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Promoting energy efficiency in housing: policies in the U.S. and France[1]

By David Rosen and Claude Taffin

1. Introduction

Since the 1970s, there has been a growing awareness of the importance of sustainable development in our societies. The exponential growth of world population, energy and natural resource consumption, the cost of energy, and greenhouse gas [GHG] emissions combine to create an economic and environmental imperative to conserve energy.

This is no longer considered a luxury for the few rich countries, but is a priority for governments in the developed and emerging economies alike. Key environmental objectives are supported at the international level by the Kyoto Protocol, adopted in 1997 and in force from 2005. Recent environmental agreements between the U.S. and China further underscore the importance of promoting sustainable development practices. Several nations, including France and the U.S., adopted a range of additional measures aimed at reducing energy consumption and GHG emissions (e.g., "Grenelle de l'environnement" in France).

Housing is crucial to energy efficiency [EE] policy. In 2011, residential real estate accounted for 18% of global energy consumption (Source: U.S. Energy Information Agency). It is also responsible for an important part of GHG emissions. The U.S. Environmental Protection Agency reports that the residential and commercial real estate sector accounts for 33% of total GHG emissions in the U.S. Therefore, new policies were developed to promote energy efficient buildings and encourage "green renovations" of the existing stock. EE standards are now established for the architecture, engineering, construction and appliance sectors. In the U.S., many states have substantially revised their building codes to require ever greater energy efficiency. Energy and environmental certification systems have emerged, such as BREAM in UK, LEED in the U.S., PassivHaus in Germany, Minergie in Switzerland, and BBC in France.

2. EE improvements in the formal housing sector

This article focuses on EE retrofits of existing housing in the formal sector. We may address renewable energy retrofits for existing housing in another article, as well as energy efficiency and renewable energy standards for newly constructed housing. Further, this article does not address the important issue of water consumption, the provision of clean water, the treatment of wastewater and water conservation. Finally, few data exist to analyze the consumption of energy within the informal housing sector globally, let alone the effectiveness of energy efficient retrofit methods and financing within the informal sector.

Thus, the focus of this article is energy efficiency for owner and renter housing of existing units in the formal sector. EE goals include:

- Reduced energy consumption;
- Reduced GHG emissions;
- Lowered occupancy/ownership costs (for rental/owner housing respectively); and
- Preserving older housing stock (and neighborhoods) by modernization and reinvestment.

Investment in EE retrofits of the existing formal housing inventory will extend the useful economic life of that housing. Less expensive EE measures, the so-called "low hanging fruit," such as more efficient lighting, appliances and insulation, may be done immediately with quick economic payback. More expensive EE measures, such as replacement of doors and windows, heating, ventilating and air conditioning units, and major EE improvements to the building envelope, will likely be done in the context of overall building renovation and reinvestment.

Accordingly, more capital-intensive EE retrofit measures should be incorporated as part of standard practice upon refinancing, sale and reinvestment of existing housing. This is especially true for multi-family rental housing owned and operated by investors and professional property management/ownership companies (nonprofit, government or for-profit).

In this article, we pay particular attention to the financial feasibility of EE retrofits for housing. The decision for owners to invest in EE improvements to their housing, whether they are homeowners or investors/property owners and managers, will be based on how long it takes to repay the EE investment with a combination of reduced energy bills and favorable financing, subsidies, incentives and/or rebates. The single most important factor in determining residential EE improvement financial feasibility is the price of energy, or tariff, in the particular energy market of the property.

Energy tariffs vary widely based on: (1) the source of fuel used to generate power and heat; (2) subsidies that local, state or national governments pay to reduce the retail cost of energy, and; (3) energy price regulation. In the United States, retail energy tariffs range from as low as 4¢ per kWh to more than 30¢ per kWh, depending upon time of use and season, peak demand, and source of power generation. In developing nations, it is not uncommon for national governments to steeply subsidize the retail price of power. In those countries, EE retrofits will likely prove costly, and unpopular if

[1] The authors gratefully acknowledge the editorial assistance of Curt Smoot for this article.

they cause subsidized energy rates to increase. In other developing economies, retail prices of energy are very high, e.g., the Philippines.

3. Energy efficiency retrofit for affordable housing

While this article addresses EE retrofits for market rate housing, we are especially concerned with retrofitting affordable housing for renters and owners as well. We define affordable housing as owner or renter units benefiting from subsidies rendering the apartment or home affordable to households of limited income at rents and prices below otherwise available market rates. Low income renters and homeowners are constrained by their ability to pay for housing expenses. EE finance costs must be factored into overall affordable housing expense limits.

There is a broadly accepted principle that the level of affordable housing expenses for renters and owners should be tied to their income. This definition of affordable housing expense quantifies how much a household can afford to pay for housing, based on their income. Definitions of affordable housing expenses are fundamental to government policies, which allocate housing subsidies and other financial assistance to those most in need.

In the United States, it has been long-standing public policy to define affordable housing expense for renters as 30% of gross household income for rent, plus an allowance for utilities. This affordable housing expense standard is adjusted for household size, that is, the more people in the household, the higher the income limit and affordable renter housing expense. Importantly for this article, U.S. housing policy also establishes clear standards for utility allowances, adjusted by region and by fuel source for heating, electricity, and if appropriate, air conditioning. Utility allowances are published and updated annually by public housing authorities. Utilities paid by renters may include electricity, gas, oil, water, sewer, trash pickup and telephone service. These are utilities paid directly by the tenant, rather than the landlord. If the landlord pays a utility expense, it is not deducted from what would otherwise be calculated as an affordable rent for the tenant.

In the U.S., affordable homeownership policies vary somewhat, unlike the firm standard of 30 percent of gross household income for rent and utilities for tenants. Affordable homeownership standards typically dictate that somewhere between 30 and 40% of gross household income be devoted to the costs of homeownership. Homeownership costs typically include mortgage principal and interest, property tax, property insurance premiums, property mortgage insurance premiums (where appropriate), homeowners' association [HOA] dues (where appropriate), and possibly a utility allowance and/or maintenance allowance. In the wake of the mortgage crisis, U.S. banking and mortgage regulators have established new standards for Qualified Residential Mortgages [QRMs].

The QRM standard of homeownership affordability requires that a household's debt to income ratio does not exceed 43%. This is a total debt ratio, not just a housing mortgage debt ratio. QRM rules adopted by U.S. bank regulators enable mortgage originators to sell their loans into the secondary market without retaining a 5% interest in the mortgages they sell. The QRM total household debt-to-income ratio for affordable homeownership does not include allowances for utilities, property taxes or property insurance. It does include an allowance for property mortgage insurance premiums, and excludes homeowners' association dues.

As we consider the financial feasibility of EE retrofits for affordable renter and owner housing, we must remain cognizant of these definitions of affordable renter and owner housing expenses. Importantly, because the definition of affordable rental housing includes a utility allowance, a reduction in energy consumption (and cost) allows for an equivalent increase in affordable rent or mortgage-paying ability. This has the effect of increasing net operating income for rental housing, providing a source of leveraged financing for EE improvements.

4. Multiple cases require distinct solutions

Designing public policies to promote EE retrofit of residential buildings is not an easy task for a number of reasons.

The cost of investment is significant and the payback period can be both long, and uncertain given occupant behavior, energy price volatility, and uneven standards for energy audits and quality construction of EE improvements. Moreover, there are multiple cases in terms of building type, ownership and occupancy, which require different approaches.

4.1 Owner-occupied single-family homes

In many countries, including France and the U.S., the majority of the housing stock consists of owner-occupied single-family houses. The owner-occupant is the single decision-maker on the demand side. The owner pays the energy bills, pays for the improvements, and benefits from the energy savings and their impact on the value of the property (see box)[2].

Green Value

The "Green value" of a building can be defined as the impact on property value of energy efficiency and other environment-friendly features (building materials, access to public transportation, etc.). Research on this topic usually focuses on the energy dimension of the green value.

The first attempts to assess this green value conducted in the United States and Europe (Germany and Switzerland) estimated gains of around 5% for "green" buildings, mostly commercial, characterized by regulatory definitions or certifications. A 2013 study by the European Commission provides similar results based on an international survey of newly sold or rented housing units[1]. In France the capture of the energy performance rating (DPE) in the notaries' databases allows us to quantify the impact of this label on the sale price of units.

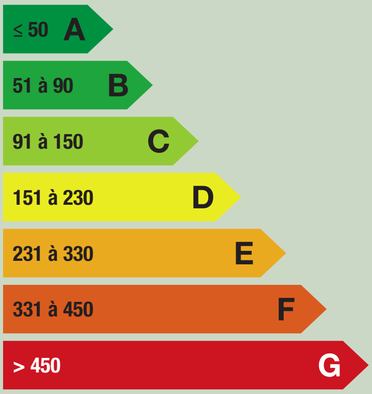
Indeed, the DPE rating includes two labels that classify the unit in seven classes from the best (A) to the worse (G) according to its level of energy consumption (« energy » label – figure 1) and its GHG emission (« climate » label). Since November 2006, DPE labels must be included in any sale (or pre-sale) agreement. From 2010, they have been progressively integrated into the notaries' real estate databases, which capture data on real estate transactions, including characteristics of the unit, of the seller, and of the buyer.

[1] 2013 EC survey: "Energy performance certificates in buildings and their impact on transaction prices and rents in selected EU countries."

[2] In the case of more expensive single home measures such as solar photo-voltaic [PV] systems, homeowners may opt to lease the solar equipment from a solar installer, who installs and owns the equipment. The solar lease rate is calibrated to be lower than the homeowner's current annualized electric bill.

Figure 1: The energy label

(Energy consumption in KwH par sq. m. and per year of primary energy)



A first study was conducted in 2013, based on transactions of years 2010-11. It used a standard hedonic price regression model, i.e. an econometric model linking the price of a house to its characteristics – as used to calculate house price indexes. It provided an order of magnitude of the green value for a segment of the market, the second-hand houses declared in good conditions (by the seller) and located in other regions than Paris. No significant result was found either for apartments or for houses in the Paris region.

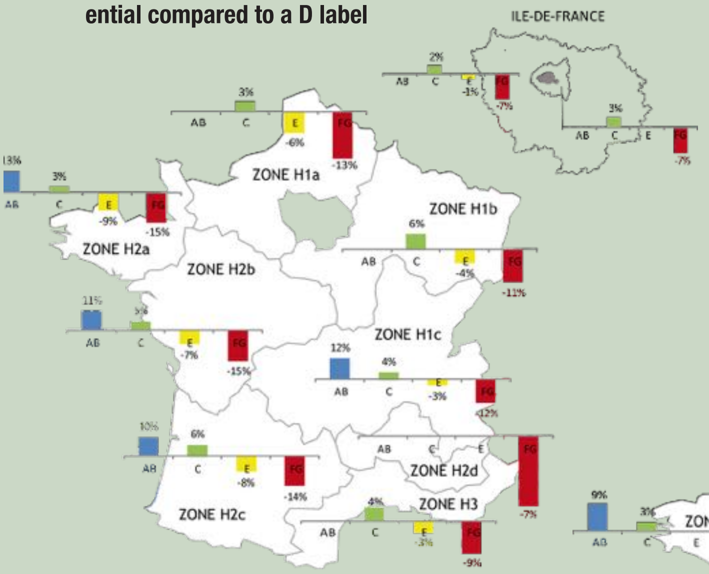
A second study was conducted in 2014, based on transactions of years 2012-13. It benefits from a larger sample of 120,000 units, as the number of transactions for which the information on energy performance was available has significantly increased. The calculation method was also improved by using a SEM (Spatial Error Model): such models aim to take into account the phenomenon of spatial correlation of real estate data. In common words, this means that the price of a given transaction is dependent on the prices of neighboring units. This dependence is a source of bias in the traditional hedonic models (Ordinary Least Squares).

For houses located outside of the Paris region, the difference of price due to one energy label letter difference, all other things being equal, is usually close to 5%. As shown in figure 2, taking the D label as a benchmark, because it is the most frequent, the loss in value due to an E label varies between 3% and 9% with the climate zone. The impact of a better rating is more or less symmetric: with a C label, the gain in value is between 3% and 6%. In both cases, the impact is doubled for letters at both ends of the scale (A & B, F & G).

Significant results are less numerous for apartments, because the sample size is smaller and the impact, in particular that of bad ratings, is often lower (figure 3). In the Paris region ("Ile-de-France," which belongs to climate zone H1A), there is little difference between the green value of houses and that of apartments. The loss in value for houses with an F or G label (7%) is thus much lower than in the rest of H1A (13%).

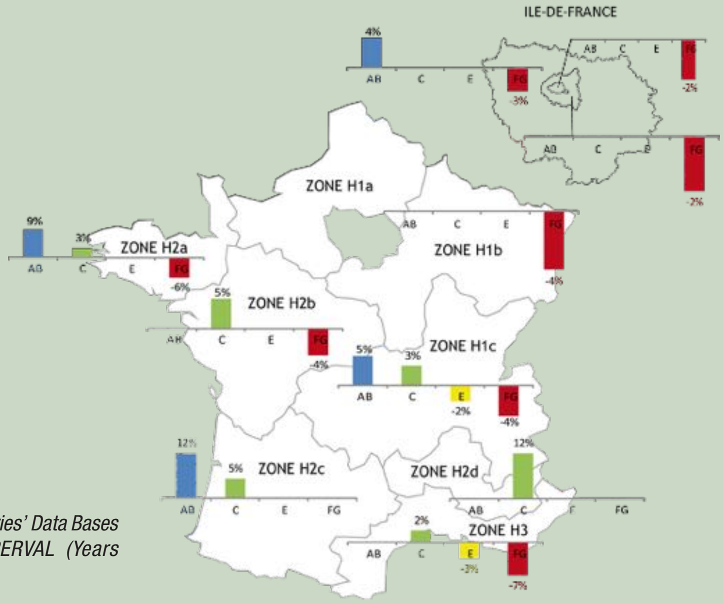
Two distinct phenomena seem to combine their effect to explain these differences between locations and types of unit. Firstly, there are big differences between markets: when supply is abundant a poor energy performance provides buyers with a base for negotiation, whereas on markets with high demand, their room to maneuver is narrower. Next, the owner of a house and that of an apartment in a condominium (more likely to be rented) do not have the same capacity to influence their utility bill and the EE retrofit.

Figure 2: Impact of energy label on house prices by climate zone; price differential compared to a D label



Source: Notaries' Data Bases BIEN and PERVAL (Years 2012-2013)

Figure 3: Impact of energy label on apartment prices by climate zone; price differential compared to a D label



Source: Notaries' Data Bases BIEN and PERVAL (Years 2012-2013)

4.2 Condominium owner housing

The case of owner-occupied condominium buildings differs from the owner-occupied single-family home. The final decision not only depends on the condominium law and the required majority vote of the HOA members, but its consequences also vary with the type of EE measure. In the case of central heating without individual meters, which is still frequent and costly to modify, the impact of individual behaviors on the utility bills can be substantial. Numerous studies have sought to better understand the relationship between technologically based EE improvements and changes in occupant behavior regarding energy consumption.

In many countries (Spain, U.S.), a vast majority of condominium apartments are occupied by owners. In a few others (France, Germany), there is a mixed occupancy by owners and tenants. This creates potential conflicts between owner-occupiers and lessors on the one hand, and between lessors and renters on the other hand, because of their diverging interests.

4.3 Multi-family rental housing

In the case of a multi-family rental building with a single-owner, the owner is typically a private or public company. If the owner pays utilities, the motivation of the owner to conduct EE retrofits is similar to that of owner-occupied single-family houses. If the occupants pay utilities, the owners bear the investment cost, but it is the tenants who will capture the largest share of the financial benefit of the investment.

We discuss additional considerations for affordable rental housing EE retrofit finance later in this article.

For residential investment property, that is, multi-family rental housing, low cost EE retrofit measures, the so-called "low hanging fruit" such as insulation, weather stripping, light bulbs, may be profitably undertaken immediately. More capital intensive measures such as doors, windows, heating and ventilating systems, fixtures, will likely be performed together with periodic renovation of the entire structure. This is typically done on a 10-15 year cycle. Appliances may be replaced with energy efficient units when needed.

5. Assessing financial feasibility of EE retrofits

McKinsey estimates that, if fully executed, gross energy savings worth more than $1.2 trillion may be realized in the U.S., well above the projected $520 billion in capital investment needed through 2020 to finance these EE measures. McKinsey estimates that a comprehensive EE program would reduce energy consumption in 2020 by 9.1 quadrillion BTUs (about 23% of total projected energy demand) and potentially avoiding more than 1.1 gigatons of GHG emissions annually. But to realize these enormous benefits, a comprehensive and innovative approach to financing and installing such EE measures must be adapted to overcome the "significant and persistent" barriers to stimulate EE demand among millions of building owners.

To achieve this scale of energy savings and GHG avoidance, McKinsey identifies five requirements for a comprehensive EE retrofit strategy:

- Recognize energy efficiency as an important energy resource that can help meet future energy needs while nations concurrently develop new no-and low-carbon energy sources.
- Formulate and launch at both national and regional levels an integrated portfolio of proven, pilot, and emerging approaches to unlock the full EE potential.
- Identify methods to provide the significant upfront funding required by any plan to capture energy efficiency.
- Forge greater alignment between utilities, regulators, government agencies, manufacturers, and energy consumers.
- Foster innovation in the development and deployment of next-generation EE technologies to ensure ongoing productivity gains.

(Source: Unlocking Energy Efficiency in the U.S. Economy, McKinsey Global Energy and Materials, 2009)

Applying these standards to EE retrofits for housing requires identifying elements in a critical path for development and finance purposes. We describe these elements below, and note where the refinements apply to owner and renter occupied housing as appropriate.

The dwelling or building should first undergo an energy audit. Such an audit should be undertaken by a certified energy auditing and/or engineering firm. In California, home energy rating systems [HERS] standards have been established to assure compliance with California's Title 24 building and energy efficiency standards, which date to the early 1970s. For multi-family housing and multi-unit condominium structures, energy audits are typically undertaken by engineering firms that assess not only the entire building envelope, but key building components, such as heating, ventilating, air conditioning, elevators, lighting, controls and appliances. The energy audit should identify a series of specific EE measures, and associated projected energy savings from each measure. An energy audit consists of three components:

1. Collection and analysis of utility bills;
2. A survey of the building, including all of its energy related systems, as well as its passive measures such as insulation, windows, doors, orientation to the sun, exposure to wind, etc.; and
3. Identification of EE measures and projection of savings from the "benchmark" performance of the building in its existing condition.

Energy auditors employ a variety of models to project energy savings from the installation of various EE measures. These tools range from simple estimates to complex computer simulations of the building's systems and energy performance.

The specification of EE measures should include equipment, building material specifications, associated costs, and projected energy savings from benchmark data associated with the building's current energy consumption. After EE measures have been identified, costed, and associated with projected energy savings, a determination by the owner should be made whether there are sufficient financial benefits to proceed with specifically identified EE measures. At that point, construction bids should be obtained from contractors who are certified to provide quality installation and inspection for the construction and installation of all EE measures.

Alternatively, for larger multi-family properties, energy service companies [ESCOs] may be retained to specify and construct the EE improvements, assure their quality installation, and finance the improvements in exchange for a revenue stream derived from energy savings over time.

Following installation of EE measures, building owners (and ESCOs) should monitor and modify energy savings results and associated cost savings.

If the installation and construction of EE measures are to be financed, especially for multi-family buildings, owners and investors will need to satisfy the underwriting requirements of lenders (and investors) who finance such EE improvements. Underwriting EE investments will rely on the collection of the best available empirical data on energy consumption and the projection of energy savings, discounted to provide for margins of error. This will require building owners to obtain basic energy consumption data prior to, or at the point of, loan application. It will require benchmarking a building's current energy consumption performance, by system (e.g., heating, lighting, ventilation, etc.) It will further require certification by qualified energy auditors of projected savings associated with each of the proposed EE measures. Lenders will likely cap projected savings to improve on a building's (or a portfolio's) realization rate of projected savings. Realization rate refers to comparing actual energy savings achieved divided by initially projected energy savings. Lenders will also require effective installation, inspection, construction, implementation and management of EE measures, much like any construction lender requires compliance with plans, specifications and building codes prepared by architects and engineers for basic construction.

6. Constraints on financing EE retrofits for housing

Numerous constraints restrict large scale adoption of EE retrofits for housing.

These include: affordability; split incentives for investment properties; cost effectiveness in the context of building renovation or replacement; appraisal practices; bank underwriting practices; lack of adequate, reliable and understandable information about the value of EE retrofits for each type of housing and occupant behavior regarding energy consumption.

Low income homeowners and renters are constrained in their ability to pay for housing expenses. Energy efficiency finance costs must be factored into overall affordable housing expense limits, as we have discussed.

The problem of split incentives for investor-owned rental housing represents a significant barrier to EE retrofits for such properties. Owners bear the cost of EE investments, but may not capture an adequate share of the financial benefits of such investments, which often accrue to the utility-paying tenants. A "green lease" may solve the problem of split incentives. Such a lease provides financial incentives to tenants to reduce energy use, and penalties if their use increases. The amortized costs of EE retrofits may be added to the rents, but incentives to reduce use may offset such increases.

In the case of affordable rental housing, where rents are restricted to an affordable housing expense that combines rent plus a utility allowance, a lower "energy efficient" allowance may be combined with a higher rent, which does not hold the tenant liable for any overall increase in their housing (i.e., rent plus utility) expense. Note, this only works when the pre-EE retrofit rent is below maximum allowable rent levels for low income renters in a given market area.

The decision to invest in a costly whole building EE retrofit will be based on economic calculations by building owners. These decisions will rely on the payback period and the underlying residual land value of the property, combined with its overall physical condition and need for substantial renovation. If the useful economic life of the building may be extended by rehabilitation, then substantial EE retrofits may pay off. However, an EE retrofit alone will not salvage a building otherwise beyond repair. If the payback period for EE improvements is too long, then subsidies and other incentives such as utility rebates or tax benefits will be needed to spark EE investments.

For buildings in need of substantial repair, in low value markets, without government or utility incentives, EE retrofits will not occur.

Owner and consumer demand for EE retrofits in housing can be increased through effective marketing and information campaigns. Such campaigns may be conducted through the utility companies themselves, contained in the monthly bill. Utilities can also compare owners' actual energy consumption with comparable data from their neighbors, citing large discrepancies in consumption, and bills. Lenders, regulators, community-based organizations, churches, trade associations, property management firms, all can be effective marketers of effective EE investments. All of these information sources may be used to provide consumers with verifiable cost, payback and energy savings projections. They can also be a source for qualified home energy auditors, installers, contractors and certified appliance dealers.

If an owner must finance EE improvements, a lender's underwriting and credit approval standards may be material in determining the project's viability. For homeowners with adequate equity, this may not be necessary, as a home equity line of credit may be used to finance EE improvements. However, in these cases, homeowners should take care to satisfy themselves that the EE measures will result in real energy savings that may be used to pay back a loan.

For investment property owners, lender underwriting and credit criteria and practices will be key to securing a loan for EE improvements. Conventional lenders treat with skepticism projected energy savings, and rarely incorporate them into their underwriting. They rely instead on historic building energy consumption data. One exception to this is the case of affordable rental housing utility allowance models. Where the regulated utility allowance is lowered due to a certified EE retrofit, and affordable rents are concomitantly raised, lenders may rely on increased net operating income [NOI] projections, as long as the increased affordable rents fall below allowable rent levels for the property's market area.

7. EE housing retrofit cases in the U.S.

The U.S. has engaged in very large scale residential building EE retrofit efforts over several decades. We profile three cases:

1. A study of 21,000 unit retrofits in 231 rental buildings in New York City;
2. A program to perform EE retrofits of small (less than 50 units) rental buildings in Chicago; and
3. The Better Buildings Neighborhood Program of the U.S. Department of Energy.

A 2012 study of multi-family rental housing energy retrofits in New York City conducted by Deutsche Bank and Living Cities provides important empirical data to guide bank underwriting behavior. (**Recognizing the Benefits of Energy Efficiency in Multifamily Underwriting**, Deutsche Bank, Living Cities, Steven Winter Associates, HR&A Advisors, January 2012). The Deutsche Bank study expressly aimed to address the key constraint of lender confidence in projected energy savings to underwrite EE loans. The study examined 231 properties comprising more than 21,000 units. The study sought to:

- Assess trends in pre- and post-retrofit energy consumption, building by building;
- Analyze the reliability of projected energy savings, i.e., the realization rate; and
- Use the findings to inform how bank underwriters may incorporate projections of energy savings in their credit decisions.

The study found that building retrofits saved energy. Across the examined portfolio of 231 properties, fuel consumption declined by 19% and electricity consumption declined by 7%. Fuel EE measures saved more than electricity measures. On average, fuel measures saved $240 per unit, while electricity measures saved $50 per unit for common area electricity. Fuel savings were less variable and more predictable than electricity savings. Pre-retrofit fuel usage typically ran five to ten times that of per unit common area electricity charges, accounting for $1,000 to $1,600 versus $100 to $300 per unit, respectively.

Importantly, actual savings were very strongly correlated with pre-retrofit fuel usage, namely, the amount of fuel a building consumed in kBTU per square foot of heated building area. Higher pre-retrofit consumption also directly correlated with greater realized savings potential. Further, the study found building age and heating system type to be good predictors of fuel use intensity.

Importantly, the Deutsche Bank study found that "strategically capping" energy savings projections improved the portfolio's realization rate. Fuel savings projections ranged from 25% to 50% for about two-thirds of the properties, while most properties actually achieved measurable savings of 10% to 40%. While the study found a number of factors influenced the realization rate (e.g., how much of the proposed scope of work was carried out; equipment specifications; the quality of installation and inspection, the energy audit and ongoing building management), it could not quantify the relative influence of each factor.

The study concludes:

"…neither the existing physical models employed by (energy) auditors nor the empirical model the study developed is sufficient: buildings are complex and unique, and a variety of factors interacted in each building…A "hybrid approach" that uses both…, results in savings projections upon which a lender could rely…"

In Chicago since 2008, a partnership between a community-based lender and an energy-oriented technical assistance provider combined to retrofit 480 buildings and 20,000 units, including $17 million in financing for 160 buildings and 6,000 units. The Community Investment Corporation [CIC] of Chicago is a Community Development Financial Institution [CDFI] certified by the U.S. Department of Treasury. CIC is a deeply experienced lender to small multi-family rental property owners, originating $1.2 billion in 2,000 loans since 1984. Elevate Energy, formerly the Center for Neighborhood Technology, is an energy efficiency service provider which offers EE assessments, construction oversight, advice and ongoing monitoring of energy consumption post-retrofit. Energy Savers is a partnership of CIC and Elevate Energy to reduce energy consumption in multi-family rental buildings. On average, a $3,000 per unit EE investment resulted in a 30 percent savings in energy consumption, in a typical 24 unit building saving $10,000 per year with a 5 to 7 year payback.

Energy Savers provides a one-stop energy efficiency shop for owners of multifamily rental buildings that offers:

- Energy audit and analysis;
- Cost effective energy saving recommendations;
- Low cost financing through CIC;
- Construction oversight; and
- Tracking of building performance to ensure savings.

The program has doubled its production since 2012. For the period 2008 through November 2014, the program has performed audits on 1,096 buildings and 44,452 units. It has completed 480 building retrofits of 19,877 units. Gas therms saved a total of 4.8 million, with 12.9 million kWh saved. CO2 emissions have been reduced by 37,000 metric tons, and 488 jobs were created through construction of the EE retrofit measures.

Of the $17 million in EE retrofit financing, CIC offered loans in second position to the senior mortgage, with personal recourse to the owners. Loan rates were 3%, with CIC's (subsidized) cost of funds at 1%. Debt service coverage ratio [DSCR] was underwritten at 1.15, after retrofit, with a 90% loan to value cap, based on recent appraisal. The loan term was seven years, with 7 to 10 year amortization. The loans were underwritten to cover debt service with projected energy savings. The program offers building owners a low barrier to entry, with a free cost assessment and free technical assistance. No compulsion was imposed on owners; their participation was strictly voluntary. The program is flexible, and offers low cost financing if needed.

As part of the 2009 Stimulus Act (American Recovery and Reinvestment Act, ARRA), the U.S Department of Energy [DOE] granted $500 million to 41 state and regional government agencies and consortia to conduct large-scale EE retrofit programs in single family and multi-family housing and the commercial real estate sectors. Called the Better Buildings Neighborhood Program [BBNP], DOE sought to retrofit 100,000 residential and commercial buildings, save consumers $65 million annually on their energy bills, achieve at least 15% energy savings from assisted projects and leverage $3 billion in EE project financing, while creating or retaining 30,000 jobs.

By the second quarter of 2012, BBNP had carried out 28,000 single family home EE retrofits, 3,100 multi-family housing EE retrofit projects, and saved a total of 1.2 million MMBtu's. Average single family home MMBtu savings were 40, and 27 for multi-family rental units. Single family retrofits saved 32 million kWh of electricity, 6 million therms of natural gas, and 370,000 gallons of fuel heating oil. Multi-family retrofits saved 2.6 million kWh of electricity, and 490,000 therms of natural gas. DOE evaluated the realization rate of actual savings by comparing reported source savings with net verified source savings in MMBtu, resulting in a realization rate of 79% for single family home EE retrofits.

As part of its research, DOE conducted a literature review of the impact of EE on the financial performance of commercial buildings. More than 50 studies were reviewed. (See **Energy Efficiency and Financial Performance: A Review of Studies in the Market**, March 2014, US DOE, Waypoint, for the complete bibliography.) The study originally sought to review all research on EE and financial performance, but the final product focused on "green labeled" buildings, using either a LEED [Leadership in Energy and Environmental Design] designation or Energy Star certification of DOE. The studies found positive correlations with EE designation and rental rates, occupancy rates, utility expenses, sales prices and construction costs. Preliminary correlations were found with tenant quality, occupant health, comfort and productivity, and capitalization (cap) rates. Mixed results were found correlating to total operating costs.

8. EE housing retrofit cases in France

In France, the new law on "energy transition for green growth," adopted in October 2014 by the National Assembly, but not yet discussed at the Senate[3], is an example of carrot and stick, or as a reviewer nicely phrased it, "a carrot as hard as a stick or a stick with a taste of carrot." The law imposes a target: 500,000 EE retrofitted units per year, half of which are occupied by low income households, so that the whole stock will be energy-efficient in 2050.

The main principle of the law is that any overall building renovation, improvement, or enlargement will necessarily "embark" energy-efficiency retrofit. The penalty for never renovating a building is an increase in transfer taxes: "départements" will be allowed to use

[3] When this article was written (December 2014).

a variable tax rate, between 3.1% and 4.5% instead of a fixed 3.8%, depending on energy-efficiency. At some point, it had been debated whether selling or renting the least efficient units would be forbidden but such a severe measure was rejected. The law also states that all private residential buildings with a consumption of primary energy above 330 Kwh per sq. m. per year, corresponding to an E, F, or G label, should be renovated before 2030. However, the law does not say how this should be achieved.

The act provides some financial measures. Third-party financing, which is the equivalent of abovementioned ESCOs, will be developed. Such companies perform an analysis of the property, design an energy efficient solution, install the required elements, and maintain the system to ensure energy savings during the payback period. The owner does not have to finance the retrofit, or only a part of it, because the ESCO is paid through the energy savings. The act also creates a guarantee fund that aims to facilitate access to credit for low income borrowers (a similar mechanism – Fonds de Garantie de l'Accession Sociale [FGAS] exists for low income home-buyers) and for condominium associations.

The fiscal situation of the country does not allow a substantial increase in subsidies for renovation. However, the numerous existing mechanisms – some available for any housing renovation, some specifically for energy-efficiency retrofit, some means-tested, some for every household – are maintained and sometimes improved.

A new condition, applicable since September 2014, is that all works should be undertaken by a professionally certified "RGE," which means "acknowledged guarantor of environment"; this label provides assurance that the professional is qualified to perform energy-efficiency works.

ANAH [National Housing Agency] allocates its own subsidies to low income owner-occupiers and to lessors of low income housing (there is a maximum rent and a maximum tenant's income). These support a few specific renovation measures including energy-efficiency. For EE measures, the energy performance should be improved by at least 25% (35% for lessors). In all cases, the building must be at least 15 years old. Additional subsidies can be distributed by the various levels of local authorities ("régions, départements, communautés d'agglomérations and communautés de communes").

Previously the condominium law had been amended in order to facilitate the realization of EE retrofit works involving common areas and equipment. It is an important issue in France because of the number of units involved: nearly 10 million out of the entire housing stock of 35 million, and because of the unusually balanced mix between owner-occupiers (51%) and tenants (45%). The French condominium law includes a complex set of majorities depending on the nature of the decision to be made. Majorities requested for EE retrofits are lowered by the law: for example, for works that are compulsory by law, the majority is lowered from 2/3 to 1/2.

The law also imposes a global technical audit of the building so that all co-owners are informed of the condition of the building and able to plan appropriate EE retrofit work. In order to finance these works, all condominiums will have to create individual funds; these funds will be fueled by an annual payment of at least 5% of the provisional budget. These measures are applicable only from 2017.

France also has a large social rental stock of nearly 5 million units. The landlords are either local public or non-profit private companies. Both are subject to the same regulations in terms of subsidies and commitments such as rent levels and tenants' eligibility rules. In agreement with the government, the social landlords are committed to perform EE retrofits of 120,000 units per year. They benefit from a VAT rate of 5% (instead of 10%) and from a "Social Housing Eco-Loan" at a very low (adjustable) rate, now at 0.50%. The loan has an amount between 9,000 and 16,000 € per unit, and can be used to renovate units with an energy-efficiency D label or above.

The landlord is allowed to increase the rents as long as the upper legal limit has not been reached; otherwise he may introduce a so-called "third-line" on the bill (i.e., in addition to the rent and utilities) and charge up to 50% of the energy-savings. In practice, this third-line is very rarely used. One major concern is that the gain on the energy bill would be offset by an increase in maintenance costs. Lower income tenants, in both the social and private rental stock are eligible for housing allowances. These allowances include an amount for utilities. This amount depends on location and family size. It is not related to the real utility bills. When utility bills change, there is therefore a 100% impact on the net cost of housing, and none on the amount of the allowance.

Specific subsidies for EE retrofit in France

	Beneficiaries	Amount
CITE (Tax credit for energy transition)	Owner-occupier, tenant. Main residence, more than 2 years old.	30% tax credit on expenses.
Eco-PTZ (0% loan)	Owner-occupier, tenant. Unit built between 1949 and 1989.	Up to 20,000 € for 2 works and 30,000 € for 3 works.
Eco-loan for condos	Condominium associations. Building built before 1990.	From 10,000 € to 30,000 €, depending on the number of works.
CEE (Energy premium)	Owner-occupier, lessor or tenant. Main residence, more than 2 years old.	Up to 20% of expenses.

9. Public policies promoting residential EE retrofits

Between the carrot and the stick the path is narrow and uneasy for public decision-makers. New construction is the easier part and most countries have started, in some cases (California) since the 1970s, to introduce strict energy conservation regulations in their national and state building codes. The main concern is the capacity of builders to balance proven energy conservation building codes with construction costs associated with such code requirements.

However, one-year's production is often less than 1% of the existing stock and demolition less than 0.1%, which means that it would take centuries to reach a fully energy-efficient housing stock through regulation of new construction alone. Addressing the existing stock is thus necessary. A pre-requisite is to reconcile energy tariff policy with EE retrofit policy. Artificially low (i.e., subsidized) energy prices will prevent any EE retrofit from being profitable. Development policy should carefully weigh the cost/benefit of subsidizing the retail price of energy versus subsidizing EE retrofit costs for housing.

"White certificates," or "energy savings certificates," are carrots for consumers and sticks for energy producers, suppliers and distributors. Indeed, the latter are required to assist the former in taking energy-efficiency measures. In some countries, they receive tradable certificates when they reach their target and these certificates can be purchased by those who do not. In France, those who do not reach their 3-year target have to pay a penalty (two cents per missing KwH). The white certificate concept can be compared to the more mature renewable energy credit or "green tag" trading.

Beyond carrots and sticks, the importance of informational and educational measures must be emphasized. Labels showing the energy-efficiency class (introduced in EU in 1992) inform consumers when they buy an automobile, a household appliance, and when they buy or rent a housing unit (made compulsory in EU in the mid 2000s). Promotion of EE usage is made through campaigns and, in the few countries that have a well-developed public rental stock, it is a natural champion to promote EE retrofit (see France above).

Some public policies will need revision if they are to remain consistent with EE goals. These include:

- Rental law: Why renovate if tenants benefit from a cheaper utility bill and the lessor may not increase rents?
- Tax law: Is the investment cost deductible from rental income? Are losses deductible against other income or possibly carried forward?
- Condominium law: In countries where owners are split between occupiers and lessors (France and Germany), and lessors are usually opposed to new expense, majority rules for renovation often make it impossible to decide in favor of EE retrofit.
- Mortgage law: Is lending to homeowners' associations possible? In practice, however, making it possible will not be enough as lenders will always be reluctant to make loans of a small amount and a high complexity.
- Zoning law: EE retrofit may entail changing facades; in a few cases, adding one or two floors was seen as a solution to shorten the payback time.

Further, public policy, often in collaboration with private financial sector partners, will need to provide flexible and diverse EE financial assistance tools. These include: mortgage financing; tax code reform; utility company rebates; EE assessment districts; rebates and grants; and the establishment of energy certificate markets, as noted above.

Tax incentives may be imbedded in the income tax code, providing credits and depreciation benefits to owners and financiers of qualifying EE retrofits. Private owners and investors in buildings and EE retrofits may use such income tax benefits. Nonprofit and government owners of affordable housing would need to sell, or syndicate such tax benefits to third parties (e.g., ESCOs, limited partnership energy companies, banks, utilities and other investors interested in, or required to invest in, EE improvements).

Property tax benefits may be offered to owners of buildings, and homes, which undertake qualified EE retrofit improvements. Because tax subsidies such as these occur at a cost to a nation's treasury, government should conduct cost/benefit analyses of the most effective EE investments and their environmental benefits. This is particularly true for governments that currently subsidize retail utility rates, a policy that may often be far more costly than subsidizing the conservation of energy through EE retrofits. This of course requires the ability to meter, bill and collect for the cost of energy consumed.

Utility and power companies can offer rebates for EE retrofits. This is often in the financial interests of power companies, and EE measures which reduce demand are far more cost effective, and less controversial, than building new power plants. If demand exceeds a utility's capacity to deliver power, it will be in the utility's self-interest to reduce usage.

An EE assessment district approach may be used to finance EE improvements in a neighborhood or geographic area. Owners of property in a specified geographic area pay monthly assessments to pay for the costs of installing and maintaining EE (and renewable) energy measures and systems. This finance approach works best for larger, district-wide improvements, such as district heating, or district solar energy systems.

10. Conclusion

We cannot "newly construct" our way to an energy efficient built environment. That would take centuries. We must find solutions to retrofit our existing buildings and communities to be more energy efficient, and housing is a critical component of this challenge. Over the past few decades, we have made substantial progress in overcoming the constraints on EE retrofits of housing. We have achieved real improvement in technical, regulatory, finance, construction, marketing, management and monitoring of EE improvements for housing. Learning and adapting from this experience will enable us to develop comprehensive EE retrofit of housing at very large scale worldwide, regardless of the particular climate, energy regulatory environment and fuel source we rely on to power our homes. We cannot afford to wait.