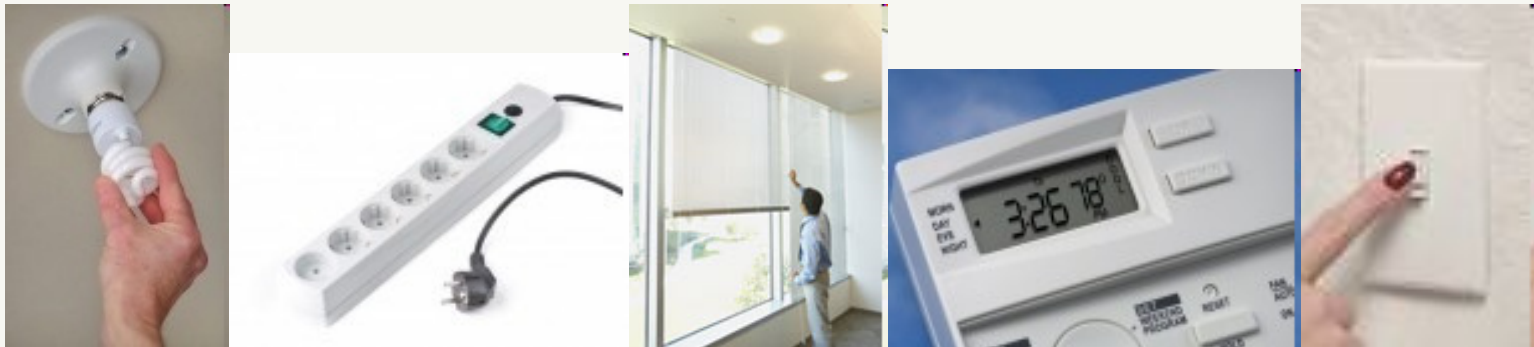


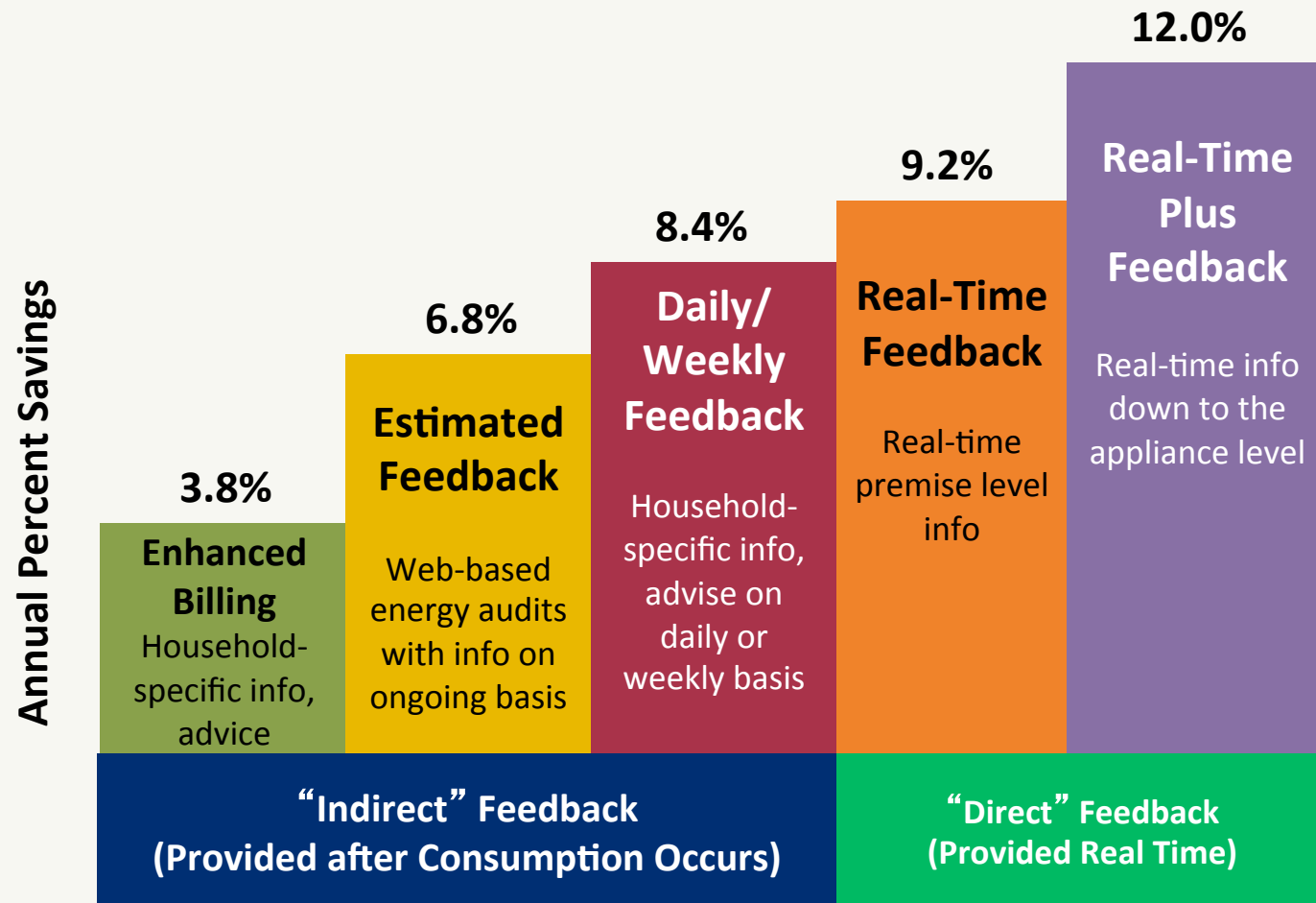
Comparison of Feedback-Induced Behaviors Across 3 Types of Feedback

Does the type of feedback matter?



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

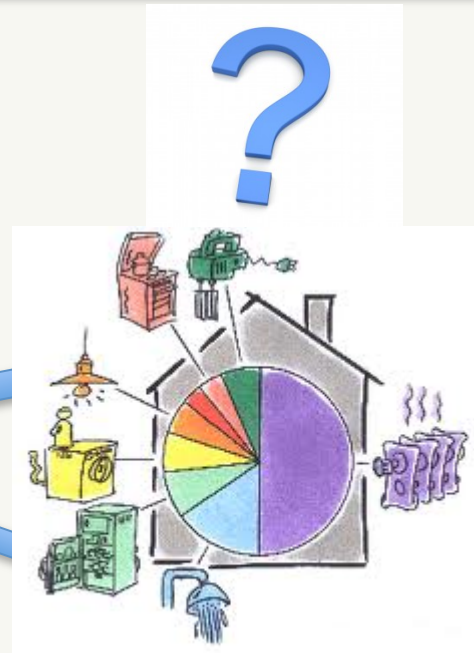


Source: Ehrhardt-Martinez et al. 2010

Research Questions

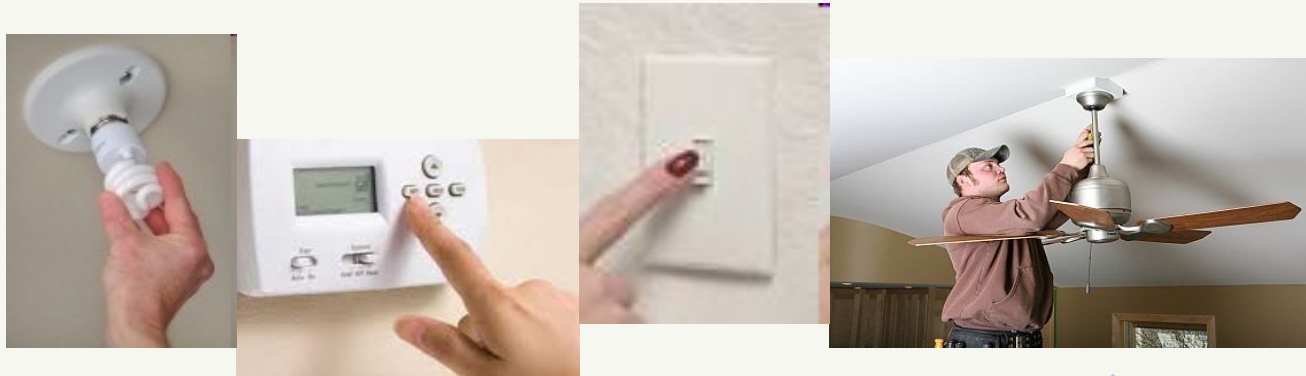


PowerTab Display by Energy Aware



Research Questions

1. What types of behaviors are people most likely to engage in as a result of feedback? And how useful are our current categorization schemes for distinguishing types of behaviors?
2. Do those behaviors vary depending on the *type* of feedback?
3. Are certain types of behaviors linked more closely to certain types of feedback?



What we hope to learn...

1. What most people are doing.
2. The types of opportunities that remain.
3. Clues about how to use different *types* of feedback more strategically or in combination to achieve maximum savings.



ECEEE Research Paper

1. **What types of behaviors are people most likely to engage in as a result of feedback? And how useful are our current categorization schemes for distinguishing types of behaviors?** 2011 ECEEE paper looked across 13 different studies. (Ehrhardt-Martinez 2011)

Behavioral Categorization Schemes Limit our Understanding

Curtailment vs. Efficiency

Investments vs. non-investment behaviors

Shortcomings of 13 Studies:

- Don't acknowledge wasteful practices
- Equate curtailment with sacrifice (think Jimmy Carter).
- Leave other sources of variation unrecognized.

3 Categories of Behaviors

	Frequency of Action	
	Infrequent	Frequent
Low-cost or No-cost	Energy Stocktaking Behavior and Lifestyles Choices Reprogram the thermostat Install weather stripping Replace furnace filter Caulk windows Lower temperature on hot water heater	Routine and Habitual Behaviors Wash only full loads of laundry Wash clothes in cold water Air dry laundry Reduce oven use Use window fans instead of AC
Higher Cost / Investment	Investment Choices and Purchasing Decisions Purchase new EE Appliances Purchase new insulation Purchase a new EE Furnace Purchase new EE Windows Purchase new EE electronics	

(Adapted from Laitner et al. 2009)

Research on Feedback-Induced Behaviors

That review found that...

*Among the many potential types of energy efficiency and conservation behaviors, people were most likely to make changes in a wide variety of **everyday practices** and engage in **some energy stocktaking behaviors**.*

Only a small proportion of people reported having made investments in more energy efficient products and appliances.

Source: (Ehrhardt-Martinez 2011)

Research on Feedback-Induced Behaviors

Among the most frequently reported behaviors...

1. Turning off lights
2. Installing energy efficient light bulbs
3. Changing the thermostat setting
4. Turning off the AC or reducing its use
5. Turning down electric space heater settings
6. Reducing the use of clothes washer
7. Using cold water to wash clothes.

Source: (Ehrhardt-Martinez 2011)

Research Questions

1. What types of behaviors are people most likely to engage in as a result of feedback?
2. Do the categories of behaviors generated by feedback vary according to the type of feedback?
3. Are certain types of behaviors linked more closely to certain types of feedback?

Research Questions

For example...

1. Darby (2006), suggests that ***indirect feedback*** (feedback that has been processed in some way before reaching the energy user) is usually more suitable for demonstrating changes in space heating and the impact of investments, while ***direct feedback*** is better for addressing the impact of smaller end uses.
2. Are some types of feedback more likely to result in technology investments or investments in building retrofits?

Present Research Focus

Research Focus	Compare behaviors across different types of feedback.
Types of Feedback Investigated	Enhanced Billing, Monthly Online Feedback, Real-time, In-home Displays
Core Challenge	Finding a way to make meaningful comparisons across programs when there are hundreds of types of behaviors that people might engage in.

Alternative Categorization Scheme

	Behavior Category	Description
1	A l t e r n a t i v e Technology Choice	Choosing btwn technologies w/different energy implications (ex: window fan vs. AC, or CFL vs. incandescent light bulb)
2	C o n s e r v a t i o n Behavior	Doing things differently in ways that save energy (ex: washing and drying full loads of laundry, taking shorter showers)
3	Conservation Setting	Changing the settings on lights, appliances and electronics (ex: changing thermostat, computer, or fridge settings)
4	Enhanced Control	Purchasing and using special equipment that allows for enhanced control (ex: using power strips, timers, & program. thermostats)
5	Investment Decision	Purchasing more EE technologies that cost > \$200 (i.e: attic and wall insulation, a new furnace or AC unit, or new kitchen appliances)
6	Low Cost Investment	Purchasing relatively inexpensive things (<\$200) that aren't replaced often w/the goal of reducing energy consumption (ie: insulation for a hot water heater, low-flow shower head)
7	Maintenance	Maintaining existing equipment in ways that reduce energy consumption (i.e.: cleaning furnace filters, or replacing fridge seals)
8	Turning Off	Turning off appliances, electronics and any energy using device.
9	Unplugging	Unplugging appliances, electronics or any energy using device.

Feedback through Enhanced Billing

Distribution of Identified and Actual Actions for Enhanced Billing Feedback

Type of Action	Identified Actions		Actual Actions		Difference
	#	%	#	%	
Practice	18	47%	388	82%	+35%
Purchase	17	45%	78	16%	-29%
PP	3	8%	10	2%	-6%
Alternative Tech. Choice (ATC)	1	3%	118	25%	+22%
Conservation Behavior	8	21%	10	2%	-19%
Conservation Settings	1	3%	53	11%	+8%
Enhanced Control	3	8%	10	2%	-6%
Investment	14	37%	63	13%	-24%
Low Cost Investment	3	8%	15	3%	-5%
Maintenance	0	0%	0	0%	0%
Turn Off	4	10%	166	35%	+25%
Unplug	3	10%	41	9%	-1%
TOTAL	38	100%	476	100%	

Feedback through Enhanced Billing

Ten Most Popular Actions for Enhanced Billing Feedback

	Action	Type	Freq	% of HHs
1	Turn off lights	Prac.	132	26.4%
2	Replace incandescents with CFLs	Prac.	118	23.6%
3	Change thermostat setting	Prac.	53	10.6%
4	Unplug devices and electronics	Prac.	41	8.2%
5	Turn off devices	Prac.	34	6.8%
6	New EE appliances (washer, fridge, unknown)	Invest.	12	2.4%
7	Install Insulation (attic, basement, crawl space, garage)	Invest.	10	2.0%
8	Plastic window covering	LCI	10	2.0%
9	New EE Windows	Invest.	9	1.8%
10	Install Programmable Thermostat	PP.	6	1.2%
	Number of HHs taking one or more actions.		425	100%

Online Monthly Feedback

Distribution of Potential and Actual Actions for On-line Feedback

Type of Action	Potential Actions		Actual Actions		Difference
	#	%	#	%	
Practice	66	65%	28,046	78%	+13%
Purchase	31	31%	3,552	10%	-21%
PP	4	4%	4,235	12%	+8%
Alternative Tech. Choice (ATC)	11	11%	4,927	14%	+3%
Conservation Behavior	41	41%	19,352	54%	+13%
Conservation Settings	4	4%	1,126	3%	-1%
Enhanced Control	2	2%	1,351	4%	+2%
Investment	23	23%	2,472	7%	-16%
Low Cost Investment	8	8%	915	3%	-5%
Maintenance	5	5%	1,767	5%	0%
Turn Off	3	3%	2,346	7%	+4%
Unplug	4	4%	1,577	4%	0%
TOTAL	101	100%	35,833	100%	

Online Monthly Feedback

Ten Most Popular Actions for On-line Feedback

	Action	Type	Freq	% of HHs
1	Replace incandescent bulbs with CFLs	PP	2871	70%
2	Use blinds during summer days	Prac.	2704	66%
3	Wash larger loads of dishes	Prac.	2699	66%
4	Turn off computer when not in use	Prac.	1832	45%
5	Turn off coffee maker when not in use	Prac.	1639	40%
6	Use microwave instead of conventional oven	Prac.	1292	31%
7	Raise AC thermostat	Prac.	1183	29%
8	Use a drying rack for clothes (instead of dryer)	Prac.	1177	29%
9	Turn off extra lights	Prac.	1150	28%
10	Use a smart strip to reduce standby electricity use	PP	832	20%

Real-Time, In-Home Feedback

Distribution of Potential and Actual Actions for Real-Time Feedback Users

Type of Action	Potential Actions		Actual Actions		Difference
	#	%	#	%	%
Practice	72	59%	634	71%	+12%
Purchase	38	31%	119	13%	-18%
PP	12	10%	138	15%	+5%
Alternative Tech. Choice (ATC)	9	7%	99	11%	+4%
Conservation Behavior	20	17%	172	19%	+2%
Conservation Settings	17	14%	138	16%	+2%
Enhanced Control	9	7%	111	12%	+5%
Investment	29	24%	97	11%	-13%
Low Cost Investment	9	7%	22	2%	-5%
Maintenance	12	10%	108	12%	+2%
Turn Off	7	6%	95	11%	+5%
Unplug	9	7%	47	5%	-2%
TOTAL	122	100%	889	100%	

Real-Time, In-Home Feedback

Ten Most Popular Actions for Real-Time Feedback Users

	Action	Type	Freq	% of HHs
1	Use power strips on home entertainment system	PP	31	38%
2	Use power strips on home computer system	PP	29	36%
3	Reduce wattage in multiple bulb fixtures	PP	26	32%
4	Power off external computer speakers	Prac.	26	32%
5	Clean your dryer lint filter	Prac.	25	31%
6	Use CFLs in indoor fixtures	PP	24	30%
7	Set dryer timer to the minimum time required	Prac.	23	28%
8	Run your dishwasher with a full load	Prac.	22	27%
9	Use lighting controls or timers	PP	19	24%
10	Install ENERGY STAR indoor light fixtures	Purch.	17	21%

Comparisons and Conclusions

Practices versus Purchases:

- All 3 types of feedback are *more likely to result in changes in HH practices* than investments.
 - 82% for enhanced billing
 - 78% for online feedback
 - 71% for real-time feedback
- Investment activities ranged from 7% for online feedback to 13% for enhanced billing.

Predominant Activities: Notable differences across feedback types

- **Enhanced billing:** turn things off and use alternative technologies.
- **Online feedback:** conserv. behaviors and alternative technology use.
- **Real-time feedback:** most varied, more inclined to focus on conservation settings, enhanced control mechanisms, and maintenance activities.

Comparisons and Conclusions

Darby (2006), suggests that *indirect feedback* is more suitable for revealing changes associated with space heating and investments, while *direct feedback* is better for addressing the impact of smaller end uses.

Findings not 100% in line with Darby's expectations...

But we do see that HHs receiving real-time feedback were more focused on actions associated with devices as opposed to HVAC and less likely to mention thermostat management and investments.

Caveats

- These findings are very preliminary – a first attempt.
- They do not result from a controlled experiment.
- The type of feedback is not the only source of differences between programs.
 - Some programs provided tips and others did not.
 - Some allowed for online interactions.
- All are based on *reported* behaviors.

Snapshots versus Understanding

More work is needed to Understand Causality and the Effects of:

- **Feedback Type**
- **Tips and recommendations**
- **Other program design elements (opt-in vs. opt-out)**
- **Household characteristics (rent/own etc.)**
- **Demographics**
- **Individual values, concerns, and affinities**
- **Biases and errors in self reporting**

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