Innovative Financing of Home Efficiency Improvements

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Residential new construction and renovation programs, home energy rating systems programs and energy efficient mortgage instruments are some of the many ways that local energy utilities and other state or federal agencies attempt to increase the supply and demand of energy efficient housing. While recognizing that these programs play an important role in promoting voluntary efforts to upgrade the energy efficiency of our nation's housing stock, this paper discusses the underlying premise behind some of these programs, including issues of market barriers and homebuyer affordability, and explores the limitations of these initiatives and their effectiveness in producing the desired results. The advantage of a market-oriented profit-seeking company that promotes the efficient use of all natural resources is described. The necessary environment for such a company is the elimination of monopoly franchises, the growth of retail competition and the dissemination of communication technologies, all of which are on the near horizon. Several scenarios demonstrate that this company can shift investment risk away from home builders and homebuyers and deliver private and social resource efficiency benefits that are larger and more certain than those of present programs.

INTRODUCTION

For over fifteen years regulated local utilities and state and federal agencies have launched various residential demand side management programs, such as new construction programs, renovation and retrofit programs, home energy rating systems programs and energy efficient mortgage programs in attempts to increase the supply and demand of energy efficient housing. While recognizing that these programs play an important role in promoting voluntary efforts to upgrade the energy efficiency of our nation's new housing stock, this paper explores the limitations of these programs and their effectiveness in producing their intended results. In addition to focusing on utility-sponsored residential new construction programs, this paper explores the rationale for, and value of, energy efficient mortgage (EEM) instruments. EEMs are intended to increase homebuyer affordability and to facilitate sales of energy efficient houses. A market-based alternative that can provide the same benefits as these programs, and more, is described by way reference to a private company called MARVCO. (The author is open to suggestions for a more impersonal-sounding company name).

Advocates of publicly-subsidized or ratepayer subsidized energy efficiency programs maintain that these programs are necessary because various market barriers lead to socially suboptimal levels of private investment in energy efficiency. Particularly with respect to the new construction market, failure to take advantage of opportunities to build higher energy efficiency levels into new homes is thought to result in societal loss of resources. This is because it is far more costly to retrofit an existing house than it is to build an energy efficient house from scratch. Moreover, lost opportunities in housing construction are long-lived as new house tend to last at least 30 years. Frequently-mentioned market barriers to investing in energy efficiency include limited product information, inadequate access to financing and benefit uncertainty.

This paper describes the advantage of a market-oriented profit-seeking company that promotes the efficient use of all natural resources. The necessary environment for such a company is the elimination of monopoly franchises, the growth of retail competition and the dissemination of communication technologies, all of which are on the near horizon. Several scenarios demonstrate that such a company can shift investment risk away from home builders and homebuyers and deliver private and social resource efficiency benefits that are larger and more certain than those of present programs. Before describing various aspects of MARVCO the features of utility-sponsored residential new construction programs, and EEMs which make the financing of these homes more attractive to homebuyers, are summarized. These programs are used for illustration because they embody many of the limitations that are inherent in most of the existing regulation-driven energy efficiency programs be they for the new construction or renovation/retrofit markets.

BACKGROUND OF NEW CONSTRUCTION PROGRAMS AND EEM INSTRUMENTS

There are hundreds of residential energy efficiency new construction programs in the United States many of which are versions of the Good Cents or Super Goods Cents new home certification programs. In general, these certified

homes are engineered to use significantly less energy than conventionally-built homes while providing the same or higher levels of housing services, e.g. warmth in the winter and coolness in the summer. Typically, these programs are operated by electric utility companies. The diverse ways in which many of these programs operate, and the effectiveness of various program implementation strategies, are documented in articles such as Vories (1994). The main technical features of these programs are:

- building audits conducted by professionals;
- engineering-based analysis tools for assessing the gross energy savings associated with the installation of energy efficiency measures;
- methodologies for rating the energy efficiency of comparable homes; and,
- official certifications that are recognized by professional organizations and mortgage lenders and publicized to consumers.

The strategy underlying residential new construction programs is to simultaneously encourage consumers to purchase, and home builders to build, energy efficient homes. Consumer demand is encouraged through dissemination of information to homebuyers, real estate agents and other trade allies that publicize the added value, in comfort and financial savings, in owning an energy efficient home. As construction and equipment quality cannot be easily or costlessly ascertained, to minimize consumer risk most of these programs offer professional seals of approval or certifications. These certifications guarantee that homes that have passes through program inspections meet prespecified state-of-the-art standards for building shell and climate control system energy efficiency.

Strong, demonstrable consumer demand for energy efficient homes is the best encouragement home builders can have to build energy efficient homes. Towards this end, most programs work with home builders to publicize their products and to shape the homebuying market. In addition, many utility programs encourage home builders to build energy efficient homes by offering them design assistance, training in new construction techniques and new building materials, and information on new appliance and equipment choices. Some programs also offer cash incentives to home builders to build energy efficient homes.

To further boost the market for energy efficient homes and to increase product demand, EEMs are available to homebuyers. These financial instruments relax the conventional financial ratios used by lending institutions to manage mortgage default risk. On the presumption that households living in energy efficient homes have reduced utility bills, buyers of energy efficient homes can qualify for mortgage financing having less income than would otherwise be required to service a given loan amount. Instruments of these kinds are approved by the Federal Home Loan Mortgage Corporation and the Federal National Mortgage Association, the two major privately-owned secondary mortgage market institutions.

Table 1 offers a comparison of the workings of a conventional mortgage instrument and an EEM instrument. In this example, the conventional payment-to-income ratio for determining affordability is 28 percent. Using this ratio, a household with an annual gross income of $36,000 can afford a house payment (including payment of principal, interest, taxes and insurance) of $840 per month or $10,080 per year. Assuming taxes and insurance are a fixed amount of $106 per month and that the mortgage instrument is a 30 year note with a fixed annual interest rate of 8 percent, the 28 percent ratio implies that the household can qualify for a loan amount of $100,000. If this household purchases a certified energy efficient home and opts for an EEM, the payment-to-income ratio may be increased to 29 percent to reflect the lower electric bill this household will incur. The new ratio allows the same household to qualify for monthly payments of $870. Presumably, the increase in mortgage payment of $30 per month will be offset by a decrease of at least $30 in lower monthly electric bills that will go towards the higher mortgage payment. The new ratio implies that the household can qualify for a loan amount of approximately $104,000.

Examining the workings of the EEM instrument from the alternative perspective, a household with an annual income of $34,750 that wishes to purchase an energy efficient home can apply for an EEM and qualify for a loan of $100,000 where otherwise, all things being equal, the maximum amount the household could have borrowed would have been $96,000. Hence, the EEM serves one main purpose—it allows a household with a given income to purchase an energy efficient home that, because it is energy efficient, is more expensive to purchase than an otherwise identical conventional home. This promotes energy efficient home affordability, particularly for first time or low-income buyers. Additional details regarding EEMs and new alternative financing initiatives are provided by Luboff (1995).

REEXAMINATION OF NEW CONSTRUCTION PROGRAMS AND EEM INSTRUMENTS

In the rapidly changing world of utility deregulation it is essential for policymakers and investors to anticipate the future relationship between utilities and their current residen-

Table 1. *Effect of Change in Payment-to-Income Qualifying Ratio*

	Conventional Mortgage		EEM	
Payment-to-Income Ratio	28%	28%	29%	29%
Annual Income	$ 36,000	$ 34,750	$ 36,000	$ 34,750
Annual Payment	10,080	9,730	10,440	10,078
Monthly Payment	840	811	870	840
Monthly Taxes & Insurance	106	106	106	106
Monthly Principal & Interest	734	705	764	734
Maximum Loan Amount	$100,000	$ 96,000	$104,000	$100,000

tial customers. Since most new construction programs are operated by electric utilities, reexamining the underlying logic of these programs is a necessary step towards charting not only the future course of these programs but the future course of residential energy services. To understand how these programs might evolve in the near future it is useful to revisit arguments dating from the 1970's for creating residential energy efficiency new construction programs.

Residential real estate markets are not inefficient

The arguments for these programs begin with home builders and their disinterest in promoting energy efficiency. Approximately 20 percent of all the energy consumed in the United States is used to service residential structures making them a relatively large target for energy efficiency improvements. Unfortunately, like car manufacturers in the 1960's who could not envision a mass market for compact and fuel efficient cars, most home builders cannot envision a thriving market for energy efficient homes. They believe that homebuyers, through indifference, risk aversion or lack of knowledge, do not value energy efficiency. Therefore, builders believe that the value of the improvements will not be capitalized in the sale price, i.e. buyers are unwilling to pay an incrementally higher price to purchase these improvements. As a result, most builders are unwilling to incur incrementally higher costs to construct energy efficient homes.

New construction programs and EEMs are, in effect, concessions to home builders. By creating uniform standards to rate the relative efficiency of homes, new construction programs offer homebuyers objective information about the energy efficiency characteristics of homes, information that presumably would be unable to be otherwise communicated to homebuyers. Moreover, these programs publicize these home ratings and certifications, and the benefits of energy efficient homes, to all parties involved in real estate transactions. Many also provide training to builders in energy efficient construction techniques and equipment and occasionally there are programs that offer rebates or cash incentives to home builders to purchase energy efficient materials or comply with various standards. Last but not least, many new construction programs attempt to link the sales of energy efficient homes to EEMs to defuse any notion that energy efficient homes are unaffordable due to higher prices and lack of homebuyer affordability.

The key question at the center of all these layers of activity is whether or not homebuyers properly value energy efficiency when purchasing a home. If they do, there would appear to be no reason for using taxpayer or ratepayer dollars to subsidize programs that encourage their construction and purchase. Rather, willing suppliers and willing buyer would meet and the results would be transactions that lead to socially optimal levels of investment in energy efficiency. On the other hand, if homebuyers do not properly value energy efficiency then new construction program activities may be socially beneficial. What, then, is known in a scientific, empirical way about homebuyer willingness to pay for energy efficiency?

Several studies in the past decade, such as Linneman (1986) and Meese and Wallace (1994), have addressed the issue of whether or not residential real estate markets can generally be characterized, like capital markets, as efficient. By and large, these studies have concluded that the residential real estate market is *efficient*, meaning that market-clearing prices reflect all known information about the product being bought and sold, including all future expectations related to real returns from home ownership and real costs. To the degree that these conclusions are generalizable across different geographic areas, time periods and housing stock, they

suggest that real estate markets are well-suited to incorporate the net value of new features, such as energy efficiency, into housing prices.

With particular regards to energy efficiency, two studies provide strong evidence that housing markets incorporate the value of energy efficiency into selling prices. Dinan and Miranowski (1989) find this to be the case for the resale of existing homes. Although they could not directly determine whether the housing market was pricing fuel savings efficiently, their model indicated that at the average efficiency level of homes in the sample, an energy efficiency improvement which reduced expenditures on maintaining a house at a given temperature level by $1.00 led to an increase of $11.63 in the selling price of the house.

In a study that is directly applicable to energy efficient new construction, Horowitz and Haeri (1989) empirically estimate the annual energy savings associated with Model Conservation Standard (MCS) homes —the equivalent of Super Good Cents standards—using monthly billing data for a study sample consisting of MCS homes and comparable, conventionally-built new homes. Further, using an hedonic price model that controls for variations in house features, they estimated the average implicit difference in selling price between the conventional and energy efficient homes. The findings indicated that annual energy savings were appropriately capitalized into the sale prices of the MCS homes. From these findings it was possible to deduce that the implicit household discount rate for the energy efficiency improvements was equivalent to the prevailing average mortgage interest rate in the study period. However, it was not possible to say whether this housing market would have been as efficient as it was had the MCS Program not been as publicized and promoted as it had been.

In summary, recent studies of the real estate market confirm, as much as any body of economic studies can, that fears of market barriers in the residential home market can be set aside. This is not to say that residential new construction programs are not valuable for providing information to builders and homebuyers about the benefits of energy efficiency. Rather, while these programs may stimulate or accelerate interest in energy efficiency, it is important to recognize that buyers appear to have no problem in appreciating the present and future value of these improvements. Looking at the big picture, there does not appear to be much reason why energy efficiency improvements should not be viewed by the housing industry in the same light as any other home construction improvement or amenity. Over the past ten years, homebuyers have indicated their willingness to purchase many kinds of housing upgrades, from larger kitchens to more bedrooms, bathrooms, fireplaces and skykights. In addition, more homebuyers have been willing to purchase larger water heaters, hot tubs, central air conditioning and heat pumps units and solar heating units. Opportunistic builders have had little problem complying with these wishes and profiting on the sale of these improvements when they have perceived the market to be moving in that direction. The lesson in all this is that behooves builders themselves to promote energy efficient homes, as they do other housing innovations, to keep their businesses viable and growing.

Energy savings do not help pay the mortgage

The promotion of EEMs in the effort to promote upgrading of the energy efficiency of new housing stock is perhaps the most least understood aspect of the entire energy efficient new construction program movement. The impetus for EEMs begins with the idea that annual electricity savings is constant from year to year for each house and moreover, that households can, without the benefit of professional assistance, modify their energy use in a way that consistently achieves the predicted savings. EEMs are further propelled by a second notion that rational homeowners will apply all the extra energy savings dollars towards their mortgage payments.

Before giving reasons to take exception to these ideas, an irony related to the determinants of mortgage default risk should be noted. It is well-known among real estate research economists and financial specialists that only one of the many formalized ratios that are used to assess credit risk is in any way a useful measure of borrower default. After decades of research, only the borrower's loan-to-value ratio appears to have any power whatsoever to predict the decision of homeowners to cease their mortgage loan payments. Moreover, even this ratio has been found, in studies such as Kau et al. (1994), to be insufficient to predict when homeowners would rather be in default than pay their mortgages. According to Vandell (1993) ''as we look back upon these criteria we realize that they were inadequate in many respects; they were completely ad hoc and based upon impressions and prejudices. There was no formal validation based on actual default experience in the market. . . . Nonetheless, their use persisted, and they remained essentially unchanged (with some minor changes in the cut-off points) for almost 40 years.''

Setting this knowledge aside for the moment, it is important to understand the technical aspect of predicted energy savings to understand the short-sightedness of EEMs. EEMs are founded on the premise that the payment-to-income ratio of borrowers can be relaxed due to the lower electricity expenses of households living in energy efficient homes. Thus the most relevant of all questions is the accuracy of predicted energy savings. These predictions are generally based on engineering algorithms of some kind that either

take the form of simple equations are more complex simulation models.

There are many varieties of engineering-based systems for predicting savings just as there are many methods for achieving energy efficiency. Some programs use a prescriptive approach that specifies the exact measures that need to be installed in a home to meet required energy savings levels based on unit savings per measure. Others use a performance-based approach that does not specify individual measures but rather offers builders the flexibility to design homes and install measures as they see fit. However, the home must be judged, usually by a computer model, to save a given level of energy efficiency for it to achieve the proper certification. Unfortunately, regardless of the predictive method, years of energy efficiency program evaluation research has found that net energy savings is often 20 to 80 percent below expectations for most residential and commercial energy efficiency programs, see for example Nadel and Keating (1991). In addition, empirically estimated annual energy savings is subject to high variance both between different households and within the same household across years. Errors in engineering-based predictions come about for many reasons, among them oversimplified physical and material relationships, inaccurate behavioral assumptions and inadequate treatment of interactions, price and income effects. As such, allowing households to qualify for fixed higher monthly payments, in the example in Table 1 of $30 per month, on the presumption that the level of energy savings is known, certain and constant does neither the borrower nor the lender much of a favor.

A further notion is the idea that the full dollar amount saved in energy bills will be applied towards the mortgage payment. Price theory, which assumes that consumers are rational, logically demonstrates that some of the energy savings dollars will go towards the purchase of additional energy and some of the savings will go towards the purchase of all other consumer goods such as food, clothing and shelter. Many complex factors determine the marginal rates of substitution between every good and every other good, and it is these rates which ultimately determine how the energy savings will be distributed in any given household. By any stretch of an economist's imagination, it is unrealistic to believe that households, even if they knew what their energy savings were, would earmark all or most of their energy savings for inclusion in their mortgage payment.

For these reasons, it is most likely the case that EEMs do not really aide homebuyer affordability or do very much to increase, or decrease, homebuyer risk of default. Whether the market clearing price of energy efficiency improvements is set at the incremental cost of installing the energy efficient measures (which has been shown by studies, such as Jennings et al.(1990), to be between $1,000 and $4,000 dollars) or whether the market clearing price of energy efficiency improvements is set at the present value of the savings benefits the small effect of the incremental increase in the overall house price is likely to be neutral with respect affordability, as demonstrated by the example above, or with default risk, as shown by economic studies of the determinants of default.

As a final note on the subject of EEMs it is worth mentioning that there is presently at least one major effort underway to revise the residential mortgage credit rating system. According to Harney (1996) a joint venture of the Federal Home Loan Mortgage Corporation and Standard and Poor's Corporation is currently in the process of rolling out a computerized underwriting system that can add more insight into borrower affordability and default risk than current indicators. This system is intended to *see through* surface facts to determine underlying borrower creditworthiness. It is easy to imagine that in the near future such a system will entirely do away with the need for ad hoc risk ratios.

Stronger action is needed

A seemingly large effort continues to be made to convince home builders, for their own good, to build energy efficient homes. Most of these efforts have been undertaken through electric utility companies whose motives, rightfully so, are typically to maximize the number of homes in their spatial monopoly franchise who heat and cool with electricity. I come now to the my central thoughts regarding these efforts.

Why have residential new construction energy efficiency programs at all? They serve a small market relative to the resales of existing homes; they focus mostly on a single fuel such as electricity yet most houses uses multiple fuels and other natural resources; and, they promise consistent energy savings, yet energy savings are not easily controllable, measurable or guaranteed. Lastly, they are run by local utility monopolies, yet soon any company will be able to serve energy to any customer and no individual utility will want to continue subsidizing customers who are up for grabs.

Why residential new construction energy efficiency programs? One good reason comes to mind—to avoid a resurgent movement for uniform federal or local building codes. Minimum standards are already in place so that the grossest forms of construction fraud may be prevented. Few economist would argue against minimum codes for complex, durable products. At their best, codes are an efficient way of avoiding costly information searches. To the degree that these programs provide energy-related information the way labels on food packages provide ingredient and nutrition information, these programs can be a way of decreasing the costs of information and making the real estate market

increasingly efficient. At the same time, they prevent movement towards economically inefficient building codes.

Why EEMs? EEMs have been around for at least 15 years yet few homebuyers have cared to use them, as borne witness to by the fact that there has been no interest in creating a EEM database or in studying the determinants of EEM choice or EEM default rates. The same might be said for attempts to promote energy improvement mortgage (EIM) instruments as a way of encouraging improvements to resale houses. It is no secret in the energy services community that engineering estimates of energy savings are imprecise. Furthermore, future energy prices are becoming increasingly uncertain and more volatile. Hence, counting the savings before they happen is risky business. Especially now with the increasing popularity of alternative mortgage instruments, refinancing, new methods of underwriting and new methods of packaging mortgage portfolios for the secondary mortgage market (such as option pricing models), EEMs and EIMs may soon be relics of the pre-information highway era, new promotional efforts notwithstanding.

A NATURAL RESOURCE RESIDENTIAL EFFICIENCY SERVICES COMPANY

Having described some of the shortcoming of one type of energy efficiency program, the remainder of this paper takes the *intentions* of this type of program and shows how it can be developed into a resource-saving, money-making, socially-beneficial industry. We may call this industry the vanguard of the *truce* movement—*t*ruly *u*nsubsidized *c*apitalistic *e*nvironmentalism. Imagine when utility companies are no longer monopoly franchises. Rather, they compete with one another not only for customers, but for the sale of all manner of product lines, not just electricity or cable television exclusively. Imagine that a single company can sell every one of the products that flow into a home through distribution wires and pipes. Or at the very least, it can act as a go between by mixing and matching the best combination of wholesale suppliers of these services. Such a company and such competition between companies is possible for the simple reason that with the new information and communication technology that is currently being built and tested, flows of many different resources can be precisely tracked for the purchase, delivery, metering and billing of services. As we all know, automatic meter reading and the like are well within sight by the end of this event-filled century.

Suppose a company called MARVCO approached a builder of new homes with the following idea. MARVCO will pay the builder the incremental cost for building the new home so that it is not only electric energy efficient, but comprehensively natural resource efficient. For most homes these natural resources include, at a minimum, electricity and water, though natural gas, oil or some other heating fuel might also be in use. What MARVCO asks in return for its investment is the following: either the exclusive right to provide natural resource services to the prospective homebuyer under a shared resource savings agreement; or, the right to lease the various resource efficiency improvements to the homebuyer; or, the right to have its investment bought-out either by the home builder or the homebuyer at a fair price.

If the builder takes MARVCO up on its offer he does not have to risk any additional monies to build a resource efficient home. Nor does he bear the exclusive burden of selling the home, because MARVCO now has an incentive to work with the builder to find a buyer. Moreover, if he wishes to jettison MARVCO as a partner he can simply buy out MARVCO's investment. The homebuyer gains by having several options; she can pay the full purchase price for the house and its resource efficiency improvements and never deal with the builder or with MARVCO again. Or, she can reduce the sale price by purchasing the house in exclusion of the improvements and then lease the resource efficiency improvements from MARVCO. Lastly, she can reduce the sale price and simply agree on a shared resource savings plan with MARVCO.

Table 2 provides examples of the scenarios a homebuyer would face when purchasing a comprehensive resource-efficient home. In the first option, shared resource savings, the affordability issue is completely laid to rest—the homebuyer pays the same price as if a conventional home had been

Table 2. *The Resource-Efficient Home Purchase: Three Options*

	Shared Resource Savings	Homebuyer Lease	Homebuyer Buyback
Home Builder Price	$100,000	$100,000	$100,000
MARVCO Price	4,000	4,000	4,000
Buyer Loan Amount	100,000	100,000	104,000
Buyer Lease Payment	——	425	——
Incremental Mortgage Cost	——	——	360
Baseline Resource Bill	1,600	1,600	1,600
Annual Savings	600	600	600
Bill from MARVCO	1,425	——	——
Buyer Savings	$175	$175	$240

purchased. This allays any fear that a home builder may have regarding consumer affordability. Yet, the homebuyer is now efficiently using all the natural resources flowing into the house and receiving a 11 percent discount over what buyer would have been paying for natural resources had the home not received resource efficiency improvements. In return for the 11 percent discount and the lower loan amount, the homebuyer allows MARVCO to manage the $4,000 worth of efficiency improvements. It is this management of resources by MARVCO, who is an expert at resource management and who has developed an effective electronic/statistical control and feedback system, that allows both the homebuyer and MARVCO to profit off this investment. In fact, this is one of the features that distinguishes MARVCO from earlier, centrally-planned energy efficiency programs; MARVCO can achieve actual savings that are much closer to predicted savings because it can monitor and control usage in ways that were formerly not possible.

In this example, MARVCO receives a 10 percent rate of return on its investment for a period of 30 years. A fair contract is arranged in which neither MARVCO nor the homebuyer are exploited—the buyer never has to complain about the level of resource services and MARVCO never has to provide unduly high levels of service without compensation. In the event of a resale of the house, the options are again opened with the former homebuyer able to buy out the depreciated improvements or with the new homebuyer able to enter into a new shared resource savings agreement, lease or buyback from MARVCO. This is a win-win-win and win again (for society) situation.

The second scenario, the homebuyer lease option, has the advantage for the home builder of avoiding the incremental investment in resource efficiency. However, in the event that the old underwriting ratios are still around, it does not necessarily circumvent the issue of affordability. Although the payment-to-income ratio will be the same as that for the shared resource option, the borrower's debt-to-income will be higher by the amount of the lease, whose present value, at a 10 percent discount rate for 30 years, is $4,000. This option allows the buyer an 11 percent savings in resources, too. However, it is now up to the buyer alone to achieve all the savings required to pay the lease and have savings left over—MARVCO, which is a professional service company, no longer has an obligation to guarantee the homebuyer's resource savings. This scenario is a partial win for everyone—the home builder does not pay for the improvements but also may worry about the homebuyer ratios and affordability; the homebuyer must manage its resource use wisely to make the lease profitable; MARVCO financed part of the construction costs but did not win the rights to the thirty year annuity; and last but not least, society does not enjoy the full amount of resource savings unless the homebuyers really knows how to manage resources well.

The third and last option is, of course, the conventional option that is similar to that offered by new construction programs. The only difference here is that if the home builder so chooses, the incremental outlay for the efficiency improvements will be made by MARVCO. However, in return the home builder will be obliged to pay MARVCO the full amount of the outlay irrespective of the amount of the final selling price. With this option, the homebuyer is the owner of the improvements and resource savings are again dependent on how wisely the homebuyer manages its own resource use.

Before summarizing the advantages of the MARVCO shared resource savings operation, a few notes should be added regarding the technical issues of the baseline resource bill and managed resource services. I envision a number of methods for constructing a household-specific baseline resource bill that would be satisfactory both to the homebuyer and to MARVCO and that would be superior to current methods. For example, statistical research can be used to develop relatively simple models that predict total annual utility bills based on home and household characteristics. Or, as in the real estate appraisal field, the more pedestrian method of studying a small sample of comparables may be used to develop a baseline bill. Provisions can be made for adjusting and fine-tuning this baseline over time, just as provisions are made for reassessing the value of home after improvements are made. Once a reasonable baseline is established, sufficiently accurate estimates can be made of the potential savings that MARVCO will not take on excessive risk in contracting with the homebuyer. This level of fine-tuning is not possible with existing new construction programs because it is not economical for organizations that promote these efficiency programs to continually monitor and fine-tune resource use for individual customers—utilities and public organizations tend to have one-time-only involvement with customers as their financial health does not depend on making sure that the investments remain sound over time. Furthermore, it is uneconomical for an individual homebuyer to develop monitoring and feedback systems for itself as the costs of these systems are prohibitive without the advantages of economies of scale.

One of the features of the deal that allows MARVCO to feel confident that it is not taking on excessive risk is the bundling together of all the natural resources in the home. This can be viewed as a hedging strategy—one month the savings from electricity may be lower than expected but this may be made up by savings from water or natural gas. Another feature of the deal that reduces MARVCO's risk is MARVCO's expertise in home resource management technologies and communications and monitoring. MARVCO will install the necessary electronic equipment in the home to allow it adjust resource usage in ways that are unobtrusive to the household. MARVCO will also develop

systems for detecting wasteful practices or events. Finally, MARVCO will also offer the customer the opportunity to enter into a full service contract for maintaining existing equipment and appliances and for offering advice and financing for new purchases.

What has been gained by replacing residential energy efficiency new construction programs and EEMs with MARVCO? Restricting our discussion to the shared resource savings option, the list is rather long:

- MARVCO addresses all natural resources rather than merely electricity;
- MARVCO does not need to restrict its activities to new construction—the exact same schemes will work for sales and resales of existing homes or, for that matter, simply for any homes that are interested in resource efficiency renovations or retrofits regardless of whether or not a sale has taken place;
- MARVCO does not need to restrict its activities to the residential sector—the same ideas apply to the commercial and industrial sectors;
- MARVCO pays the incremental cost of the efficiency improvements rather than the home builder or homebuyer;
- MARVCO has as much incentive to sell the resource efficient home as does the home home builder and thus the costs of information and promotional campaigns can be shared;
- MARVCO essentially guarantees that as large a quantity of natural resources as is possible will be conserved for society—the larger the savings, the greater MARVCO's profits and the more society benefits;
- MARVCO has incentives to shop nationally or internationally for the cheapest resource prices;
- No utility or public agencies need be involved in any program—MARVCO is the end use service provider;
- MARVCO does not recognize geographic boundaries, nor does it need customers that are concentrated in specific locations;
- MARVCO consolidates all the natural resource utility bills for the customers thus saving paperwork and transaction costs.

CONCLUSION

The new approach to natural resource efficiency offered in this paper can accomplish the same goals as residential energy efficiency new construction programs, EEMs and EIMs, or for that matter many other types of residential and commercial building energy efficiency programs while shifting the financial risks of resource efficiency improvements away from builders, mortgage borrowers and lenders and on to resource service providers. For the rapidly receding present there is nothing wrong with programs that promote energy efficient new construction through home energy ratings, home certifications and campaigns of persuasion directed at home builders, real estate agents and trade allies. However, why should individual local utilities be enthusiastic about expending funds on such programs when the day is soon to arrive when its residential customers, both new and old, will no longer be captive? Many of these utilities may not even be around in their present form by the end of the decade. Better to let a financially strong, technically competent and competitive company incur the risk, and most of the rewards, of saving scarce natural resources.

I have little doubt but that in the immediate future energy efficiency programs will continue to be promoted. However, the day is not far off when bolder and more exciting prospects will be ready to be realized. Perhaps many of the good people currently involved in these programs will be a part of these new opportunities. In the meantime, it would be advantageous for those of us involved in these programs to use them to learn how to work with home builders, appraisers, bankers, trade allies and customers to promote resource efficiency. It would also behoove program supporters to use their experiences with these programs to learn how to achieve and measure the expected savings for new and existing homes and to master the intricacies of the real estate contract law and real estate financial markets. Someday soon we may all be competing for who can save the most natural resources most profitably.

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