Deutsche Bank
Corporate Social Responsibility

Passion to Perform

Recognizing the Benefits of Energy Efficiency in Multifamily Underwriting

January 2012

In conjunction with:

LIVING CITIES
INNOVATE ▸ INVEST ▸ LEAD

Prepared by:

Steven Winter Associates

HR&A Advisors

The Deutsche Bank Americas Foundation ("DBAF") administers the philanthropic activities of Deutsche Bank within the United States, Latin America and Canada. DBAF, together with the Bank's Community Development Finance Group (CDFG), carries out the firm's corporate citizenship commitments through a program of loans, investments and grants. Deutsche Bank relies on a network of nonprofit organizations and community development intermediaries to achieve results, and actively seeks to partner with philanthropic, government and private sector institutions in its work.
See: http://www.db.com/usa/content/en/social_responsibility.html

Deutsche Bank Americas Foundation
60 Wall Street
New York, NY 10005
www.db.com

Living Cities is an innovative philanthropic collaborative of 22 of the world's largest foundations and financial institutions. Living Cities members participate at the senior management level on the Living Cities Board of Directors and contribute the time of 80+ expert staff toward crafting and implementing its agenda, which is focused on improving the lives of low-income people and the urban areas in which they live. Living Cities aligns local, state and federal policies to effectively address the issues surrounding jobs, housing, climate change, asset building and health care, leveraging the collective power of the public, private and philanthropic sectors especially through new and innovative ways of aggregating capital.
See: http://livingcities.org/

Living Cities
1040 Avenue of the Americas, Floor 17
New York, NY 10018
www.livingcities.org

Foreword

Deutsche Bank Americas Foundation instigated this project to encourage the financial industry to scale up financing of building energy efficiency retrofits. Deutsche Bank has a long history of supporting multifamily / affordable housing through its community development finance capabilities, and throughout the world the Bank has played a leadership role on climate issues. Scaling up building retrofits has become a compelling aspiration for the Bank, because of the alignment between our carbon reduction and community development goals.

Building scientists, auditors, enlightened building owners, and contractors have been retrofitting multifamily buildings in New York City for many decades, but the retrofit industry has largely relied on public subsidies, a limited resource that has constrained the industry's ability to scale. Private capital, if deployed for retrofits, could prove transformational in achieving significant carbon reductions while upgrading multifamily buildings and stimulating much-needed job creation. This study has tried to address a key bottleneck for private capital: the lack of confidence in energy savings for lenders to underwrite loans against.

New York City proved an exceptional laboratory for commencing the study. A long tradition of public private partnerships enabled the project to be stewarded by hands-on group of practitioners from city and state housing agencies, community development intermediaries, utilities, energy program incentive providers, and other mission-driven nonprofits. (A full list of organizations represented can be found in the *Approach* section of this report.) A key partner in the effort is Living Cities, a national community development collaborative, which is helping propel the study's findings to a national audience.

Special thanks to Rockefeller Brothers Fund, who in partnership with the New York City Department of Housing Preservation and Development, provided additional resources to the project. We are also grateful to the Oak Ridge National Laboratory and the National Weatherization Assistance Program Evaluation, who generously provided access to additional data on New York City buildings. Finally, special thanks to Steven Winter Associates and HR&A Advisors, who excelled in aligning the often disparate worlds of building science and finance towards a compelling case for investing in energy efficiency retrofits.

Gary Hattem

President
Deutsche Bank Americas Foundation

Sam Marks

Vice President
Deutsche Bank Americas Foundation

Table of Contents

Prepared by:

Steven Winter Associates
307 Seventh Ave, Ste 1701
New York, NY 10001
www.swinter.com

HR&A Advisors, Inc.
99 Hudson St, 3rd Fl
New York, NY 10013
www.hraadvisors.com

Jason Block
Candace Damon
Liz Eisenberg
Dara Goldberg
Cary Hirschstein
Marc Zuluaga

Questions? Contact:

Marc Zuluaga
(212) 564-5800 x114
mzuluaga@swinter.com

Cary Hirschstein
(212) 977-2704
cary@hraadvisors.com

01 Executive Summary

The Challenge

Our nation's multifamily buildings contain billions of dollars of energy savings potential. A 2009 study by McKinsey and Company estimated that the capital required to unlock energy efficiency opportunities in low-income residential buildings between 2009 and 2020 is approximately $46 billion, and would provide a present value of $80 billion in savings. Almost a quarter of this energy efficiency potential is in multifamily buildings.

The capital to unlock these improvements is usually not readily available. Energy savings potential could be utilized to support requests for additional capital. Conventional lenders, however, treat energy savings projections skeptically and virtually never incorporate them in the underwriting models that determine the sizing of loans. Rather, they rely on historic building performance or industry standards, not forward-looking projections.

Many lenders explain their reluctance to underwrite against savings by pointing to the lack of data by which to judge the accuracy of energy savings projections. Despite decades of investment in energy efficiency in multifamily buildings, there are no commonly accepted datasets, data standards, or third party verification practices to measure and confirm energy savings. This means that lenders cannot reliably assess the risk associated with lending against energy savings projections.

Our Approach

In response to this challenge, Steven Winter Associates and HR&A Advisors were commissioned by Deutsche Bank Americas Foundation and Living Cities (DB/LC) to aggregate and analyze a dataset of affordable multifamily housing projects.[1] The team amassed a database of 231 projects – more than 21,000 units – that had undergone energy efficiency retrofits in New York City.

A dataset of this size and scope has never been built before for multifamily housing. Its development allows for insights into three key areas:

1. Assessing trends in pre- and post-retrofit building performance;
2. Analyzing the reliability of savings projections; and
3. Utilizing findings to frame an approach for incorporating energy savings projections into underwriting.

The project team analyzed New York City projects that had participated in multifamily programs sponsored by the New York State Energy Research & Development Authority (NYSERDA) and/or the federal Weatherization Assistance Program (WAP). The team also engaged the affordable multifamily lending community, as a means to understand the potential for incorporating energy efficiency savings projections into underwriting.

Team member HR&A Advisors also conducted a study of the benefits of energy efficiency retrofits that accrue to building owners, tenants, and their communities. Energy efficiency retrofits provide an opportunity to ensure the long-term viability of affordable housing, create "green collar" jobs, generate economic activity in very low- to moderate-income communities, improve tenant health and comfort, and reduce greenhouse gas emissions.

For more on this portion of the study, please refer to http://www.db.com/usa/content/en/ee_in_multifamily_underwriting.html

[1] More than 96% of projects in the database were affordable rental housing. Due to the unique energy usage and building characteristics of this market sector, outcomes cannot be translated directly to other market sectors.

Central Findings

The project team analyzed the 230+ building dataset to assess total savings achieved and savings as a percentage of projections. These data-driven findings suggest a rationale and methodology for underwriting against fuel savings projections.

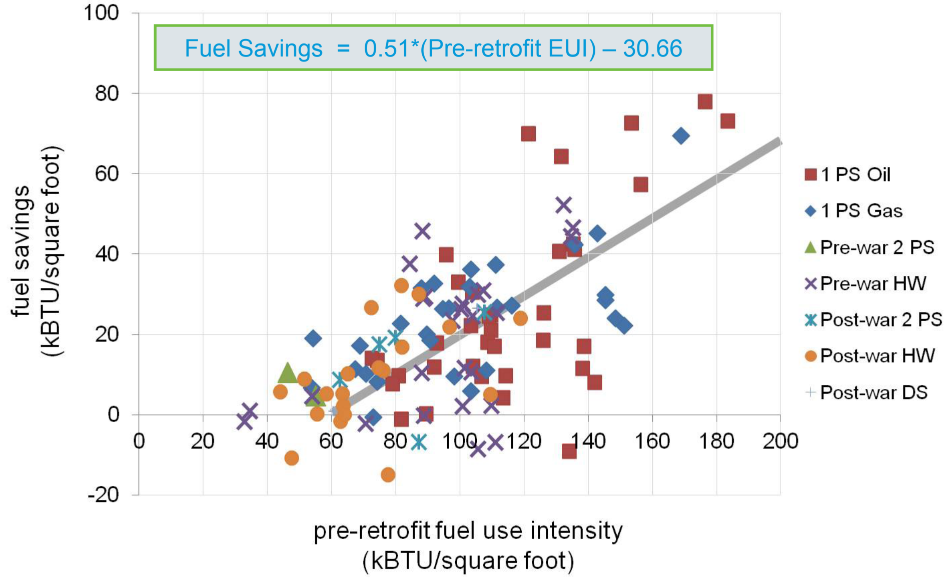
1. Building retrofits save energy. Across the DB/LC "portfolio," buildings reduced their fuel consumption by 19% and electric consumption by 7%.[2]

2. Fuel measures save more than electric measures. On average across the portfolio, buildings recorded $240 in per unit savings for fuel and $50 in per unit savings for common area electricity. In general, fuel savings varied less than electric savings and were more predictable. Pre-retrofit fuel usage was typically a greater expense than common area electricity, accounting for upwards of $1,000 to $1,600 per unit, versus $100 to $300 per unit.

3. Actual savings are strongly correlated with pre-retrofit fuel usage. The study analyzed a wide range of building characteristics and retrofit scope measures to examine how they impacted savings. While a number of weaker correlations existed, only one factor was significantly related to post-retrofit performance: pre-retrofit fuel use intensity (the amount of fuel a building consumes in kBTU per square foot of heated building area). Higher pre-retrofit fuel use intensity translated to greater savings potential; the buildings that consumed the most fuel on a per square foot basis pre-retrofit often achieved greater savings. Furthermore, the team found that heating system type and building vintage are good proxies for fuel use intensity.

Relationship Between Buildings' Actual Post-retrofit Savings and Pre-retrofit Fuel Consumption

Actual Fuel Savings vs. Projected Fuel Savings



Using regression analysis, the team derived an empirical model that identified the linear relationship between a building's post-retrofit savings and pre-retrofit fuel consumption. This relationship, depicted by the grey line in the chart above, represents the only statistically significant trend identified in post-retrofit performance relative to pre-retrofit characteristics in the DB/LC dataset.

[2] For master metered buildings in the study, whole-building electric consumption was examined.

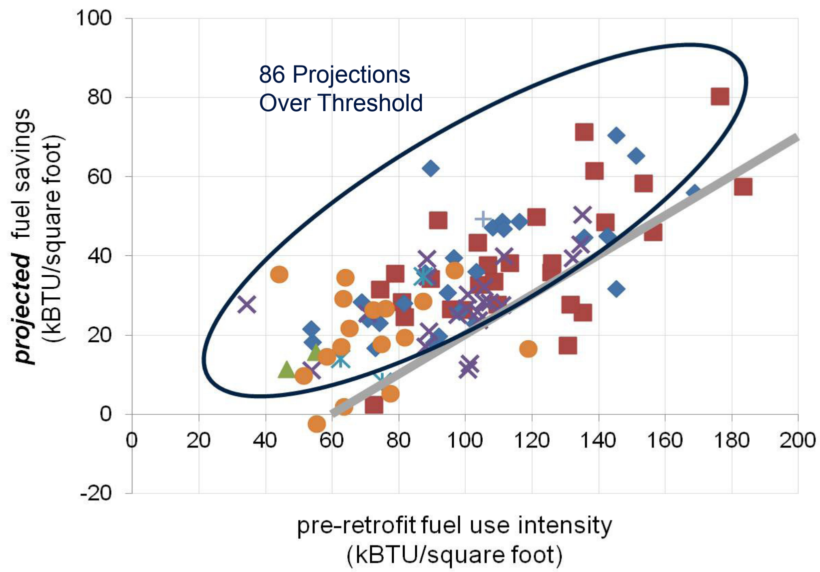
4. **Strategically capping projections can improve a portfolio's realization rate.** The team examined the portfolio's "realization rate" – a term used in this report to mean actual savings divided by projected savings – to assess achievement of projected savings across the dataset. While fuel savings projections ranged from 25% to 50% across about two-thirds of the buildings, most projects actually saved 10% to 40%.

   A variety of factors influence the ultimate accuracy of savings projections, including how much of the associated scope of work was implemented, equipment specifications, the quality of construction and ongoing facility management, and the quality of the energy audit. Nonetheless, there is no systematic means of quantifying the relative influence of each of these key factors individually across the DB/LC dataset.

   A lender or auditor can use pre-retrofit fuel usage to "cap" projections that may be overly optimistic and place a conservative upper boundary on anticipated savings. Reducing these "over-projections" improves the fuel realization rate across the portfolio from 61% to 117%.

   The study suggests that neither the existing physical models[3] employed by auditors (e.g., energy modeling software) nor the empirical model the study developed is sufficient: buildings are complex and unique, and a variety of factors interacted in each building examined with idiosyncratic results. A "hybrid approach" that uses both a physical and empirical model in tandem, however, results in savings projections upon which a lender could rely for underwriting purposes across a portfolio.

Using the Threshold To Determine More Conservative Projections
Projected Fuel Savings vs. Pre-retrofit Fuel Use Intensity



By strategically "capping" projections based on the linear relationship identified between actual savings and pre-retrofit fuel use intensity, the team improved the portfolio's overall realization rate. This methodology can reduce the risk of over-projections when underwriting against savings projections.

[3] A physical model is a tool for estimating how a building utilizes energy, providing a forward-looking means to identify potential for consumption reduction. The model might include anything from a series of simple equations to a more complicated computer simulation of a building's systems. The computer simulation attempts to represent how a building utilizes energy; most of the projects in the DB/LC database used TREAT or EA-QUIP to determine savings projections, but there are other software tools available.

Implications for Underwriting

The study suggests an approach to underwriting against fuel savings projections, balancing the need for simplicity with that for accuracy.

1. Collect basic energy data prior to or at the point of loan application, including building vintage, heating system type, total fuel expenses, current commodity prices, electric metering configuration, and past or planned capital work.

2. Benchmark buildings to identify savings opportunities, comparing a building's fuel usage against its peers by age and heating system type. This will indicate whether savings opportunities may exist and whether an energy audit should be pursued.

3. Develop procedures to ensure the quality of energy audits, including pre-qualification of auditors and deployment of standardized data reporting procedures that would provide lenders with a clear, concise summary of audit findings and recommendations, allowing for apples-to-apples comparisons across lenders' portfolios.

4. Incorporate cost and savings projections into underwriting. Following completion of an energy audit, lenders would review auditor recommendations and benchmark cost estimates. If traditional underwriting practices do not cover the cost of the proposed retrofit, an underwriter would utilize "enhanced" procedures. First, the lender would estimate the additional cash flow required to finance the retrofit cost.

   Then the lender would use a simple lookup table to compare the audit projection to the DB/LC "capped" threshold for anticipated savings based on a building's pre-retrofit fuel use intensity. The lender would then choose the lower of the two (the "adjusted projection"). If the additional cash flow required is less than the adjusted projection, then the lender can safely underwrite to that amount. If not, it can underwrite to the adjusted projection.

   In both cases, we recommend that lenders also consider a set of additional quantitative and qualitative factors in their underwriting practices, including an owner's energy efficiency project experience, facilities staff training, auditor and contractor experience, and a range of financial considerations.

5. Ensure effective implementation and management. Best practices guidelines for owners, delivered in the form of a simple manual, would recommend actions to maximize achievement of projected savings and reduce risk of underperformance. Standards and requirements for the long-term tracking and reporting of energy performance are also central to the success of the effort, to allow for intervention when projects are not performing as projected.

Portfolio Analysis

To understand the implications of the strategic capping methodology on a hypothetical set of loans, the team applied the methodology to the 100 projects in the DB/LC portfolio with comprehensive fuel data, comparing how loans might have performed if the lender underwrote against energy savings.

The capping methodology resulted in a realization rate of 117% versus 61% in the case of unadjusted audit projections. Under the capping methodology, lenders would have underwritten slightly less than the actual savings supported, assuming that the energy retrofit is financed as part of a 30-year amortized mortgage, resulting in positive performance across the portfolio.

The capping methodology also cut annual repayment shortfalls across the portfolio to less than a fifth of what would have occurred if lenders had underwritten to audit savings projections.[4] Note that any remaining repayment shortfalls only apply to the energy savings loan increment, and not the overall loan, which would be much larger. Of those loan increments falling short in repayment due to energy savings underperformance, the median annual shortfall would have been $110 per unit. This is a very small amount of overall building expenses, approximately 2% on average, not including taxes.[5] On average, the surplus cash flow required by debt service coverage standards on the energy portion of the loan would cover about two-thirds of this shortfall. Presumably, the debt service coverage requirements on the overall loan would cover the shortfall in all cases.

Finally, the study found that for half of these projects, the new loan increment derived from fuel savings projections was sufficient to fully support the capital required for comprehensive energy efficiency improvements.

In the case of standalone (add-on) financing, the study suggests that additional screening measures could be explored to improve portfolio performance and reduce repayment shortfalls. For instance, additional screening might include special treatment of buildings heated by one-pipe steam systems, which have high variability in retrofit performance.

Next Steps

The next step toward market transformation will be proof of concept, executing transactions that show how underwriting against energy savings projections can be a viable financing practice. The DB/LC study provides a starting point for an underwriting methodology. Lenders, credit enhancers, and building science experts now need to collaboratively refine the methodology. Similarly, the industry must develop complementary tools and resources, including standardized data reporting protocols, owner best practice guidelines, and energy monitoring standards.

A 2012 follow-up grant to the New York City Energy Efficiency Corporation by Living Cities will permit taking this next step, utilizing the DB/LC dataset to pilot new underwriting guidelines and the development of complementary resources through an initial series of transactions with affordable housing lenders.

---

[4] Assumes a 30-year amortized mortgage, with an interest rate of 7% and debt service coverage ratio of 1.30.

[5] Assumes annual building expenses of $5,000 to $6,000 per unit per year, net of taxes.

02 Approach

The Deutsche Bank Americas Foundation / Living Cities study is the first step towards aggregating and analyzing pre- and post-retrofit performance data for the purposes of underwriting against projected energy savings.

Background

Recognizing that lack of reliable data is a critical factor limiting investment in energy efficiency, Deutsche Bank Americas Foundation and Living Cities cosponsored a study of multifamily retrofits in New York City. The objectives were to:

1. Assess trends in pre- and post-retrofit building performance;
2. Analyze the reliability of savings projections; and
3. Utilize findings to frame an approach for incorporating energy savings projections into underwriting.

The study sought to integrate the worlds of building science and finance, translating buildings science analyses into principles for multifamily underwriting.

In support of this effort, Deutsche Bank and Living Cities (DB/LC) assembled an advisory committee of public sector agencies, local utilities, community development financial institutions, and a variety of nonprofit institutions. The group was selected to provide an interdisciplinary, cross-sectoral representation of utility companies, and building science, housing and finance experts.

The advisory committee made its priorities clear: assemble, analyze, and disseminate reliable data as a means to create change in how public and private underwriters and investors approach energy efficiency investments in affordable multifamily housing. The effort was also intended to provide critical insights to advance public policy and improve the effectiveness of public incentive programs and mandates.

The advisory committee included members from the following organizations:

- Consolidated Edison
- Community Preservation Corporation
- Enterprise Community Partners
- Local Initiatives Support Corporation
- Low Income Investment Fund
- National Grid
- Natural Resources Defense Council
- NYC Department of Housing Preservation & Development
- NYC Economic Development Corporation
- NYC Energy Efficiency Corporation
- NYC Housing Development Corporation
- New York City Investment Fund
- NYC Office of Long-Term Planning and Sustainability
- New York State Energy Research and Development Authority (NYSERDA)
- NYS Homes & Community Renewal
- Rockefeller Brothers Fund
- Seedco Financial Services

The interdisciplinary project team was charged with bridging the traditionally separate worlds of building science and multifamily finance.

With the advice of the advisory committee, DB/LC retained two consultant firms, Steven Winter Associates and HR&A Advisors, to conduct the study. The project team included:

Steven Winter Associates, Inc. (SWA) is a 39-year-old architectural and engineering firm providing research, consulting and advisory services to improve commercial, residential, and multifamily built environments for public and private sector clients. SWA specializes in certification, energy, sustainability and accessibility consulting as well as R&D, compliance services and training programs.

HR&A Advisors, Inc. (HR&A) is a 30-year-old real estate, economic development and public policy consulting firm with a specialized practice in the economics of energy efficiency in existing buildings. In the past decade, HR&A has emerged as a forerunner in economic feasibility assessment and management of large-scale energy efficiency initiatives for existing buildings.

Michael Blasnik & Associates provided analytic support to the team. Principal Michael Blasnik has 25 years of experience in energy efficiency, building science research, and program evaluations. His practice focuses on pilot program design and analysis, impact evaluation methodology, assessment and refinement of engineering algorithms for predicting energy savings, development of building diagnostics approaches, statistical analysis, and mathematical modeling of building performance.

Northern Manhattan Improvement Corporation (NMIC), a community-based, not-for-profit organization founded in 1979 to serve the Washington Heights and Inwood communities, and Association for Energy Affordability, which provides weatherization services to improve the energy efficiency of multifamily buildings, provided additional data on pre- and post-retrofit performance of multifamily buildings that recently underwent weatherization.

Project Approach

In July 2010, the DB/LC project team commenced the collection of pre- and post-retrofit energy data, as well as energy audit reports, from affordable[6] multifamily buildings in New York City that had completed NYSERDA's Assisted Multifamily Program, NYSERDA's Multifamily Performance Program, and/or the federal Weatherization Assistance Program. Over the course of 15 months, the team amassed an unprecedented dataset, the largest and most detailed in the multifamily housing sector to date, encompassing 231 projects and more than 21,000 units.

The project team analyzed the dataset to compare savings predictions to actual performance, based on a range of building and retrofit characteristics. One primary objective was the identification of simple predictive models for energy performance, as well as key risk factors and best practices for achievement of savings projections. In addition, the team sought to translate trends in building performance and savings projections into a methodology for incorporating energy efficiency savings projections into underwriting standards.

In addition to the building data analysis, the project team conducted two rounds of outreach to lenders to review existing underwriting practices with regards to energy efficiency and to obtain feedback on the team's suggestions for incorporating energy savings projections into underwriting. The initial round of lender outreach consisted of a series of interviews with public and private multifamily lenders, which helped identify potential benefits and market barriers to incorporating energy savings projections in the underwriting practice.

In the second round of lender outreach, the team discussed its proposed methodology and approach to incorporating savings projections into underwriting. Lenders' feedback on the new underwriting guidance helped the team to refine its proposed methodology.

The project team also participated in interim working group discussions and presentations, and aligned with other data collection efforts and energy efficiency policy initiatives, including:

- Collaboration with the National Weatherization Assistance Program evaluation, which is collecting data from WAP-funded projects to estimate total energy savings achieved by the program;
- Utilization of study findings to align with two of New York City's Greener, Greater Buildings Plan local laws: LL84, which requires that all buildings over 50,000 square feet (SF) submit yearly energy data to the city to be included in a publically-available database, and LL87, which requires those same buildings to have an energy audit and retro-commissioning study every ten years;
- Coordination with the Residential Energy and Water Data Collaborative (REWDC), a collaboration between Enterprise, LISC, Neighborworks, SAHF, and HPN which seeks to establish national standards for energy data collection;
- Convention of stakeholders to develop national standards for the collection of building performance data, a Living Cities initiative receiving significant support from the MacArthur Foundation; and
- Participation in Fannie Mae/EPA Multifamily Data Taxonomy, which is working to expand the existing Portfolio Manager tool to include and provide a rating for multifamily buildings.

[6] More than 96% of projects in the database were affordable rental housing as defined by NYSERDA and Weatherization Assisstance Program standards.

03 Methodology

The project team collected energy data for 231 retrofit projects, comprising more than 21,000 units of affordable multifamily housing in New York City.

The SWA-HR&A team prepared an initial estimate of the number of projects and corresponding units to be included in the study. The project team identified the preliminary target for dataset size based on its understanding of the recent energy efficiency incentive program pipelines. Data for this study was drawn from three sources:

- NYSERDA's Multifamily Performance Program (MPP);
- NYSERDA's Assisted Multifamily Program (AMP, predecessor to MPP); and
- Weatherization Assistance Program (WAP).

Like AMP before it, MPP is a ratepayer-funded program available to multifamily buildings with five or more units. For each building in the program, a whole-building assessment is done and an approved energy reduction plan is created, which outlines implementable steps to increase energy efficiency. The goal of the program is to increase performance by quantifying and implementing energy efficiency measures.

WAP is a U.S. Department of Energy program that provides funds to states for use in weatherizing single family and multifamily buildings occupied by low-income households. Dan Rieber of Northern Manhattan Improvement Corporation supplied data to the study on WAP multifamily projects completed by the organization. Data on additional WAP projects was obtained through a data sharing agreement with Oak Ridge National Laboratory and the assistance of the Association of Energy Affordability.

SWA-HR&A's objective was to collect a dataset that maximized breadth, size, and resource-efficiency. The final dataset consisted of over three times as many projects as originally projected, totaling 231 projects and more than 21,000 units. A dataset of this size and scope has never been compiled before in the multifamily housing sector.

More than 96% of projects in the database were affordable rental housing. Due to the unique energy usage and building characteristics of this market sector, outcomes cannot be translated directly to other market sectors.

Original Projection:	75 projects
	15,000 units
Final Dataset Count:	231 projects
	21,022 units

Spotlight: What is an Energy Audit and Who or What Affects Achievement of Project Savings?

An energy audit is an evaluation of a building's existing energy profile to determine ways to improve performance.[7] Standard practice examines energy usage, durability, and occupant health/ safety.

An energy audit consists of the following three items:

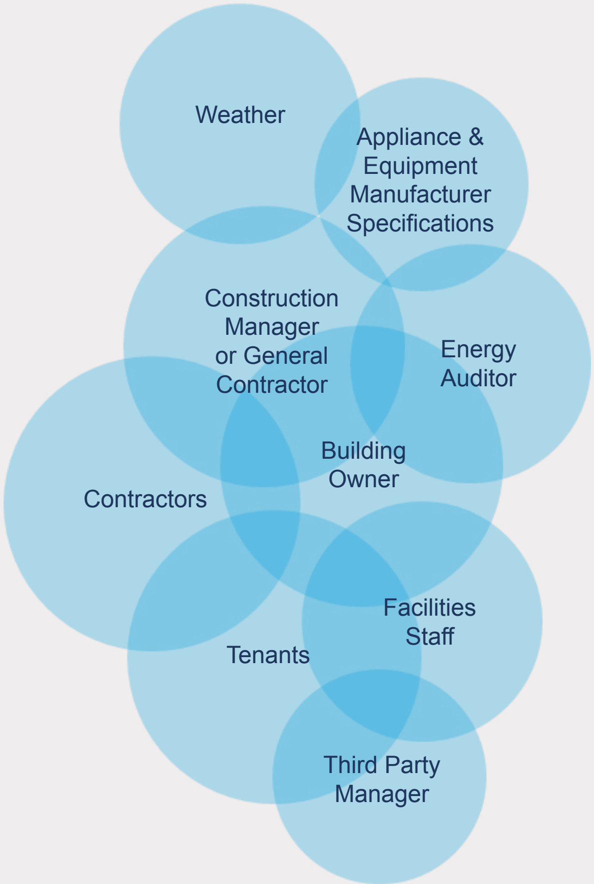
- collection and analysis of utility bills;
- survey of the building, including all energy-related systems; and
- identification and analysis of energy efficiency opportunities.

In order to estimate projected savings, auditors develop a physical model, a tool that estimates how a building utilizes energy and provides a forward-looking means to identify consumption reduction potential. Models range from a series of simple equations to a more complicated computer simulation of a building's systems. Once a model has been created to represent existing conditions, certain variables can be changed in order to project how proposed efficiency retrofits will impact the building's consumption. The auditor uses this physical model to then determine a proposed scope of work for the building owner to implement.

[7] Building Performance Institute. See also Local Law 87 of New York City's *Greener Greater Buildings Plan*.

Following an energy audit, there are a number of players that might impact a building's achievement of projected savings. Successful retrofits are not only dependent upon the auditor, but also equipment manufacturers, construction managers and general contractors, tradespeople, facility staff, owners, managers and tenants. As shown in Figure 1, all of these factors or parties influence a building's ability to achieve its projected savings post-retrofit.

Figure 1: Factors Influencing an Energy Efficiency Retrofit

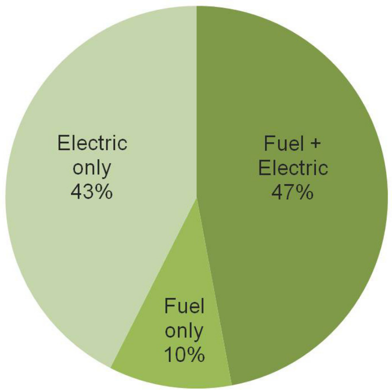


The DB/LC dataset contains various amounts of usable fuel and electric data. Of all projects in the dataset, 104 had usable, comprehensive records including pre- and post-retrofit fuel and electric bills. The remaining projects either had sufficient fuel or electric data, but lacked comprehensive information for both end uses. However, information from these projects still proved valuable, despite lacking the data to analyze both fuel and electric savings.

The team was charged with examining the end-uses relevant to lenders and building owners regarding buildings finances:

- heating fuel use;
- domestic hot water (DHW) fuel use; and
- owner-paid electricity.

Figure 2: Breakdown of Dataset by Utility Data Availability

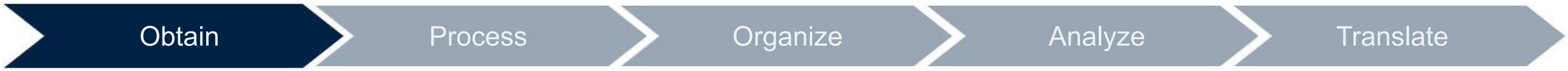


n = 231 projects

The methodology for collecting and analyzing the dataset was a five-step process.

1. Obtain: The team aggregated data from the aforementioned programs, a fifteen-month process.
2. Process: The team devised a framework by which data could be organized and compared. This included a thorough data review for irregularities relative to climate, weather normalization, and other factors.
3. Organize: The team organized the dataset by building ages and systems for both fuel and electric. These comparative groups were useful for identifying a general work scope and understanding the nature of buildings' energy usage.
4. Analyze: The team undertook a complex and careful statistical analysis of the dataset to examine the impacts of a variety of retrofit measures and building characteristics on building performance and savings achieved, as well as to screen for additional weather effects and background noise.
5. Translate: Lastly, the team identified the critical metrics to inform underwriting against energy savings projections, including fuel and electric use intensity, dollars saved, and a new metric known as the "realization rate," which is used to evaluate the accuracy of auditors' savings projections.

Obtaining the data was an intensive 15-month process, including outreach to a wide variety of organizations and coordination with concurrent data collection efforts.



The initial data collected varied widely in terms of content, as dictated by incentive program reporting requirements and a range of auditor tools. For NYSERDA programs, energy modeling and audit reports were conducted by a host of NYSERDA-approved auditing firms, resulting in some divergence in the characterization of systems and measures. The New York City agencies that weatherize multifamily buildings using WAP funds keep their records in a format specified by New York State Homes and Community Renewal, resulting in additional audit report and energy modeling variation. The project team gathered the audit reports with building characteristics and recommended energy conservation measures; energy models with associated projected savings; pre- and post-retrofit utility bills; and, in WAP cases, as-built work scopes. From the MPP, AMP and WAP files, the project database was built with commonly used data fields, including utility, building characteristic and retrofit information.

Due to limitations of individual retrofit project documentation, comprehensive data was not available for every project. Although having two years' of pre- and post-retrofit utility data is ideal, one year of pre-retrofit data is what was typically available for most projects complying with MPP, AMP and WAP programs' documentation requirements. While MPP had (and still has) a mechanism for collecting one year of post-retrofit utility data, the same was not the case for AMP or WAP. Those projects with insufficient pre- or post-retrofit utility data required a significant amount of time and reconnaissance in order to obtain the information necessary for analysis.

While it would have been optimal to also analyze water savings, data limitations made it infeasible. Given changes to New York City's tracking of water bills, future studies should have improved access to collect and analyze such data.

Please refer to *Appendix C* for a full list of relevant datafields.

A comparison of the project dataset with that of the New York City Housing and Vacancy Survey indicated that the DB/LC dataset included a reasonable cross-section of multifamily housing types.

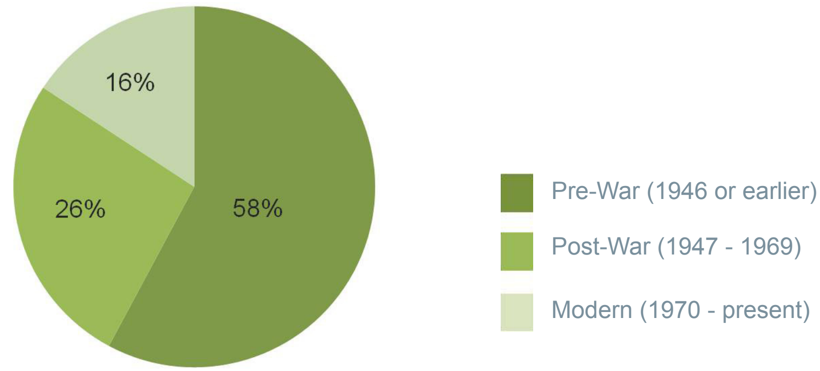
To improve our understanding of the residential housing market, the New York City Housing and Vacancy Survey (NYCHVS) was consulted. According to the NYCHVS, the majority of the housing stock, over 1.9 million units, was built prior to 1946. While the DB/LC dataset does not completely align with the NYCHVS, the major building types identified by the NYCHVS are well represented in the DB/LC dataset.

To maximize the utility of the DB/LC dataset to owners and lenders, the project team sought to include the most common multifamily building types (by vintage, size, heating system, etc.) in New York City, in hopes that it will allow others to apply the study's findings to their portfolios. That said, while the NYCHVS reports on the entire residential market, the DB/LC dataset is predominately comprised of affordable rental units, a significant sector of buildings in New York City.

Although this study was conducted on a sample of New York City buildings, there is an opportunity to replicate this work in other regions. The critical methodology would remain the same regardless of geography: collecting and organizing data, weather-normalizing pre- and post-retrofit utility bills in order to estimate savings, and then comparing actual savings to projections.

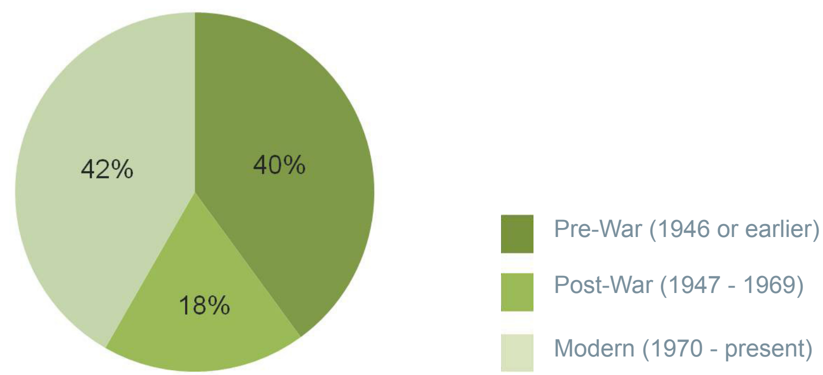
More on the replicability of this study can be seen in the *Policy Considerations* section.

Figure 3: Breakdown of Residential Units in New York City by Vintage



Source: U.S. Census Bureau, 2008 New York City Housing and Vacancy Survey

Figure 4: Breakdown of Residential Units in DB/LC Dataset by Vintage



The team developed a systematic framework for identifying and aligning data across all projects, determining the most useful fields for comparing pre- and post-retrofit information.

Obtain | **Process** | Organize | Analyze | Translate

The SWA-HR&A team developed a research database to (a) organize the multifamily energy efficiency data collected from MPP, AMP and WAP, and (b) conduct systematic assessments of savings performance by groups of energy efficiency measures. The process involved identifying and aligning data fields, inputting pertinent building characteristics and energy modeling fields, compiling pre- and post-utility bills, and coding the utility readings with the appropriate meter type. To support this process, Michael Blasnik & Associates developed a methodology for processing and analyzing the building data, which was customized to accommodate the constraints of the data availability and organization of data fields across programs. A full listing of the relevant data fields can be found in *Appendix C*.

All raw data was entered into multiple Excel spreadsheets and then imported into a Stata statistics package, which used a master key of data fields to combine all data into a single dataset. Stata was used to run statistical analyses and cross tabulations, the output of which was then exported back to Excel for further study and presentation. Range check and quality control algorithms were developed in Stata to prevent the inclusion of nonsensical values and to flag for further investigation values that were at the limits of reasonable bounds.

Stata was also used to determine if there was a good fit between the utility data and the weather, based on a variable degree day analysis. A good fit indicates that there is a well understood relationship between usage and either heating or cooling degree days (HDD and CDD, respectively). If the relationship between usage and weather is not well understood, it is impossible to accurately predict the weather normalized savings.

To maintain the highest level of certainty in results, projects with poor fits in either pre- or post- retrofit periods were not included in the study. This screening resulted in the removal of 18% of fuel projects from the dataset. In addition, a small number of projects were not used even though data was fully collected, primarily where the type of building systems and retrofit were extremely atypical of New York City affordable housing.

The project team organized the dataset into comparative groups based on building age, system type, and end use.

Obtain | Process | **Organize** | Analyze | Translate

Over the past 100 years, buildings and their systems have changed both in terms of how they use energy and the amount used. One of the most significant trends has been a decrease in fuel use and an increase in electricity use. When the energy performance of one building is compared to another, the comparison group is typically an entire sector or large swath of a particular sector, based on vintage. The study reports a wide variation in energy use across various multifamily building types – a finding corroborated by the work of previous efforts.[8] To create more specific peer groups and allow for more informative comparisons, the project team developed a set of data-driven comparative groups. Building on vintage definitions aligned with the NYCHVS, these comparative groups have been further defined in terms of heating fuel, heating system type and electric metering configuration.

Fuel comparative groups:

1. One-pipe steam
2. Pre-War hot water
3. Post-War two-pipe steam
4. Post-War hot water

1. One-pipe steam

2. Pre-War hot water

3. Post-War two-pipe steam

4. Post-War hot water

[8] One such study is the "Building Energy Use Tracking System" authored by the Energy Conservation Division of the NYC Department of Housing Preservation and Development in December 1989.

1. One-pipe steam. One-pipe steam ("1 PS") refers to the heating distribution system whereby a single pipe carries steam to radiators and allows condensate to drain back to the boiler. These systems are notoriously difficult to control.

   Of the 139 one-pipe steam buildings in the dataset, 132 are pre-War and all are six stories or less in height. One-pipe steam buildings were also subdivided into those with oil as a primary fuel versus those that burn gas. In the study, the average one-pipe steam gas building was 40 units and the average one-pipe oil building was 47 units.

2. Pre-War hot water. Pre-War hot water ("Pre-War HW") buildings present a unique circumstance from a building science perspective, in that none were originally built with hot water heat. Rather, all had the original steam heating system removed at some point and replaced with hot paper piping and a circulating pump. Of the 38 pre-War hot water buildings in the dataset, 32 are six stories or less in height, 36 burn gas, and 28 were equipped with atmospheric boilers. The average pre-War hot water building in the study was 67 units.

3. Post-War two-pipe steam. Post-War two-pipe ("Post-War 2PS") steam refers to the heating distribution system whereby one pipe carries steam to radiators and another pipe allows condensate to drain back to the boiler. This system is inherently more controllable than one-pipe steam. Post-War two-pipe steam buildings are typically large high rises with mechanical ventilation. The average building in the dataset was 19 stories and 304 units. All were constructed between 1961 and 1994.

4. Post-War hot water. Post-War hot water ("Post-War HW") buildings range greatly in size, with projects containing 24 to 1,024 units. They are mostly high-rise or mid-rise buildings, all with some degree of mechanical ventilation.

5. Two additional comparative groups warrant consideration, though they represent a much smaller portion of the DB/LC dataset:

   a) Pre-war two-pipe steam ("Pre-War 2PS") buildings tend to have less mechanical ventilation, insulation, and electric loads than post-War two-pipe steam buildings.

   b) District steam ("DS") buildings purchase steam directly from Con Edison; they do not have boilers or the energy losses associated with heat loss up chimneys. The cost per BTU for district steam is two times higher than gas and one and a half times higher than oil, which impacts the return on investment associated with an energy retrofit.

Electric comparative groups were also similarly organized, focusing on owner-paid electric meters.

The critical distinction in electric buildings is between those that are direct- versus master-metered, including sub-metered buildings. In a direct-metered building, the owner pays for common area electricity, and tenants hold accounts directly with the utility company and pay for their own apartment electricity use. In master-metered buildings, all electric utilities are on a single meter, and the owner pays for electricity use in both common areas and apartments.

The DB/LC study focused solely on owner-paid utilities. Retrofits that impact apartment electricity use (refrigerators, apartment lighting, etc.) were only evaluated in master-metered buildings.

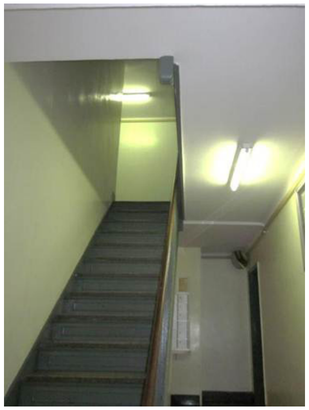
The project team divided the dataset into four electric comparative groups. In direct-metered buildings, these categories are effective proxies for the amount of installed electrical loads and reflect the overarching trend of a greater intensity of electricity-consuming widgets in newer buildings and systems.

Electric Comparative Groups:

1. Master-metered buildings, where all electric utilities are on a single meter, and the owner pays for electricity use in both common areas and apartments.
2. Direct-metered, pre-War steam buildings tend to have minimal common-area lighting (daylighting in stairwells, etc.), corridor light levels that might be considered unacceptably dim by today's standards, and no electricity-using ventilation fans or large pumps.
3. Direct-metered, pre-War buildings with hot water heat have an electricity-consuming circulating pump that is installed as part of the conversion from steam to hot water. In coordination with that same conversion, these buildings have often been retrofitted with roof fans to provide mechanical ventilation in at least some apartments.
4. Direct-metered, post-War buildings tend to have higher light levels in corridors, mechanical ventilation fans, and major pumps. In addition, these buildings tend to have a host of smaller electricity-consuming devices, including electric heaters, air handling and air conditioner fans, more program space with dedicated HVAC and lighting systems.

Pre-War

Post-War



Common areas in pre-War buildings are under-lit by today's standards. When pre-War buildings undergo retrofits, lighting fixtures may be added to common areas, thereby increasing electric load post-retrofit.

The team analyzed the dataset to identify potential sources of error, then ran a statistical analysis of building characteristics and retrofit measures that might impact savings.

Obtain | Process | Organize | **Analyze** | Translate

There are number of external factors, unrelated to retrofit scopes, that impacted the apparent savings measured by a pre-/post-retrofit utility analysis. The magnitude and significance of these factors can vary from project to project. When actual energy savings are small relative to the overall energy bill, external factors have a more significant impact on results.

Weather is a principal external factor. The utility data started out as a series of monthly or delivery bills, and additional analysis had to be performed in order to make useful comparisons between the different pre- and post-retrofit time periods. One of the primary ways this was done was through weather-normalization, which removes some of the variation associated with the severity of weather (for more information on this process, see the Weather Normalization sidebar on the next page). While this process adjusts for the impact of outdoor temperature, other factors such as wind speed and solar radiation were not explicitly accounted for in this analysis.

The spread in retrofit project years throughout the database helped control for these weather variations. If this study were to only track retrofits over one specific time period (e.g., all projects had a pre-retrofit data year of 2008 and post-retrofit monitoring year of 2010), there would likely be systematic bias in the study's results. For instance, if wind speeds in 2008 were lower than average and solar radiation was higher than average, the "true" severity of the winter would not be as great as would be suggested by only looking at outdoor temperature. Fortunately, the DB/LC database is somewhat insulated from this effect since pre- and post-retrofit years are spread over a nine-year period, thereby mitigating this effect when viewed portfolio-wide.

Regression models helped explain the observed variations in usage. Once the utility data was collected, Stata was used to analyze how the building's energy usage compared to the weather. By looking at how the utility data varied with the outdoor temperature, we were able to estimate how the building's energy usage corresponded to the weather. On the fuel side, this required at least six months of data, enough to see the usage vary between periods with no heating load and periods with high heating loads. On the electric side, nine months were required in order to track the usage through a cooling, heating and shoulder season. The vast majority of projects in the DB/LC database met these criteria, although some only met one or the other. Projects with utility bills that did not have a good statistical fit were not used, since there may have been unexplained contributing factors. Fuel use tends to be more dependent on weather than electric use; consequently, the majority of the unused data was fuel-related.

Oil records provide a unique challenge. Oil delivery records indicate how much fuel was delivered on a specific date, not how much was used over a particular period. In some cases, consecutive oil bills were aggregated into larger time periods in order to remove the variability that may be caused by looking at multiple deliveries in a short time period. While this helped to make more of the oil data usable, these projects were still held to the same standard of regression fit discussed above, and, as a result, the majority of the unused fuel data were for projects that burned oil.

In addition to weather, other external factors, such as seemingly unrelated capital upgrades and maintenance practice changes, may impact energy usage. These external factors are identified and explored further in the *Additional Hypotheses* section of this report.

Spotlight: Weather-Normalization

Without weather-normalizing utility usage, a change between pre- and post-retrofit utility bills may simply be due to a less severe heating season. Building upon industry best practices, this methodology attempts to minimize that effect.

Figure 5: Gas Billing Cycle, Heating and Domestic Hot Water Use

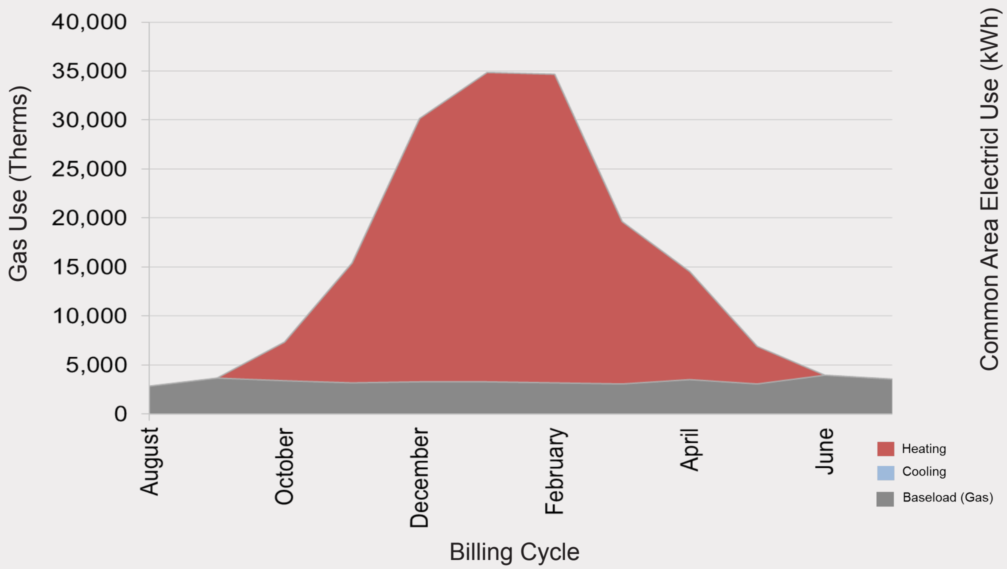
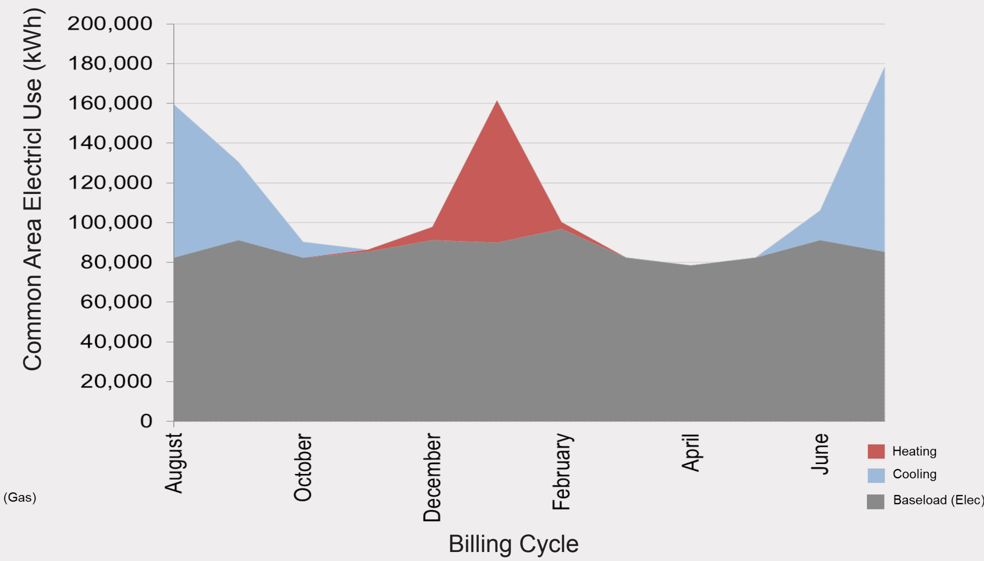


Figure 6: Electric Billing Cycle, Common Area Electric Use



A rigorous building science analysis methodology was applied to the data. Fuel results for both pre- and post-retrofit periods were normalized for weather using a variable degree day method. Outputs of this method include:

- A weather-normalized relationship between actual fuel use and HDD during the corresponding period;
- An “apparent baseload” for summertime fuel use that is associated solely with domestic hot water production; and
- A corresponding portion of the fuel bill associated solely with building space heating, normalized for a typical New York City winter of 4,800 HDD.

Electricity results for both pre- and post-retrofit periods were normalized for weather using a seasonal degree day method. Outputs of this method include:

- The weather-normalized relationship between the actual electric use at a building and the actual cooling degree days during the corresponding period;
- An apparent baseload for spring/fall electricity use that is associated with constant year round loads (lights, fans, etc);
- A corresponding portion of the electric bill associated with winter electric heating normalized for a typical NYC winter; and
- A corresponding portion of the electric bill associated with summer cooling normalized for a typical NYC summer.

The team utilized several standard statistical methods of analysis to identify trends and broader dataset characteristics within the dataset. These included:

- **Standard Deviation:** a measure of the variability or distance from the mean.
- **Confidence Interval:** a measure of the uncertainty in the estimate of the mean itself.

The team utilized Stata software to identify potential causal relationships between certain building characteristics (e.g., age, size, height, number of units, etc.), retrofit measures (e.g., boiler upgrades, window replacements, lighting controls and sensors, etc.), and post-retrofit energy savings.

Dataset sample size framed the team's ability to analyze specific relationships. An important aspect of the study's data analysis was to ensure that the sample size used to assess the relationship among building characteristics, retrofit measures, and post-retrofit savings was statistically significant. A reasonable statistical industry standard assumes that once a database reaches a certain critical mass of data points, confidence intervals can be halved if the number of data points - in this case retrofit projects - is quadrupled. The number of projects collected as part of this study is large enough that there is a high degree of certainty that average results across the whole dataset can be accurately extrapolated. This certainty is reflected in the confidence intervals which have been calculated for the relevant findings. These indicate that, even at the low end of the interval, the results are meaningful. For instance, the 95% confidence interval for total fuel savings (19% across the portfolio, described in the *Central Findings* section) in this study is ± 3%. If the sample size were quadrupled, there is 95% certainty that total fuel savings across the new dataset would be 19% ± 1.5%.

In some cases, the project team was limited in drawing statistically significant correlations among smaller, segmented groups of data points. Nonetheless, when data is segmented and the number of data points significantly decreases (e.g., only five post-war hot water buildings that had a certain type of boiler upgrade and did not implement air sealing), increasing the sample size can have a substantial impact on the ease and confidence with which statistically significant conclusions can be drawn regarding the more granular aspects of retrofit scopes.

The DB/LC dataset is currently the single largest database of building energy retrofit information in the multifamily sector and allows for meaningful analysis. Nonetheless, the project team recognizes the value of the future expansion of the dataset, which would allow for more in-depth analysis of certain interactions among multiple variables.

In addition, expansion of the dataset could help fill data gaps for comparative groups that are currently underrepresented in the database. For instance, the database includes 127 pre-war one-pipe steam buildings but only five pre-war two-pipe steam buildings.

Upon completion of data analysis, the team determined useful metrics for presenting and translating findings to the lending community.

Obtain | Process | Organize | Analyze | **Translate**

For simplicity and maximum impact, energy measurement for this study relies primarily on two comprehensive metrics:

- Fuel use intensity: kBTU per square foot (weather-normalized fuel use for a typical year)
- Owner-paid electric use intensity: kWh per square foot (weather-normalized electric use for a typical year)

Converting Energy to Dollars

Rather than rely on commodity pricing, which can vary from year to year and by owner, the following commodity prices were applied to the raw consumption data for all buildings:

- Electricity: $0.17 per kWh
- Gas: $1.35 per therm
- Oil: $2.52 per gallon oil (all grades)

To align with industry standards, the resulting operating costs were normalized per apartment, resulting in the following operating cost metrics:

- Dollars per unit for fuel
- Dollars per unit for electricity (owner-paid)

When applying or using the DB/LC dataset as a reference, if an owner or lender thinks that an alternative set of assumptions for commodity prices is more appropriate, the results of this study could be easily modified.

In order to compare auditors' savings projections to actual post-retrofit performance, the project team developed a metric called the "realization rate." The realization rate compares a project's actual post-retrofit savings to its pre-retrofit projected savings, provided by the energy audit:

realization rate = actual savings / projected savings

Actual energy savings are based on the difference between pre-retrofit energy use (weather-normalized for a typical New York City year) and post-retrofit energy use (weather-normalized for a typical New York City year). Projected energy savings represent the forward-looking estimate of potential operating cost reductions as a result of a building retrofit. Projected energy savings are also weather-normalized for a typical New York City year.

04 Central Findings

Central Findings

The project team analyzed the dataset to assess total savings achieved and savings as a percentage of projections. These data-driven findings suggest a rationale and methodology for underwriting against fuel savings projections:

1. Building retrofits save energy. Across the DB/LC "portfolio," buildings reduced their fuel consumption by 19% and electric consumption by 7%.[9]

2. Fuel measures save more than electric measures. On average across the portfolio, buildings recorded $240 in per unit savings for fuel and $50 in per unit savings for common area electricity. In general, fuel savings varied less than electric savings and were more predictable. Pre-retrofit fuel usage was typically a greater expense than common area electricity, accounting for upwards of $1,000 to $1,600 per unit, versus $100 to $300 per unit for electricity.

   Electric savings were also less predictable than fuel savings. However, electricity makes up a relatively small portion of total owner paid utility costs in direct-metered buildings.

3. Actual savings are strongly correlated with pre-retrofit fuel usage. The study analyzed a wide range of building characteristics and retrofit scope measures to examine how they impacted savings. While a number of weaker correlations existed, only one factor was significantly related to post-retrofit performance: pre-retrofit fuel use intensity. Higher pre-retrofit fuel use intensity translated to greater savings potential. Furthermore, heating system and building age are good proxies for fuel use intensity.

4. Strategically capping projections can improve a portfolio's realization rate. A variety of factors influence the ultimate accuracy of savings projections, including how much of the associated scope of work was implemented, the quality of construction and ongoing facility management, and the skill of the auditor and quality of his/her modeling tools. While auditors projected 25% to 50% fuel savings across about two-thirds of the buildings, most projects actually saved 10% to 40%.

   The study suggests that neither the existing industry standard physical models employed by auditors nor the empirical model the study developed is sufficient: buildings are complex and unique, and a variety of factors interacted in each building examined with idiosyncratic results. Use of both a physical and empirical model in tandem, however, could result in savings projections upon which a lender could rely for underwriting purposes.

   By utilizing pre-retrofit fuel usage as a simple predictive model to establish a threshold for likely savings, a lender or auditor can "cap" projections that may be overly optimistic. Reducing these "over-projections" improved the fuel realization rate across the portfolio from 61% to 117%.

[9] For master metered buildings in the study, whole-building electric consumption was examined.

Central Finding 1: Building retrofits save energy.

Across the DB/LC portfolio, projects significantly reduced energy consumption. Because the study aimed to understand and affect underwriting behavior, only owner-paid utilities were examined. Savings on the "owner's side" averaged:

Fuel: 19% consumption reduction

Electric: 7% consumption reduction[10]

total portfolio-wide energy savings translates to:

145,000 MMBTU

or **$2.3 million**

in savings for fuel costs

4.3 million kWh

or **$730 thousand**

in savings on electric costs

11,624 tons of reduced carbon emissions

[10] Because the dataset includes both master-metered and direct-metered buildings, electric savings relate to total building usage in master-metered buildings and common area usage in direct-metered buildings.

Central Finding 2: Fuel measures save more than electric measures.

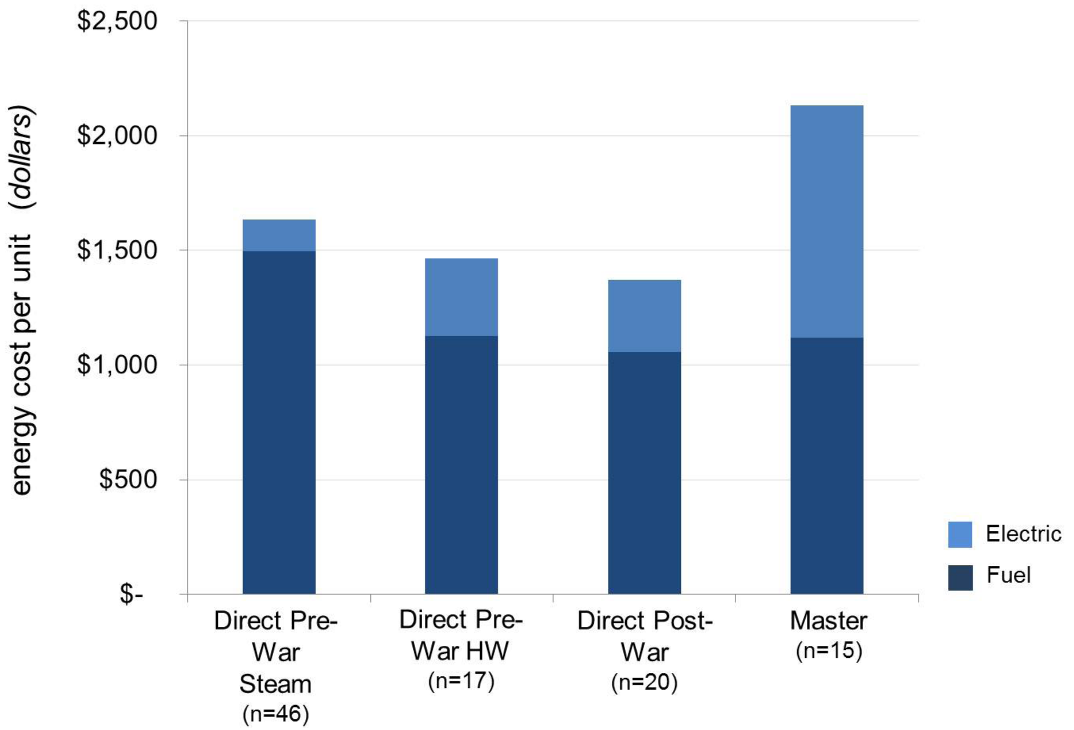
Owner-paid fuel measures save almost five times as much energy as owner-paid electric measures. On average, savings achieved per unit by end use were:

Fuel: $240 per unit

Electric: $50 per unit

The majority of utility costs for a typical New York City affordable multifamily building are generated by fuel consumption, as shown in Figure 7. For direct-metered buildings, fuel makes up 75% to 90% of the annual owner-paid energy costs. While electricity use is higher in newer, direct-metered buildings, electricity use is still a relatively small portion of the owner's utility costs. Therefore, underwriting against fuel savings would be more appealing to a lender, given the greater savings opportunity. This is further described in the *Implications for Underwriting* section.

Figure 7: Total Owner-Paid Energy Cost per Unit by Electric Comparative Group

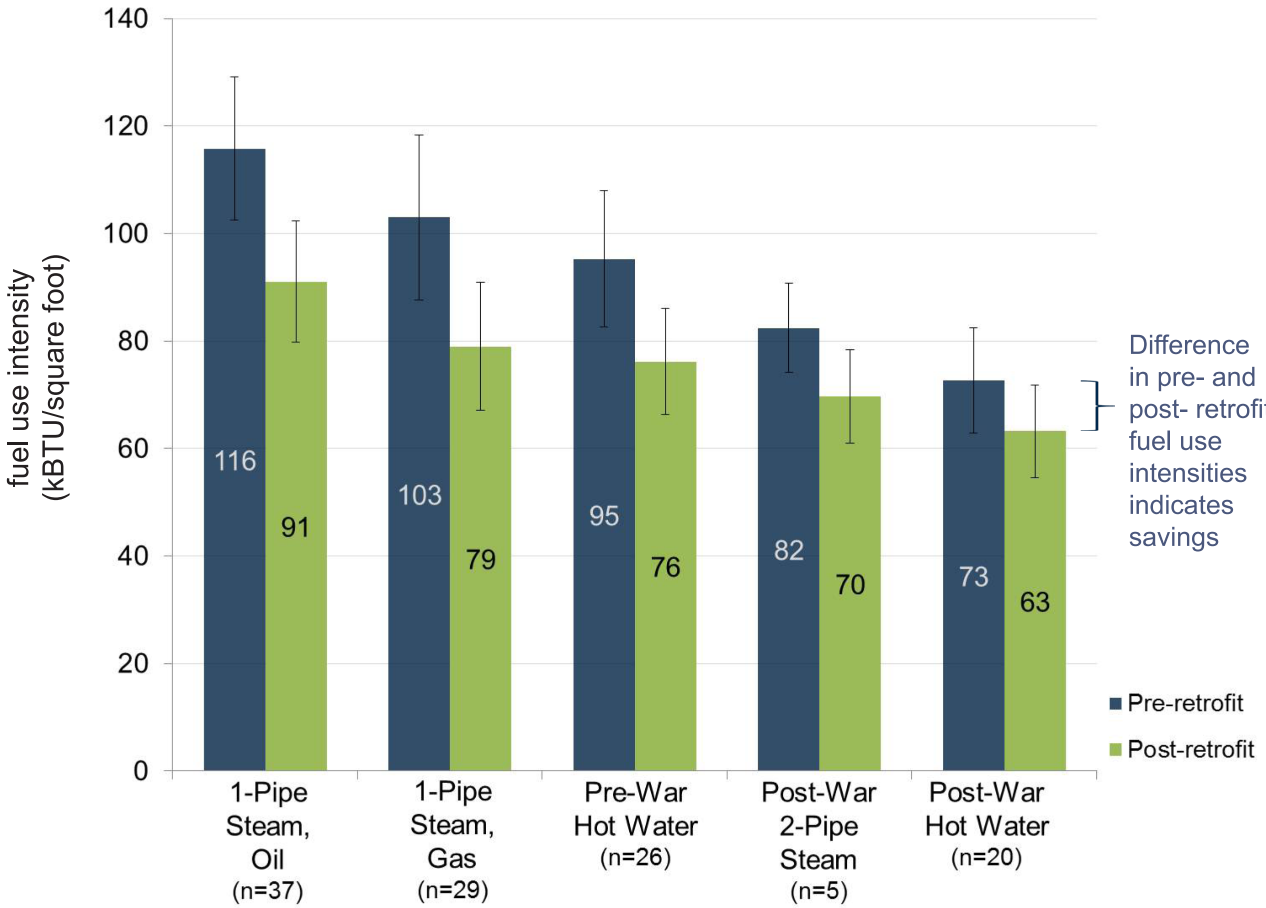


In direct-metered buildings, fuel costs are significantly greater per unit than electric costs.

Most projects evaluated achieved significant fuel savings, ranging from 13% and 23% by building age and heating system comparative group, as shown in Figure 8. These results indicate that buildings that started out with the highest usage, such as one-pipe steam buildings, saved more than the average building in the dataset. Those on the lower end, the post-War two-pipe steam and hot water buildings, saved less than the portfolio average.

These savings varied by project depending on the opportunity for savings at the particular building, the scope and execution of work, and the type of fuel. All other factors being equal, a BTU saved in an oil-heated building will result in 30% more operating cost savings than a BTU saved in a gas-heated building due to current utility rates.

Figure 8: Pre- and Post-retrofit Fuel Use Intensity, by Comparative Group



The error bars shown on the chart represent half standard deviations above and below the mean for each comparative group. If multifamily buildings were normally distributed along a bell curve, the range would approximately represent the middle 40%.

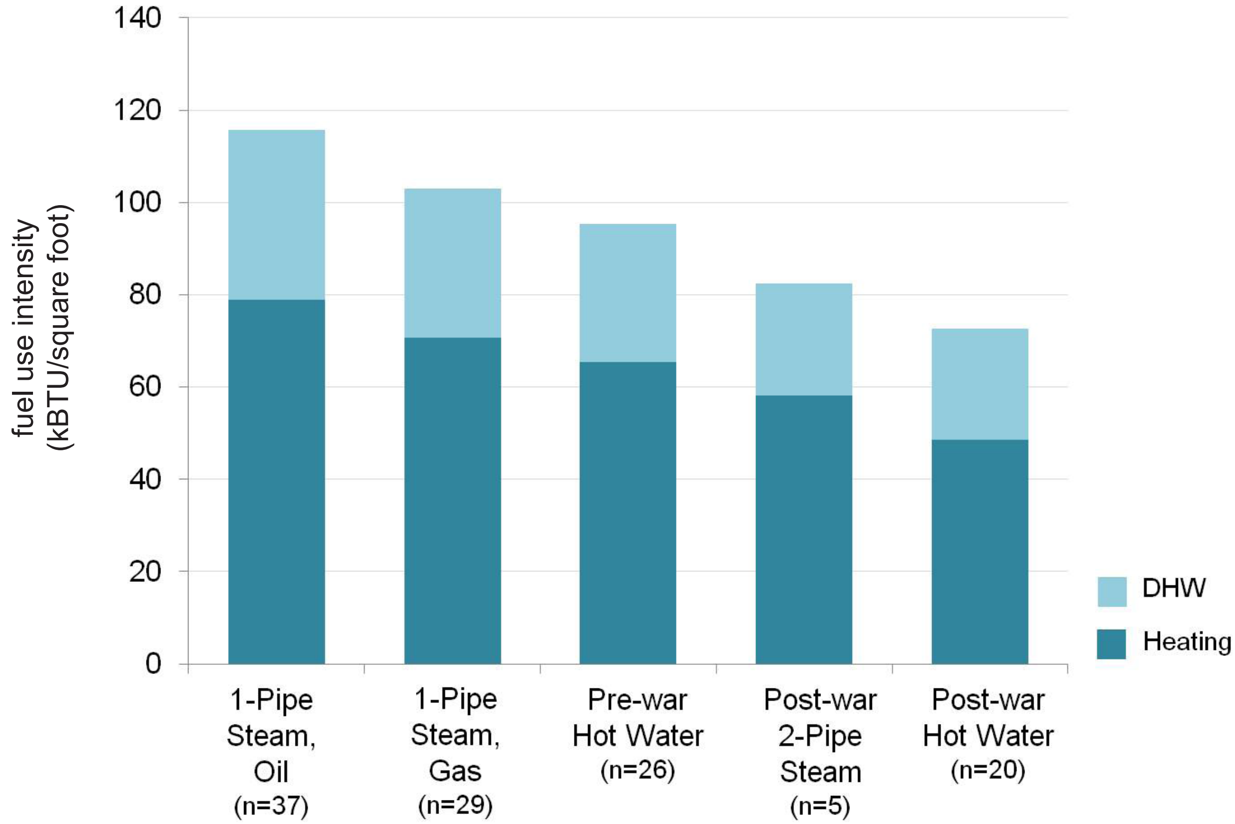
A small standard deviation indicates that the data points tend to be very close to the mean, whereas a large standard deviation shows that the data points are spread out over a wide range of values.

The split between savings from heating and from domestic hot water (DHW) was relatively even. The projects resulted in 18% savings on heating costs and 21% savings on apparent DHW costs. Across all buildings studied, an average of 67% of fuel use was used for space heating, with the remaining 33% of fuel consumption dedicated to DHW.

Smaller projects generally achieved higher fuel savings on a per unit basis. This result is primarily due to the fact that the vast majority of smaller buildings in the dataset are older pre-War buildings with higher pre-retrofit fuel use intensities, providing more opportunity for efficiency improvements. Larger projects, for which energy efficiency improvements were more easily scalable, often achieved significantly higher gross savings. Results indicate that there are cost-effective investment opportunities across all project sizes analyzed by the DB/LC study.

Project Size (units)	Fuel Savings (per unit)	Fuel Savings (project-wide)
<100	$272	$10,794
100 +	$198	$52,632

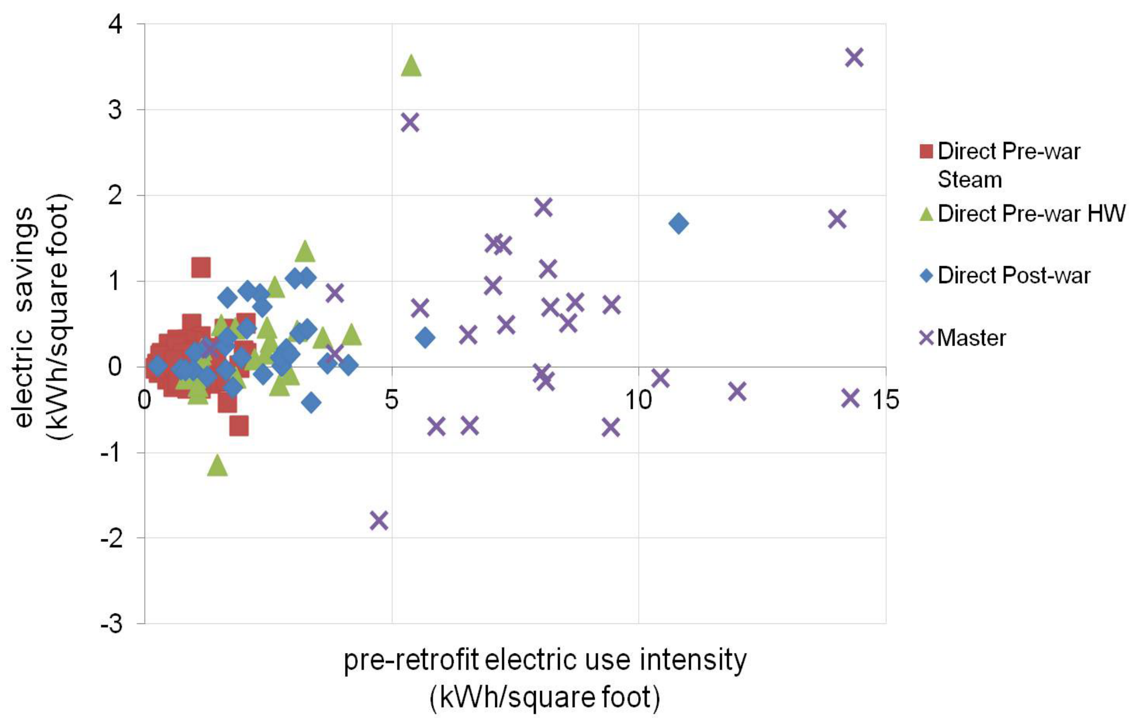
Figure 9: Fuel Use Intensity by Comparative Group, Domestic Hot Water vs. Heating



The amount of fuel use dedicated to DHW versus heating was consistent across comparative groups, with about a third of pre-retrofit fuel used for DHW.

In contrast to fuel savings, electric savings varied widely and unpredictably. This is of limited importance to lenders given electricity's relatively lower significance to most owners' expenses. As can be seen in Figure 10, in which actual electric savings are indicated on the Y axis versus pre-retrofit electric use intensity on the X axis, savings for all metering configurations were widely-distributed. The direct-metered buildings are clustered towards the left end of the graph, as their electric usage includes common-area only and correspondingly results in a lower pre-retrofit electric use intensity. As further discussed in the *Implications for Underwriting* section of the report, the study does not recommend underwriting against electric savings at this point in time.

Figure 10: Electric Savings by Comparative Group vs. Pre-retrofit Electric Use Intensity

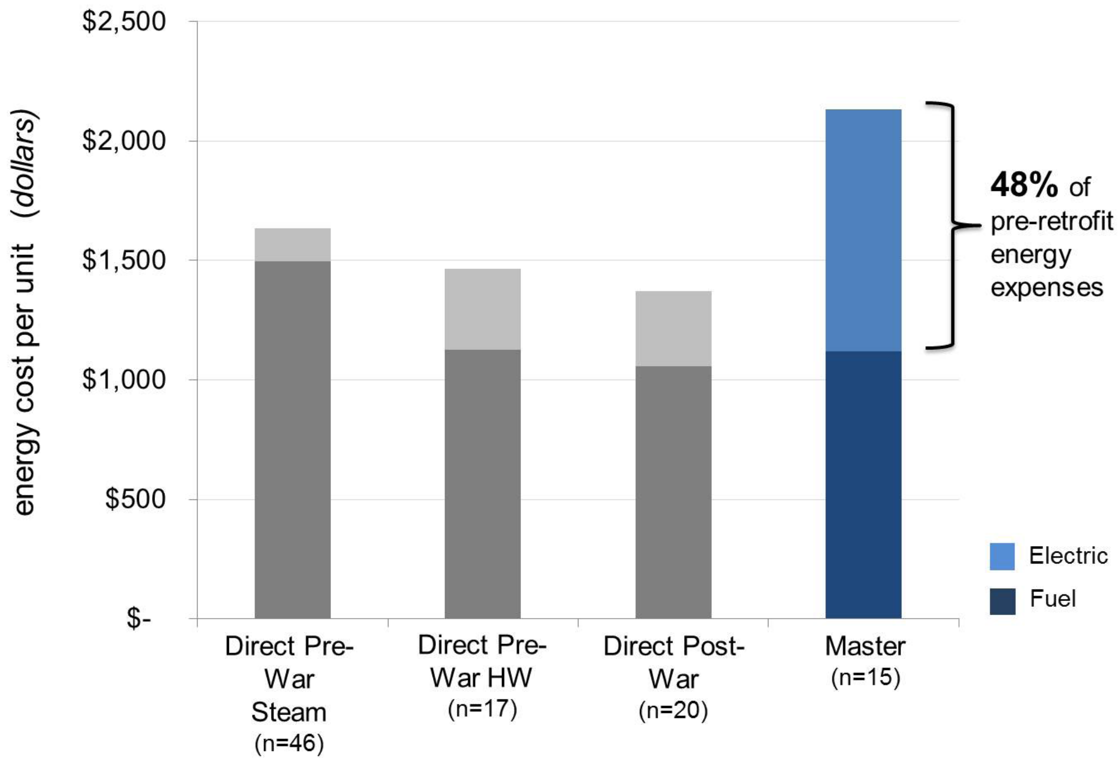


Direct-metered buildings' electricity usage is common-area only, which accounts for their considerably lower pre-retrofit electric use intensity and limited post-retrofit savings. Master-metered buildings, which can achieve greater savings, exhibit greater variability.

Across direct-metered buildings, owner-paid common area electricity use is greatest in post-War buildings, though it still remains a relatively small increment of overall utility expenses. Variation in total owner-paid utility costs between pre-War and post-War direct-metered buildings is fairly small. The average post-War direct-metered building used 29% less fuel but 75% more electricity than the average pre-War direct-metered building. As a result, total owner-paid energy costs were, on average, only 16% higher in the direct-metered pre-War buildings than in the direct-metered post-War buildings.

Notwithstanding lower electric than fuel savings across the portfolio and great variability in those savings, electric consumption reduction potential in master-metered buildings may warrant attention. This is because in the master-metered buildings studied, owner-paid electricity represents an average of 48% of pre-retrofit energy expenses. While there is clearly the opportunity to achieve significant savings in master-metered buildings, more research is needed to identify risk factors that can be applied to minimize the likelihood of poor performance when considering underwriting against electric savings projections.

Figure 11: Savings Opportunity in Master-Metered Buildings, Electric vs. Fuel Energy Cost



Central Finding 3: Actual savings are strongly correlated with pre-retrofit fuel usage.

Of the many variables analyzed, only pre-retrofit fuel use intensity was a statistically significant predictor of post-retrofit results. The team investigated the relationship between a variety of existing conditions/retrofit measures and actual energy savings. The data fields examined included:

Building characteristics

- building age
- building size
- number of units
- high-rise versus low-rise
- total square footage
- pre-retrofit fuel use intensity
- heating system type
- fuel type

Implemented measures from the retrofit scope of work

- boiler replacement
- heating controls and/or distribution improvements
- window replacement
- air sealing
- DHW/low-flow fixtures
- other

A full list of the data fields examined in this study can be found in *Appendix C*.

The team found that projects that started out with higher pre-retrofit fuel use intensities tended to save more energy, and that no other factor analyzed predicted post-retrofit performance with statistical significance. In other words, the buildings consuming more energy per square foot have the greater potential to save.

Using Linear Regression To Identify Statistical Significance

A common way to determine the relationship between two variables is by performing a linear regression, which attempts to find a linear trend through a scattered set of data points in order to best represent the relationship between those variables. This best fit line is calculated by minimizing the sum of the squared vertical deviations from the line. A confidence interval around the slope of line is then created, and if that range does not include zero, then the relationship can be considered statistically significant—that is, it is different from zero. This means that it is unlikely to have occurred by chance.

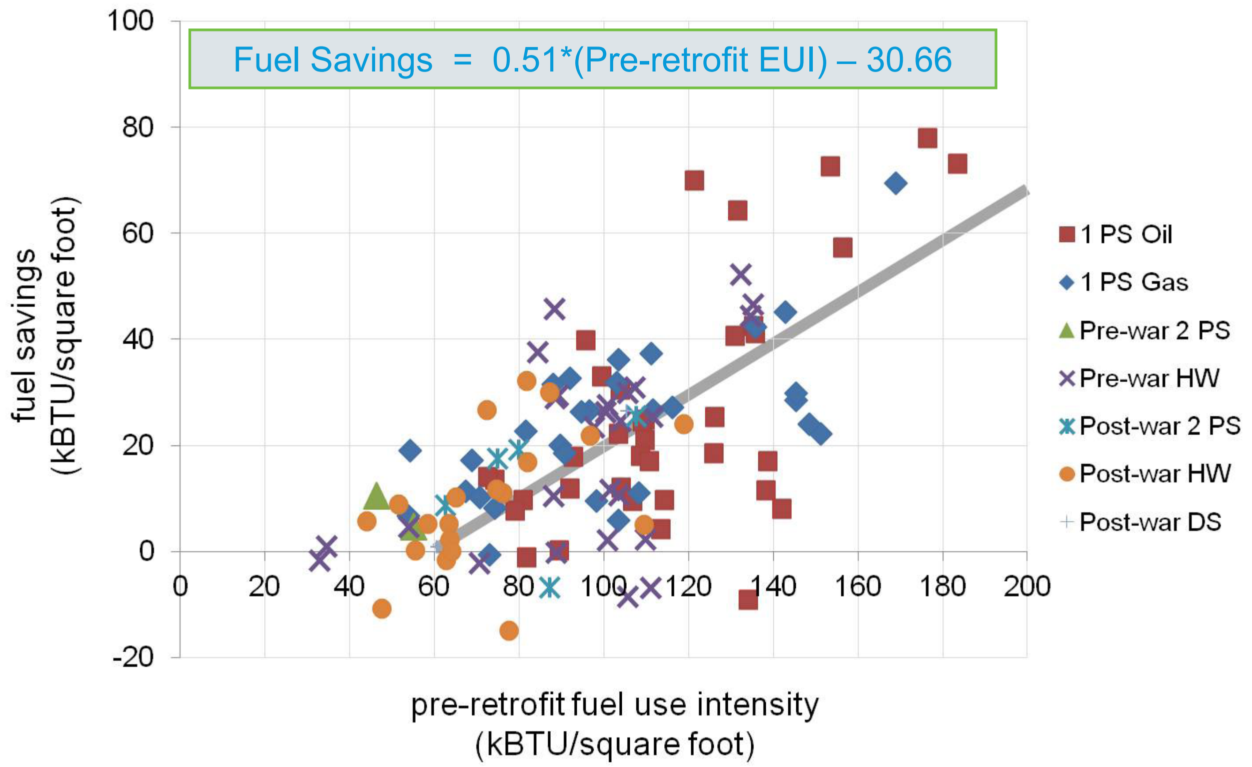
The scatter plot in Figure 12 shows the actual savings achieved on the Y axis versus the pre-retrofit fuel use intensity on the X axis. The line represents the best fit equation found for the relationship between the actual savings and pre-retrofit fuel use intensity.

For instance, findings suggest that a building with a pre-retrofit fuel use intensity of 140 kBTU per SF will tend to save approximately 40 kBTU per SF (28% of total pre-retrofit fuel use), while a building with a pre-retrofit fuel use intensity of 100 kBTU per SF will tend to save 20 kBTU per SF (20% of total pre-retrofit fuel use).

While pre-retrofit fuel use intensity informs actual savings, each building is unique. The study suggests that an empirical model would be most effectively used as a resource for examining findings derived from a physical model.

Figure 12: Relationship Between Buildings' Actual Post-retrofit Savings and Pre-retrofit Fuel Consumption

Actual Fuel Savings vs. Pre-retrofit Fuel Use Intensity



The interactions of particular retrofit scopes with particular building characteristics cannot be explained with a simple linear equation. Significantly increasing the number of projects in the database would allow for the identification of other statistically significant relationships (e.g., between a combination of measures or physical characteristics and actual savings achieved), in addition to those identified in this study.

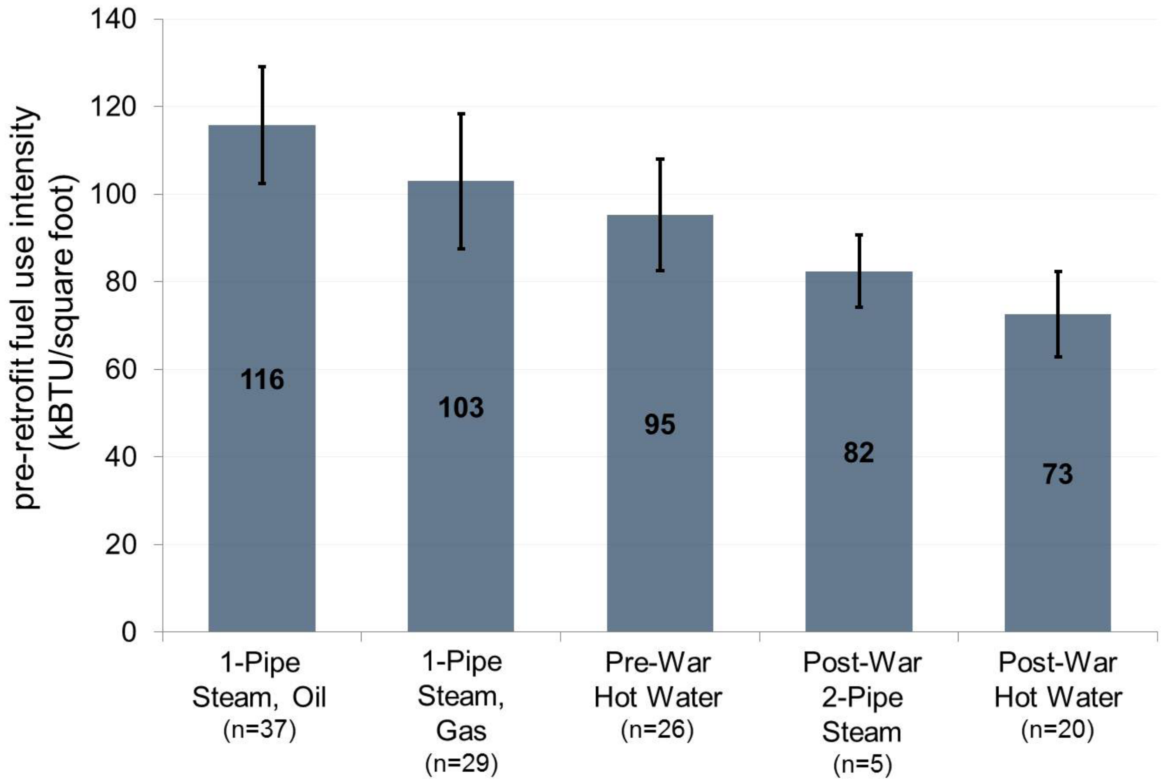
It is not possible – and probably unnecessary – to tease out which particular building characteristics are driving performance within each building comparative group, given the size of the dataset. For instance, one-pipe steam buildings are typically pre-War, less than seven stories in height, less than 50 units, have uninsulated walls, and use tankless coils for domestic hot water. The physical characteristics defining a one-pipe steam building are therefore a relatively simple proxy for a host of other important parameters such as vintage and size. It is impossible to separate the effects of these related factors without much more data. From a practical standpoint, however, since these parameters are almost always linked, it is of primary importance to understand simply how a one-pipe steam building performs.

Typical one-pipe steam buildings

Building age and heating system type are good proxies for determining pre-retrofit fuel use intensity. The scatter plot in Figure 12 also shows that the different groups of age/system building types tend to fall into vertical bands corresponding to different pre-retrofit fuel use intensities. Figure 13 takes this grouping one step further by examining the average for each type.

Each building type has an "energy signature" with a much tighter range of energy use than does the portfolio as a whole. Knowing where a particular building falls relative to its peers – defined by age and heating system type - can provide insights into savings potential. Within any particular building comparative group, the range of energy performance is primarily driven by factors within the control of an owner though operations and maintenance practices, or a typical moderate retrofit scope. For example, a one-pipe steam building that starts with a pre-retrofit fuel use intensity of 100 kBTU per SF has a fundamentally different savings potential than a hot water building that starts with the same fuel use intensity. Additionally, knowing what the normal range for one-pipe steam is compared to that of hot water buildings provides insight into the savings potential from converting from one distribution system to the other.

Figure 13: Pre-retrofit Fuel Use Intensity by Comparative Group



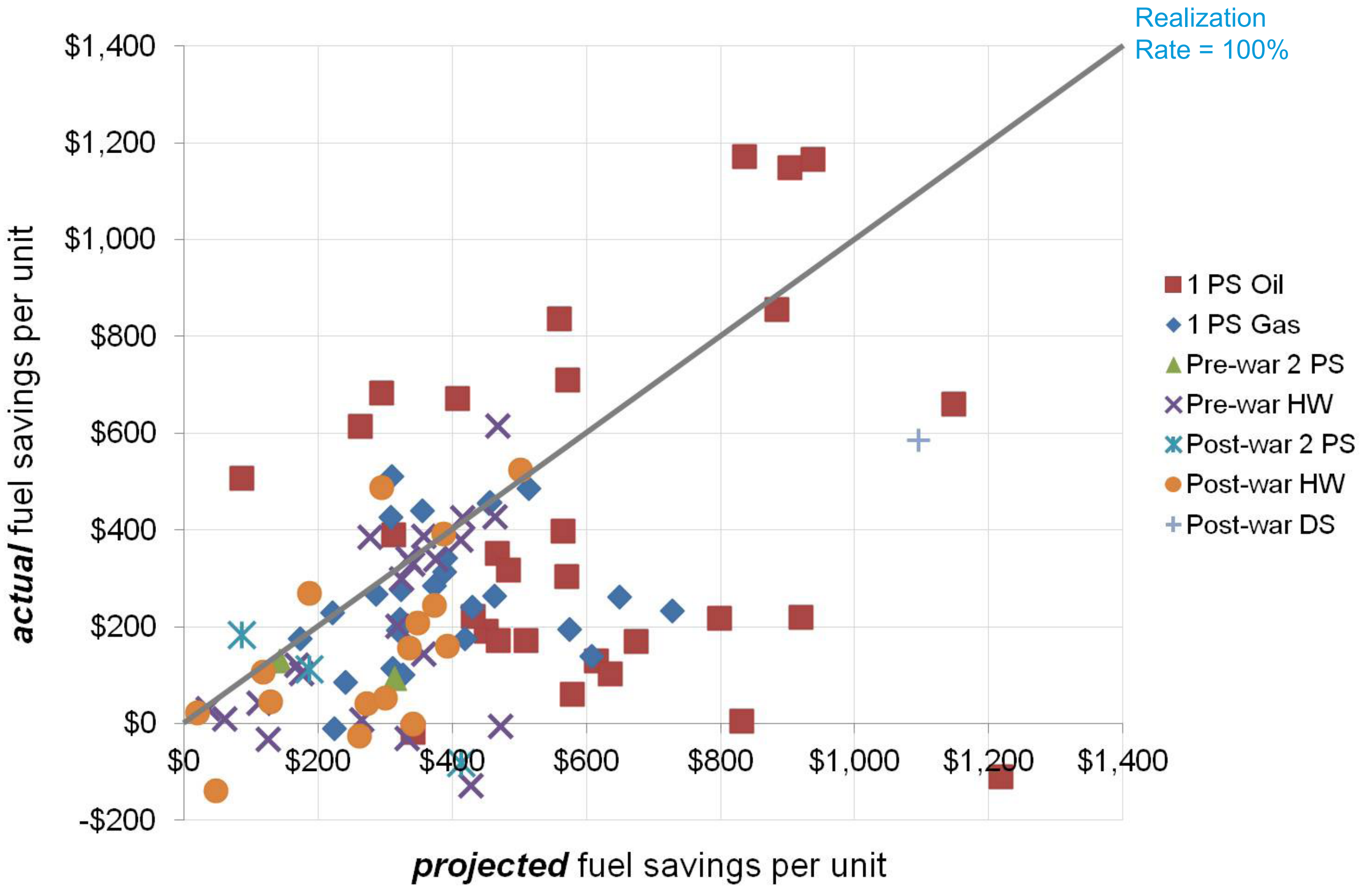
Likewise, each building comparative group tends to have a "retrofit signature," where the scope of a retrofit is significantly a function of the building attributes that define the comparative groups. For instance, a pre-War one-pipe steam building is typically treated by a relatively finite number of energy measures, including controls, distribution upgrades and roof insulation.

Moreover, energy assessments can be informed by the fact that similar retrofit measures can have different impacts on different building types. Boiler replacement and roof insulation in a one-pipe steam building is different than a boiler replacement and roof insulation in a post-War hot water building. While there is often much greater opportunity to improve boiler efficiency in hot water buildings than in one-pipe steam buildings, the steam buildings may provide a greater savings opportunity from roof insulation, as they are typically six stories or less and often have vented roof cavities. Post-War hot water buildings may have fewer opportunities for savings due to roof insulation, as roof cavities are not usually vented, and total roof area is often a proportionally smaller percentage of the overall building surface area.

Central Finding 4: Strategically capping projections can improve a portfolio's realization rate.

Although the retrofits saved energy, post-retrofit savings generally fell short of auditors' projections. In Figure 14 at the right, the 1:1 line represents a realization rate of 100%, indicating post-retrofit savings that were exactly as predicted by the auditor. A majority of the buildings in the study fell below this 1:1 line, indicating they achieved realization rates below 100%. Across all projects, the fuel realization rate was 61% with a 90% confidence interval of ±14%.

Figure 14: Actual Fuel Savings vs. Projected Fuel Savings, per Unit



Fuel savings projections tended to range from 25% to 50%, but fuel measures typically resulted in 10% to 40% in savings. Figure 15 indicates projected savings on the Y axis versus project size by unit count on the X axis. Figure 16 indicates actual savings on the Y axis versus project size by unit count on the X axis.

Figure 15: Projected Savings vs. Number of Units in Project

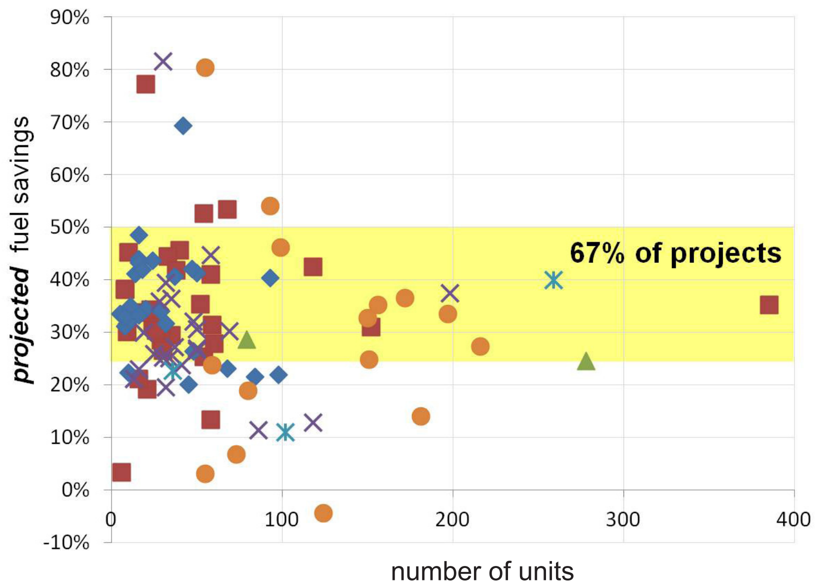
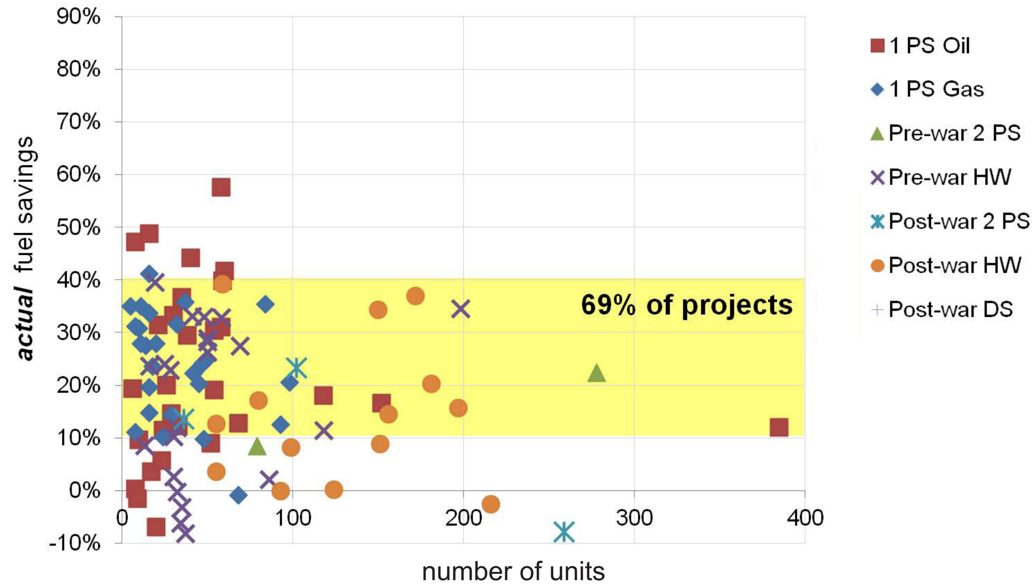


Figure 16: Actual Savings vs. Number of Units in Project



The "Capping" Methodology, in Three Steps

The portfolio's fuel savings realization rate can be vastly improved by strategically capping projections. Using this method, the overall fuel realization rate increases from 61% to 117%.

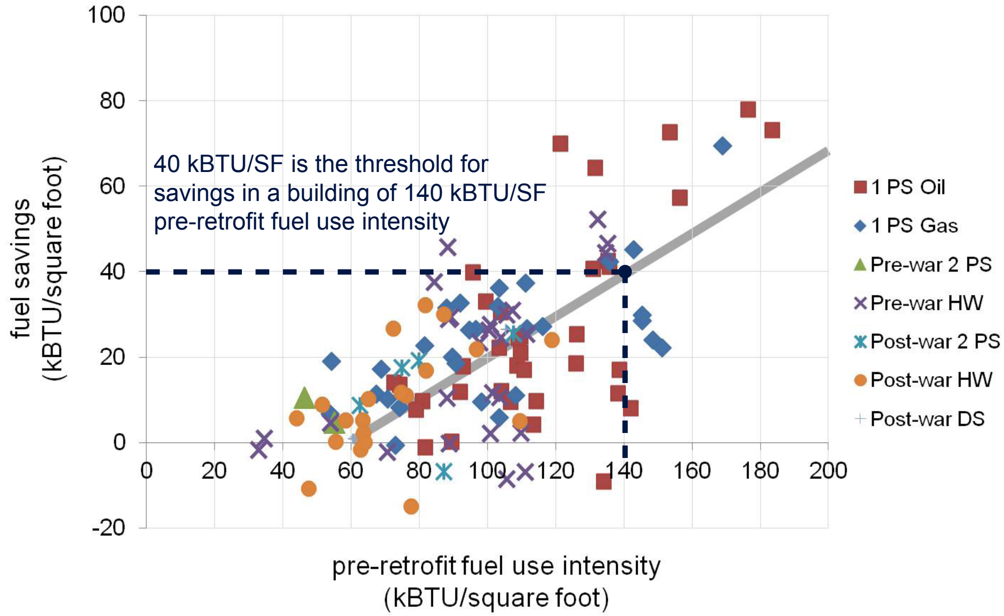
While pre-retrofit fuel consumption is a useful predictor of savings potential, the DB/LC study suggests that an approach purely based on empirical models is not an effective means of predicting savings at the building or portfolio level. Buildings are unique and complex, and a wide confluence of factors influences retrofit effectiveness.

Nonetheless, the study also suggests that an underwriting methodology cannot rely solely on auditors' projections, though auditors are critical given their firsthand knowledge of the building in question, as well as their role in recommending appropriate energy efficiency upgrades.

The study proposes a methodology by which lenders can mitigate the risk of "over-projected" savings by limiting an auditor's projected savings to a reasonable threshold of expected savings, as indicated by a building's pre-retrofit fuel use intensity

STEP 1: The correlation between pre-retrofit fuel use intensity and fuel savings is utilized to establish a conservative threshold for savings projections, following the statistically significant trend line documented in Central Finding 3 (page 34). For instance, a projected fuel savings of 40 kBTU per square foot is established as a ceiling for a building that consumes 140 kBTU per square foot pre-retrofit, as seen in Figure 17.

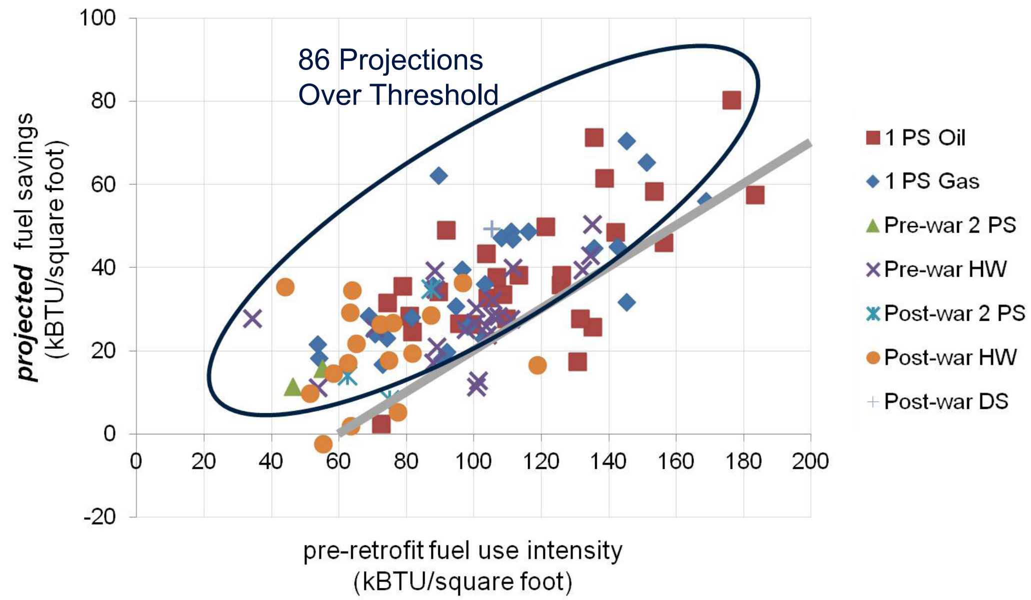
Figure 17: Historical Pre-retrofit Fuel Use Intensity Indicates a Threshold for Likely Savings



STEP 2: **Audit projections are compared to the established threshold.** The team reviewed a dataset of 100 projects that had undertaken fuel measures with comprehensive data: savings projections, pre-, and post-retrofit consumption. In this dataset, 86 of 100 fuel projections exceeded the threshold for savings based on their pre-retrofit fuel use intensity profile.

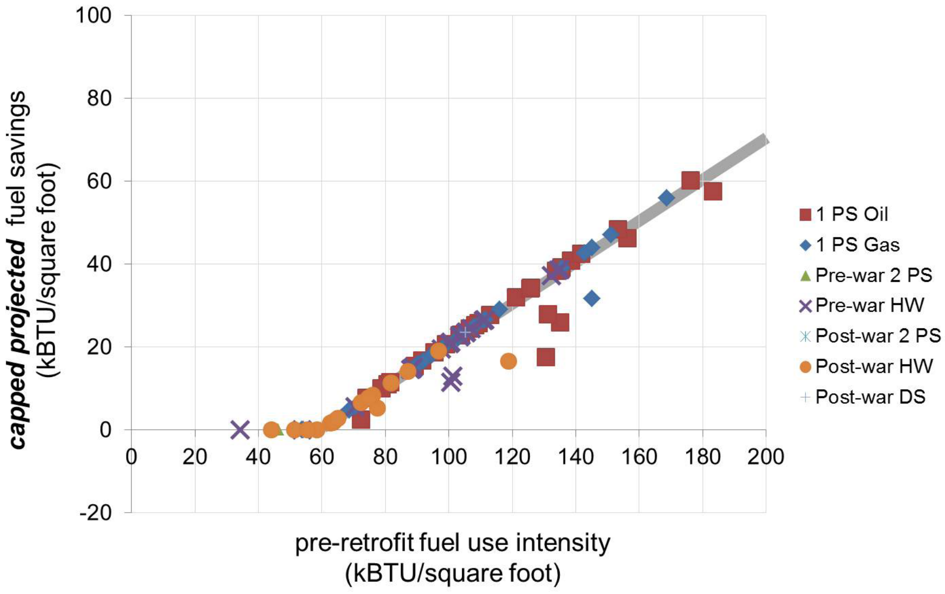
Because the fit line passes through "0" actual savings at approximately 60 kBTU per SF of pre-retrofit fuel use intensity, any projects that start out with low pre-retrofit fuel use intensities are not good candidates for lending against energy savings, and should therefore be removed from consideration.

Figure 18: Buildings' Projected Fuel Savings are Compared to the Threshold, Based On Their Pre-retrofit Fuel Use Intensity



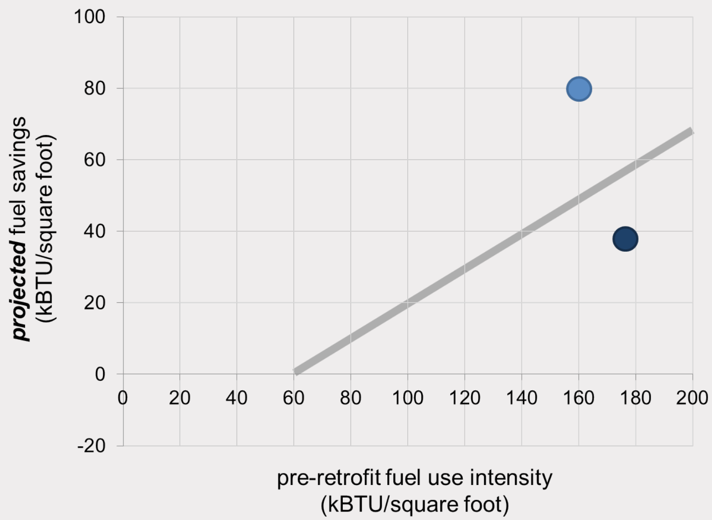
STEP 3: Any savings projections above the threshold are adjusted to the best-fit line. For example, if a building that uses 140 kBTU per SF pre-retrofit were projected to save 60 kBTU per SF, the capping methodology indicates that the projection should be reduced to the threshold of 40 kBTU per SF. If that same building were projected to save 25 kBTU per SF, which is below the threshold for a building of that pre-retrofit fuel use intensity, then the audit projection could be regarded as conservative for the basis of underwriting.

Figure 19: Projections Greater Than the Threshold Are Adjusted Down to the Trend Line, Based On Pre-retrofit Fuel Use Intensity

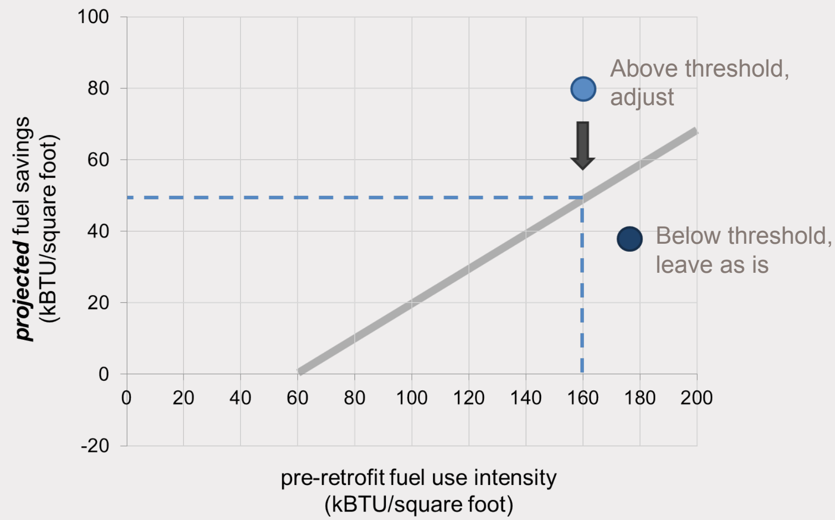


Spotlight: Strategically Capping the Projected Fuel Savings of Two Buildings

STEP 1. Identify where the two buildings' projected fuel savings fall relative to the anticipated savings threshold, per each buildings' pre-retrofit fuel use intensity.



STEP 2. If the buildings' projected fuel savings fall above the threshold, the threshold savings should be used for the purpose of underwriting against energy savings. If the building falls below the threshold, the audit projection can be used as is.



STEP 3. These two savings projections can then be utilized for the purpose of underwriting.

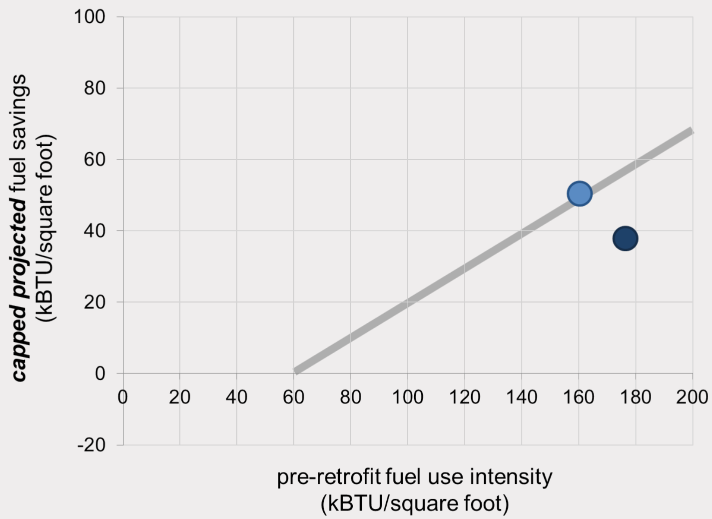


Figure 14: Projected Fuel Savings vs. Actual Fuel Savings, per Unit

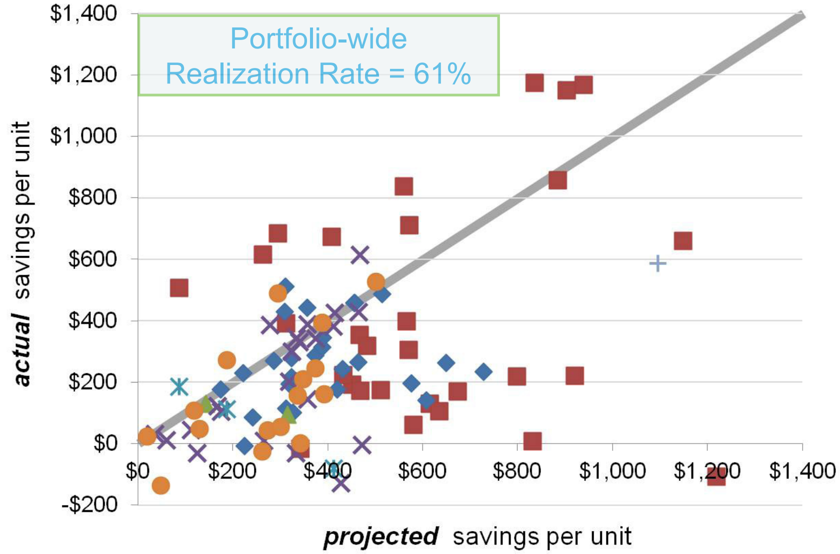
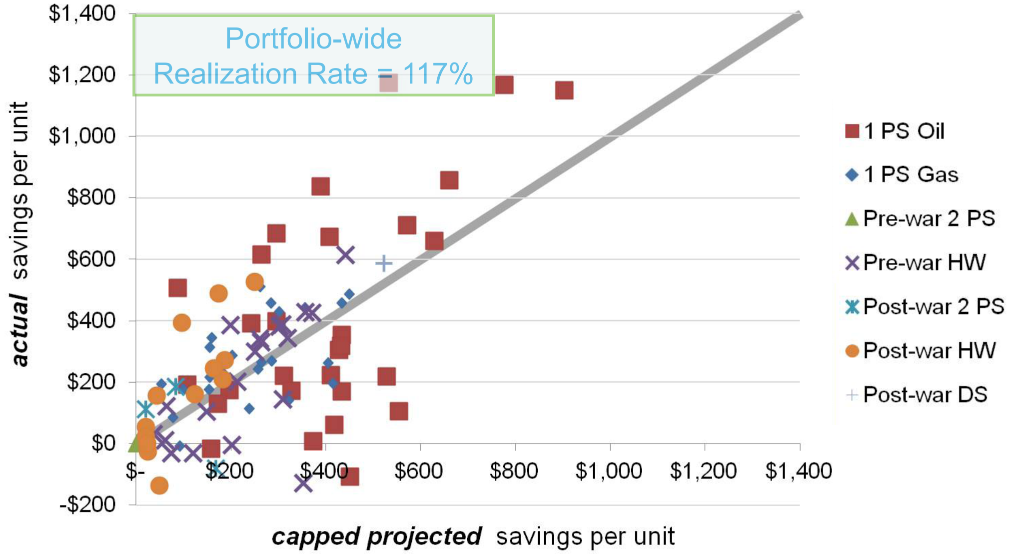


Figure 20: Capped Projected Fuel Savings Increase Portfolio Realization Rate
Capped Projected Savings vs. Actual Savings, per Unit



Across the portfolio of buildings evaluated, the capping method results in a realization rate of 117% with a 90% confidence interval of ±21%. Even taking the more conservative lower bound of the confidence interval, the capping method results in a near perfect portfolio-wide realization rate of 97%.

Figures 14 and 20 show actual savings on the Y axis and projected savings on the X axis. Figure 14 shows unadjusted projections, and Figure 20 shows projections that were capped at the best fit line from Central Finding 3. Even with the capping method, however, there are still some particular projects below the 1:1 line.[11]

An alternative to the strategic capping methodology is to take the original realization rate of 61% ±14% and simply cut every audit projection by ±50%. While this simpler method may help lenders to avoid some risk, it will reduce the number and size of loans offered, leaving potential for energy and cost savings unmet. It also over-penalizes accurate projections and under-penalizes some over-projections. By strategically capping projections, lenders can address risk more effectively, and will be better able to maximize each project's savings potential.

To understand the implications of the strategic capping methodology on a hypothetical set of loans, the team applied the methodology to 100 fuel projects in the dataset for which a full set of data was available and compared how loans might have performed if the lender underwrote against energy savings. This evaluation can be found in the *Portfolio Analysis* section.

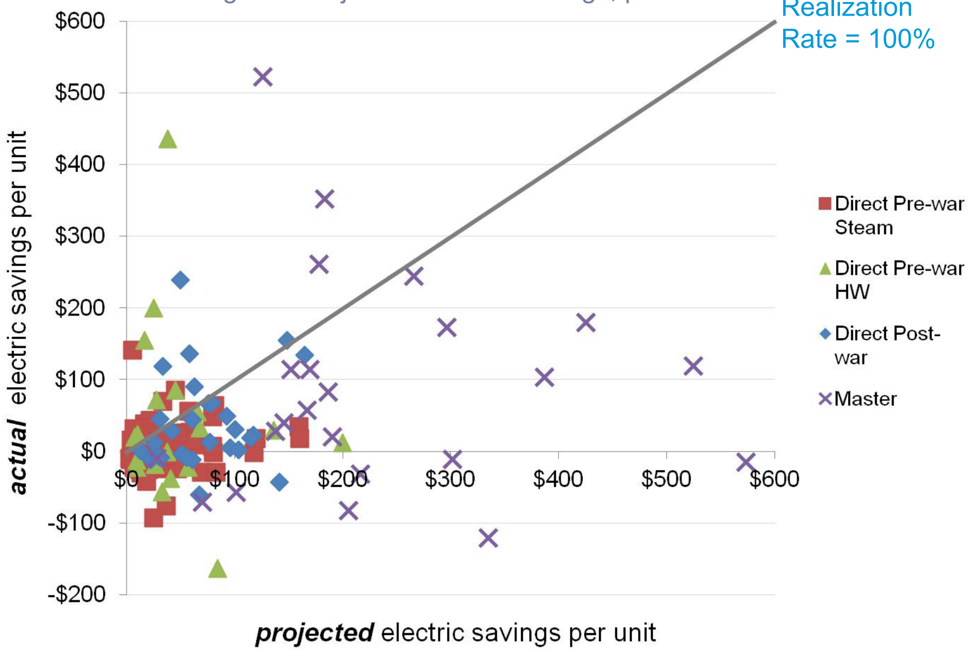
[11] One-pipe steam buildings are the most complex of the dataset, as (a) they predominate among projects that are furthest above and below the 1:1 line, and (b) average savings for one-pipe steam buildings are better than any other comparative group category.

Given the lower portfolio-wide realization rate and wider confidence interval, the capping methodology was not applied to electric savings projections.

The portfolio-wide realization rate for electric was 18%, with a confidence interval of ±40%. Figure 21 shows projects' actual electric savings on the Y axis and its projected electric savings on the X axis, per unit. With this wide variation and confidence interval, it would be difficult for lenders to have assurance in the projected savings, as well as the representative nature of the DB/LC dataset versus a larger and different pool of projects.

Figure 21: Electric Realization Rates Exhibited Wide Variation

Actual Electric Savings vs. Projected Electric Savings, per Unit



05 Additional Hypotheses:

Risk Factors & Effective Measures

This section reviews hypotheses for causes of underperformance, as well as risk factors lenders might consider when underwriting against an energy efficiency retrofit. The chapter discusses general under-performance, in which buildings achieved little savings, as well as under-realization, in which the buildings achieved much lower savings than projected in the audit. Given the varying results and confidence in fuel measures versus electric measures, the project team discusses their relative risk factors for under performance separately.

There appear to be four primary causes of under-realization of fuel savings and/or low savings for fuel measures.

1. Inappropriate/inadequate retrofit scope. An auditor serves an important role early in the retrofit process. It is the auditor's job to examine a building's physical characteristics and systems and apply experience and judgement to identify energy saving measures. The auditor utilizes software and other tools to project savings correlated with implementing those measures. There are inherent risks associated with reliance upon those projections:

   Audit over-projections. Auditors may over-project energy savings potential either by misusing tools and energy modeling software or by relying on overly optimistic assumptions (e.g., assuming "ideal case" scenarios for measure implementation and ongoing management). Energy modeling software also has limitations in the representation and analysis of particularly complex aspects of building performance.

   Building management's capacity. Auditors may recommend scopes of work that do not take into account the technical capacity of building management staff. For instance, advanced digital controls may not be appropriate in certain buildings with a less sophisticated operations staff.

2. Improper execution of the retrofit scope.[12] Savings projections often assume that retrofit contractors implement work correctly and that building owners carry out the full recommended scope of work:

   Poor retrofit implementation. Buildings may underperform if contractors do not properly install recommended measures. For example, if new windows were installed without appropriate air sealing, or if heating load reductions were installed (e.g., new insulation) without controls that have the ability to reduce the heat correspondingly, the building would likely not achieve its projected savings post-retrofit.

   Incomplete retrofit implementation. Building owners do not always implement all recommended measures, often due to financial constraints. In these instances, the project may realize lower savings than projected, particularly when owners opt for retrofit measures popular with building occupants that have much lower savings but significantly higher costs, such as window replacement.

[12] As part of the team's data collection process, significant effort was made to verify the retrofit scope. If it differed from the audit recommendations (e.g., only 3 of the 5 recommended measures were installed), the projections were adjusted accordingly.

3. Unexpected post-retrofit operations and maintenance (O&M) or tenant behavior. Following the retrofit implementation, there are a number of factors that can impact the achievement of energy savings. This includes the actions of building owners, management, and tenants:

   Lack of training, specifically related to controls. It is critical to train building management to use building controls so that savings of installed measures are maximized. Improper usage of new systems and controls can result in lower savings.

   Lack of third-party attention to operating building systems. When off-site service contractors are responsible for maintaining equipment, there is a potential for a lack of response to system changes and improvements, which can result in missed savings.

   Tenant behavior. As the primary users of the building, residents can have a huge impact on energy usage. For example, they may remove low-flow showerheads, throw out AC covers, or open their windows instead of adjusting their radiator control to reduce heat.

   Lack of ongoing maintenance for certain measures. Measures that require ongoing maintenance, such as AC sleeve weatherization, may not receive the attention they require.

There appear to be four principal causes of lower electric savings and under-realization of electric savings projections.

1. Inadequate understanding of lighting systems and human use of those systems. Some retrofits target efficiency savings (e.g., replacing an older T12 fixture with a more efficient T8), while others focus on conservation (e.g., the installation of an occupancy sensor to reduce fixture run-time). Although run-time reductions can potentially have a larger impact on energy savings, they are more difficult to account for in the energy audit due to the interactions between occupants and controls.

2. Improper execution of the retrofit scope.

   Poor retrofit implementation. Run-time reductions that rely on occupancy sensor controls are also more sensitive to installation issues than measures that simply improve efficiency without controls (e.g., replacing an older T12 fixture with a more efficient T8).

   Incomplete retrofit implementation. An owner may decide to forego some of the recommended scope, usually as a first cost savings. In these cases, just as on the fuel side, the project may realize lower savings and achieve less than the audit projection.

3. Unexpected post-retrofit tenant behavior

   CFL removal. Tenants may remove screw-in CFLs and replace them with standard incandescent lamps.

   Electric space heaters. There are several examples in the dataset in which the electric baseload decreased but the apparent electric heating increased. In these cases, tenants may be using electric heat to offset a reduction in fuel heating.

4. Load growth and metering issues

Apartment plug loads. The proliferation of flat-screen televisions, cell phones, and other consumer electronics continually increases the amount of electricity consumed by plug loads. For the purposes of this study, this is of particular concern in master-metered buildings, since these plugs loads are included in the owner-paid utilities. The addition of a control group that has not implemented any energy retrofits may help us understand the masking effects of this load growth.

Common area plug loads. Installation of new equipment can increase plug loads in common areas as well. One project in our dataset installed 2,000 new security cameras, which was estimated to account for a 1 kWh per SF increase post-retrofit in building electric use intensity.

One meter serves many uses. The vast majority of fuel is used for heating and DHW boilers, limiting use to a small amount of equipment. In contrast, electricity is used to power many different lights, appliances and equipment in a building for which the usage of these disparate loads is aggregated in a single meter or small number of central meters. A measurement and verification (M&V) program that can track specific equipment separately from the building's main meter may help isolate those electric loads which are targeted for energy savings. With electricity, it is very possible for small energy reductions in one load (e.g., lights) to be masked by fluctuations in other loads connected to the same meter.

Analysis of high performing outliers suggested additional savings opportunities.

As mentioned in Central Finding 3, the team had conducted a regression analysis of all recorded measures to understand their impact on energy savings, for which none showed statistical significance. In order to understand more about projects that had underperformed and or had considerably exceeded original savings projections, the team conducted an extensive outlier analysis. By investigating projects that had achieved greater energy savings than expected, the team was able to identify a series of potentially effective measures and approaches for implementing efficiency retrofits.

This section focuses on those approaches to retrofitting multifamily buildings that may succeed in maximizing energy savings and achieving high realization rates. These seven best practices are high impact fuel retrofit measures suggested by either the dataset or follow-up investigations of particular high saving projects.

1. Replace atmospheric boiler with sealed combustion units.
2. Install cogeneration (combined heat and power) systems.
3. Switch fuel type from oil to gas.
4. Undertake retrofits that allow steam boilers to be offline during the summer.
5. Upgrade steam controls and distribution in one-pipe steam buildings.
6. Install roof insulation.
7. Perform distribution upgrades in two-pipe steam buildings.

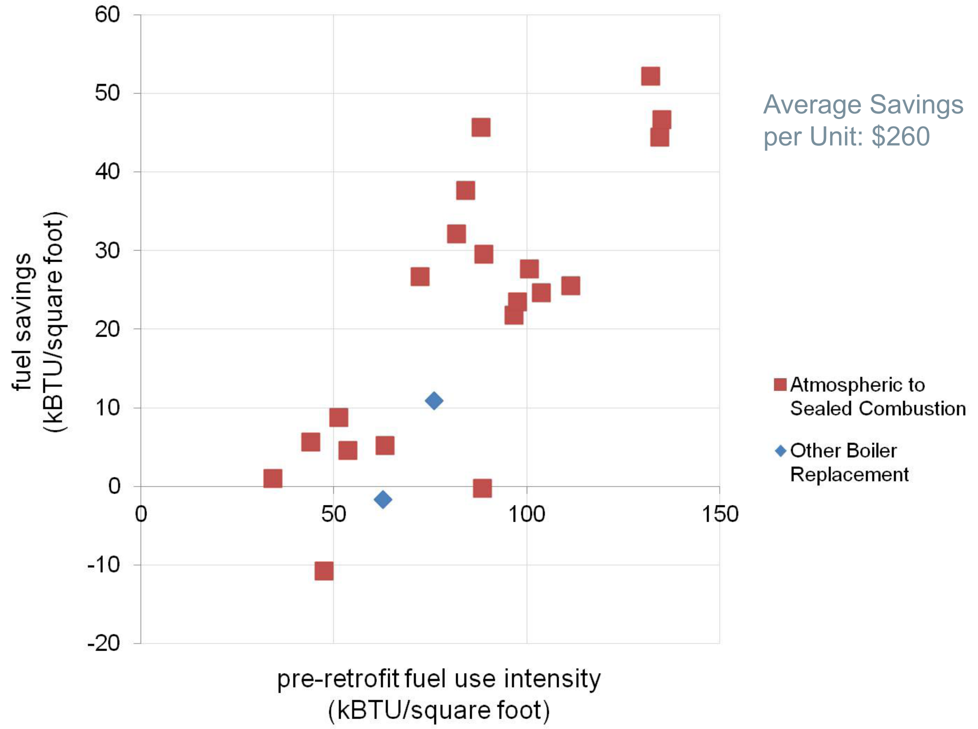
Effective measure 1: Replace atmospheric boilers with sealed combustion units.

Projects that replaced atmospheric boilers with sealed combustion units achieved greater than average fuel savings, $260 per unit compared to an average of $160 per unit across all gas projects. The subset of those atmospheric boiler upgrade projects that started with a pre-retrofit fuel use intensity greater than 70 kBTU per square foot achieved an average savings of $310 per unit.

Many hot water buildings, both pre- and post-War, use modular atmospheric boilers to provide space heating and domestic hot water. These boilers have combustion chambers open to the room, which allow air from the building to constantly move through the boiler and carry useful heat up the chimney, even when the boiler is not firing. This greatly reduces the efficiency of these boilers to well below the nominal rating.

One common retrofit to increase the efficiency of the boiler plant is to replace these atmospheric boilers with sealed combustion units, which have combustion chambers that are sealed off from the room air, thereby stopping the waste of heat up the chimney. This is a well-known issue in the building science community, but lenders need to understand that not all boiler replacements are equal from an energy savings standpoint.

Figure 22: Fuel Savings vs. Pre-retrofit Fuel Use Intensity, Atmospheric Boiler to Sealed Combustion Unit



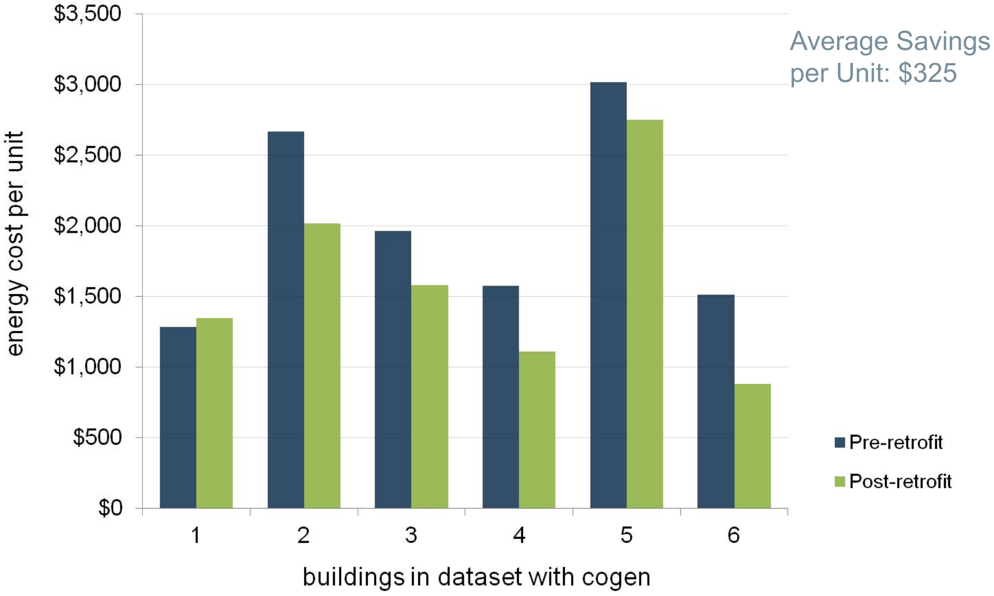
Effective measure 2: Install cogeneration systems.

On average, projects that installed cogeneration systems saved $325 per unit, which is almost double the $175 per unit of a typical gas project. Of the six projects in our study that installed cogeneration systems, five showed a decrease in overall energy costs and only one showed a slight increase.

Cogeneration, also known as combined heat and power (CHP), is a system that generates electricity on-site and then makes use of the waste heat from the process, increasing overall efficiency of the system. Typical grid-delivered electricity is approximately 30% efficient after generation and transmission losses are taken into account. Cogeneration does not create electricity more efficiently than a power plant does, but its ability to capture and use the waste heat can translate to an overall system efficiency of 85%. Waste heat can be used to provide heating, cooling or a process load, but in most multifamily buildings it is used to offset the domestic hot water load, which is constant year-round. These systems are especially attractive in New York City given the electric and gas rate structure. Although smaller micro-CHP systems are just now phasing into the market, most of the current CHP success stories have been with larger systems installed in buildings of 200 or more units.

The interaction of fuel and electricity in these systems make the savings analysis more complicated than in a typical retrofit, since projects with cogeneration systems will likely see an increase in natural gas consumption but a decrease in electricity usage. Therefore, the correct method for analyzing pre- and post-retrofit performance is to compare total utility costs.

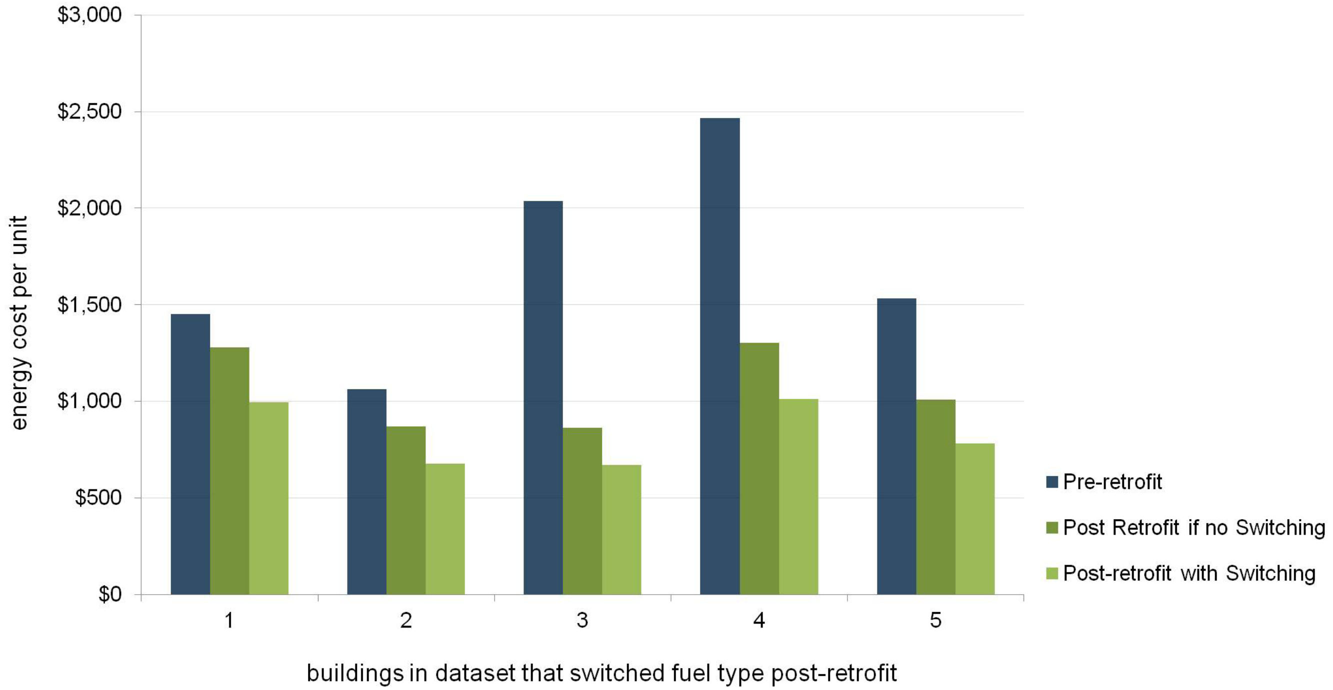
Figure 23: Energy Cost per Unit, Pre-retrofit vs. Post-retrofit in Buildings that had Installed Cogeneration Systems



The team calculated pre- and post-retrofit energy costs per unit using pre- and post-retrofit energy bills.

Effective measure 3: Switch fuel type from oil to gas.

Figure 24: Energy Cost per Unit, Pre-retrofit vs. Post-retrofit in Buildings that Converted from Oil to Gas



Average Fuel Savings if no Switching: $340/unit

Average Fuel Savings with Switching: $590/unit

Difference: $250/unit

When implemented in conjunction with energy retrofits, fuel switching can provide even greater operating cost savings than would be achieved due to energy reduction alone at current commodity pricing. For the five projects in our study that underwent gas to oil conversions, fuel switching boosted operating cost savings by an additional 75%, from $340 per unit to $590 per unit. This is nearly double the typical oil project savings of $310 per unit.

Switching from oil to gas can be an important source of operating expense savings at current utility prices. It is also be logical to coordinate a fuel switch retrofit with an energy retrofit scope. The rate for natural gas is currently about $13.50 per MMBTU, and oil is almost 30% more, at $17.50 per MMBTU. Even if no energy retrofits are implemented, there would be cost savings based solely on the difference in utility rates. However, the extra savings does require an investment. There can be significant costs associated with switching fuels, including the costs of relining the chimney, running a new gas line, decommissioning the oil tank, and/or installing a new burner.

Effective measure 4: Undertake retrofits that allow steam boilers to be offline during the summer.

A few projects in the dataset undertook energy efficiency retrofits that allowed steam boilers to be offline during the summer. Many achieved significant fuel savings, in some cases over 30% of the total pre-retrofit fuel consumption.

The most common multifamily domestic hot water (DHW) system found in New York City is a tankless coil, which is a series of copper pipes installed inside the building's space heating boiler. The domestic water is heated as it passes through on its way to the apartments. The notable disadvantage of this system is that it requires the heating boiler to remain on year-round, even though it is vastly oversized for the DHW load alone. One retrofit option for this system is to install a separate DHW system that allows the main heating boiler to be turned off during the summer months, which can be effective in achieving higher energy savings. While significant savings are often possible with such an approach, the cost effectiveness is dependent on site specific factors, such as the ease by which the new boiler can be vented. As part of this retrofit, it is important that proper maintenance procedures are followed in order to protect the main heating boiler during the extended down time.

This finding is corroborated by NYSERDA and other energy-focused organizations. However, more research is needed to better estimate the benefits of this capital-intensive measure.

Steam Boiler

Effective measure 5: Upgrade steam controls and distribution in one-pipe steam buildings.

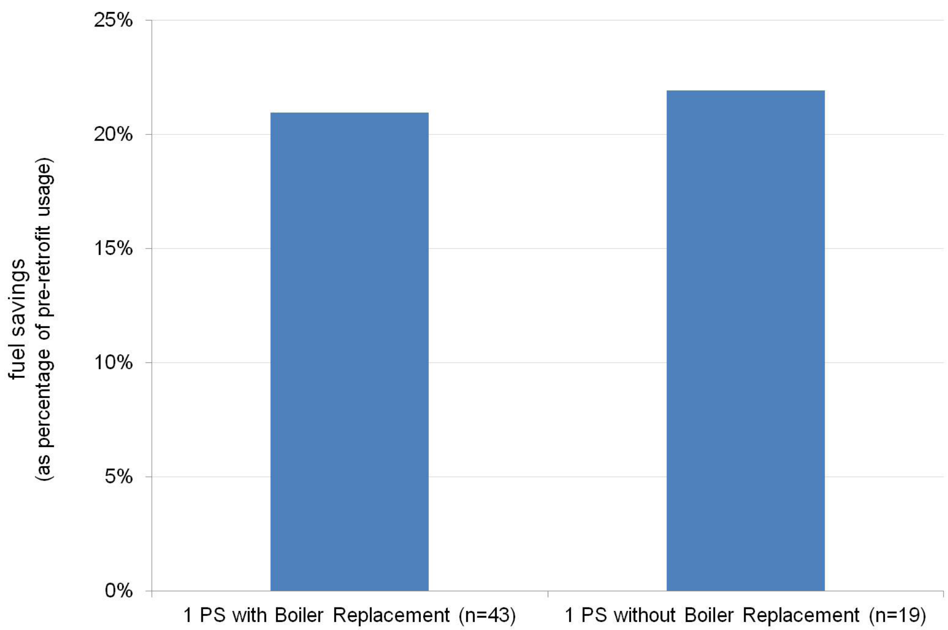
One pipe steam buildings had the highest variability in savings of all of the comparative groups. Although on average the fuel savings were 21% of pre-retrofit consumption, making them the highest savers, the savings for any particular project ranged from -32% to 58%. Weather factors and difficulties correlating oil deliveries to actual consumption may account for an approximately 10% discrepancy from year to year, but that is not enough to explain such a wide range. Rather, it is more likely that small differences in scope and execution are significantly responsible.

One-pipe steam is the oldest and simplest form of central heating in the dataset. It has few moving parts, and correspondingly has a relatively limited number of upgrades. One-pipe steam systems essentially have not changed since the late 19th century, and it is not uncommon to see boilers that are decades old and still working well. Replacing a well-performing, older boiler with a new boiler rarely offers much benefit because the physics of boiling water into steam is a fixed process. In fact, data indicate that the savings for one-pipe steam buildings that had implemented boiler replacements are equivalent to those that did not replace boilers, as seen in Figure 25.

Retrofit cost also does not appear to have an impact on achieved savings. One-pipe steam buildings that were low savers (i.e., saved less than 10%) spent approximately $2,400 per unit on the retrofit fuel measures, the same amount that was spent on those projects that were high savers and achieved greater than 20% savings.

Given that one-pipe steam systems are so simple, there are only two retrofit techniques for improving efficiency: upgrade the controls or improve the distribution.

Figure 25: Fuel Savings for One-pipe Steam Buildings With and Without Boiler Replacements



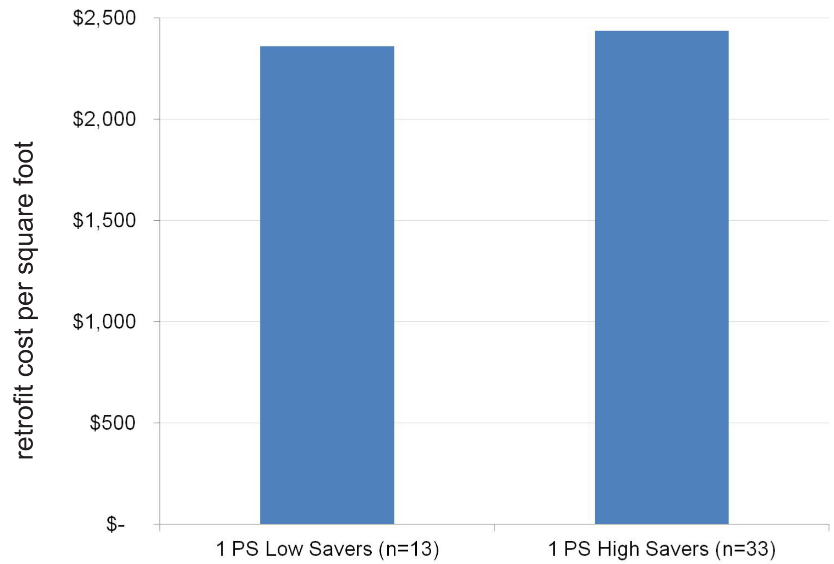
The firing rate is the rate at which the burner uses energy is extremely important to set accurately. Unfortunately, it is often incorrectly set and results in energy waste. If the firing rate is too high, more energy is sent into the boiler than can be used, and that excess is sent up the chimney. It can also cause more system cycling and the associated inefficient warm-up and cool-down losses. Properly adjusting the firing rate so that the burner modulates in order to match the load at various conditions can increase the system efficiency and save energy at a relatively low cost.

Adding interior feedback, usually in the form of wireless temperature sensors in just a handful of apartments, can prevent the control from providing steam when the apartments are already adequately heated, reducing a building's fuel consumption. Nearly all steam buildings in New York City have controls that feature outdoor reset, which varies the amount of steam provided to the building with the outdoor temperature. When the temperature is lower, more steam is provided than when weather is milder. Very few of these controls monitor what the temperature is inside the apartments. Therefore, the system sends steam up regardless of whether it's needed, creating overheated apartments. This leads to the common practice of opening windows during the winter. However, adding interior feedback may not be appropriate for every building.

It is widely recognized by the building science community that the best way to improve the distribution and create a balanced system is by installing vents at strategic locations to remove the air quickly and allow the steam to reach every apartment at approximately the same time. Such master venting is relatively inexpensive and can have a substantial impact on project savings. However, it is important to note that master venting requires a site-specific design specification (e.g., not a "one size fits all" approach) and a higher level of construction management than most measures. One of the main causes of unbalanced distribution is air, which restricts the flow of steam through the building, and may result in certain apartment lines that never seem to get enough heat. To satisfy those problem apartments, the super usually adjusts the settings so that more steam is sent up to the building. This may fix the problem for the under-heated apartments, but since steam travels in all directions, all other apartment lines become overheated, which in turn leads to open windows.

Further research and analysis of the impact of these specific measures on one-pipe steam buildings is warranted, especially since these buildings typically have high pre-retrofit fuel use intensities and offer the greatest potential for savings.

Figure 26: One-pipe Steam High Savers vs. Low Savers, Fuel Measures



Effective measure 6: Install roof insulation.

The installation of roof insulation can reduce energy consumption for any building, although its impact is generally greater in smaller buildings for which the roof represents a relatively larger portion of the envelope surface. One method of insulation, typically found on taller and newer buildings, is to install the insulation entirely above the roof structure itself. This works well in buildings for which there is no space between the roof deck and the top floor ceiling.

In contrast, pre-War buildings often have a cavity between the top floor ceiling and the roof deck. In order to prevent the buildup of moisture, this cavity is usually vented to the outside, which would reduce the effectiveness of any insulation located above the deck. Additionally, these older buildings also have bypasses (e.g., wall or piping chases) that allow heated air to flow up, around, and through whatever insulation may already be installed in between the rafters. The most effective way to retrofit this type of roof cavity is through a combination of air sealing and blown-in insulation; a guide published by the General Robotics, Automation, Sensing and Perception Laboratory in 1992 provides best practice techniques for this retrofit. In an evaluation of 80 row house buildings in Philadelphia, energy savings more than doubled on average and were also more consistent when best practice air sealing was combined with insulation of vented roof cavities.[13]

Two pre-War projects in the dataset that installed this type of roof insulation were very high savers, reducing fuel consumption by 35% and 39%, respectively. While the potential to seal up large holes in the top of buildings can result in substantial savings, the likelihood of fully realizing the air sealing benefits depends in part on how much space there is in the roof cavity for a contractor to work. This level of detail (e.g., the height of the roof cavity at various locations) is usually not reported in audits even though it could provide more insight into the possibility of achieving high savings due to air sealing with this measure.

Cavity between roof deck and top floor ceiling

Combination of air sealing and blown-in insulation

[13] Blasnik, Michael and GRASP. *Impact Evaluation of the Residential Electricity Conservation Pilot, Final Report*. January 1994.

Effective measure 7: Perform distribution upgrades in two-pipe steam buildings

Orifice plates and thermostatic radiator valves can considerably reduce overheating in apartments.

Two-pipe steam distribution is a more advanced system than the similar one-pipe steam system. The addition of an extra pipe allows for separation of the steam and condensate flows and offers better control options. However, the disadvantage of this type of system is that it has more moving parts, largely in the form of steam traps. These steam traps keep the steam contained to the supply side of the system. When the traps fail and steam gets into the return side of the system, the system's balance is upset and distribution issues, such as over- or under-heated apartments, can occur. These issues lead to fuel waste just as they do in unbalanced one-pipe distribution systems.

One way to fix these balancing issues is to install orifice plates at the inlet of every radiator. These orifices, which are small copper discs with a hole in the center, limit the amount of steam entering the radiator to slightly less than the radiator's total capacity. This means that all steam that enters the radiator will condense before reaching the outlet, effectively keeping steam out of the return piping. These simple plates can improve the balance of the distribution system and reduce fuel consumption for heating.

Orifices are often combined with thermostatic radiator valves (TRVs), which are installed in place of the typical hand valve on a radiator. TRVs monitor the room temperature and throttle the amount of steam entering the radiator as the room nears its desired setpoint.

Orifices and TRVs are two of the retrofits that can be installed on two-pipe steam systems. There is anecdotal evidence of the effectiveness of orifice plate and TRV installations. One two-pipe steam project that underwent this retrofit had fuel savings of almost 24%. Unfortunately, two-pipe steam buildings are the comparative group that is least represented in the dataset, with only nine projects across all vintages and fuel types. Given the small sample size and potential savings from this retrofit, more data collection and study of two-pipe steam buildings should be a priority.

Thermostatic Radiator Valve (TRV)

06 Implications for Underwriting

The project team conducted lender interviews to understand the opportunities and challenges associated with modifying underwriting practices to account for projected energy savings.

Current Underwriting Practices with Respect to Energy Efficiency

HR&A Advisors, with support from the DB/LC Advisory Group, conducted 14 interviews with public and private lenders, appraisers and other industry professionals. This section provides an overview of the team's findings, with additional information available in *Appendix D*.

The current lending climate is one of conservatism. While some lenders are focused on the importance of energy efficiency, none underwrite against it. Rather, underwriters rely on commonly accepted assumptions and historical data rather than forward-looking projections. Industry standards often provide a starting point for considering future expenses. Underwriters may utilize a set of per unit, per room, and/or per project assumptions at the line item level. With respect to existing affordable multifamily housing in New York City, The Community Preservation Corporation's (CPC) utility expense standards are widely utilized.[14] For some, a building's historic usage serves as a starting point in the analysis, to then be compared against industry standards.

For purposes of estimating revenues or expenses in buildings, it is uncommon for lenders to rely on projected performance. Most view projections as unnecessarily risky for the purposes of establishing a viable loan.

Challenges to Incorporating Energy Efficiency Projections in Underwriting

Lenders identified a number of barriers to incorporating energy savings projections into underwriting.

- Individuals interviewed felt that there was a broad lack of motivation for lenders and borrowers to consider energy savings projections. Compared to overall building revenues and expenses, potential energy savings are small. Furthermore, the economic crisis has made lenders more conservative, and lenders felt that borrower demand for energy efficiency is unclear. Lastly, most borrowers lack the equity for investment.
- Currently lenders lack access to data, both historical data measuring building performance and post-retrofit data verifying the performance of energy retrofits, limiting their capacity to incorporate energy savings projections into the underwriting process.

[14] CPC actively tracks operating expenses across its portfolio, and once a year analyzes this data to produce a set of standards for the coming year. For the purposes of estimating heating costs for a New York City multifamily building, CPC assumes $420 per room per annum for gas systems and $420 to $440 per room for oil-based systems, based on oil type. For gas and electric, the standard is $100 per room per annum for a walk-up building and $150 per room for an elevator building.

- External risk factors are felt to introduce an untenable level of variability into the projection process. These include fluctuations in commodity costs, weather patterns, and market trends that might impact occupancy.
- Many building owners and lenders do not understand energy efficiency in the context of their larger goals, i.e. as a means of ensuring financial returns or maximizing housing affordability.
- In affordable housing, there are also a number of structural or regulatory impediments. Government housing regulators often have discretion over capital improvements and release of reserves. Rent and utility allowance caps may also preclude building owners from fully recovering energy cost savings.

Potential Benefits of a Greater Focus on Energy Efficiency

Interviewees identified a range of potential benefits of energy efficiency for their lending practices:

- Better energy performance creates stronger cash flow to pay debt service. Investment in efficiency would increase net operating income and strengthen an owner's ability to meet debt service coverage ratios, reducing the risk of default on the loan.
- Increased cash flow might allow for a larger loan or subordinate debt. Holding debt service coverage ratios constant, a building with lower energy expenses could support higher levels of debt service, either through a larger loan or acceptance of future subordinate debt. The additional loan could be used to cover the cost of those energy measures.
- Energy performance improvements can benefit long-term asset value. As a result of energy efficiency investments, lenders may consider lowering the risk profile of the asset in question, or alternatively might adjust the cap rate downward, resulting in a higher terminal value for the asset.

Furthermore, the market potential for a loan product that incorporates energy savings projections is considerable. Developing a new loan product that leverages energy savings would allow lenders to increase market share and capitalize on more than $16 billion of savings potential in multifamily housing.

Opportunities to Incorporate Energy Efficiency Projections into Underwriting

Interviews identified a set of opportunities to enhance traditional lending practices to incorporate energy efficiency savings into the process.

- Incorporate the practice into the first mortgage. The most effective means to recognize potential energy savings in underwriting is likely through the first mortgage.

  Similarly, construction lenders might develop a specialized product whereby they provide larger-sized construction loans or more attractive financing terms based on projected savings from energy efficiency retrofits.

- Incorporate the practice into a second mortgage. In the case where first mortgagees are not willing to increase the loan size, they may be willing to allow borrowers to take out subordinate debt for undertaking energy efficiency capital improvements. In this case, interests are most easily aligned if the second mortgagee is the same entity that holds the first mortgage. Assuming initial investment in some efficiency measures under the first mortgage, a lender could alternatively require a period in which to monitor performance before agreeing to additional debt.

- Create a mini-permanent loan product. A mini-permanent loan could be used to bridge the period between construction and permanent lending, which may provide an opportunity to consider the benefits of capital renovations during that period.

The vast majority of interviewees felt that the public sector or intermediaries should initially take on the risk of incorporating energy savings projections. Many lenders stated they were not comfortable taking this step absent another entity doing so first, citing need for the public sector to shoulder some of the risk associated with underperformance of projected savings.

This study suggests an approach to underwriting against fuel savings projections, balancing the need for simplicity with that for accuracy.

Methodological Approach

The study's central findings provide a meaningful starting point for incorporating energy savings projections into underwriting. A viable approach to such underwriting requires finding a balance among:

- Reliance on a hybrid approach that utilizes the DB/LC empirical model to place a conservative boundary on audit savings projections. While pre-retrofit fuel consumption is a useful means of estimating savings potential, the DB/LC study suggests that sole reliance on an empirical model is not an effective means of predicting savings at the building or portfolio level. Buildings are unique and complex, and a confluence of factors influences retrofit effectiveness. Further, skilled auditors are critical given their knowledge of the building in question, and ability to recommend an appropriate scope of work.

  The study also suggests that an underwriting methodology cannot rely solely on auditors' projections. The project team therefore recommends a hybrid approach that relies upon an auditor to assess energy savings opportunities and recommend a scope of work, but utilizes an empirical model to assess the level of risk associated with audit projections.

- A methodology that is simple, transparent and flexible versus one that strives for technical accuracy. The methodology and procedures for implementing it must be flexible as they will need to work on and with a variety of lenders' platforms and underwriting approaches.

  Nonetheless, one must be able to reliably interpret technical data to assess the risk associated with performance projections. Most lenders are not experts in building science and do not have specialized resources on staff.

Principles for "Enhanced" Underwriting

The proposed underwriting methodology is framed by the following guiding principles:

- Underwrite against fuel savings rather than electric savings, given greater consistency, volume of savings, and comparative pre-retrofit energy costs. There may be opportunities in the future to underwrite against electric savings, but the wide confidence interval for electric data implies significantly greater risk, suggesting fuel savings as a launching point for innovating underwriting practices.

- Screen savings opportunities across a portfolio by examining pre-retrofit fuel usage in comparison to buildings of similar vintage and heating system. Lenders can utilize this practice to compare performance across their portfolios, and identify when an energy audit is warranted as part of the lending process.

- **Strategically "cap" auditors' savings projections** to improve the portfolio's realization rate. Lenders can mitigate the risk of "over-projected" savings by limiting an auditor's projected savings to a reasonable threshold of expected savings, as indicated by a building's pre-retrofit fuel use intensity.

- **Empower buildings to perform better.** Underwriting practices alone will not result in successfully performing buildings. The study recommends the development and deployment of standardized data reporting procedures, best practice guidelines for building owners and managers, and a regimen for energy monitoring, reporting and intervention.

The traditional lending process provides a framework for how energy efficiency could be effectively incorporated into underwriting practices.

1	2	3	4	5	6	7
loan application	application review	due diligence	underwriting	closing	capital work	servicing

An effective methodology for "enhanced" underwriting practices, incorporating energy savings projections, must be easily incorporated into existing lending processes. Below, we provide a brief overview of the traditional lending process.

1. Loan Application. The borrower completes a loan application, including requested supporting documentation (e.g., regarding cash flow and outstanding debt).

2. Application Review. Lenders review the loan application and, utilizing historical financials and standards, develop a financial model that estimates cash flow available to service debt and potential loan size. Lenders issue a letter of commitment proposing loan terms, contingent upon the accuracy of the loan application information.

3. Due Diligence. Should a loan move forward, lenders typically require the completion of a set of due diligence activities, including a property appraisal; a physical needs assessment; and title, debt and lien searches. In most cases, lenders require that their borrowers cover the cost of these activities, and utilize pre-qualified vendors to do so.

4. Underwriting. Underwriters review findings and incorporate them into their financial models. In the case of a physical needs assessment, for instance, lenders might require additional capital work be completed as part of the refinancing process. The proposed loan package is then presented to a lender's credit committee, reviewed and approved. The loan structure is finalized, and closing documents are prepared.

5. Closing. At closing, loan documents are executed and funds are released.

6. Capital Work. Capital upgrades are undertaken post-closing. In many cases, lenders will require the verification of installation of such capital work.

7. Servicing. Finally, loan servicers monitor loan repayment over the life of the loan, as well as reserve balances, escrows for property taxes and other expenses, and overall physical conditions.

An energy efficiency-enhanced lending process could and should be integrated into the existing underwriting framework.

1
loan application

2
application review

Process for "Enhanced" Lending

1. Loan Application

At the point of application, lenders should collect data about the building's energy usage in order to assess opportunities for energy savings. Such data should include:

- Building vintage;
- Building square footage;
- Heating system type;
- Pre-retrofit fuel consumption, in dollars;[15]
- Commodity rates or prices, so that lenders might back into a rough estimate of fuel consumption;
- Electric metering configuration; and
- Past and/or planned capital work, with specific focus on work that may have impacts on energy consumption.

2. Application Review

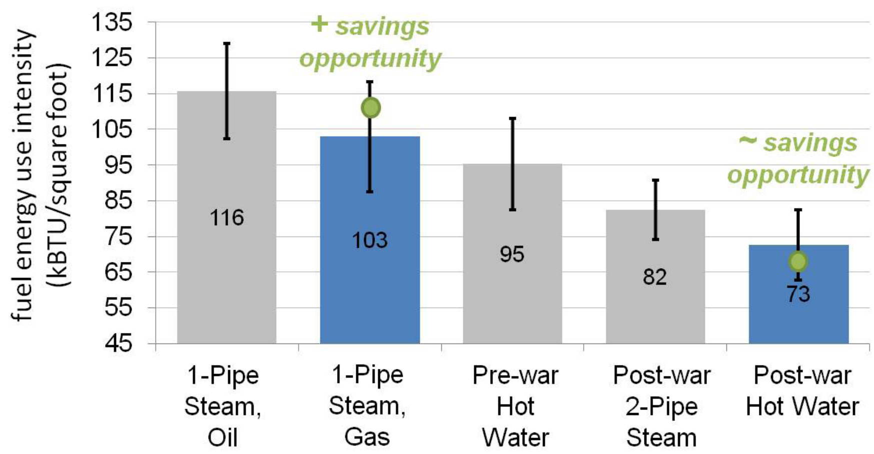
The lender would utilize the above information to develop a rough, order-of-magnitude benchmark of pre-retrofit fuel consumption to understand how the building performs relative to its peers. The DB/LC study indicates that vintage and heating system type are good proxies for understanding what a typical range of fuel use intensity might be for particular types of buildings. A lender could estimate fuel intensity use in kBTU per square foot utilizing the data from the loan application, allowing comparison to peer buildings. Buildings that consume more fuel than their peers present greater savings opportunities. In these cases, a lender might request that the borrower conduct an energy audit. Buildings that fall towards the lower end of the consumption range may not warrant an audit.

[15] To the extent that fuel consumption data is readily available in kBTUs, lenders may opt to undertake a more fine-grained benchmarking analysis. Not all owners have the capability to collect that information however, and lenders must weigh the rates of borrower participation against the desire for a more detailed benchmarking analysis.

2

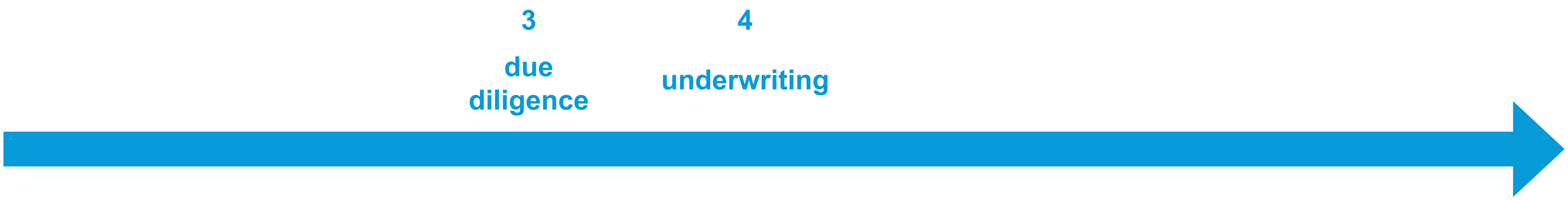
application review

Figure 27: Pre-Retrofit Fuel Use Intensity Benchmarking Exercise



Understanding how a building performs versus its peers is a basic but useful means for understanding a building's savings opportunity.

Ideally, a lender could also review a number of other characteristics that affect a building's energy expenses, particularly the owner's commodity costs. Separating a building's fuel usage into heating and DHW would also help a lender to understand more detail about a building's energy expenses, such as the cost disparity between fuel consumption dedicated to DHW and heating, as well as the associated base usage waste.



3. Due Diligence

In those instances in which the lender requests an audit, it will wish to consider:

- Quality assurance. Lenders will need to employ a set of standards to ensure that audits are of high quality and provide reliable data. Similar to how physical needs assessments are conducted, a lender might create a pre-qualified list of auditors, and require their borrowers to contract with an auditor from that list.
- Standardized data reporting procedures. A standardized reporting procedure will ensure that lenders can easily comprehend the output of an audit report, and that they can compare "apples to apples" across their portfolio. These guidelines could take the form of a one-page summary completed by the auditor that provides both a quality assurance check and a high level summary of the most critical parameters from the lending perspective to evaluate a particular scope of work. A simple checklist would accompany the form, aiding auditors in a review to ensure that they are reporting data in an accurate and credible manner.

4. Underwriting

Following completion of an energy audit, the underwriter would incorporate the costs and savings projections provided by the auditor into his/her pro forma. This consists of three key steps:

- Review the retrofit scope & projected costs. The lender should review the auditor's recommended scope of work and cost estimates, and benchmark them against similar capital work implemented in comparable buildings.
- Underwrite per traditional practices. The lender would then underwrite the loan per its traditional practices. Underwriters utilize a building's income and expenses to derive its net operating income (NOI), before debt. They then apply a debt service coverage ratio to the NOI, which describes the amount of excess cash flow the lender will require to support debt service. The result is the annual debt the building could support. Based on the interest loan-to-value ratio and term of the loan, an underwriter then calculates the loan amount, which is often capped at a loan-to-value rate (e.g., 80%).

  If the loan amount covers the estimated retrofit project cost, then no additional steps are required to finance the retrofit. However, if the loan amount does not support the full retrofit cost, "enhanced" underwriting may be warranted.

4

underwriting

- **Underwrite per "enhanced" practices.** As a first step in the "enhanced" underwriting practice, the lender must first determine the capital shortfall, or the additional cash flow required to implement the energy efficiency scope of work. The capital shortfall allows for a comparison point against the annual savings projected. For comparison purposes, this will be referred to as factor X, the capital shortage.

total required capital		**X**
– traditional loan	⇨	additional cash flow required
– incentives		
capital shortage		

The lender evaluates the auditor's projection using the DB/LC "capping" methodology. Using a simple lookup table, a lender could compare whether the auditor's projected savings falls above what is typical for a building of that pre-retrofit fuel use intensity. If the audit projection is below the threshold, then the lender would rely upon the auditor's projection. However, if the auditor's projection is greater than the typical savings for a building of that pre-retrofit fuel use intensity, the lender would "cap" the projection, pulling the projected savings down to what is indicated by the trend line, as can be seen in Figures 12 and 18 at the right.

This variable is referred to as **Y, the lender's adjusted audit projection.**

Figure 12: Post-Retrofit Fuel Savings vs. Pre-Retrofit Fuel Use Intensity

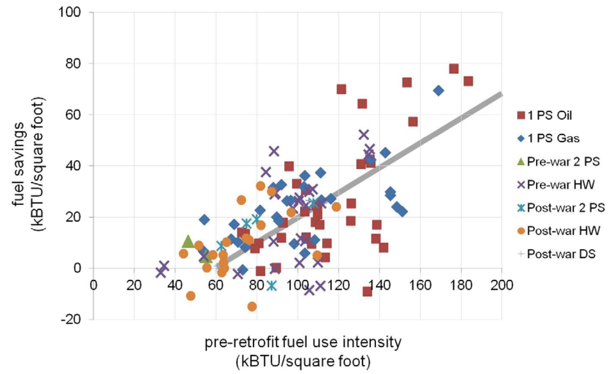
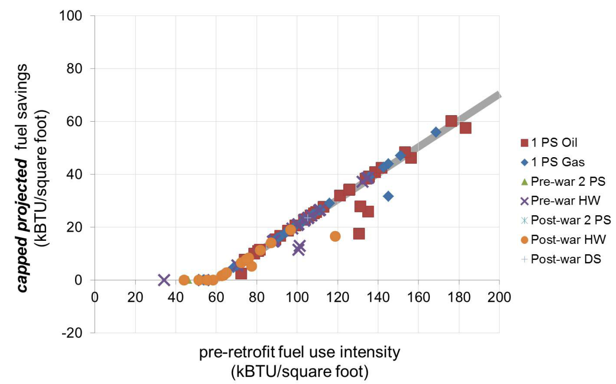


Figure 18: Capped Projected Fuel Savings vs. Pre-Retrofit Fuel Use Intensity

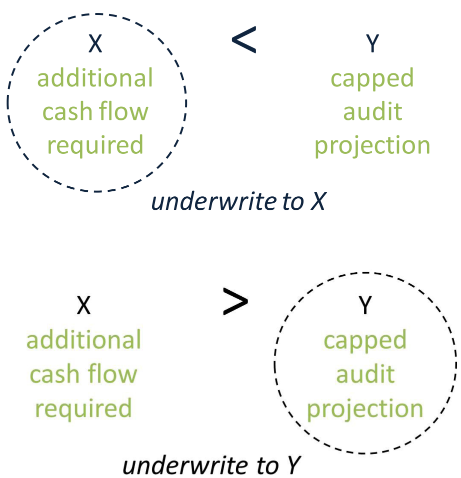


4

underwriting

If the capital shortfall required to cover the cost of the incremental energy efficiency work is less than the adjusted projected savings - if factor X is less than Y - then the lender would underwrite to the additional cash flow required to implement the energy efficiency work.

In some cases, however, the capital shortfall will be greater than the lender's adjusted projected savings. In those cases, the lender would underwrite against the adjusted projection, Y, to cover a portion of the energy efficiency retrofit work. As part of this practice, the lender would need to ensure that the owner was still completing the full retrofit scope, or revisit the projected savings from the measures that would be pursued.



A variety of additional qualitative and quantitative factors also influence underwriting. While the DB/LC empirical model is helpful in mitigating the risk of audit over-projections, there are a variety of additional factors that should influence underwriting assumptions, including but not limited to:

- Building owner best practices
    - Past retrofit experience
    - Building management competency
    - Facility staff training
    - Tenant education
- Implementation factors
    - Auditor, construction manager, and contractor experience and qualifications
    - Verification of installation
    - Participation in energy programs (e.g., NYSERDA, WAP, etc.)
- Financial factors
    - Excess cash flow
    - Available grants
    - Low existing debt
    - Credit enhancement

These factors, as well as additional building and retrofit considerations, might be addressed in a checklist that lenders could review to ensure a comprehensive approach to enhanced underwriting practice.

6

capital work

6. Capital Work

The project team believes that the results obtained by using the enhanced underwriting methodology are likely to be better if supporting resources are employed.

- Best practices guidelines. Lenders might provide best practices guidelines to borrowers undertaking energy efficiency retrofits to improve the likelihood of achieving a high realization rate. These practices would take the form of a simple, manual that lenders would distribute to borrowers at the time of application. The guidelines would recommend actions that owners could take to maximize their achievement of projected savings and reduce risk of underperformance, with a focus on the implementation of energy measures, and ongoing maintenance and monitoring.

- Retrofit implementation. A general contractor or construction manager experienced with energy efficiency can be an effective means of managing the retrofit implementation, particularly if the owner is employing a number of contractors to carry out different portions of the work. Lenders may develop specific standards or requirements for general contractors or construction managers with regards to energy efficiency capital work.

- Verification of installation. Lenders should also require verification of installation through a third-party, such as the auditor, to confirm that the recommended systems, appliances, fixtures, and other scope items were installed as designed.

- Facility staff training. The lender should require the borrower's building management staff to undertake training and education to prepare them to successfully operate the building systems. This includes ensuring that staff can maintain new systems, utilize controls, detect if systems or measures are not operating properly, and respond to tenant needs without mishandling or misusing equipment. A variety of successful training programs currently exist in the New York City marketplace.

- Tenant education. Initiatives to engage and educate tenants on energy efficiency conservation and the overall retrofit process can help support effective building operations and maintenance.

7

servicing

7. Servicing

Upon completion of capital work, lenders should consider ongoing monitoring of building performance to ensure that systems are performing as anticipated and that savings accrue. Borrowers would be required to track energy consumption on a monthly basis, and share that information with lenders. This effort could make use of existing third party energy tracking software tools and building management system products that are currently available on the market, such as EnergyScoreCards and WegoWise.

If the retrofit is not resulting in savings, the lender would require the owner to employ the services of a building specialist to review the installed systems to determine the source of the building's underperformance. Corrective measures could then be considered.

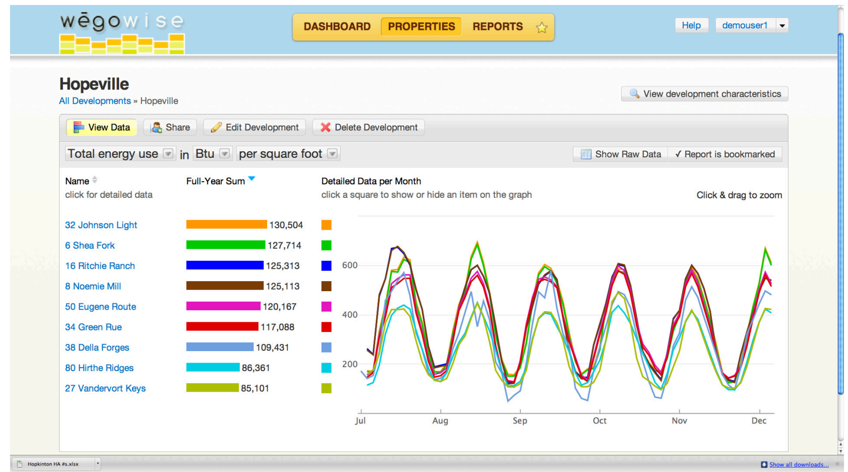


Image courtesy of WegoWise

Image courtesy of EnergyScoreCards

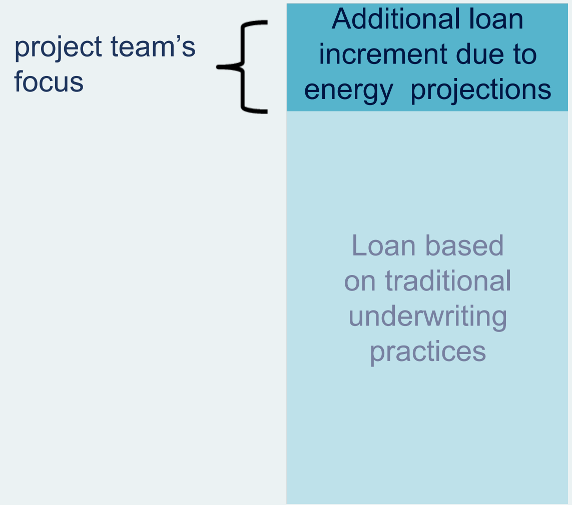
07 Portfolio Analysis

Comparative Portfolio Analysis

Utilizing the DB/LC fuel dataset, the project team undertook a comparative analysis, examining the impacts of the capping methodology on loan performance versus underwriting against unadjusted savings projections. The portfolio analysis was hypothetical, utilizing pre-retrofit characteristics and audit projections of the dataset to size potential loans, and comparing these mock loans to actual energy performance as a means to examine the hypothetical loans' viability. The fuel dataset included 100 projects, totaling 8,100 units, for which pre-, projected and post-retrofit data were available.

The project team analyzed one potential application of the underwriting methodology, whereby a lender would utilize the projected energy savings to increase the loan size on a first lien mortgage at point of refinancing. The analysis focused on the new loan increment created by underwriting against adjusted energy savings projections, rather than on the performance of the entire loan, as illustrated in Figure 28. The overall loan amount would typically be much greater than the energy savings loan increment, which creates an additional cushion for underwriting against energy savings projections.

Figure 28: Energy Savings Loan Increment

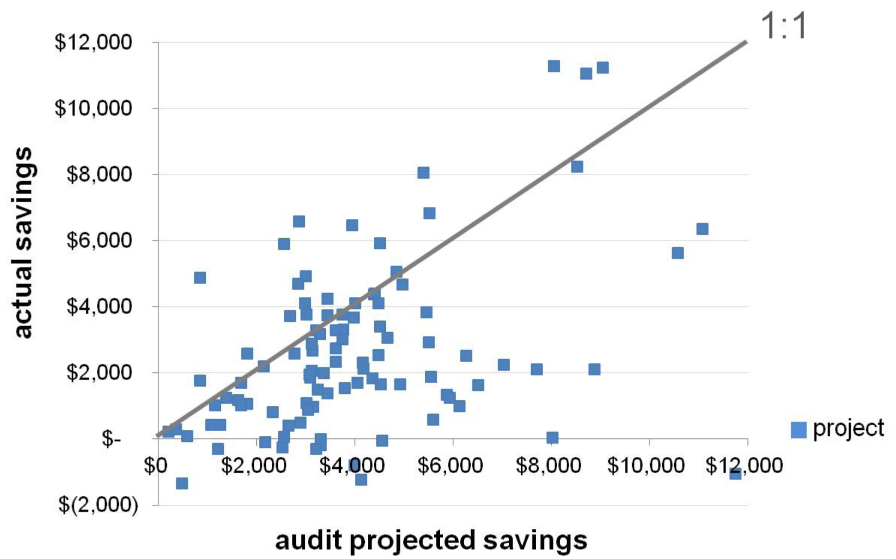


Loans were assumed to be amortized over a 30-year term, at an interest rate of 7% and debt service coverage ratio of 1.30. The project team recognizes that mortgages are typically written for less than 30 years - often even less than even 10 years – and suggests that improved energy performance should put a building in a better financial position for future refinancing. Furthermore, we recognize that measure life is also an important consideration in thinking about the term of debt and crediting of savings. Measures with shorter useful lives could often be addressed through the build-up of capital reserves over the life of the loan, while larger capital expenses could be addressed at future refinancings.

Figure 29 plots the additional debt per unit that would be loaned to each building in the DB/LC fuel dataset if unadjusted audit projections were created. These estimates are compared with the debt levels that are supported by the actual savings recorded by each building in the DB/LC study, to examine the potential performance of the energy savings loan increment. Buildings falling above the 1:1 line have energy savings loan increments that are performing positively, while those below the line would fall short of repayment of the energy savings loan increment (though perhaps not the overall loan itself).

In the case of hypothetical loans that were underwritten against unadjusted audit projections, a majority (71%) are not supported by the actual savings recorded within the first year or two of the energy monitoring period. While the actual savings in this portfolio would support more than $19 million in total incremental debt due to energy savings, underwriting against savings projections would have resulted in energy savings loan increments totaling more than $31 million, resulting in a shortfall of more than $12 million, or a realization rate of 61%. Annual repayment shortfall across the portfolio as a whole would be ($1,103,000) or a median of ($153) per unit per year.

Figure 29: Debt Supported per Unit, Audit Projected Savings



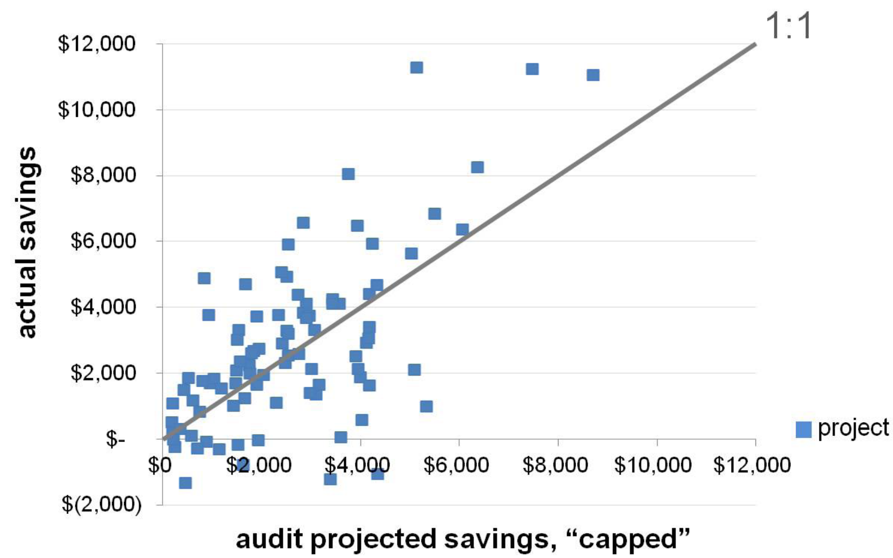
Debt supported by actual savings	$	19,116,000
Debt supported by audit projection	$	31,339,000
Difference	$	(12,223,000)
Realization rate		61%
Percent of loans where actual savings < projections		71%
Annual repayment shortfall (portfolio)	$	(1,103,000)
Median annual shortfall (per unit)	$	(153)

The capping methodology proposed by this study improved portfolio performance. While the actual savings in this portfolio would support more than $19 million in total incremental debt due to energy savings, underwriting against adjusted savings projections would have resulted in energy savings loan increments totaling just under $16 million, reflecting a realization rate of 117%. Two-thirds of the projects received loan increments supported by the actual savings, compared to only a third in the case of unadjusted projections Annual repayment shortfall across the portfolio was cut by more than 80% to ($205,000).

Of those loans falling short in repayment due to energy savings underperformance, the median annual shortfall was $110 per unit. This is a very small percentage (approximately 2%) of overall building expenses, not including taxes.[16] On average, the surplus cash flow required under debt service coverage standards – counting only the energy savings increment of the loan – would cover about two-thirds of this shortfall. Complete coverage of this shortfall would have been achieved by most debt service coverage requirements on the overall loan, considerably larger than that of the energy increment by itself.

The study found that for half of these projects, the debt sized per the DB/LC approach was sufficient to support the full cost of the fuel retrofit. Many of the cases in which loans weren't large enough were due to the high cost of fuel retrofits. This is not surprising, as many end-of-useful life heating system upgrades may not be cost-effective, but are certainly necessary to provide building residents with heat.

Figure 30: Debt Supported per Unit, "Capped" Audit Projected Savings



Debt supported by actual savings	$	19,116,000
Debt supported by capped audit projection	$	15,713,000
Difference	$	3,403,000
Realization rate		117%
Percent of loans where actual savings < projections		35%
Annual repayment shortfall (portfolio)	$	(205,000)
Median annual shortfall (per unit)	$	(110)

[16] Assumes annual building expenses of $5,000 to $6,000 per unit per year, net of taxes.

Additional screening procedures do not appear to improve portfolio performance. Refinement of the enhanced underwriting methodology might include additional screening procedures, aimed at boosting portfolio performance and reducing repayment shortfalls. A variety of screening approaches were examined, including (a) removal of buildings with one-pipe steam heating systems, as they had high variability in performance across the study; (b) removal of buildings with either very low or high retrofit costs; and (c) limiting the portfolio to buildings with high pre-retrofit fuel consumption. Of the screening approaches reviewed, none had significant positive impact on the portfolio's performance. This may not be surprising, given that the study did not find significant correlations between building and retrofit characteristics, with the exception of pre-retrofit fuel use intensity. Further exploration of additional screening procedures could be undertaken based on the specific characteristics of a lender's portfolio, their risk tolerance, and long-term goals for product development (e.g., limited to specific building types, or rolled out more broadly).

08 Policy Recommendations

The findings of the DB/LC study inform a set of policy considerations for the affordable housing sector, energy policymakers and program managers, and the lending community.

From early in the days of this initiative, it has been the goal of Deutsche Bank Americas Foundation and Living Cities to utilize the study's findings as a means to transform practices in the lending community, inform the effectiveness of public policies and programs, and take steps towards improving the long-term sustainability of our nation's affordable multifamily housing stock. With this goal in mind, the project team frames three sets of policy implications for consideration:

1. Shaping reliable building energy databases;
2. Increasing accountability in audit projections; and
3. Transforming market practices to incorporate energy savings into underwriting.

Shaping reliable building energy databases

The current DB/LC database is a strong starting point for the creation of a living database that can help advance the field of energy efficiency and retrofit financing. This section reviews next steps that will need to be taken to create that living database.

Further data collection. As has been previously discussed, an expanded dataset could allow for examination of more granular relationships among building characteristics, retrofit measures, and savings. Based on a survey of the available data sources for multifamily retrofit projects in New York City and State, the database of retrofit projects could be grown considerably in the next two years. Conservative estimates include:

- NYSERDA Multifamily Performance Program
    - Downstate[17] 30 projects, 4,700 units
    - Upstate 80 projects, 9,000 units
- Weatherization Assistance Program:
    - New York City 160 projects, 5,700 units

Other data sources might include The Community Preservation Corporation's Green Loan Fund, Con Edison programs, National Grid programs, statewide Weatherization programs, PSE&G programs, and New Jersey's Pay for Performance program.

The project team also recommends that existing programs mandate that participating multifamily projects collect a set of critical data fields to support the growth of this effort.

[17] Includes New York City and Westchester. Note that 2011 downstate estimates reflect the fact that many of the projects are already in the DB/LC database.

Continued alignment with other data collection initiatives. Many industry stakeholders recognize that a dearth of data has held back the energy efficiency field's progress, and have initiated a variety of projects to address this problem. The alignment of these efforts, informed by the DB/LC study, is critical to the overall success of energy data collection and analysis nationwide.

- The Residential Energy and Water Data Collaborative (REWDC) is an alignment of stakeholders including Enterprise Community Partners, the Local Initiatives Support Corporation, NeighborWorks America, Stewards of Affordable Housing for the Future and the Housing Partnership Network. The goal of this effort is to synchronize data collection standards for the multifamily affordable market nationwide, through compilation of a unified list of data points and definitions for building characteristics and utility consumption.
- U.S. Environmental Protection Agency (EPA) and Fannie Mae have launched an initiative to define data fields and collect data to support the creation of a Multifamily ENERGY STAR rating system within Portfolio Manager.
- New York City's Local Law 84 requires the benchmarking and eventual public reporting of certain benchmarking outputs for all residential and commercial buildings above 50,000 square feet.

Ultimately, alignment of initiatives could support interesting data sharing opportunities. For instance, the benchmarking-only databases (REWDC, EPA-Fannie, and LL84) may contain tens of thousands of buildings in the mid term. There are interesting opportunities for overlaying outputs of the DB/LC effort with a much larger database of basic energy usage information. Conversely, outputs of a broader database could inform the definition of comparative groups and normal ranges for use in the analysis of the DB/LC retrofit database.

Ongoing stewardship and access to the DB/LC dataset. Ongoing maintenance, development, and access to the DB/LC dataset would support the work of a variety of potential users, including energy auditors, lenders, owners, government agencies, and perhaps even equipment manufacturers. The existing dataset provides a comprehensive template to facilitate further data collection, for which the relevant data fields are listed in *Appendix C*. Long-term maintenance of the dataset is an active task, requiring not only data collection but also the screening and "cleaning" of such data before incorporating it into the database. As the number of projects in the dataset grows, the analyses should be rerun in order to update the central findings, thereby minimizing the confidence intervals. With a considerably larger dataset of projects, additional trends may be found among certain measures and building characteristics, given greater statistical significance.

The most likely candidate for long-term stewardship of the database would be a government agency or a non-profit organization with a focus on building science and/or energy. The future geographic extent of the dataset will also be a factor in determining the ideal steward.

Replicability of DB/LC study. The opportunity to replicate this work in other regions should be explored. Two potential paths exist: (1) applying the study's findings directly to other cities that have building stock similar to New York City, and (2) replicating the DB/LC study in new markets by building new datasets. Much of the multifamily housing in New York City features central heating systems, typically with steam or hot water distribution, which formed the basis of the comparative groups used in this study. These types of systems are also commonly found in cities such as Chicago and Boston, but are not often found in multifamily buildings in newer urban areas.

For replication of the study itself in new markets, the key methodology would remain the same regardless of geography: collecting data, aligning data fields, weather-normalizing pre- and post-retrofit utility bills in order to estimate actual savings, and then comparing actual savings to projections. Two main considerations exist should the study be adapted to other locations:

- Data availability. While the DB/LC dataset contains projects that participated in the National Weatherization Assistance Program, the study also relies on data collected from projects that had participated in NYSERDA's MPP or AMP programs. These projects were required to collect thorough pre- and post-retrofit information in order to comply with program requirements and obtain incentives. Other potential study regions would need to identify additional data sources. Furthermore, WAP program reporting may vary from state to state.
- Comparative groups for analysis. As previously noted, the comparative groups present in New York may also be relevant in cities such as Chicago and Boston but not in cities with newer building stock. For example, if forced air systems or packaged heat pumps were the common systems in the new study area, those systems would determine the relevant comparative group definitions. In addition, since the vast majority of the projects in the DB/LC dataset are affordable, some of the results may not be directly translatable to market rate buildings.

Increasing accountability in audit projections

The DB/LC study suggests that increased accountability of audit projections could be of significant value to the lending community, as a means to improve the realization rate of such projections. Accountability will grow from increased accuracy and consistency of energy savings projections, as well as efforts similar to the DB/LC study that allow for a backwards look at savings projections, project execution, and post-retrofit performance.

A number of efforts may help advance the accountability of audit projections:

- Reporting auditing firms' performance. Energy program administrators such as NYSERDA have considered the public reporting of auditors' realization rates on their projects. A move in this direction might require more intensive involvement in implementation and post-retrofit management by the auditor, which will have price impacts that may or may not be feasible in some cases. Nonetheless, a feedback loop should ultimately be helpful to auditors in informing future projections.

- Mitigating against overly optimistic audit projections. Many energy programs incentivize work that achieves a specific savings threshold, by using cost effectiveness tests or overall building consumption reduction targets. Such policies create an implicit incentive for auditors to project savings optimistically, and owners to accept those optimistic projections as a means to obtain program incentives. Many energy program administrators are well aware of this issue. The outputs of this study could be used to inform screening and quality assurance processes already in place to mitigate against these effects.

- Defining quality assurance standards. As discussed in the study, lenders will need to define quality assurance standards for auditors and their reports. While some may be reliant upon the standards of existing energy programs, a number of forces are driving the expansion of benchmarking and auditing efforts, including New York City's Greener, Greater Buildings Plan, and Fannie Mae's focus on refining a green module for their physical needs assessment. For the purposes of underwriting against energy savings projections, further discussion is required to frame (a) how data collection efforts may be aligned to support the benchmarking and underwriting process, (b) the relationship and interaction of physical needs assessments and more comprehensive energy audits, and (c) recommended approaches for increasing lender assurance of audit quality, which may include pre-certification processes for participating auditing firms.

- Improving the accuracy of electric savings projections. Significant additional focus needs to be placed on the accuracy of electric savings projections. Follow-up studies should examine the potential causes of electric savings over-projections. These studies might include more granular electric data collection, as well as the addition of a control group, which can help to understand the masking effects of load growth. Furthermore, measurement and verification procedures could be pursued to track specific electric loads separately from the main meter. Specific focus should also be placed on master-metered buildings, which offer the greatest potential for underwriting against electric savings projections.

Transforming market practices to incorporate energy savings projections into underwriting

Creating a set of successful transactions here in New York City is the most effective way to engender change in multifamily underwriting practices throughout the United States. Recognizing the value of proof of concept, Living Cities has agreed to fund the New York City Energy Efficiency Corporation, in collaboration with HR&A Advisors and Steven Winter Associates, to develop and implement this new, innovative financing model with lenders in the marketplace, resulting in a set of transactions that utilize an enhanced approach to underwriting.

Several critical factors align nationally and locally that make this opportunity ripe:

- **A comprehensive dataset.** The completion of the DB/LC study delivers a pool of pre-, projected and post-retrofit data for more than 21,000 of multifamily affordable housing here in New York, which allows for the systematic analysis of risk associated with lending against energy savings projects.

- **A source of credit enhancement.** The recent establishment of the nonprofit New York City Energy Efficiency Corporation (NYCEEC), created by the City of New York, brings $37.5 million in ARRA funds for energy efficiency projects, which can be used as credit enhancement to encourage lenders to undertake this pioneering practice. Absent credit enhancement, lenders have not demonstrated any appetite for piloting this new practice.

- **Complementary national efforts.** While there is a great need for a financing solution that responds to this challenge - and market potential is considerable – a first step is required to prove that underwriting against savings projections can be a viable model. The creation of a lending product that leverages discounted energy savings projects will not only create an opportunity for expansion here in New York City, but prove out the concept so that other parties across the nation will be moved to action. Because the DB/LC initiative has positioned the New York City multifamily market ahead of the curve, it is a natural launching point for the development and piloting of a practice in underwriting against energy savings projections.

There are a number of complementary efforts across the nation that will position other players to adopt these innovative practices in coming years, following NYCEEC and Living Cities' proof of the concept. For example, the U.S. Environmental Protection Agency and Fannie Mae are collaborating on an ENERGY STAR® rating for multifamily buildings, and Living Cities members (in particular the MacArthur Foundation) have been actively convening stakeholders to develop national standards for the collection of building performance data. Such efforts have benefitted from the complementary work of Enterprise, LISC, SAHF, and NeighborWorks, who have agreed to align their data taxonomies. As institutions continue to aggregate building performance data, other markets will soon become grounds for implementing a similar practice of underwriting against energy savings projections. The development of an approach here in New York will facilitate the dissemination of a methodology that allows others to adopt the practice. Proof of concept, and a sound methodology, will begin to drive national market transformation.

The upcoming Living Cities grant will cover the collaborative refinement of the DB/LC underwriting methodology and related procedures. The project team will develop standardized data reporting procedures, to ensure that lenders can easily comprehend the output of an audit report, and that they can compare "apples to apples" across their portfolio. The grant will also fund the sourcing and execution of eligible transactions.

As discussed in the *Implications for Underwriting* section of this report, the development and deployment of additional complementary resources are also recommended:

- Best practices guidelines for undertaking energy efficiency retrofits to improve the likelihood of achieving a high realization rate. These practices would take the form of a simple, streamlined manual that lenders would distribute to borrowers at the time of application and require as a condition to closing.

- Energy monitoring procedures, to ensure that systems are performing as anticipated and that savings accrue. Borrowers would be required to track energy consumption on a monthly basis and share that information with lenders. This effort could make use of existing third party energy tracking software tools and building management system products that are currently available on the market, such as EnergyScoreCards and WegoWise.

Appendices

Appendix A - List of Charts In Document

Appendix B - Glossary

Term	Definition
British thermal unit (BTU)	A unit of energy used to represent the amount of heat given off by fuel or a heat generating device, equivalent to the amount of heat required to raise the temperature of one pound of water by 1 °F. The report often refers to kBTU, which represents thousands of BTUs.
Confidence Interval	A measure of uncertainty in the estimate of the mean for a given dataset.
Cooling Degree Day (CDD)	A measure that reflects the severity of the weather and indicates the amount of energy required to cool a building. This is traditionally calculated by taking the day's average temperature and subtracting it from an interior reference point, typically 75 °F. For example, if a particular day's average temperature was 85 °F, that day would contribute 10 CDD.
Debt service coverage ratio (DSCR)	The ratio of available cash to service debt, which measures a borrower's ability to pay back his/her loan. For example, the report utilizes a DSCR of 1.30, such that for every dollar a borrower obtains through a loan, the lender requires that the borrower has access to a least $1.30 of capital to repay the loan.
Electric use intensity	A metric created by dividing a building's annual owner-paid electric use by its square footage (SF), in order to make useful comparisons between buildings, represented in kWh per square foot (SF), or kWh/SF.
Empirical model	A method of using historical results to inform or determine future outcomes.
Heating Degree Day (HDD)	A measure that reflects the severity of the weather and indicates the amount of energy required to heat a building. It is traditionally calculated by taking the day's average temperature and subtracting it from an interior reference point, typically 65oF. For example, if a particular day's average temperature was 30oF, that day would contribute 35 HDD.
Hot water (HW)	A heating distribution system whereby hot water circulates through the building. This system was developed more recently than two-pipe steam and offers a greater control opportunity.
Kilowatt Hour (kWh)	A Watt is the common unit used to measure electricity. When a building consumes electricity it is measured in electricity usage per hour, or its rate of its electricity usage. Buildings are billed by how many thousands of Watts (kilo-Watts) per hour, or kilo-Watts per hour (kWh).
Linear regression	A method for determining a relationship between two variables by creating a best fit line that minimizes the sum of the squared vertical deviations from the line.
Loan-to-value rate	A ratio of the amount of money borrowed to the value of the property, useful in determining an owner's minimum equity stake.
Net operating income (NOI)	An owner's operating budget, equal to gross income less expenses, before debt service.
One-pipe steam (1 PS)	A heating distribution system whereby a single pipe carries steam to radiators and also allows condensate to drain back to the boiler. This is one of the oldest forms of central heating and is typically found in pre-war buildings that are six stories or less.
Physical model	A physical model is a tool for estimating how a building utilizes energy, providing a forward-looking means to identify potential for consumption reduction. The model might include anything from a series of simple equations to a more complicated computer simulation of a building's systems. The computer simulation attempts to represent how a building utilizes energy; most of the projects in the DB/LC database used TREAT or EA-QUIP to determine savings projections, but there are other software tools available.
Post-War	A building that was constructed after the end of World War II, from 1947 onward.
Pre-War	A building that was constructed approximately before the end of World War II, before 1947.
Standard deviation	A measure of variability or distance from the average or mean value.
Realization rate	A metric that compares a building's actual post-retrofit savings with the savings projected by the energy audit, equal to actual savings divided by projected savings, or actual savings as a percentage of projected savings.
Two-pipe steam (2 PS)	A heating distribution whereby one pipe carries steam to radiators and another pipe allows condensate to drain back to the boiler. This system is more advanced than one-pipe steam systems and offers greater potential for control.

Appendix C - List of Relevant Datafields

Building Information

- Project name
- Address
- Number of floors
- Number of units
- Square footage
- Year constructed/year of last gut rehabilitation
- Heating fuel type
- Heating distribution system

Tenant Characteristics

- Income range of tenants (affordable or market rate)
- Type of housing (senior or family)

Retrofit Evaluation

- Program: Weatherization Assistance Program (WAP); NYSERDA Assisted Multifamily Program (AMP); NYSERDA Multifamily Performance Program (MPP); Other
- Recommended energy conservation measures
  - Projected installation cost by measure
  - Projected energy savings by measure, in dollars and units (MMBTU, kWh)

Retrofit Information

- Other non-energy capital improvements recently undertaken or planned

Implementation

- Actual energy conservation measures undertaken
  - Actual installation cost by measure
- Timeframe of installation

Utility Information

- Electric metering type (master- or direct- metered)
- Utility account numbers (excluding apartments)
- At least 12 consecutive months of pre- and post-retrofit utility bills (gas, oil, and electric bills)

Appendix D - Lender Interview Memorandum

Recognizing the Benefits of Energy Efficiency

Incorporating Energy Efficiency Savings Projections into Multifamily Underwriting

Deutsche Bank Americas Foundation & Living Cities | October 22, 2010

INTERVIEW SUMMARY

Prepared by HR&A Advisors, Inc.

Analyze. Advise. Act.

Introduction

Despite significant investment in energy efficiency over the past 35 years, many knowledgeable observers cite the paucity of good data demonstrating the reliability of savings as a critical factor limiting investment. To address these challenges, The Deutsche Bank Americas Foundation and Living Cities (DBLC) enlisted Steven Winters Associates and HR&A Advisors to examine the relationship between pre-retrofit savings projections and actual results in existing New York City affordable multifamily buildings. The DBLC study aims to utilize this information to develop principles for recognizing energy efficiency in underwriting guidelines.

Deutsche Bank and Living Cities created a committee, chaired by Sadie McKeown of Community Preservation Corporation, to conduct interviews with a variety of lenders, appraisers and industry experts to gain perspective on current multifamily underwriting practices and the potential for incorporating energy savings projections into future underwriting.

The interview committee consisted of:

- Sadie McKeown, *Senior Vice President*, Community Preservation Corporation
- Sam Marks, *Community Development Program Officer*, Deutsche Bank Americas Foundation
- Marc Norman, *Vice President*, Deutsche Bank
- Geoffrey Lewis, *Global Banking Analyst*, Deutsche Bank
- Neal Parikh, *Senior Policy Advisor*, The Mayor's Office of Long Term Planning and Sustainability
- Greg Hale, *Senior Financial Policy Specialist*, Natural Resource Defense Council
- Yerina Mugica, *Associate Director of Center for Market Innovation*, Natural Resource Defense Council
- Candace Damon, *Vice Chairman*, HR&A Advisors
- Cary Hirschstein, *Director*, HR&A Advisors
- Dara Goldberg, *Analyst Fellow*, HR&A Advisors

Fourteen interviews were conducted from September 28th, 2010 to October 7th, 2010 with the following organizations:

- Amalgamated Bank of New York
- Bank of America
- Citibank
- Community Development Trust
- Community Preservation Corporation
- Freddie Mac
- Green Building Finance Consortium
- JP Morgan Chase Community Development Banking
- M-Core Credit Corporation
- Metropolitan Valuation Services
- New York City Housing Development Corporation
- New York Housing Finance Agency
- State of New York Mortgage Agency
- Anonymous lender

The project team intends to use the information obtained from these interviews to shape the methodology and data collection activities of the study, outline the opportunities and challenges associated with modifying underwriting practices, and inform the structure of the project's outputs to maximize their utility within the lending community.

Examining Current Underwriting Practices

Interviewees described a variety of approaches to examining energy expenses within their underwriting processes. Some lenders begin with standard assumptions that may be adjusted upward or downward based on past building energy performance, while others begin with a review of past actual performance and compare it against industry standards.

- ***In many cases, historical industry standards offer a starting point for considering future expenses.*** In considering a building's viability to service debt, underwriters may utilize a set of per unit, per room, and/or per project assumptions at the line item level. Interviewees explained that these expense estimates were based on historical performance of comparable buildings, sometimes adjusted for specific building characteristics.

  With respect to existing affordable multifamily housing in New York City, Community Preservation Corporation's (CPC) utility expense standards are widely utilized for this purpose. CPC actively tracks operating expenses across its portfolio, and once a year analyzes this data to produce a set of standards for the coming year. For the purposes of estimating heating costs for a New York City multifamily building, CPC assumes $420 per room per annum for gas systems and $420 to $440 per room for oil-based systems, based on oil type. For gas and electric, the standard is $100 per room per annum for a walk-up building and $150 per room for an elevator building.

  Underwriters may also examine historic usage and qualitative characteristics of the building in question. For some, historic usage serves as a starting point in the analysis, to then be compared against industry standards. Most lenders described their work as more "art than science," explaining that standards were a starting point for a more in-depth consideration of the building's performance. Based on past performance and an examination of relevant factors, underwriters are oftentimes open to adjusting these standards. These adjustments are typically in the range of 5% to 10% of the basic assumption, though may be greater if compelling reasons are presented.

  In one case, a lender described how he reduced his heating expense assumptions because a borrower was replacing an old inefficient boiler with a new high-efficiency model. Based on an engineer's estimate of the change in efficiency of the model, assuming the same level of consumption in the building, he accepted a lower overall assumption for the building heating expenses. However, he refused a similar approach to insulation, citing a number of uncontrollable factors that can easily erase projected savings (e.g. a tenant opening his window in the winter to let out excess heat). In another case, an interviewee cited a similar instance in which a community bank reduced its heating expenditure assumptions in cases where high efficiency boilers were in place. At the other end of the spectrum, one lender claimed that he never adjusts his utility expense standards, and treats them as relatively static.

Furthermore, lenders typically require a physical needs survey for buildings, in which the lender's engineering consultant inspects the overall state of a building's structure and systems. In addition to current conditions, some lenders may also assess projected physical needs in order to arrive at reserve requirements. One interviewee noted that physical needs surveys do not currently include analysis of energy conservation measures, and the lender questioned whether the assigned engineers have the capacity to do so.

Finally, some lenders explained that they will do a loan modification if a borrower demonstrates that energy savings projections were achieved, and results differ substantially from underwriting expense assumptions.

- ***Despite some relative flexibility in these standards, all cited a conservative approach to underwriting***. The primary concern is ensuring that the borrower can adequately service the loan and maintain a functioning property. Underwriting standards therefore always assume conservative performance. For instance, CPC's utility expense standards have a "cushion" built in to hedge against risks in cost overruns.

- ***No one relies on forward-looking projections.*** For the purposes of estimating revenues or expenses in existing buildings, none of the interviewees rely on projected performance, nor are they aware of any lender that does. Absent additional data and a number of other requirements, cited below, most view projections as unnecessarily risky for the purposes of establishing a viable loan.

- ***In addition, some underwriters consider other variables that may be useful in thinking about building energy performance***, though they do not establish a direct causal relationship. This may present some synergy with the structure of the Deutsche Bank / Living Cities study. Some of the factors examined include building type (e.g. walk-up versus elevator, prewar versus modern), major building systems (e.g. fuel type and its impact on expenses), management and resident control over systems (e.g. presence of heat timers, centralized controls and thermostatic radiator valves), and in limited cases, third party verification such as ENERGY STAR and LEED. However, not all lenders track these variables.

- ***Appraisals inform the underwriting process, but do not typically focus on energy performance.*** Generally, appraisers are not focused on the role of energy efficiency within its overall value, primarily because they are relying on indexes and comparables to establish revenue and expense estimates. Some appraisers rely on the portfolios of large multifamily operators to collect comparables data. In addition, appraisers may not differentiate between factors that can have a large impact on energy performance. For example, while a gut renovation should result in a tighter building, some appraisers do not distinguish between a gut renovation and an existing occupied building in their analysis.

Challenges of Incorporating Energy Efficiency Projections into Underwriting

Interviewees stated that a major hindrance to incorporating energy efficiency projections into underwriting is the "theoretical" nature of the projection, which introduces considerable risk into the loan. We conceptualize five main types of challenges to incorporating energy efficiency savings projections into underwriting:

1. ***Lack of motivation***

   - Potential energy savings are a small proportion of total building finances. Compared to overall building revenues and expenses, interviewees argued that potential energy savings are not significant, making this a less profitable venture for lenders. First, utility expenses are only a small proportion of total building expenses; estimates of building utility expenditures range from 15% to 25% of total building expenses. One interviewee elaborated on this topic, noting that expenses average $3,500 to $3,800 per unit per year, and that potential energy savings may only be $50 comparatively. Second, small changes to the revenue side of the equation typically result in significantly greater returns to the owner, and thus may be more financially attractive from both an owner's and lender's perspectives.
   - The current economic climate is conservative. Most interviewees agreed that the lending community is currently focused on safety and soundness of investments, and that the changing of practice at the present would prove difficult.
   - Market interest remains unclear. While some lenders recognized borrower demand for incorporating energy efficiency savings projections into underwriting, one interviewee questioned the level of market demand from building owners.
   - Many owners currently lack the equity for investment. To the extent owners are interested in investing in energy efficiency, some interviewees contended that the current economic climate and the high cost of implementation (inclusive of construction, systems, and maintenance) is preventing owners from investing in energy efficiency retrofits and other major capital improvements.

2. ***Lack of data or verifiable standards***

   - No existing universal dataset. Despite years of public energy efficiency programs, lenders do not have access to data reflecting past building performance. Furthermore, once these energy efficiency retrofits have been installed, there has been a lack of measurement and verification to examine the performance of the retrofit. This has posed a problem to investors because it doesn't offer any information based on the performance of the retrofit. We recognize that organizations like CPC are beginning to track building performance across their portfolio.

- <u>No universal data standards</u>. Interviewees also mentioned that, in order for loans to incorporate energy efficiency projections, they would need a universal standard in place by which they could measure the results against the projection. Some lenders noted that they cannot trust the borrower's energy audit, and require some third party verification. Furthermore, in order for lenders to accurately compare and assess the need for the retrofit, standards for data measurement should be in place.

3. *External risk factors*

- <u>Unpredictability of external factors</u>. Some interviewees asserted that even though the energy efficiency retrofit could potentially reduce utility expenses at the time of installation and upon initial implementation, a number of external factors beyond their control could impact the relative energy savings over time. These include fluctuations in commodity costs, uncharacteristic weather patterns such as an excessively cold winter or inclemently hot summer, and larger market trends that might impact occupancy.
- <u>Human error/behavior</u>. Interviewees identified a number of risk factors related to human error and behavior. The expertise, experience, and execution level by which certain players (e.g. auditor, contractor, building manager, resident) have a role in the retrofit and later maintenance in the project can have a huge impact on the effectiveness of the retrofit.

4. *Lack of awareness about the benefits of energy efficiency*

Not all of the interviewees understood how energy efficiency could advance their larger mission, either ensuring financial returns or maximizing opportunities for sustaining housing affordability. One interviewee stated that their mission relates to affordable housing and not to sustainability, suggesting that some lenders do not even associate energy savings with building expenses. Similarly, not all building owners and investors understand the savings potential associated with energy efficiency improvements in their buildings. Finally, interviewees agreed that appraisers are not interested in energy efficiency, and in order to incorporate energy savings in the underwriting process will need appraisers to place an emphasis on energy efficiency in property valuation.

5. *Structural / regulatory impediments*

- <u>Challenges faced by the lender</u>. The decision to modify underwriting standards is not an underwriter's alone. She must convince her bank's credit committee of the adjustment and, in the cases of regulated institutions, also convince government housing regulators. This can be challenging. For instance, because regulators are hesitant to accept projected energy savings as a basis for loan repayment, some lenders felt that regulators might write those loans down at a lower grade, requiring lenders to put up greater reserves in support of the project.

- Challenges faced by the borrower. In some cases, recovering investment for energy efficiency measures in tenant units can be very difficult for owners given the regulatory requirements of the affordable housing sector. In the case of many HUD and DHCR regulated affordable multifamily buildings, rents and utility allowances are capped at affordable levels (e.g. LIHTC buildings are required to cap rent and utilities at 30% of the household's adjusted monthly income). Utility allowances are not determined by building performance, but rather by the Housing Choice Voucher (Section 8) utility allowance level or, less frequently, by a local utility company estimate. Should an owner invest in measures that reduce tenant utility expenses, that cost can only be recovered by the owner to the extent that HUD or DHCR will recognize a decrease in the required utility allowance, and thereby grant an equivalent increase in monthly rent. If the adjustment is not granted, the benefit of that investment will be absorbed solely by the tenant, making retrofits a far less desirable investment for owners.

Potential Benefits of Incorporating Energy Efficiency Projections into Underwriting

Interviewees identified that there would be benefits of modifying underwriting guidelines to incorporate energy efficiency savings projections. It is worth noting that potential benefits of integrating projections into current lending practices may differ by lender type, including lender position, and it is likely that permanent lenders ought to recognize greater benefits from this practice than short-term construction lenders. This section therefore focuses on permanent lenders.

- ***Most lenders recognized that higher energy performance would create greater cash flows to pay debt service.*** This was the most widely cited potential benefit among interviewees. Incorporating projected energy savings into underwriting would recognize expense savings, boost net operating income, and leave a building with a greater ability to meet debt service coverage ratios. From the lender perspective, this improves the financial health of the building and reduces the risk of default on the loan. Additional cash flow can be used to generate funds for replacement reserves that are frequently needed for future rehabilitation.

- ***Some suggested that increased cash flow might allow for a larger loan or subordinate debt.*** Holding debt service coverage ratios constant, a building with lower energy expenses could support higher levels of debt service, either through a larger loan or acceptance of future subordinate debt. The additional loan could be used to cover the cost of those energy measures. Lenders' judgments on the potential value of this additional savings ranged from "significant" to "minimal" and "not worthwhile."

  As a result of the recent mortgage crisis, some noted concern about over-leveraging buildings. As an example, rent-stabilized buildings are limited in the extent to which they are able to build capital reserves, so lenders would like avoid turning higher net operating income into a larger loan. In similar fashion, other lenders noted that they are primarily focused on a quick payback in recovering the loan, and would prefer smaller sized loans rather than lending more.Higher levels of energy performance are therefore only seen as an increased means to recover the loan more quickly, potentially resulting in a shorter term.

Furthermore, the appetite for accepting larger loan sizes might vary by the position of the lender; some first mortgage lenders favored larger loans, while one second lender preferred to utilize those funds to make a greater number of loans.

- ***Some lenders suggested that a projected improvement in energy performance had benefits to long-term asset value.*** One lender noted that they view "green" investments as lowering the risk profile of the asset. Another suggested that he might adjust the cap rate downward, resulting in a higher terminal value for the asset.

Opportunities & Recommendations

Interviewees offered a wide variety of opinions concerning the level of feasibility of modifying underwriting practices to incorporating energy savings projections. Many shared their thoughts on the opportunities for adjusting underwriting practices, and recommended the exploration of a number of interesting concepts.

- ***Incorporate the practice into the first mortgage.*** Many lenders voiced the opinion that the most effective means to recognize potential energy savings in underwriting is through the first mortgage. Furthermore, first mortgagors ought to recognize greater benefits from the practice than second mortgagors. The Deutsche Bank / Living Cities dataset could allow these underwriters to better understand the reliability of proposed energy saving opportunities. It was noted that there is a relatively small group of first mortgagors for affordable multifamily housing in New York City, mainly the New York City Department of Housing Preservation and Development.

  One lender described an instance where they held additional funds in escrow for a stabilized period of one year following an initial set of energy efficiency upgrades, to ensure that the projected savings were achieved and could be counted on for long-term expense reductions. Upon release of the additional funds, the borrower would undertake additional capital work. Other lenders suggested a willingness to explore this model. On the other hand, some lenders believed that this was not a viable option for most affordable housing, due to the constricted nature of their current financial state.

- ***Incorporate the practice into the second mortgage.*** In the case where first mortgagors may not be willing to increase the loan size due to projected increases in net operating income, they may be willing to allow borrowers to take out subordinate debt for undertaking energy efficiency capital improvements. Similar to the escrow concept described above, assuming initial investment in some energy efficiency capital measures under the first mortgage, a lender could depend upon an initial period to monitor performance before agreeing to additional debt.

- ***Create a mini-permanent loan product***. In another case, a construction lender explored the idea of a mini-permanent loan that could be used to bridge the period between construction and permanent lending, which may provide an opportunity to consider the benefits of capital renovations during that period.

- ***Regulators or lenders might require a higher level of building performance.*** A simple way to recognize many of the benefits discussed above is for housing regulators or lenders to require buildings to install high efficiency systems at the time of upgrade, utilize ENERGY STAR appliances, and undertake other cost-effective efficiency measures. One interviewee believes that most regulators employ rehabilitation specifications that are energy efficient; however, the shift to these specifications has not changed underwriting practices, which tend to merely trend history.

- ***The public sector or intermediaries should initially take on the risk of incorporating energy savings projections.*** Many lenders stated they were not comfortable taking this step absent of another entity doing so first, citing need for the public sector, Enterprise Community Partners, CPC or others to shoulder some of the risk associated with underperformance of projected savings. The City of New York's proposed energy efficiency corporation may help to serve this purpose.

- ***New York City's Greener, Greater Buildings Plan will likely increase efficiency and data tracking.*** The City of New York recently passed legislation that requires buildings over 50,000 square feet to undertake benchmarking of their energy use on an annual basis beginning in 2011, as well as comprehensive energy auditing and retro-commissioning once every ten years beginning in 2013, among other requirements. Benchmarking data will be made public and could serve as a valuable resource to lenders to track building energy performance. Auditing may help to increase awareness of energy saving opportunities, leading to greater levels of implementation.

- ***Similarly, market demand for "green" features is likely necessary to encourage appraisers to incorporate energy efficiency into property valuation***. As newly constructed buildings include more and more energy efficient features, existing buildings could be encouraged to upgrade in order to remain marketable. This market demand could drive appraisers to consider energy performance, though one appraiser expressed doubt about whether the industry has the capacity to understand energy issues.

Comments on the Deutsche Bank / Living Cities Study

Interviewees viewed the Deutsche Bank / Living Cities study as a very positive step in the right direction, and recognized the utility of the project outputs, including the establishment of a database, identification of trends in building performance, and guidelines for incorporating energy savings projections into underwriting. Most interviewees agreed that the study and the data may make lenders more comfortable in this practice, but that it may not ultimately lead to modifications in practice by itself.

- ***The majority of interviewees agreed that this dataset would be very helpful*** in facilitating lenders to incorporate energy efficiency projections into underwriting practices, as well as better understanding the variables influencing energy performance within their own portfolios. Interviewees stated a preference to be able to compare projected performance relative to the actual performance of similar buildings that have undergone similar retrofits.

- ***Even absent information on projections, lenders would appreciate data that allows them to better understand their buildings' current energy performance***. The proposed dataset would help lenders to better assess the influence of the following elements on energy performance:
    - <u>Specific building characteristics</u>, including multifamily housing classification, building type, heating system type, quantifiable building exposure and street frontage, number of rooms, and quality of building management staff.
    - <u>Specific types of measures</u>, including the ability to correlate building characteristics with backwards-looking energy performance data to understand the effectiveness of implementing certain energy efficiency retrofit packages.

  One interviewee suggested that the study should track "non-energy" capital improvements that may indirectly result in energy-savings, such as re-piping of a building's water distribution system. This data would provide more comprehensive understanding of the actual results of traditional energy efficiency upgrades.

- ***This dataset would provide lenders with a means to analyze risk across their portfolios***. Some interviewees clarified that, while desirable, the statistical significance of the dataset was not a requirement for its overall utility in this purpose. One lender noted that it would be helpful to see guidance on the percentage of projections that it would be sensible to underwrite. For instance, most lenders would never underwrite to 100% of the projected savings, but could consider 25 to 50% as a more conservative estimate.

- ***Some interviewees would also like to be able to correlate the impact of energy performance on a building's overall financial health.*** Interviewees described a desire to understand two types of financial benefits:

- Cost side, whereas owners and lenders could relate reductions in consumption and/or increases in efficiency to dollars of reduced energy expenditures;
- Revenue side; including whether energy improvements translated into increased lease-up rates or decreased turnover.

- ***Most lenders would welcome guidelines for incorporating energy efficiency projections into current underwriting practices***. Many lenders would appreciate a comprehensive listing of the factors that should be considered when assessing energy performance.

Conclusion

As the market becomes more aware of issues surrounding environmental sustainability, many lenders have begun to think more carefully about energy efficiency. Interviewees viewed the Deutsche Bank / Living Cities study as an opportunity to learn more about their portfolios and make more informed decisions around capital investments into those buildings. Given that current underwriting practice is built upon standards and historical data, and that modification to current practices may be difficult in today's lending environment, we recognize that there is likely no "silver bullet" at this time for incorporating projected energy savings into underwriting. Nonetheless, our engagement of the lending community suggests that the study will certainly help to advance lenders' consideration of energy efficiency, which could produce significant positive impacts over the long term.

Our engagement of the lending community was also helpful in sharpening the methodology of the Deutsche Bank / Living Cities study. Looking forward, the study will work towards identifying pre- and post-retrofit energy performance trends associated with quantitative and qualitative building characteristics. Building upon our understanding of the underwriting process, these technical findings will be translated into a useful set of financial guidelines that underwriters may use to evaluate the relative potential of proposed retrofit measures as they relate to building type, systems, and management. It would be beneficial to undertake additional follow-up with the lending community as part of that process, either to consult with them on our findings on the implications of performance trends and/or to solicit feedback on a draft final report.

Steven Winter Associates, Inc.
Building Systems Consultants

Appendix: Study Overview

Deutsche Bank Americas Foundation & Living Cities

Building Energy Efficiency Data Report

Despite significant investment in energy efficiency over the past 35 years, many cite the paucity of good data demonstrating the reliability of savings as a critical factor limiting investment. To respond to this need, **Deutsche Bank Americas Foundation** and **Living Cities** are funding a study of multifamily retrofits in New York City to examine the relationship between pre-retrofit savings projections and actual results. The study seeks to integrate the worlds of building science and finance, and will translate these findings into principles for recognizing energy efficiency savings projections in multifamily underwriting guidelines.

In support of this effort, Deutsche Bank and Living Cities assembled an advisory committee of public sector agencies, local utilities, community development financial institutions, and a variety of nonprofit institutions. The group collectively determined a priority for assembling, analyzing, and disseminating reliable data as a means to create change in how public and private underwriters and investors approach energy efficiency investments in multifamily housing. The effort is also intended to provide critical insights to advance public policy and improve the effectiveness of public incentive programs and mandates.

The committee recruited two consultant firms, **Steven Winters Associates** and **HR&A Advisors**, to conduct the study. The consultant team will aggregate and analyze pre- and post-retrofit data for 12,000 to 18,000 units of affordable multifamily housing in New York City, examining buildings that have either completed NYSERDA's Assisted Multifamily Program, NYSERDA's Multifamily Performance Program, or the Weatherization Assistance Program. Savings predictions will be compared to actual performance based on a range of building characteristics and measure types, identifying a set of simple predictive models for energy performance, as well as key risk factors and best practices for achievement of savings projections. These findings will be translated into guidance for lenders on incorporating energy efficiency savings projections into underwriting standards.

Helping unlock new sources of funding for energy retrofits will generate considerable energy savings for residents, create new jobs, and improve the sustainability of our communities. The report will provide a means to value the economic benefits of retrofits by creating a methodology for tracking economic and fiscal impacts, which will consist of a set of economic benefit multipliers for job creation to be applied to energy efficiency capital retrofits.

HR&A Advisors and Steven Winters Associates have established the following timeline for project execution. A final project report is expected in November 2011.

October 15, 2010

- Completed the first round of data collection and commenced population of project database;
- Completed engagement of the lending community.

February 1, 2011

- Create a methodology for valuing the economic and fiscal impacts of energy efficiency retrofits.

April 1, 2011

- Analyze the existing data set and provide a report of interim findings;

July 1, 2011

- Complete the second round of data collection and entry into the project database.

November 1, 2011

- Analyze the updated data set and provide a final report;
- Provide commentary on the structure, uses and benefits of a system for ongoing data collection and dissemination;
- Identify the impacts of public sector participation and investment in energy retrofits.