“Follow the Money”: Overcoming the Split Incentive for Effective Energy Efficiency Program Design in Multi-family Buildings

Don Hynek, Megan Levy and Barbara Smith, Wisconsin Division of Energy Services

ABSTRACT

As energy efficiency programs in the multifamily building sector ramp up, renewed exploration of the “split incentive” problem is in order. It is a substantial barrier to saving energy in most apartment buildings. It also assures that most multifamily buildings (MFBs) offer substantial energy savings to a program with the right design. (MFBs waste a lot of energy!) Secondly, the fact that most apartment residents qualify as “low income” suggests programs can (or should) serve multiple goals. Understanding these two characteristics of multifamily housing substantially improves the possibilities for successful program design to serve this housing stock.

The authors base their analysis on experience implementing the ARRA Multifamily Program (AMP), a cold-climate low-income weatherization program funded largely with 2009 American Recovery and Reinvestment Act (ARRA) stimulus funds. This program invested $20 million to complete substantial energy retrofits of 84 low-income apartment buildings (5,755 units) in Wisconsin in fewer than three years. From this experience we conclude that most (but not all) MFBs are/were designed to be built with the lowest possible first cost. They then operate in a chronically undercapitalized environment. As a result, these buildings have energy-wasting shells and systems, and rarely see energy improvements as they age. They offer good potential for energy savings through retrofit programs, but at substantial program expense.

From a financing standpoint, there are four distinct multifamily housing markets. Each presents owners with very different incentives and energy cost management goals. Designing a program to capture the substantial energy efficiency opportunities in multifamily housing requires that program implementers (and evaluators) understand just which of these very different markets they intend to impact. Programs frequently need to offer (and justify) substantial incentives, and other support, to overcome split incentive and other barriers and capture the very substantial energy conservation opportunities available in MFBs.

Cracking Multifamily Markets -- “Follow the Money”

As residential energy efficiency programs across the U. S. grow and develop, more and more attention is coming to bear on the 25 percent of households living in rental housing. Most utility conservation programs now have a multifamily element. More and more of those programs are moving beyond the ubiquitous online fact sheet telling tenants to buy CFL lamps and close windows in the winter (McKibben, et. al., 2012). After the massive $5 billion infusion of low-income weatherization funds in the 2009 ARRA Stimulus bill, DOE and HUD signed an MOU to foster more and better weatherization in rented housing. When Wisconsin’s “Focus On Energy” program received an EPA “Sustained Excellence” award, the award citation repeatedly called out the program’s excellent multi-pronged efforts in MFBs.

One reason for this interest is because MFBs offer a lot of energy savings. But another reason is economies of scale. In fact, the driving force of the multifamily housing market is that of economies of scale at all levels. Larger, taller residential buildings are cheaper to build, per unit and per square foot. This lower cost is the primary driver for MFB development. These construction cost efficiencies are attained partly because larger projects justify the use of cost-saving and labor-saving technologies that are unsuited for smaller residential buildings. The same cost efficiencies can be brought to bear in efficiency programs. However, multifamily energy efficiency programs are notoriously difficult to make work. The customer market is diffuse. The buildings are very diverse in their residence patterns and technologies.

However, we believe the single largest barrier to improving the energy performance of MFBs is the "split incentive" that drives many MFB management decisions. Our evidence[1] is that the split incentive is especially problematic in MFBs. Since it is a market failure, rather than a technical problem, understanding the split incentive in MFBs requires clear thinking about how these buildings are funded and how they operate.

The split incentive is a particularly pernicious market failure that plagues any number of energy improvement programs. Put simply, a "split incentive" market failure[2] is said to exist when benefits of a transaction pass to someone other than the party paying the cost.

In MFBs, the split incentive manifests itself when tenants pay the utility bills (directly or indirectly) but have no control over capital investments that affect energy consumption. Those few investments that a tenant might make that could impact their utility bill tend not to be completed, as the tenant will be unable to take the improvement with them when they move.

Understanding the split incentive means first of all accepting a radical reappraisal of how the money works in MFBs – that is, *whether or not the tenants have a utility account, the tenants pay the utility bill*. When one looks in detail at how MFBs get built and how they are operated, it will be obvious that this fundamental principle (almost) always holds true.

However, there is not just one multifamily housing market; at least for purposes of program design, there are four different MFB markets. The financial structures and financial incentives vary a great deal from market to market. The "tenants pay the bills" regime is a major driver in the two largest markets, and only a moderate or small driver in the others. This paper offers a taxonomy of MFBs and their financial environments. It is intended to help program designers and evaluators think through program designs and parameters to overcome the split incentive barrier and design the most effective MFB program possible.

"How the Money Works" in Multifamily Housing Market(s)

In Wisconsin, 49 percent of tenants in 20+ unit buildings pay directly for space heating, 31 percent pay directly for water heating, and 85 percent of tenants pay their unit-level electric bill, (Pigg & Price, 30-31). The larger the building, the less likely it is that tenants pay utilities.

So, the owner/operator writes the check to cover some or most utility bills. In a market-rate apartment building all those operating costs are then loaded into the rent. In buildings in heating-dominated climates, utility costs are typically the second largest operating expense, after debt service.[3] Therefore, whether directly or indirectly, utility bill costs are paid by the tenants. In the case of housing authorities, the actual utility bill is paid directly by the housing authority, but funded almost entirely by HUD, through a complex, multi-year formula.

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[1] In contrast to the findings of Dyson and Chen (2010).

[2] The "split incentive" problem is known more generally in policy discussions as a "principal-agent" problem, as in Jaffe and Stavins (1994). We prefer the term "split incentive" since it captures the essence of the issue perfectly; the incentives various actors do or do not see as they make investment decisions.

[3] In high-end service-intensive properties with numerous amenities, maintenance cost may come in second, and push energy costs down on the list.

A special case of the general split incentive problem is that MFBs are designed and built by actors that will not live in them. They are typically designed to low budget and built through a low bid process. When cost over-runs occur, energy-efficient and innovative systems are usually the first sacrifices made to keep the building within budget. Thus multifamily housing is generally *designed and built* to be less energy-efficient than comparable owner-occupied housing, making it an excellent target for energy efficiency efforts[4].

Furthermore, the financial imperatives of operating low-income multifamily housing assure that buildings will rarely be improved without a concerted public program. Virtually every large residential building is, above all, systematically under-capitalized for its intended purpose. Managing a financially viable apartment building requires maintaining full occupancy, above all else. This is especially true when one notes that the MFB housing market is predominantly a low-income market. Department of Energy analysis (DOE 2011) indicates that 70 percent of all renters are low-income households. When the customer base is generally from the lower end of the income scale, tenants are very price-sensitive, and rents are very competitive.

The Split Incentive In Action – Owner-occupied Homes vs. MFBs

This split incentive problem manifests itself in many ways, most of which assure that MFBs will be built to lowest first cost, and to the lowest level of energy efficiency allowed by building codes. Table 1 summarizes some characteristics of Wisconsin residential buildings, to illustrate the problems that result from split incentives.

Table 1. Selected Characteristics of Wisconsin Housing[5]

		20+ Unit MF Building	**Rented SF Detached Home**	**Owned SF Detached Home**
Vintage	Built post-1960 (%)	92	14	60
	Built post-1980 (%)	52	9	9
Building Size	Dwelling Unit Size (Ft^2)	730	1,310	1,630
	Dwelling Unit Size including Common Space (Ft^2)	910		2,640 (w/basement)
Fuel	Heating Energy Index (BTU/Ft^2/HDD)	4.9	10.3	7.5
	Tenant-Paid Electric Use per Unit (no electric heat) (kWh/yr)	5,600	9,500	
	Owner-Paid Electric Use per Unit (no electric heat) (kWh/yr)	2,300		9,330
	Electric Consumption (kWh/Ft^2/yr)	8.68	7.25	5.72
	NG as space heat fuel (%)	59	85	64
	Electricity as space heat fuel (%)	38	0	4
	Natural Gas as DHW Fuel (%)	59	67	62
	Electric as DHW Fuel (%)	40	33	28
Equipment and Structure	Incandescent lighting present (%)	5 (common area) 93 (in-unit)	81	----
	Low-flow showers (%) [6]	7	51	98
	Double-pane windows (%)	88	90	99+
	Shell insulation opportunities (%)	8	16	22

[4] In one project, our program invested a quarter million dollars in a 100-unit building built just 12 years before. The measures implemented are projected to save $1.20 for every dollar invested, using technologies and devices generally available at the time of design. The developer could clearly have made all the same decisions we did (at less cost) during original construction and constructed a more profitable building, but chose not to do so.

[5] Data for owned SF housing (Pigg and Nevius 2000); rented SF and MF housing (Pigg and Price 2005).

[6] "Low flow" in this case is 2.5 GPM for MFB and Rental SF, 3.5 GPM for Owned SF

The MFB data (from a statistically representative sample) reflects mostly the configuration of privately-capitalized, privately funded MFBs. The data on the difference between SF owned homes and SF rented homes is an especially illustrative look at the split-incentive problem, in buildings that are largely identical except for the difference in ownership.

Note some particular markers of the split incentive at work here. More than one-third of apartments[7] have electric heat, and essentially no owner-occupied houses do. Electric space heating is a key element of many buildings designed specifically to shed space heating costs to renters. It is inexpensive to install, which is important to a developer looking for maximum profit from limited capital. Installing electric heat requires only running wiring, instead of hard-piped natural gas plumbed to each unit. Electric baseboard units require no ducts or chimney, and present no fire or carbon monoxide hazard. The sizable exception is those buildings developed specifically as high-end or luxury housing, where renters demand an individual NG-fired furnace (especially to allow installation of central air conditioning).

Good windows consume a lot of capital. In a single-family house (with windows constituting only 15 or 20 percent of sidewall area), poor windows can have significant energy and comfort impacts, and homeowners find them unacceptable. Single pane windows are virtually never found in owned SF homes. Why are they still found in one-eighth of apartments (and in a similar proportion of rented SF homes) in spite of the fact that windows may be 25 to 40 percent of the wall area in an MFB? Because MFB developers are more sensitive to the cost of capital than MFB owners are to energy/operating costs.

This systematic under-capitalization has operating implications as well. In most MFBs, non-cosmetic maintenance is typically completed only upon failure. This is a barrier to multifamily energy efficiency programs of all types; successful programs must engage owners at the crucial instant that a key system has failed and must be replaced. In a weatherization context, this “replace on failure” (ROF) imperative means that weatherization in MFBs must deal with a backlog of deferred maintenance issues.

Curiously enough, the one exception is that of in-unit refrigerators. Refrigerators are often seen by operators as a cosmetic/marketing tool, not an energy issue. They are the only energy sink in MFBs that prospective tenants are fully qualified to evaluate when making a leasing decision, and MFB operators appear to replace refrigerators earlier in their life cycle than is the case in SF housing (PA Government Services 2002). Still, we found cost-effective refrigerator replacement opportunities in most of the buildings in our program, and replaced 49 percent of all refrigerators. We found that most buildings had two or three “families” of refrigerators, with each family being of identical model and age. This indicated clearly that several large waves of refrigerator replacement had been undertaken, rather than a constant trickle of ROF replacements.

The Split Incentive in Action – MFB Design Decisions

In our ARRA AMP program, we completed walk-through assessments and manager meetings in 120 buildings. After an investment-grade audit on the best candidates, we completed extensive work in 84 buildings. A key element of our assessment was the property’s operating structure, as that proved to be the key to understanding the essential factors; who funds energy retrofits and who pays for utilities. The primary markers here are the metering configuration and

[7] Nationally, the penetration of electric space heating in apartments is even higher, at 43% (DiCicco and Diamond 1995.)

specification of electricity as a heat source (rather than for lighting, motors, etc.) Electricity is the heating fuel of choice when the developer intends to pass on costs directly to tenants.

The data garnered from buildings in our program indicates that split incentives vary a great deal, depending on the operator model.

However, it is a high-risk choice; all-electric buildings in Wisconsin often have higher vacancy rates. Renters learn during their first winter that electric heat is expensive – the cost of a Btu from electricity is 2½ times that of a Btu delivered from natural gas. So electric heat is still designed into less than half of all Wisconsin MFBs; most of the rest have space heating on the owner's meter, with a NG-fired boiler driving hot water baseboard distribution.[8]

By contrast, when the developer is a publicly-funded entity, electricity is used for space heating only when no other choice is possible; when natural gas is not available to the neighborhood. So, it is clear from our assessment data that private owners make decisions to dodge utility costs far more often than public developers – exactly as expected of a developer or owner influenced by split incentive concerns.

Table 2. Configuration of Buildings Participating in Wisconsin's MFB Wx Program

Ownership	Build-ings	Units	% Units	DWH Fuel	Space Heat Fuel	Tenants pay heat	Tenants pay elec.
Private For-Profit	40	2723	47%	37 NG/ 3 Elec	34 NG 6 Elec	3	23
Private Non-Profit	20	1249	22%	16 NG/ 4 Elec	15 NG 5 Elec	2	10
Housing Authority	20	1605	28%	19 NG / 1 Elec	20 NG 1 Elec	0	1
Public/municipal	4	178	3%	4 NG	3 NG 1 Elec	1 (no NG to site)	1
Total	84	5,755	100%			6	3

Space Heating vs. DHW Fuel

Another important marker of the split incentive at work is the proportion of buildings where electricity is the space heating fuel compared to those where it is also the domestic hot water (DHW) fuel. An important element of MFB design is that, even when space heating is paid by the tenant (electric baseboard heat), water heating is almost always a centralized service, on the owner's meter. The only buildings we assessed with individual hot water heaters in every unit were buildings that had been rehabbed from a different function to MFB housing.

To understand this issue, we interviewed[9] an architect specializing in affordable MFB design. He educated us as to the significant cost to install individual water heaters in units. There is the substantial added cost to buy a water heater for each unit, and to plumb the units for a water heater. Fitting a large-enough water heater inside small affordable units presents a substantial design challenge, especially since it "robs" valuable living space for a utility room. He also indicated that most developers and owners recognize the substantial hassles (and risk of

[8] See especially the discussion in Levinson and Nieman regarding owner payment of space heating costs to resolve an information asymmetry market failure. They argue that owner-paid heat is a "costly signal" to prospective tenants regarding the comfort and energy performance of their potential residence.
[9] Personal communication, Thomas Hirsch, RA.

water damage) involved in having water heaters distributed through a building. The result is that it is generally more cost-effective in MFBs to design and build a central DHW system.

When we looked at the fuel used (on the owner's meter) to make hot water, we found it always to be (lower cost) natural gas, instead of electricity, if at all possible. Every building we assessed with electric DHW used that water heating fuel only because natural gas was impossible to use (no gas line to the neighborhood.)

The lesson to take from this is that private owners are often willing to saddle their tenants with electric space heating, but are willing to pay themselves for more expensive electric hot water heating only if they had no other choice.

In-unit vs. Common-area Lighting

Another marker of split incentives at work is the divergence in lighting technologies used in common areas as opposed to in units. Compact fluorescent (Edison-base lamp) lighting as a technology has matured significantly in Wisconsin over the last decade. CFL market saturation in Wisconsin residential lighting is roughly 20 percent (Smith, Mapp, et. al., 2010). If MFB owners approached in-unit energy bills the same way single-family owners manage their homes, one would expect that 20 percent penetration to be mirrored in MFB units.

In fact, we found that lighting technologies reflected precisely a split incentive model. We found no CFLs (and no pin-based CFL fixtures) installed in units in privately-owned buildings. Where small fixtures were installed in common areas, we found a high proportion of pin-based CFLs and screw-base CFLs. Conversely, in master-metered publicly-owned buildings, where the owner (and HUD) pay the entire electric bill, the in-unit CFL penetration (often pin-based CFLs in hard-wired fixtures) varied from 50 to 99 percent.

A Taxonomy of Multifamily Housing Markets

To understand the role of split incentives in MFBs, it is important to first understand that (from the standpoint of ownership models) there are four very different MF markets. In three years of deep involvement with 84 remodeling projects, we learned a good deal about the typical design, operation, and decision-making in Wisconsin apartment buildings. We found it useful to define these MFB markets by two dimensions; the primary source of capital for development of the property and who pays most of the utility costs. These two dimensions drive all the major decisions made in operating the property *and* in financing energy efficiency improvements.

There are approximately 3,100 MFBs (larger than 20 units per building) in Wisconsin. Roughly 2,000 of them are occupied entirely or primarily by low-income households.[10]

- At one end of the spectrum are purely for-profit, investor-owned buildings. These buildings may have some units for subsidized tenants (Section 8 vouchers, etc.) but owner decisions are market-driven. This population constitutes over 50 percent of Wisconsin's MFB housing stock. 1,000 of them constitute the entire non-low-income MFB stock in the state. The other 600+ buildings are primarily low-income housing.
- Privately-capitalized, publicly funded buildings (HUD Section 8 contract, etc.) act much like privately-owned buildings (from an EE program standpoint), except that the residents are all low-income. Roughly 400 MFB's (13 percent) in Wisconsin fall in this category.

[10] The percentages below are our estimates, based on an analysis of U.S. census data, WHEDA and HUD housing inventories, and other sources, especially (Brown and Wolfe 2007) and (Stone 2009).

- Publicly-capitalized (LIHTC/Section 42 program, RHD program, etc.) privately-owned buildings tend to be more energy efficient (from our program experience), because they are developed partially with public subsidies. The owners' operating imperatives are identical to those of privately owned and operated buildings. The residents are all low-income. These buildings are superb targets for new-construction/gut rehab EE programs. Somewhat over 900 buildings (30 percent) of Wisconsin MFBs fall in this category.
- Publicly-capitalized and publicly-owned/operated buildings (public housing authorities, etc.) tend to present fewer EE opportunities, but readily participate in programs that allow long payback cycles. In Wisconsin, this population is only 100 to 200 buildings.

Within these general families there occur a host of variations. However, we have found that each "market" operates in a very different fashion, and owners in each market have very different motivations. Understanding these different markets provides significant and useful insight into effective energy program design.

Privately-Capitalized, Privately-Operated Buildings and Their Owners

In the wholly private MFBs we weatherized, debt service is virtually always the single largest operating expense, typically in excess of 25 percent of revenue. Every operating decision is made with an eye to keeping current on debt payments. Further, in privately-capitalized buildings, debt service rarely goes away. Equity in a MFB can be a very substantial asset, one that can be put to work to buy other properties. Any owner entity seeking to maximize profit constantly strips equity from existing properties by refinancing them, to add to the owner's rental inventory, revenue and (ideally) profit. Since finance costs are significant and unremitting, most MFB managers are risk-averse on multiple levels. One strong marker of this risk-aversion is that buildings in this market are the most likely to have utility costs metered to tenants when it is deemed possible by the designer/developer.

There is little room for owners in these buildings to increase rents or gain marginal profit by marketing amenities, add-ons, or services. Renter customers (especially low-income renters) are aggressive shoppers; in market rate buildings, annual turnover rates approach 50 percent as tenants move to find lower rent. In Wisconsin, typical turnover costs (in actual vacancy, marketing, cleaning, transaction costs, etc.) are equivalent to two month's rent. An owner's profit margin may come *entirely* from a competitive advantage in reducing turnover.

As a result, those capital expenditures that do occur are oriented to low-cost, cosmetic improvements – such as re-furbishing the halls – that will attract prospective renters and induce existing tenants not to move. Since energy improvements are generally invisible to tenants, require substantial skill and experience, and impact only deductible costs, owners/operators almost always "under-invest" in them, preferring improvements with less perceived risk and more immediate returns. In the battle of new paint and carpeting versus new boilers, the carpeting wins every time.[11]

In addition, energy improvements have significant non-monetary costs. Most MFB managers are risk-averse on multiple levels, and are quick to anticipate (and avoid) these non-monetary costs. Good, effective retrofits work to complete multiple measures and capture system interactions. Thus, intensive energy retrofits affect the entire building, and can be disruptive to

[11] In our weatherization work, owners in this class told us explicitly and repeatedly that they would not fund measures with a simple payback period longer than two years. We had little success in convincing owners that this demand, an ROI bar in excess of 50% annual rate of return, was not in their best interest.

managers and especially to tenants. Many owners are very sensitive to the trade-off between improving their property and keeping residents from complaining about noise and security.

Systems retrofits present other challenges. MFB managers are not often specifically trained in systems maintenance, HVAC operations, and especially not in energy efficiency. While they may have acquired the craft knowledge to manage existing systems, new systems, requiring new knowledge, present new challenges.

Above and beyond the financial realities of MFB programs, these added "costs" make them complex to implement. An effective MFB program has to address them, and provide complete solutions to owners with concerns that go far beyond their utility costs. For all of these reasons, these buildings present split-incentive problems in full.

Privately-Capitalized, Publicly-Funded Buildings

In Wisconsin, a significant portion (roughly 13 percent) of the MFB inventory is in buildings with a building-wide contract to provide subsidized housing to low-income (usually elderly) residents. These contracts are usually structured with a defined rent for each unit, based on a market study. When an income-qualified tenant moves in, they pay a fixed percentage of their income, and HUD pays all the rest of the rent. HUD also pays a pre-established "utility allowance" for each tenant, intended to offset the entire cost of utilities up to the cap established by the allowance. The entire utility allowance is paid to the tenant unless the owner pays for space heating; in that case, the owner receives payment from HUD for the proportion of the utility bill assumed/analyzed to be incurred for space heating.

Some buildings in this class were designed specifically for this market, and utility services are almost entirely electricity. The owner pays only common area electric cost, and the tenants (from a utility allowance) pay almost all the utility costs. HUD does establish moderate building insulation standards for buildings developed specifically for their programs. The few properties in this class involved in our AMP program developed specifically as HUD "project-based" Section 8 housing were marginally more efficient than typical all-electric buildings.

Most of the buildings of this type were developed and built as private, market-rate housing, and have "aged into" this market when they became less competitive with middle- and upper-income renters. These building are older, and more likely to present energy efficiency opportunities. They are also less likely to have tenant-metered space heating.

In this market, the owners bear no cost for utilities unless the property is especially inefficient. As a result, these properties present especially significant split incentive problems.

Publicly-Capitalized, Privately-Operated Buildings

These buildings are developed and operated by private entities with public subsidies at construction. Two high-impact examples are the IRS Section 42/Low Income Housing Tax Credit (LIHTC) program and the Dept. of Agriculture Rural Housing Development (RHD) program. They were created in the 1980s to fill a growing need for quality housing for fixed-income/senior and low-income households. The programs operate by providing a subsidy or grant to private, for-profit developers when they commit to building new buildings restricted (entirely or in part) to tenants of limited income. These programs provide much-sought-after capital funding, and the buildings developed are usually designated for senior housing. (This is not because the senior market is especially profitable, but because seniors are very desirable, low-hassle tenants.)

Since many of the existing buildings falling in this group are relatively new, they rarely offer substantial retrofit energy efficiency opportunities. They are ideally suited for efficiency programs focused on new construction. Developers planning these projects are less sensitive to the higher capital costs of very efficient systems, and a "green" marketing initiative can go a long way to overcome NIMBY resistance to a new low-income development proposed in a middle-income neighborhood. (When one sees a small MFB in Wisconsin with a little PV array on the roof, it is likely that the array was not cost-effective at design and that the building is an LIHTC project.) In the last few years, many state housing finance agencies have been opening their capital programs to support partial or gut rehab development projects. In that case, an EE program oriented toward incentives for above-code construction may be effective.

It takes a good deal of program negotiation to get these developers to actually innovate and go much beyond standard practice. However, a few state housing finance authorities (who control disbursement of LIHTC tax credits) are coming to demand high-performance buildings (Brown and Wolfe, 2007).

Publicly-Capitalized, Publicly-Operated Buildings

Publicly-capitalized, publicly-owned/operated buildings (housing authorities, etc.) are buildings that tend to least exhibit the energy defects of MFBs. First of all, they are developed and built for the intended owner. The developer/owner intended never to sell the building. As a result, operating costs were part of the design criteria right from the start.

Another important design parameter is that Housing Authorities exist specifically to shelter vulnerable residents from high housing costs, and especially to assure that fixed-income residents see minimal variation in housing costs from month to month. As such, they are almost always master-metered for all utilities.

These buildings tend to present fewer easy EE opportunities. They are most likely to have professional managers, providing service to a number of properties. They are more likely to pursue effective operations and regularly-scheduled maintenance.

Since HA owners never intend to sell buildings, they readily participate in programs that allow long implementation cycles and longer returns on investment. These buildings may also present the fewest problems with co-pays; since HUD requires HAs to fund "capital improvement" accounts, agencies often can receive permission from HUD to tap those accounts to support energy investments, especially when the effort is supported by a dis-interested entity that funds extensive analysis of a planned project. These buildings are typically least subject to split incentive problems. Their owners are also adept at prospecting for "other people's money" to improve buildings or train operators.

Harvesting Waste – What's Possible in MFBs?

The AMP Multifamily Weatherization program was initiated in early 2009 by the Division of Energy Services to complete comprehensive weatherization work on more than 5,000 units of low-income housing in buildings larger than 20 units, and to provide much-needed economic support to the hard-hit commercial construction industry. Upon completion (before June 2012), the program will have completed weatherization improvements in 84 buildings with 5,755 units of housing, with an aggregate budget of $20 million, using a blend of federal DOE ARRA funds, State of Wisconsin Public Benefits funds and owner co-pay funding.

The program was designed to maximize stimulus spending in the construction industry (which was essentially in "meltdown" in Wisconsin.) Program funders thus mandated that we stretch the financing envelope as far as possible to implement measures. As a result, we completed very substantial work in every building. One valuable outcome is that we put out to bid an extraordinarily broad range of measures. We are only now beginning to develop a general cost-benefit analysis[12] (based primarily on savings-to-investment ratio, or SIR) of all that work.

In aggregate, average total cost for all weatherization work was $2,800 per unit, with hard (construction) costs of $2,300/unit. (Small-building weatherization in Wisconsin during the same period cost an average of $6,800 per unit.) On average, projects had an SIR of 1.42; this corresponds roughly to a ROI of 12.5 percent, or a simple payback of seven years.

Aggregated data from energy models (utility bill analysis has not yet been started) indicate that the work completed should save 29 percent[13] of pre-weatherization energy consumption (MMBtu basis). Comprehensive and aggressive air sealing was typically the most cost-effective measure implemented. Lighting upgrades (both in-unit and indoor common area lighting) were also likely to show good cost-effectiveness. Ventilation upgrades demonstrated enormous energy savings and good cost-effectiveness in the few buildings where the opportunity was present, but implementation required substantial innovation, and the costs and complexity are daunting. Conversion of electric hot water heating, while complicated, was very cost-effective in the buildings where it presented an opportunity.

Given their substantial cost, space heating and DHW replacements, while they had *very* substantial utility bill impacts, were rarely completely cost-effective, except in the largest and oldest buildings weatherized. The use of multiple funding sources (to promote the goals of rapid deployment and supporting employment of laid-off construction workers) allowed completion of these measures without substantial owner co-pay. In the absence of these supplemental funds, owner co-pays of roughly 25 percent ($400/unit) would have been required to bring these measures to a program SIR of 1.0 or better.

Effective Program Design in the World of Split Incentives

The lesson to be learned from all this is that the split incentive is alive and well. If a given building has sufficient operating cash flow, owners and managers are not motivated to make energy improvements. In fact, most managers we worked with were resistant to improvement; they are risk-averse. Effective MFB efficiency programs have to work around the inertia.

The strategy we chose in our ARRA program was to ask "cui bono?" and then go where the answer led us. That is, if it is true that

- most residents of MFBs are low-income, and
- *whether or not the tenants have a utility account, the tenants pay the utility bill,*

then any energy improvement in a building ultimately benefits the tenants, and the tenants are likely to be low-income. In some cases, the benefit is directly reflected on a tenant meter. In many cases, the benefit is less direct, but still present.

This brings a very different dimension to multifamily program design, one where program designers can achieve multiple goals. A good multifamily energy efficiency program

[12] Weatherization measures are evaluated for a savings-to-investment ratio" (SIR) of 1.0 or greater. SIR analysis is essentially an NPV calculation, using (DOE policy) a 1 percent fuel cost escalator and a 3 percent discount rate.
[13] Exactly in line with Stone, 2009.

that achieves sizable energy savings can also reduce the energy burden on low-income households. The key is to understand which of the four MFB markets is the target audience, and design to address the incentives those owners see as they assess their buildings' energy costs.

We conclude that the program designs most likely to perform well in MFBs will:

- prioritize the desired MFB market, not all MFBs in general
- market to those owners/operators in their existing networks
- market to contractors (not owners) to capture energy savings in large systems at replace-on-failure.
- recognize and design intending to fulfill social (low-income) goals as well as energy savings goals, in order to…
  - provide and justify high incentive levels
  - fund "turn key" programs including most of the management and most of the labor needed (i.e., a staffed direct install CFL program, not delivering cases of CFLs to the building super)

EE Program Design for Privately-Capitalized, Privately-Operated MFBs

In this market, new construction is very schedule-driven[14], and developers are very risk averse. Incentive/voluntary programs to promote efficient construction should be expected to be generally ineffective. The only significant driver for new construction efficiency (in all but a few luxury buildings that may seek LEED or MF Energy Star certification) is a mandatory program; building codes and mandatory equipment performance standards.

Existing buildings in this class can be impacted by several types of energy programs, so long as they are all designed so that program staff pay virtually all costs[15] and provide virtually all the labor and retrofit management costs. Several initiatives deliver such excellent energy savings that a direct install program can be very cost-effective, even with dedicated program labor to complete all implementation work. The best candidates for this program model include in-unit light retrofits, in-unit hot water saving measures, and especially blower door-guided air sealing retrofits (at least in smaller, wood-frame buildings.)

Programs to impact larger energy-consuming systems (space heating boilers, water heating, etc.) are complex to implement in MFBs. These systems are replaced *only* on failure. To be effective, any program must be available at exactly the moment of failure and respond to an incentive application within days. Wisconsin's "Focus On Energy" program has gotten good results from a program that provides relatively modest incentives for high-efficiency hydronic boilers that are replaced on the failure of the conventional systems. That program is marketed not to building owners, but to the medium-sized HVAC contractors that serve apartment owners (through their wholesaler supply houses.) Contractors sell the program to building owners, contact program staff when they are quoting a job, and assure that owners submit applications and documents as rapidly as needed. This program model can be complex to start up, and cannot be "turned on and off" over the short term without doing great damage to the implementer's credibility to a key audience. However, a sponsor willing to make a long-term program commitment and field a nimble, responsive implementer can garner significant energy savings.

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[14] We have pursued construction observation and measurements in new-construction MFBs where tenants were moving into the second floor even as the 12th floor was still an empty shell.
[15] We repeatedly had owners of wholly private buildings decline to co-fund EE measures unless we could demonstrate a simple payback of less than 2 years on their invested funds.

EE Program Design for Privately-Capitalized, Publicly-Funded MFBs

New construction in this market is identical to that of wholly private buildings (above.) It is generally the case that voluntary new construction programs are unlikely to develop much traction with developers of properties intended for this market.

Retrofit programs may have better results than in wholly private buildings, with the right program design. Owners of these buildings typically participate readily in direct-install programs (with install labor included), since low-income funders encourage energy efficiency initiatives.

The difference is that systems replacement (boilers, water heaters, air conditioning, etc.) can be more effective. Within the management structure most funders require, systems replace is sometimes actually planned, offering more time for effective program influence. And, HUD and other funders typically require that owners maintain a “capital fund” to assure that predictable maintenance costs are budgeted in advance. These planned replacements provide a gateway to program implementers, if they have the patience to ride out long decision-making cycles.

EE Program Design for Publicly-Capitalized, Privately-Funded Buildings

Since many of the buildings falling in this group are relatively new, they rarely offer substantial retrofit energy efficiency opportunities. However, few of these buildings will have seen much attention given to in-unit lighting, and a direct-install lighting program can be very effective. (By contrast, domestic hot water is on the owner’s meter, and these buildings are more likely to have relatively low-flow showerheads and faucet aerators.)

These developers are ideally suited for efficiency programs focused on new construction. Developers planning these projects are less sensitive to the higher capital costs of very efficient systems. In the last few years, many state housing finance agencies have been opening their capital programs to support partial or gut rehab development projects. In that case, an EE program oriented toward incentives for above-code construction may be effective.

A number of state housing finance authorities (who control disbursement of LIHTC tax credits) are coming to demand high-performance buildings. They see their mission as funding the development of decent, low-cost housing. If program staff are educated about the impact of high energy costs in undermining the effects of low rent, they may become effective “implementers by proxy.” In Wisconsin, LIHTC developers are required as part of their application (WHEDA 2012) to design to achieve energy efficiency two percent better-than-code and utilize Energy Star-rated appliances throughout their planned LIHTC building specification.

EE Program Design for Publicly-Capitalized, Publicly-Funded Buildings

These buildings, operated by housing authorities and not-for-profit agencies are typically the easiest to bring into an energy efficiency program. They have dedicated management staff, operating buildings they intend to own for the long term. Managers are also (typically) more aware of energy costs and efficiency strategies.

Because of this more intensive management, these are also the least likely to offer exceptional energy opportunities. However, buildings in this class may participate in systems retrofit programs offering substantial savings, if the timing is right. A moderate incentive may be sufficient to accelerate a boiler replacement (to condensing, sealed combustion systems) by a few years, delivering sizable savings.

Managers of wholly public buildings are almost open (more than most MFB managers) to innovative technologies, like renewable hot water or combined heat and power systems.

However, we found small opportunity to implement advanced strategies; buildings that primarily house seniors are generally not heavy users of hot water. In the buildings we assessed for renewable DHW, the low absolute load limited the cost-effectiveness of these systems. Large low-rise buildings (with large roof areas and proper orientation) could offer substantial solar electric potential.

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