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 \(^5\)

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\(^1\) 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

Source: Texas Solar Power Association
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
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

>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

- 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>
<thead>
<tr>
<th>TPB Factors and Environmental Concern</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy Efficiency</strong></td>
<td></td>
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<tr>
<td>Attitude (EA)*</td>
<td>5.39</td>
<td>1.03</td>
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<tr>
<td>Subjective Norms (ESN)*</td>
<td>5.25</td>
<td>1.45</td>
</tr>
<tr>
<td>Descriptive Norms (EDN)*</td>
<td>5.03</td>
<td>1.64</td>
</tr>
<tr>
<td>Personal Norm (EPN)*</td>
<td>6.35</td>
<td>1.02</td>
</tr>
<tr>
<td>Perceived Behavioral Control (EPBC)*</td>
<td>5.36</td>
<td>1.28</td>
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<tr>
<td><strong>Solar Energy</strong></td>
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<tr>
<td>Attitude (SA)*</td>
<td>5.31</td>
<td>1.34</td>
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<tr>
<td>Subjective Norms (SSN)</td>
<td>5.28</td>
<td>1.70</td>
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<tr>
<td>Descriptive Norms (SDN)*</td>
<td>3.75</td>
<td>1.59</td>
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<tr>
<td>Personal Norm (SPN)</td>
<td>5.47</td>
<td>1.74</td>
</tr>
<tr>
<td>Perceived Behavioral Control (SPBC)</td>
<td>3.15</td>
<td>1.65</td>
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<tr>
<td><strong>Environmental Concern</strong></td>
<td>5.93</td>
<td>1.14</td>
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* indicates index variable
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<th>Models for Intentions and Behavior (odds ratios (OR) and standard errors in parentheses)</th>
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<tr>
<td><strong>Eleffort</strong></td>
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<td>Pr (&gt;Chisq)</td>
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<tr>
<td><strong>OR (Intercept)</strong></td>
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<td><strong>Attitude</strong></td>
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<td><strong>Subjective Norm</strong></td>
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<td><strong>Descriptive Norm</strong></td>
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<td><strong>Personal Norm</strong></td>
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<td><strong>PBC</strong></td>
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<tr>
<td><strong>Environmental Concern</strong></td>
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<td><strong>Age</strong></td>
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<td><strong>Gender</strong></td>
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<td><strong>Income</strong></td>
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<td><strong>Education</strong></td>
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<td><strong>Home Area</strong></td>
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<td></td>
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<tr>
<td><strong>Home Value</strong></td>
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<td><strong>Solar Incentives</strong></td>
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<td><strong>Solar Financial Return</strong></td>
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<td><strong>El_effort</strong></td>
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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:

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

• 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

<table>
<thead>
<tr>
<th>Variable</th>
<th>p-value (Final-Initial)</th>
<th>Change in means</th>
<th>Initial level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>t-test</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPBC</td>
<td>0.006**</td>
<td>1.14</td>
<td>3.07</td>
</tr>
<tr>
<td>SI_quote</td>
<td>0.038*</td>
<td>0.69</td>
<td>3.19</td>
</tr>
<tr>
<td>S_incentivesD</td>
<td>0.027*</td>
<td>0.35</td>
<td>0.04</td>
</tr>
<tr>
<td>EA</td>
<td>0.002**</td>
<td>0.63</td>
<td>5.33</td>
</tr>
<tr>
<td>EPBC</td>
<td>0.007**</td>
<td>0.56</td>
<td>5.39</td>
</tr>
<tr>
<td>EB_conserve</td>
<td>0.030*</td>
<td>0.38</td>
<td>5.93</td>
</tr>
<tr>
<td>EL_auditor</td>
<td>0.033*</td>
<td>0.77</td>
<td>(final only)</td>
</tr>
</tbody>
</table>

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

That PBC is consistently affected 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
Acknowledgements

• Research funded by the Department of Energy’s SunShot Initiative under the Solar Energy Evolution and Diffusion Studies (SEEDS) program

• AEP North Texas and AEP Central Texas
  – Project design
  – Outreach and participant recruitment

• Vergence/RingoRang team
  – Robert Feeney (CEO) and Greg Pinter (VP, Engineering)
  – Great collaborators!

• Jay Zarnikau and Frontier Associates
  – Project design
  – Outreach and participant recruitment
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**

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**Ringorang®**

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