Superefficient Affordable Housing: Solutions to Hurdles

2317 SNOWMASS CREEK ROAD | SNOWMASS, CO 81654

Table of Contents

0. EXECUTIVE SUMMARY

We spend 10 times more on utility bills for affordable housing than we do on government investments in energy efficiency.[1] Looking at that statistic, it's not surprising that our public housing uses 38% more energy than privately owned housing for the same floor space.[2] Investment in energy efficiency has the potential to lower this bill in the short run and hedge against future rises in energy prices in the long run. Moreover, investing in energy efficiency measures typically provides a beneficial return on investment (usually higher than that of renewable energy production, thus cost-effective efficiency should be implemented first).[3] However, there are many hurdles that stand in the way of increased energy efficiency in our affordable housing stock. These hurdles can be divided into four distinct categories: programmatic, financial, technical, and operational. These hurdles are not new,[4] and in the past 18 years they have only become more complex. Within each of these categories are many individual hurdles that raise the perceived or actual cost of energy efficiency improvements above the price that many affordable housing developers are willing or able to pay.

While not every affordable housing provider faces all of these hurdles, each can be a stumbling block in the path toward increased efficiency. Programmatic hurdles arise from information gaps, incentive gaps, or regulatory barriers between the regulating agency and the affordable housing provider. The financial hurdles are generally the result of three problems: a $26B backlog of existing capital work,[5] continued underfunding of public housing programs, and a complicated mixed financing model that requires the acquisition and balancing of several funding sources. Technical hurdles arise from standard practices within the design and construction industry that do not prioritize energy efficiency and an integrative design process. Operational hurdles are found in mixed tenant incentives for energy use and the lack of retro-commissioning in our existing buildings. Each of these hurdles has a complex set of causes, yet for many of these hurdles, solutions exist and have been implemented in leading affordable housing developments.

The solutions to our energy efficiency problems are as varied as the hurdles that they address, but again they can be divided into programmatic, financial, technical, and operational solutions. Programmatic solutions involve changing the regulatory infrastructure in which affordable housing exists to lower the transaction cost of engaging in energy efficiency. To drive energy efficiency into our housing stock, we need to make it easier—from a regulatory standpoint—to design and build an energy-efficient building than to design an energy-wasteful building. Financial solutions involve budgeting projects for long-term success, utilizing existing HUD programs, understanding projects that are currently profitable to implement, and recognizing all available funding sources. Technical solutions can address both the technical hurdles and financial hurdles. Through integrated project delivery, goal setting, and other integrative design processes, energy efficiency can be achieved within our building stock at a reasonable price. Operational solutions involve the careful and insightful design and implementation of tenant engagement programs as well as the periodic re-evaluation of system performance.

In conclusion, while affordable housing providers currently face many hurdles to energy efficiency implementation, there also exist solutions to many of these hurdles. Through the propagation of these solutions and the diminishment of these hurdles, it is possible to create an incentive structure that results in the rapid adoption of energy efficiency within our affordable housing stock.

1. INTRODUCTION

For the past five years, the United States government has spent an average of $1.6B on public housing utility allowances[6] and over $5B on affordable housing utility allowances,[7] respectively 3.5 and 10 times the amount that we spent on energy efficiency programs in 2011.[8] And despite cost effective solutions for energy efficiency in both new and existing buildings, public housing remains 38% more inefficient than similar private residential buildings.[9] Yet, a current investment of $43B in energy efficiency in existing low-income properties would yield $80B in present value savings, according to McKinsey and Co.[10] As RMI co-founder and chief scientist Amory Lovins once said, "Efficiency is the lunch you're paid to eat." While the financial argument for energy efficiency in public housing usually pencils out in the long run, affordable housing providers still face significant hurdles in the planning and implementation of energy efficiency projects.

Fortunately, over the past several decades many affordable housing providers have been making progress overcoming these hurdles to integrate increased energy efficiency into affordable housing projects. Several of these case studies have been cited throughout the Solutions section of this paper to highlight the potential for leveraging particular strategies to integrate energy efficiency. These projects provide informative examples of how energy efficiency can be effectively and profitably integrated into our affordable housing stock.

The first section of this paper is an explanation of the hurdles that were identified by the interviewed affordable housing providers (AHPs). While not all of the hurdles apply to every owner, each is a major obstacle to increased energy efficiency listed by several of the interviewees. Where possible, direct quotes from the interviews have been added (while preserving the anonymity of the interviewees). The second section includes solutions based on programs that have been used by AHPs, as well as researched solutions from other sectors that could be applied to affordable housing. This section is a great resource for AHPs who are looking to overcome hurdles they have faced integrating energy efficiency into their building stock. Note that the solutions recommended in this paper are based on long-term incentive programs; transient incentives, such as funding from the American Recovery and Reinvestment Act and other short-term incentive programs, have been excluded from this paper.

Methodology

RMI interviewed 17 public housing agencies (PHAs) nationwide, community development corporations (CDCs), and for-profit affordable housing developers; collectively, we will call this group the affordable housing providers (AHPs). In addition, to better understand the technical hurdles involved with the integration of increased energy efficiency, RMI interviewed architects from three architectural firms that have done extensive work in affordable housing. The thoughts and concerns provided in these interviews were then compiled into the categories that appear in this paper, with quotations from the interviews provided when applicable. The referenced solutions were elucidated through the interview process and through the independent research of Rocky Mountain Institute. References to specific researched solutions have been provided within the text. In addition, references to all background reading and in-text citations have been provided at the end of the paper.

Definitions

Affordable Housing – Public or private housing that is limited to low-income, very low-income, and extremely low-income families and individuals by government regulation. Total rent and utility expenses for affordable housing is capped at 30% of the tenant's gross income.

Affordable Housing Provider – Any owner and/or manager of affordable housing stock. This group is inclusive of public housing agencies, nonprofit providers, and for-profit providers of affordable housing.

Community Development Corporation (CDC) – A nonprofit organization devoted to supporting the economic stability and growth of the community in which it works. Often community development corporations are involved in the development of affordable housing for their communities.

Deep Retrofit – A retrofit that takes a "whole-building" approach to realize cross-system efficiencies and reduce energy usage for a lower cost. Deep retrofits try to achieve at least 50% energy savings over pre-retrofit usage.

Department of Housing and Urban Development (HUD) – The federal government department that determines the budget for and oversees the development and management of affordable housing in the United States, among other responsibilities.

Energy Performance Contract (EPC) – A contract, usually administered by an energy service company, whereby debt is incurred to pay for the implementation of energy efficiency measures specifically identified by an investment-grade energy audit. The energy savings reaped from the energy efficiency measures is then used to service the debt for the life of the contract.

Energy Service Company (ESCO) – A company that specializes in performing energy audits on existing buildings, identifying cost-effective energy efficiency measures, implementing those measures, and measuring the savings achieved from them. In addition, the energy service company can help arrange financing for an energy performance contract based on anticipated savings.

Integrative Design – An iterative design process that requires architects, engineers, contractors, and owners to collaborate more effectively and combine technologies in novel ways to create efficient whole-building systems.

Life-Cycle Cost Analysis (LCCA) – An analysis that accounts for all costs associated with a product or system, including acquisition, operation, and disposal.[11]

Low-Income – Tenants whose annual income is below 80% of the area median income (AMI) for the region in which they live.[12]
Very Low-Income – Tenants whose annual income is below 50% of the area median income (AMI) for the region in which they live.[13]

Extremely Low-Income – Tenants whose annual income is below 30% of the area median income (AMI) for the region in which they live.[14]

Low-Income Housing Tax Credit (LIHTC) – A federal tax credit for the utilization of private equity to develop affordable housing for low-income Americans. More attractive than tax deductions (because they provide dollar-for-dollar reduction in income tax rather than reduction in taxable income), LIHTC accounts for approximately 90 percent of all affordable rental housing created in the United States today.

Office of Public and Indian Housing – The office within the Department of Housing and Urban Development tasked with helping to develop and manage public housing in the United States.

Public Housing Agencies (PHA) – Locally-managed agencies which receive federal aid from the Department of Housing and Urban Development to provide and operate housing for low-income residents at affordable rents.

Qualifications-Based Selection (QBS) – A process used by owners to select architects and engineers based on the qualifications that they bring to the project.

Qualified Energy Conservation Bond (QECB) – Bonds that may be used by state, local and tribal governments to finance certain types of energy projects including energy efficiency capital expenditures in public buildings that reduce energy consumption by at least 20%; green community programs; renewable energy production; various research and development applications; mass commuting facilities that reduce energy consumption; several types of energy related demonstration projects; and public energy efficiency education campaigns.

Retro-commissioning (existing building commissioning) – A systematic process for analyzing and optimizing the performance of existing building systems by improving their operation and maintenance and supporting those improvements over time with enhanced documentation and operator training.

Superefficient – 60% more efficient than the 2006 IECC. Alternatively, having a Home Energy Rating System (HERS) Index of 40 or below (without renewable energy included).

Tax Increment Financing (TIF) – a public financing method that is typically used to subsidize redevelopment, infrastructure, and other community-improvement projects in distressed or underdeveloped areas. TIF creates funding for a public or private project by borrowing against the future increase in the property tax revenues of the real estate surrounding the project.

Transaction Cost – The cost incurred in making an economic exchange. Examples include information costs (costs incurred while seeking information about a possible market

transaction) and bargaining costs (costs incurred in coming to an agreement about the conditions of the deal).

Utility Allowance – The amount that a PHA determines is necessary to cover a resident's reasonable utility costs. Federal housing law directs that the resident's share of rent in federally assisted public housing should equal 30 percent of the household's adjusted monthly income, and HUD defines the total resident payment for "rent" to include both shelter and the costs for reasonable amounts of utilities.

Acronyms

AHP – Affordable Housing Provider (includes PHAs, CDCs, and for-profit developers)
CDBG – Community Development Block Grant
CDC – Community Development Corporation
EPC – Energy Performance Contract
ESCO – Energy Service Company
HUD – Housing and Urban Development, Department of
LCCA – Life-Cycle Cost Analysis
LIHTC – Low-Income Housing Tax Credit
PIH – Public and Indian Housing, Office of
PHA – Public Housing Agency
QECB – Qualified Energy Conservation Bond
QBS – Qualifications-Based Selection
TIF – Tax Increment Financing

2. HURDLES

At first glance, it appears that all of the financial incentives are aligned for increased investment in energy efficiency in affordable housing, yet there are programmatic, financial, technical, and operational hurdles facing public housing agencies that seek to implement energy efficiency within their building stock. Unfortunately, these hurdles are similar to those faced by affordable housing providers in the past.[15] These hurdles include information gaps, high project transaction costs, insufficient funding of basic needs, diversity in funding sources' requirements, variability in design and construction knowledge, a lack of integrative design knowledge, and tenant disincentives, just to name a few. These hurdles are the product of the complex ecosystem of project design and finance for any affordable housing project. While no single hurdle is insurmountable, as will be seen in the Solutions section, in combination these hurdles stand in the way of bringing increased energy efficiency to our affordable housing stock.

Programmatic Hurdles

Programmatic hurdles arise from information gaps, incentive gaps, or regulatory barriers between the Department of Housing and Urban Development and an affordable housing provider. The existence of these hurdles should not be construed as the "fault" of one party or the other; they are simply a product of the current affordable housing system.

Lack of Diffusion of Information About Existing HUD Program

The Department of Housing and Urban Development's Office of Public and Indian Housing has created several programs to encourage increased energy efficiency within the public housing stock,[16] most notably an energy performance contract incentive program. While some of these programs have been in existence for over a decade, there is still misinformation and a lack of awareness within the public housing community about the how these programs function and about their potential to affordably drive energy efficiency. While these programs, such as the utility incentive or EPC program, have been adopted with much success by several large housing agencies, there are still housing agencies that remain misinformed about the risks and benefits of these programs. Two possible causes for this lack of program information diffusion are: 1) that the information, albeit available, is not presented in such a way that it is readily understood by the audience, and 2) that the time cost of finding the information relevant to a given program is high enough to discourage participation.

High Transaction Costs to Implement HUD's EPC program.

"So far, from a couple of other housing authorities I've talked to that have EPCs, the amount of money they told me they've recaptured in savings will not pay back their EPC in 12 years"

The EPC program has created a positive incentive for PHAs to work with energy service companies (ESCOs) to bring increased energy efficiency to the public housing stock. However, the program also carries significant front-end and regulatory transaction costs that can be a hurdle for PHA engagement with the program.

Regulatory Costs

An information gap exists between the organizers of the program and the PHAs that are trying to establish the regulatory groundwork required to engage in the EPC incentive program. Because the PHAs do not have a stable contact within PIH to guide them through this process, the increased time required to figure out the correct way to establish the program adds to the perceived and real transactional costs. In addition, the time-sensitive nature of EPC contract financing requires a timely review of applications, and due to an increase in utility baseline applications, the utility incentive approval time has grown. The lengthening of this approval process creates additional transaction costs for the PHA during the contract negotiation process that can be a barrier to project success.

Information Hurdles

Another hurdle to the engagement with the EPC program is that most PHAs don't have the specific background needed to negotiate an EPC contract. Because each PHA must learn a process quite different from the functions they normally perform, much time is wasted in simply learning the process and the terms of negotiation instead of carrying out the EPC.

Time Costs

Even for those PHAs who have an understanding of the EPC and utility baselining processes there is a significant time cost to engaging in these programs. For housing agencies that aren't large enough to devote a staff member to these projects, the time it takes to engage in them can be a draw away from their day-to-day work, and a barrier to engagement with the programs.

Lengthy Utility Allowance Adjustment Process

In order for tenant-based nonprofit and for-profit affordable housing developers to realize the benefits of energy efficiency upgrades within their housing units, they must apply for an adjustment of their utility allowances. In new construction, which is likely to be significantly more efficient than the building stock upon which the utility allowance is based, the post-occupancy time period that is used to reset the utility allowance becomes a cost to the developer of the project. The longer the approval process takes for the new utility allowance, the more costly the process is to the developer. In 2008 the IRS added new methods for calculating utility allowances for LIHTC projects but these new allowances, while helpful *once developments have consumption data*, do not adequately address how to accurately set utility allowances immediately after construction or renovation.

> *"The utility allowance system is NOT responsive to energy improvements and needs to be more responsive. In theory it can … it could say, if you do that insulation work and that furnace and new windows…and model how much you should be saving in energy. If you do all those things, when that's complete we'll reduce the utility allowance from x to y … and have a little commitment to do that, and then I can finance off of that. But the system is not set up to do that."*

Weak Goals for Energy Efficiency in New Construction

While HUD and the Department of Energy have made sustainable development a priority within their five-year strategic plan[17] and have developed several programs to promote the implementation of energy efficiency in existing low-income buildings,[18] only weak incentives exist to integrate energy efficiency into new public housing stock. While the Choice Neighborhood Implementation Grant applicants are required to meet Energy Star for Home requirements (approximately 25–30% more efficient than IECC 2006) or to be 15% more efficient than ASHRAE 90.1, these goals are surprisingly low considering that the IECC 2012 will *require* that buildings be 30% more efficient than IECC 2006, and the expected 2015 IECC may require buildings to be 50% more efficient than the 2006 IECC.

Financial Hurdles

Our public housing stock has a $26B backlog of existing capital needs, and this backlog has only gotten marginally better since 1998.[19] Additionally, the capital funding for PHAs has been steadily decreasing over the past decade. To solve this problem of underfunding for existing and new projects, HUD has moved to a model of using the limited funding that HUD is able to offer to leverage outside capital for projects.[20] However, this model often results in complicated mixed-financing scenarios that pose additional hurdles to the adoption of energy efficiency.

Competing Needs for Funding

Between 2001 and 2011, the capital funds for PHAs were cut 45%,[21] despite having a similar number of units.[22,23] Currently, the backlog of existing capital needs for buildings is so great that capital funds often go toward life safety and health-related improvements instead of investing in energy efficiency modernization projects for existing units. This problem is especially acute in public housing due to the age of the building stock, over 60% of which is 25 years old or more.[24] (As of 1994 our metropolitan affordable housing had a mean age of 46.56 years.[25]) This short-term focus on fixing only the dire problems can lead PHAs to do piecemeal retrofits, as described later in the Technical Hurdles section.

"You're making choices to really do the most critical health and life safety improvements. Money can be used for any kind of modernization—kitchen, bath, landscaping, anything—but that's not what most housing authorities wind up using it for."

Multiple Green Requirements from Various Funding Sources

"There's a state right now where we have a federal grant associated with the project, so we're being asked to use LEED for Neighborhood Development standards. There are state funds in it so we're being asked to do Enterprise Green Communities or LEED for Homes because they don't recognize LEED ND as a valid green building system for individual homes. And the locality also has its own "build my city green" campaign that is not necessarily overlapping with the federal and the state program. So now we've got three different rating systems and three different sets of paperwork, two different green raters and a lot of additional work to do as a result of the fact that there's very little coordination between the three."

The practice of requiring "green" design as a condition of funding has pushed many developers to include more energy efficiency than they normally would have. However, for affordable housing projects that may pull in as many as four or five different sources of funding, affordable housing developers are often confronted with multiple green certification requirements. For example, a project that is using Choice Neighborhoods funding, LIHTC funding, local or city funding, and utility incentives in a project—not abnormal for a mixed-financing project—could be required to apply for LEED for Homes (Choice Neighborhoods), Earthcraft Homes (LIHTC), specific city requirements, and use-specific technologies (utility incentives). While these projects will end up with increased levels of energy efficiency, they will also suffer both temporally and financially through the increased documentation requirements for each of these programs.

Increased Transaction Costs of the Mixed-Funding Model

The decrease in funding and the subsequent requirement for PHAs to leverage several funding sources requires increased time and operational resources to bring projects to fruition. Also, any additional upfront capital that a public housing agency needs in order to implement additional energy efficiency measures must be sourced, applied for, and granted, adding to the total transaction cost of investing in these measures. Moreover, the requirements of these various funding sources must be coordinated, adding to the time cost of organizing a project.

Limited Knowledge of Available Funding Sources

The funding sources available for energy efficiency in new construction and retrofit projects are numerous, but they are spread across many different government and private agencies. There is no centralized source of information for financial resources that can be referenced to provide the extra capital needed to integrate energy efficiency into new projects or retrofits. Additionally, funding sources are not stable over time, varying by the amount of funding that is currently allocated. While the Database of State Incentives for Renewables & Efficiency (DSIRE) provides a good resource for funding opportunities, there are many governmental and non-governmental grants and funding sources available to PHAs that are not listed on the site. Having no central source for energy efficiency funds creates an information gap between affordable housing developers who know where to look for funding and those who don't. Also, the time spent researching all of the financing options adds even more transaction costs for those PHAs seeking to fund energy efficiency in their projects.

Lack of Life-Cycle Cost Analysis

Life-cycle cost analysis (LCCA) is a method for assessing all costs of a product or system, including acquisition, installation, operation, maintenance and disposal. LCCA allows the user to analyze different products, not just on their purchase and installation cost, but also on all the costs (and benefits) they will impose over the life of the product. While some PHAs give preference to energy-efficient products, very few of the PHAs interviewed utilize a formalized LCCA in their decisions about maintenance and modernization products. By not giving a concerted look at the full costs of products, the owner could end up choosing products that add significant operational cost in the long run.

"So far we have discussed the life-cycle cost analysis, but we haven't gotten down to point of being able to implement it."

"We've done fairly simple payback stuff on project-by-project, system-by-system basis in the past. For our most recent building…we did a life-cycle analysis looking at 6 different options…and that's the first time that we've gone that far to do a study like that."

Diverse Utility Incentives

"There are different programs for a property where the tenant pays the heat as opposed to one where the tenant does not pay the heat. So with one particular property that is set up so that the tenants all pay their own heat, we were eligible for this nice big rebate. On the other property we did right next door, with the same physical setup and the same system replacements, we are not eligible for the utility rebate there because the landlord pays the heat on that one."

Many affordable housing developers rely on utility demand-management incentives to help finance energy efficiency improvements. However, utility incentives vary widely in what they are willing to pay for, sometimes offering only specific technologies in specific renting circumstances. Figuring out under what circumstances they can utilize specific utility incentives is another time and information hurdle that affordable housing providers must cross in the financing of energy efficiency upgrades.

ESCO Hesitancy to Engage Small PHAs

Although HUD has an established program for the retrofit of existing buildings under an energy performance contract, small PHAs (<500 units) often do not have enough units to make the project profitable enough for an ESCO to engage. Thus, even though small PHAs can technically engage in HUD's EPC program, it is much harder to find an ESCO with which to contract. This lack of engagement of small PHAs is a problem because small PHAs control over 350,000 affordable housing units across the United States, accounting for 30% of the total public housing building stock.[26]

Technical Hurdles

Technical hurdles are complications that arise during the design and construction process that diminish the energy efficiency included in a project. There is often a fine line between technical and financial hurdles, because a design professional who does not practice integrative design, energy modeling, or right-sizing of systems can easily misinform a client that achieving an increased level of efficiency will cost more, when with the integration of these techniques, some costs could be significantly reduced. Thus finding a knowledgeable design professional can also serve to decrease the financial hurdles that an owner faces.

Underestimation of Technical Potential

The technical potential of energy efficiency is the amount of energy efficiency that could be installed in a building with available current technologies, regardless of price. Because design professionals (let alone public housing officials) are rarely confronted with the maximum technical potential for energy efficiency, few understand its full value. Architects we interviewed estimated the technical potential for energy efficiency to be 50–75% better than code, yet buildings exist that prove that the technical potential for new buildings is at or above 85% in some locations. While 85% savings will not be available or realistic for every project, without a better understanding of just how much efficiency can be achieved with existing technologies and design, designers will miss opportunities for increased energy efficiency. As a result of this lack of understanding, designers will begin to add more expensive renewable technology before the limits of efficiency are achieved. It should be noted that, even though these designers have underestimated the technical potential for energy efficiency, they still recognize the importance of implementing energy efficiency before renewable energy.

Lack of Energy Modeling as a Design Tool

> *"In our projects [energy models] have only been used to measure if they've met the criteria or not. We've never used them as a design tool."*

Energy modeling gives designers an understanding of the potential energy usage of the building by using a representative model of the building along with occupancy and weather assumptions to predict the annual energy usage of a building. Energy models are often used to determine the efficiency of a building over a baseline model. Architects working with affordable housing developers tend to use energy models not as a design tool, but as verification tool for showing the savings needed for a specific certification. Often these design professionals design based on an intuition of which measures will create a more energy-efficient building, but do not test their intuition against an energy model until the end of a project

phase. By not using these tools during the design phase, designers may be missing non-intuitive and cost-effective energy efficiency measures.

Variability in Design and/or Contractor Knowledge

Designer and contractor knowledge of energy-efficient systems and details is highly variable by location. In general, most affordable housing providers feel that designer and contractor knowledge is sufficient. However, affordable housing developers who are pushing the envelope the most still encounter conservative designers and uninformed contractors. For designers, the major concern is that they don't adequately account for changing environmental conditions throughout the building to get the maximum amount of efficiency, or that they design for the worst-case scenario and propagate the same system throughout the building. Additionally, there is limited concern that, in seeking to create more efficient buildings, designers put in systems that are technically more efficient systems, but are beyond the understanding of the client maintenance staff. For contractors in certain regions, there is simply a lack of knowledge about new systems or new details. Once this knowledge gap is overcome, they are more than willing to use new details and systems.

"I see a number of buildings where people have put in overly complicated systems where I think they didn't really necessarily understand how the system was going to operate and didn't recognize that they were building a building for an operator who's not a hospital operator."

"What I've seen on the construction side is the trades, they get paid for how much sheet rock they put up on the wall, they don't care about the installation underneath, so they may be ripping out insulation or not installing it correctly in the first place, so what we're starting to see is that the contractors that we're working with, the more we're educating them, the more they're eventually forcing their folks to start caring about what they're doing, so I think that's increasing the quality of their trade."

"We're still seeing in the marketplace that especially mechanical, electrical, and plumbing engineers are still … not appreciating with the differences that you need to make in terms of green construction ... Our MEP engineers would tend to size for the worst-case scenario, the southern-facing top unit for an air conditioning system, and then size the AC system for that, add a rule of thumb that's a safety factor on top of that and then choose the tonnage of their air conditioning system based on that scenario and apply it to all of the units in the building."

Conducting Piecemeal Retrofits

Due to the backlog of existing capital improvements needed in our public housing stock and the decline of capital funding from the federal government, housing agencies are constantly fighting to fulfill the basic needs of their housing stock with capital funds. Because of this, housing agencies often have to

"It's not just about the economics of the energy stuff, it's often about the availability of tax credits, the eligibility of the property for tax credits or new financing in general. So we're in this highly regulated environment and it doesn't always set itself up to be eligible for or viable to do that kind of scale of comprehensive work…we've been forced into a piecemeal approach."

simply replace items as needed. While they may replace equipment with more efficient equipment than existed before, they rarely have enough capital to perform a deep retrofit due to competing needs. Such piecemeal retrofits do not allow the housing agency to capitalize on the systemic benefits that can be gained in a deep retrofit.

> *"[In one of our projects] the boilers are sized for a much more efficient envelope and a whole bunch of other things we're doing at the same time. But that's a major recapitalization for the property, that's something that we do, but it's a lot of work and it only works in certain circumstances for affordable housing."*

Lack of Energy Efficiency Goals

Very few of the interviewed public housing agencies have defined a specific energy efficiency target for major retrofit work. Many interviewees stated that they approached efficiency on a project-by-project basis. While this lack of internal energy efficiency targets may be a result of the diversity of funding requirements described in the Programmatic Hurdles section, for projects that are not governed by other energy efficiency requirements, this lack of an internal energy efficiency requirement can lead to a lack of prioritization of efficiency.

Operational Hurdles

Not all of the hurdles come in the funding, design, and installation of more energy-efficient systems. Some of the hurdles to increased energy efficiency within affordable housing come from the operations and maintenance of these systems. As with any building system, the proper function of these systems is dependent on their use and maintenance over time.

Tenant Engagement

> *"I did a new construction elderly building recently … with a very fancy computer-controlled central heating system. Obviously, every unit had a thermostat, but it's all centrally monitored, with computerized valving and distribution, and the tenants can't use the thermostat. And the maintenance people struggle to get the thermostats right, too … it's a constant struggle"*

Tenant engagement and incentives for reducing their energy load is an ongoing struggle for affordable housing developers. Because their rent and utilities budget is capped at 30% of their income, tenants have no financial incentive to reduce their energy usage in master-metered facilities. All of the affordable housing providers interviewed had some tenant engagement programs; however, we would be remiss not to mention this as a hurdle to increased energy efficiency.

Lack of Retro-commissioning

While the aptitude of maintenance personnel on new equipment is not a hurdle for the majority of interviewed affordable housing providers, few had planned for the retro-commissioning of their equipment. Commissioning of systems ensures that

> *"We've never had retro-commissioning a couple years later; it's probably a good idea, but it's another one of those 'what pot of money would that come out of?' questions. "*

they are performing as designed to perform and ensures continued energy efficiency. Without continued commissioning of these systems it is possible that improper functioning of building systems could erode energy efficiency that has been designed into projects.

3. SOLUTIONS

While the hurdles to energy efficiency in affordable housing may seem daunting, many existing PHAs have overcome these hurdles through discerning policy, motivated employees, and knowledgeable design teams. The solutions that follow are a sampling of the innovative techniques that PHAs have used to address the hurdles holding them back from realizing increased energy efficiency. In addition, the research proposes additional potential solutions for consideration by the affordable housing community.

Programmatic Solutions

The real or perceived transaction costs of engaging in a program can quickly become a strong disincentive to affordable housing providers with limited human resources. While HUD has programs in place to encourage the implementation of energy efficiency, the transaction costs of engaging in the programs are too high for some public housing agencies. To the extent that these costs can be lowered, more programs will be implemented and more energy efficiency will be wrought.

Increase Communication about the EPC program

To counter misinformation and a lack of awareness surrounding the EPC program within the public housing community, HUD has taken steps to distribute more information about the EPC program through a dedicated website, success story page, and FAQ page (see the resources section following the Boston Housing Authority case study later). In addition, HUD is contemplating the establishment of a regular monthly session to address questions regarding the EPC program.[27] However, in addition to these "passive" measures that require PHAs to engage, HUD should actively engage the community through direct communication that highlights the benefits of the incentive program, both for HUD and the PHA. As a starting point, HUD could target the PHAs that have a high utility usage per unit and have not already engaged in an EPC. Since HUD stands to benefit from these retrofits in the long term, investing in a proactive approach for promoting this program will be repaid by reduced utility allowances in the future.

Streamline the Utility Incentive Program

Utility Incentive Approval Time

To address the regulatory transaction costs of engaging in the EPC incentive program, HUD has developed an "Energy Center" to help review applications and provide clear, consistent, and timely feedback to PHAs regarding their utility incentive application (see the resources section following the Boston Housing Authority case study later). Due to the increase in EPC applications within the last five years,[28] HUD should strongly consider investing in further training of field office personnel for processing these applications. Increased knowledge and staffing will decrease processing time and encourage more engagement with the program. Investments in training can

likely be justified through increased utilization of the program, which will lead to decreased long-term energy price risks and decreased utility costs.

PHA Project Advocacy
As described above, PHAs often lack the knowledge required to navigate the utility incentive approval process. To decrease the information requirements on individual PHAs, HUD should assign an advocate to each PHA that has engaged in the process to facilitate their application's utility incentive review. Assignment of an advocate for the project within the HUD process will decrease the information load that the PHA has to bear and thus encourage participation in the program.

EPC Technical Assistance
In order to relieve the information hurdle that housing agencies face in learning about the process of engaging an ESCO about an EPC, HUD could offer technical assistance. By having a few technical assistants that help to guide PHAs through the process of negotiating and implementing an EPC, HUD would encourage participation in the program and reap long-term energy savings.

Streamline the Utility Rate Adjustment Process

The implementation of increased energy efficiency in private housing is being hampered by the inability of developers to receive assurance of lower utility allowance rates in newly developed and renovated units. Reducing the time between finalization of construction and setting utility allowances for new (and significantly renovated) projects should be a high priority for HUD to encourage energy efficiency projects with tenant-paid utilities. Because much of the new affordable housing development is happening through private developers,[29] HUD should incentivize energy efficiency within this building stock as strongly as possible to ensure long-term reduction of utility allowances. One potential idea for addressing this problem is listed below.

Acceptance of the Engineering Method for First Year Utility Allowances
Currently, private affordable housing developers use a preset baseline until they have the energy consumption data to apply for a utility allowance adjustment.[30] This requirement means that developers must sacrifice utility savings while they prove that their building is more efficient than the utility allowance reference housing. While the engineering-based method for utility allowance calculation is an accepted method for PHAs, it is not one that is accepted by the IRS or HUD for LIHTC and Section 8 housing. If HUD and the IRS accepted the engineering method for project-based Section 8 and LIHTC projects, developers could reap the first year of savings and would be more motivated to invest in energy efficiency.

Set Stronger Goals for New Construction

HUD currently has incentives for integrating energy efficiency into new public affordable housing stock, but only for a shallow amount of energy efficiency. However, incorporating energy efficiency into new building stock is significantly easier to implement than retrofitting older building stock. To reduce long-term exposure to utility prices, HUD should strengthen their incentives for energy efficiency in new construction by raising efficiency requirements within the Choice Neighborhoods competitive application process for funding.

Financial Solutions

Below are several financial resources that PHAs, CDCs, and for-profit affordable housing developers have used nationwide to finance additional capital needs for energy efficiency projects. While many financial resources have been available recently through the American Recovery and Reinvestment Act, the resources cited below are only long-term programs for financing retrofits, and thus exclude temporary grants and funding sources. Note that, as mentioned above, the selection of a knowledgeable design professional is the first step in reducing the additional cost of energy efficiency. Implementing the measures below in conjunction with the technical solutions that follow can dramatically reduce the initial capital cost of energy efficiency projects.

Budgeting for Whole-building Efficiency

New Construction

While affordable housing providers are often pushed to build more units due to the increasing gap in affordable housing unit needed and units available,[31] by opting to set a development budget that allows for higher-energy-efficiency units, the owner will lower the future operating needs of the project and ensure that the energy and health needs of the tenants are served well into the future. A recently updated study by Enterprise Community Partners and Davis Langdon has suggested that the integration of energy efficiency and sustainability measures, when implemented at the front end of a project, adds only 2% over the typical development cost.[32] Previous studies have suggested that the cost of energy efficiency and sustainable design may be on par with other projects.[33,34] Acknowledging the possibility of these costs and building them into the initial project budget allows designers the flexibility to include energy efficiency measures without the concern that they will be "value engineered" out of a project. Most of these upfront capital investments pay for themselves over the life of the project and do not typically increase the combined construction, operation, and maintenance cost of a project.

Renovation

Resource constraints on PHAs often result in the piecemeal retrofit of properties. However, this method doesn't capture whole-building system synergies that can create more efficiency while decreasing the lifetime cost of ownership. To overcome these temporary resource constraints, PHAs can engage in programs that leverage the continuous funding that they get from HUD to pay for a larger upfront cost, especially the capital fund financing program (CFFP) and the operating fund financing program (OFFP). By exchanging this string of payments for an immediate infusion of capital, PHAs can lower the effective cost of efficiency by engaging in a systemic design or renovation process. See Appendix A for information on the CFFP and OFFP.

Case Study: Sacramento Housing Authority

Instead of doing renovations in a piecemeal, fix-as-you-go fashion—as was common in the past—Sacramento Housing Authority is now "taking developments off of [the] 'endangered list.'" As noted by the housing authority, "By doing a complete rehab, we're basically providing long-term preservation; these units are preserved for the next 25 or 30 years, whereas using the piecemeal approach, it may only be a few years before you need something else.

Resources:

General Services Administration. "LEED Cost Study"
http://www.wbdg.org/ccb/GSAMAN/gsaleed.pdf

Davis Langdon, "The Cost of Green Revisited"
http://www.davislangdon.com/USA/Research/ResearchFinder/2007-The-Cost-of-Green-Revisited/

Davis Langdon, "Costing Green: A comprehensive Cost Database and Budgeting Methodology"
http://www.davislangdon.com/upload/images/publications/USA/2004%20Costing%20Green%20Comprehensive%20Cost%20Database.pdf

Engage HUD's EPC Incentive Program

Over 240 energy performance contracts have been completed by PHAs nationwide over the last 20 years,[35] thanks to a program by HUD to encourage housing agencies to engage in EPCs. While housing authorities are always allowed to implement retrofits that save energy, to engage in these incentive programs HUD must pre-approve PHAs for a specific energy-saving retrofit.

1) Frozen Utility Baseline Incentive[36] – Housing agencies can apply to HUD to freeze the rolling baseline for utility allowances at pre-retrofit levels for the term of the EPC contract. By freezing the utility allowance baseline, the housing agency is able to pay for the debt financing of the performance contract through the difference between the frozen baseline and the actual energy payments. Any incentive that is not applied to debt service is kept by the housing agency as additional operational funds.

2) Add-on Operating Subsidy Incentive[37] – Housing agencies can apply to HUD for an increase in their operating funds for the amount of the debt service over the life of an EPC contract. This subsidy will cover the expenses of the EPC and for the first three years the housing agency will reap additional operating funds from the discrepancy between HUD's rolling base utility calculation and the actual usage pattern of the building.

As mentioned above, while these programs are technically available to small PHAs, they have much more trouble engaging ESCOs for a number of reasons, including: limited human capacity and technical knowledge; limited financing opportunities; and a less attractive return for the ESCOs. To help smaller PHAs engage in this program, HUD has begun a number of initiatives:[38]

1) Training for small PHAs – HUD has made a concerted effort to teach small PHAs about the basics of energy performance contracting and the benefits of the program to the PHAs.

2) EPC-EZ Program (Pilot) – This program would simplify the EPC program by decreasing architectural and engineering services needed through modeling, standardizing financial pro-forma to encourage lending, and standardizing HUD forms for decreased HUD transaction cost.

3) PHA-driven Consortia – Several small PHAs have created consortia to pool their human and technical resources and create a more attractive offer for ESCOs. HUD is working with these programs and evaluating their potential for further adoption.

Case Study: Boston Housing Authority

By combining private investment, utility incentives, and internal capital funds, Boston Housing Authority expects to decrease energy usage by 31.5% across 13 of its existing buildings (saving

approximately $5M per year before debt service, and $750,000 after). Boston Housing Authority decided to drive deep efficiency into its projects by investing $15M of its own capital funds on top of the savings identified by the energy audit. By investing its internal funds on top of the energy performance contract, BHA was able to incorporate even greater efficiencies that will allow even more energy (and dollar) savings over the life of the performance contract.

Resources:
HUD field office
http://portal.hud.gov/hudportal/HUD?src=/localoffices

HUD EPC resources
http://portal.hud.gov/hudportal/HUD?src=/program_offices/public_indian_housing/programs/ph/phecc/eperformance

EPC Success Stories
http://portal.hud.gov/hudportal/HUD?src=/program_offices/public_indian_housing/programs/ph/phecc/eperformance/epcsuccess

Common EPC Questions
http://portal.hud.gov/hudportal/HUD?src=/program_offices/public_indian_housing/programs/ph/phecc/eperformance/faq

Understanding the HUD Standard Recapture Horizon

Because of HUD's three-year rolling utility base, improvements that provide a dramatic reduction in energy usage can be financially feasible even without engaging in a frozen utility base incentive. Once the feature is implemented, the PHA will reap financial benefits for the next three years as the utility baseline slowly adjusts down to the new energy usage. Because of this lag in utility adjustment, implementing solutions that have a payback of less than two years will actually *earn* money for the housing agency in the short run.[39] To optimize savings, these measures should be combined with a larger program, where possible, to harness the systemic savings that come from deep energy retrofits.

Resources:
HUD (1998) Energy Conservation for Housing – a Workbook
http://www.abtassoc.com/reports/D19980034.pdf

Consolidation of Major Funding Sources for Energy Efficiency

To lessen the time requirement of developers seeking funding, a central forum for energy efficiency programs available to affordable housing could be established and updated. While HUD currently has a list of potential funding sources available on their website, many of the links to more information about those sources are broken. If there were a database that tracked energy efficiency funding sources by state and even locality, like DSIRE but for affordable housing, this would dramatically decrease the time cost to housing developers to getting funding to engage in energy efficiency. See Appendix A for a list of major stable funding sources for energy efficiency.

Resources
HUD List of Funding Resources
http://portal.hud.gov/hudportal/HUD?src=/program_offices/public_indian_housing/programs/ph/phecc/funding - other

Technical Solutions

Technical solutions can often be the answer to financial hurdles. Setting energy targets, holding predesign green charrettes, using energy modeling within the design process, and engaging in deep retrofits can end up lowering the total cost of ownership. There are tools that affordable housing providers can use to ensure that these design techniques are included in projects in order to reap the most energy efficiency out of their projects.

Qualifications-Based Selection for Architects, Engineers, and Contractors

Hiring a design professional who understands the integrative design process and has experience in energy-efficient design and deep energy retrofits is crucial to achieving the maximum amount of energy efficiency for the least amount of money. Designers with extensive deep retrofit experience can save the project money both in the short term due to the proper sizing and integration of building systems, and in the long term through diminished energy costs. Similarly, the selection of a contractor with experience in the construction of high-efficiency buildings will save the owner money through decreased necessity for quality control and an expedited construction schedule. When sourcing designers and contractors housing, authorities should heavily weight the design professional's energy efficiency knowledge and skills and previous experience with deep energy retrofits and advanced building systems.

Resources:
Michigan Qualification-Based Selection Coalition
http://www.qbs-mi.org/

Set Design Guidelines and Construction Standards

Setting design guidelines gives designers and contractors a baseline level of quality and energy efficiency for all of your projects, both new construction and renovation. While not all of the guidelines will apply to every project, simply having guidelines sets the priorities of the project and helps designers understand the energy efficiency expectations for the project. There are many sets of standards upon which an owner can model its own design and construction standards, but the developer should carefully craft its guidelines to make sure that they fulfill the mission and vision of the agency. Within the design standards, the developer should set measurable performance goals, with units specified.

Case Study: British Columbia Housing Authority
British Columbia Housing Authority has developed a thorough set of design and construction guidelines that explicitly state its priorities and criteria for the integration of sustainable design into its building stock. Notable excerpts from the design standard include:

1) *BC Housing is committed to actively support the provincial government's actions leading to the creation of a low-carbon economy.*

2) *BC Housing will reduce its greenhouse gas emissions from PRHC-owned and -leased buildings relative to 2005 baseline by … 50% in 2020/2021.*
3) *The building enclosure and building systems are designed to minimize energy demand.*
4) *Life-cycle cost analysis will be used to identify effective GHG emission and energy reduction strategies.*[40]

These design standards not only give designers guidance on how they should approach the design of a BC housing project, they provide designers with a strong account of the long-term environmental vision that the housing authority has for its building stock.

Resources:
BC Housing Design and Construction Guidelines
http://www.bchousing.org/Partners/Standards_Procurement/Standards

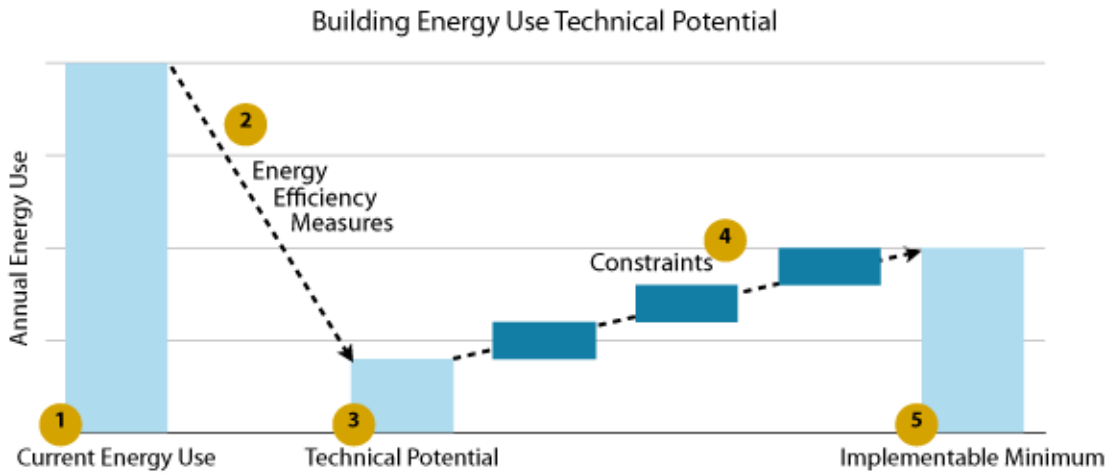
Integrative Design Essentials for New and Retrofit Projects

Technical Potential
As noted above, many designers do not understand the full technical potential for energy efficiency, leading them to consider the addition of renewable energy before all the opportunities for efficiency have been captured. By ignoring cost at the beginning of a project and determining the technical potential for energy efficiency within a building, the designers can identify the energy conservation measures that will have the greatest impact yet still fit into the budget of the project. As a part of the early design process, the housing agency should require the design team to determine the technical potential for energy efficiency within the building. Once that baseline has been determined and the potential system-level efficiencies have been identified, the designers can impose cost and constructability constraints to determine the feasible level of energy efficiency.

Technical Potential: Definition, Importance, and Calculation
Technical potential is the minimum amount of energy that a building (or network of buildings) could use, given the building's basic features and market-available technology. This is a theoretical exercise focused on energy efficiency potential that answers the question "How low can we go?" It changes how we set energy efficiency targets in buildings, allowing us to compare our actual building to the best theoretical version of itself.

When targeting aggressive building energy goals, it's important to understand what could be technically feasible before bending to the constraints of budget, schedule, or other limitations. When we focus on constraints as design guidelines, we often arrive at incremental energy reductions. Understanding what is technically possible before leaping to what is implementable helps design teams arrive at more creative and cost-effective solutions.

The technical-potential approach is a process RMI uses to first identify the lowest possible energy use of a building or system and then through more detailed energy and lifecycle cost analysis, determine what level of energy efficiency is actually possible. As each constraint (e.g. budget, schedule) is reintroduced, the team can understand and quantify its true impacts and determine if those constraints are justifiable or negotiable.



Step 1: Determine the current or typical energy use and end-use breakdown
Step 2: Brainstorm efficiency targets and measures (including envelope performance, daylighting, system design, and system elimination) in an interactive, multidisciplinary workshop
Step 3: Estimate the technical potential—the building's lowest technically feasible energy use
Step 4: Analyze efficiency measures, taking into account nonnegotiable constraints (e.g. time, financial, etc.)
Step 5: Arrive at the implementable minimum

Integrated Project Delivery (IPD)
Integrated project delivery requires heightened collaboration between the architects, engineers, contractor, and owner throughout the design and construction process. Especially important are the early design meetings when the goals for the project are laid out and the initial concepts of the building are conceived. The energy efficiency goals for the project should be clearly laid out as a design requirement during these early design meetings.

Using Energy Modeling as a Design Tool
In the typical design process, design teams use energy modeling primarily as a verification tool. In an integrative design process, energy modeling should inform the design and facilitate a comprehensive life-cycle cost analysis. It is important to provide energy modeling outputs in a timely manner in metrics (e.g. dollars and cents) and in ways (e.g. face to face) that result in implementation. When energy modelers provide the type of information that will impact critical decisions in each design phase, the likelihood of actual implementation increases. These strategies can maximize implementation of energy efficiency recommendations to drive down energy use in buildings.

Life-Cycle Cost Analysis (LCCA)
Life-cycle cost analysis uses expenses and benefits gained over the life of a product to determine its long-term financial feasibility. LCCA is especially important for affordable housing developers because they are often managing the properties in which they're making long-term investments.

Rocky Mountain Institute has developed a tool (LCCAid) to "enable optimal decision making during energy-efficient design and deep retrofit projects." Housing agencies should make a concerted effort to reduce their long-term operational expenses by engaging in a formalized life-cycle cost analysis process for their new or retrofit projects.

Whole-building Design

Deep retrofits and superefficient buildings use a whole-building approach to energy savings, reaping the cascading benefits that can result from the upgrade of multiple systems. Often a deep energy retrofit will allow an owner to afford energy improvements that, when looked at as a single system, would not seem financially feasible. Standard retrofit approaches that focus on replacement of individual technologies can capture a substantial portion of this efficiency potential. However, much larger savings and greater value can be achieved cost-effectively through integrative design that optimally combines those technologies. While it is tempting to phase projects because of limited funding, this phasing leads to missed opportunities for achieving significant energy and financial savings. Only through taking a big-picture approach are projects able to achieve the systemic solutions that drive costs down. To this end, housing agencies should push designers to look for these cross-system benefits instead of focusing on the payback of single systems. Many resources for the education of designers on deep energy retrofits can be found in the resources section below.

Resources:
Rocky Mountain Institute – Retrofit Depot
http://www.rmi.org/retrofit_depot

AIA Integrated Project Delivery Guide
http://www.aia.org/contractdocs/AIAS077630

Whole Building Design Guide – Life-cycle cost analysis
http://www.wbdg.org/resources/lcca.php

Operational Solutions

Designing and installing energy-efficient systems is only part of the solution of bringing energy efficiency to our affordable housing stock. Without proper upkeep of installed systems and tenant engagement programs, efficiency gains from advanced building systems can easily erode.[41] Housing agencies should use targeted tenant-engagement strategies to overcome the barriers to tenant energy conservation and should check the operations of their systems through retro-commissioning to ensure they are operating as designed.

Increased Tenant Engagement

As cited above, tenant engagement is being practiced—with mixed results—by almost every housing agency interviewed. However, there are a few studies that can shed light on effective ways to engage tenants. McMakin et al.'s study[42] of two U.S. military bases, where tenants do not pay their utility bill, suggested that people are more likely to adopt energy efficiency behaviors when:

1) *People are presented with energy efficiency in terms of the benefits that they are deriving from it, such as increased thermal comfort and health.*
2) *Energy use and savings are made visible, thus providing goals and motives where they did not previously exist.*
3) *Information is conveyed in a vivid, salient, and personal format, including visual modeling of specific actions to take.*

The study goes on to mention that emphasizing a common group identity in seeking increased energy efficiency can lead to more cooperative behavior and improved performance. The results of the targeted tenant engagement in this study show the potential for significant reduction in energy use (10% below baseline), yet also emphasizes the complexity of designing tenant engagement programs.[43]

Case Study: British Columbia Housing Authority
A British Columbia Housing Authority pilot used two "on-the-ground" facilitators (Ameresco's Green Collar Corps and BC Healthy Communities) to implement tenant engagement strategies around energy conservation. The pilot included five sites with 447 units and 829 tenants. It is notable that before even engaging the tenants, BC Housing and its partners: 1) analyzed the behaviors they were hoping to change, 2) figured out the barriers to that change, and 3) developed specific strategies to overcome those barriers. Only after taking those three steps did they begin to pilot the strategies with residents. Their three engagement strategies included:

1) Targeted awareness campaigns including educational posters, presentation boards, information sessions, and informational games
2) Energy conservation prompts reminding tenants of the energy conservation action
3) Energy challenges and personal pledges

These strategies resulted in a decrease in energy consumption of 1.75% at the beginning of the study, rising throughout the second and third months of the study to approximately 5% savings over the baseline. These studies show that energy efficiency through tenant engagement is possible, but requires significant advance planning and study.

Implement Retro-commissioning

Retro-commissioning is the process of analyzing the performance of existing building systems and correcting for any design flaws, construction defects, malfunctioning equipment, and deferred maintenance.[44] These corrections can have a significant effect on building performance ranging from indoor air quality to energy efficiency. Two meta-analyses by Lawrence Berkeley National Laboratory, in 2005 and 2011, suggest that the retro-commissioning of buildings can provide significant benefits to tenants and affordable housing providers alike. The analysis showed that the retro-commissioning of buildings cost approximately $\$0.30/ft^2$, reduced energy consumption by a median of 16%, and had an average payback of 1.1 years.[45] These savings were not reaped from any equipment replacement or tenant behavior change; these savings were achieved by simply making sure that existing systems were performing as they were designed to perform. The 1.1-year median payback is well under the two-year threshold, which means that investing in retro-commissioning for buildings has the potential to actually *earn* money for the PHA due to the lag in the utility allowance adjustment. For these reasons, affordable housing providers should consider

the immediate retro-commissioning of their existing building stock to achieve increased energy efficiency.

Resources:
Lawrence Berkeley National Laboratory – 2005 Retro-commissioning Study
http://evanmills.lbl.gov/pubs/pdf/ncbc_mills_6apr05.pdf

Lawrence Berkeley National Laboratory – 2011 Retro-commissioning Study
http://evanmills.lbl.gov/pubs/pdf/cx-enef-mills.pdf

4. CONCLUSION

When affordable housing providers are responsible for the long-term energy costs of the housing they provide, it is financially desirable for them to engage in energy efficiency upfront, and to retrofit existing housing as soon as possible. However, there are many hurdles that have stood in the way of affordable housing providers implementing this energy efficiency. These hurdles are programmatic (a result of bureaucratic costs or disincentives), financial (a result of illiquidity and disjunction in funding sources), technical (a result of insufficient design and construction knowledge), and operational (a result of mixed incentives for usage and maintenance). Luckily, solutions exist for many of these hurdles, and several of these solutions and case studies have been documented here, but many more exist. In order to adequately address energy efficiency in our affordable housing stock, these solutions need to permeate the affordable housing community and systemic hurdles need to be addressed. Concern for utility prices is only growing among affordable housing providers, and these hurdles should be addressed as quickly as possible to ensure a lengthy and prosperous future for our affordable housing.

Appendix A

Additional Resources

Federal Low-Income Housing Tax Credits (LIHTCs)[46]
Many affordable housing developers have taken advantage of both 30% present value tax credits (4%) and 70% present value tax credits (9%) to leverage equity through the syndication of the credits. Housing Tax Credit allocations are made to states, where the state housing finance agency is responsible for distribution of the credits. There is a competitive application process for receiving 9% credits that is guided by each state's Qualified Allocation Plan. The 4% credits are available and are used in cases where other federal subsidization is being used on the project, as is common in housing agency projects; 4% credits are generally paired with tax-exempt bonds and are less competitive than the 9% credits.[47] To the extent that energy efficiency improvements increase the development cost of the project they also increase the eligible basis on which the project can reap tax credits, offsetting a portion of the additional cost. While the money received from the syndication of these credits has been used to increase the viability of projects in the past, through budget setting that prioritizes a project's increased energy efficiency, these credits can be used to provide upfront funding for efficiency measures.

Resources
Enterprise Green Communities
http://www.enterprisecommunity.com/financing-and-development/low-income-housing-tax-credits

HUD – LIHTC Basics
http://www.hud.gov/offices/cpd/affordablehousing/training/web/lihtc/basics/

Traylor, William (ND). "*A Primer: The Low-Income Housing Tax Credit*"
www.ncbcapitalimpact.org/documents/aalLIHTCprimer.pdf

Nixon Peabody – Tax Credit Finance and Syndication
http://www.nixonpeabody.com/tax_credit_finance_and_syndication

Novogradac & Co – LIHTC Awards by State
http://www.novoco.com/low_income_housing/lihtc/federal_lihtc.php

State Affordable Housing Tax Credits
Many states offer affordable housing tax credits that can supplement the use of federal Low-Income Housing Tax Credits. State tax credits alleviate the holder from payment of state tax liability and can be syndicated to investors in the same manner as the federal tax credits. Affordable housing developers operating in these states should investigate the opportunity of including these tax credits in financing models to extend their budget and include increased energy efficiency.

Resources:
Novogradac & Co. – Affordable Housing Resource Center
http://www.novoco.com/low_income_housing/lihtc/state_lihtc.php

Carbon Offset Credits

A carbon offset is "a measurable avoidance, reduction, or sequestration of carbon dioxide (CO_2) or other greenhouse gas emissions."[48] In some markets carbon offset credits that are verified by a third party can be bought or sold in order to meet greenhouse gas reduction targets. However, due to a lack of greenhouse gas limits in the United States, carbon offset credits are commonly sold on a voluntary market to companies that are offsetting emissions for marketing or corporate responsibility purposes. There are several principles that carbon offset credits must meet before becoming a verified source: they must be real and measurable; they must be permanent; they must be additional to what would have otherwise been done; they must be independently verifiable; and they must be trackable.[49] While all of these qualifications can apply toward GHG reductions that are achieved through residential energy efficiency improvements, until recently there hasn't been a standard for tracking and verifying these offsets. Affordable housing providers, once the proper infrastructure has been laid for the tracking and verification of these offsets, can integrate the sale of carbon credits into the financing structure of their projects, thus increasing the amount of efficiency they can achieve.

Because of the measurement and verification systems that are required for both energy performance contracting and carbon offset credit programs, there is possibility for the two programs to work together in order to increase the available funding for the performance contract. While this seems like a potential synergy between the two programs, due to the relative youth of the residential energy efficiency carbon offset market, the effects of combining the two programs on the criteria for carbon offsets has not been determined.

Case Study: Maine State Housing Authority

Maine State Housing Authority (MSHA) is pioneering the verification and sale of residential energy efficiency. After developing a standard for tracking and verifying offsets from residential housing, the MSHA contracted to sell the carbon credits it is producing from the weatherization of 5,500 homes to auto-maker Chevrolet for approximately $750,000.[50] This additional funding has allowed them to extend their existing budget for efficiency (provided by the Weatherization Assistance Program).

Contacts:

Steve Erario, Maine State Housing Authority – serario@mainehousing.org

Resources:

Congressional Research Service – Voluntary Carbon Offsets: Overview and assessment.
http://www.fas.org/sgp/crs/misc/RL34241.pdf

World Resources Institute – The Bottom Line, 2010
http://www.wri.org/publication/bottom-line-offsets

Ecosystem Marketplace & Bloomberg New Energy Finance. State of the Voluntary Carbon Market, 2011
http://www.forest-trends.org/documents/files/doc_2828.pdf

Maine Carbon Offsetting Program Fact Sheet
http://www.mainehousing.org/docs/carbon/general-mainehousingsummaryvcsproject.pdf?sfvrsn=2

Local Utility Programs

Demand management programs run by local utilities have historically been a large source of funding for energy efficiency upgrades.[51] However, utility incentives are as numerous and diverse as the number of nationwide utilities. There are programs that fund specific energy efficiency technologies, programs that pay for percentage improvement over baseline, and many other incentives.[52] But regardless of what form, utilities are willing to pay for demand management, and housing agencies should always check with the local utility before engaging in any project with energy efficiency improvements. Be forewarned that often these programs come with particular requirements that can exclude certain types of affordable housing, so you should always have a discussion with your utility provider before assuming that a rebate applies to a project.

Case Study: Sacramento Housing and Redevelopment Agency

Sacramento Housing and Redevelopment Agency (SHRA) has made extensive use of a Sacramento Municipal Utility District's (SMUD) multifamily housing program that allows projects to receive utility financing based on the percentage of energy saved over baseline. In one recent $14.6M project—financed through a combination of capital, federal, state, and local funds—SHRA received $200,000 back from SMUD for increased energy efficiency in tenant space. In previous projects, where they have reduced consumption by 25 to 30%, they have received utility rebates of over $1M.

Resources:

Database for State Incentives for Renewables and Efficiency
www.dsireusa.org

Community Development Block Grants (CDBGs)

Community Development Block Grants were created to provide affordable housing, services, and jobs to the most vulnerable in our communities. CDBG is annually allocated to "entitlement areas (large cities and counties)" directly from HUD and to "non-entitlement areas (small cities and counties)" through state agencies.[53] Housing agencies should work with their city or state government (depending on whether or not they are in an entitlement area) to make sure that their development needs are included in the agency's consolidated plan for the use of CDBG funds. Once allocated, the housing agency should apply for the funds necessary to provide energy efficiency measures for its building stock. The housing agency can use these funds to augment existing financing and cover any upfront capital requirements for energy efficiency.

Resources:

CDBG General Information
www.hud.gov/cdbg

State Housing Finance Agency Programs

State housing finance agencies are generally state-chartered, independent agencies designed to assist the development of affordable housing in the state. Housing finance agencies have established numerous housing programs based on funding provided from both federal and state funding sources (including the administration of LIHTCs and several other financing sources listed here). Many programs administered by the state housing finance agency, such as the Home Investment Partnerships program, can provide the extra capital needed to drive increased energy efficiency into projects.

Resources:
National Council of State Housing Agencies
http://www.ncsha.org/

Tax Increment Funding (TIF)
Tax increment funding is a development tool used by municipal governments to create economic growth within a certain district. Once a TIF district is established, the property tax rates are benchmarked at a determined baseline. The government sets its spending based on that baseline and all property tax that comes in above the baseline is used to reimburse the community or partner developer for community improvements.[54] Often, because these districts raise property prices, TIF proceeds are used to fund affordable housing projects. Alternatively, the government can incentivize developers to build affordable housing to revitalize the area and raise property taxes. In either case, housing agencies and affordable housing developers should check with their municipal government to determine if there are any tax increment funding districts in their operational areas. If so, that money can be used for the development of energy efficiency in affordable housing.

Resources
Tax increment funding basics
http://www.housingpolicy.org/toolbox/strategy/policies/tif.html

Maine State Housing Authority Example
http://www.mainehousing.org/TaxIncrement

Housing Trust Funds
In order to encourage the development of affordable housing, national, state, and city housing trust funds have been established that use funds from a dedicated revenue source to advance low-income housing. To date, there are nearly 700 housing trust funds across 47 states. These agencies are devoted to the development of affordable housing and generate close to $1B a year.[55] Affordable housing developers should engage these funds, where available, to fill any upfront capital requirements for energy efficiency.

Resources:
Center for Community Change
http://housingtrustfundproject.org/

List of Housing Trust Funds
http://housingtrustfundproject.org/wp-content/uploads/2012/03/HTFunds-in-the-US-2012.pdf

National Housing Trust Fund
http://nlihc.org/issues/nhtf

Capital Fund Financing Program (CFFP)
The Capital Fund Financing Program allows public housing agencies to use their future capital funds as collateral to borrow private capital. The housing agency receives a loan from a private lender using future capital fund allocations to service the debt payments. This program allows

housing agencies to leverage more capital immediately to overcome the "piecemeal retrofit" hurdle previously noted. HUD approval is required for all capital fund financing programs.

Resources:
HUD CFFP Basics
http://portal.hud.gov/hudportal/HUD?src=/program_offices/public_indian_housing/programs/ph/capfund/cffp

Operating Fund Financing Program (OFFP)
The Operating Fund Financing Program, very similar to the CFFP above, uses the annual allocation of operating funds for a PHA to collateralize financing and service debt on a private loan. Private loan money must be applied toward the redevelopment or modernization of the public housing. As with the CFFP, all OFFP transactions require advance HUD approval. While reviewing the OFFP application, HUD will determine how much of the PHA's operating fund can reasonably be applied to debt service by reviewing the PHA's financial statements for the past two to three years. Once HUD has made its determination, the PHA can spend up to that annual amount for debt service.

Resources:
HUD OFFP Guide
www.portal.hud.gov/huddoc/opfund-financing-guide.pdf

Public Housing Mortgage Program (PHMP)
While restrictions formerly precluded PHAs from promising their assets, after the Quality Housing and Work Responsibility Act of 1998, with specific approval from HUD, a housing agency may mortgage a property to raise funds for the redevelopment of its properties.

Resources:
HUD PHMP
http://portal.hud.gov/hudportal/HUD?src=/program_offices/public_indian_housing/programs/ph/capfund/phmp

Weatherization Assistance Program (WAP)
The Weatherization Assistance Program provides financing for the implementation of energy efficiency in low-income housing. Allocated by the Department of Energy to the state energy office or other state program, the funds can be used for measures of energy efficiency ranging from energy audits to furnace replacements. As of January 2010, affordable housing units identified and published by HUD may meet WAP requirements without need for further evaluation before receiving WAP funds.[56] Housing agencies should contact their state energy office, or administrator of the Weatherization Assistance Program, to determine whether or not they can utilize WAP funding to increase the energy efficiency of their building stock.

Resources:
DOE information
http://www1.eere.energy.gov/wip/wap.html

DOE and Multifamily Property partnership
http://www1.eere.energy.gov/wip/multifamily_guidance.html

DOE - Weatherization and State Energy Program Contact Map
http://www1.eere.energy.gov/wip/project_map/

Qualified Energy Conservation Bonds (QECBs)
QECBs are a low-interest debt financing structure administered through the local or state government whereby affordable housing providers can lower their capital costs for energy efficiency projects. While not a grant structure, because of their low interest rate, QECBs can be used to leverage more capital than through normal debt financing opportunities that HUD allows. Depending on whether or not the local government accepted their allocation of bonds, the affordable housing developer should contact the state energy office or the local government to determine the availability of bonds.

Case Study: Boulder Housing Partners
Boulder Housing Partners used $1.5M from QECBs to finance an energy performance contract (which also benefited from HUD's EPC incentive program). The EPC covered several weatherization and energy-reduction improvements across eight buildings.

Resources:
DOE – QECB Primer
http://www1.eere.energy.gov/wip/pdfs/qecb_creb_primer.pdf

State and Local Energy Report – BHP Case Study
http://www.stateenergyreport.com/2011/05/05/using-qecbs-for-multifamily-housing-upgrades-a-case-study/

NOTES

[1] HUD 2009
[2] As cited in Department of Energy (2011). "Building Energy Data Book"
[3] McKinsey and Company 2009
[4] Miller 1994
[5] Abt Associates 2010.
[6] Public and Indian Housing 2011
[7] HUD 2009
[8] Based on the FY 2013 budget for Building Technology Research, Federal Energy Management and Weatherization & Intergovernmental activities under the Office of Energy Efficiency and Renewable Energy, page 4, current appropriations for 2011.
[9] As cited in Department of Energy (2011). "Building Energy Data Book"
[10] McKinsey and Company 2009
[11] http://www.wbdg.org/resources/lcca.php
[12] As defined by HUD 2011 (Income limits)
[13] As defined by HUD 2011 (Income limits)
[14] As defined by HUD 2011 (Income limits)
[15] Miller 1994
[16] http://www.hud.gov/offices/cpd/affordablehousing/training/web/energy/programs/hud.cfm
[17] Department of Housing and Urban Development 2010
[18] http://www.hud.gov/offices/cpd/affordablehousing/training/web/energy/programs/hud.cfm
[19] Abt Associates 2010

[20] Department of Housing and Urban Development 2010, subgoals 2B and 2C
[21] In Real $2011 from a comparison of enacted budget appropriations
[22] 2001 estimate based on an estimate of public housing stock reported in a 2002 HUD report to congress
[23] http://portal.hud.gov/hudportal/HUD?src=/topics/rental_assistance/phprog
[24] Harvard University Graduate School of Design 2003
[25] Somerville & Mayer 2003
[26] Hustwit 2012
[27] Hustwit 2012
[28] Hustwit 2012
[29] Wallace 1995
[30] Kang 2012 & Tanner 2012
[31] Joint Center of Housing Studies of Harvard University 2012
[32] Altus Group 2012 (BC Housing Study)
[33] Davis Langdon 2004
[34] Davis Langdon 2007
[35] Hustwit 2012
[36] 24 CFR 990.185 (a)(1)
[37] 24 CFR 990.185 (a)(3)
[38] Hustwit 2012
[39] Abt Associates 1998
[40] http://www.bchousing.org/Partners/Standards_Procurement/Standards
[41] Mills et al. 2004
[42] McMakin, A., Malone, E. & Lundgren, R. 2002
[43] ibid
[44] Mills et al. 2004
[45] ibid
[46] "Low-Income Housing Credit," Title 26 U.S. Code, Pts. 42. 2012 ed.
[47] http://www.hud.gov/offices/cpd/affordablehousing/training/web/lihtc/basics/work.cfm
[48] Ramseur, Jonathan L. 2009
[49] Goodward, J. & Kelly, A. 2010
[50] http://www.bloomberg.com/news/2011-06-01/chevy-offsets-corvette-carbon-with-inflated-green-housing-claim.html
[51] Miller 1994
[52] www.dsireusa.org
[53] www.hud.gov/cdbg
[54] Housing Policy, 2012
[55] ibid
[56] http://portal.hud.gov/hudportal/HUD?src=/recovery/partnerships/HUD_DOE