How Behavioral and Social Science Can Help Understand and Reduce Energy Consumption

Paul C. Stern

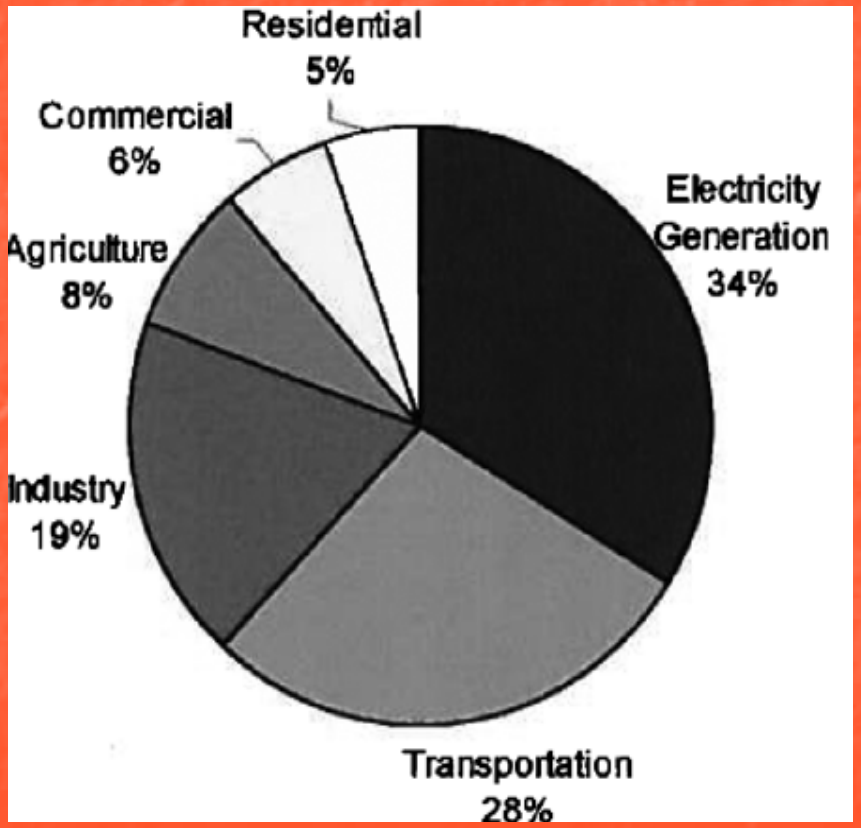
Director
Committee on the Human Dimensions of Global Change
National Research Council, USA

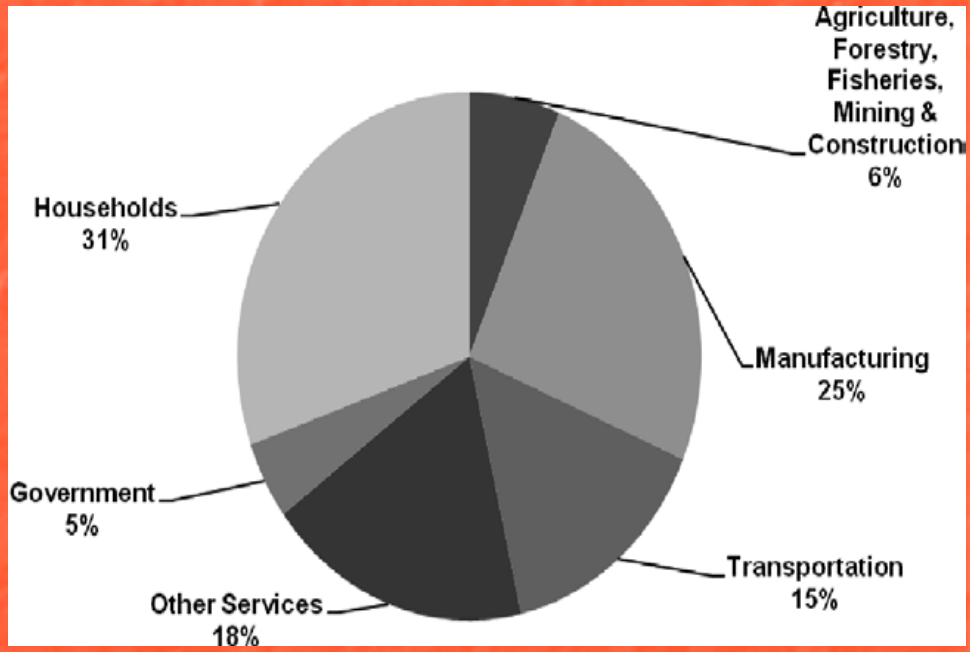
American Academy of Arts and Sciences
Symposium on Social Science
and the Alternative Energy Future
Washington DC, May 19, 2011

Two ways to analyze energy consumption:

Left: By place of use (EPA GHG inventory, 2005 data)

Right: By end user (Dept. of Commerce, 2006 data)





Household direct consumption:

Energy savings with available technology, no net cost

Estimated potential emissions reduction from cost-effective use of existing technology, U.S. households (Dietz et al., 2009)

	MtC	Percent
Building shells	25.2	
Home heating and cooling efficiency	12.2	
Efficient home appliances	22.8	
Vehicle efficiency	63.7	
		19.5
Home equipment adjustments, maintenance	15.1	
Daily in-home actions	25.3	
Auto maintenance	8.6	
Driving behavior	24.1	
Carpooling, trip chaining	36.1	
		17.1
TOTAL	233.1	36.6
		(of sector)

Why does this large gap persist?

The dominant analytical model (the Physical-Technical-Economic Model, or PTEM; Lutzenhiser et al., 2009)...

...does not adequately explain behavior

The model presumes that energy consumption will be reduced if and only if:

- Existing technologies can provide energy services with less energy
- They do so at zero or negative net cost

Behavioral analysis can be broader: Example: household direct consumption

Household actions can be classified by their behavioral demands

- Adopting more efficient technology
  - Weatherization investments (including HVAC)
  - Other energy-efficient equipment
- Changing use of technology
  - Adjustment of household equipment
  - Maintenance of household equipment
  - Daily actions or routines

Technology choice is influenced by the context of behavior…

- First cost of efficiency improvements (not only life-cycle cost)
- Split incentives (e.g., owner – renter)
- Supply chain issues (choices by manufacturers, builders, retailers, repair personnel, etc.)
- Regulatory barriers (e.g., utilities do not invest unless they are allowed to earn returns)
- Difficulty/impossibility of getting useful, credible, targeted information on savings from specific actions
- Infrastructure barriers (e.g., suburbanization)
- Consumerist cultural pressures (increasing home size, vehicle power over time)

Lesson: the context of household choice constrains the ability to reduce emissions

...and by personal factors

- Invisibility of energy use and savings
- Available information is not easily to understand
- Cognitive heuristics and habits
  - availability heuristic—focus on the actions that are easiest to think of but not the most effective
  - divided accounts—energy efficiency treated as an expenditure, not compared to other investments
- Economizing on the cognitive effort needed to get useful, credible, targeted information
- Motives beyond self-interested cost minimization

Lessons:

- Reducing external barriers to change is not sufficient
- Reducing psychological barriers is also not sufficient

Strategy for finding effective actions

The details vary. So…

- Identify the behaviors with high impact (and who the key actors are)
- Identify the barriers to action for each target behavior
- Address multiple barriers with multiple interventions and targets—“full court press”
- Full-court press is behavior specific

Implications for action

There are usually multiple barriers to taking any new action

Most policies address only one barrier—with limited results

- Prices and financial incentives matter, but
  - the efficiency gap is the change they fail to produce
  - they could be made much more effective
- Information: People have systematic misunderstandings, but information alone has little effect

The most effective policies are multi-pronged

How much can reasonably be achieved? The behavioral wedge (Dietz et al., 2009)

Definition: The amount ofenergy or emissions reduction that can be achieved by voluntary changes in household adoption and use of technology

Estimates based on most effective demonstrated practices

Analysis covers:

- Only technologies available at retail
- No new standards or regulations
- Only actions with negative cost, zero cost, or attractive returns on investment to consumer
- No appreciable change in lifestyle/loss of well-being
- No appreciable change required in preferences for energy services (comfort, speed, etc.)

[Emissions reductions without sacrifice: a limited program]

Reasonably Achievable Energy Use Reduction
(estimated % of U.S. national household share, year 10)

Category	
Weatherization, HVAC	5.1
Other Equipment	9.0
Maintenance	1.5
Adjustment	0.4
Daily Activities	3.8
TOTAL	19.8 (123 MtC)

...and much is omitted:

- mandated phaseout of incandescent lighting in 5 yr, preempting behavioral interventions and adding 4-5%
- technologies on the verge of mass market penetration (heat pump HVAC, electric vehicles, LED lighting)

Significance of this achievable reduction

- Major near-term reduction is possible (slightly larger than national emissions of France; more than 40% of Obama's 10-year commitment for Copenhagen)
- Achievable only by combining intervention types—**such policies are rarely in place**
- Technology or cap-and-trade cannot work this fast
- Does not require an Act of Congress
  - Implementation possible by states, municipalities, PUCs, private companies

What are the best practices?
Six design principles for effective programs

- Prioritize high-impact actions (I = tpn)
- Provide sufficient financial incentives
- Market the program effectively
- Provide credible information at points of decision
- Keep it simple
- Provide quality assurance

Sources: Stern, Gardner, Vandenbergh, Dietz, & Gilligan (2010); Stern (2011)

What does a behaviorally effective program look like?

- More like Cash for Clunkers
  - Marketed intensively by industry
  - Significant incentives available immediately
  - Simple to collect
  - Known-quality products
- Less like home retrofit incentive programs
  - Disorganized marketing
  - Delayed incentives
  - Multiple paperwork hurdles
  - Uncertain product quality

How can effective policies be found?

- A full-court press is needed: Select programs that combine policy types
- Research to identify important targets and the barriers and opportunities for each
- Careful program design with experimentation to find most effective full court press
- Research on how best to design for particular actions (information systems, messages, incentives)
- Research to evaluate programs and learn from experience
- Significant financial incentives for expensive actions (e.g., home weatherization)

Beyond household direct consumption: More arenas for behavioral science

- Understanding and addressing *indirect* energy use by households (non-energy goods and services, green energy, etc.)
- Lifestyle analysis
- Behavioral issues in consumer product supply chains
- Human factors design of energy efficiency and information technology (smart meters, home equipment controls, etc.)
- Design of low-energy buildings and communities for attractiveness
- Developing user-friendly carbon accounting systems (calculators, labels, energy-cost of occupancy for homes)
- Behavioral factors in organizational energy use

The Issue of Policy Framing

- Behavioral science misperceived as influencing preferences (“mind control”)
- Much can be done by enabling preference
  - People don’t leave money on the ground because they prefer to
  - It’s not easy being green (or saving money with energy efficiency)
  - Policy can make it easier

How can we get the benefits of behavioral and social science?

- Address barriers in government
  - Energy/environment agencies need to see behavioral science as mission-relevant
  - Expand energy research agenda beyond technology and economics
- Address barriers in academia
  - Energy is not a core topic in the BASS disciplines
  - Few U.S. behavioral and social scientists have the interest and knowledge to do good work on energy policy
- Support is needed for both applied and fundamental energy social science (implies DOE-NSF collaboration)
  - This presentation focuses on part of the applied agenda
  - To attract the scientists, developing fundamental energy social science is also critical (e.g., research on consumption)

Some references, contact information

T. Dietz, G.T. Gardner, J. Gilligan, P.C. Stern, and M. Vandenbergh, Household actions can provide a behavioral wedge to rapidly reduce U.S. carbon emissions, in preparation. *Proceedings of the National Academy of Sciences,* 2009, 106:10452-10456.

G.T. Gardner and P.C. Stern, *Environmental Problems and Human Behavior, 2nd ed. Pearson Custom Publishing, 2002.*

National Research Council, *Facilitating Climate Change Responses.* National Academies Press, 2010.

P. C. Stern, Contributions of psychology to limiting climate change. *American Psychologist,* 2011, 66:303-314.

P.C. Stern, G.T. Gardner, M.P. Vandenbergh, T. Dietz, and J. Gilligan, Design principles for carbon emissions reduction programs. *Environmental Science & Technology,* 2010, 44:4847-4848.

Contact: Paul C. Stern

National Research Council, Washington DC, USA

pstern@nas.edu