# Field Study of An Intelligent, Networked, Retrofittable Water Heater Controller

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Center for Energy and Environment

# Acknowledgements


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- Gas Technology Institute is the project lead

- Aquanta is the project's industry partner

# Project Goal

To validate the field performance and energy savings of an innovative, intelligent, networked water heater controller for residential and small commercial storage water heaters for potential inclusion within Minnesota's Technical Reference Manual (TRM) and as a program measure within Conservation Improvement Program (CIP) portfolios.

# Methodology

- Install 30+ controllers
  - Mix of gas and electric
  - Mix of hot water loads
  - Mix of inlet water conditions
- Detailed M&V on 10 sites
  - Detailed Instrumentation w/ high resolution data collection
  - Alternating mode analysis
    - Evaluating different control algorithms
- Analysis of controller
  - Assess installation
  - Characterize energy performance
  - Characterize impact on energy use profile
  - Assess the impact on hot water delivery
  - Evaluate the devices measurement capabilities

# Installation and Validation

- Tank Sensor through TMP Valve


- Control Units
  - Electric
  - Gas Valve


- Additional Sensors
  - Leak Detection
  - Water Inlet Temperature

# Installation and Validation

| Site | Fuel Type | Water Heater Size | Water Heater Unit | Hot Water Use (GDP) | Number of Occupants | Energy Factor |
|---|---|---|---|---|---|---|
| d216_gas_01 | Gas | 50 | American Standard PCG6250T403NOV | 36.2 | 4 | 0.70 |
| d216_gas_02 | Gas | 40 | Rheem XG40S09HE38U0 | 18.1 | 2 | 0.62 |
| d216_gas_03 | Gas | 50 | AO Smith FPSH 50 250 | 34.0 | 2 | 0.62 |
| d216_gas_04 | Gas | 50 | AO Smith GPVL 50 200 | 52.5 | 4 | 0.70 |
| d216_gas_05 | Gas | 40 | Rheem 43V P40 SE2 | 35.0 | 2 | 0.67 |
| d216_elec_01 | Electric | 50 | Rheem PROE 50 T2 RH95 | 24.6 | 2 | 0.95 |
| d216_elec_02 | Electric | 50 | Marathon MR 502 45 B | 31.3 | 1 | 0.95 |
| d216_elec_03 | Electric | 50 | Reliance 606 650 DOCT | 36.0 | 5 | 0.90 |
| d216_elec_04 | Electric | 50 | AO Smith ECT 52 200 | 45.6 | 8 | 0.91 |
| d216_elec_05 | Electric | 50 | Bradford White M250T6DS-1NCWW | 31.6 | 4 | 0.90 |

# Installs

# Field Sites

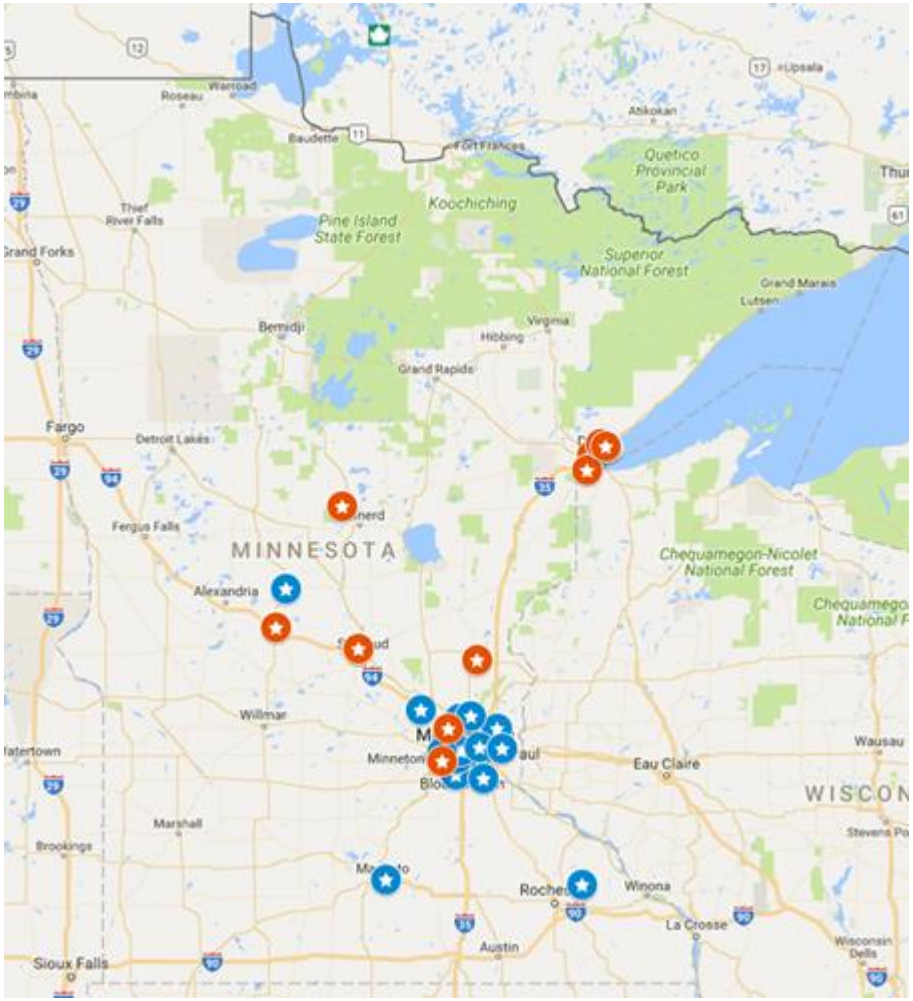



**Figure 1 33 Field Sites in Minnesota**
**(22 Natural Gas; 11 Electric)**

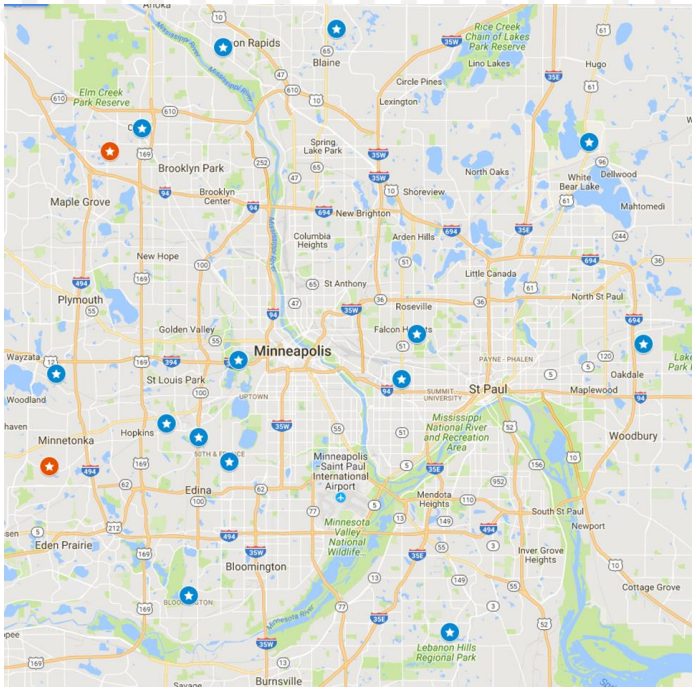



**Figure 2 16 Field Sites in the Greater Minneapolis / St. Paul Area (12 Natural Gas; 2 Electric)**

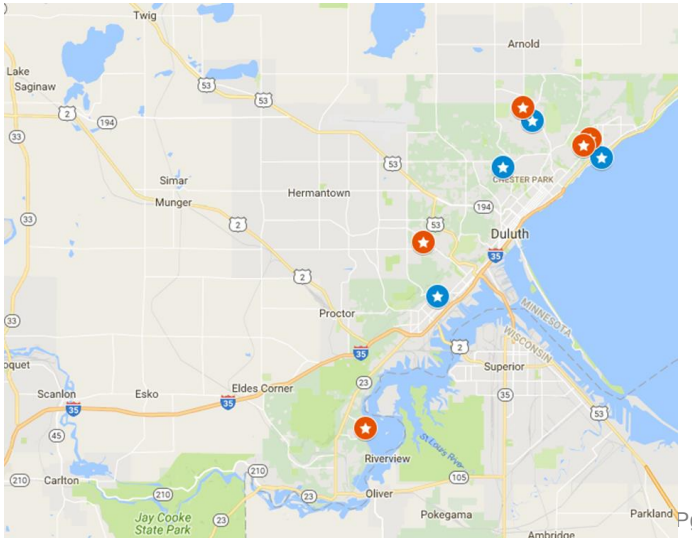
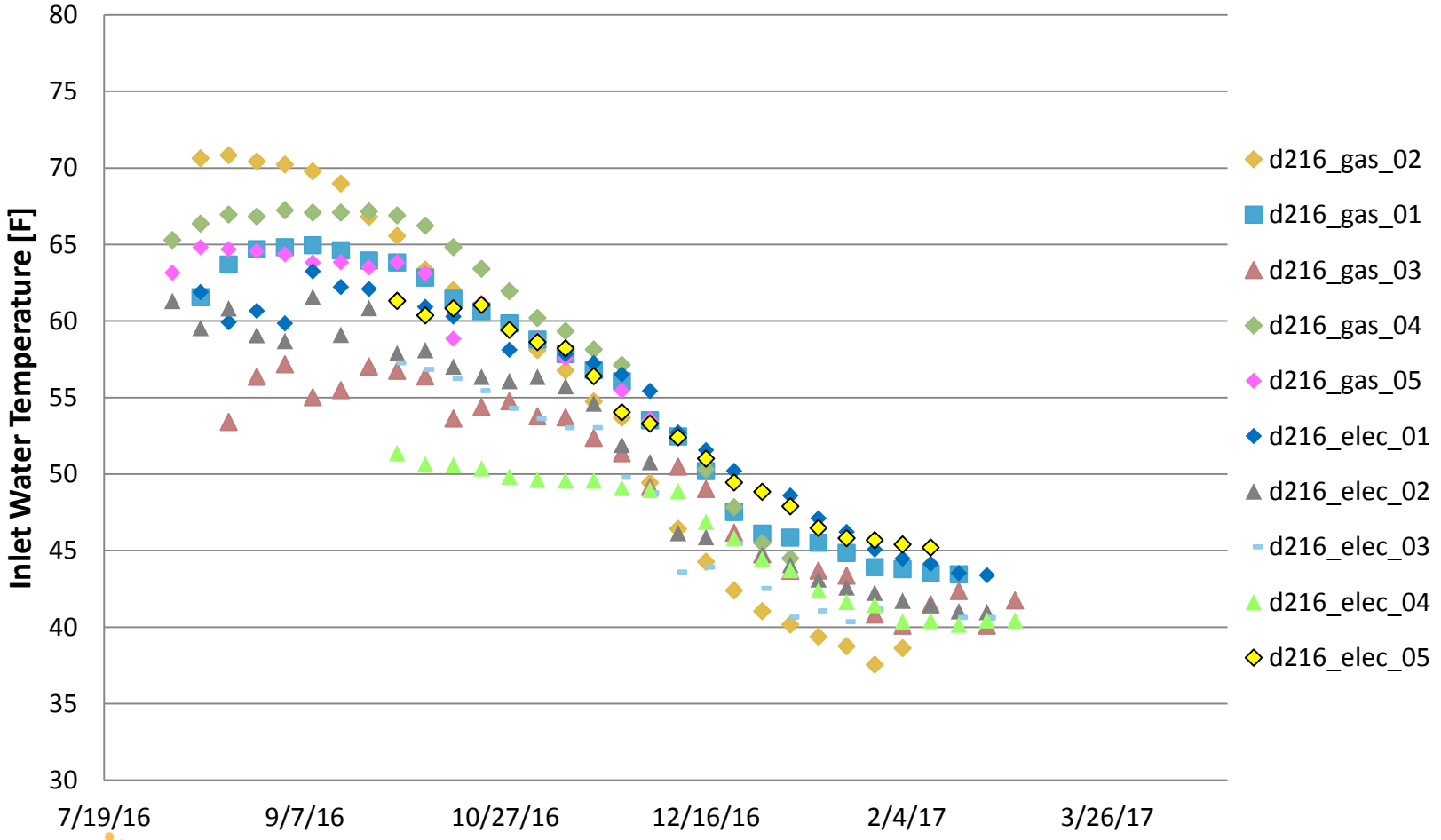
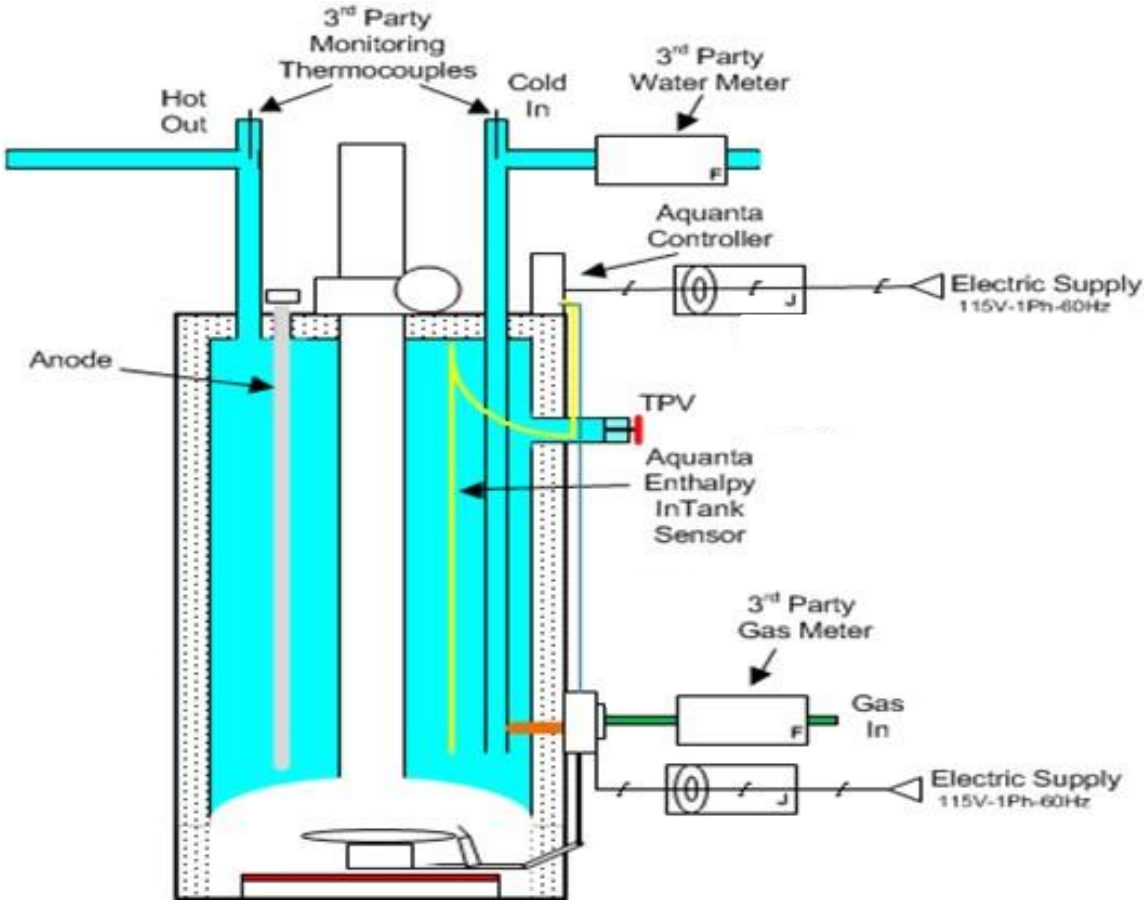



**Figure 3 9 Field Sites in the Duluth Area**
**(4 Natural Gas; 5 Electric)**

# Inlet Water Temperature



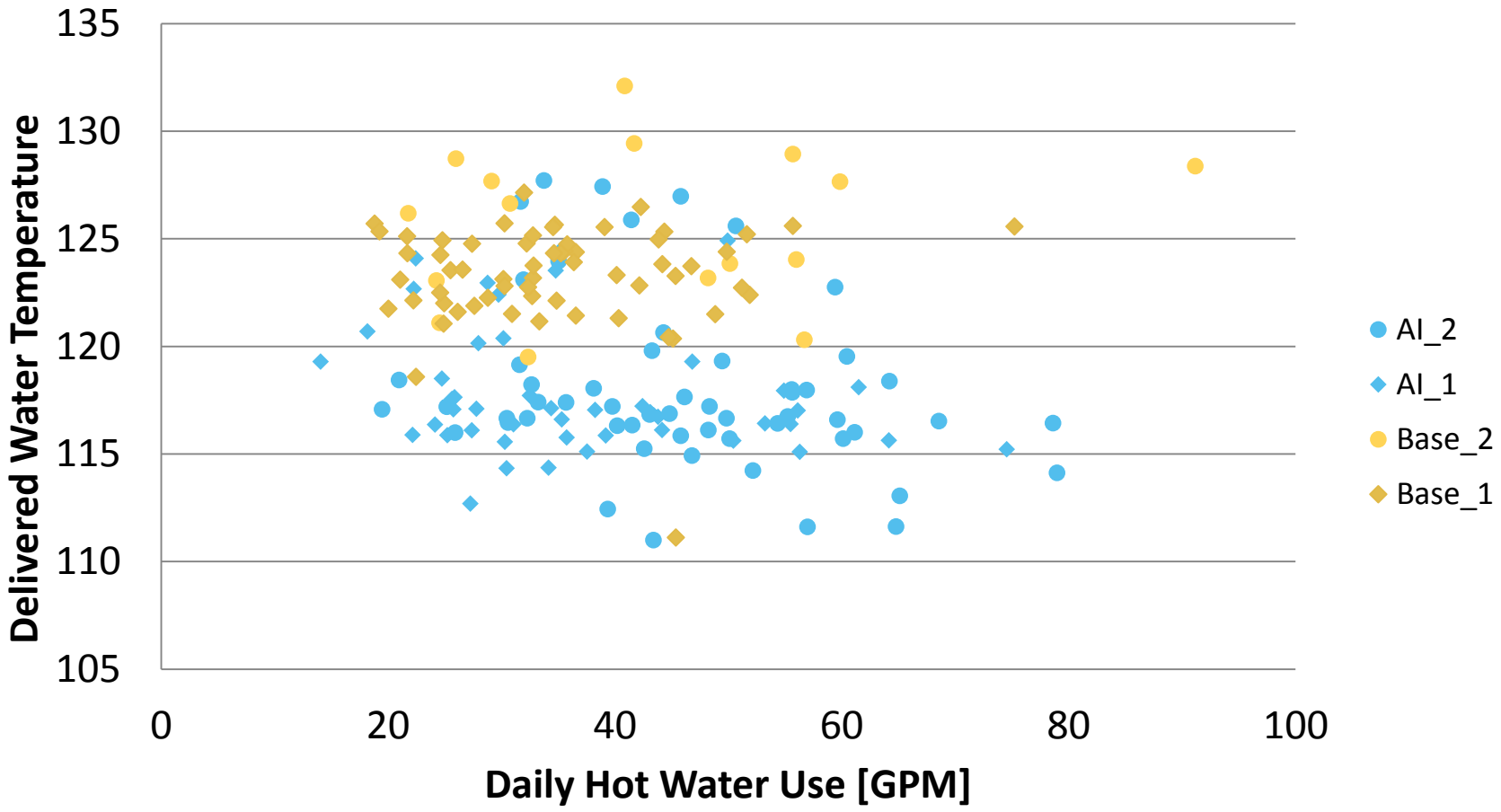
# M&V Instrumentation



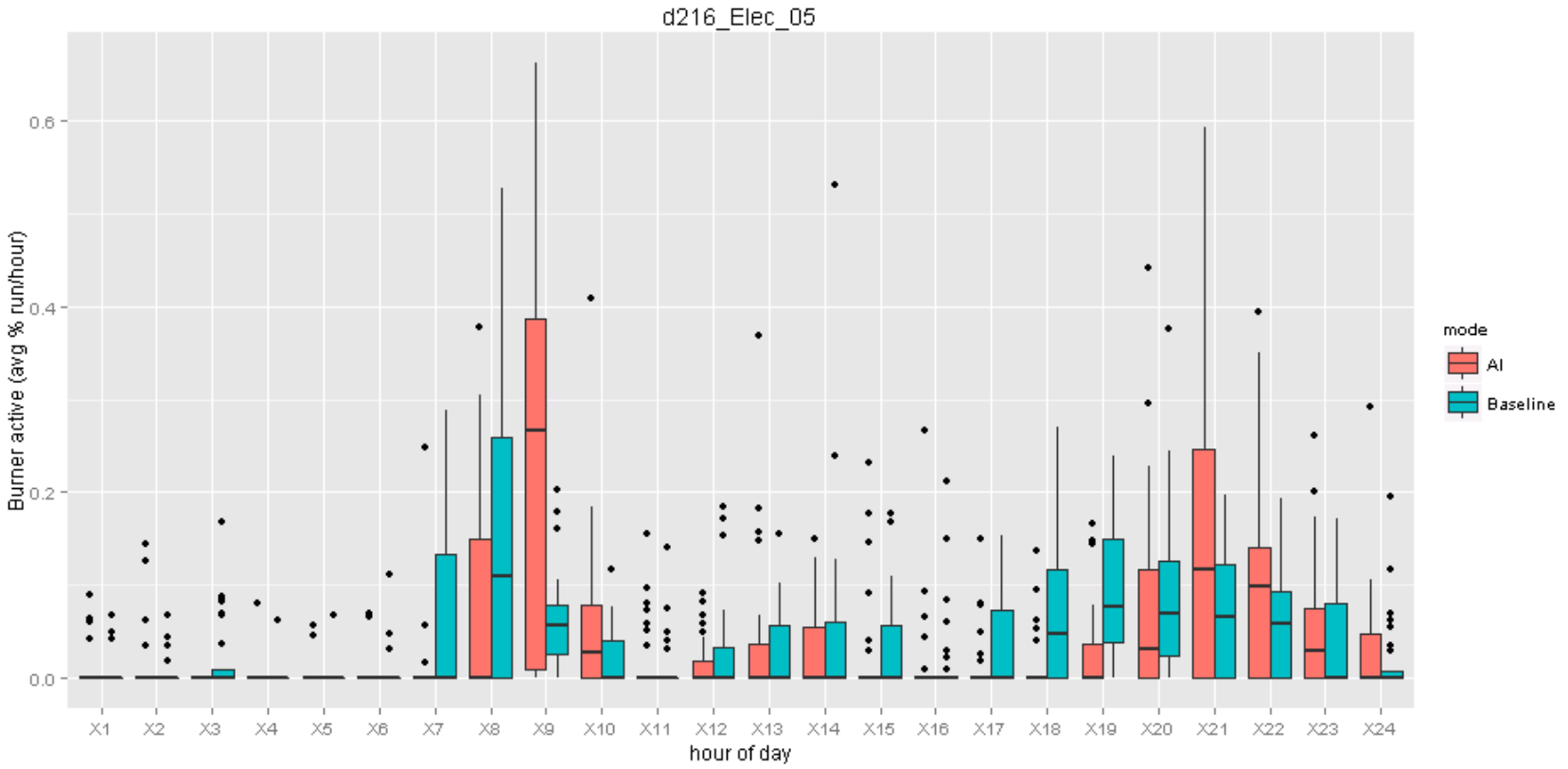
# Preliminary Performance

- Energy Savings
  - Reduced stand-by or idle loses
    - Lower tank temperatures (through reducing set point)
    - Eliminate unnecessary reheats (through lock out)
  - Reduction of over heating (through reducing set point)

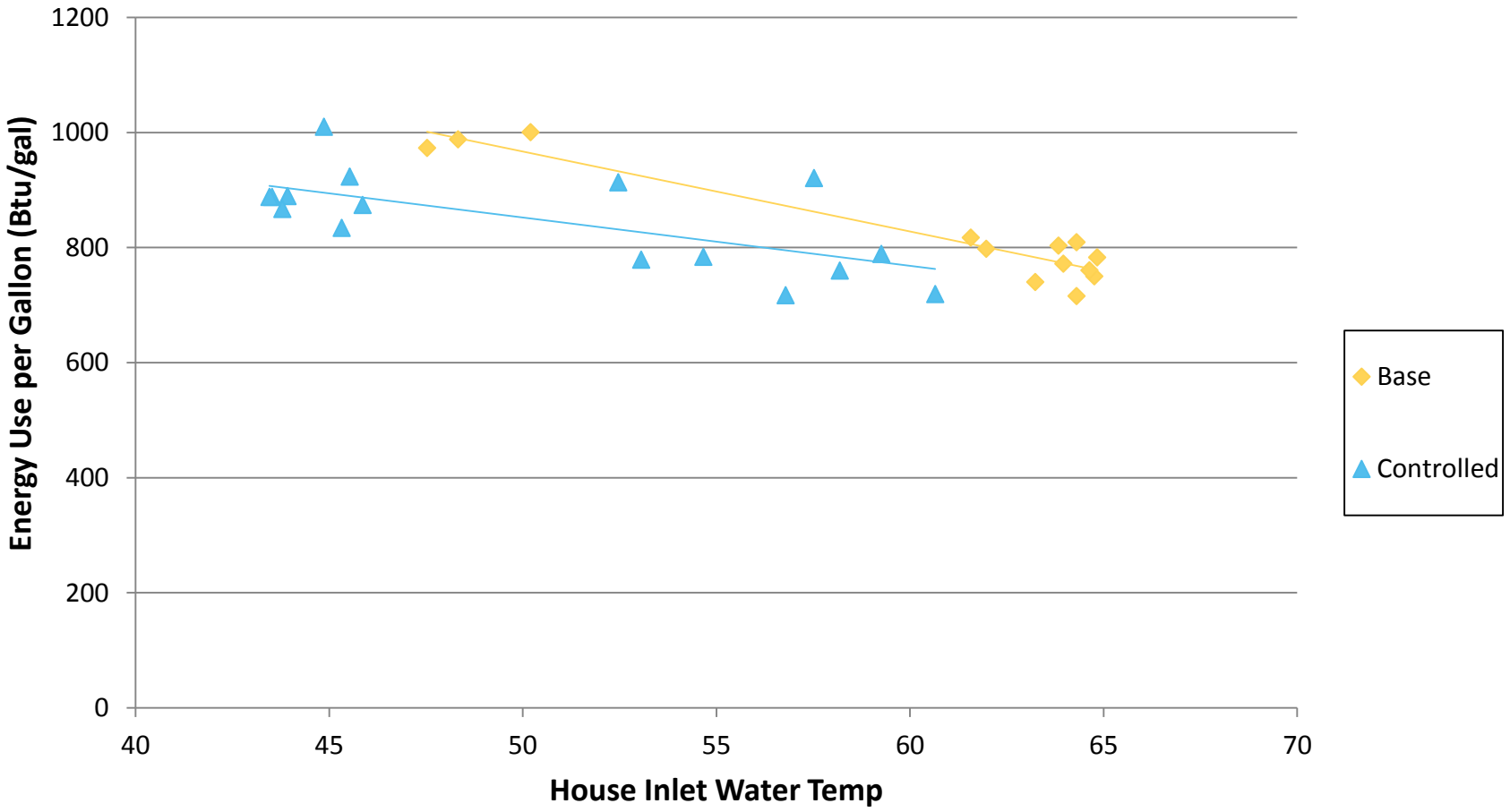
# Supply Water Temperature



# Energy Use Profile



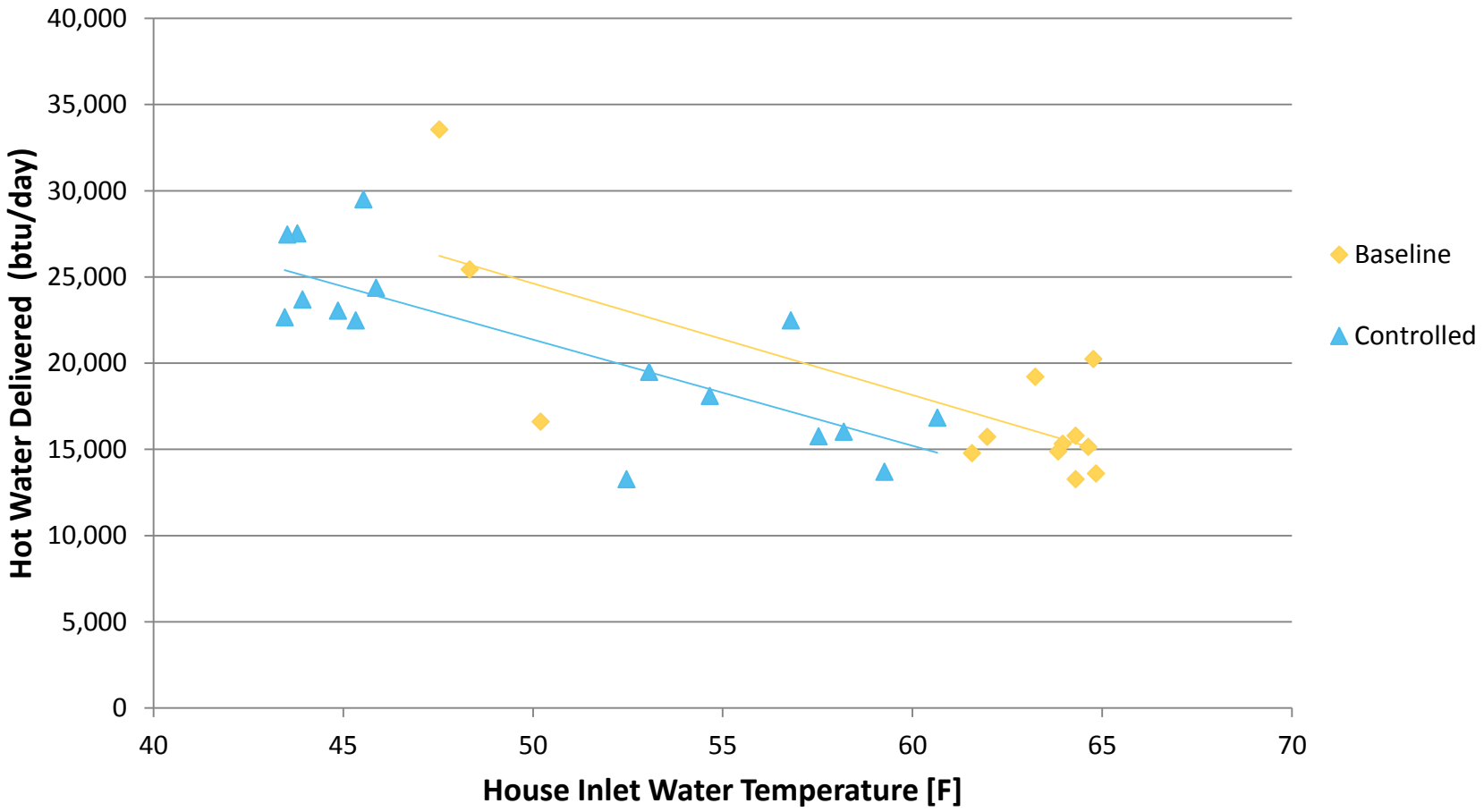
# Energy Use per Gallon of Hot Water



# Energy Use per Gallon

- Btu per gallon is lower with the controller active at all 10 sites
- Energy per gallon is reduced up to 15%
- Energy use per gallon is NOT water heating savings
  - If the water temperature has changed the flow profile may have changed

# Hot Water Load




This site as the longest monitoring time had shows ~10% savings

# Controller as a Measurement Device

- Direct measurement
  - Change in total tank energy
  - Current sensing (on/off)
  - Power usage (kWh)
  - Cold water inlet temperature (F/C)
- Derived values from data:
  - Water heater energy input
  - Water heater energy output (load)
  - standby loss
  - Hot water usage
  - Hot water available

# Conclusions

- Smart controllers can
  - control water heater usage profiles
  - eliminate unnecessary reheats
  - reduce energy use for water heating
  - Measure, calculate and provide data and information to occupants

## Future

- Monitoring through the summer 2017
- Project completion in fall 2017

# THANK *you!*

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