



# Anatomy of a Demonstration Pilot: Smart Grid Appliances Case Study

2013 Behavior, Energy & Climate Change Conference

Jolyn Newton  
November 19, 2013



# The Project

---

- Reducing residential load through bundled small “background” actions
  - 2-year comparative field test in Glasgow, KY
  - “intelligent” appliances - GE Profile® line ENERGY STAR® Appliances enabled with Brillion® technology
  - 20 Test sites, 10 Control sites
  
- Objectives
  - Quantify baseline of residential appliances
  - Quantify energy & demand impact of bundled high-efficiency appliance retrofit
  - Measure demand response and load shifting capability
  - Observe ability & willingness of homeowners to allow 3<sup>rd</sup> party control
  - Assess customer behavior change and acceptance relative to the perceived benefits
  
- Challenges
  - Small participant pool
  - Selection bias
  - Lots of experiment possibilities – hard to narrow down to satisfy all partners

# The Project Team



UNIVERSITY  
of LOUISVILLE

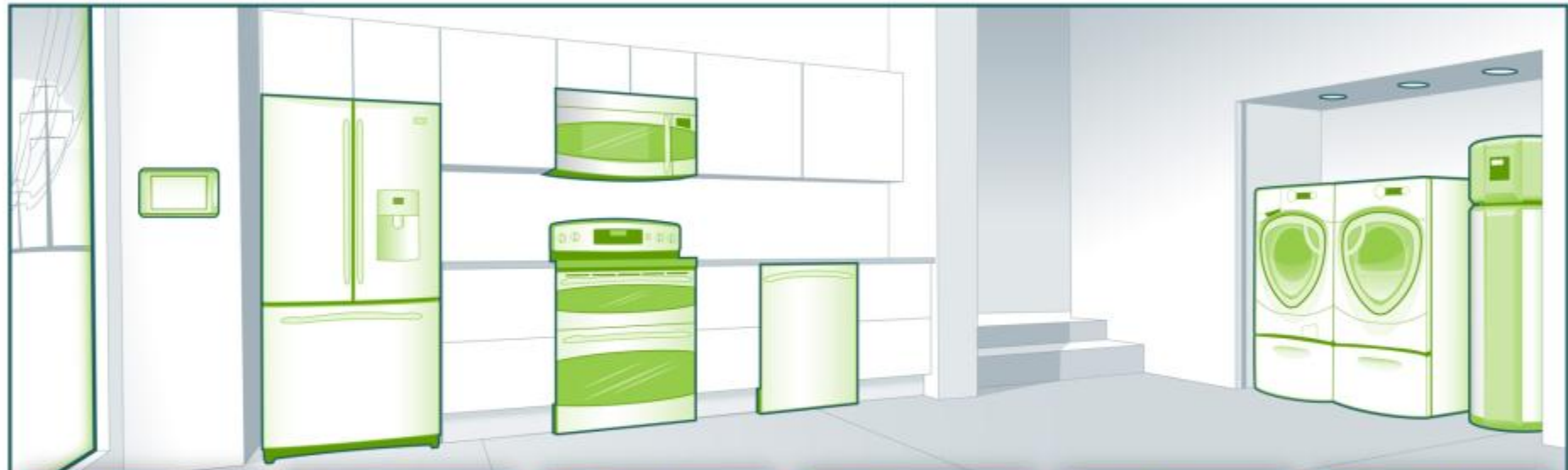
# GE Energy Management & Demand Response Appliances



Utility companies that have implemented time-of-use pricing communicate their daily rate schedules to the home.

GE's Demand Response Appliances react, saving money while lowering peak demand and the need for more power generation.

Optionally, the GE Home Energy Manager correlates rates with user-preferences to balance cost, comfort, and convenience.



### Home Energy Manager

This energy brain works in conjunction with you and your home to help understand and optimize energy use.



### Refrigerator

This Profile refrigerator can reduce energy use on demand and delay defrosts to inexpensive rate periods.



### Range & Microwave

Cooking energy is reduced and with dual cavities, the range can preference the smaller upper oven.



### Dishwasher

The dishwasher is aware of expensive rate periods and can wait to run when energy costs are lower.



### Laundry Pair

When high rates arise, this laundry pair will save you money while getting your clothes clean and dry.



### Hybrid Water Heater

The water heater can switch to heat-pump mode and modify temperature settings during high rates.



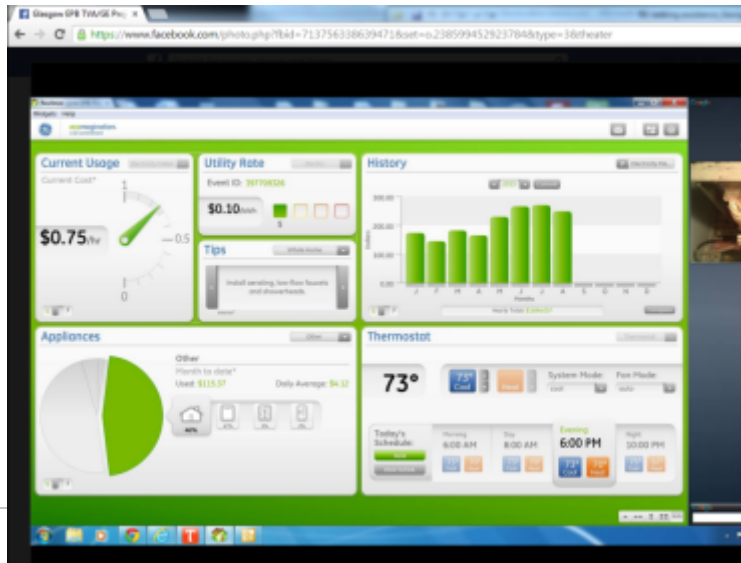
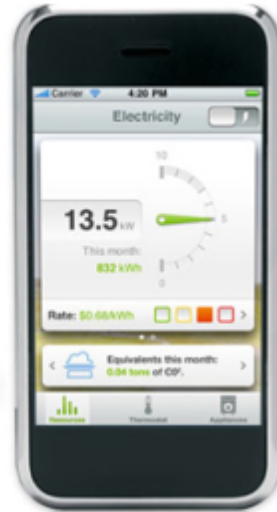
# The Brains of the Operation



Nucleus energy manager plugs into any standard electrical outlet, and is designed to wirelessly gather power usage information from the smart meter, thermostat, and from “Brillion” enabled appliances



# Human Interaction

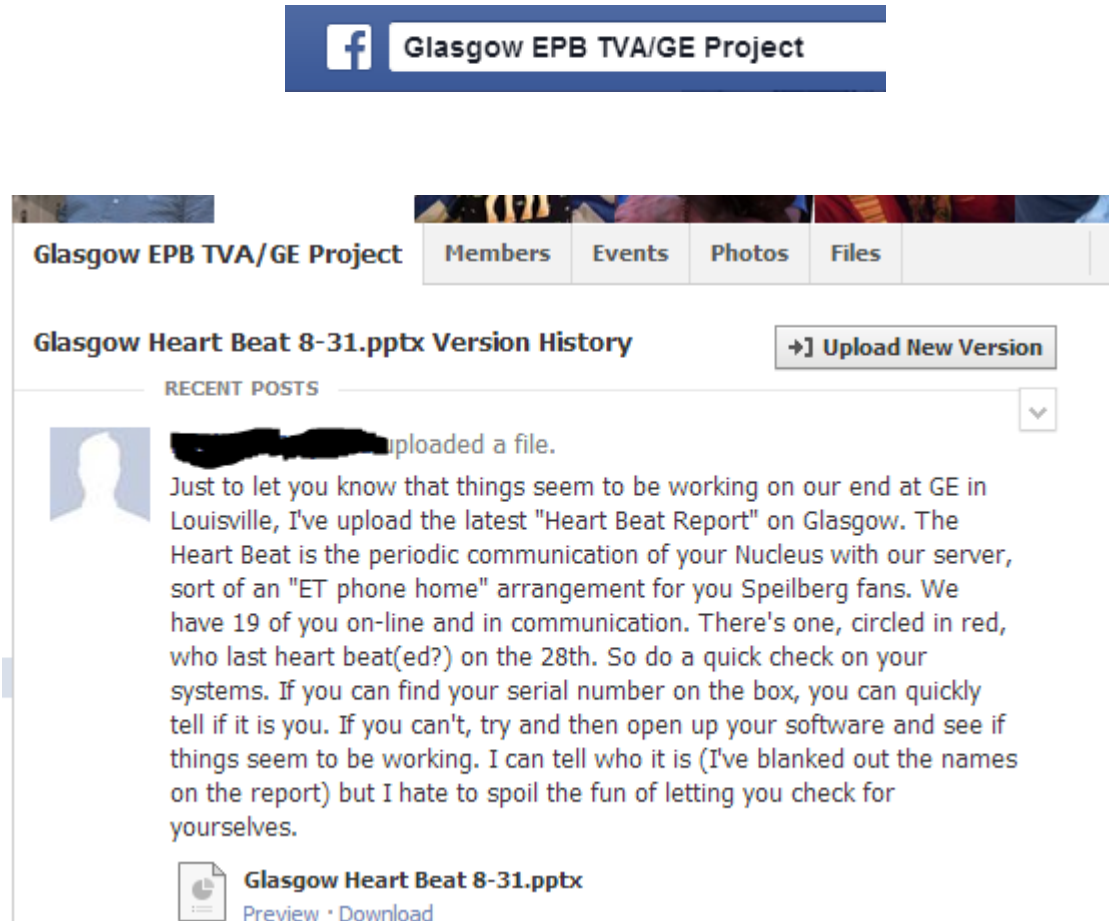


# Engaging Participants through Social Media



# Project Facebook Page


- Includes utility, GE, consumers, researchers
- Communication alerts from project sponsors




**Glasgow EPB TVA/GE Project** Members Events Photos Files

**Glasgow Heart Beat 8-31.pptx Version History** [→\] Upload New Version](#)

RECENT POSTS

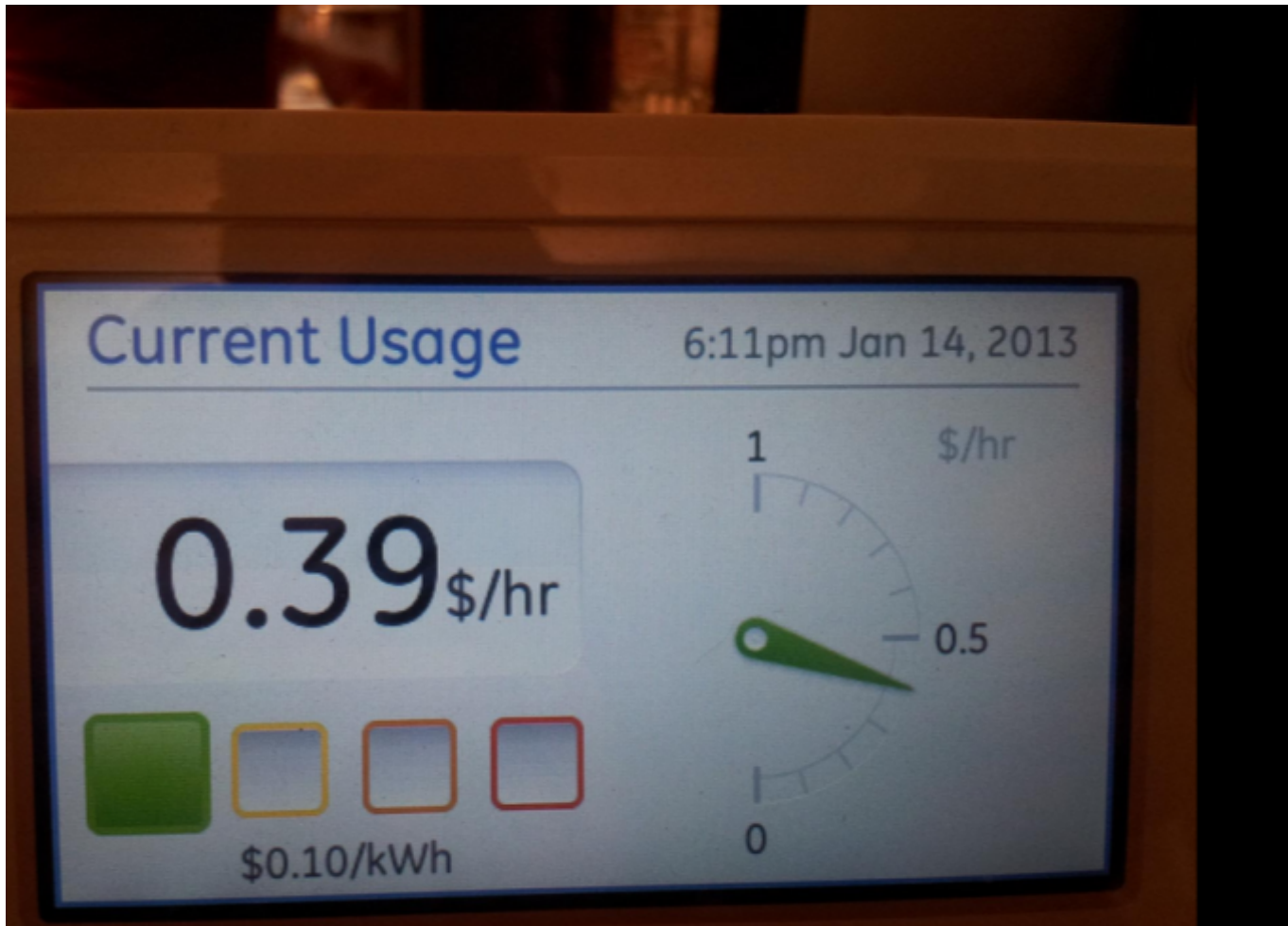
 **[REDACTED]** uploaded a file.

Just to let you know that things seem to be working on our end at GE in Louisville, I've upload the latest "Heart Beat Report" on Glasgow. The Heart Beat is the periodic communication of your Nucleus with our server, sort of an "ET phone home" arrangement for you Spielberg fans. We have 19 of you on-line and in communication. There's one, circled in red, who last heart beat(ed?) on the 28th. So do a quick check on your systems. If you can find your serial number on the box, you can quickly tell if it is you. If you can't, try and then open up your software and see if things seem to be working. I can tell who it is (I've blanked out the names on the report) but I hate to spoil the fun of letting you check for yourselves.

 **Glasgow Heart Beat 8-31.pptx**  
[Preview](#) · [Download](#)



# ...for troubleshooting with participants



The screenshot shows a Facebook post from the "Glasgow EPB TVA/GE Project" page, dated January 14. The post text says: "Looks like it is working notice the date." Below the text are interaction options: "Like · Comment · Follow Post · Share". A comment from a user with a blacked-out profile picture says: "It's fixed. So happy the on off on off on off is over." The comment is dated "January 14 at 7:15pm" and has a "Like" button. Below the comment is a text input field for "Write a comment..." and a camera icon. Below the post are three sponsored advertisements: "Verizon Wireless" (with a Jetpack image), "Old Navy Outerwear Sale" (with a puffer jacket image), and "Environmental Master's" (with a person in a field image). At the bottom, there is a link for "Help HAITI from Music Row" with a small image.


...for bragging



 [Glasgow EPB TVA/GE Project](#)  
November 23, 2012

Just a quick update on the Thanksgiving feast. I did not cook a Turkey, I was told to cook each person a mini turkey. So I got 18 Turkey's and ran them through the shrink cycle in the new dryer and that worked great. Next I brined the mini turkey's in the briner drawer of the new fridge, I used 1 cup of salt 1 cup of brown sugar and a couple of handfuls of rosemary out of the garden to a gallon of water, let the mini turkeys brine in this for 12 hours. Took them out and ran them through the rinse cycle of the dishwasher. A tittle Lowery's salt and pepper mix. Into the oven with the probe set for 180 degrees, when the internal temp. was 180 I turned the oven to broil for 5 min., just to brown. Do not attempt this at home, I am a professional and was using special modified GE appliances.

Like · Comment · Follow Post · Share

 2 people like this.

# ...for confessions



[Redacted Name]

► Glasgow EPB TVA/GE

Project

October 1 via mobile

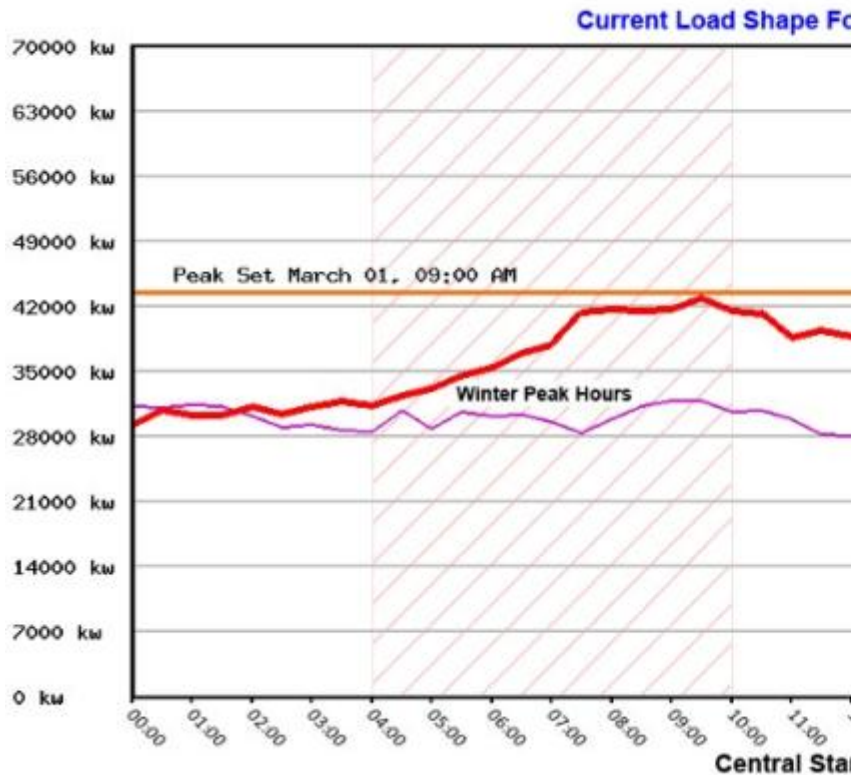
near Glasgow, KY

Well... We had a good run going, but I finally had to override today... We were down to 1 diaper!!

Like · Comment · Follow Post · Share



# ...and for Thank-You's



## William Ray ▸ Glasgow EPB TVA/GE Project

Follow · March 4

Thanks to everyone in the project (and a lot of other customers in Glasgow), just look at how we were able to manage our peak this morning! Though the 20 homes in the project were not the whole story, this does give you all a realistic example of why we think it so important for appliance manufacturers to work with utilities to enable us to actively manage our load. The ability to flatten peaks and fill in valleys of a community's electrical demand is one of the most promising technologies that we hope will allow us to reduce the amount of new generation capacity needed. If successful, the understanding of this capacity may yield lower electric rates for all. Thanks for being a part of this research!








# The Study – One Year In





# Study Phases

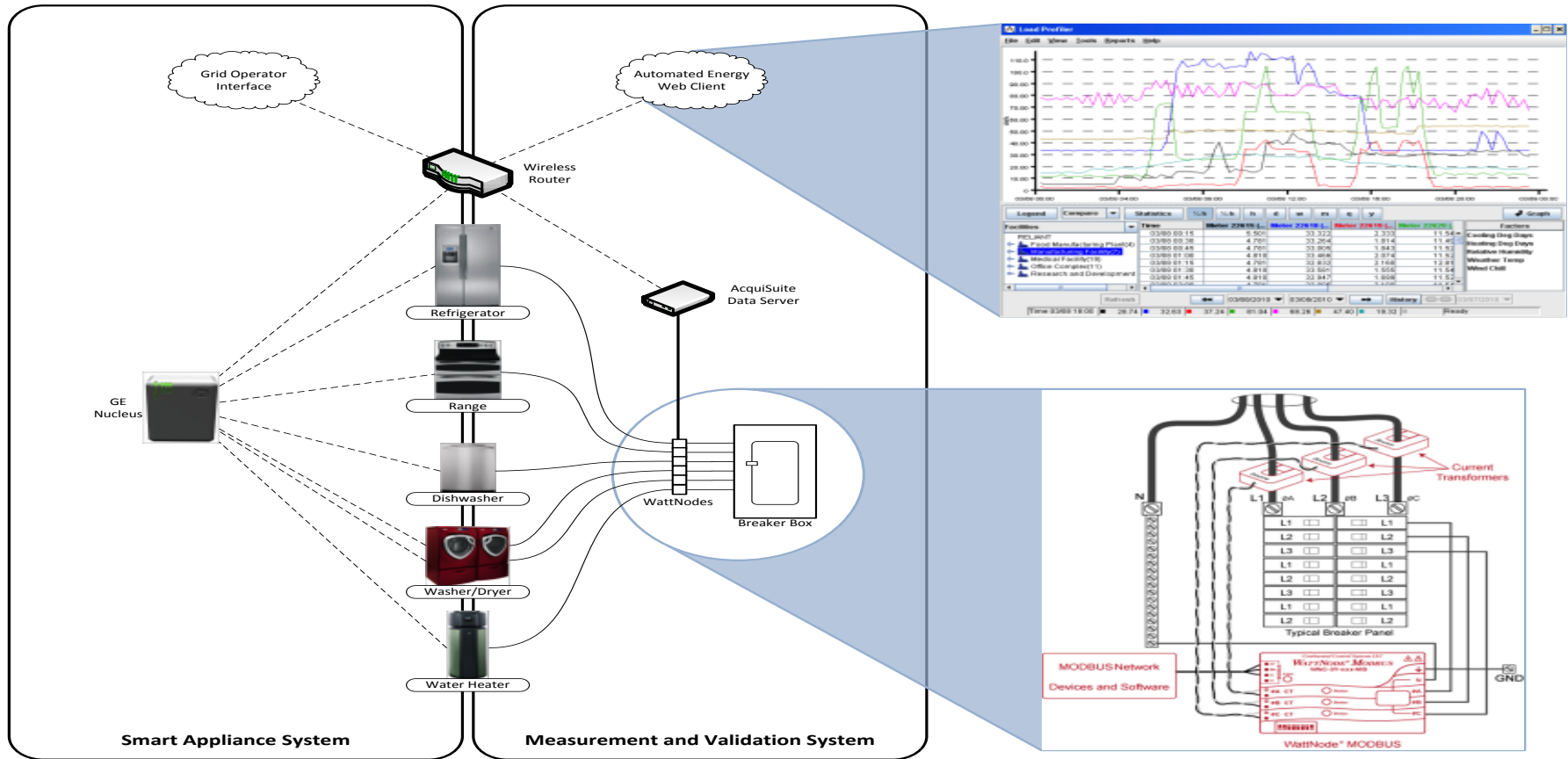
 Phase 1	 Phase 2	 Phase 3a	 Phase 3b	 Phase 4
<p>Installed metering devices</p> <p>Monitored energy use of existing appliances</p> <p>Established baseline profile of each home</p> <p>3 month duration</p>	<p>Installed GE smart appliance bundle</p> <p>Monitored baseline energy use of appliance bundle</p> <p>Quantified efficiency gains</p> <p>3 month duration</p>	<p>Initiated test parameters</p> <p>Pricing signals for 4 hours during peak event period of 2 p.m. to 6 p.m. on weekdays</p> <p>Remotely applied low-energy mode during event periods</p> <p>\$1 per day incentive provided for not overriding low-energy settings during event</p> <p>4 month duration</p>	<p>Altered test parameters</p> <p>Pricing signals shifted to 6 hours during peak event of 6 a.m. and 12 p.m. on weekdays</p> <p>Remotely applied low-energy mode during event periods</p> <p>\$1 per day incentive provided for not overriding low-energy settings during event</p> <p>Conducted in-home evaluations</p> <p>4 month duration</p>	<p>In process - will alter test parameters over 11 month period</p> <p>Seasonal pricing signals from phases 3 and 3.5</p> <p>Enact Critical Peak Pricing events</p> <p>Enact HVAC control</p> <p>Remotely apply low-energy mode during peak event periods</p> <p>Incentive adjustments</p>

# Phase One – Establish the Baseline

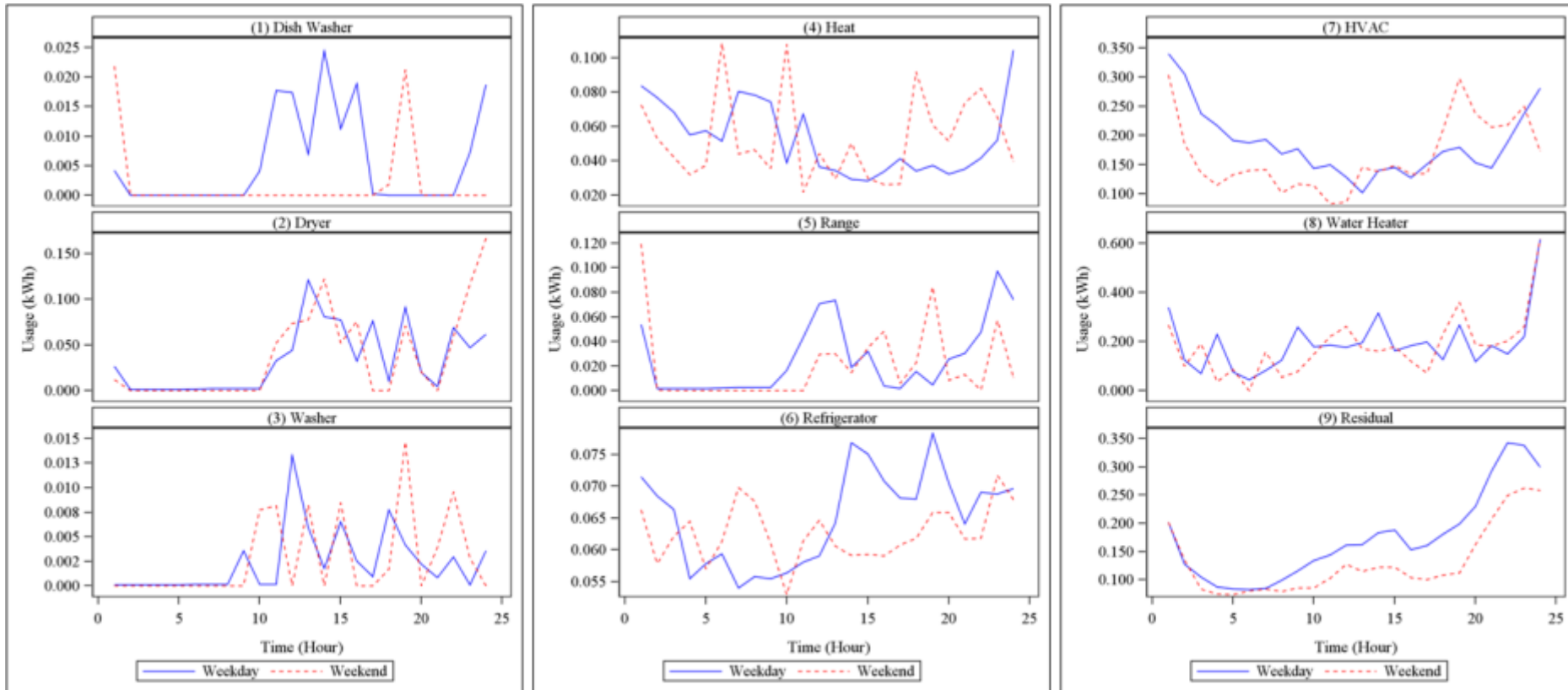
---

- Instrumentation and monitoring Test and Control sites
- Installation of the End-Use Meters on select appliances as well as collection of inside and outside temperatures. The purpose is to create baseline results for comparison against performance in subsequent phases.

# Anatomy

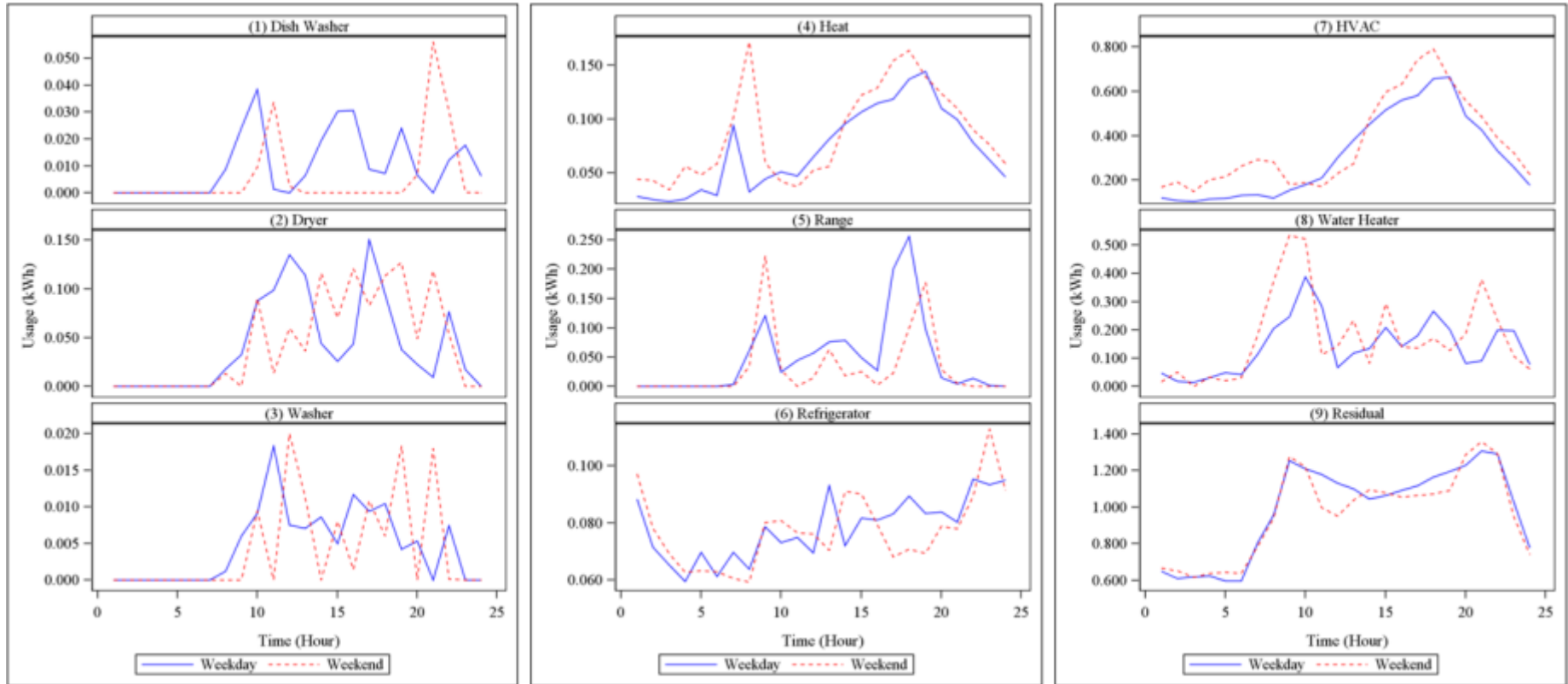


## Average Demand by Appliance – Weekday/Weekend Breakdown



- This customer tends to use his appliances late at night, along with other plug loads, leading us to believe this family tend to be “night owls”.

## Average Demand by Appliance – Weekday/Weekend Breakdown



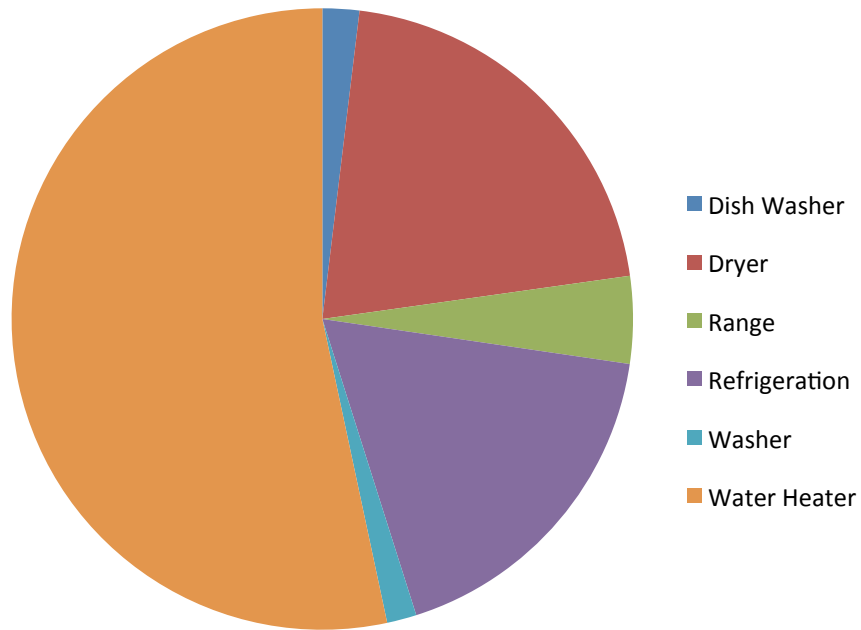
- This customer tends to be much more similar to a typical residential customer where the appliances tend to be used in the morning and evening hours.



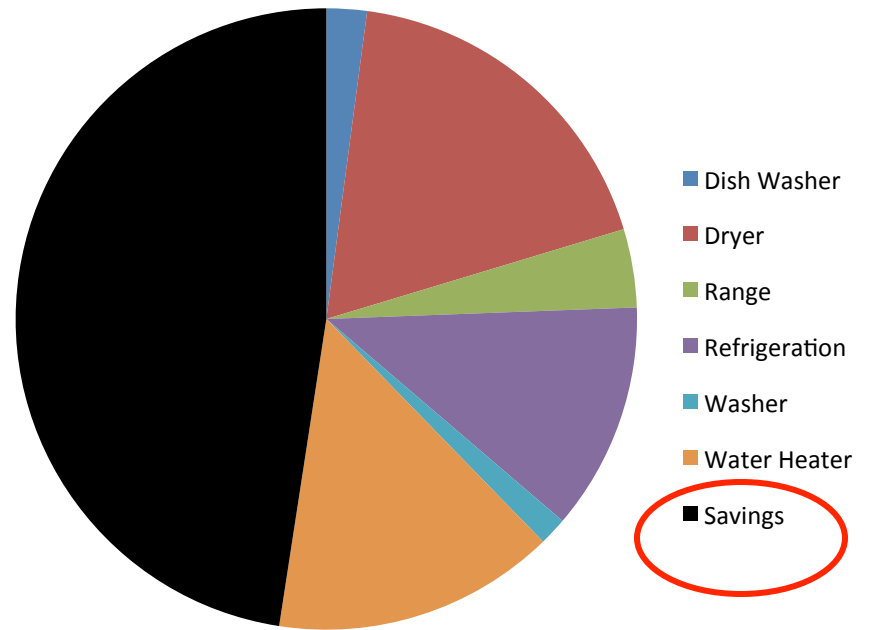
# Phase Two – Quantity Efficiency Gains

48% reduction in usage

Phase 1 Usage by Appliance

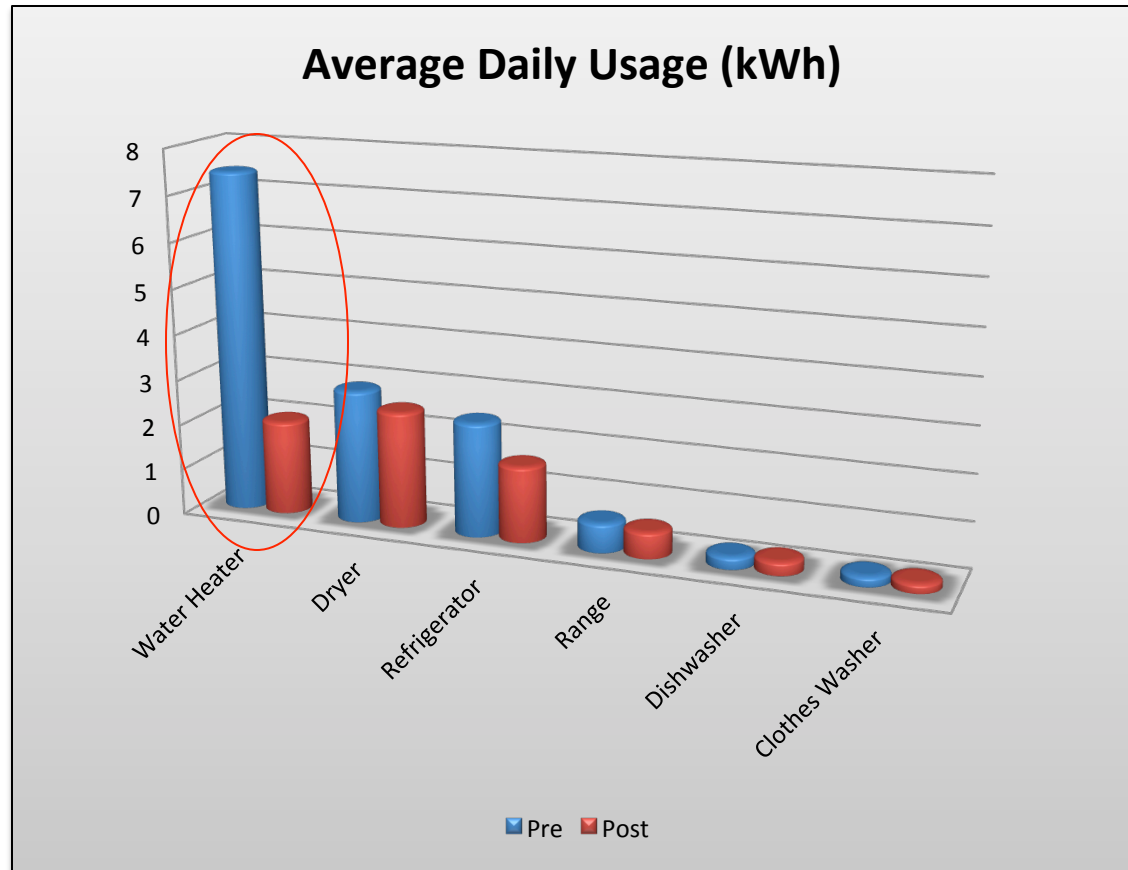


Phase 2 Usage by Appliance

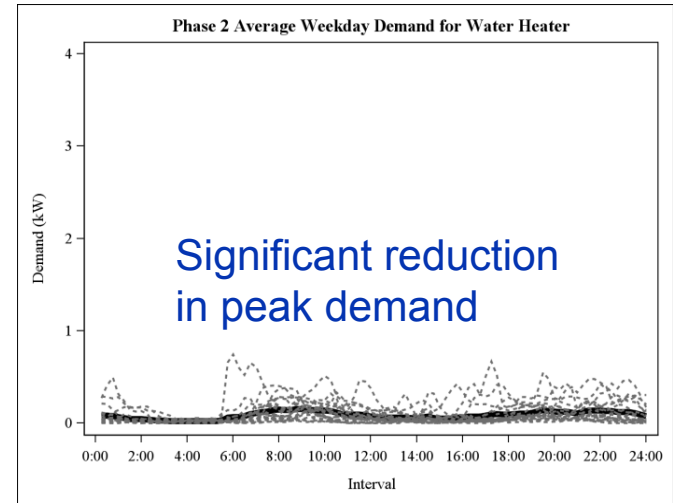
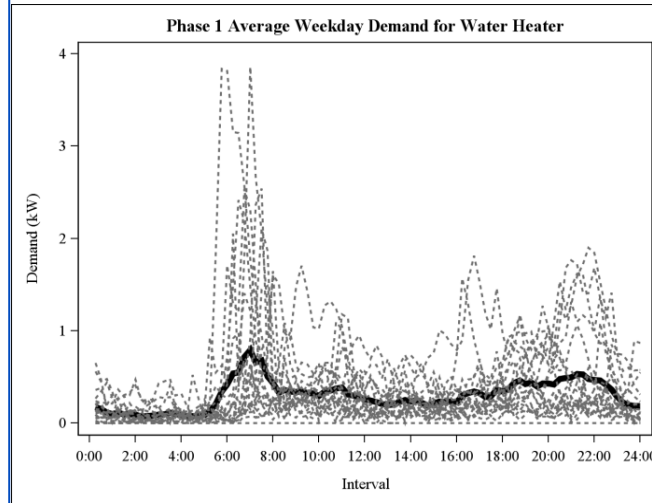
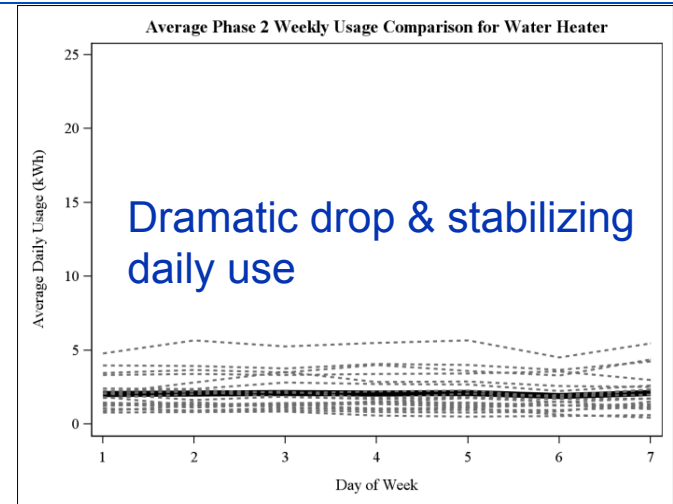
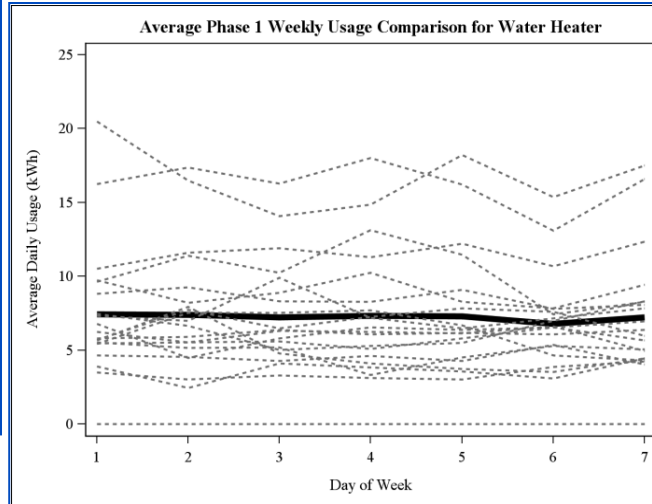
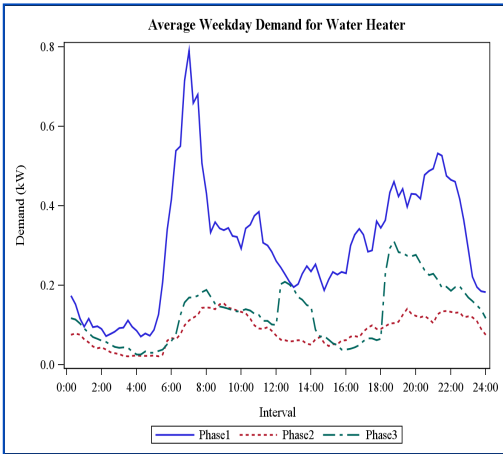


# Individual Appliance Efficiency Gains

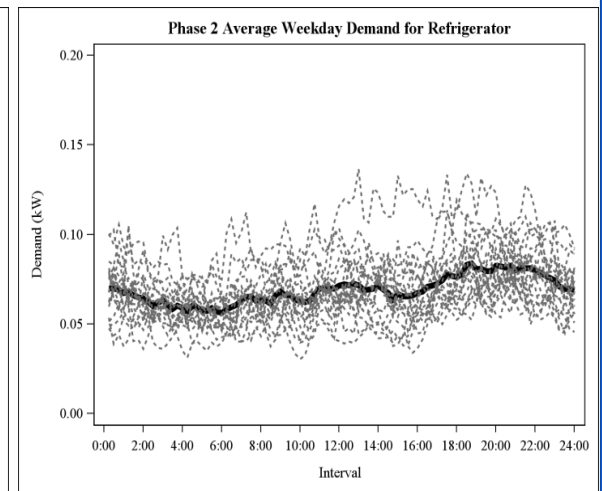
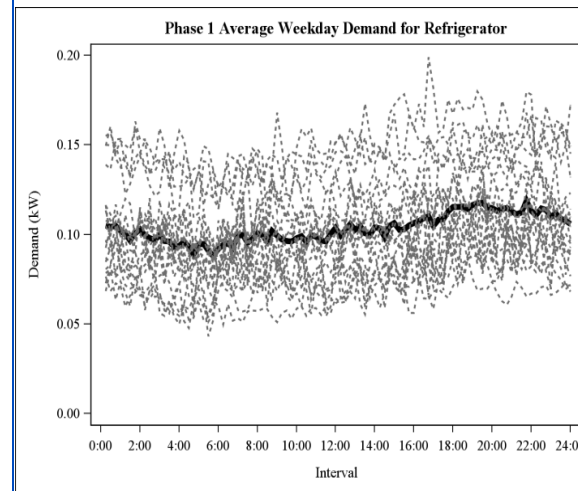
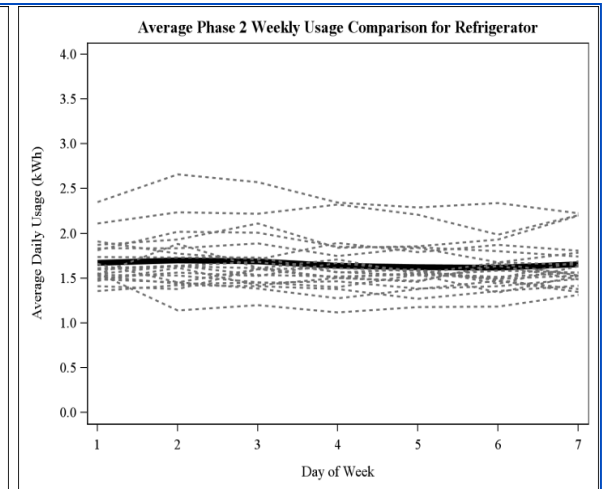
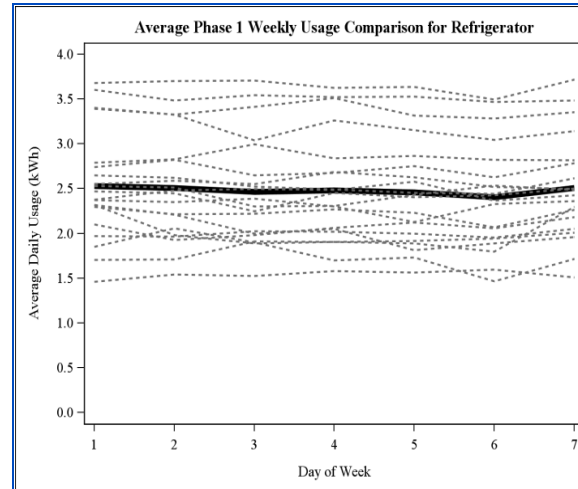
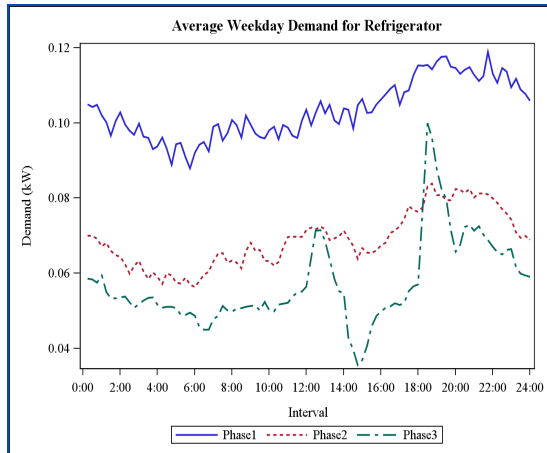
- Heat pump water heater 70%
- Refrigeration 33%
- Dryer 9%
- Range 8%
- Clothes Washer 5%
- Dishwasher -5%



# Electric Water Heater Performance



# Refrigerators



# Phase 3 – Response to Pricing Signals

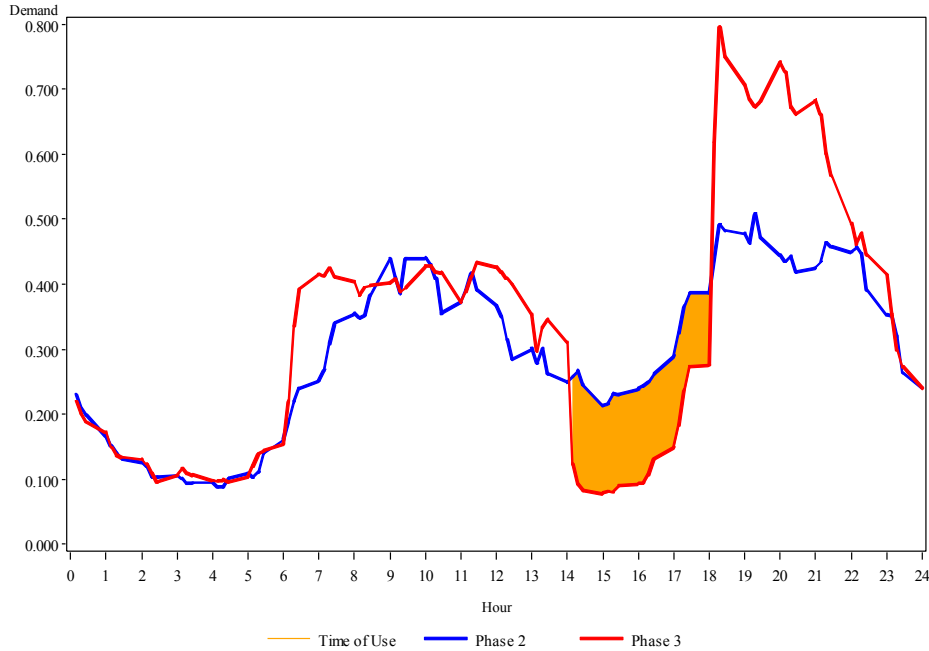
- Nucleus reacts to utility high-price-period signal by signaling all appliances to shift into a low-energy mode
- Event parameters
  - 10¢/kWh base rate, 20¢/kWh peak period rate
  - Call period for phase 3a: 2p.m. – 6p.m.; phase 3b: 6a.m. to Noon

Appliance	Low Energy Mode
Dishwasher	Dry cycle disabled
Clothes Washer	Cold water only
Dryer	Cycle runs in reduced heat mode – one of two heating elements de-activated
Heat Pump Water Heater	Set point lowered to 110° F; HP-only mode activated, upper resistance element de-activated
Refrigerator	Freezer set point raised, features disabled include: TurboCool/Quick Chill/Quick Defrost/Quick Freeze/Quick Ice
Range	Lower oven prevented from starting, outer broil elements disabled on upper oven, preheating slowed, burners reduced to ~80% power, self-clean mode disabled

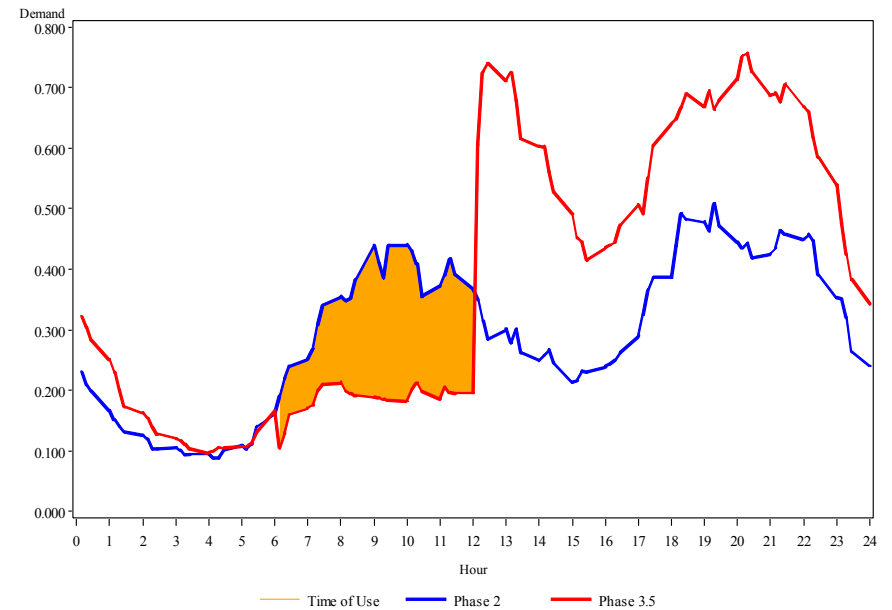


# Phase 2 versus Phase 3: Full Appliance Bundle

Average Hourly Weekday Comparison: Phase 2 vs Phase 3  
Appliance: Total Appliance Bundle Analysis Type: Demand

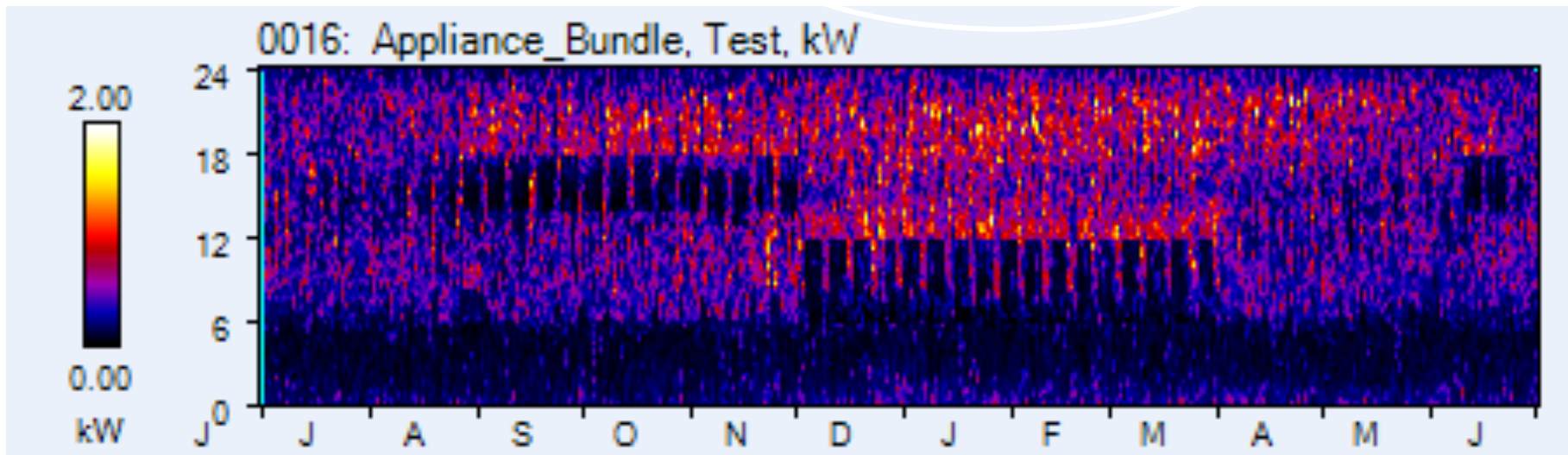


Average Hourly Weekday Comparison: Phase 2 vs Phase 3.5  
Appliance: Total Appliance Bundle Analysis Type: Demand



# Energy Footprint

- We see the impact in the energy footprint → participants allowed 3<sup>rd</sup> party control 97% of the time over 30 week period
- 3% opt-out: #1 appliance overridden? #2?



# Phase 4 – Activating Thermostats

- In process now, continues for 11-months
- Builds on Phase 3 by adding thermostat control
- Will they be as willing to allow temperature fluctuations?
- Looking at persistence
  - Maintain 3% opt-out rate?
  - Participant fatigue?



# The Future?



GE & other appliance manufacturers are moving away from utility control for grid stabilization and energy optimization and toward consumers for convinces enabled through smart phone apps.

## Utility Pilot Customers



The Nucleus energy manager and its associated family of products are no longer available, but

Utility customers will continue to be supported through the duration of their pilots.

For questions related to utility pilots or retail purchase, please visit our [Nucleus Support Page](#).

### Control your appliances from anywhere in your home

Preheat your oven without being in the kitchen.



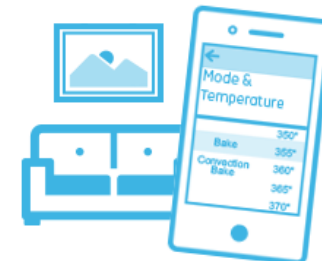
Turn your oven on with your Brillion app.

No more waiting for the beep!



Get an alert when your cookies are ready.

Not quite ready for dinner?



Change your oven's temperature from your living room.

Thank-You!

Jolyn Newton

[www.dnvkema.com](http://www.dnvkema.com)

[Jolyn.Newton@dnvkema.com](mailto:Jolyn.Newton@dnvkema.com)

(615) 577-2701

