Behavioral Interventions in Energy Consumption

Prepared for the Mason Energy Symposium

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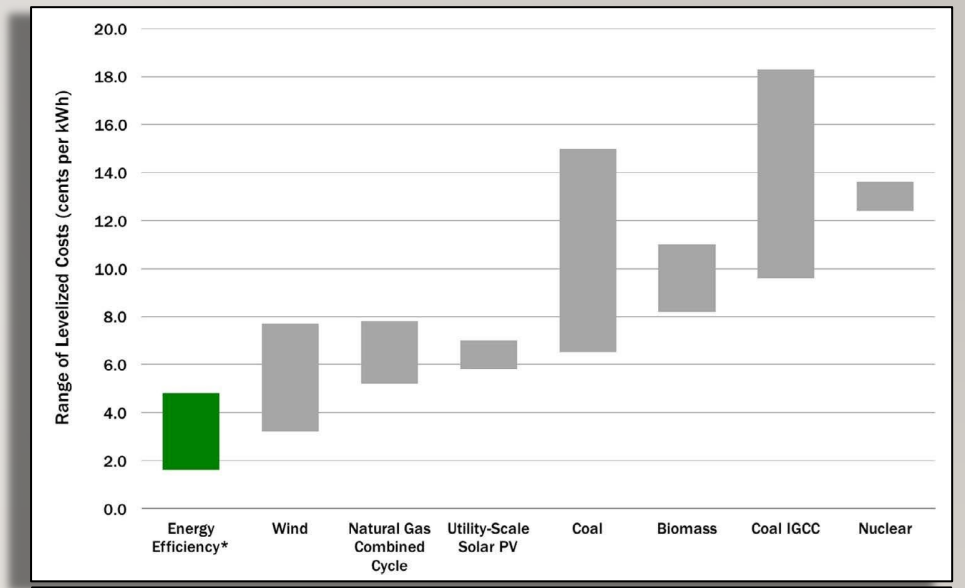
Public Policy Motivation

- Controlling energy costs through demand management
  - Cheaper to save 1 Kwh of energy than it is to generate 1 Kwh
  - Why do people not invest more in energy efficiency? = ”Energy Efficiency Paradox” or “Energy Efficiency Gap”
  - Consumers should be more heavily rewarded for reducing demand
  - Rebates and other conservation programs suffer from free-ridership
- Behavioral “nudges” have worked in energy conservation:
  - Neighbor or “peer” comparisons of energy usage (e.g. home energy reports)
  - Increased awareness/frequency of energy usage
  - Financial incentives - Pay for Performance
  - Loss Aversion still unexplored



American Council for an Energy Efficient Economy - eschwass, “How Much Does Energy Efficiency Cost?,” Text, ACEEE, March 17, 2016, http://aceee.org/how-much-does-energy-efficiency-cost.

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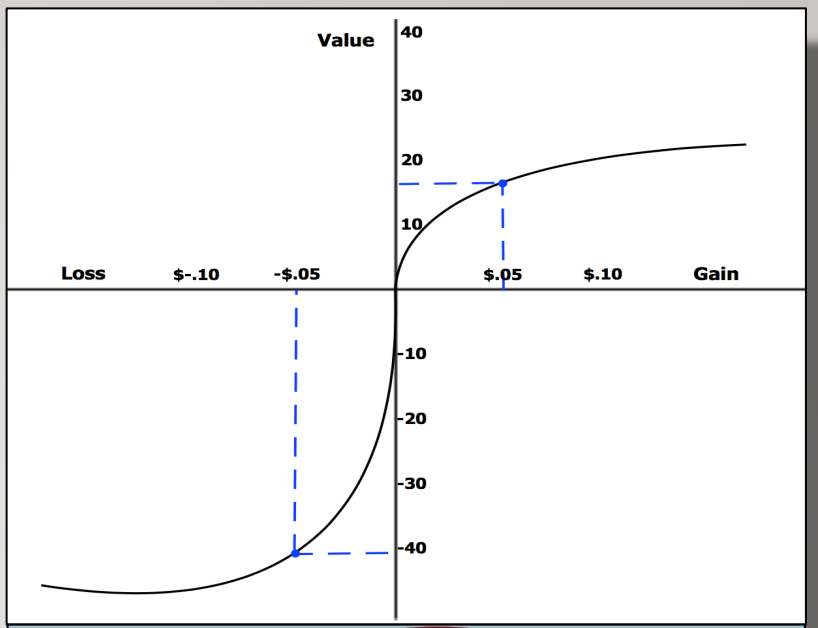
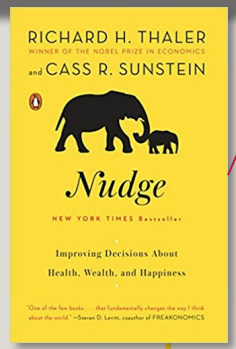
What is the theory?

- Loss Aversion or The Endowment Effect
  - Multiple studies show that people overvalue things they already own *relative to the same thing* they do not own (WTP < WTA)
  - Use an Energy Efficiency Escrow (EEE) as a proxy for potential losses
- Usage feedback
  - We know that increased information feedback can decrease consumption (meta-analysis of 42 studies → 7.1%)
  - Many caveats incl.
    - Frequency of feedback
    - Persistence
    - Environmental Predisposition



Daniel Kahneman, Jack L. Knetsch, and Richard H. Thaler, "Anomalies: The Endowment Effect, Loss Aversion, and Status Quo Bias," *Journal of Economic Perspectives* 5, no. 1 (March 1991): 193–206, https://doi.org/10.1257/jep.5.1.193



2018 Nobel Prize in Economics Winner

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Research Question - Hypothesis

Can Loss Aversion be used as to incentivize energy conservation?

- Hypothesis: Loss Aversion (through an EEE) will result in lower energy consumption relative to the same incentive given as a pay-for-performance program.

Establish User Baselines (e.g. 12 kWh per day)

Reward users with $0.10 for every kWh below baseline

Energy Efficiency Escrow

"your average daily power usage was 12.0 kW-hr/day. We will reward you $0.10 for every kWh you save below your average. We have calculated the maximum reward you could receive by using no energy over the next 60 days. This is your energy efficiency escrow (EEE)"

$(12.0 \text{ kW-hr})/\text{day} \times (60 \text{ days}) \times (\$0.1/(\text{kW-hr})) = \$72.00$

It will continuously decrement to reflect your actual usage. For instance, if after 60 days your average usage decreased from 12.0 kW-hr/day to 11.5 kW-hr/day your EEE will show a balance of:"

$[((12.0 - 11.5) \text{ kW-hr})/\text{day} \times (60 \text{ days}) \times (\$0.1/(\text{kW-hr}))] = \$3.00$

Pay-for-Performance

"your average daily power usage was 12.0 kW-hr/day. We will reward you $0.10 for every kWh you save below your average."

If average usage over the next 60 days is 11.5 kW-hr/day your reward will be:"

$[((12.0 - 11.5) \text{ kW-hr})/\text{day} \times (60 \text{ days}) \times (\$0.1/(\text{kW-hr}))] = \$3.00$

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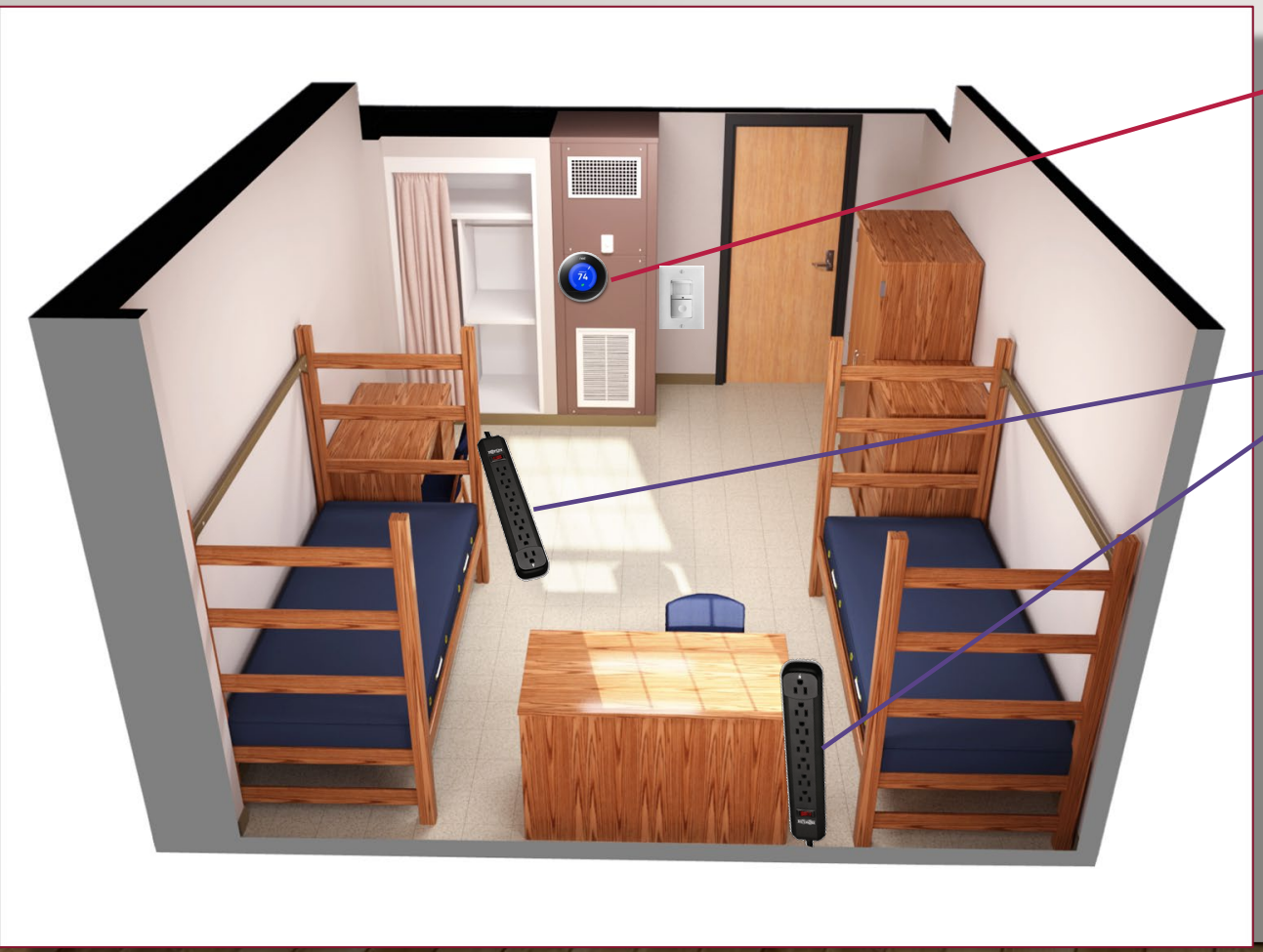
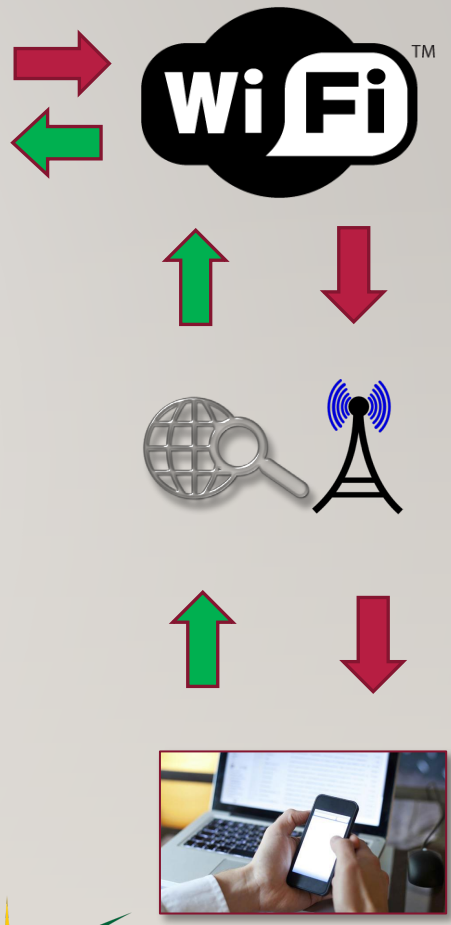
ARCHITECTURAL VIEW OF STUDY



Space Heating/Cooling

Variable loads – Monitor at PLUG level



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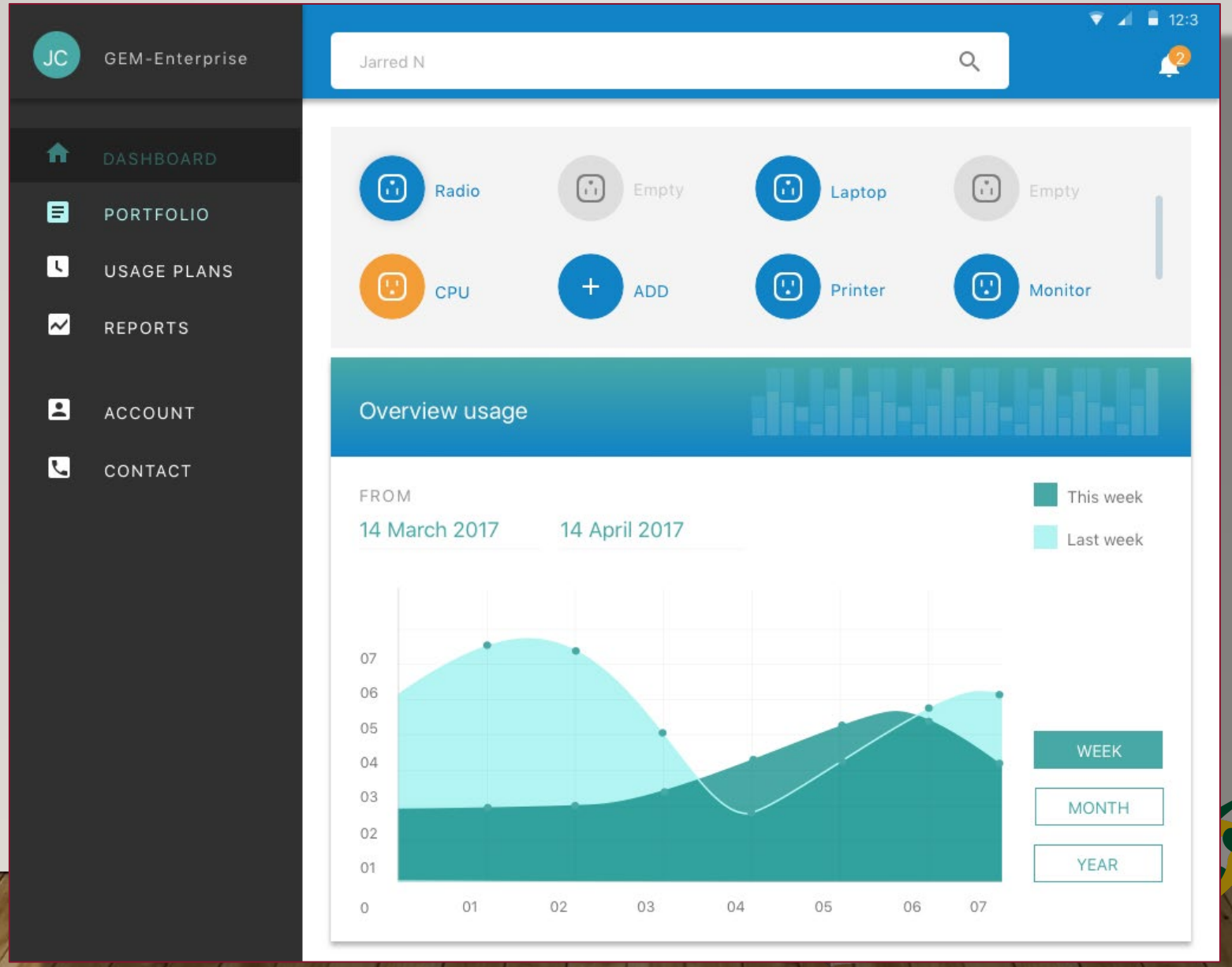
Student Mobile App



ELEMENTS OF PILOT STUDY

		Pre-experiment Setup AUG 27 - SEP 3	SEP 4 - OCT 4	OCT 5 - NOV 3	NOV 1 - DEC 8	Total
	Semester Days	8	31	30	35	104
	Data Collection Day (omit Holidays)	0	31	30	30	91
		D-7 through D0	D+1 through D+31	D+32 through D+67	D+68 through D+104	
Control Group	Monitoring only (no app)					
	Information feedback (Self only)					
	Information feedback (self and group comparison)					
	Pay-for-Performance					
	Escrow (loss Aversion)					
Treatment Group A	Monitoring only (no app)					
	Information feedback (Self only)					
	Information feedback (self and group comparison)					
	Pay-for-Performance					
	Escrow (loss Aversion)					
Treatment Group B	Monitoring only (no app)					
	Information feedback (Self only)					
	Information feedback (self and group comparison)					
	Pay-for-Performance					
	Escrow (loss Aversion)					
Treatment Group C	Monitoring only (no app)					
	Information feedback (Self only)					
	Information feedback (self and group comparison)					
	Pay-for-Performance					
	Escrow (loss Aversion)					
Treatment Group D	Monitoring only (no app)					
	Information feedback (Self only)					
	Information feedback (self and group comparison)					
	Pay-for-Performance					
	Escrow (loss Aversion)					

- Install programmable thermostats and plug-level power strips in 14-20 suites (4 students/suite)
- Control group will have loads monitored….no control…..no usage
- Experiment group (12-14 rooms) will have ability to 1) look at trend data, 2) receive usage comparisons with other rooms
- Purpose of pilot study is to see if there are sufficient differences to justify a larger, scientific study.

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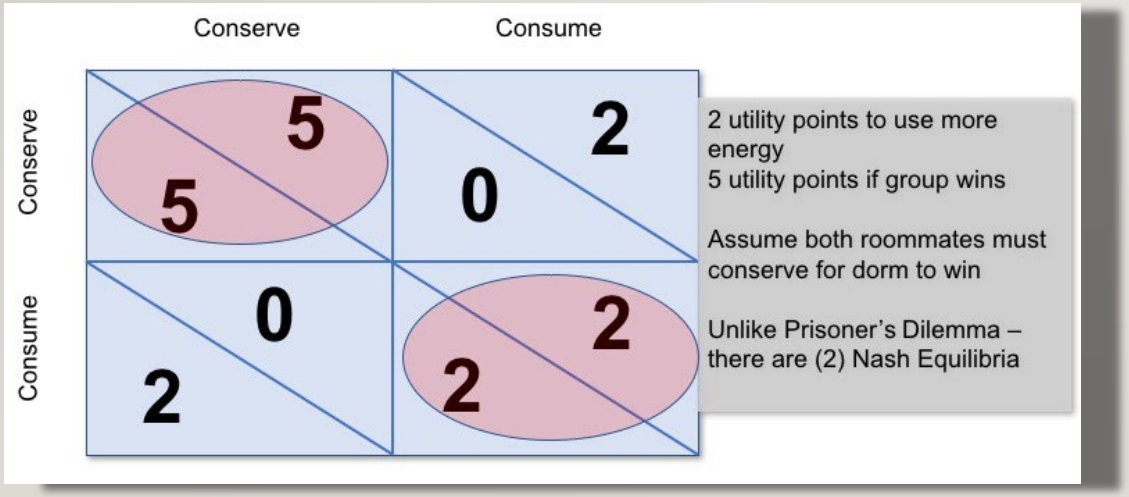
ELEMENTS OF LARGE FOLLOW-ON STUDY (2019-2020)

Research Question: Will energy consumers reduce personal consumption in a “continuously repeating” public goods competition?

- Hypothesis: Students will reduce personal consumption relative to their baseline to realize a potential public gain.
  - Nash Equilibrium shows less than optimal social benefit is individually rational behavior



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