

Psychological Research on Energy Reporting and Display

Beth Karlin

Transformational Media Lab

CUSA | Center for
Unconventional
Security Affairs

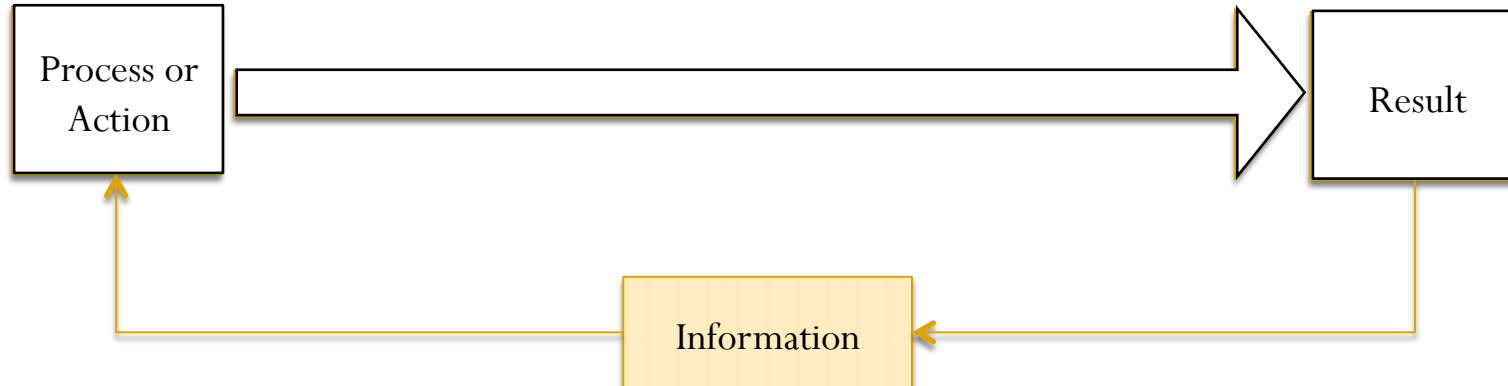
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Papers listed here. Contact me for details: bkarlin@uci.edu.

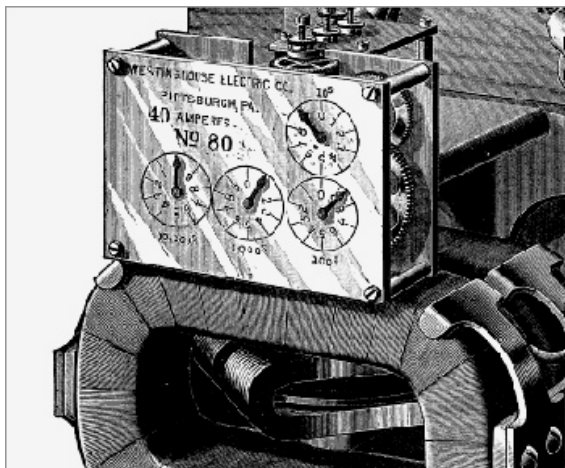
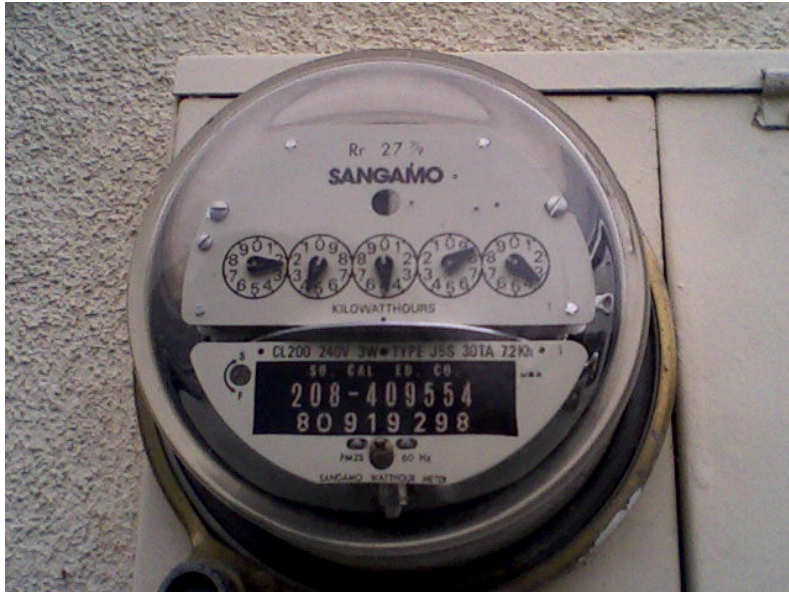
Feedback – a definition

“Information about the result of a process or action that can be used in modification or control of a process or system”

Oxford English Dictionary



Energy Feedback



1888

FPL
 P.O. Box 025270
 Miami, FL 33102

7 / 27

Please request changes on the back. Notes on the front will not be detected.

The amount enclosed includes the following donation:
 FPL Care To Share \$ _____

B 2,3,4,7,8 4118 6
 #0VNDJNO *** AUTO **CO 4501 116049 Z
 #0188843BQ485818#
 DELRAY BEACH FL 33445-3504

Make check payable to FPL in U.S. for and mail along with this coupon to:
FPL GENERAL MAIL FACILITY
 MIAMI FL 33188-0001

Account number	Total amount you owe	New charges due by	Amount enclosed
	\$295.43	Jul 16 2008	\$

Your electric statement
 for: May 27 2008 to Jun 25 2008 (28 days)
 Customer name:
 Service address:

Account number: _____
 Statement date: Jun 25 2008
 Next meter reading: Jul 23 2008

Amount of your last bill	Payments (-)	Additional activity (+ or -)	Balance before new charges (=)	New charges (+)	Total amount you owe (=)	New charges due by
328.10	328.10 CR	0.00	0.00	295.43	\$295.43	Jul 16 2008

Meter reading - Meter 7C18171
 Current reading - 50489
 Previous reading - 50153
 kWh used - 2336

Amount of your last bill
 Payment received - Thank you
 Balance before new charges 328.10

New charges (Rate: RS-1 RESIDENTIAL SERVICE) 328.10

Energy usage	Last Year	This Year	Electric service amount	Storm charge	Gross service amount	Franchise charge	Utility tax	Late payment charge	Total new charges
Wh this month	3375	2336							
Service days	32	29							
kWh per day	105	81							

*The electric service amount includes the following charges:
 Customer charge: \$5.34
 Fuel: (First 1000 kWh at \$0.052270) \$135.46
 Non-Fuel: (First 1000 kWh at \$0.062270) \$110.35
 (Over 1000 kWh at \$0.041340)
 (Over 1000 kWh at \$0.031660)

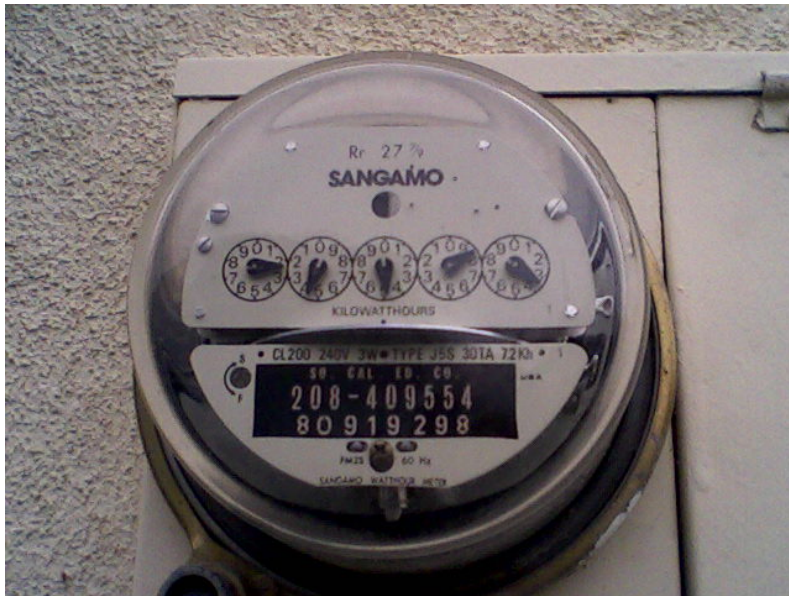
*A late payment charge of 1.50% will apply if not paid by July 16, 2008, and your account may be subject to being billed an additional deposit.
 *Would you like one less bill to think about & help the environment too? Enroll in FPL Automatic Bill Pay & your bill is always paid on time. Save time, postage, check writing & paper. Plus, cut fuel consumption of cars & trucks that transport checks. Enroll at FPL.com or see authorization form in this bill.

Total amount you owe \$295.43

Florida Power & Light Company
 P.O. Box 025270
 Miami, FL 33102

Please have your account number ready when contacting FPL.
 Customer service: (561) 994-8227
 Outside Florida: 1-800-228-3545
 To report power outages: 1-800-4OUTAGE (468-8245)
 Hearing/speech impaired: 711 (Relay Services)

Our Window of Opportunity



Mechanism is a “meter reader”



Digital, wireless, real-time

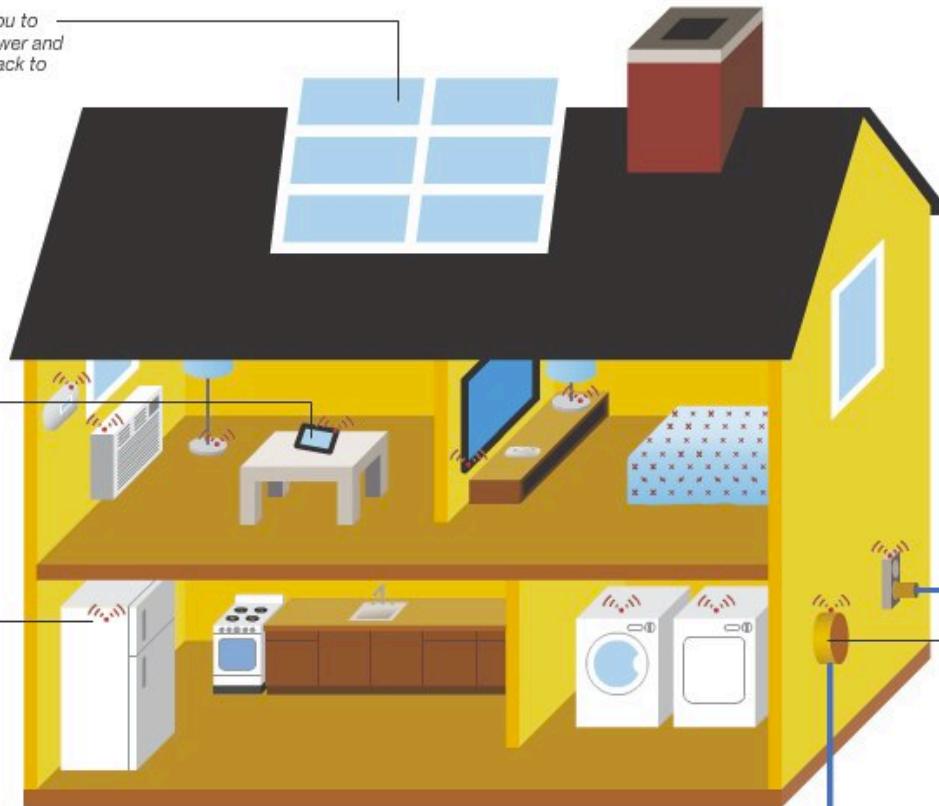


Our Window of Opportunity

Solar Panels allow you to generate your own power and send excess energy back to the grid.

In-Home Energy Monitor communicating with the smart meter allows you to track and manage your energy use.

Smart Appliances communicate with your in-home energy monitor, allowing you to program them so that you use less energy.



Plug-in Electric Car can connect to the grid and charge overnight or when demand is low for a cleaner, greener planet.



Smart Meter gathers information about how you are using energy, so we can monitor your needs more efficiently and anticipate challenging peaks.



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Our Window of Opportunity

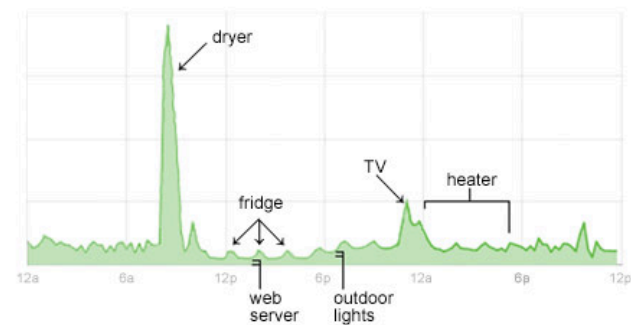
GREEN BUTTON INITIATIVE



ACCESS YOUR OWN DATA

Google™ POWERMETER

Home Electricity Use



Feedback is effective...

- 100+ studies conducted since 1976
- Reviews found average 10% savings
- Mean r-effect size = .1174 ($p < .001$)
- Significant variability in effects
(from **negative** effects to **over 20%** savings)



Feedback ~~is~~ *can be* effective...

- 100+ studies conducted since 1976
- Reviews found average 10% savings
- Mean r-effect size = .1174 ($p < .001$)
- Significant variability in effects
(from **negative** effects to **over 20%** savings)



Feedback ~~is~~ *can be* effective...

It depends...

Moderators identified in meta-analysis

- Study population (**WHO?**)
- Study duration (**HOW LONG?**)
- Frequency of feedback (**HOW OFTEN?**)
- Feedback medium (**WHAT TYPE?**)
- Disaggregation (**WHAT AMOUNT?**)
- Comparison (**WHAT MESSAGE?**)

Karlin, Ford & Zinger. (2014). The Effects of Feedback on Energy Conservation: A Preliminary Theory and Meta-Analysis. Under Review

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HOW Is Feedback Effective?



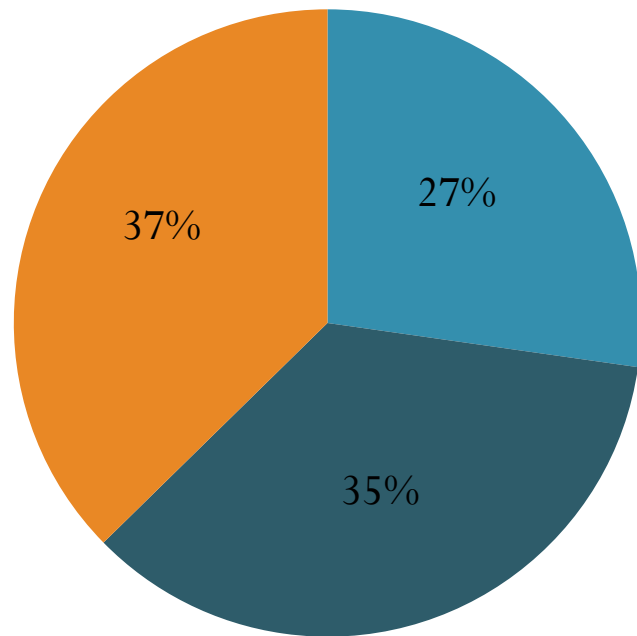
Ford, Karlin, & McCullough. (2014). The 5W's of Feedback: An Analytical Framework Investigating the Potential of Energy Feedback Technologies. In Preparation.

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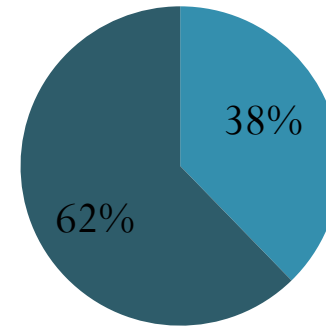


Who?

I have never heard about this kind of mechanism as I have not been proactive in learning about it.



- Aware of devices
- Aware, but not specific
- Not aware of feedback



- Adopted
- Not adopted

Had no idea that these exist.

Karlin, Davis, Sanguinetti, Gamble, Figuera, Baker, Kirkby, & Stokols. Diffusion of Feedback: Perceptions and Adoption of Devices in the Residential Market. In Preparation.

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Who?

Variable	Feedback users	Non-feedback users
Gender***	46% female 54% male	70% female 30% male
Age**	45.5 years	39.9 years
Race	81.7% Caucasian 1.2% Hispanic 6.1% Asian 1.2% African-American 9.7% Other/Decline	81.8% Caucasian 6.7% Hispanic 6.1% Asian 1.6% African-American 3.8% Other/Decline
Marital Status*	62% married 38% not married	52% married 48% not married
Political Affiliation*	2.04	2.33
Education	17.9 years	17.4 years
Income**	\$104,000	\$88,000
Home Type **	74% detached house 26% apartment/condo/other	53% detached house 47% apartment/condo/other
Homeowner***	82% own 18% rent	57% own 43% rent

Karlin, Davis, Sanguinetti, Gamble, Figuera, Baker, Kirkby, & Stokols. Diffusion of Feedback: Perceptions and Adoption of Devices in the Residential Market. In Preparation.

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Who?

Variable	Feedback users	Non-feedback users
Environmental		
- Environmental Concern^{***}	4.40	4.18
- Environmental Motivation^{**}	3.18	2.80
Financial		
- Price Consciousness[*]	0.70	0.59
- Financial Motivation^{**}	2.67	3.07
Social		
- Social Norms	3.04	2.92
- Social Motivation	1.95	1.83

* $p < .05$, ** $p < .01$, *** $p < .001$

Karlin, Davis, Sanguinetti, Gamble, Figuera, Baker, Kirkby, & Stokols. Diffusion of Feedback: Perceptions and Adoption of Devices in the Residential Market. In Preparation.

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Why?

Tracking

“Interesting in **tracking** instantaneous home energy use overall”

“would help to have a timer so that the information provided could be **tracked** over the exact amount of time.

“I like to check myself to make sure I’m on **track**”

“it is interesting to change your behavior and then **track** how your energy use changes over time”

Learning

“to **learn** my energy/carbon footprint”

“to educate myself and **learn** about programs that might apply to me”

Okay for researching and **learning**, but not for modifying behavior on an ongoing basis”

“**Learning** how high the wall voltage was in my area”

Why?

Tracking

Learning

Happens over time

Happens in a moment

Many “bits” of information

One “bit” of information

Not necessarily correlated to specific action(s)

Enables specific action/behavior change

Enables comparisons (e.g., historical, social)

Does not provide comparable information

Provides additional motivation for conservation behavior (e.g. competition, goal)

Potential for rebound and/or decreased attention to smaller conservation behaviors

Generally associated with aggregate (whole-home) feedback

Generally associated with disaggregated (appliance-specific) feedback

Karlin, Davis, Sanguinetti, Gamble, Figuera, Baker, Kirkby, & Stokols. Diffusion of Feedback: Perceptions and Adoption of Devices in the Residential Market. In Preparation.

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What Amount?



Temporal Granularity

- Monthly 12
- Daily 365
- Hourly 8,760
- Continuous 31,536,000

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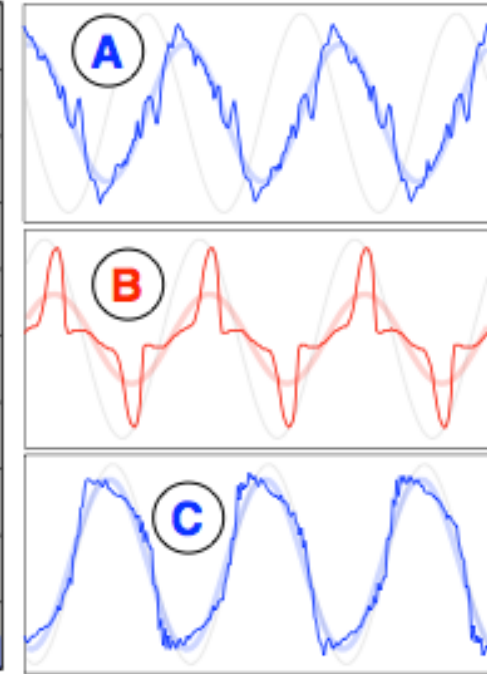
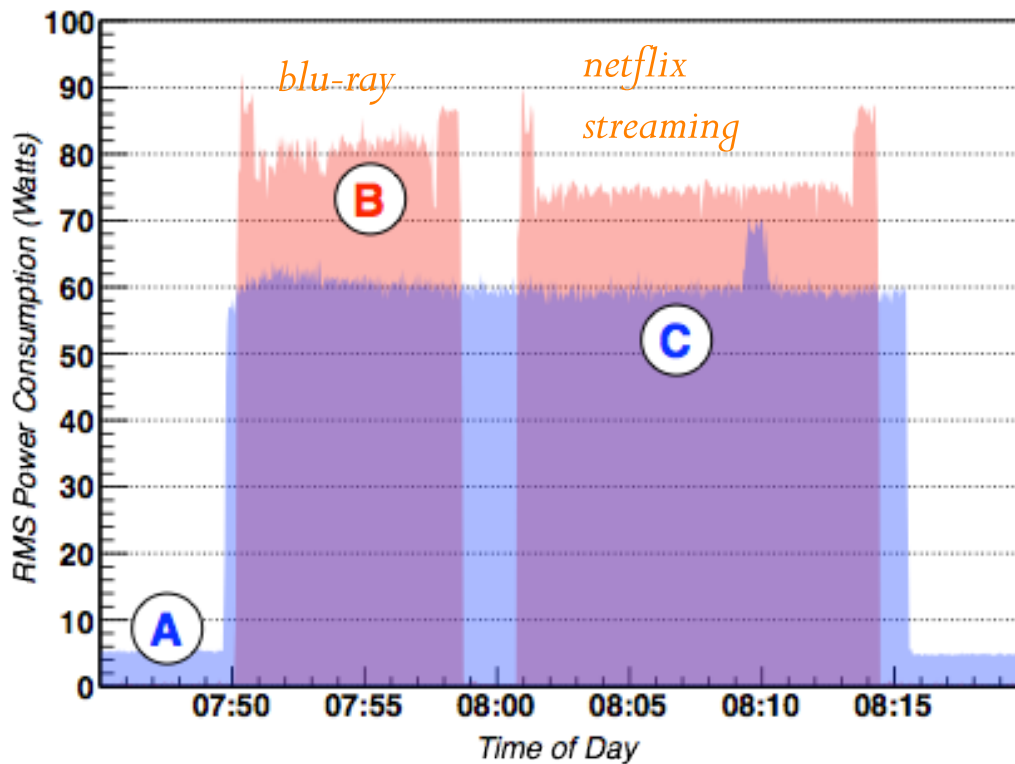
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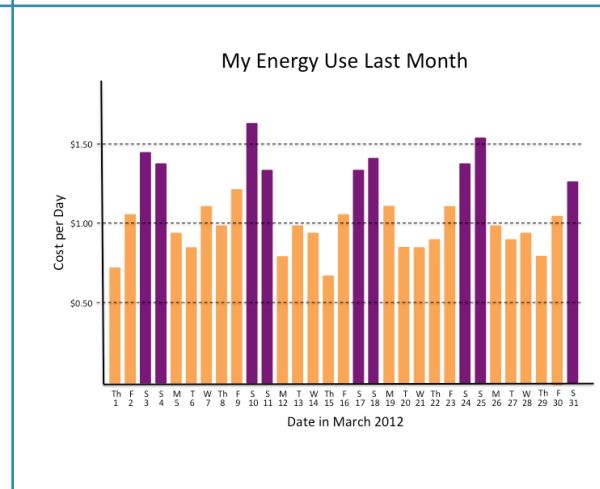
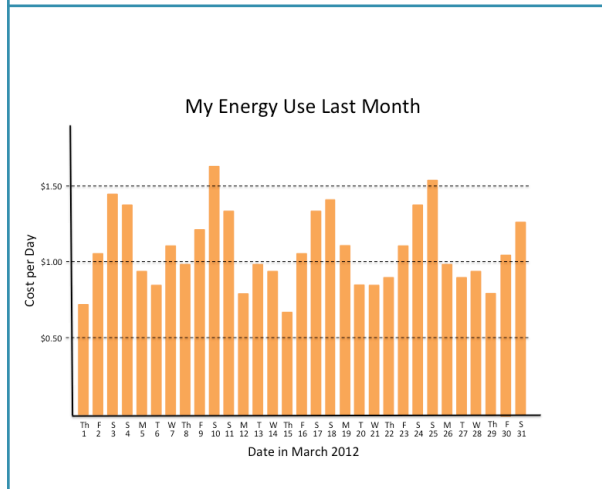
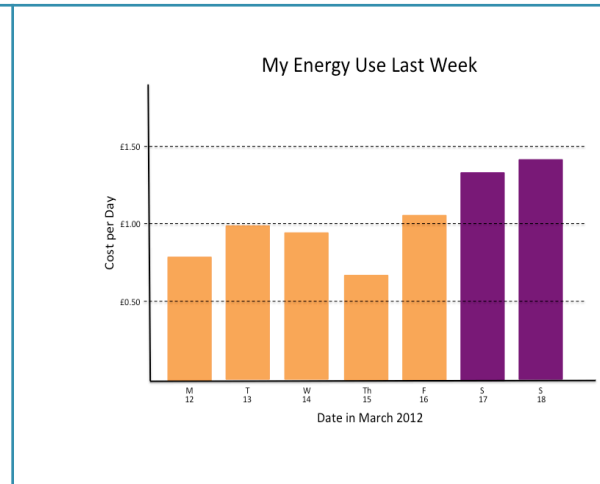
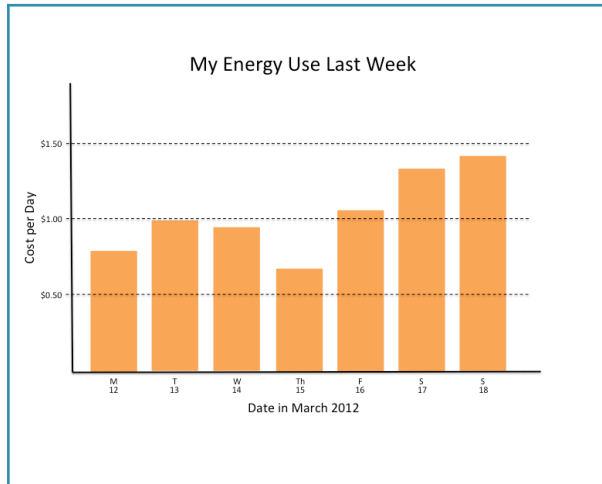
What Amount?

(up to **6.3 trillion** data points/year)

200 microsecond sampling



What Amount?



Ford & Karlin. (2013). Graphical Displays in Energy Feedback Technology: A Cognitive Approach. In: Proceedings of the Human Computer Interaction (HCII) Conference, Las Vegas, NV: ACM.

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What type?

1079 KwH/year



65.9 Billion



\$\$\$

\$.25/load

\$85/year

5.8% of average home

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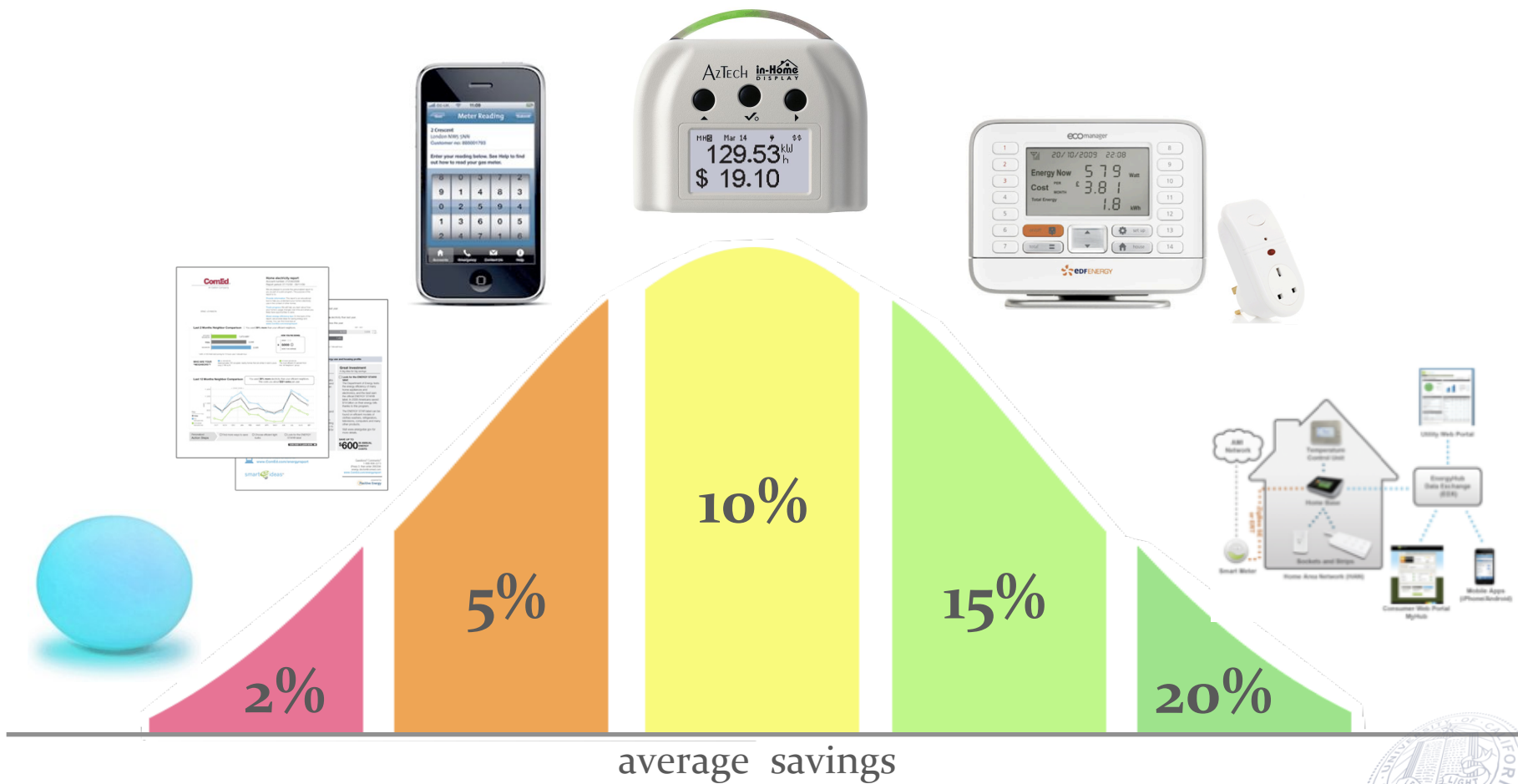
What type?

Impacts of leaving your router on when not in use

- 1 Leaving your router on wastes energy.
- 2 Turning your router off when not in use saves .07 kWh per day.
- 3 If you turn your router off when not in use, you can save \$2.63/year.
- 4 A router left on all day uses the equivalent of 37 AA batteries.
- 5 If all Americans turn off routers, we would save over \$800 million/year.



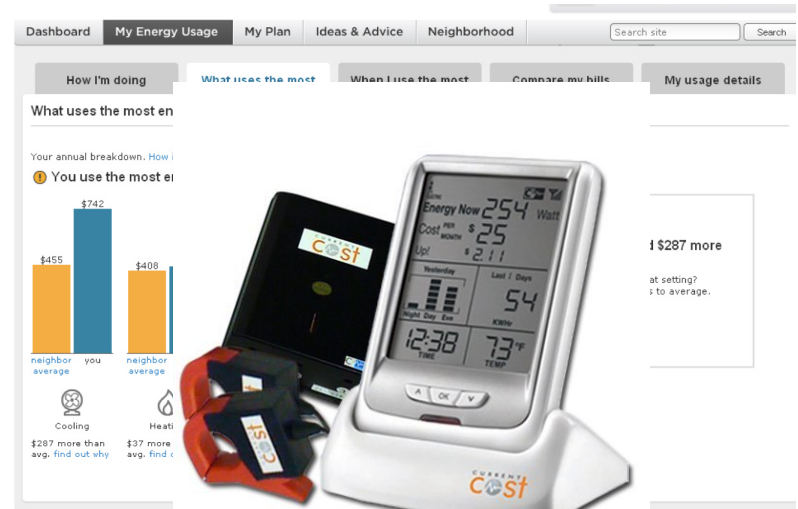
What Type?



average savings



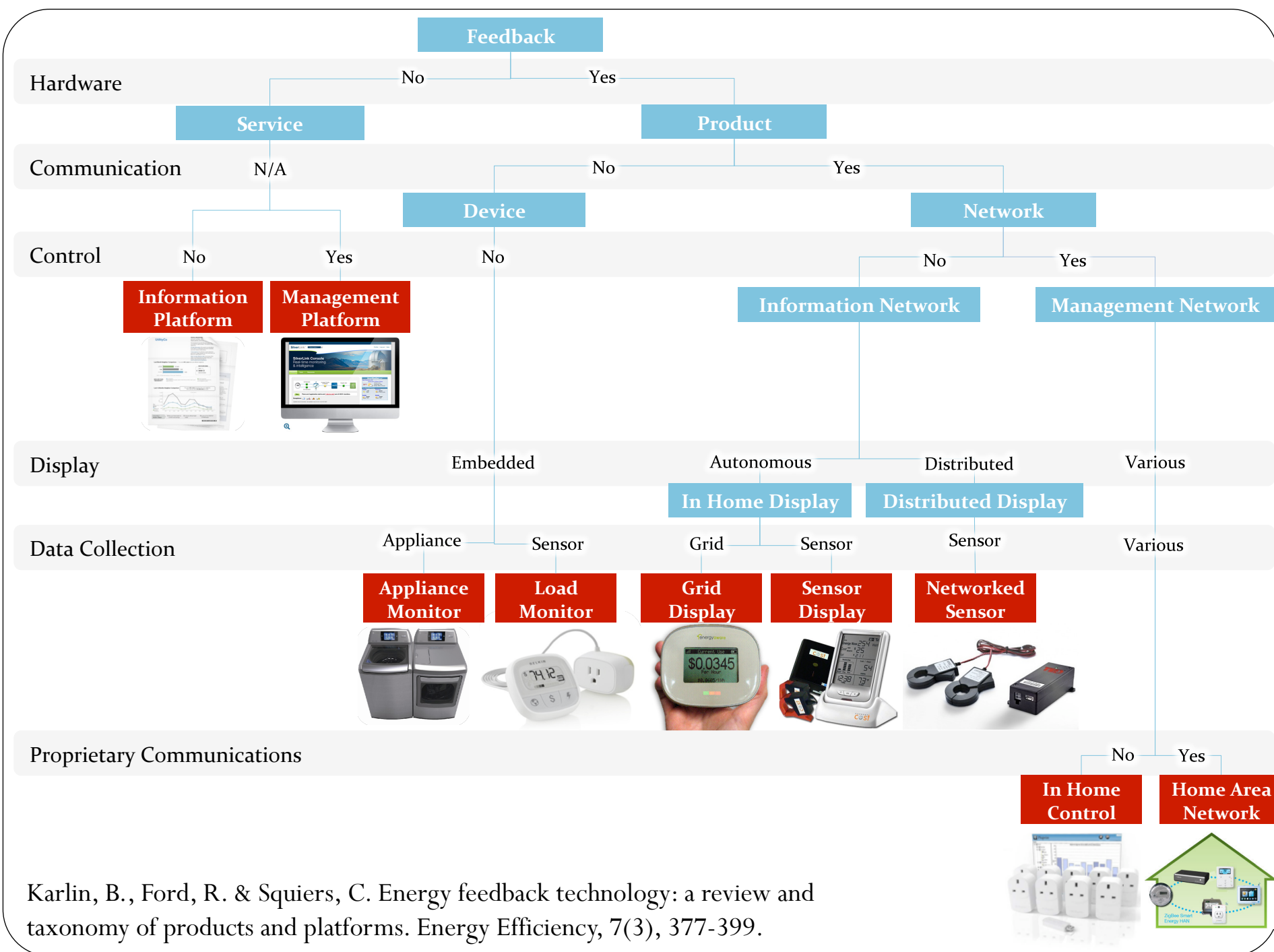
What Type?



Karlin, B., Ford, R. & Squiers, C. Energy feedback technology: a review and taxonomy of products and platforms. *Energy Efficiency*, 7(3), 377-399.

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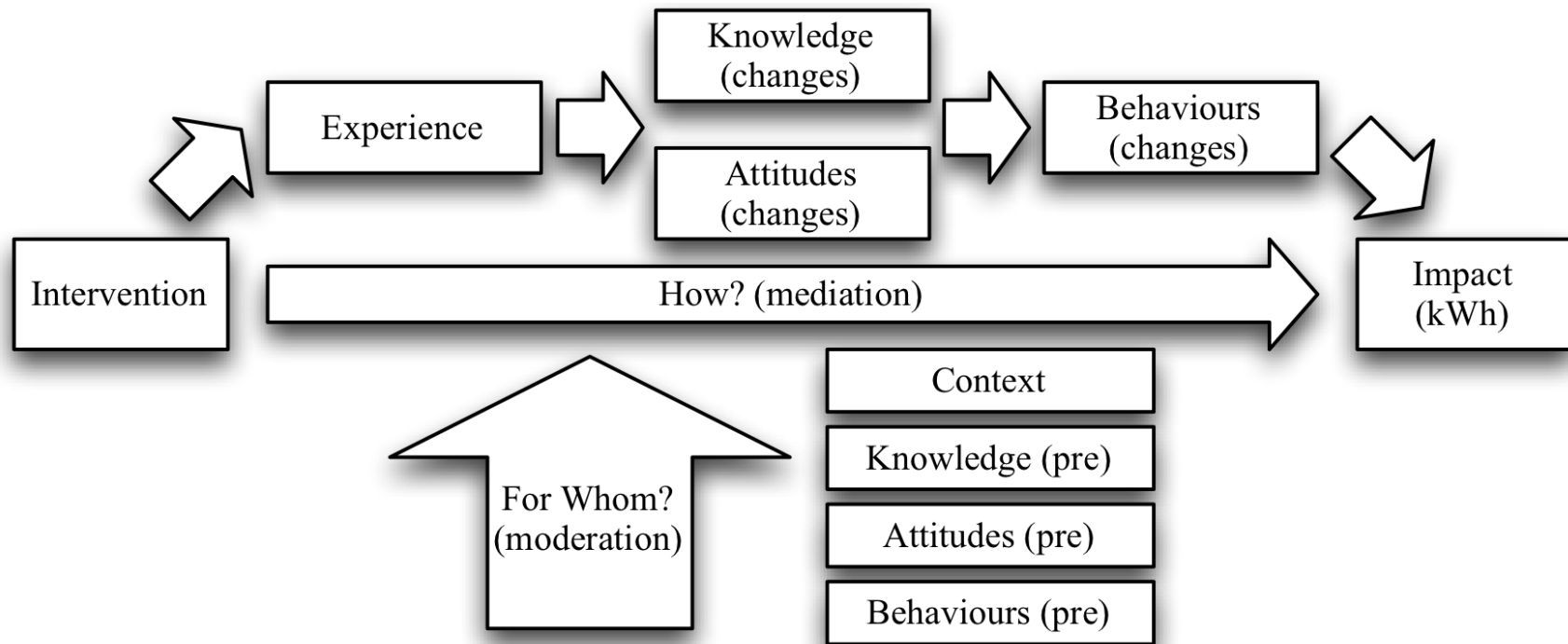




Karlin, B., Ford, R. & Squiers, C. Energy feedback technology: a review and taxonomy of products and platforms. *Energy Efficiency*, 7(3), 377-399.



What Outcome?



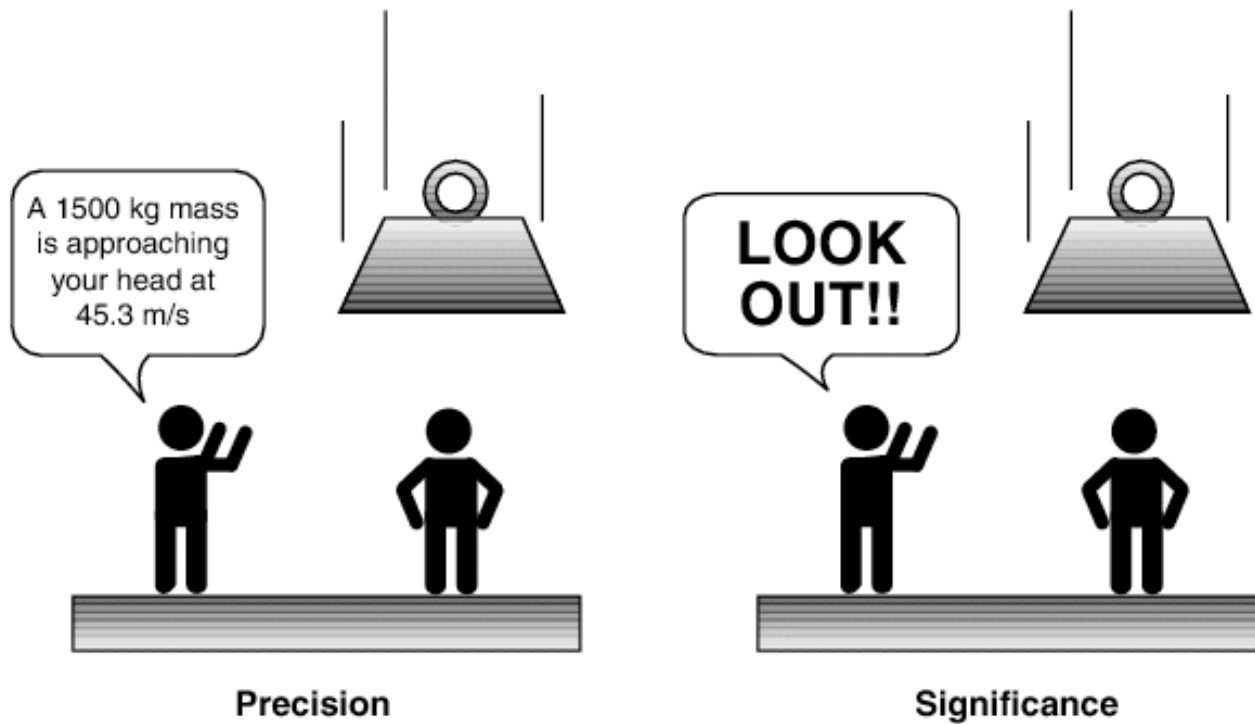
Karlin, Ford, & Rottman. (2015). Beyond kWh: A Framework for Assessing Behavior-Based Energy Interventions. IEA Task 24 Subtask 3 Report.

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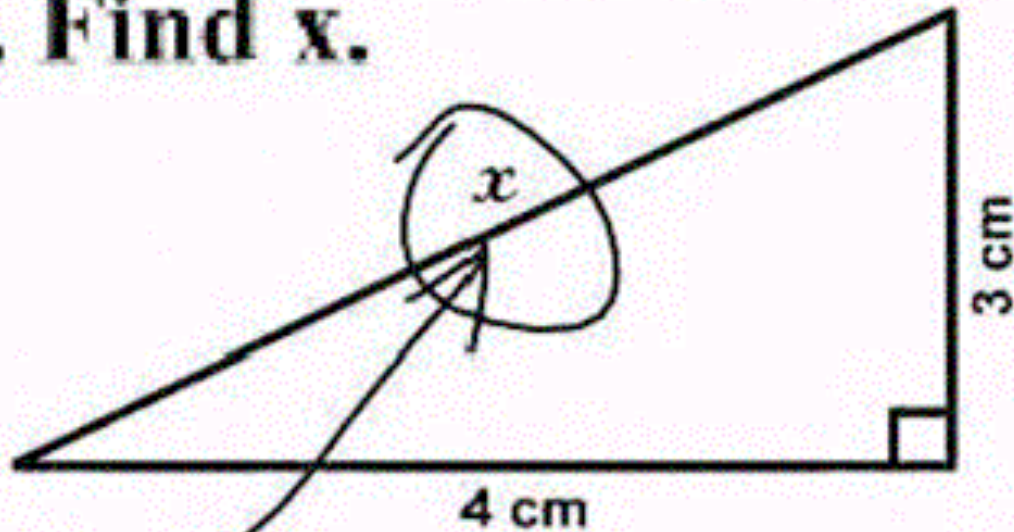
There are benefits to simplicity...

Precision and Significance in the Real World



But it's not always that easy...

3. Find x .



Here it is



Thank you!

Beth Karlin

Transformational Media Lab

CUSA | Center for
Unconventional
Security Affairs

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