

Residential EE & Solar Adoption Behavior: An Online Gamification Study



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Info Gaps Everywhere. Can Gamification Help?

- The world of energy is full of **information gaps**: both lack of information and information overload
- Can gamification be an effective information dissemination medium to address those gaps?
- How does participation in gamified information campaigns impact:
 - Subject knowledge
 - Attitude, agency, and intention/behavior



Energy Conservation and Solar Expected to Play a Significant Role in Texas's Electricity Future

SOLAR BY THE NUMBERS:

- **60%** drop in average solar panel prices since 2011 ¹
- **213 MW** solar PV installed in TX through Q1 2014 (U.S. rank = 13th) ¹
- **13,395 MW** solar PV installed in U.S. through Q1 2014 ¹
- **138,900 MW** solar PV installed globally through 2013 ²
- **20,625,000 MW** solar PV capacity potential in Texas ³
- **74,000 MW-ac** ERCOT peak demand capacity ⁴
- **\$13.7 billion** market value of 2013 U.S. PV installations ¹
- **4,100** Texas solar industry employees ⁵
- **142,000** U.S. solar industry employees ⁵

¹ GTM Research/SEIA: U.S. Solar Market Insight®

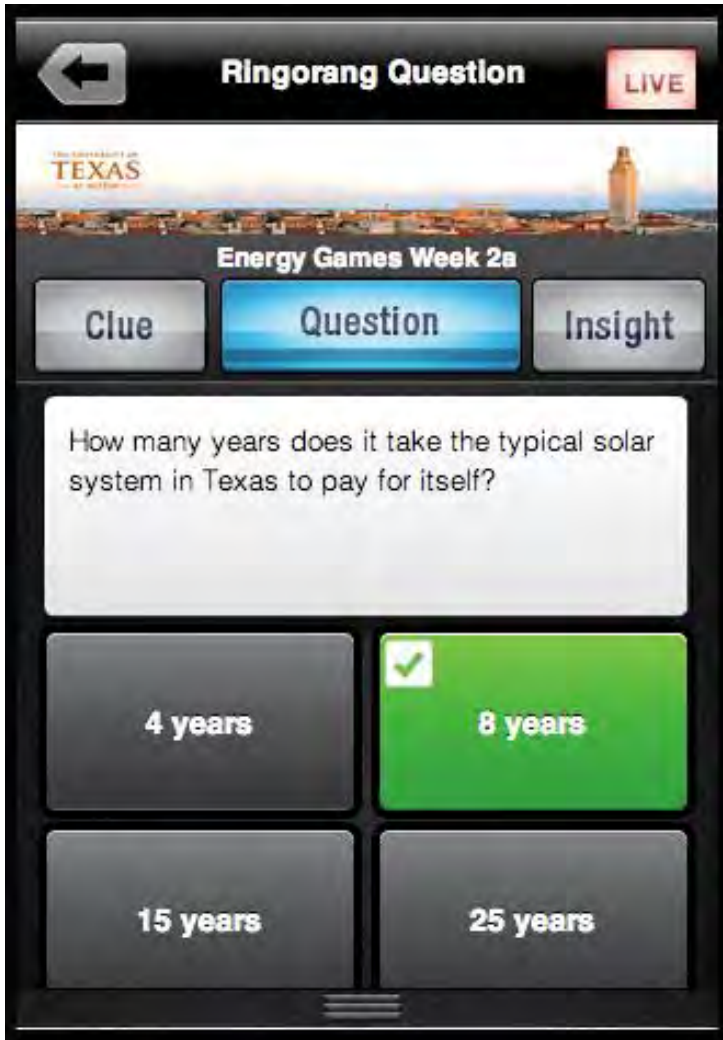
² EPIA Global Market Outlook for Photovoltaics 2014-2018

³ Lopez, Anthony, et. al., U.S. Renewable Energy Technical Potentials, NREL

⁴ ERCOT Quick Facts

⁵ The Solar Foundation – Solar Census 2014

Experiment Overview



- Use **initial survey** to capture existing attitudes and intentions regarding **energy conservation and solar**, as well as other controls
- Create two **randomized** cohorts:
 - Control
 - Treatment (Gamified information)
- Employ trivia-style **mobile gaming platform** to succinctly deliver key information to the Game cohort
- Use **final survey** to capture changes in attitudes and intentions regarding energy conservation and solar, and perceived effectiveness of gamified platform

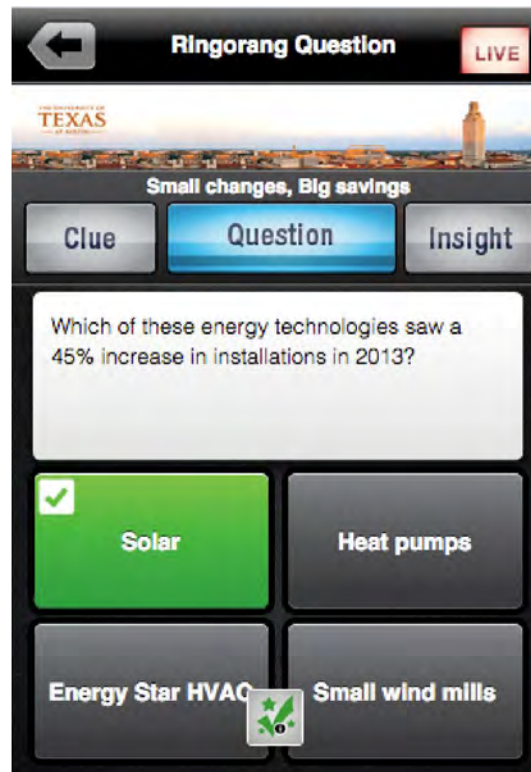
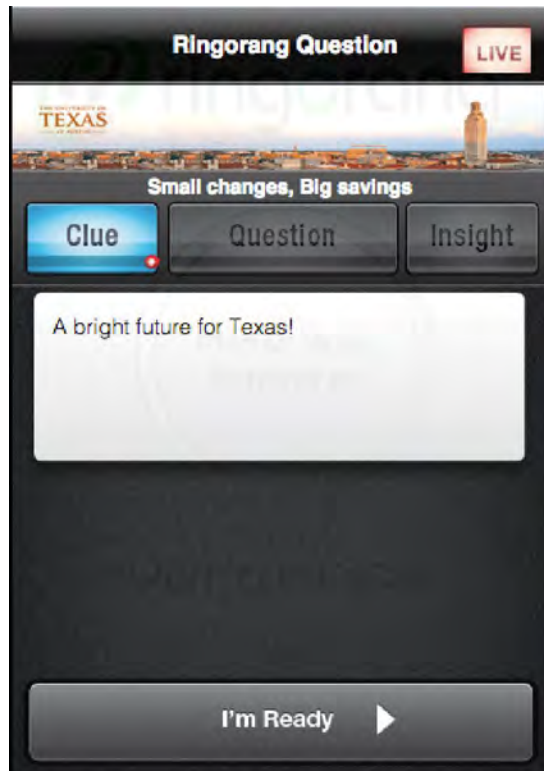
“Hunger Energy Games”



“Energy Games” Content

- **Topics: Energy conservation and solar PV**
 - Energy Efficiency Behavioral Measures: thermostat setting, water heater setting, vampire power, washing machine water temperature
 - Energy Efficient Equipment Upgrades: ENERGY Star appliances, LED lighting, Insulation, Ductwork, Door and window seals
 - Solar PV Systems: Technology basics, Cost, Leasing option, Incentives/rebates
- **Length – 2 Weeks**
 - Week 1: Small Changes, Big Savings! (15 questions: 5q x 3days)
 - Week 2: Big Changes, Bigger Savings! (15 questions: 5q x 3days)
- **Communication**
 - Reminders to play
 - Follow-up emails (1/week) summarizing key info

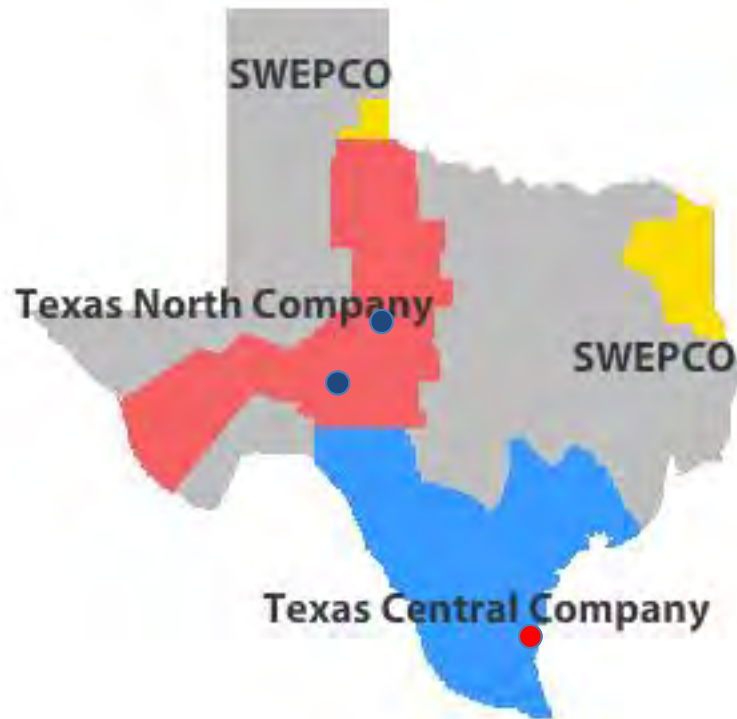
Game Platform: Ringorang®



- A *clue* gives a little hint for players new to energy topics
- A *question* conveys actionable or educational information
- An *insight* provides more context or information about the topic **< 1min**
- A “*learn more*” link to a web site for additional research or information on incentives
- A sliding scale for *points* based on how quickly you answer
- A *leaderboard* to compete with other players

Participant Recruitment

- AEP Texas Territory
- AEP Texas North
 - Abilene (26%)
 - San Angelo (27%)
- AEP Texas Central
 - Corpus Christi (47%)
- Randomized direct mail outreach with incentives
 - August/September 2014



TPB Survey: Energy Conservation Measures

- Attitudes. 1) Conserving energy takes a lot of time (reversed scale); 2) Conserving energy can save money; 3) Conserving energy is easy.
- Subjective norms. 1) If I conserve energy, people who are important to me would approve; 2) If I conserve energy, people who are important to me would notice.
- Descriptive norm (DN). People who are important to me make an effort to conserve energy. (peer effects)
- Personal norm. Regardless of what others do, I think it is important to conserve energy.
- Perceived Behavioral Control (PBC). 1) I know effective ways to save energy; 2) I have time to implement energy saving strategies.
- Intention. 1) I intend to increase my energy conserving efforts.
- Behavior. 1) I try to conserve energy at home; 2) I have called an energy auditor for an energy audit on my home.

TPB Survey: Solar Measures

- Attitude and norms: Similar to energy conservation measures
- Perceived Behavioral Control (PBC). 1) A solar system is affordable for my household.
- Intention. 1) Are you considering installing a solar system on your house?
2) How likely is it that you will call a solar installer for a quote?
- Behavior. 1) Have you ever called a solar installer for a quote? With response options “Yes” or “No.”

Pre-Game Survey: TPB Constructs (N=520)

- **Energy conservation**
 - Quite positive on all measures
 - Descriptive norm (DN) is lowest, possibly due to lack of visibility
- **Solar**
 - PBC and DN quite low;
 - PBC much lower than conservation PBC

TPB Factors and Environmental Concern

	Mean	SD
<i>Energy Efficiency</i>		
Attitude (EA)*	5.39	1.03
Subjective Norms (ESN)*	5.25	1.45
Descriptive Norms (EDN)	5.03	1.64
Personal Norm (EPN)*	6.35	1.02
Perceived Behavioral Control (EPBC)*	5.36	1.28
<i>Solar Energy</i>		
Attitude (SA)*	5.31	1.34
Subjective Norms (SSN)	5.28	1.70
Descriptive Norms (SDN)*	3.75	1.59
Personal Norm (SPN)	5.47	1.74
Perceived Behavioral Control (SPBC)	3.15	1.65
<i>Environmental Concern*</i>	5.93	1.14

* indicates index variable

- Only ~15% of survey respondents were aware of solar incentives (federal or local)
 - **Customer awareness of the cost of solar has not caught up** with available incentives and rebates, declining prices, and lease options that are quickly increasing the affordability of solar energy.

Table 5

Models for Intentions and Behavior (odds ratios (OR) and standard errors in parentheses)

	Eleffort	EBconserve	Slquote	Slquote2	Slconsider	Slconsider2
n	392	392	367	293	266	266
AIC	994	685.6	1163.1	946.6	189.8	171.9
Pr (>Chisq)	< 2.2e-16	< 2.2e-16	< 2.2e-16	< 2.2e-16	< 2.2e-16	1.71E-14
	OR	OR	OR	OR	OR	OR
(Intercept)					0.0249 . (1.9516)	0.0202 . (2.3129)
Attitude	1.2250 . (0.1085)	1.6056 *** (0.1302)	1.3453 * (0.1261)	1.3948 . (0.1708)	1.9235 . (0.3396)	2.2090 * (0.3835)
Subjective Norm	1.4377 *** (0.0948)	1.0001 (0.1018)	0.9400 (0.0923)	1.0218 (0.1089)	0.8627 (0.2331)	0.8300 (0.2497)
Descriptive Norm	1.1614 . (0.0779)	1.0894 (0.0876)	1.1979 * (0.0896)	1.1971 . (0.1049)	1.8240 ** (0.1949)	1.8631 ** (0.2128)
Personal Norm	1.1639 (0.1425)	2.3261 *** (0.1614)	1.2673 * (0.0969)	1.1417 (0.1226)	1.1516 (0.2612)	1.1175 (0.3056)
PBC	1.9352 *** (0.0983)	1.7559 *** (0.112)	1.5936 *** (0.0762)	1.4844 *** (0.0861)	1.5302 ** (0.1584)	1.5542 * (0.1728)
Environmental Concern	1.5487 *** (0.1251)	1.0136 (0.132)	1.0138 (0.1013)	1.0583 (0.1171)	0.7883 (0.2603)	0.8694 (0.285)
Age	0.9876 . (0.007)	1.0080 (0.0085)	1.0003 (0.0065)	1.0025 (0.0074)	0.9556 ** (0.0166)	0.9518 ** (0.0183)
Gender	1.3931 . (0.1942)	1.0560 (0.2281)	0.8779 (0.184)	0.7972 (0.2238)	0.2325 ** (0.4612)	0.2644 ** (0.4998)
Income	0.9221 (0.0754)	0.8808 (0.0863)	1.1921 * (0.0752)	1.1994 * (0.0853)	1.1236 (0.1654)	1.0940 (0.1758)
Education	0.8814 . (0.0767)	0.9537 (0.0894)	0.8592 * (0.0718)	0.8319 * (0.0817)	0.8184 (0.1587)	0.8458 (0.1676)
Home Area	0.9999 (0.0003)	1.0005 (0.0003)	1.0000 (0.0003)	1.0002 (0.0004)	1.0000 (0.0004)	0.9998 (0.0004)
Home Value	1.0030 (0.0019)	0.9978 (0.0019)	0.9996 (0.0018)	0.9992 (0.0021)	1.0045 (0.0032)	1.0067 . (0.0039)
Solar Incentives				1.1751 (0.2962)		2.2141 (0.5909)
Solar Financial Return				1.0882 (0.0962)		0.8131 (0.2132)
El_effort		1.4998 *** (0.1102)				

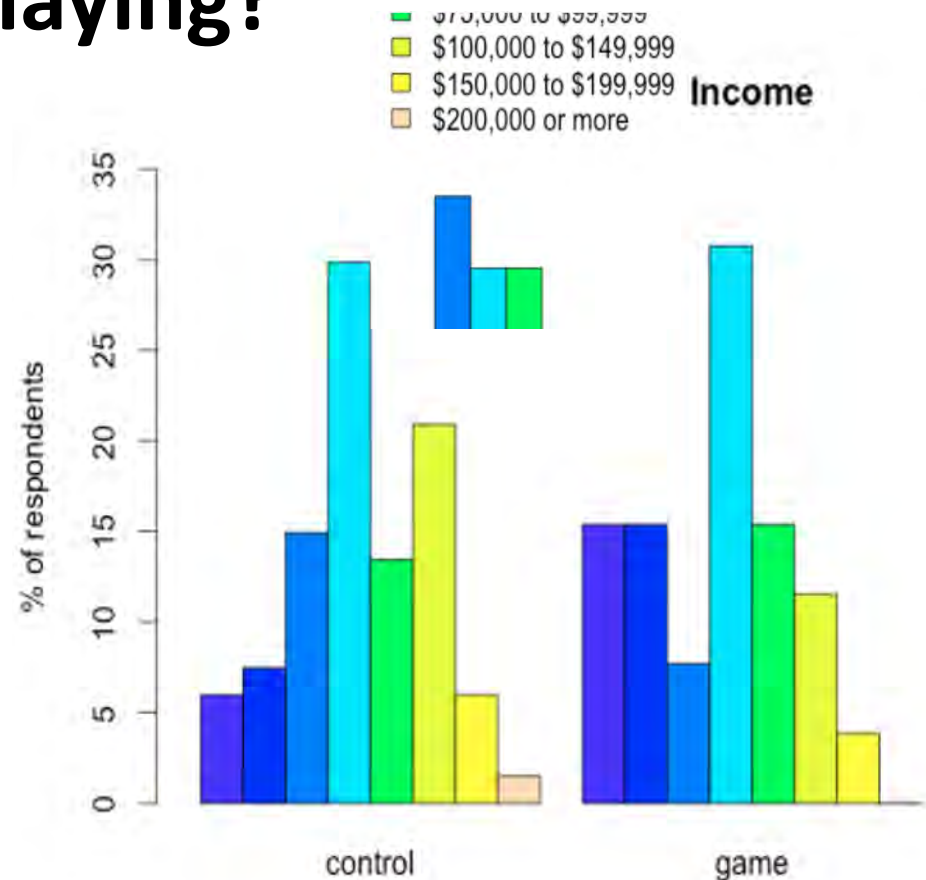
significance 0.001***, 0.01**, 0.05*, 0.1 ' '

TPB Model Findings

- **Perceived Behavioral Control (PBC) *only* factor significant ($p < .05$) across all models**
 - However, respondents' perceived behavioral control is much greater for energy conservation (5.36) than solar (3.15)
- **Descriptive norms significant for solar models**
 - Respondents feel more knowledgeable and confident with energy conservation than with solar energy; thus, looking to others for information and/or confirmation has greater benefit
 - Consistent with recent literature: Bollinger & Gillingham (2012); Rai & Robinson (2013)

Energy Games: Who's Playing?

- Control
 - 148 from initial survey
 - **76 completed final survey**
- Game
 - 343 invited to play
 - 40 downloaded; 30 active
 - **27 completed final survey**



- **Game vs. Control: No significant differences along income, education, age, gender, location, and most TPB constructs.**
- Some differences observed on initial quotes requested (before treatment), awareness about incentives, and descriptive norms
 - Robustness checks show that these do not impact the main findings

Energy Games: Beneath the 30-Question Treatment

- **PBC: 23** (12 En.Cons./11 Solar)
 - *Which thermostat setting can save the typical Texas household 15% on cooling costs?*
- **Attitude: 8** (3/5)
 - *How many years can solar panels keep producing more than 80% of full power?*
- **Norms: 4** (1/3)
 - *For the typical Texas household, 40% of the electric bill is spent on what?*
- Hard to address subjective/personal norms within the gamified framing

Energy Games: Highlights

- 85% participation rate; mean playtime 11 minutes per week per player
- Most right answers:
 - Energy Efficiency: top 3 all AC
 - Solar: soft balls (e.g., water use)
- Most wrong answers:
 - Energy Efficiency: vampire power, dishwasher efficiency, water heater setting
 - Solar: cost of solar, panel lifetime/performance

Energy Games: Feedback

- 69% intend to implement some of the energy efficiency tips and upgrades as a result of participating in the game
- Summary of participant feedback:

Survey Feedback	Mean	sd	Mode	Median
The information provided in Energy Games was useful to me.	6	1.17	7	6.5
The information provided in Energy Games was new to me.	5.85	0.92	6	6
I plan to use the energy efficiency tips given during Energy Games.	5.73	1.15	6	6
The solar energy information provided in Energy Games will make me more likely to consider installing solar in the future.	5.5	1.42	6	6

- Open comments:

“Opened my eyes about solar potential.”

“Solar panels last about 25 years.”

“Made me aware of the savings in solar energy”

“Will now consider solar energy installation”

Energy Games: Impact

Variable	p-value (Final- Initial)	Change in means	Initial level
	t-test		
SPBC	0.006**	1.14	3.07
SI_quote	0.038*	0.69	3.19
S_incentivesD	0.027*	0.35	0.04
EA	0.002**	0.63	5.33
EPBC	0.007**	0.56	5.39
EB_conserve	0.030*	0.38	5.93
EI_auditor	0.033*	0.77	(final only)

significance 0.001***, 0.01**, 0.05*, 0.1 '.'

That PBC is consistently effected is a good indication that bridging the info gap helps participants feel agency.

Energy Games: Impact

- The interactive nature of a trivia game **tests respondents perceived knowledge**
 - More “aha” moments (vs. say a newsletter) with the gamified version → Higher attitude and PBC
- **Awareness of incentives significantly increased**, which indicates that incentive programs may not be well publicized for passive audiences
- **Likelihood of calling to request a solar quote increased** following the game. This is one of the key factors to influence as it is a critical and necessary hurdle in the solar adoption process

Overall Conclusions

- **Huge gap between attitude and PBC for solar**
 - Solar perceived as expensive due to incomplete information about performance, leasing, and incentives
 - Addressing info gap could open up large potential demand
- PBC proved highly influential in TPB models developed from the initial survey. That **gamified info significantly improved PBC** indicates:
 - Information gap
 - Gamification can “activate” the passive potential customer base

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 - Project design
 - Outreach and participant recruitment

Ringorang®



A software app
designed to
overcome
the “Forgetting
Curve”
with repetition,
incentives and fun

Workforce Training and Reinforcement:

Reinforce critical information **without taking time away** from work
Data Proof of knowledge and skill **retention**

Customer Engagement and Education:

DOE trials under SGIG grants **delivering heightened engagement**

Multiple interactions **daily**

Thanks/Q&A