SMUD's Residential Summer Solutions Study

Real-Time Energy Feedback with Dynamic Rates and AC Automation

Karen Herter, Ph.D.
Herter Energy
RESEARCH SOLUTIONS

Behavior, Energy & Climate Change Conference

November 14, 2012

Research Team and Funding

- Research Team
  - Herter Energy Research Solutions
  - Sacramento Municipal Utility District (SMUD)
- Funding
  - Sacramento Municipal Utility District (SMUD)
  - California Energy Commission Public Interest Energy Research via the Demand Response Research Center at Lawrence Berkeley National Laboratory

Background

Successful "Smart Grid" Programs

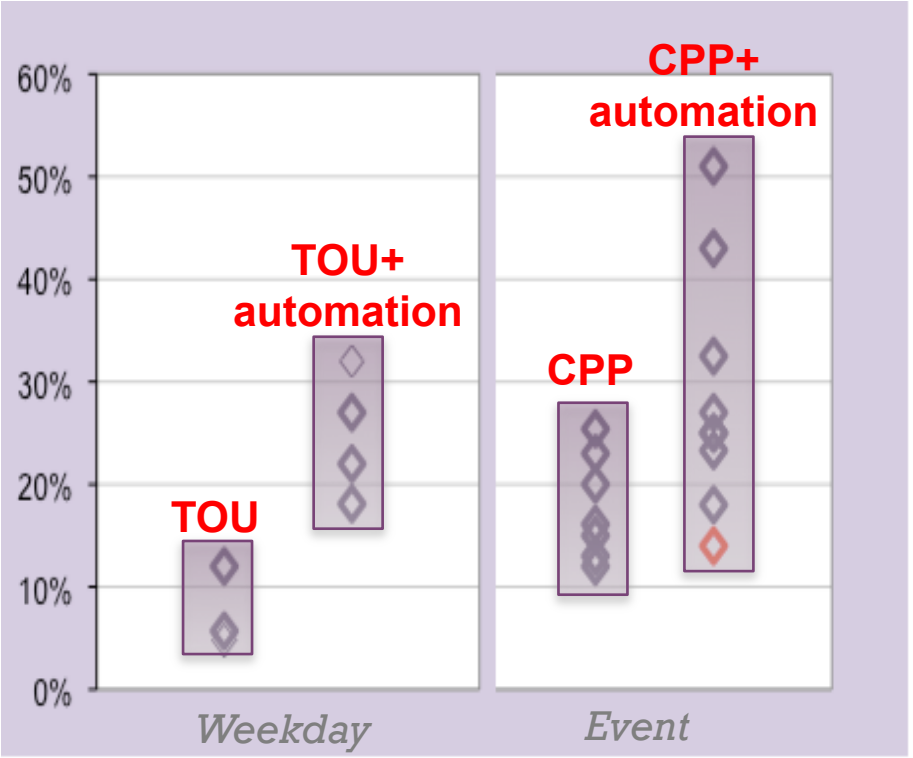
First AMI, then… IMA

- Information → see and understand energy use
  - Real-time information directly from meters
  - Aggregated energy and cost reports from utility
- Motivation → earn or save $$
  - Lower energy use = lower bills
  - Discount periods of TOU and dynamic rates
  - Payment for load drop during events
- Automation → use technology to manage energy use
  - Customer programs and controls their own end uses
  - Utility controls customer end uses

What we already know

Motivation + Automation = Peak Savings

- Pay participants for utility-controlled automation
  - a.k.a Direct Load Control
- Time varying rates →→→→
  - TOU rates shift load every day
  - CPP rates shed load during events
  - Automation enhances both of these effects



Results of pricing studies in Ontario, California, Puget Sound, Florida, Australia, Illinois, Missouri, New Jersey, Maryland, Connecticut, Washington DC (p.s. There are many more. Ask me for references.)

What we already know (maybe)

Information = *Energy Savings*

	Small (≤100)			Large (>100)		
	Avg. Savings	Median Savings	Number of Studies	Avg. Savings	Median Savings	Number of Studies
DURATION						
Short (≤6 months)	13.3%	13.0%	18	6.6%	6.0%	13
Long (>6 months)	8.7%	7.2%	9	6.7%	6.3%	14
Total	11.6%	12.0%	27	6.6%	6.0%	27

Source: Erhardt-Martinez 2011. The Persistence of Feedback-Induced Energy Savings.

Q: Is 6 months really a "long" study? Is 100 participants really a "large" study?
A: No – but at least they piqued our interest. But only 14? Not so good.
Resolution: Look for results of SGIG-funded information studies in 2013-14.

Questions to Answer

(Spoiler – A: yes)

- Sure demand response and dynamic pricing reduce peak loads, but will they reduce overall energy use?
- It seems that the provision of real-time energy information reduces overall energy use, but will it also enhance peak and event impacts?
- Is there added value in providing real-time appliance information?
- Do any of these effects persist beyond the first year – or two?

2008 Small Business Summer Solutions

Motivation + Automation = TOU-CPP + Thermostat

(No real-time energy Information.)

Business Type	N	Peak Event Impact (% 2008 baseline)	Summer Energy Impact (% 2007 baseline)	Summer Bill Impact (% 2007 GSN Bill)
Office	34	-28%	-31%	-38%
Retail	28	-15%	-18%	-38%
Restaurant	9	-3%	-10%	-21%
All	**71**	**-14%**	**-20%**	**-25%**

Residential Summer Solutions Study

Information + Motivation + Automation

Information

Participants assigned to 3 treatments

Baseline Information

- No real-time data
- Access to day-before interval data on SMUD's website

Home Information

- Real-time energy data for the home
  - Access via PC and thermostat

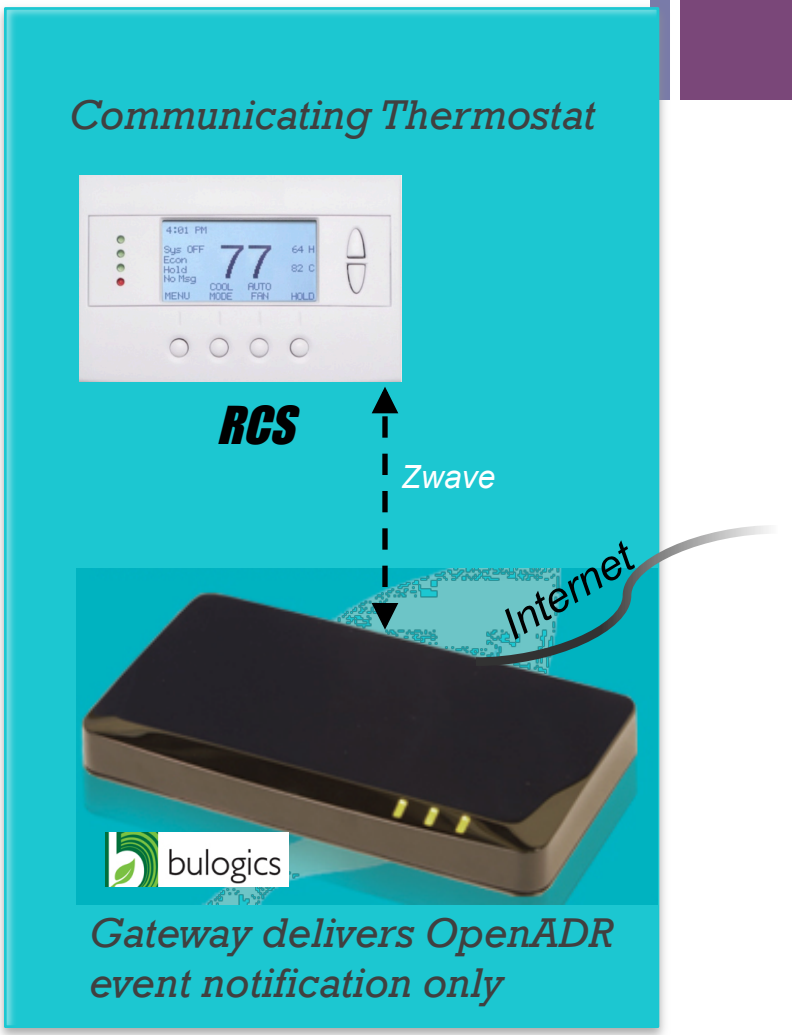
Appliance Information

- Real-time energy data for the home + AC + one 240V appliance + one 120V appliance
  - Access via PC and thermostat

All participants had access to their "day-before" interval data on SMUD's website, and received an Internet-connected thermostat that notified them of events

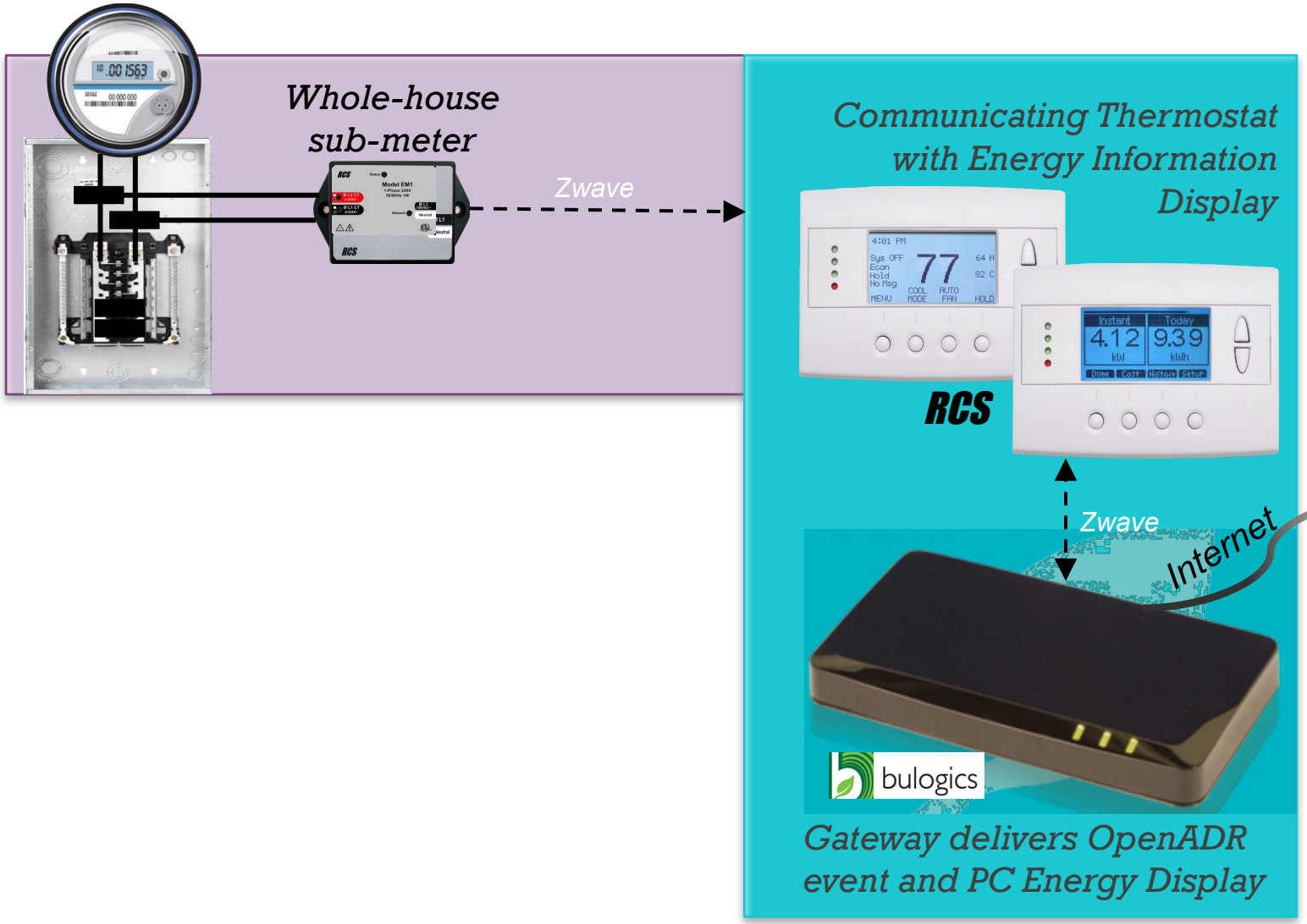
Baseline Information

- No real-time energy information



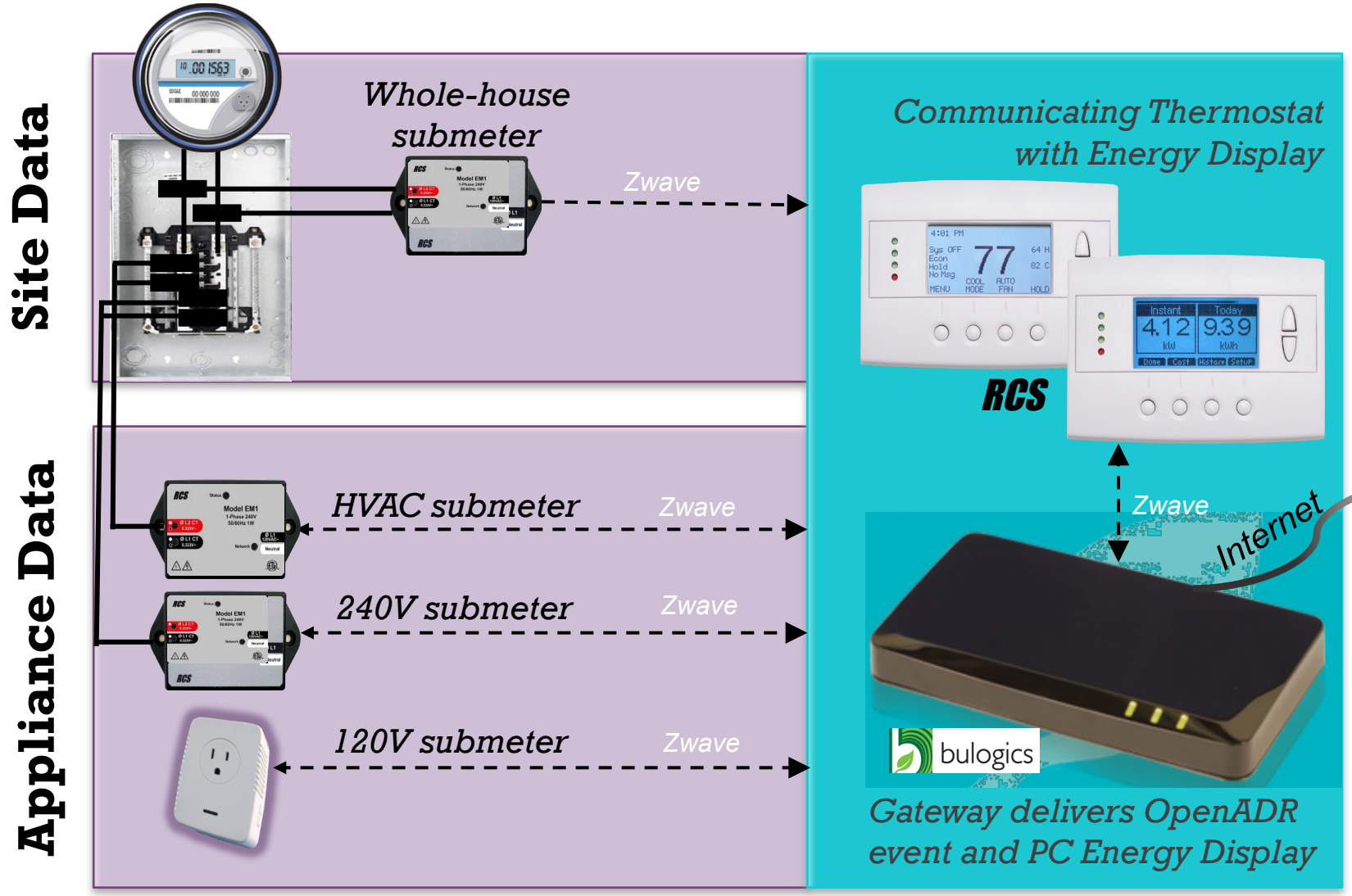
Home Information

Site Data

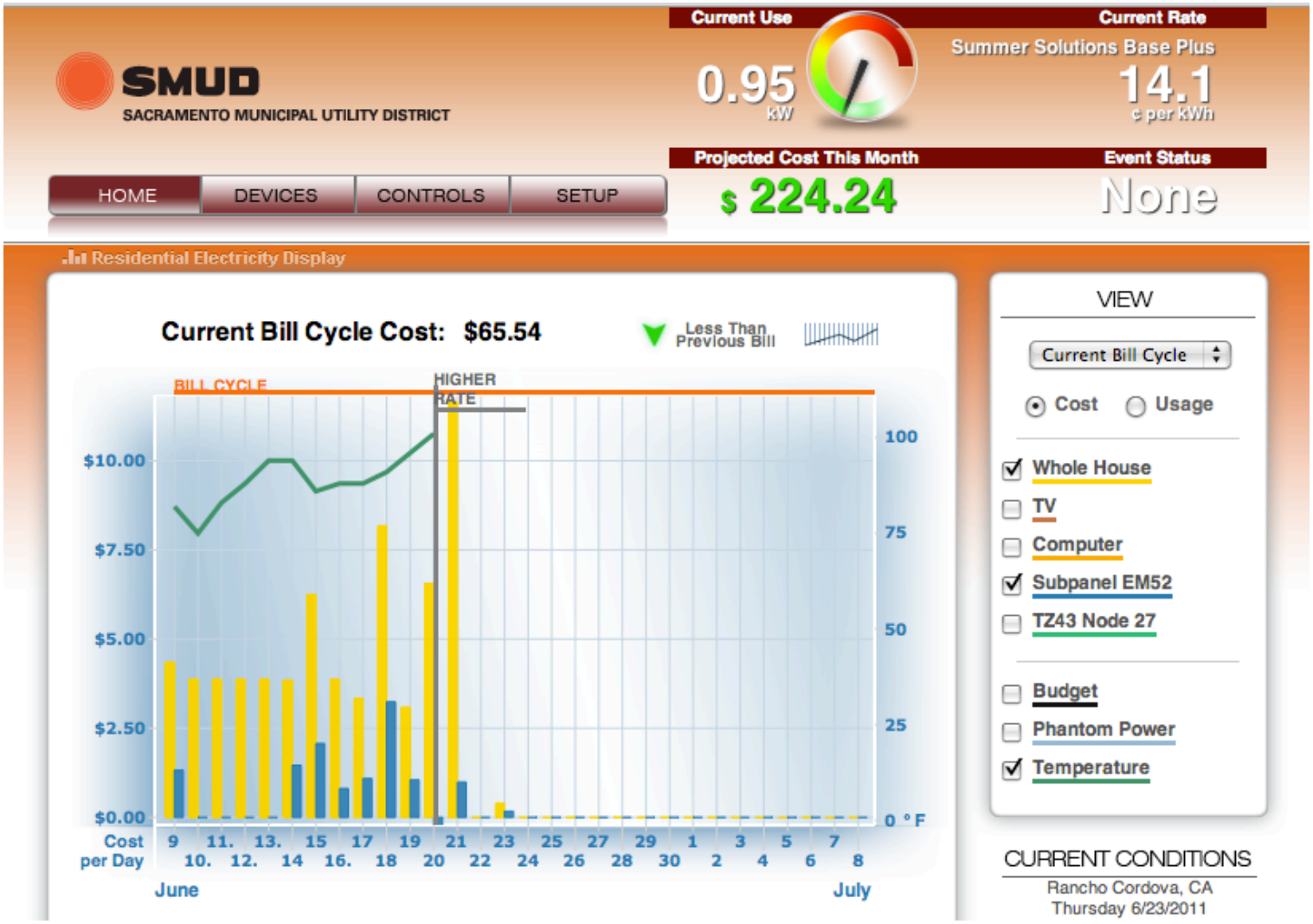


Data Storage & Presentation

Appliance Information



Real-time Energy Display on PC



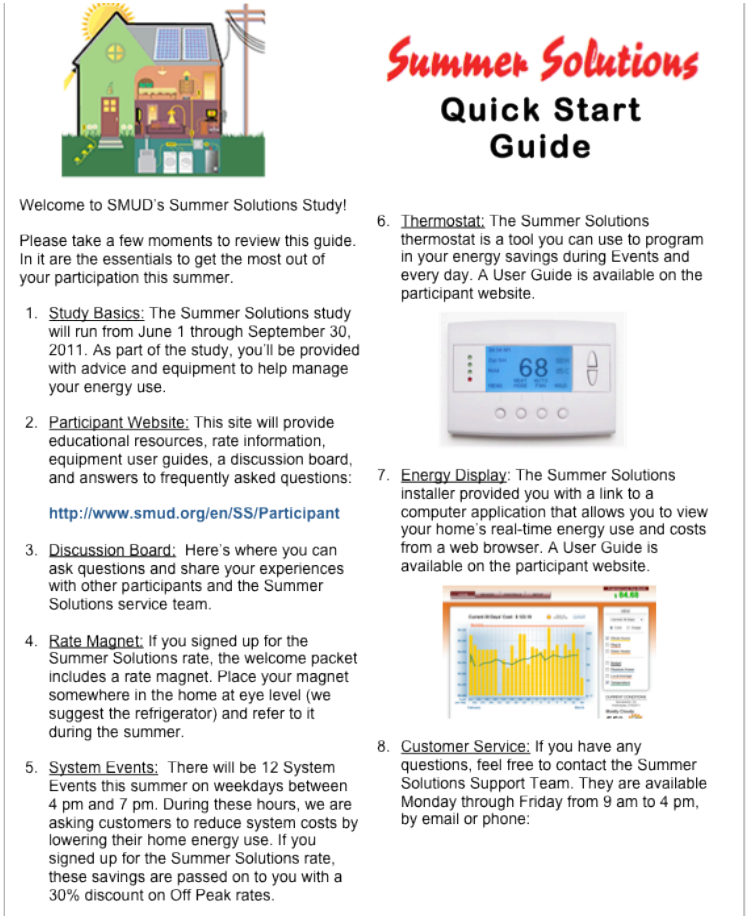
Real-time Energy Display on PC

Real-time Energy Display on Stat

- Screen with instantaneous kW and daily kWh
- Scroll through appliances one at a time for Appliance group
- Can be made default screen

Other Information Provided

- Installer assistance
- Dedicated customer support
- Website
- Quick Start Guide
- Home Energy Assessments
- Summer Solutions rate magnet
- SS rate vs. Standard bill comparison
- Email notification with tips for each of 12 events



Summer Solutions

Quick Start Guide

Welcome to SMUD's Summer Solutions Study!

Please take a few moments to review this guide. In it are the essentials to get the most out of your participation this summer.

1. Study Basics: The Summer Solutions study will run from June 1 through September 30, 2011. As part of the study, you'll be provided with advice and equipment to help manage your energy use.
2. Participant Website: This site will provide educational resources, rate information, equipment user guides, a discussion board, and answers to frequently asked questions:

   http://www.smud.org/en/SS/Participant
3. Discussion Board: Here's where you can ask questions and share your experiences with other participants and the Summer Solutions service team.
4. Rate Magnet: If you signed up for the Summer Solutions rate, the welcome packet includes a rate magnet. Place your magnet somewhere in the home at eye level (we suggest the refrigerator) and refer to it during the summer.
5. System Events: There will be 12 System Events this summer on weekdays between 4 pm and 7 pm. During these hours, we are asking customers to reduce system costs by lowering their home energy use. If you signed up for the Summer Solutions rate, these savings are passed on to you with a 30% discount on Off Peak rates.
6. Thermostat: The Summer Solutions thermostat is a tool you can use to program in your energy savings during Events and every day. A User Guide is available on the participant website.

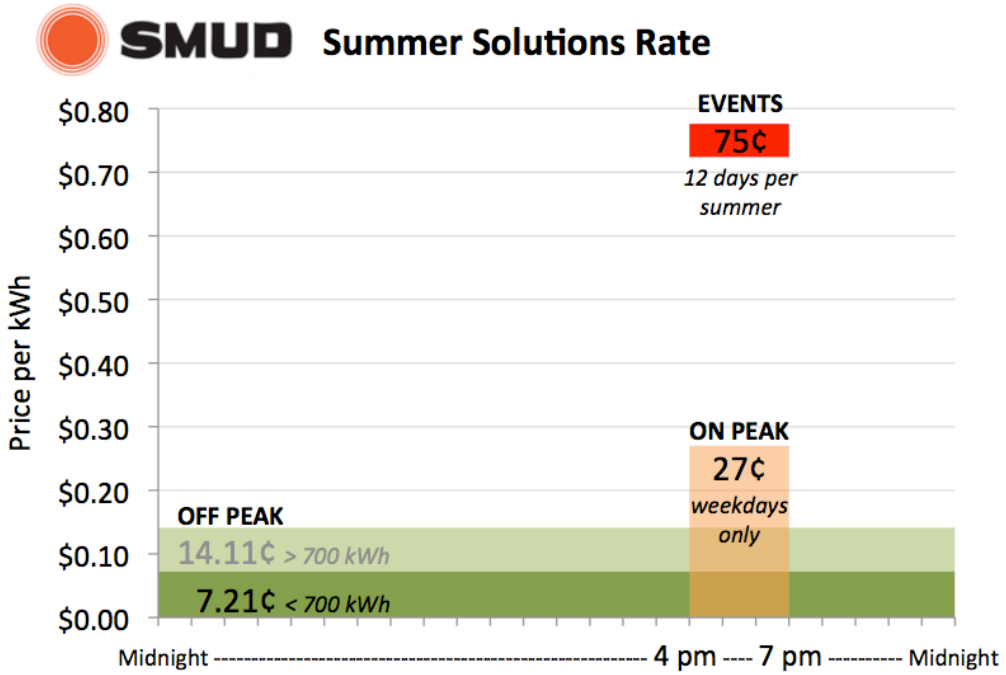
7. Energy Display: The Summer Solutions installer provided you with a link to a computer application that allows you to view your home's real-time energy use and costs from a web browser. A User Guide is available on the participant website.

8. Customer Service: If you have any questions, feel free to contact the Summer Solutions Support Team. They are available Monday through Friday from 9 am to 4 pm, by email or phone:

Motivation + Automation

Participants given 4 options

- Automatic Temperature Control (ATC)
  - Utility-controlled 4° setpoint increase during events
  - $4 payment per event
  - One override in 12 events
- Summer Solutions Rate →
  - Dynamic TOU-CPP rate
  - Customer sets automated response to 12 events
- Both ATC and Rate
- Neither ATC nor Rate
  - No Motivation



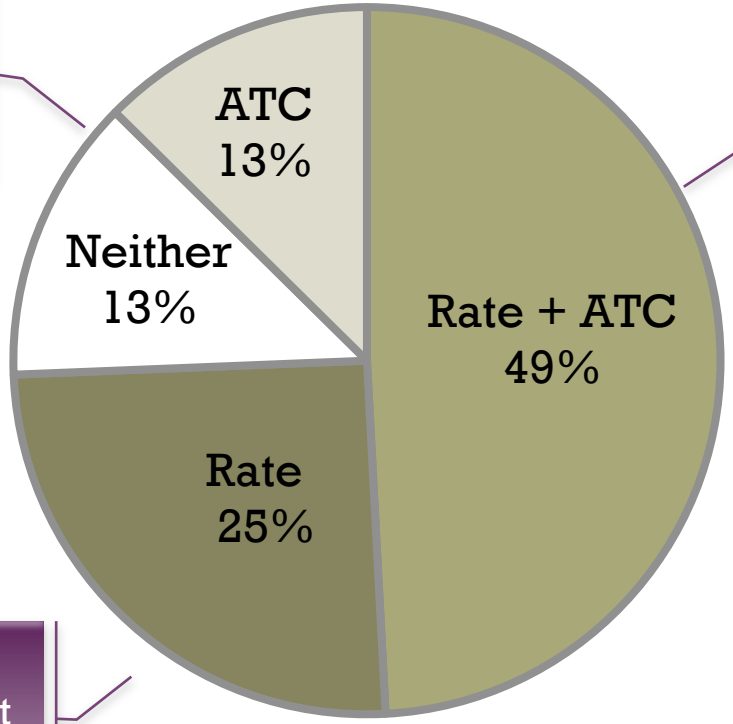
Results

Motivation + Automation Choices

SMUD can control my AC, but no dynamic rate please

I'll take the technology, but leave my rate and AC alone

I think I can save money on the TOU-CPP rate, but I don't want SMUD controlling my AC



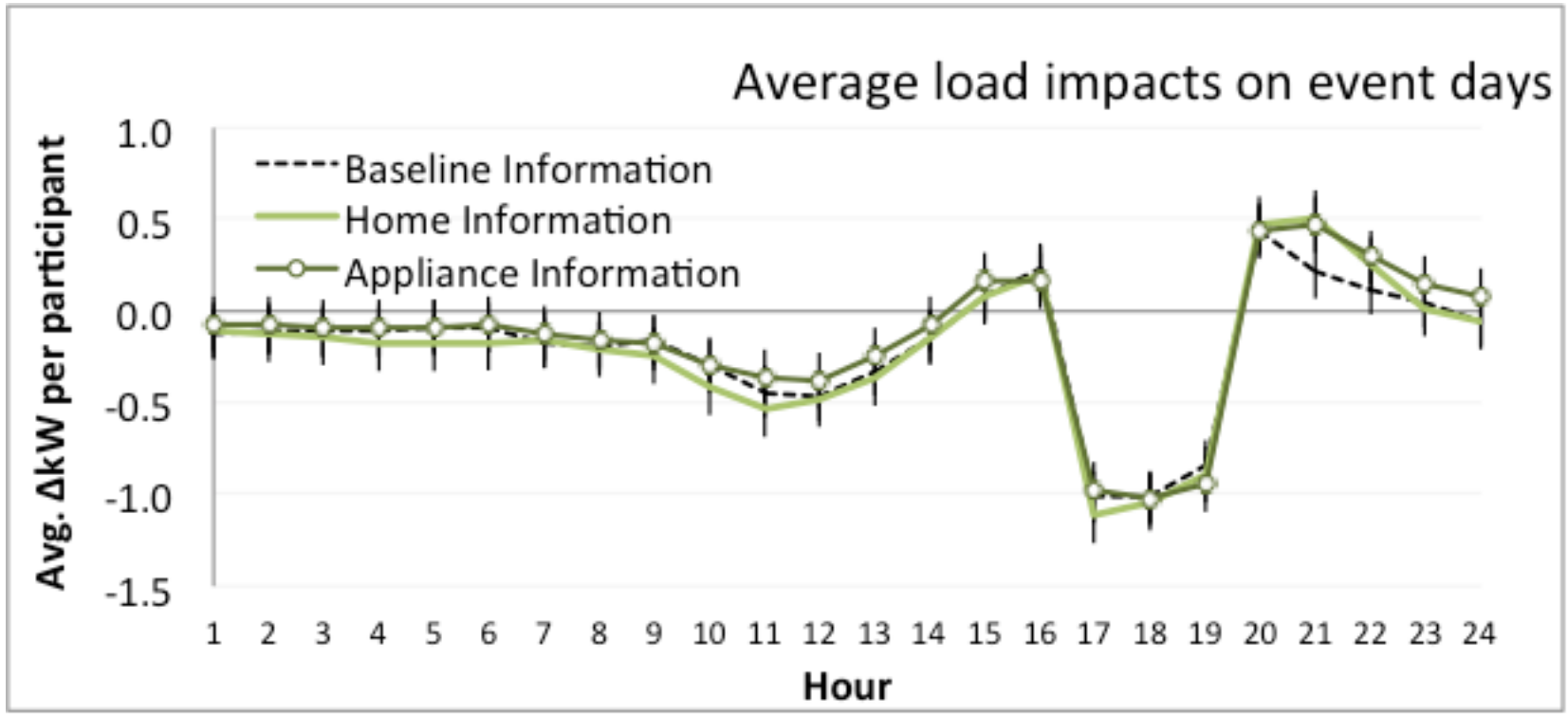
I think I can save money on the dynamic rate, and I'm fine with SMUD controlling my AC during events

N=238

Real-time Information Effects

events

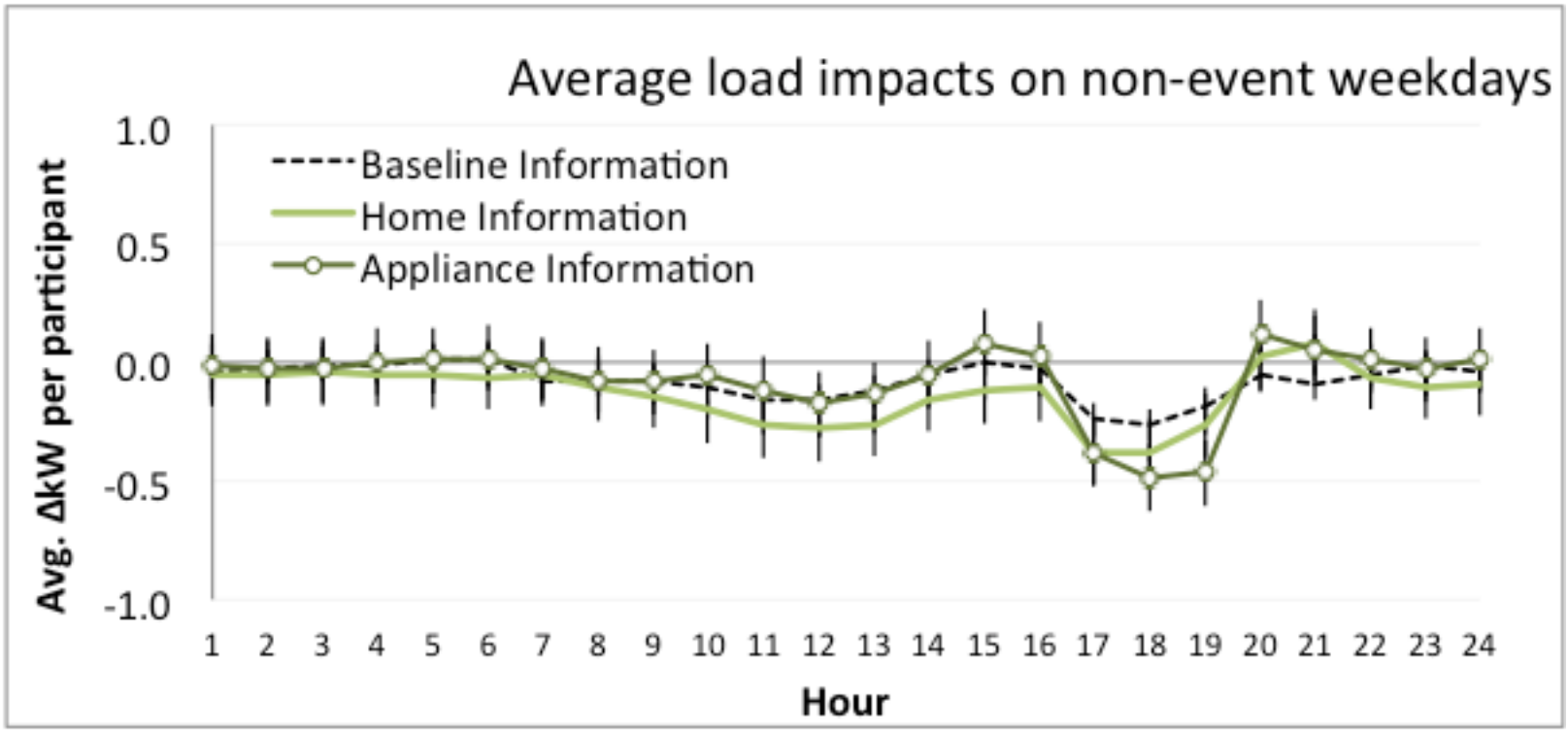
- Statistically similar event impacts



Real-time Information Effects

non-event weekdays

- More granular information → Greater peak impacts

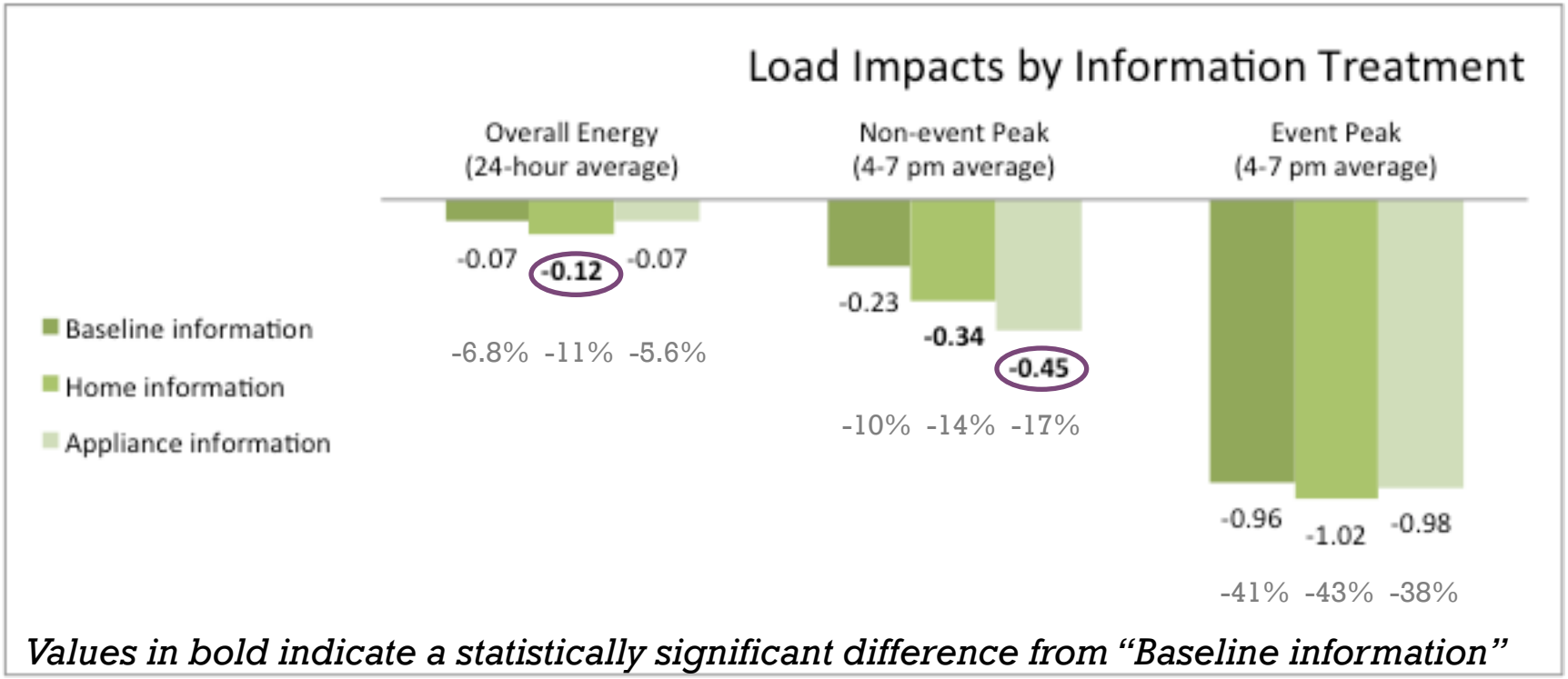


Real-time Information Effects

first-year Summary (2011)

For participants in the first year of the study,

- Home data had the greatest energy savings (NOTE: see next slide)
- Appliance data had the greatest peak savings
- No significant effects on event savings



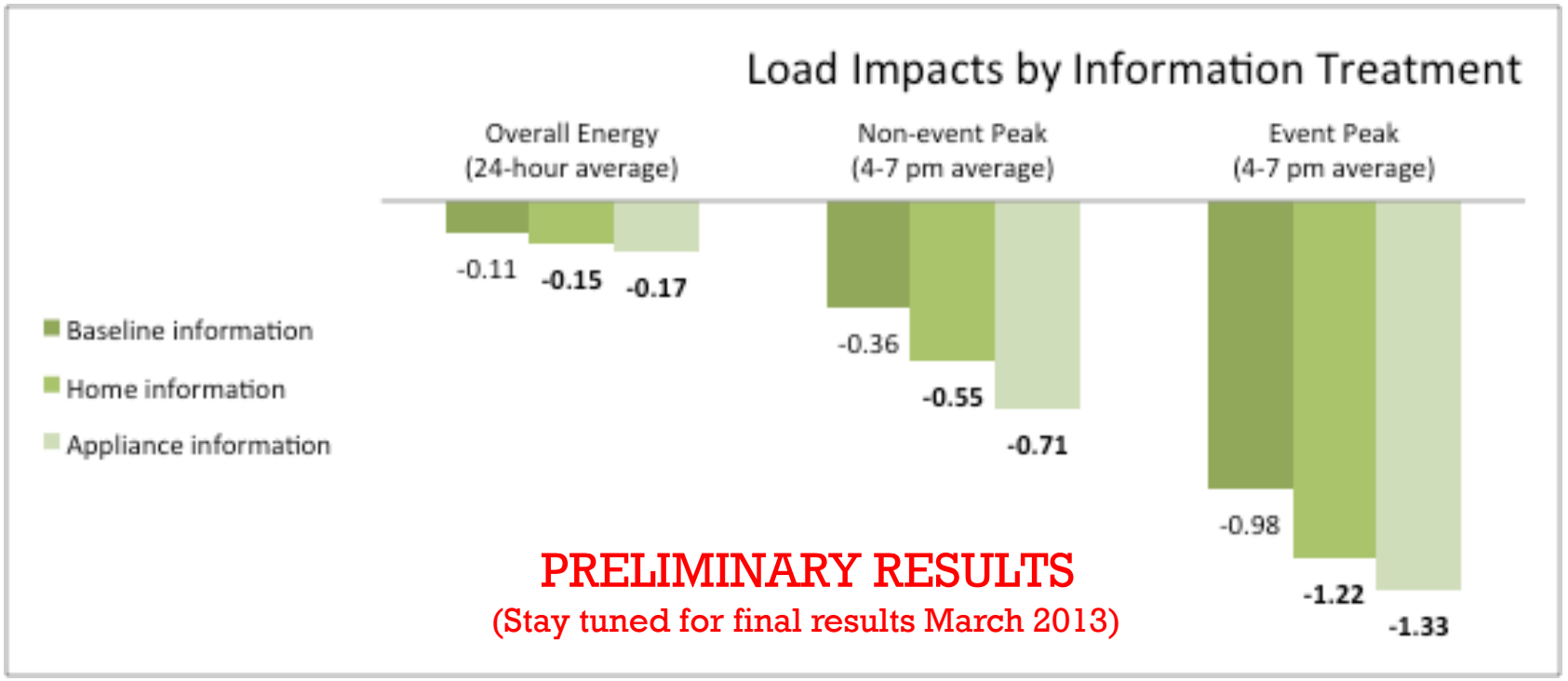
Values in bold indicate a statistically significant difference from "Baseline information"

Real-time Information Effects

second-year Summary (2012)

For participants in the second year of the study,

- Real-time information improved savings at all levels
- Appliance-level information outperformed Home-level information

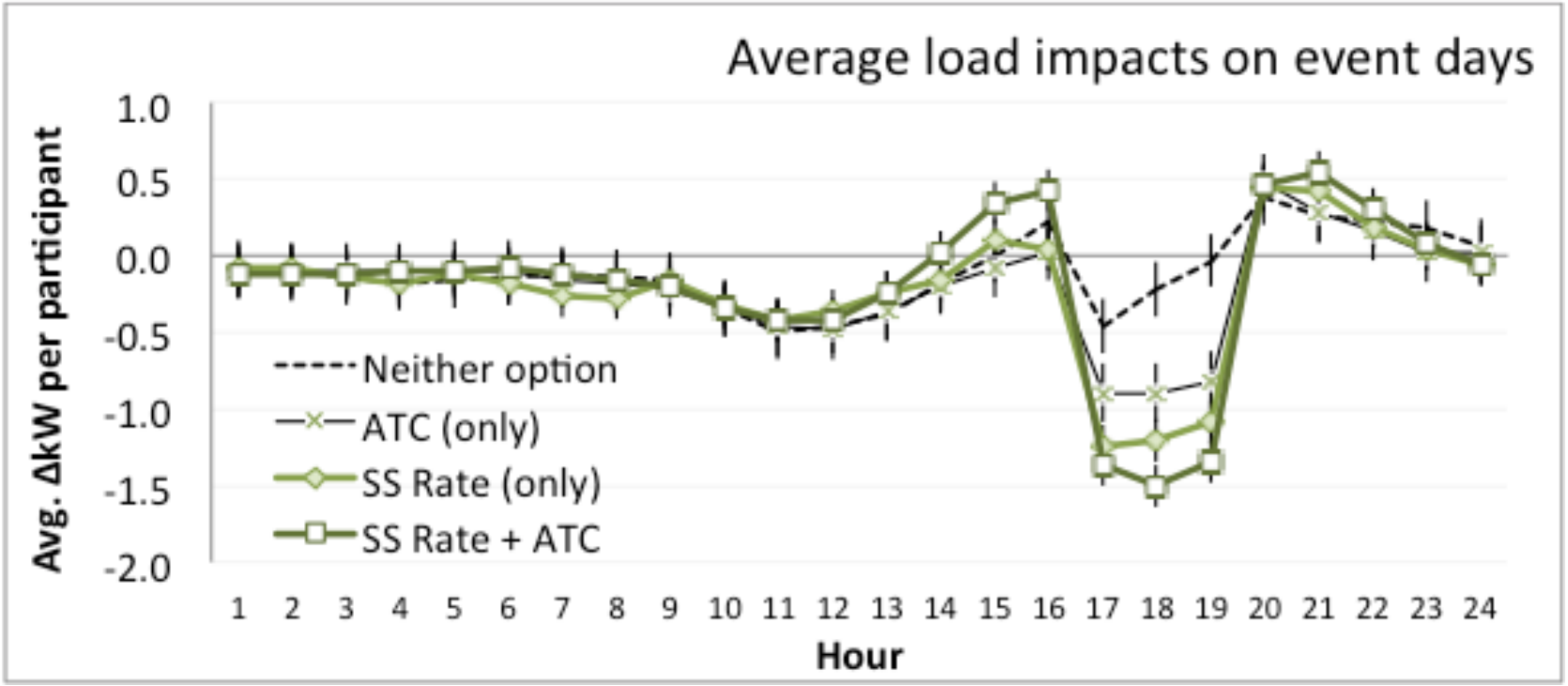


Values in bold indicate a statistically significant difference from "Baseline information"

Motivation and Automation Effects

event days

- Participants with Motivation had significantly greater event day savings
- Customer-controlled automation outperformed utility-controlled automation

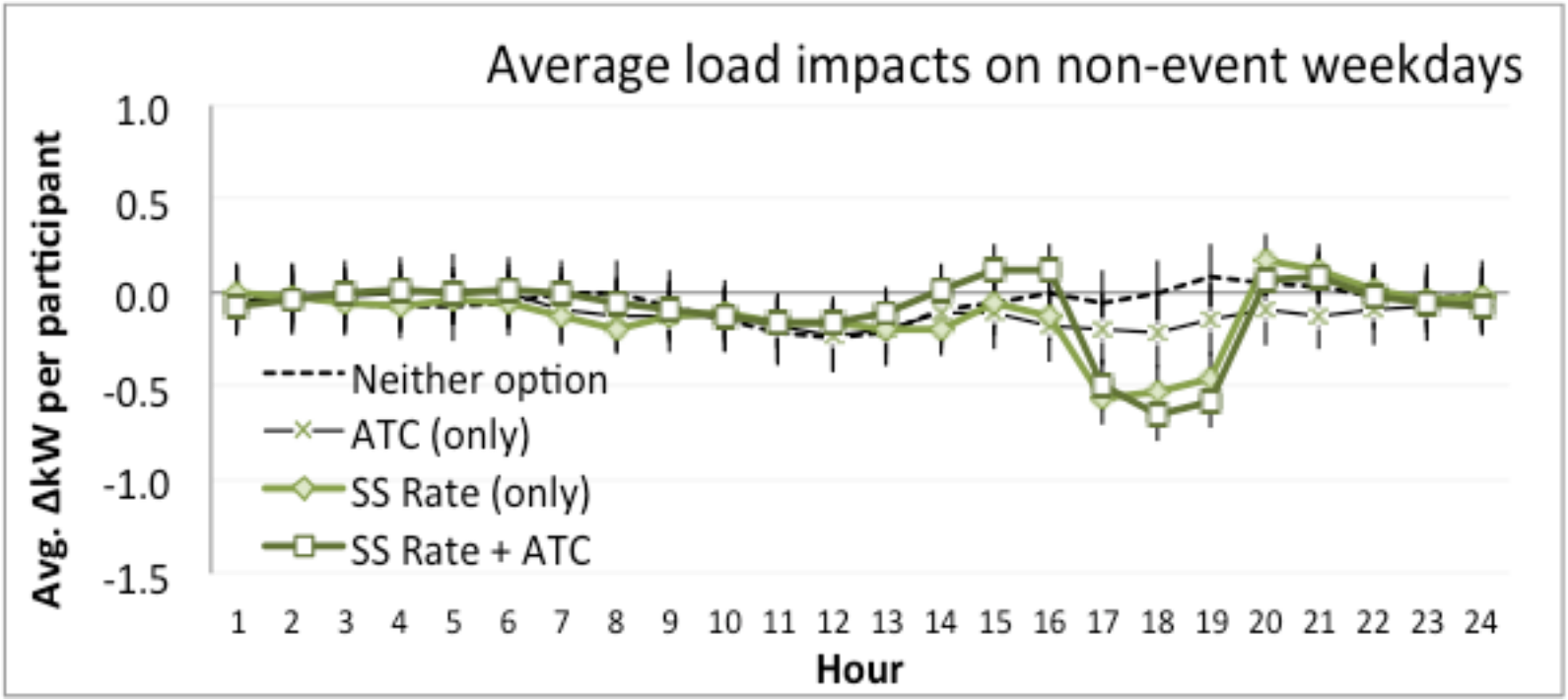


Remember: options were chosen by participants, not randomly assigned.

Motivation and Automation Effects

non-event weekdays

- No Automation available to shed peak load every day
- No Motivation for "Neither option" or "ATC-only" to reduce peak load
- Dynamic rate participants had the greatest Motivation - and impacts

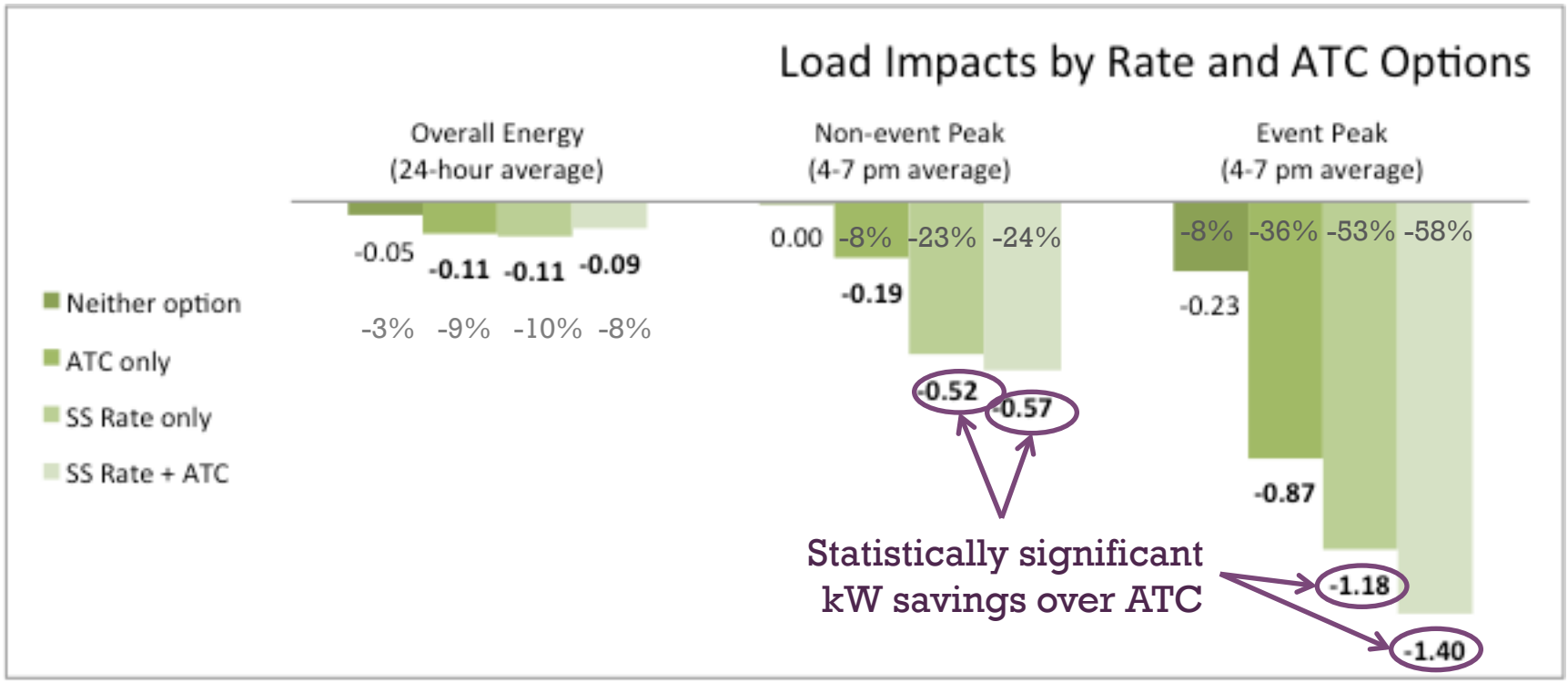


Remember: options were chosen by participants, not randomly assigned.

Motivation and Automation Effects

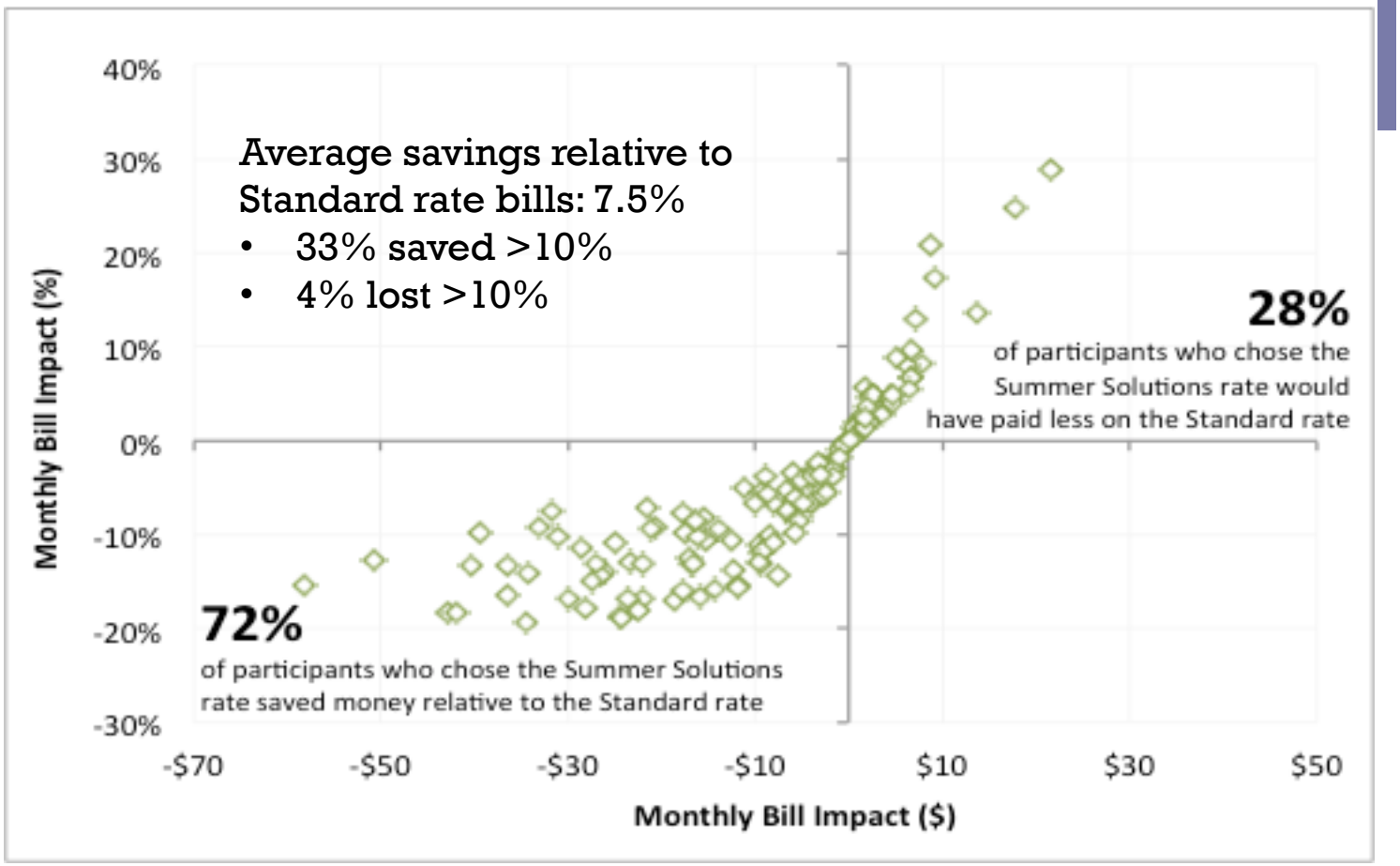
first-year Summary (2011)

- Similar energy savings across all groups except Neither
- Peak and event load reductions greatest for dynamic rate – meaning customer-controlled response outperformed utility-controlled response



Values in bold indicate a statistically significant difference from "Neither option"

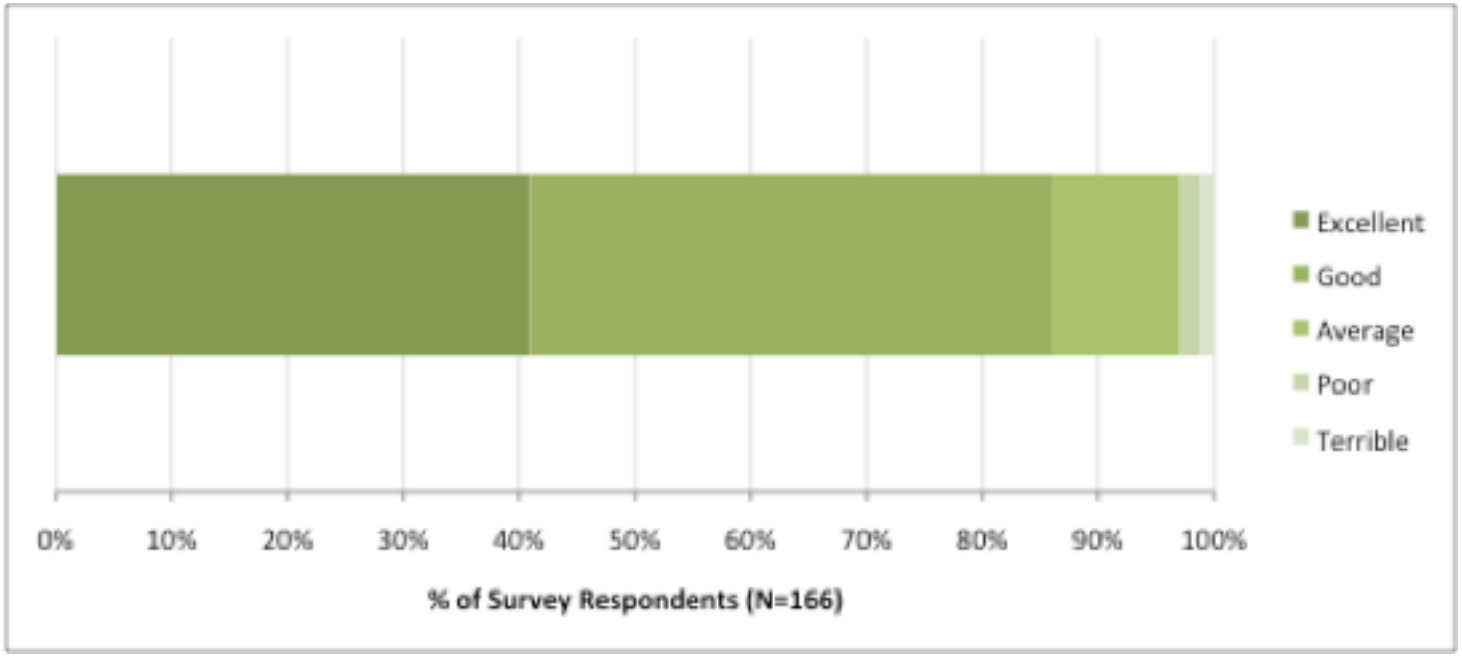
First-year Bill Impacts



These bill savings are <u>in addition</u> to those associated with energy savings: those on the SS rate saved about twice as much ($20/mo) as those on the Standard rate ($10/mo).

First-year Satisfaction

- 86% rated the program Excellent or Good
  - No significant difference across groups
- 90% signed up again for Summer Solutions 2012
  - 5% dropped out, 5% unreachable



Recommendations and Lessons Learned

1. Dynamic Rate

Lowers energy use, daily peak, event loads *and* bills

- Peak and event savings efforts → energy savings
  - 5% replaced an old AC unit
  - 6% sealed ducts
  - 7% increased attic insulation
  - 10% sealed the attic hatch
  - 12% removed an old refrigerator from the garage
  - 15% set cooling to 78°F or higher
- On average, participants on the dynamic rate saved 15% on their summer bills

2. Advanced Thermostats

Provide, rebate, or recommend

- Non-communicating thermostats
  - User friendly
  - Precooling and peak settings for daily TOU peak pricing
  - Display the current electricity rate (non-dynamic only)
- Communicating thermostats
  - User friendly
  - Precooling and peak settings for daily TOU peak pricing
  - Precooling and peak settings for CPP event pricing or DR events
  - Display the current electricity rate and event status
- Optional (but nice) for all thermostats
  - Display real-time energy data for the home
  - Display real-time energy data for appliances
  - Proven energy optimization algorithms

3. Enhanced Customer Service

Engaged customers want personalized tools & advice

- Offer online tools that use customer-specific data to provide accurate "what-if" scenarios
  - Effects of different rates
  - Effects of conservation and load shifting behaviors
  - Effects of efficiency investments
- Integrate basic home energy assessments into EEDR offers
  - Home energy assessments were rated the most useful feature of the Summer Solutions study
  - Or, offer free HEAs and use the contact to promote EEDR options

4. Real-time Information

- … is substantially more effective in the presence of real-time Motivation – i.e. dynamic rates
- …is slightly more effective if provided at the appliance level
  - But unlikely to be cost effective with current technology
- … significantly enhances energy, peak and event load impacts

5. Something for everyone

One size doth not fit all

- Evidence?
  - 94% of invited SMUD customers were uninterested in the free real-time energy information or thermostat
  - 38% of participants did not want the utility to control their thermostat
  - 26% of participants were unwilling to try the dynamic rate
- What to do? Offer a portfolio of mix-and-match energy management tools + incentives, and let the customers choose
  - Efficiency measures + rebates → energy savings
  - Customer-controlled scheduling + TOU pricing → peak savings
  - Utility-controlled automation + payments → event savings
  - Customer-controlled automation + TOU-CPP → peak & event savings

Contacts

Karen Herter
Herter Energy Research Solutions
www.HerterEnergy.com
916.397.0101

Vikki Wood
Sacramento Municipal Utility District
www.SMUD.org
916.732.6278

Full Report (February 2012) at:
http://www.HerterEnergy.com