Cook County Energy Savers: How Energy Efficiency in Chicago's Multi-Family Buildings Has Evolved to Meet New Challenges from the 1980's to the Present Day

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ABSTRACT

In the face of the abandonment of older multifamily buildings due to rising energy costs in the 1980s, the Chicago-based Center for Neighborhood Technology (CNT) pioneered energy efficiency retrofit programs. The Chicago Energy Savers Fund (CESF), sponsored by People's Gas, retrofitted 12,500 units between 1984 and 1989, effected a 20-37% drop in pre-retrofit fuel consumption and strong practices in multifamily energy efficiency. Despite its success, CESF was discontinued in 1989 because it did not pass the "total resource test" narrowly-defined by the State Utility Commission.

In 2007, CNT formed the Cook County Energy Savers (CCES) as part of a revived multifaceted strategy to preserve affordable rental housing in Chicago. CCES, which is supported by contributions from foundations, electric and gas utilities and government agencies, is modeled on the success of CNTs experience with the CESF in the 1980s. CCES continues today and is evolving in response to changing market conditions. CCES is designed to help landlords and tenants save money, maintain and improve housing for lower-income renters, and respond to growing environmental concerns over Greenhouse Gas emissions (GHG). This paper examines how the Cook County Energy Savers program is developing in relation to its predecessor, the Chicago Energy Savers Fund, to meet the challenges of energy efficiency in multi-family housing within the context of the climate change and affordable housing preservation.

Introduction

In Chicago in the 1980s, rising energy costs forced rental building owners to abandon older multifamily buildings. In respond to this challenge, CNT worked to develop best practices in multifamily energy efficiency; both with regards to program development and energy modeling software. CNT pioneered two early multi-family energy efficiency retrofit programs. The Chicago Energy Savers Fund (CESF), sponsored by Peoples Gas, Light and Coke Company, retrofitted 12,500 units with $9 million of financing from 1984-1989 (De Cicco et al, 1995). CESF, in turn, was built from CNT's previous experience with the Multi-family Energy Conversation Program (MECP), which involved 346 units in 18 building and approximately $560,000 of retrofits. (Evens et al).

CESF was discontinued after several years by the State Utility Commission for failing the total resource test. Later research, however, proved the program's effectiveness. An analysis of the CESF, based on utility bill analysis, was performed by Wisconsin Energy Conservation Corporation (WECC) in 1991. WECC found that CESF was very successful in saving energy, resulting in a 20-37% drop in pre-retrofit fuel consumption. Benefit Cost Ratios (BCRs) were analyzed in three ways: building-specific, participant-specific and the total resource test (adopted by the state utility commission and the Illinois Commerce Commission). Building- and

participant-specific BCRs of 1.77 and 1.80 respectively indicate that the program was indeed cost-effective. However, the total resource BCR was 0.77. Utility funding was discontinued because it did not pass this narrowly defined "total resource test" (De Cicco et al).

The Cook County Energy Savers began pilot building audits in the spring of 2007 and began auditing and retrofits in January 2007. CCES is modeled after the success of its predecessor, CESF. CCES is designed to help building owners invest in energy efficiency to reduce energy (and operating) costs and improve comfort for building occupants. CCES is being offered to owners of rental properties of 5 units or more within Cook County. Like its predecessor CESF, CCES is a "one stop shop" model through which owners can receive technical, financial and construction assistance. CNT offers custom energy assessments and specific energy-efficiency recommendations, financing options for implementing energy recommendations (including energy tax credits and grants for income eligible units), construction oversight and bid package review and annual reports on energy performance. Building-specific energy assessments include: utility bill analysis, field audit, building modeling and a written report with energy efficiency recommendations including up-front costs and payback period estimates. CCES also provides ongoing performance monitoring through post-retrofit energy bill reviews and annual performance reports. Re-assessment and tune-ups may be performed if the proposed energy savings are not reached.

This paper compares the CESF, and Cook County Energy Savers programs, and explains the multifaceted rationale behind the CCES program and how this energy efficiency program is adapting to meet the ongoing challenges of increasing energy efficiency in multi-family housing. The development of this program highlights the importance of energy efficiency as a means of preserving affordable rental housing, reducing greenhouse gas emissions and continuing to develop place specific strategies for energy retrofit programs.

CCES Rationale

In developing the CCES, CNT Energy understood that energy efficiency should not be justified solely in terms of costs and paybacks. Although economic analysis facilitates owner investment, it should not be the only yardstick by which energy retrofits are measured. There are additional benefits to improving the existing housing stock including: preserving affordable housing, improving existing housing comfort and quality and reducing GHG gas emissions.

In 2007, CCES was developed in response to both economic and environmental concerns. The combination of rising energy costs, the deterioration of the rental market due to abandonment and condominium conversion, and the poor quality of low-income housing buildings led to the formation of the Preservation Compact in 2007. The Cook County Energy Savers program is a keystone partner in this program. The benefits of improving and preserving rental housing are numerous and extend beyond simple cost-benefit analysis. In addition to reducing energy bills, increasing energy efficiency can help owners of affordable housing maintain affordable rents in their buildings.--an ongoing public benefit of the CCES program. Retrofitting existing building stock is a critical opportunity to integrate climate concerns, energy efficiency and the cost and quality of housing for owners and tenants. This combination of benefits far outweighs the simple "total resource test" applied by the utilities to the CESF in the 1980s.

Why Retrofit Affordable Housing?

CNT's efforts on behalf of energy efficiency and housing preservation were instigated by high fuel costs and concerns about rental housing stock attrition. Housing trends in Chicago indicate that from 1973 to 1989 available private market (unsubsidized) rental housing dropped by 41% due to abandonment of units, conversion to higher-priced rental units and condominiums, and rising energy costs (Katrakis, Knight and Cavallo 1994). This loss is of great import in Chicago, where approximately 56% of housing units are in rental buildings.

Lower-income renters are increasingly forced to spend proportionally more of their income on housing costs. In 1989, 56% of low income renters spent at least 50% of their income on rent and utilities and more than 80% of (5.1 million) spent at least 30% of their income on rent and utilities. In sharp contrast, a middle-income family with an annual income of $50,000 spent less than 15% of its income on rent and utilities (Katrakis, Knight and Cavallo 1994). In 2006, 52 % of low income renters (individuals making $24,400.00 or less annually) paid more than half of their income on housing and 25% of people living in subsidized housing pay more than 50% of their income on rent. Low income renters with higher housing costs make ends meet by spending less on other needs including food, transportation, healthcare and insurance (Joint Center for Housing Studies of Harvard University, 2008).

Equally troubling is that lower income renters are getting less for even the higher portion of their income they are spending on housing. Lower income people often live in insufficient housing lacking in basic utilities (Schmitz, et al 2005). Housing available to low-income families is often rife with problems including: holes in the floor, missing or inefficient stoves or refrigerators, overcrowding, lead-based paint, asbestos, lack of adequate and safe heat, lack of comfort and safety, fire hazards and poor indoor air quality. Because energy efficiency retrofits address both building systems and the building envelope, they can be an effective tool to address this inequality. Multi-family retrofits can result in significant economic and ancillary benefits for owners and occupants.

The Preservation Compact

By 2007 condominium conversion in Chicago had supplanted abandonment as the primary means of attrition in the affordable rental housing stock. More than 50,000 Chicago-area homes were in foreclosure in 2007, a 50% increase from 2006 (Yue, L, February 13, 2008). These trends in the instability of the housing market further underscore the need for affordable rental housing.

In response to the combined pressure of high energy costs and rapidly-depleting rental housing stock, CNT helped to form the Preservation Compact, a multifaceted strategy to preserve affordable rental housing in Chicago. The Preservation Compact includes many initiatives, including the establishment of funds to acquire, hold and maintain at-risk and existing rental units, a focus on community organizations and effective tenant organizing to preserve housing, and data review and property surveys to collect new characteristic baseline property data. CCES is both a partner and an essential part of this strategy to retrofit and preserve affordable rental housing in Chicago. Our project goals include 2000 units audited and 600 units retrofitted in 2008. To date, we have audited 1300 units and completed retrofits on 200 units.

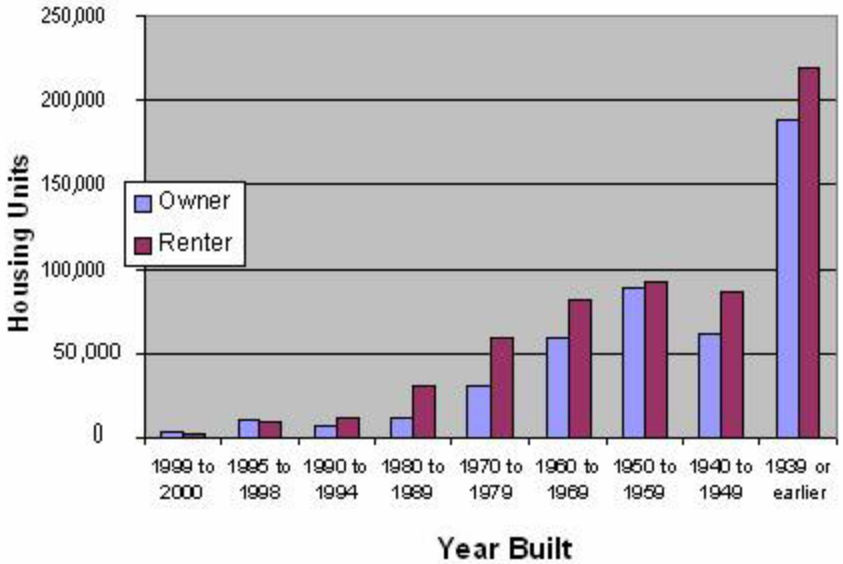
Benefits of Energy Efficiency Retrofits

Beyond the financial benefits of energy efficiency, there are ancillary benefits. Air sealing can improve indoor air quality, reduce draftiness and prevent vermin from entering the building; upgrading HVAC equipment and insulating walls can reduce noise pollution and balancing steam heat systems can increase thermal comfort. (Thorne-Amann, J. 2006)

Climate Change and Existing Buildings

Another example of developing benefits from improved housing is highlighted concerns around global warming and greenhouse gas (GHG) emissions. According to the Pew Center on Global Climate Change, "Given the durable nature of buildings, the potential for GHG reductions resides mostly with the existing building stock for some time to come." However, as Figure 1 emphasizes, the majority of today's Chicago housing, approximately 220,000 units, was built during or before 1939. Those buildings are therefore both not designed for energy efficiency and are becoming less energy efficient through physical plant deterioration. Energy use in Chicago buildings is responsible for 70% of GHG emissions in Chicago; 50 % of those emissions are from energy use in residential buildings. Because 80% of the buildings existing today will be used in 2020, great potential for GHG emissions reductions exists in building energy efficiency programs. Building owners will ideally be more motivated to pursue energy efficiency because of climate change awareness. In summary, retrofitting existing building stock is a critical opportunity to integrate climate concerns, energy efficiency and the cost and quality of housing for owners and tenants.

Figure 1: Chicago Housing Stock by Year Built and Ownership



Source: U.S. Census 2000, www.factfinder.gov

Audits and Retrofit Strategies: Then and Now

Overview of Building Types

Like CESF, CCES focuses on the typical Chicago 3 story walk-up building with a flat roof, single pipe steam heat with cast-iron radiators and atmospheric gas boilers that are between 15 and 20 years old. Common layouts include rectangular, L-shaped and U-shaped courtyard buildings (Evens et al). 70 % of 64 buildings audited under the Cook County Energy Savers program to date are typical Chicago walk-up building with central steam or hot water boilers. Approximately 25 % of the buildings audited to date are newer 6 unit buildings, approximately 40 years old, with forced air gas furnaces or hot water gas boilers with radiant piping/baseboard fin distribution. These buildings characteristically have no basement. In many cases, tenants control their own heat, although the owner supplies and pays for heat from a central distribution system.

Typical Retrofits

During the original CESF the most common retrofits (in order of decreasing frequency) were: storm windows, indoor thermostats, boiler replacements, radiator work and ceiling cavity insulation. In 2008, the list (in order of decreasing frequency) is: lighting, HVAC upgrades (including installation of boiler controls & steam/hot water distribution/radiator work), low cost items (such as air sealing, compact fluorescent light-bulbs and pipe insulation), ceiling cavity insulation, repair of exterior brick and mortar/stucco walls and educational efforts focused on operations and maintenance.

It is immediately apparent is that storm windows are no longer a common recommendation. In fact, 80% of the 64 buildings audited currently have installed newer double glazed vinyl or aluminum frame window within the last 10 to 15 years. In addition, lighting retrofits have increased in frequency, reflecting the advent of newer, more efficient lamps and ballasts.

Building Modeling Techniques

Chicago Energy Savers was a pioneering program and CNT engineers developed new computer modeling programs using bin methods to calculate building energy use and perform building simulation modeling at a time when modeling tools and software packages were not readily available as they are today. Auditors were trained to calculate metrics including: infiltration losses, internal gains from lighting, cooking and appliances, solar gains, heat conduction losses, calculated savings for non-interacted and interacted ECMs (Energy Conservation Measures) and life cycle costing. The computer software was conducted in 6 modular steps: Utility Bill Analysis, Building Characteristics, Simulation of Energy Consumption, Non-Interacted Savings, Interacted Savings and Life Cycle Costing.

By 2007, many energy modeling software programs for varied applications had been developed. Rather than re-format earlier programs CNT chose to use EA-QUIP (Energy Audit using the Queens Information Package) Version 2. EA-QUIP is based on the Computerized, Instrumented, Residential Audit (CIRA) developed in the early 1980s at the Lawrence Berkeley

Laboratory (de Cicco et al). Ea-Quip was chosen because it has the capacity to model multi-family projects, with its own library of retrofits and costs.

EA-QUIP does not require programming skills for most operations and the Department of Energy has recognized EA-QUIP as a viable tool in weatherization programs (http://www.eere.energy.gov). EA-QUIP uses utility bill data and building-specific information entered into user-friendly data entry fields and the program will determine which retrofit options make the most economic sense within a particular project budget. Standardized reports itemize retrofits based on economic and energy saving criteria including life -cycle savings, Saving to Investment Ratio (SIR) and simple investment return (SIR).

An Example: Heating

The question of building heating illustrates the complexity of today's landlord-tenant relationships and the different problems that the CCES faces in the 2000s than the CESF program did in the 1980s. This issue is more complicated today because of the increased variety of boiler types, maintenance practices and heating control systems as compared to the 1980s. The typical boiler surveyed in the 1980s was a Kiwannee coal boiler that had been converted to natural gas. Heating fuel bills were largely paid by the owner and heat was distributed via 1-pipe steam systems and cast iron upright radiators. In CCES, the majority of boilers are central atmospheric boilers. Many building owners have installing rudimentary boiler controls including an outdoor temperature sensor or timer and aquastat on the main steam condensate line. This model allows general control over what air (and steam) temperature the boiler goes on. Other buildings provide thermostats that tenants can adjust in their units. In fact, only 2% of buildings surveyed so far in 2007/2008 have multiple temperature sensors in multiple building areas that provide a comprehensive picture of how evenly the heat is distributed in the building. This effectively means that most owners are still overheating their buildings.

Due to the volatile nature of fuel prices and newer, smaller furnace products, many landlords have converted to individual forced air furnaces. This shifts the burden of heating bills to the tenants, and reduces the incentive for related energy efficiency measures such as air sealing and insulation that can make buildings more energy efficient. Because landlords typically overheat their buildings and fuel is more expensive today, tenants have become accustomed to a comfort level that is expensive.

Split Incentives

In Chicago, the building audited under the Cook County Energy Savers Program can be divided in to two categories: central steam-heated buildings, in which landlords pay the heating bills and tenants use radiator valves and windows to condition their air, and centrally heated buildings in which owners pay the heat, but units are equipped with tenant controlled thermostats. The latter case is an enduring split incentive to multi-family retrofits. Landlords in these buildings are less likely to invest in HVAC improvements if tenants have control over their own heat. On the other hand, tenants have no incentive to control usage if the owner is paying the bill. "Split incentives occur in the general context of landlord/tenant relationship which can be characterized by mutual distrust" (De Cicco et al. 1995). CNT is currently working to develop incentive programs to encourage tenants in these building to reduce energy usage.

Split incentives are also directly linked to building operation and whether the owner is pursuing a pro-active or reactive maintenance program: "A tenant complaint about lack of heat is more likely to be addressed by turning the heat up, than by insulating the apartment" (De Cicco et al. 1995). This is due to a variety of factors: landlords don't have enough time or information to improve insulation, and they don't know what the temperature is in the apartments. To skirt this issue, owners are increasingly converting from central steam or hot water boilers to central boilers with zoned valve heating systems (which allow more control and ability to diagnose problems within the distribution system).

In response to the issue of split incentives surrounding heating systems CNT has developed a three-pronged approach: financial, programmatic and educational. The financial response stipulates that grant funding cannot be used to convert from central to individual furnaces.[1] This also serves to encourage landlords to pursue a "whole building" approach that takes wall insulation and air sealing into consideration when developing a retrofit package.

CNT is also focusing on educating tenants, operations and maintenance staff, and, if possible, setting up incentive programs to encourage energy savings and pro-active maintenance programs. The field audit is also of great importance as a time when the building owner/operator and CNT auditor can examine building-specific conditions, such as un-insulated piping and leaking masonry and door openings. These items can be rectified at low cost and by the owner in order to develop a pro-active approach to energy efficiency.

CNT is also working to offer energy efficiency programs to tenants in buildings where we have pre-existing relationships with owners. This is an effective way to address the issue of split incentives. Programs being planned include training and installation of compact fluorescent light bulbs and real-time electricity pricing.

Lessons Learned from CESF

Program Design and Financial Structure

CESF was designed as an energy efficiency program and a community economic development initiative. CNT sent auditors through an intensive 8-week training covering building science and energy use theory, field work, data collection, computer modeling, specification writing and construction requirements. The auditors were then involved in an apprenticeship period during which their work was monitored by CNT. Finally, the auditors worked from 8 local community based organizations.

The high administrative cost burden of the CESF satellite offices proved to be detrimental in the final resource analysis performed by the gas utility, People's Gas and Coke Light. As a result, CNT chose to streamline the re-deployed Cook County Energy Savers program. While making for a more efficient energy program, CNT loses the community development and opportunity for long-term capacity-building in multiple neighborhoods.

The One Stop Shop Approach

During CNT's initial experience with CESF it became apparent that multi-family building owners are often overworked and under-informed. They lack knowledge regarding

[1] This is in addition to the general program requirement that owners of affordable rent units who receive financing or grant funds maintain the affordable status for 5 years after completion of retrofits.

building systems and have only rudimentary understanding of energy efficiency. Much of their knowledge is based on experience with contractors, who usually arrive when something breaks, rather than making up part of a proactive building maintenance program.

The one-stop shop model responds to the fact that providing an energy audit report and discussing (or even providing) financing did not galvanize most building owners to proceed with energy retrofits. In this model continued in CCES, building owners receive a bundle of services including audits and building modeling, bid management, construction management and performance monitoring in addition to financial assistance and consulting. These services are rendered through CNT, making the relationship between CNT staff and building owners pivotal.

New CNT Energy Services: Alternative Energy Suppliers

Despite the continuity between CESF and CCES, CNT has had to develop new strategies in response to the challenges of today's energy market. Against the backdrop of recent energy market deregulation and dramatic increases in heating gas prices, alternative energy suppliers have saturated the Chicago area. These companies are rooted in the concept of a free and competitive supply market versus the monolithic gas company of earlier years. Despite the potential of free market competition, these companies generally do not help the consumer save money, but are convincing consumers to make detrimental financial decisions.

Ultimately, alternative energy suppliers are problematic because they play on consumer fears of un-predictable gas prices by offering potential savings without reducing usage. As part of our one stop shop approach, CNT is helping owners analyze their gas bills under alternative supplier contracts to ascertain whether they are saving or losing money. This program will ideally encourage building owners to make informed decisions regarding their utility contracts that will both save energy and improve the heating situation for their tenants.

Conclusion: On-going Project Development and Monitoring

The Center for Neighborhood Technology has pioneered energy efficiency programs in multi-family housing for over twenty years. CNT's current energy efficiency retrofit program, Cook County Energy Savings, builds on lesson learned and experience with the "one stop shop" model of the Chicago Energy Savers Fund, while adapting to the new challenges of substantially altered housing and energy markets. The current program is being adapted to consider operations and maintenance activities & tenant education and training as ways to overcome split incentives.

CCES is designed to address issues of affordable housing quality and preservation. Additionally, given the large stock of rental buildings in Chicago, retrofits are recognized as an important strategy for reducing greenhouse gas emissions. Given the direct and indirect economic and social importance of energy efficiency retrofits, CCES should not merely be judged based on the criteria of total resource test previously applied by the state utility.

References

Evens et al, *"Development of a Computerized Multifamily Energy Audit: Technical and Implementation Issues"*, Center for Neighborhood Technology/ American Council for an Energy Efficient Economy.

Citizens Utility Board, *Consumer Coalition says enough is enough, files ICC Complaint charging US Energy with Deceptive Marketing*, March 3, 2008, http://www.citizensutilityboard.org/pdfs/NewsReleases/20080303_USEnergy.pdf

Citizens Utility Board, *Gas Market Monitor: an Analysis of Natural Gas Offers*, http://www.citizensutilityboard.org/GasMarketMonitor.php

DeCicco, J et al, 1995, *Improving Energy Efficiency In Apartment Buildings*, Washington D.C. and Berkeley, California, American Council for an Energy Efficient Economy.

Joint Center for Housing Studies of Harvard University, 2008, *America's Rental Housing, the Key to a Balanced National Policy,* John F. Kennedy School of Government.

J.T. Katrakis, P.A. Knight, and J.D. Cavallo, 1994. *Energy-Efficient Rehabilitation of Multifamily Buildings in the Midwest*, Argonne, Ill., Argonne National Laboratory.

Schmitz et al, 2005, *Affordable Housing Designing and American Asset*, Urban Land Institute, Washington, D.C.

Thorne-Amann, Jennifer, *Valuation of Non-Energy Benefits to Determine Cost-Effectiveness of Whole-House Retrofits Programs: A Literature Review*, ACEEE, May 2006 , http://www.aceee.org/pubs/a061.htm

USDOE, Building Energy Software Tools Directory, http://www.eere.energy.gov/ buildings/tools_directory/software.cfm/ID=244/pagename=alpha_lis

Yue, L., Chicago foreclosure rate up 50% in 2007, February 13, 2008, Crain's Chicago Business, http://www.chicagobusiness.com/cgi-bin/news.pl?id=28177

Zulvaga, M. & G. Vijayakumar, Energy *Star goes Multi-Family*, Home Energy, Nov/Dec 2006.