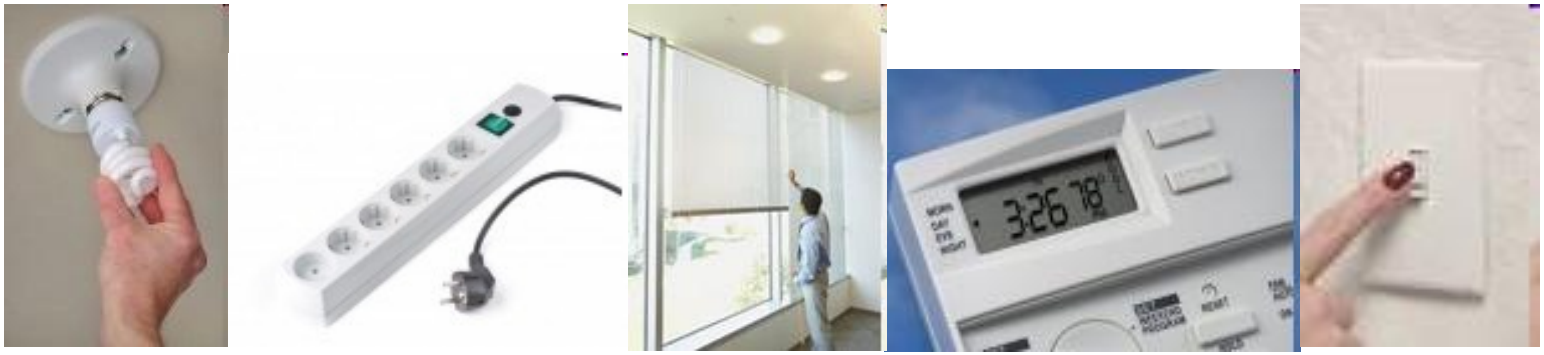
The Human Dimensions of Net Zero Buildings:

Insights on Owner Needs and Behavior



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NIST Net Zero Buildings Workshop

September 14, 2011

People as Problem
or
People as Solution

Buildings would work perfectly if it weren't for the people in them.

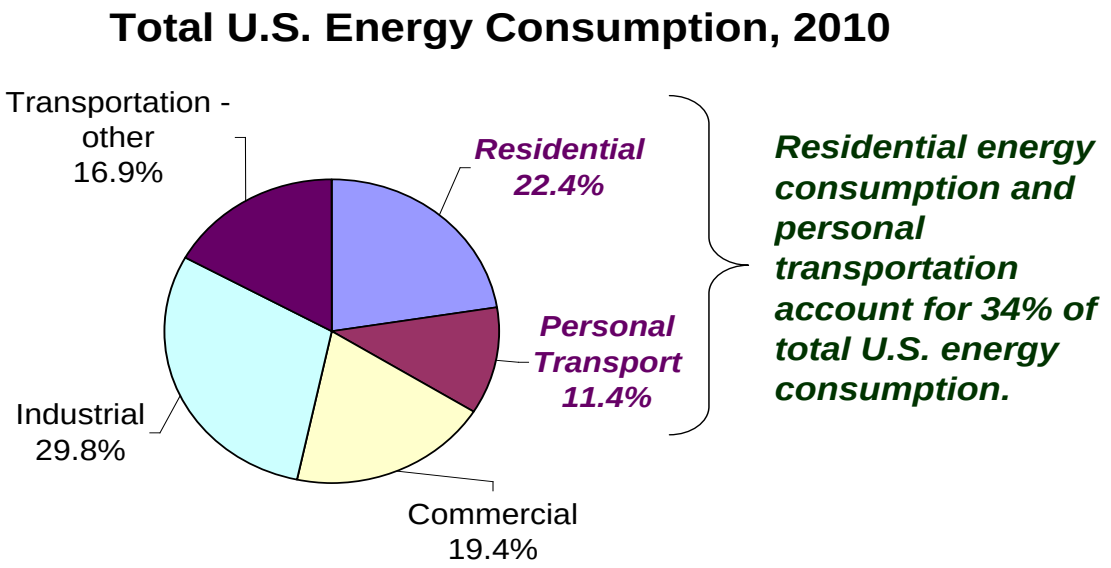
-- Anonymous, ACEEE Conference, circa 1993

Research has shown that people do matter



- Studies of nearly identical units , occupied by demographically similar families, have reported large (e .g. 200-300%) variations in energy use. (see Lutzenhiser 1993)
- Non-LEED buildings have outperformed LEED buildings as a result of occupant behavior. (Shelly and Cross 2010)
- Energy-efficiency rebound effects are likely to be larger when efforts at efficiency focus strictly on technological solutions and bypass people. (Ehrhardt-Martinez et al. 2010)

The Behavior Wedge in Existing Buildings



A growing body of research suggests that the potential size of **near-term** energy savings from initiatives focused on the human dimensions of energy consumption, in the residential and personal transportation sectors alone, is likely to equal or exceed **9% of total U.S. energy demand**.

The Behavior Wedge

- **Dietz et al. (2009):**
  explores the potential energy savings from 17 household actions and suggests that a behavioral approach could save 123 million metric tons of carbon annually in year 10, representing 20% of household direct emissions or 7.4% of U.S. national emissions.
- **Laitner and Ehrhardt-Martinez (2009):**
  explores a more extensive list of household actions and suggests that changes in three types of household behaviors could result in a 22 percent reduction in household and personal transportation energy use over a 5 to 8 year period – roughly the equivalent of 9 quads per year.

The Behavior Wedge

Leighty and Meier (2010):

In crisis situations, changes in energy practices have resulted in immediate, community-wide electricity savings of 25% and post-crisis savings of 8 to10%.

Ehrhardt-Martinez et al. (2010):

The implementation of a variety of residential feedback programs and devices have resulted in average household electricity savings of 4 to 12 percent – well-designed programs have saved as much as 15 to 20%.

Types of Energy-Related Behaviors

Cost \ Frequency of Action	*Infrequent*	*Frequent*
Low-cost / no cost	ENERGY STOCKTAKING BEHAVIOR Install CFLs Pull fridge away from wall Inflate tires adequately Install Weather Stripping	HABITUAL BEHAVIORS AND LIFESTYLES Slower Highway Driving Slower Acceleration Air Dry Laundry Turn Off Computer and Other Devices
Higher cost / Investment	CONSUMER BEHAVIOR New EE Windows New EE Appliances Additional Insulation New EE Car New EE AC or Furnace	

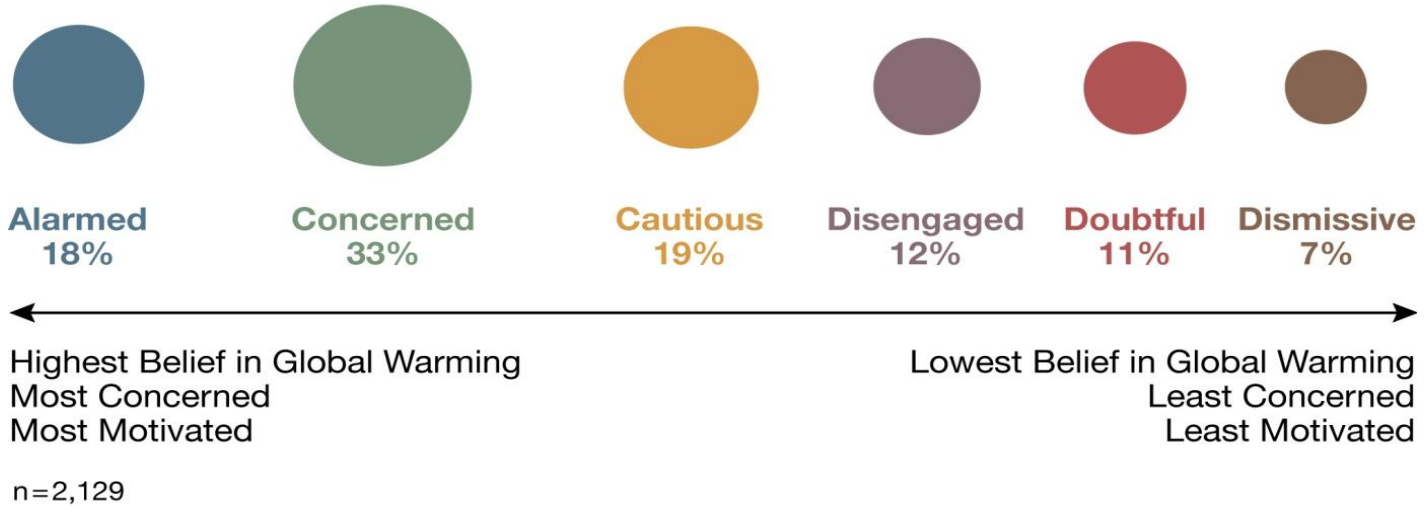
Energy Savings by Type of Behavior

Category of Actions	Potential National Energy Savings (Quads)
Conservation, Lifestyle, Awareness, Low-Cost Actions	4.9 (57% of total savings)
Investment Decisions	3.7 (43% of total savings)
Total Energy Savings	~8.6 +/- 1.5 (22% of HH energy)

How can we engage people when they just don't care?

What do Americans Think about Climate Change?

- Clear divisions among members of the American public on the issue of climate change.



Source: Maibach et al., Ch. 8, People-Centered Initiatives for Increasing Energy Savings

What do Americans Think about Energy and Efficiency?

- Despite political differences about global warming, most Americans are indeed willing to participate in a national effort to transform the way we use energy.
- Even many of the relatively small proportion of Americans who don't believe that climate change is occurring– or are otherwise unconcerned about it – do believe that our country needlessly uses and wastes energy in harmful ways.
- Most Americans are eager to reduce their own energy use, and support a range of policies to reduce the nation's energy use.

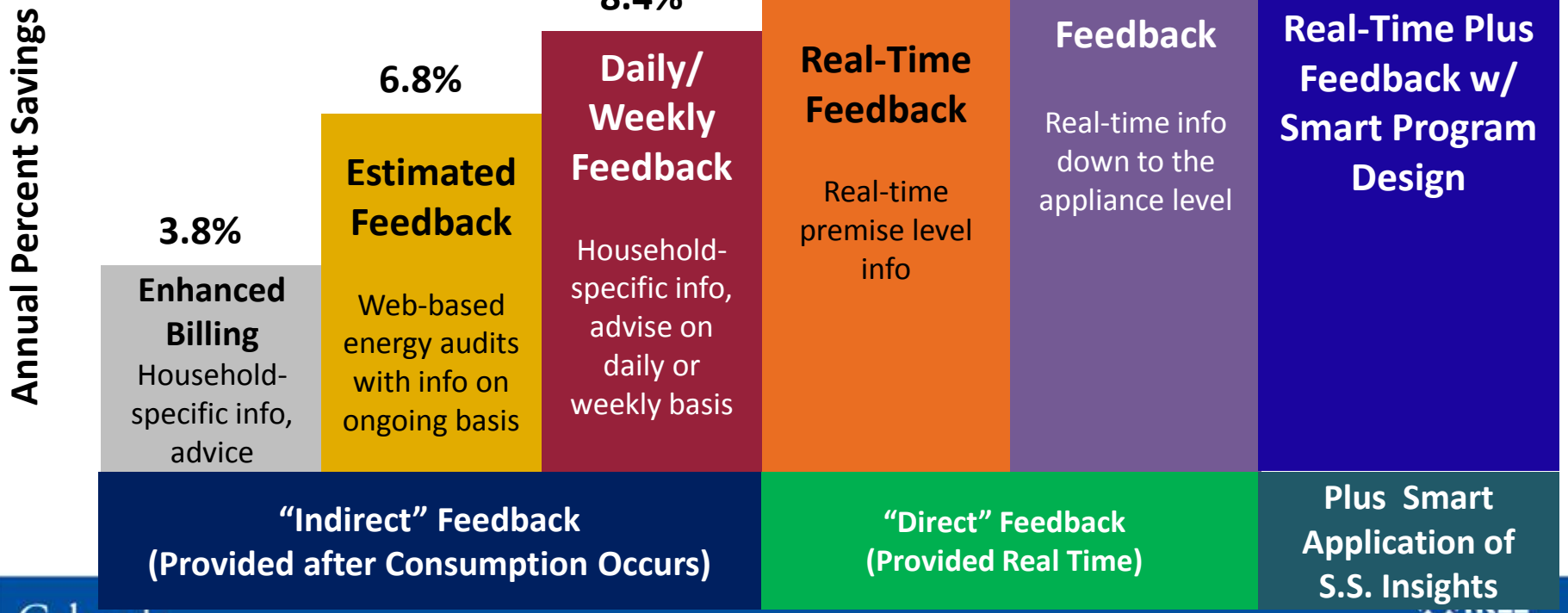
Source: Maibach et al., Ch. 8, People-Centered Initiatives for Increasing Energy Savings

How should NZE homes Engage and Empower People to Use Less Energy? Some Examples….

- *Built-in Real-time Feedback*
- *Choice Architecture on Building Features*
- *Smart Power Strips and other features that facilitate choice and control*
- *Community-Scale Renewables and Distributed Energy Systems*
- *Social Mechanisms of Support*

Residential Feedback Approaches

*Average Household Electricity Savings (4-12%) by Feedback Type**



Choice Architecture: Removing Barriers and Providing Better Choices

- Choice architecture is about creating a context in which people are likely to make better decisions – decision that will make the choosers much better off, ***as judged by themselves.*** *(Thaler and Sunstein 2008)*
- Overcoming inertia and the status quo bias
- Hence, the BECC Low-Carbon Lunch Experiment

The 2009 BECC Low-Carbon Lunch

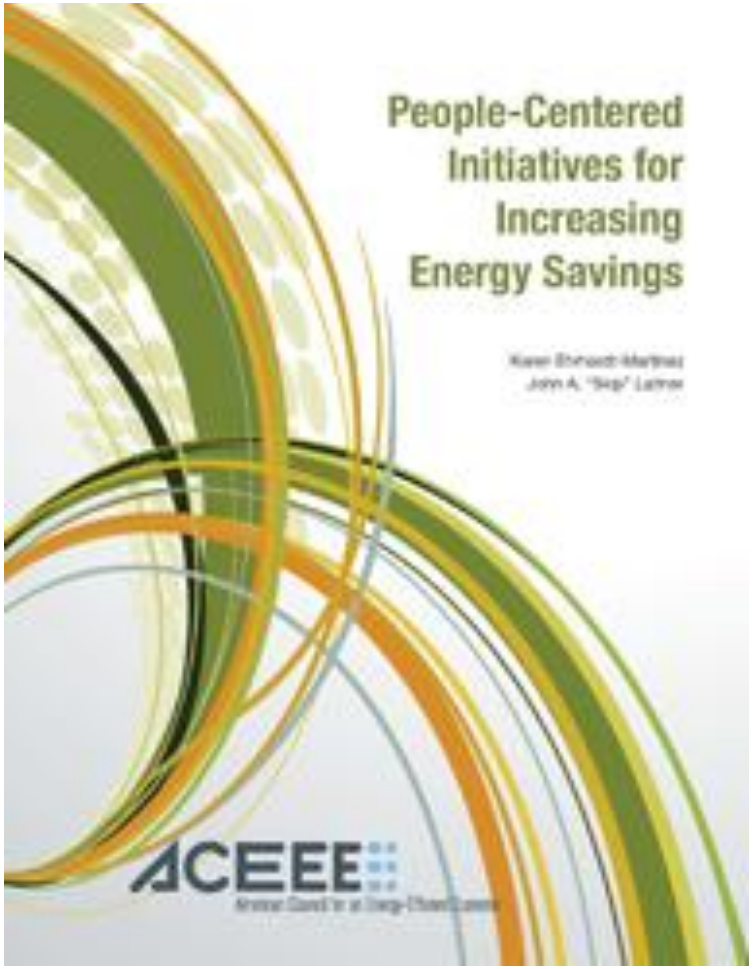
Large Indirect Savings	ACEEE Conference Standard	BECC 2007	BECC 2009
Meat-Based Lunch	90-95%	83%	20%
Vegetarian Lunch	5-10%	17%	80%

- BECC is the Behavior, Energy, and Climate Change Conference (see www.BECCConference.org)
- Meat production is responsible for 18% of the global greenhouse gas emissions (Pew Commission 2008)
- Omnivores contribute 7 times the GHG emissions than vegans

Conclusions

Generating large and persistent savings requires incorporating occupant behavior into the design and construction process.

Need to find a balance that *involves* occupants as part of the solution rather than bypasses occupants through automation but that also makes it simple, fun, and engaging.



Available at:
http://aceee.org/people-centered-energy-savings

Behavior, Energy and Climate Change Conference

behavior, energy & climate change
becc

Call for Abstracts: until May 15th

Conference:
November 29-December 2nd, 2011
Washington, DC

More Information at:
www.BECCconference.org

Selected References:

Dietz , Thomas; Gardner, Gerald T.; Gilligan, Jonathan; Stern, Paul C.; and Michael P. Vandenbergh. 2009. "Household actions can provide a behavioral wedge to rapidly reduce U.S. carbon emissions." Proceedings of the National Academy of Sciences 106(44), November.

Ehrhardt-Martinez , Karen, Kat A. Donnelly, and John A. "Skip" Laitner. 2010. *Advanced Metering Initiatives and Residential Feedback Programs: A Meta-Review for Household Electricity-Saving Opportunities*. Washington, DC: American Council for an Energy-Efficient Economy.

Ehrhardt-Martinez , Karen, and John A. "Skip" Laitner. 2010. "Rebound, Technology and People: Mitigating the Rebound Effect with Energy Resource Management and People-Centered Initiatitves." Chapter 7 in *People-Centered Initiatives for Increasing Energy Savings*. Washington, DC: American Council for an Energy-Efficient Economy.

Laitner, John A. "Skip" and Karen Ehrhardt-Martinez. 2010. "Examining the Scale of the Behavior Energy Efficiency Continuum." Chapter 3 in *People-Centered Initiatives for Increasing Energy Savings*. Washington, DC: American Council for an Energy-Efficient Economy.

Leighty, Wayne and Alan Meier. 2010. "Short-term Electricity Conservation in Juneau, Alaska: A Study of Household Activities." Proceedings of the ACEEE Summer Study on Energy-Efficiency in Buildings.

Maibach, Edward; Roser-Renouf, Connie; Akerlof, Karen; Leiserowitz, Anthony; and Matthew Nisbet. 2010. "Saving Energy is a Value Shared by All Americans: Results of a Global Warming Audience Segmentation Analysis. Chapter 8 in *People-Centered Initiatives for Increasing Energy Savings*. Washington, DC: American Council for an Energy-Efficient Economy.

Schelly, Chelsea;Cross, Jennifer E.; Franzen, William S.; Hall, Pete; and Stu Reeve.. 2010. "Reducing Energy Consumption and Creating a Conservation Culture in Organizations." *Environment and Behavior.*

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