PG&E Residential
Smart Thermostat Trial

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Pacific Gas & Electric

Honeywell
Opower
Freeman Sullivan & Co.
Trial Goals

- **Key objectives:**
  - Validate energy savings potential from reducing HVAC consumption through a smart thermostat controllable via a web/smart phone application and normative messaging.
  - Study residential consumer preferences and attitudes towards enabling technologies, behavior changes, and level of engagement with the thermostat solution.

- **Secondary objective:**
  - Calculate a baseline of efficiency savings as a basis for projecting savings for a broader program rollout.
Methodology

- Randomized control trial with 1,388 households
  - 695 in control
  - 693 in treatment (505 thermostats installed)
- Face-to-face recruiting with onsite qualification and random assignment (recruit and deny)
- Two phases of direct installations between July 2012 and February 2013
  - Phase 1: East Bay; iphone only
  - Phase 2: Central Valley, iphone and Android
- Official measurement period began mid-February 2013
Trial Eligibility

- Trial requirements:
  - 1+ iPhone or Android devices in use in the household
  - Dual-fuel PG&E customer
  - Single family homeowner or condo dweller
  - Central heating and air conditioning with single thermostat
  - Broadband connection
  - No back-up heat or auxiliary/heat pump
  - No plans to move in the next 12 months
  - Not be participating in PG&E’s SmartAC program
Usability and Interventions

- Honeywell Thermostat
- Opower
  - Web portal
  - Smart phone-based remote control
  - Push messaging capabilities

Habits and scheduling

<table>
<thead>
<tr>
<th>Program</th>
<th>Mondays</th>
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<tbody>
<tr>
<td>On a typical Monday:</td>
<td></td>
</tr>
<tr>
<td>I leave during the day.</td>
<td>✓</td>
</tr>
<tr>
<td>I’m usually at home.</td>
<td></td>
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<tr>
<td>It's unpredictable.</td>
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My Monday schedule:

| Wake up: | 06:00 AM |
| Leave home: | 07:45 AM |
| Return home: | 05:00 PM |
| Bedtime: | 10:00 PM |

Comparative feedback

How you’re doing: Great! 😊

78°F is recommended for cooling

Set a more efficient temperature
Engagement Drives User Behavior

Normative comparisons
Real-time comparisons with similar homes

Loss aversion
Calculate inefficient losses rather than efficient gains

Setpoint coaching
Notifications that encourage efficiency
Engagement is High

- **1 in 4** engage **daily** with the system

![General Sessions](image1)

- [31%](blue) Web App
- [68%](lightblue) Mobile App
- [1%](darkblue) Wall device

![Setpoint Changes](image2)

- [73%](blue) Web App
- [27%](lightblue) Mobile App
- [0%](darkblue) Wall device

* Interaction metrics cover 3 months (July-September)

- **Setpoint feedback/coaching works**
  - **Cooling:** 70% start with EPA-recommended setpoints; 45% adopt more efficient setpoints
  - **Heating:** 89% start with EPA recommended setpoints; 67% adopt more efficient setpoints
Preliminary Findings

figures for February – August 2013 percentage savings

<table>
<thead>
<tr>
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<th>Percentage Savings*</th>
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<tbody>
<tr>
<td>Electric</td>
<td>2.4%</td>
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<tr>
<td>Gas</td>
<td>3.4%</td>
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* Represents savings divided by ratio of households with a thermostat installed

- The Electric figure is statistically significant; Gas figure is not, due to high variability of gas usage
Analysis is Ongoing

- Length and variability in the installation period (grey points) requires a more nuanced regression model

**Percent Difference in Electricity Consumption**

- % Difference Pre-Treatment
  - Linear (% Difference Pre-Treatment)
- % Difference Post-Treatment
  - Linear (% Difference Post-Treatment)

*This includes all customers placed in the treatment group*
Lessons Learned (1)

- **Recruitment**
  - Recruitment under guise of survey, or recruit and delay, could provide a better customer experience

- **Hardware**
  - Installation and communication problems:
    - Thermostats could not be installed at ≈30% of treatment households (due to technical HVAC/home issues or trial opt-out)
    - Additional fallout from initial Z-Wave Gateway Connection (wi-fi substitution completed in August-September)
Wi-Fi Upgrade

Old Z-Wave Architecture

New WiFi Architecture

- Zwave solution presented radio range and data corruption issues. Led to customer frustration
- WiFi architecture is simpler and more robust. Range issues much less likely
Lessons Learned (2)

- **Generalizability.** Specificity of pilot design makes it challenging to claim that findings are generalizable to vendor-agnostic downstream rebate self-install program.

- **Isolating feedback/comparison effects.** Inclusion of a smart thermostat-only treatment group would have more explicitly shown the effects of the feedback/comparison information provided through the smart phone app and web portal.

- **Statistical Power.** Detecting effects with modest sample sizes, and a long installation period, is challenging.
Contact

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