Smart Water Heater Project Update

EPRI Smart Grid Advisory Meeting
Albuquerque, New Mexico

October 13, 2009

BTES — Bristol Tennessee Essential Services
Electric • Internet • Telephone • Cable

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CARINA Technology, Inc.

Residential Two-way Water Heater Load Control Pilot

Purpose
- Demonstrate a two-way water heater load control system
- Shift peak load minimizing customer impact
- Capture operational data and usage profiles to support Measurement & Verification
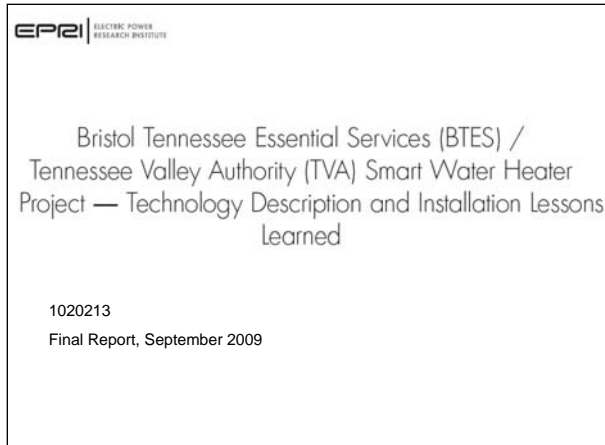
Project participants
- Bristol Essential Services (BTES) including BTES selected water heater program customers
- Carina Technology, Inc. (Communications, AMI, and controls development)
- EPRI (Project analysis and evaluation)
- TVA (Project development and management)

Report 1020213, available to members for download

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Bristol Tennessee Essential Services (BTES) /
Tennessee Valley Authority (TVA) Smart Water Heater
Project — Technology Description and Installation Lessons
Learned

1020213
Final Report, September 2009

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- Phase I - Alpha version controller – 25 units
- Phase II - Beta 1.0 units – 250 units
  - gather demographic and baseline "comfort" data, develop a plan to test Load Control Schemes, analyzing preliminary data
- Phase III – Beta 2.0 units - testing of 5000 units
  - develop seasonal data and baseline data
  - validate actual peak shifting,
  - fine tune Load Control Schemes for various demographic user groups
  - obtain third-party analysis and validation,

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TVA

System Installation
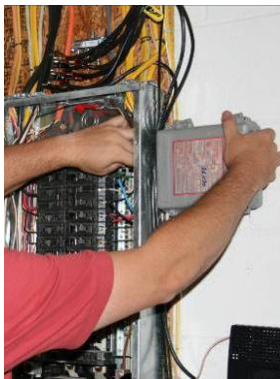

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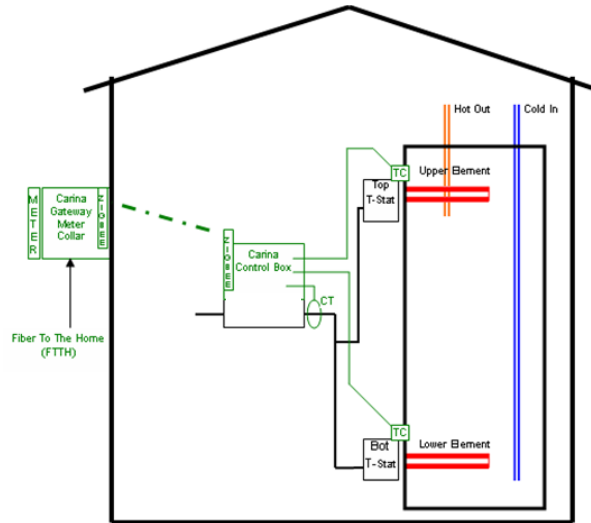
All Installs were Retrofits

Existing AMI System, Remove 1-way WH System, Install 2-way WISE Unit

Install ZigBee Module   Remove one-way Control Device   Install WISE Unit

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System Hardware

Meter Collar

Communications Box
(Optical Network Terminal)

Meter: L&G Focus

Water Heater Information
Solution (WISE) Unit

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Installation Lessons Learned

- ~4 Installations per day per installer (Retrofit)
- Average install time ~1 hour (all from 1/2 hour – 3 hour)
- BTES' strong relationship with customers – invaluable
- Installation schedule & management very important
- Training & Staging critical to reduce install time
- No issues with ZigBee wireless connection
- Considering Pre-Install Walkthru
- Thermocouple Routing (Outside vs. Inside)
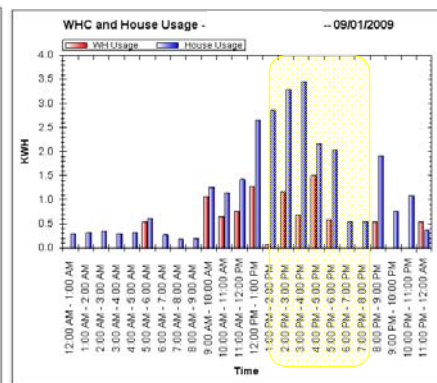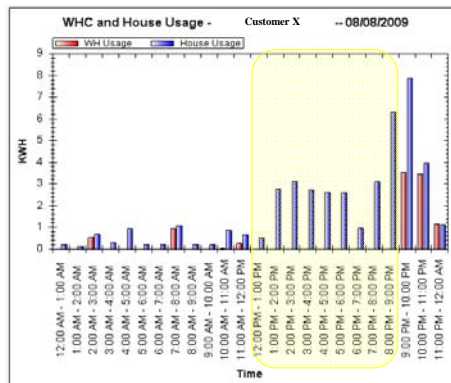- End-to-End Verification Bottlenecks

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Water Heater Control Example

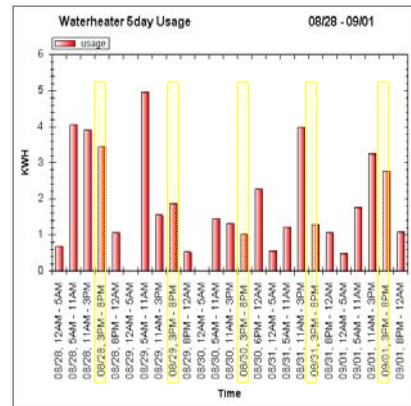Shift as much load as possible without causing discomfort

Legend: TopTemp — BottomTemp — AverageTemp — Top Set Point — Bottom Set Point
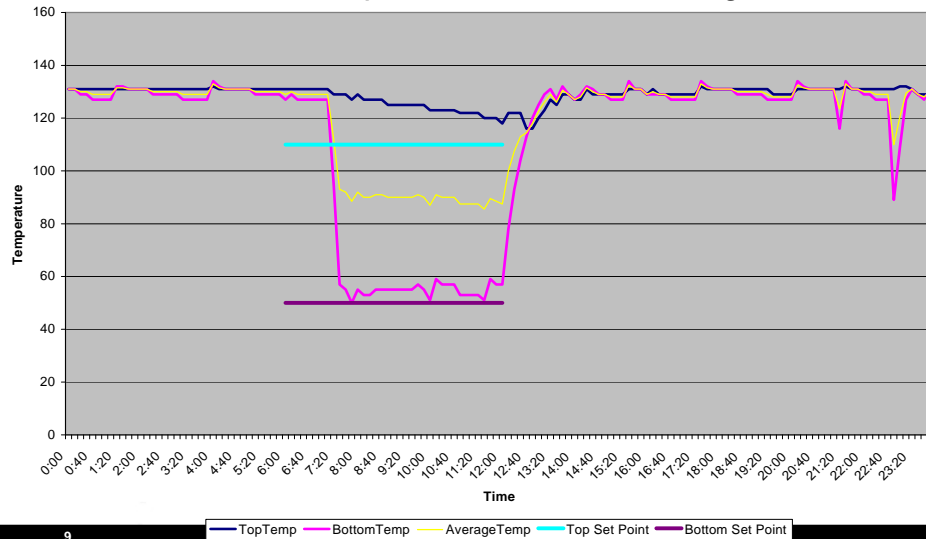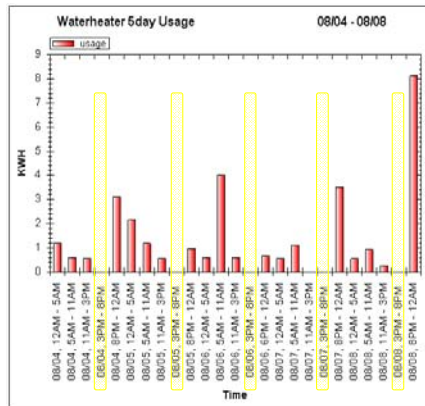
Controlled vs. Non-Controlled Mode
Water Heater & House kWH

*Note: Not a controlled data set, but from same customer

Controlled vs. Non-Controlled Mode Water Heater & House kWH. 5-Day
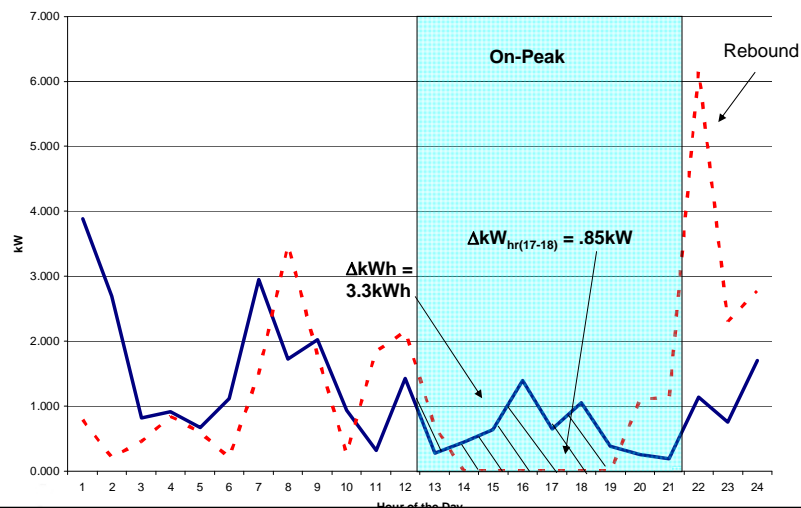

*Note: Not a controlled data set, but from same customer

Water Heater Load Shape Impacts – Thursday, August 27, 2009

Actual BTES Water Heater Load Shape @ 110 ° Control

Water Heater Data Interactions

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1. Type of dwelling (3)
2. WH Capacity (GAL) (3)
3. Clothes Washer? (2)
4. Dishwasher? (2)

5. # of persons in household (5)
   a) Ages: 0-5
   b) Ages 6-13
   c) Ages 14 -18
   d) Ages 18 - 65
   e) Ages over 65

Initial stratifications suggests 190 stratification cells. Total sample size would need to be far in excess of expected 250 sites in the initial evaluation

Source: "Modeling Patterns of Hot Water Use in Households", Lutz et al., Ernest Orlando Lawrence Berkeley National Laboratory, November 1996

- Customer Satisfaction = f(draw °)
- Utility value = f (shifted kWh) less rebound
- Shifted kWh = f(usage, script)
- Usage = f(# people, their ages, dishwasher, washer, ownership)
- Draw ° = f(usage, WH Capacity, recovery time, script, script duration)

Exogenous Variables
- Usage

Control Variables
- Script
- Script duration

Proposed Scripts
- 120 °
- 110 °
- 105 °

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Final BTES Summer '09 Stratification

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Number of Monitored Sites = 117

(Sites per Cell / Control Sites in "( )")

Sites w/ Dishwasher

	No Seniors	Seniors
1-3 Occupants	50 (24)	20 (9)
4 or more Occupants	20 (10)	0

Sites w/o Dishwasher

	No Seniors	Seniors
1-3 Occupants	13 (4)	6 (3)
4 or more Occupants	8 (4)	0

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Satisfaction Survey

- Weekly Survey – How satisfied were they with the quantity of hot water delivered when needed
- Points awarded based on timeliness of survey completion
  - Awarded $25 or $50 gift card based on points
  - Points applied towards entry for a grand-prize: Flat Screen HDTV

Satisfaction Rating: 4.64 (1-5, 5 being best)

Email response rate was 67.9% over the five week trial.

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Customer Surveys

Sample of Customer Comments:

- We did lose hot water on a Sunday Morning - after all family had showers
- I am really pleased to be part of your new monitoring system. I think it is a great way to manage water heaters
- It is taking longer to get hot water and with new baby this is NOT convenient
- Our water heats up quickly and do not have to worry about running out.
- We love the hot water heater, any time we need hot water we don't wait which is wonderful
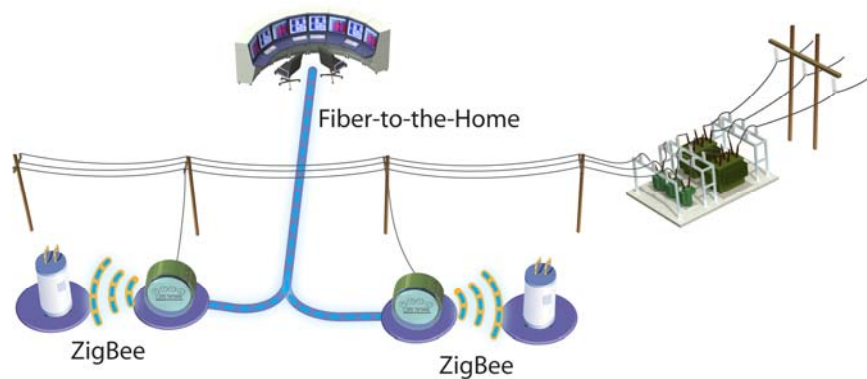- Water is too HOT!

TVA Next Steps

- Full scale impact assessment planned for coming winter and following summer
- Interim report on load shifting impacts for summer '09 and review of rebound impacts
- Summer Pilot Results will help refine stratification
- Review of rebound effects and test of potential mitigation strategies
- Other Tech Transfer Requests?
  - Webcast on interim summer results?
  - Webcast on Technology Details (Carina, BTES, TVA, EPRI)
  - Other?

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TVA Questions?

Fiber-to-the-Home

ZigBee

ZigBee

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