BEYOND BUSINESS AS USUAL:
PATHS TO DEEP ENERGY REDUCTIONS

by Linda Wigington & Judy Roberson

The recent confluence of political, social, environmental, economic, and technical awareness of global climate change makes a compelling case to re-examine our assumptions regarding the degree to which energy use can be reduced in existing homes and the speed by which this change needs to occur. Transforming the physical and institutional infrastructure to support rather than threaten global, regional, community, and household sustainability is a daunting task. In existing buildings, deep energy reductions approaching a factor of ten are possible through a combination of whole-house efficiency improvements, behavioral choices, community solutions, and renewables. The issue is not whether deep energy reductions are necessary, but how to define and support this vision.

CRISIS OF OBSOLESCENCE

Housing & Energy: Opportunity & Challenge

Residential buildings account for 21% of both U.S. energy use and carbon emissions. The 124 million households in the U.S. and 13 million in Canada represent a tremendous investment of resources as well as a commitment to maintenance and operating costs for years to come.

Five Flawed Assumptions

The assumptions that are woven into how we design, construct, finance, maintain, operate, insure, and renovate our homes have become dangerously outmoded. Yet their effect on how we continue to operate and invest in our homes is pervasive. Recognizing that these assumptions are flawed is the first step to transformation.

1 ***The first flawed assumption*** is that both the supply and costs of energy and water are predictable.

2 ***The second flawed assumption*** is that climate and weather events are stable. Unusually disruptive weather events - severe rain, wind, ice storms, and droughts - are increasingly common and predicted to worsen in the future (Hansen et al. 2007[1]; IPCC 2007[2]). Even without sea level rise, these events negatively impact housing, notably by wind damage, flooding, and power outages.

3 ***The third flawed assumption*** is that our energy use is value neutral, that energy is just a "commodity" and our patterns of use and energy sources have no ethical or environmental consequences. The costs of geopolitical conflict, greenhouse gas emissions, and environmental impacts of extraction, generation, and consumption are not reflected in the price we pay for energy, or our assumptions about its use.

4 ***The fourth flawed assumption*** is that new construction will save the day, because new homes are more efficient than older ones. However, average household energy consumption in new homes is greater than in existing homes (BEDB 2007[3]; NREL 2006[4]). Increasing house size, fewer people per household, and proliferating electric plug loads are neutralizing efficiency gains from better codes, appliance standards, and compact fluorescent lights (Waide et al. 2006).[5]

5 ***The fifth flawed assumption*** is the idea that our homes are places of safety and refuge. This is more a broken expectation than a flawed assumption. Increasingly, homes are a source of vulnerability due to loss of income, loss of property values, and increased energy and water cost. Poor indoor air quality as a result of lead, radon, and damp environments result in a staggering loss of health and life. In 2008 the loss of U.S. housing value was 3.3 trillion dollars. One of six homes with a mortgage is "under water," owing more than its current market value. Under such conditions, homes are more likely to limit rather than enhance our well being.

This crisis of obsolescence clearly requires a transformation of our approach to housing energy efficiency.

THE THOUSAND HOME CHALLENGE

The Thousand Home Challenge (THC) seeks to demonstrate the potential to dramatically reduce the energy consumption of existing homes in North America. Our goal is to achieve deep energy reductions in one thousand homes, initially, with the multiplier effect of establishing Thousand Home Challenges within and between communities as systems and capacity for deep reductions are developed.

The core strategies and guiding principles of the Thousand Home Challenge are to:

- **Reduce** total site energy consumption of existing homes by at least 75%
- **Use** indicators of home energy performance that are measurable and verifiable
- **Exemplify** the performance-based systems approach that addresses comfort, indoor air quality, and building durability
- **Demonstrate** deep energy reductions by applying a combination of efficiency measures, renewable energy resources, occupant behavior change, and community-based solutions
- **Assemble** local and regional centers of excellence for deep energy reduction
- **Stimulate** collaboration and creative problem-solving, and innovative products and approaches to transforming the North American housing stock

Defining Deep Energy Reductions

Our housing stock is characterized by huge variations in home age, style, size, condition, climate, occupants, and energy consumption. Therefore, defining "deep energy reductions" equitably for all homes is not easy.

Creating energy performance goals for the Thousand Home Challenge involved two major tasks. The first was deciding what metrics to use to evaluate home energy performance. The second was to determine the threshold value(s) that a household would need to meet or exceed.

A guiding principle for the Thousand Home Challenge is to have energy performance thresholds that are equally challenging for all combinations of housing types, households, and climates. We wanted to avoid having thousands of homes that already meet the chal-

lenge, or favoring any climate or house type. For example, absolute metrics such as energy use per square foot floor area would favor large homes with few occupants in mild climates, while households in very cold climates might not be able to meet the threshold without heroic effort and financial investment.

What does the Thousand Home Challenge measure?

The THC's fundamental metric is total net annual household site energy consumption. However, no single metric tells the full story of a home's energy performance, any more than one medical test adequately describes a person's health. Additional indicators of performance will be monitored, but not used to evaluate achievement of THC energy performance goals.

Occupants can have a large impact on actual energy use. We want to measure actual household energy performance, not the theoretical performance of a building enclosure and its mechanical systems. THC metrics also include the impact of community, behavior, and lifestyle.

Energy Performance Criteria for Participation

The THC offers two options for participation, each with a different "performance threshold" in terms of maximum total annual site energy consumption. Option A requires that a home's post-retrofit energy use be at least 75% less than its pre-retrofit energy use, using actual energy and fuel bills (including wood and pellets). Option B requires projects to meet or exceed a customized threshold that is calculated based on home size, number of occupants, climate, heating energy source, and percent shared surface area (for attached buildings). On-site renewable energy production is credited, so a home with PV would more easily meet (and could exceed) the performance threshold than a home without renewables.

Having two options enables more homes to participate. Option A encourages larger, higher-consuming households to dramatically reduce their energy use, even if they cannot meet Option B's challenging performance criteria. Option B is appropriate for (a) homes without pre-retrofit consumption data, (b) participants committed to reducing energy use as much as possible, and (c) existing homes that are already low energy users, which can serve as examples or case studies.

Michael Blasnik developed the "Threshold Calculator" for calculating Option A and B performance thresholds. That spreadsheet and other information about THC performance thresholds are posted on ACI's website: www/affordablecomfort.org /ACI Initiatives/Thousand Home Challenge.

HOW DO WE GET THERE FROM HERE?

Three Implementation Paths

Efforts to achieve deep energy reductions fall into three different implementation paths. The first, "All at Once," involves comprehensive projects, likely a remodel, renovation, or major home improvement. The key question for this path is: "What systems and infrastructure can we develop that will most effectively integrate whole-house deep efficiency measures into these valuable opportunities for intervention?"

The second path, "Phased," is characterized by being deployed in stages over a period of years. Two questions are: "How do we engage homeowners and occupants in the process of achieving deep energy reductions that happen over time through a series of investments?" and "How can we optimize the alignment of related programs and initiatives with the vision of deep energy reductions?"

The third path, "Creative," develops community and lifestyle solutions in response to physical or financial barriers to technical improvements at the household level. Questions here include "How can communities adapt existing infrastructure to transform liabilities into assets?" and "How can we adapt our expectations about housing and energy in a way that relates 'quality of life' with sustainable energy?" Investments in energy production and saving at the community level can enable deep energy reductions with less investment in individual homes.

From Demonstration to Mass Market

Deep energy reductions will transform the housing market only if they are replicated and implemented in millions of homes within ten years. That requires developing comprehensive technical systems that function as packages (in a sense "widgets") that can be tested, verified, financed, and deployed. Technical packages will simplify the design process and improve economies of scale. Packages would be designed for the most common combinations of house type, climate, and budget, and would maximize both energy savings and non-energy benefits.

A different approach is needed for behavioral choices, lifestyle, and community solutions. Rather than to dictate or even suggest behavioral choices, it is up to households and communities to re-examine their assumptions about how to meet their needs. In most cases energy use has not been examined within the context of climate change and increasing resource depletion. Much of household energy use is driven by habits. There is no precise prescription for behavior and lifestyle that support deep energy reductions. A crisis or emergency, such as an extended power outage, significant price increase, or loss of income, can stimulate this discovery process. How do we support permanent changes in lifestyle that transform energy use in existing homes by choice and creativity, rather than sacrifice and suffering? How do we stimulate the process of self examination? We propose that transparent indicators of performance such as actual total household energy consumption can facilitate behavioral change and community solutions.

The Thousand Home Challenge plans to test this proposition and change our perception of what is possible - both financially and behaviorally - by implementing case studies that demonstrate how to drastically reduce total home energy consumption, cost, and environmental impact. We are now in the pilot stage and plan to launch in the third quarter of 2009. For more information, visit the Initiatives section of ACI's website and click on the Thousand Home Challenge box.

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[1] Hansen, J., M. Sato, P. Kharecha, G. Russell, D. W. Lea, and M. Siddall. (2007). "Climate Change and Trace Gases." Phil. Trans. Roy. Soc. A **365**: 1925 - 1954.

[2] [IPCC] International Panel on Climate Change. 2007. Summary for Policymakers. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change,* M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden, and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 7-22.

[3] [DOE] U.S. Dept. of Energy. 2007. *Buildings Energy Data Book.* http://buildingsdatabook.eren.doe.gov. Washington, D.C.

[4] [NREL] National Renewable Energy Laboratory. 2006. *The Potential Impact of Zero Energy Homes.* Golden, CO.: by NAHB Research Center, Upper Marlboro MD. www.toolbase.org/PDF/CaseStudies/ZEHPotentialImpact.pdf.

[5] Waide, P., A. Hinge, and J. Thorne Amann. 2006. "Energy Efficiency in the U.S. Existing Building Stock: What's Worked; What Might Work Better." In *Proceedings of the ACEEE Summer Study on Energy Efficiency in Buildings,* 8:313-325. Washington, D.C.: American Council for an Energy-Efficient Economy.