People, Energy, and Sustainability

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Technology, People, and Conservation

Technology can solve our energy and climate problems…

But only if it is purchased, installed and used appropriately,

And only if technology strategies are accompanied by smart energy use practices, conservation, and other sustainability measures.

Technology, People, and Conservation

How can we…

1) ensure that technologies are adopted and used appropriately, and
2) People engage in smart energy use practices and conservation?

We must shift our focus from engineering to also understand the social and behavioral dimensions of energy and climate problems.

Points for Today's Talk

1. Why do people matter?
2. How big are the potential savings?
3. What does social science offer?
4. What are the essential principles?

Today's Talk

1. **Why do people matter?**
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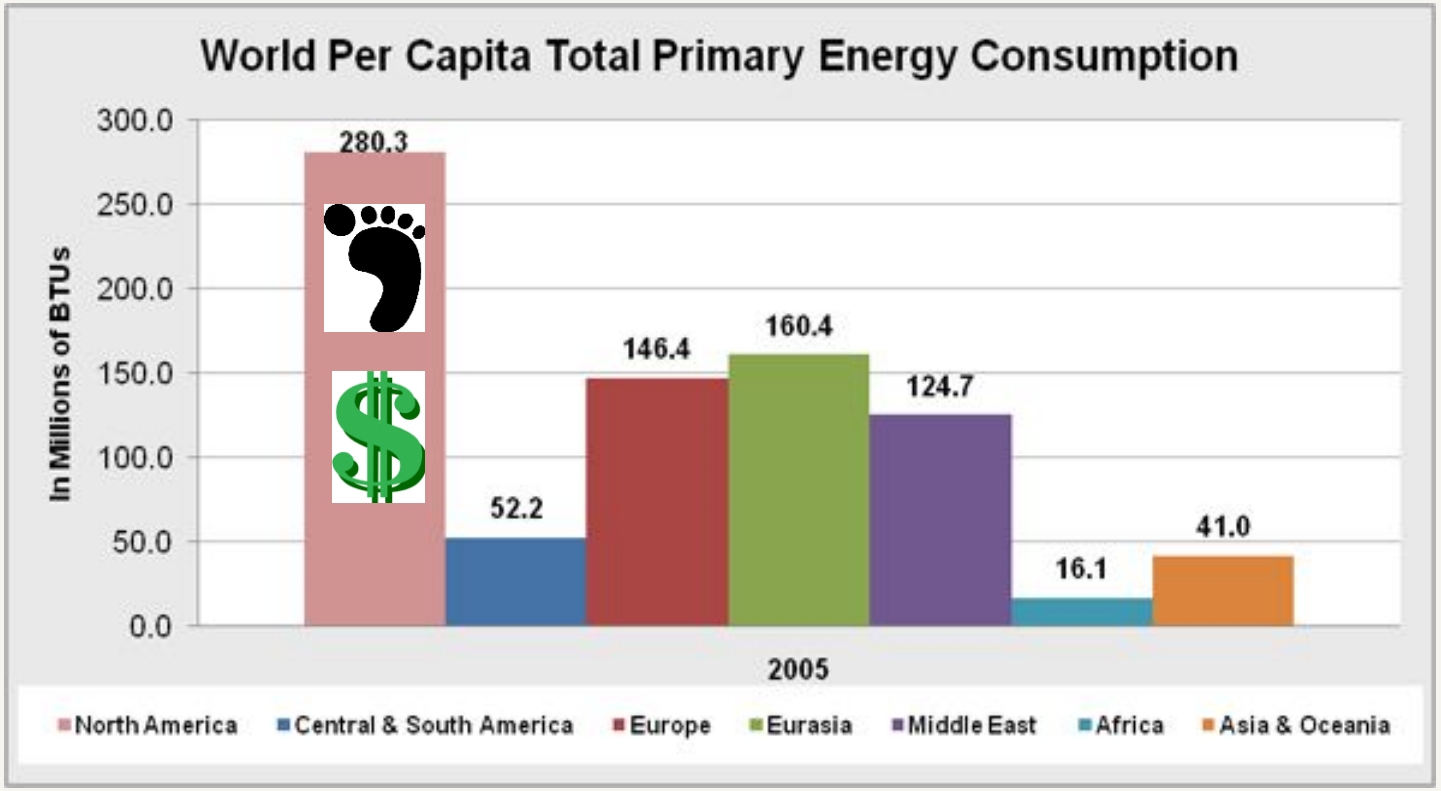
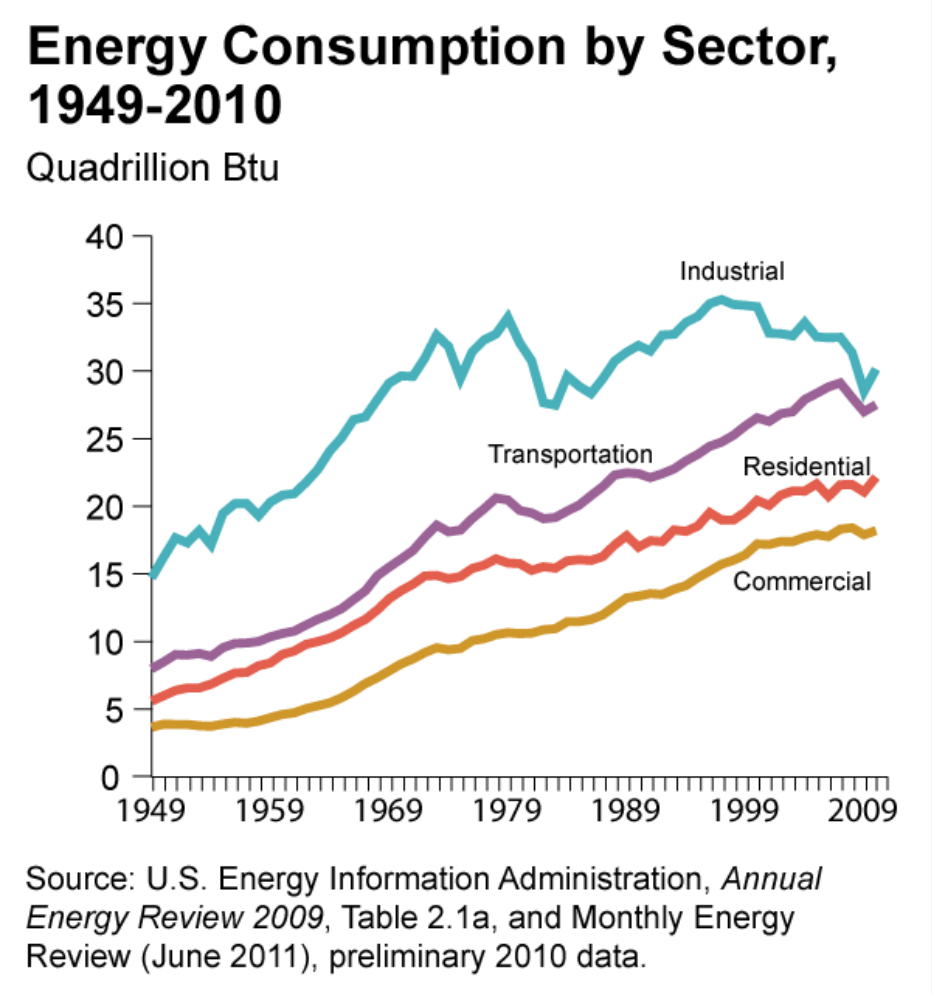
Cross Cultural Differences



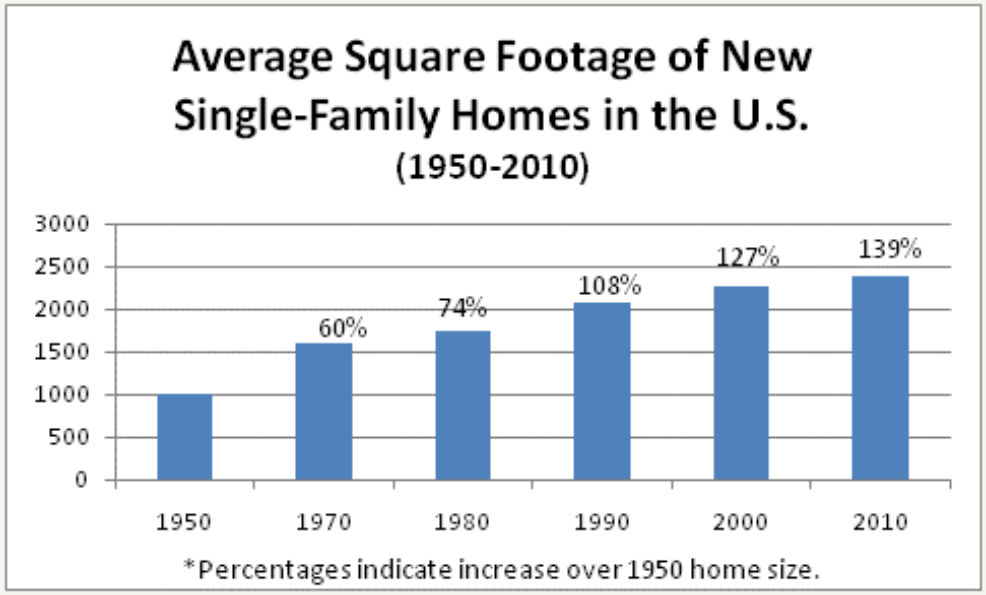
Source: U.S. Census Bureau

Trends in U.S. Energy Consumption



Countervailing Trends

- Increased Energy Efficiency
- Invisible Energy in a Culture of Consumption and Waste



Can Technologies Solve the Problem?

Creating an Energy Revolution

A revolution doesn't happen when society adopts new tools, it happens when society adopts new behaviors.

Clay Shirky, Digital Guru and NYU Professor of Telecommunications.

Buildings versus Building Occupants

- 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 schools have outperformed LEED buildings as a result of occupant behavior. (Schelly and Cross 2010)
- Standard military housing units used less energy than upgraded units. (Andres and Loudermilk 2010)

A Story of Two Schools

Table 1. Annual Electricity Use (kWh/ft^2) and Percentage Decreases by High School and Fiscal Year[a]

	Rocky Mountain High School			Poudre High School			FCHS			Fossil Ridge High School LEED School[b]		
Fiscal Year	kWh/ft^2	Percentage Decrease Year-to-Year	Percentage Decrease from 2000	kWh/ft^2	Percentage Decrease Year-to-Year	Percentage Decrease from 2000	kWh/ft^2	Percentage Decrease Year to Year	Percentage Decrease from 2000	kWh/ft^2	Percentage Decrease Year to Year	Percentage Decrease from 2000
2000	9.62	—	—	11.15	—	-	10.85	—	—	—	—	—
2001	7.80	18.9[d]	18.9	8.76	21.4[d]	21.4	9.25	14.7[d]	14.7	—	—	—
2002	7.94	(1.7)	17.5	8.52	2.7	23.6	8.86	4.3	18.34	—	—	—
2003	7.86	1.0	18.3	7.99	6.3	28.4	8.45	4.5	22.1	—	—	—
2004	7.65	2.6	20.4	7.94	0.6	28.8	8.53	(0.8)	21.4	—	—	—
2005	7.11	7.1[e]	26.1	7.62	4.0	31.7	8.08	5.2	25.5	6.95	—	—
2006	6.58	7.6[e]	31.7	7.44	2.3	33.2	8.41	(4.1)	22.5	7.01	(0.9)	(0.9)[b]
2007	4.79	27.2[e]	50.2	7.36	1.1	34.0	7.82	7.0	27.9	6.24	12.4	10.2[b]

Note: FCHS = Fort Collins High School.

a. Fiscal years begin in July of the previous year and end in June of the stated year. (e.g., FY 2000 = July 1, 1999 through June 30, 2000)

b. FRHS not included in any regression tests because of missing data.

c. These data points are compared to first year of operation, fiscal year 2005.

d. Regression-based permutation for all schools tested that the average percentage decrease in 2001 is larger than the average decrease in all other years, $p < .001$ from a regression-based permutation coefficient (StataCorp. [2005]). Stata Statistical Software: Release 9. College Station, Texas: StataCorp. LP).

e. Regression-based permutation testing that the average percent decrease after 2004 at Rocky was larger than the average percent decrease at FCHS and Poudre, $p < .001$ from a regression-based permutation coefficient (ibid.).

A Story of Two Schools

Rocky Mountain High School created a new organizational culture of conservation through:

- The work of charismatic leaders,
- By communicating expectations and successes,
- An enhanced sense of personal and group efficacy.
- By engaging the facilities manager, the administration, the teachers and the students.

A Story of a Military Demonstration Project

A recent military project sought to demonstrate the energy-saving capacity of a variety of energy-efficient technologies. The project involved four houses, each built with varying degrees of energy-efficiency mechanisms.

The subsequent assessment revealed that the control house was the most energy efficient and the Cadillac fourth house was the least energy efficient.

The couple in the control house turned off lights when they left rooms, opened windows instead of running the A/C, rarely ran their dishwasher and engaged in other energy-saving behaviors.

Energy Use in Buildings Continues to Rise

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

Today's Talk

1. Why do people matter?
2. **How big are the potential savings?**
3. What does social science offer?
4. What are some essential principles?

The Scale of Savings Opportunities

We have the means to quickly, reduce energy consumption by at least 9% and carbon emissions by at least 7.4%?

1. *Achievable* savings (in residential and personal transport) over roughly 8 years.
2. Using primarily low and no-cost solutions.
3. Documented in peer-reviewed journals.
4. Could save households, organizations and businesses billions of dollars.

National Behavior Wedge Research

	Dietz et al. (2009)	Laitner & Ehrhardt-Martinez (2009)	Gardner & Stern (2008)
Focus:	Carbon Emissions Savings	Energy Savings Opportunities	Energy Savings Opportunities
Scope:	17 Household Actions	110 HH Actions (Roughly)	27 HH Actions (Roughly)
Potential Savings: Residential Sector	20% (of HH Direct Emissions)	22%	30%
Potential Savings: National	7.4% (of National Emissions)	9%	11%
Period to Achieve Max. Annual Savings	10 years	5 to 8 years	N/A

Conservative estimates for Residential and Personal Transport only.

Energy Savings by Type of Behavior

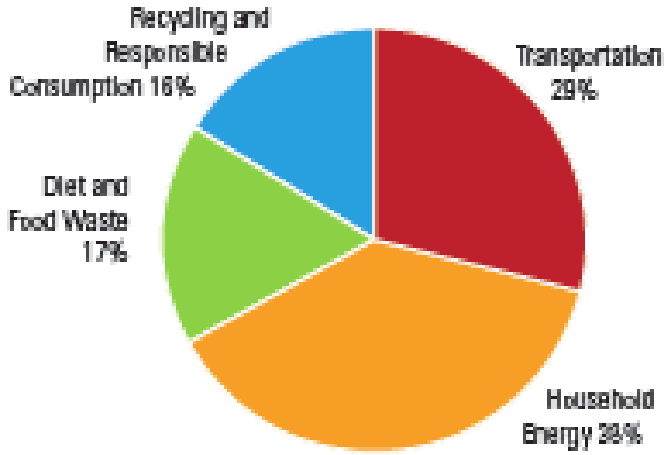
Category of Actions	**Potential National Energy Savings (Quads)**
Conservation, Lifestyle, Awareness, Low-Cost Actions	4.9 (57% of total savings)
Technology Purchases	3.7 (43% of total savings)
Total Energy Savings	~8.6 +/- 1.5 (22% of HH energy)

More Comprehensive Assessment

Simple and Inexpensive Actions Could Reduce Global Warming Emissions by One Billion Tons

Figure 1: Where in Our Lives We Can Reduce Our Impact

Share of Total Reductions, by Sector



The data in this pie chart are derived from the chart above.

Source: NRDC and Garrison Institute March 2010

Evidence from Crises Situations

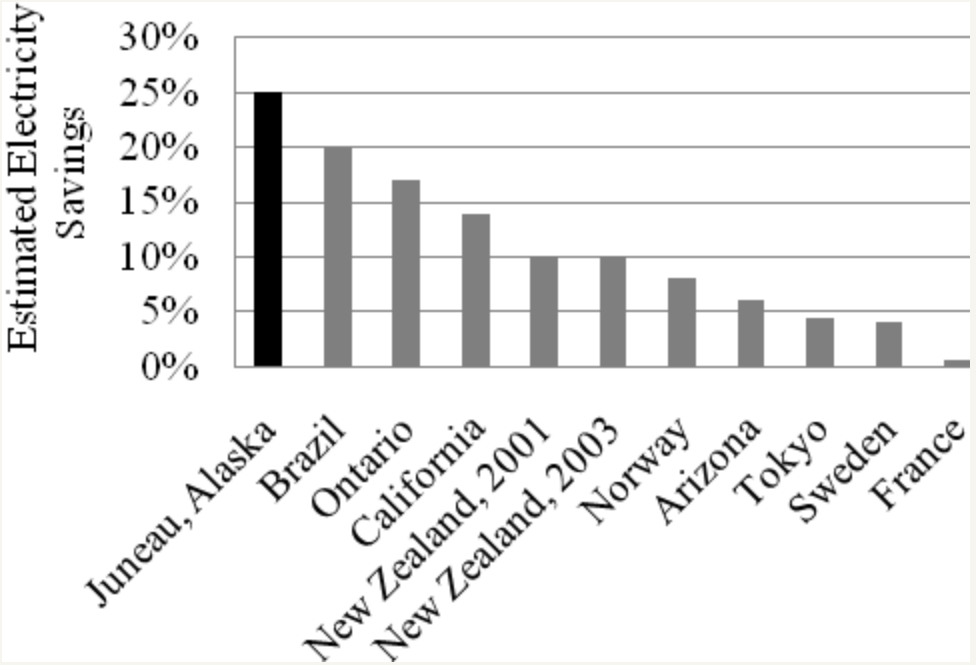
What Happens in Juneau, Alaska?

Immediate community-wide electricity savings of 25% and post-crisis savings of 8 to 10%.

2008 Avalanche

Source: Leighty and Meier 2010

Estimated electricity savings



Occupant and Operator Behavior in the *Commercial* Sector

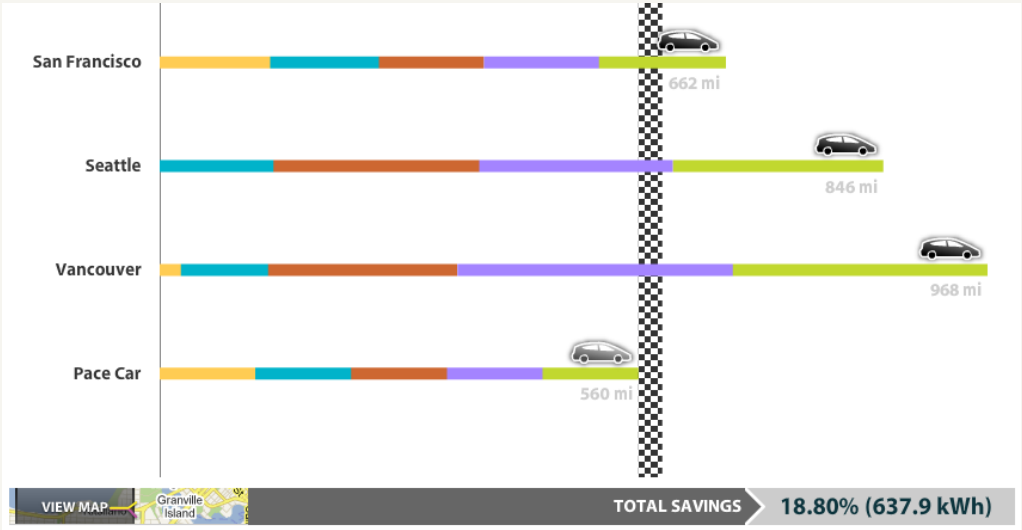
Shorenstein Building Management Company:

- Manages 25 million sq ft of commercial bldg space in the U.S.
- In 2010 and 2011 have worked to engage tenants in reducing energy consumption
- Saved $1.7 million
- Reduced electricity consumption 12.3 million kwh annually
- Saved 4800 Metric tons of CO2 emissions annually.

Occupant and Operator Behavior in the Commercial Sector

Perkins +Will: "Energy Cup Challenge"

- **Project**: Engaged 600 employees in 7 cities in a 2 week energy competition: "Energy Cup Challenge".
- **Goal** = 10% reduction in energy use.
- Motivation scheme: energy dashboard.
- **Results**: Average energy reduction of 16% with some offices saving over 40% on some days.



Occupant and Operator Behavior in the Commercial Sector

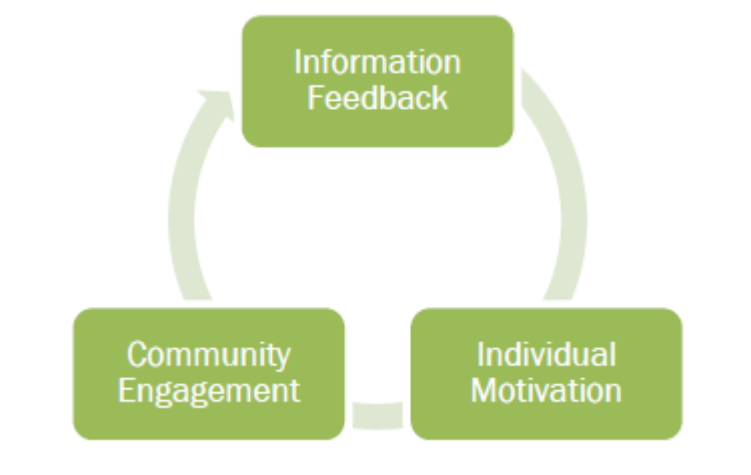
HOK:

- Project: A tenant and occupant engagement program in the Toronto Dominion Center.
- Includes six towers and 4.3 million sq ft with 90 tenant organizations and 21,000 occupants.
- Strategies: community-based social marketing.
- Low-tech work with stakeholders has included night time walk through audits of lights and equipment left on.
- Small cards are left thanking employees who turn off equipment and entering their name in a lottery.
- One assessment indicated a 12% decline in equipment being left on.

Occupant and Operator Behavior in the Commercial Sector

- **Envision Charlotte:**
  - Project: Collaborative partnership among major employers, building owners and managers and municipal and technology leaders to create an environmentally sustainable urban core.
  - 67 large office buildings; 21 million sq ft; and 75,000 employees
  - Energy Goal: 20% reduction in 5 years with 5% from behavioral and operational changes alone.

Community-wide Action Feedback Loop



Today's Talk

1. Why do people matter?
2. How big are the potential savings?
3. **What does social science offer?**

   (moving beyond information and education)

   a. **Social Norms Research**

   b. **Choice Architecture**
4. What are some essential principles?

The Power of Social Norms

What gets people to do things differently?

Asking people what motivates them is not enough.

	Naive Explanations for Energy Conservation	
	M	SD
Environmental protection	3.41_a	.75
Benefit to society	3.17_b	.77
Saving money	3.07_c	.76
Other people are doing it	2.93_d	.83

Source: Nolan et al. 2008

Responses were made on a 4-point scale (*not at all important = 1, somewhat important = 2, very important* = 3, *extremely important = 4).*

The Power of Social Norms

EXPERIMENT… Households were given one of five door hangers. Electricity consumption was measured after one month.

Economic

Save Money by Conserving Energy. You could save up to $54 per month by using fans instead of AC.

Environment

Protect the Environment by Conserving Energy. You can prevent the release 262 lbs of GHGs per month by using fans instead of AC.

Societal Benefits

Do Your Part to Conserve Energy for Future Generations. You can reduce your monthly demand for electricity by 29% by using fans instead of AC.

Social Norms

Join Your Neighbors in Conserving Energy. 77% of San Marcos residents often use fans instead of AC.

The Power of Social Norms

FINDINGS… Households given the social norm message used the least electricity.

TABLE 3: Short-Term and Long-Term Energy Consumption Adjusted for Baseline Energy Consumption

	Energy Consumption in Average Daily Kilowatt Hours (kWh)			
	Short Term		*Long Term*	
Condition	M	SE	M	SE
Environmental protection	14.12	.39	16.89	.8
Social responsibility	14.18	.41	17.52	.8
Self-interest	14.01	.40	17.45	.8
Social norm	12.97	.44	16.10	.9
Information control	14.42	.45	17.36	.9

CONCLUSIONS: people aren't always aware of what will motivate them to action.

An Example of Choice Architecture

- 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)*
- Based on Insights from Behavioral Economics

Rational or Predictably Irrational?

Homo Economicus (economic man): Individuals think and choose unfailingly well, making well-informed, thoughtful, rational decisions that determine how we act in any particular situation.

Homo Sapiens (real people): individual behavior isn't always guided by conscious choices and when it is, we are often predisposed to systematic biases in the way we think and act.

Finding 1: Two Systems for Thinking

Intuitive & Automatic	Reflective & Rational
Uncontrolled	Controlled
Effortless	Effortful
Associative	Deductive
Fast	Slow
Unconscious	Self-aware
Rules of thumb	Rule-following
Gut Feelings	Conscious Thought

Most programs focus their efforts here

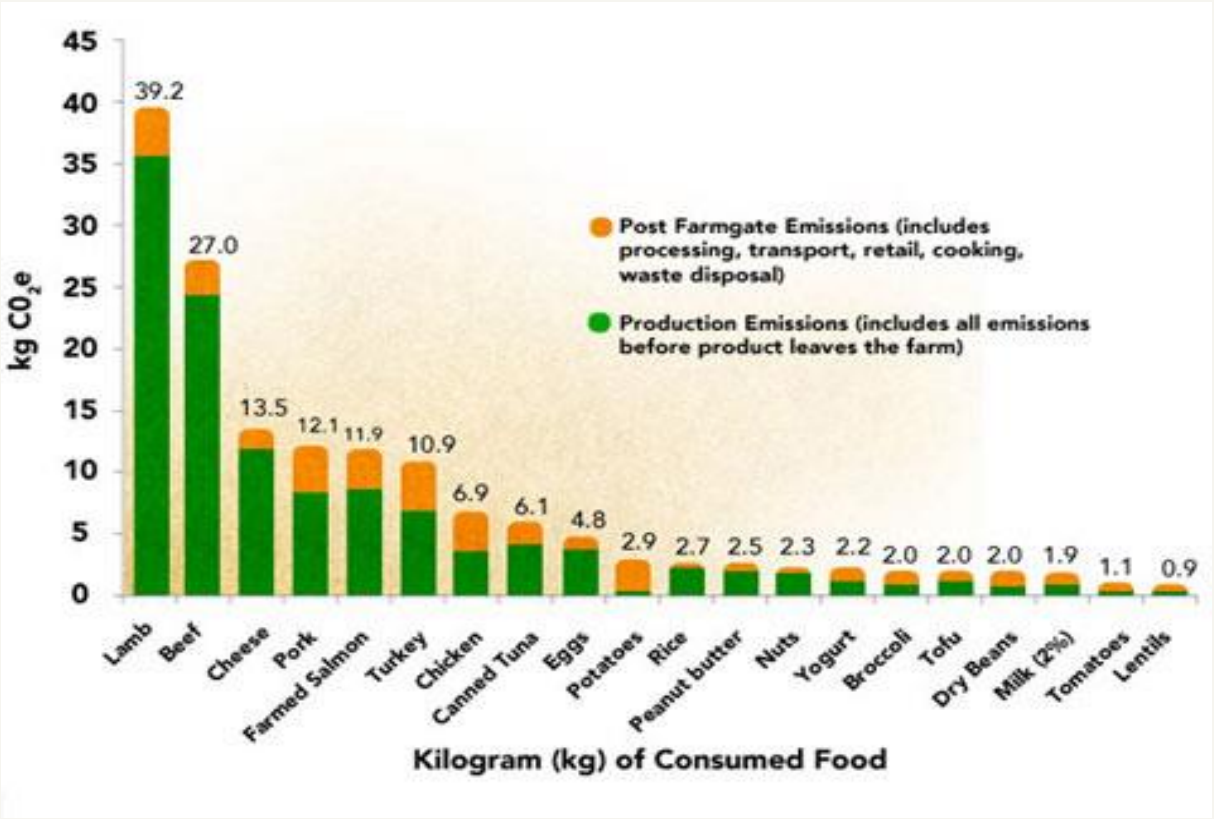
Finding 2: Ingrained Biases

Psychology, sociology, and behavioral economics provide a deeper understanding of the factors that shape choices and practices.

Biases	
Anchoring	How starting points determine decisions
Availability	How assessments of the likelihood of risk are influenced by how readily examples come to mind.
Optimism	The belief that we are above average
Loss Aversion	Losing something makes us twice as miserable as gaining the same thing makes us happy.
Status Quo	People tend to stick with their current situation.
Framing	Presenting the same information in different ways affects outcomes.

Choice Architecture Experiment

The 2009 BECC Low-Carbon Lunch



- Meat production is responsible for 18% of the global greenhouse gas emissions (Pew Commission 2008)
- Omnivores contribute 7 times the GHG emissions than vegans

Choice Architecture Experiment

The 2009 BECC Low-Carbon Lunch

- **Assumption**: People who eat meat, also like vegetables.
- **Goal:** get fewer conference participants to eat a meat-based meal.
- **Strategy**: Switch the default to vegetarian meals – but let people opt out.
- **Desired Outcome:** Everyone's happy and fewer carbon emissions.

Choice Architecture 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%

- Meat production is responsible for 18% of the global greenhouse gas emissions (Pew Commission 2008)
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TIME to Engage Communities

- **Targeting:** looking past the averages to recognize the important patterns in your community and the diversity within (people, and actions)
- **Informing/Engaging:** helping people and communities to develop the capacity to be mindful of their energy.
- **Motivating:** using financial and non-financial mechanisms such as goals, norms, networks, commitments, and other mechanisms to turn intentions into behavior.
- **Empowering/Enabling:** removing financial and structural barriers, providing better choice sets, building self-efficacy, and creating supportive communities and systems.

Targeting

Talk to People, observe current practices, and gather data

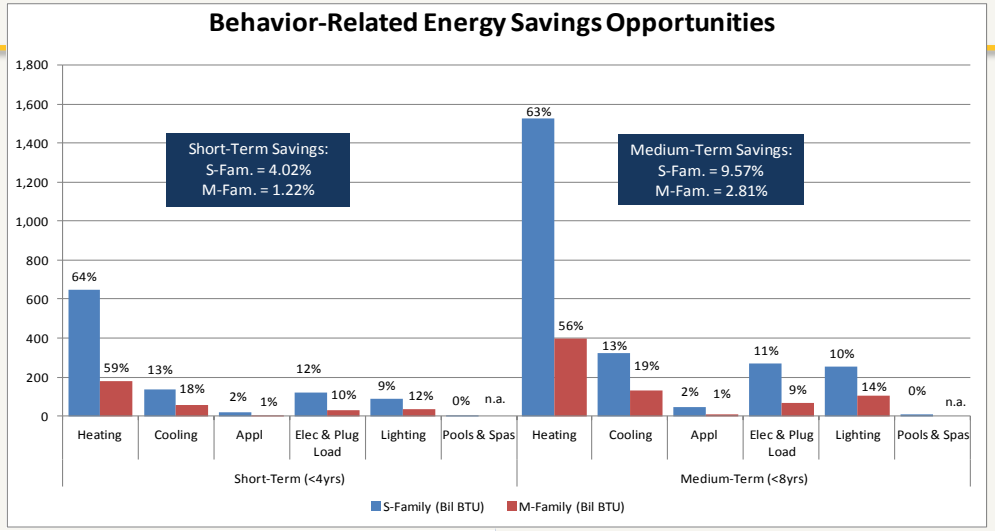
Don't Assume – Do the Homework

- People-centered Initiatives – determine:
  - perceptions and interests
  - current practices and patterns of energy consumption
  - the limited set of actions likely to yield the most savings
  - the actions that specific actors within an organization must take, how often, and when
  - important sources of diversity across groups and individuals

- Actions might include
  - Reducing plug loads in offices
  - Changing furnace filters in apartments
  - Setting/programming thermostats
  - Using fans instead of air conditioning

Targeting

City-level Behavior Wedge Profiles



Top Ten Strategies for Reducing Energy Consumption in *Single Family* *Homes*

		Savings
1	Heating & Cooling: Setbacks and programmable thermostats	3.20%
2	Heating: Furnace maintenance	1.84%
3	Heating: Reduce wasteful heating practices	1.72%
4	Plug load: Plug Load management	1.09%
5	Heating & Cooling: Weatherization	1.06%
6	Lighting: CFL bulb replacement	0.89%
7	Heating: Accelerated furnace replacement	0.67%
8	Cooling: AC maintenance	0.43%
9	Electronics: Accelerated replacement of desktops with laptops	0.26%
10	Cooling: Alternative technologies and reductions in solar heat gain	0.20%
	Total Achievable Savings	**11.36%**

Informing

…providing information about energy consumption, technologies, programs, priorities, and amount of savings achieved.

Energy Consumption Feedback

Residential Feedback

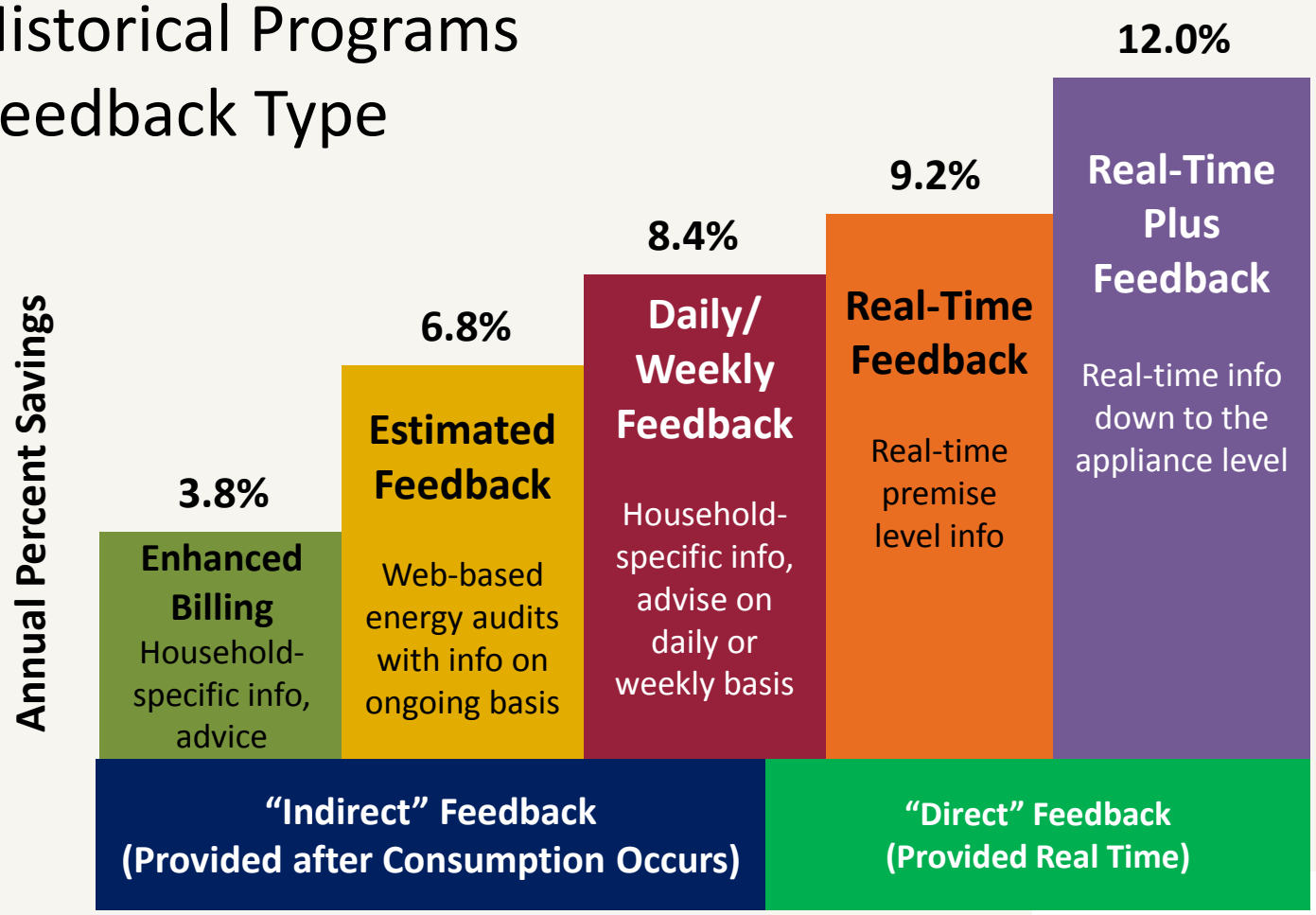
Savings: 4-12%

Savings: 20%

Cisco Mediator

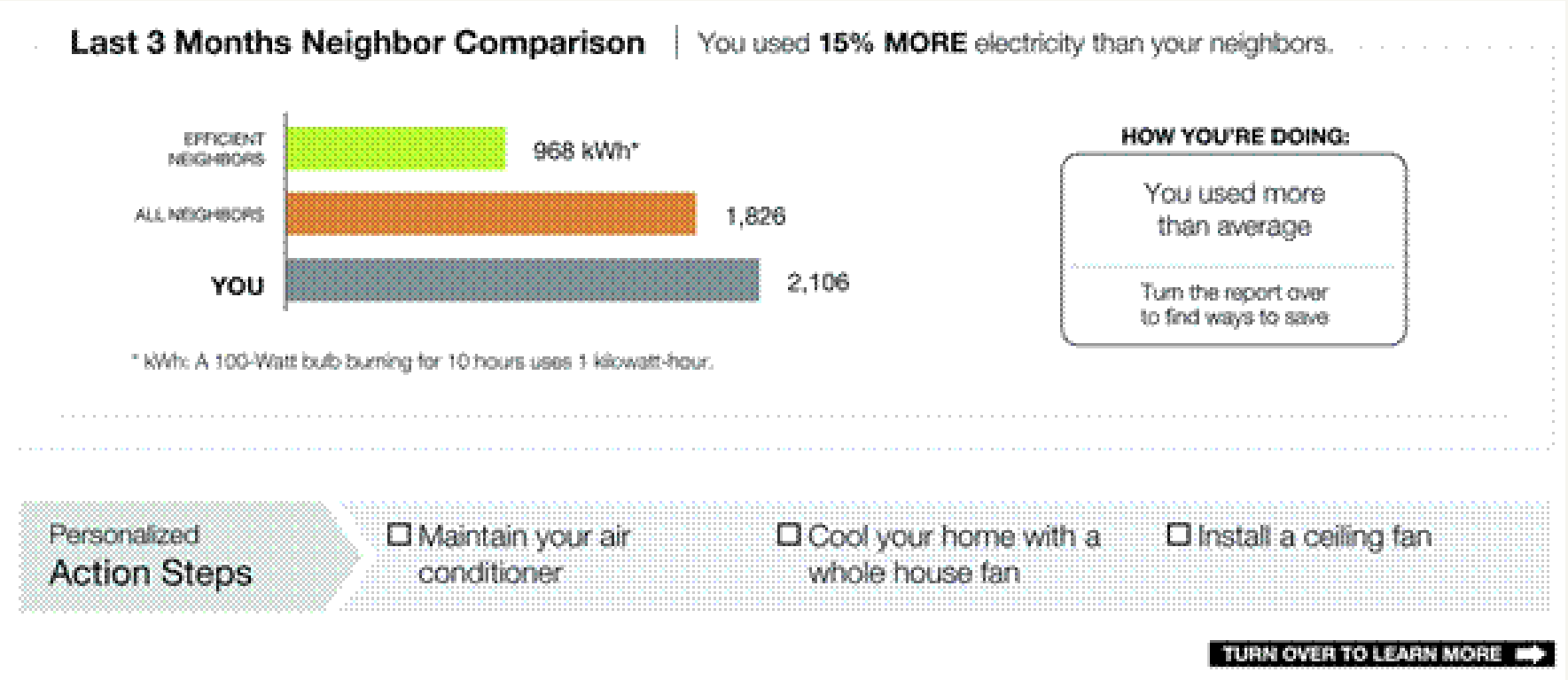
Informing

Average Household Electricity Savings (4-12%) Of Historical Programs by Feedback Type



Motivating

… looking beyond financial incentives; using social norms, networks, goals, commitments, competitions, prompts, etc. to create a shift toward new *practices*.



Empowering and Enabling

…removing financial and structural barriers, providing better choice sets, building self-efficacy, and creating supportive communities (make it easy – invite people to make a difference!)

- Distributed Energy Systems
- Well Designed Choice Architecture
  - Electricity pricing
  - Choosing green energy sources
  - Home energy management

In Sum

The human dimensions of energy and conservation can have a dramatic impact.

People don’t always act the way we expect them to.

Social science can help us to build more effective approaches.

Contact Information

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