EZ Retrofit may provide a consistent, replicable approach to assessing opportunities and developing scopes of work for common upgrades. For large portfolios, a small internal team might quickly gain practice using the tool, apply it at a number of sites, and centrally coordinate installations.

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[1] For more information on key players see: www.sahfnet.org, www.icfi.com, www.brightpower.com

- **As a screening tool before undertaking more in-depth (level II or level III) audits:** Some properties may be candidates for more significant investment in energy upgrades, but owners may lack the confidence to undertake an expensive audit without some assurance that a payback is likely. At these sites, EZ Retrofit can provide quick and comprehensive savings estimates to help decide if it is worth investing in and hiring a third party for deeper audits (level II or level III) to more fully understand building systems and develop tailored scope of work.
- **Owners or lenders estimating savings during capital events (e.g. rehabilitations using low income housing tax credit proceeds):** Decision-making about what energy efficient measures to include in a scope is frequently driven by the overall budget rather than the payback or return on investment in these scenarios. Information about the expected savings from EZ Retrofit can help with planning for operations budgets or ongoing operation and maintenance monitoring.

Basic Functioning of EZ Retrofit

EZ Retrofit identifies savings upgrades that can be implemented at multifamily buildings based on building-specific baseline conditions. Key features of the tool are listed in Figure 1.

National Coverage	Designed for use at properties across the country
	Accounts for differences in regional climates in U.S.
	Installation cost esimates adjust with building location
All Property Types	Designed for use mianly at low-rise to mid-rise multifamily properties, however, can be used at high-rise properties as well.
Benchmark	Determine if your property is a good candidate for retrofit
	Savings are calibrated to the property's utility usage
	Uncalibrated results available without utility data input
Whole Building Tool	Generates savings estimates for both owner-paid and tenant-paid accounts
	Tracks owner and tenant savings separately
Savings Estimates	Produce savings & cost estimates for all measures which will result in utility savings
Flexible Assumptions	Ability to adjust default assumptions about current systems as needed
	Adjust pricing based on local costs and/or available rebates
	Adjust savings estimates for proposed systems with contractor bids
Customizable Scope	Ability to integrate custom measures
	Select individual measures for inclusion/exclusion from the scope
	Set target metric for creating a custom scope.
Audit Report	Generate a narrative report based on selected scope to share with other interested parties or decision-makers.

Figure 1. Key features of EZ Retrofit.

EZ Retrofit begins with a benchmarking process for buildings where historic utility data is available. The tool calculates the building's energy use intensity (EUI) and water use intensity (WUI) and compares it to a similar building in a similar climate. Based on this comparison, it advises whether or not the building is likely to have significant opportunity for upgrades. Details on the algorithms and assumptions used in EZ Retrofit are available in the Technical Guide, an appendix to the EZ Retrofit User Guide.

The next step is to enter information about the building's current conditions for the ten building systems for which EZ Retrofit provides recommendations, listed in Figure 2. Within each of the ten building systems, EZ Retrofit asks for information about the current equipment based on the types of equipment most commonly found in multifamily properties.

Figure 2. Ten building systems assessed by EZ Retrofit.

There are two pathways for entering this information – the EZ Path and the Advanced Path – as shown in Figure 3. The appropriate path to start with for a particular building depends on the level of data available and the experience of the user. The EZ Path is intended for a less technical user and uses a step-by-step guide through a series of screens (a "wizard") where the user enters minimum basic information about the building and its systems. Using the information entered in the EZ Path, the tool makes additional assumptions about the current equipment's specifications. Users with more building information available and/or more technical knowledge of building systems may choose to start with the Advanced Path, which uses a spreadsheet format and where users can view and, as appropriate, override the tool's assumptions.

Once the information on current systems is entered through either path, EZ Retrofit generates results by comparing information entered on current systems to a set of potential upgrades. For any potential upgrade identified by EZ Retrofit, estimates of the utility savings, cost savings, installation costs, and useful life are provided as well as financial metrics such as payback period. Regardless of what path was used to enter data, after reviewing results users can refine the results by using the Advanced Path to provide more detailed information for those systems that appear promising based on the first round of results. Aspects that can be updated in the Advanced Path include specifications for the build's *current systems*, custom options for *proposed systems*, and refined *implementation cost* for a proposed system.
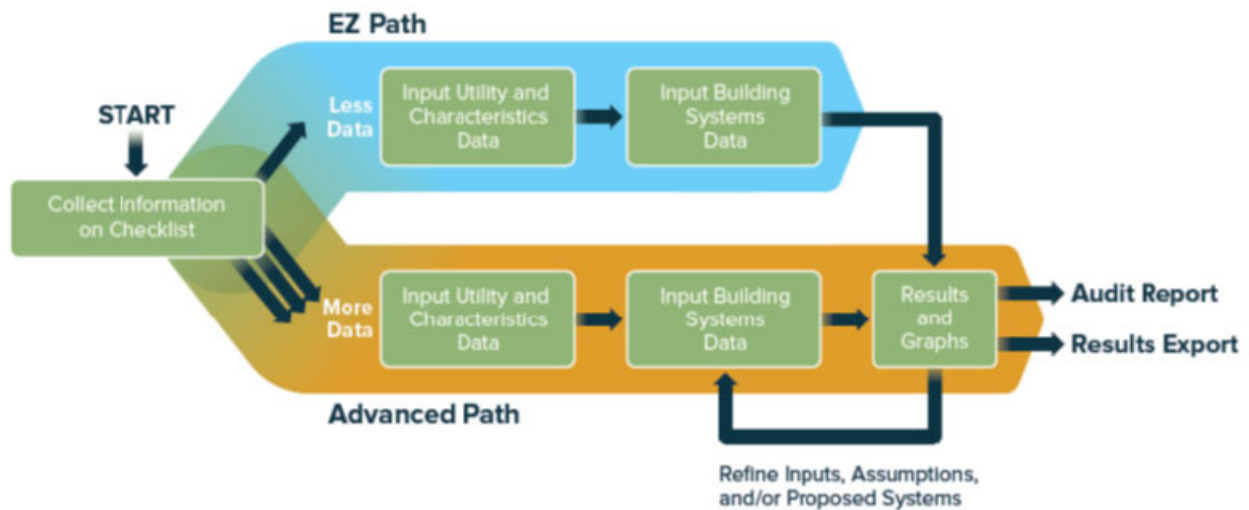
Figure 3. Basic flow of EZ Retrofit and two pathways.

There are multiple ways to view results across systems. One screen lists any measure that offers energy or water savings, regardless of the level of savings or installation costs. Within the list of all results, the tool offers a shopping cart approach, allowing users to select Yes or No and providing summary information on the package of measures selected. Another screen displays a subset of upgrade opportunities using criteria selected by the user (e.g. payback period for either individual measures or a package of measures, total cost, or a certain savings threshold). Once a package of measures is selected from either the shopping cart or criteria filter, EZ Retrofit produces an audit report that can be shared with other decision makers or potential funders.

Target User

EZ Retrofit can be used by a wide range of users. It is primarily designed for use by multifamily building owners and managers but may also be used by auditors, energy engineers, or utility program staff. Technical knowledge of building systems is not required for operation of the tool, but some familiarity with building equipment is required to collect and appropriately enter building information. Users with more in-depth technical knowledge of buildings and building systems can leverage the tool to provide more accurate results, using the Advanced Path to adjust the tool's default assumptions (e.g. by overriding default system efficiencies with observed conditions if different).

EZ Retrofit Pilot

Methodology

EZ Retrofit was used to assess 32 multifamily properties between June, 2012 and August 2015.[2] SAHF and Bright Power conducted site visits and on average spent eight to twelve hours gathering data and running EZ Retrofit. These assessments were done using the EZ Path and

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[2] An additional 5 properties were assessed between October and December 2015. These assessments are excluded from this paper because results were not available at the time of writing and an analysis.

provided critical feedback to the development of the tool itself, which was ongoing and iterative during this time. All of the pilot properties are owned by 10 SAHF member organizations. A subset of the properties received additional third-party audits which serve as a comparison point between EZ Retrofit and a more traditional audit approach. Another subset undertook retrofits during the pilot period. Numbers of properties undertaking each activity during the pilot are summarized here:

- Out of 32 properties, 8 properties had third-party audits suitable for analysis.
- Out of 32, 7 properties undertook some type of retrofit during the pilot period.

Characterization of Properties

The properties assessed encompass a variety of building locations, ages, types, and sizes.

Geographic distribution. SAHF member properties are well distributed around the country, providing a range of locations for the EZ Retrofit assessments. Properties were assessed in 14 states, spanning five of the seven ASHRAE climate zones as shown in Figure 4.[3] The climate zones are defined by the International Energy Conservation Code (IECC) and referenced by ASHRAE and building codes across the country. Zones 1 and 7 are relatively small, especially from a population perspective, and the pilot did not prioritize covering all zones.
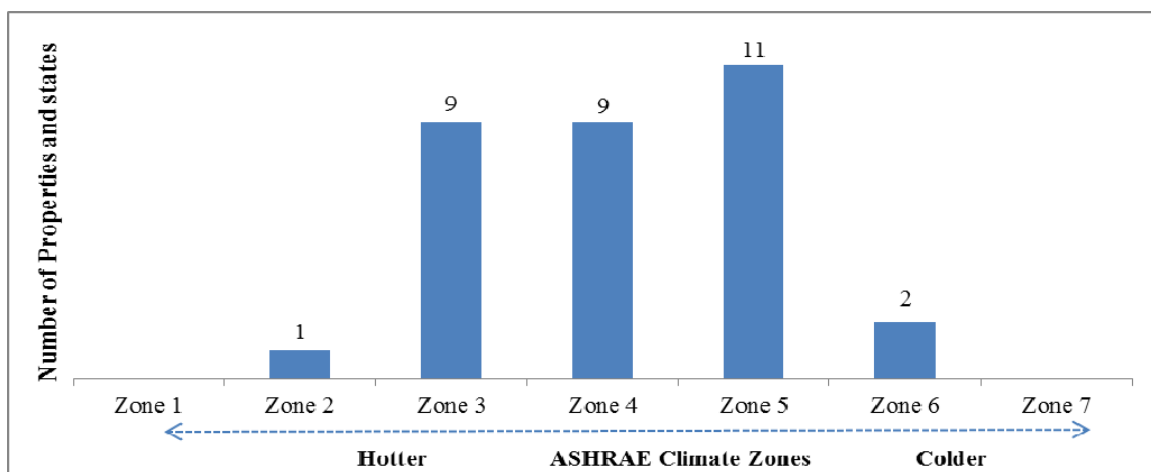

Figure 4. Distribution of properties assessed by climate zones and states

Property size and type. Properties ranged in size from 16 to 357 units, with most properties in the range of 50-100 apartments. More than 25% of the buildings assessed in the pilot contained 150 or more apartments, whereas buildings in this size range represent only 10% of SAHF member portfolios.

All four common types of multifamily properties are represented: 6 High-Rise, 8 Mid-Rise, 15 Low-Rise, and 3 Garden Style. Properties also ranged in year of construction from 1940 to after 2000, with several having undergone substantial rehabilitations within the last 20 years.

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[3] For a guide to ASHRAE climate zones see:
http://apps1.eere.energy.gov/buildings/publications/pdfs/building_america/ba_climateguide_7_1.pdf

Third-Party Audits

This evaluation used eight third-party audits that were at least a level II audit, providing a generally more expensive, in-depth and rigorous comparison to EZ Retrofit. There were several differences between the types of third-party audits that might have presented a barrier to a statistical evaluation but did not preclude our more qualitative evaluation.

While some third-party audits went beyond typical level II components, our comparison is geared to features common in level II audits, i.e. recommended measures and projected savings. Additional elements present in some of the audits such as detailed financial projections were not reviewed here. The comparisons made are more applicable to level II audits generally.

Types of Measures Included in EZ Retrofit Results

This section presents the types of measures included in EZ Retrofit results and compares EZ Retrofit to third-party audit scopes where available. EZ Retrofit offers multiple options for reviewing results. For the purposes of this evaluation, we use an 8.0 year simple payback as the maximum cut-off for inclusion in the EZ Retrofit scopes.

As shown in figure 5, EZ Retrofit identified a range of measures, with certain common, low-hanging fruit ECMs identified at a large majority of properties. There is significant overlap in the types of measures recommended by EZ Retrofit and third-party audits at the eight properties, with some notable exceptions. Lighting, low-flow aerators, and showerheads were recommended at 50% or more of the sites in both audit approaches. EZ Retrofit shows a substantially higher frequency of washing machine replacement while third-party audits more frequently recommended thermostats, toilets, DHW recirculation pumps, and DHW insulation. The miscellaneous category includes several measures not assessed by EZ Retrofit (timers on rooftop fans, new boiler or chiller controls, building automation systems, solar PV systems, vending misers, and smart-strips). Refrigerators were in fact identified by EZ Retrofit scopes at many properties, but typically did not meet the 8 year payback threshold used for this analysis.
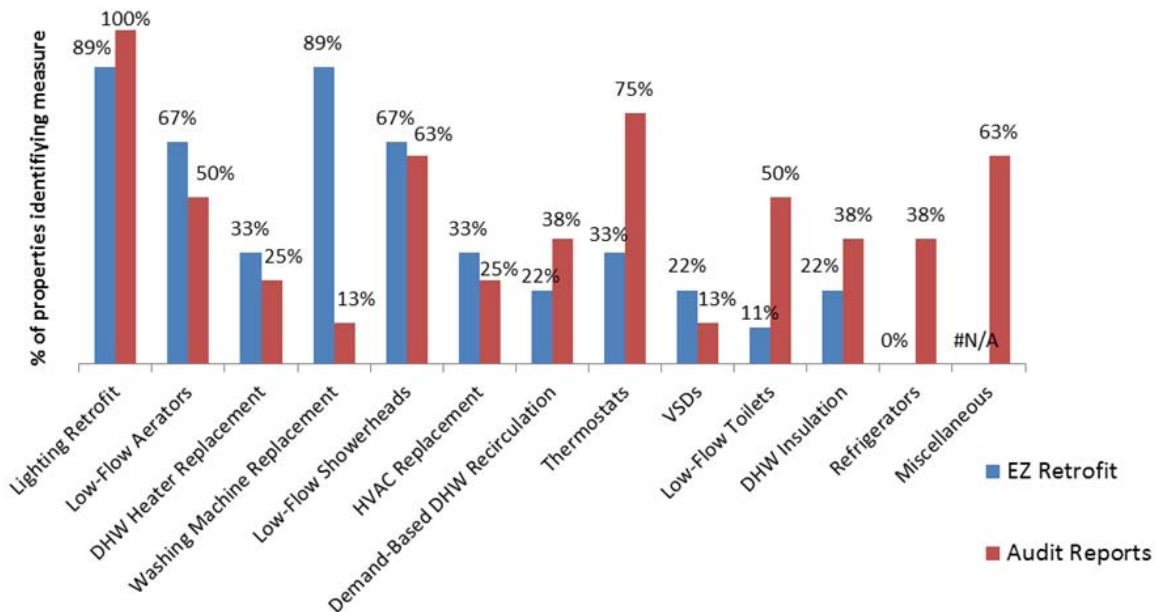

Figure 5. Most common measure types in third-party audits and EZ Retrofit using EZ Path (<8 year payback only)

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The agreement on common measures suggests that a large portion of the value of a level II audit in identifying appropriate measures is captured by EZ Retrofit. While this set of eight properties is not nationally representative or large enough to draw statistical conclusions, some possible explanations for the differences in recommended scopes include:

- The higher prevalence of washing machine recommendations in EZ Retrofit may be due to this measure being excluded from third-party audits because machines are often leased.
- The higher prevalence of thermostats in the third-party audits is partially due to a broader range of recommendations being included in this category. EZ Retrofit only evaluates installing programmable thermostats but not resetting or recalibrating thermostats.
- The miscellaneous measures not included in EZ Retrofit fall into two categories:
  - Small, low-cost measures such as vending misers: These measures have small impacts and have not been prioritized in the development of EZ Retrofit to date.
  - More custom measures such as controls for central HVAC or solar PV: Assessing feasibility and in some cases gathering the right type of data on existing conditions for these types of upgrades would be unrealistic for a non-engineer, or may require nuanced understanding difficult to program into a spreadsheet tool.

Level of Savings Projected by EZ Retrofit

Projected savings - whole property. Across 32 properties, the median projected cost savings projected by EZ Retrofit were $210/unit/year, which is lower (more conservative) than average savings seen other recent studies of national multifamily efficiency upgrade programs. For instance, an analysis of 179 multifamily properties which participated in HUD's Green Retrofit Program found actual first year savings of $308/unit/year from energy and water upgrades.[4]

Figure 7 shows the distribution of projected cost savings from EZ Retrofit scopes at each of the 32 properties. Projected savings range from under $100/unit/yr to over $700/unit/yr, with a large a majority of all properties estimating between $100 and $500/unit/year of projected savings. For the subset of eight properties that received both a third-party and an EZ Retrofit audit, the median projected cost savings from EZ Retrofit was $141/unit/year whereas the third party audits projected $171/unit/year (bearing in mind that there were differences in the recommended scopes).

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[4] "Energy and Water Savings in Multifamily Retrofits," SAHF/ Bright Power, 2014: http://www.sahfnet.org/multifamilyretrofitreport_2_1287596736.pdf
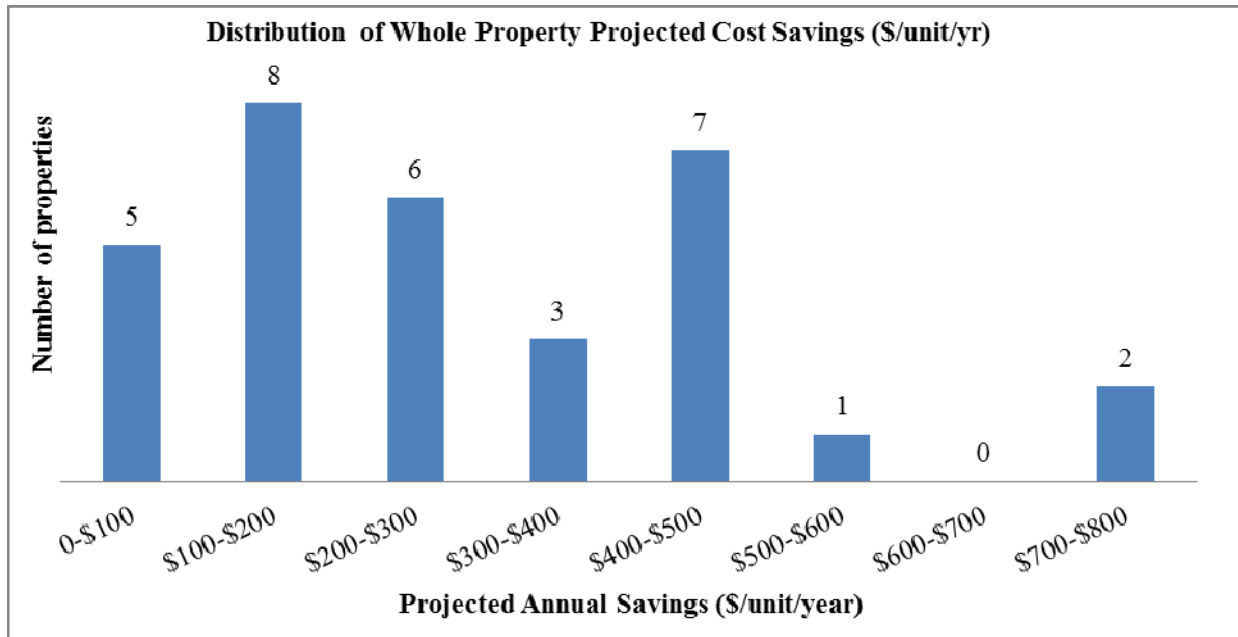
Figure 7. Distribution of whole property projected energy and water cost savings ($/unit/yr) for 32 properties (<8 year payback only).

Projected savings – by measure category. In this section we analyze the measures in the EZ Retrofit scopes that are contributing the most to the savings. Figure 8 shows the cumulative projected cost savings by measure category[5] for both EZ Retrofit and third-party audit scopes for the eight properties.

Across both EZ Retrofit and third-party audits, lighting, water efficiency, and HVAC appear to be the most impactful measures. Domestic hot water and appliances, which are very commonly recommended in both types of audits, appears less impactful overall, due to lower savings per unit for these measures.

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[5] "Other" includes air-sealing, duct-sealing and appliance measures, categories which appear in both EZ Retrofit and third-party scopes. "Miscellaneous" includes only measures not present in the EZ Retrofit tool.
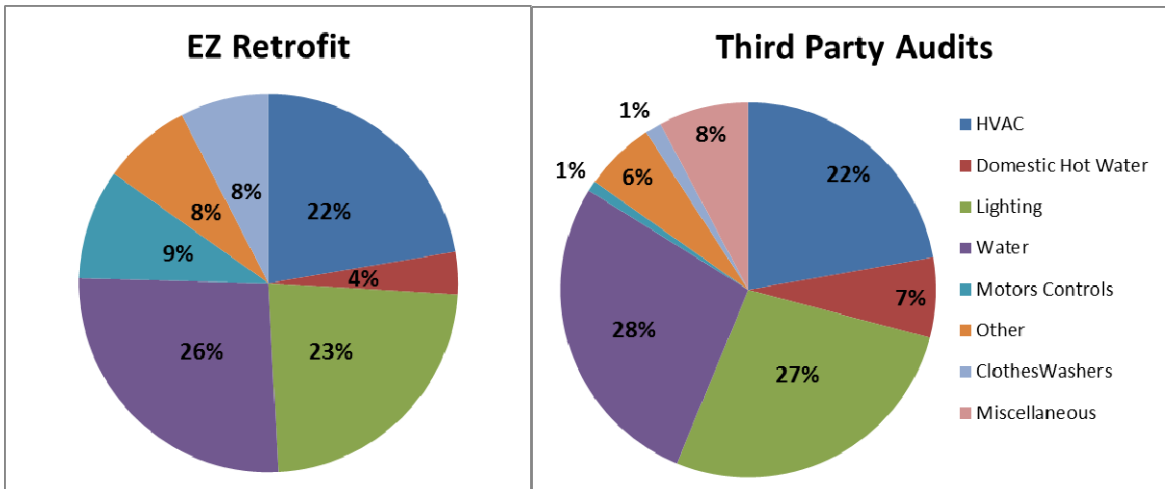
Figure 8. Breakdown of cumulative savings projections by measure type.

We found it challenging to draw any conclusions on the accuracy of savings calculations based on a juxtaposition of projections between EZ Retrofit and third-party audits for the same measures at the same site. In most cases, we found some variations in what specific upgrades were included in a measure of the same name across EZ Retrofit and third-party audits, as well differences in the recorded existing conditions of building systems, for instance:

- At one property, both EZ Retrofit and the third-party recommended pipe insulation and lighting upgrades. However, for lighting upgrades, EZ Retrofit identified common area upgrades whereas the third-party audit identified in-unit upgrades, making a direct comparison of projections impossible. On pipe insulation EZ Retrofits projected savings is roughly twice the audit projection (162 vs. 83 therms/year). In order to simplify data entry, EZ Retrofit uses an *estimate* of the length of uninsulated pipe, whereas the third-party audit included a *measurement* of uninsulated pipe, a difference in tool inputs which could easily explain the difference in results.

- At another property, both EZ Retrofit and the third-party audit recommend lighting upgrades, with EZ Retrofit projecting slightly higher savings (approximately 274,000 kWh/year vs. 246,000 kWh/year in the third-party audit). In this case the scopes appear similar. The difference in projections is also relatively minor and could easily be explained by slight differences in calculations (e.g. different assumed run-hours of lighting different choices in the particular upgrade recommended).

- At a third property, both EZ Retrofit and the third-party audit recommended water fixture upgrades, with the third-party audit projecting more than four times the savings as EZ Retrofit (507,000 gallons per year vs. 110,000 gallons per year). A reading of the audit revealed that they were recommending extremely efficient fixtures (toilets with 0.8 gpf and bathroom faucets with 0.35 gpm rating) where as EZ Retrofit uses more modest, but still high efficiency ratings to estimate savings (1.28 gpf toilets, 1.0 gpm faucets). In the EZ Retrofit assessment, toilet replacement did not meet the 8.0 year payback threshold, presumably because the savings from the more modest gain were not great enough to justify costs. In this case differences in the proposed upgrades appear to cause the differences in the savings projection.

These examples illustrate the challenge of making a direct comparison of EZ Retrofit to third-party audit savings projections. In general, where there are discrepancies there appear to be reasonable explanations and our review has not suggested any systematic problems with the EZ Retrofit calculations. It is also important to note that third-party audits employ a wide variety of calculation methods and tools, and we were not able to analyze those in detail for the eight third-party audits here. Further study would be needed to assess the accuracy of EZ Retrofit or third-party audit savings calculations.

Is EZ Retrofit a Practical Audit Approach?

The assessments conducted at 32 properties indicate that EZ Retrofit is a viable approach to multifamily building audits, capable of generating practical scopes of energy and water upgrades across a diverse set of multifamily buildings. Gathering the basic property information was feasible at all selected properties. Energy and water upgrades were identified at all properties. Some systems or system components not addressed by EZ Retrofit, including outdoor irrigation and controls for central heating systems, were present in the buildings, but the tool was able to identify other savings opportunities at these sites.

During and after the assessments, and after trainings on the tool provided for owners, feedback from a set of users was gathered through phone, email conversations and online surveys. Based on this feedback and the experience of Bright Power auditors who used the tool, the following strengths and challenges have been identified from the user perspective (comments in quotes come directly from user survey responses):

Strengths - User Perspective
- The tool was substantially faster to complete than an energy model or detailed engineering calculations.
- The minimum data required by the EZ path appears to simplify the process sufficiently for a non-engineer. One user commented, "it's easy to make baseline assumptions because the EZ Path provides options to choose from."
- In particular, the EZ Retrofit interface makes data entry easy and provides quick calculation of savings for lighting, appliances, and water.
- Flexible reporting choices offer the user the ability to customize scopes of work and export data for sharing. In particular the ability to "accommodate price changes/bids [from contractors]" was appreciated by one user.
- Several owners reported that they intend to use the tool more widely in their portfolios following the pilot. For instance, three out of four owners who attended an August 2015 webinar responded that they would "Definitely" plan to use EZ Retrofit to assess their buildings' performance.

Challenges – User Perspective
- Simplified data entry fields create the need for the user to make some judgment calls. For instance, when forced to categorize the existing condition of the pipe insulation, the user must make a subjective decision on whether existing insulation is adequate.
- Some users reported a learning curve in getting used to the tool, for instance: "becoming familiar with the terms the program uses….can take some getting used to."

- Simplified data entry fields create a challenge for more complicated systems. For instance, HVAC systems serving multiple zones cannot be accurately entered in the EZ Path.
- Gathering historical utility data, especially tenant bills – remains a challenge for many owners. (EZ Retrofit does provide results without utility data, but they are expected to be less accurate.)

Many of the challenges identified here are challenges inherent in any audit process. The need for some training and guidance was requested by early users, and "video tutorials" were often suggested as a good medium for trainings on EZ Retrofit. To address these needs during the pilot period, SAHF conducted an open webinar demo in February 2016, individual online and in-person trainings for several pilot users, and has posted online tutorials and other resources for users at: http://www.sahfnet.org/ezretrofit.html.

Conclusion

A primary goal of EZ Retrofit is to reduce the cost associated with a comprehensive audit. An owner might reasonably expect to reduce out-of-pocket costs and increase staff time commitment when conducting an EZ Retrofit audit as an alternative to hiring a third-party auditor. The owner time involved in either approach can vary substantially. We estimate a typical range of owner commitment of 12-72 person-hours/property for EZ Retrofit and 7-40 person-hours/property for a third-party level II audit (not including the time spent by the third party auditor). Based on these ranges and using an assumed hourly owner staff cost of $50/hour, not surprisingly, EZ Retrofit appears less expensive. Depending on third-party audit vendor costs and the time investment in EZ Retrofit, the difference could be as small as $2,000, or more than $30,000. Thus, when choosing an audit approach and deciding how much time and money to invest, it is important to keep in mind the expected scale of the opportunity and goals for the retrofit project.

For any type of audit, it is important for users to recognize that results may vary between approaches, providers, or programs. As with any tool, the successes of projects that use EZ Retrofit ultimately depend on the data accuracy and how the approach is employed. It is important to analyze post-retrofit data requires ongoing tracking and engagement.

The value of an energy audit should be measured by how well it informs good decisions on what upgrades to pursue and facilitates excellent results from the upgrades that follow an audit. The true life-cycle value of the retrofit project should include all benefits (energy and water savings and other) net of both installation and equipment costs and soft-costs (including audit, design, construction management, etc.). This evaluation suggests that EZ Retrofit provides a good value compared to traditional audits for the most common energy and water efficiency measures across a variety of systems.