Heat Pump Water Heaters for Demand Response





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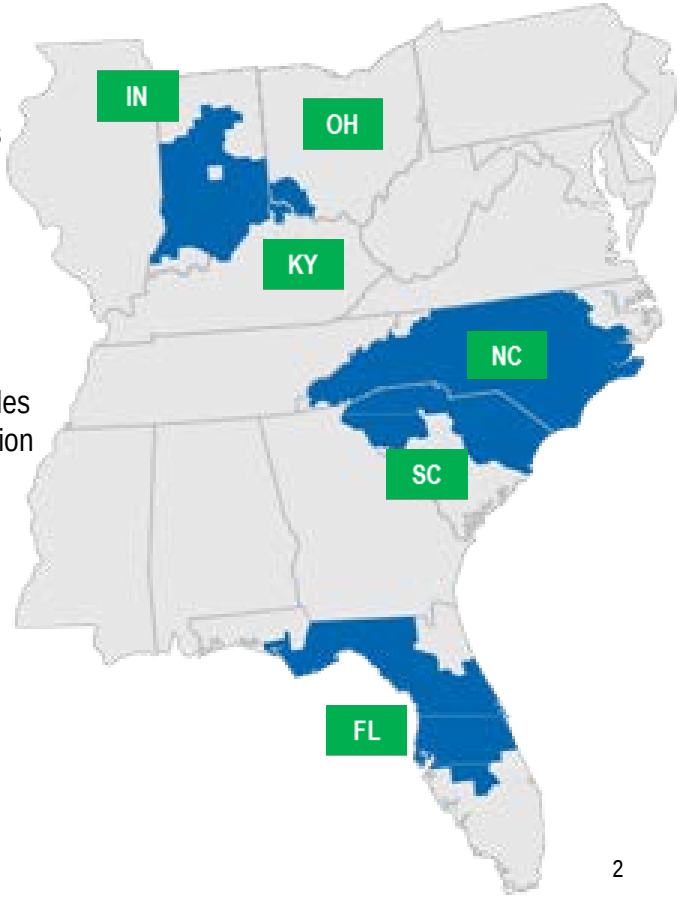
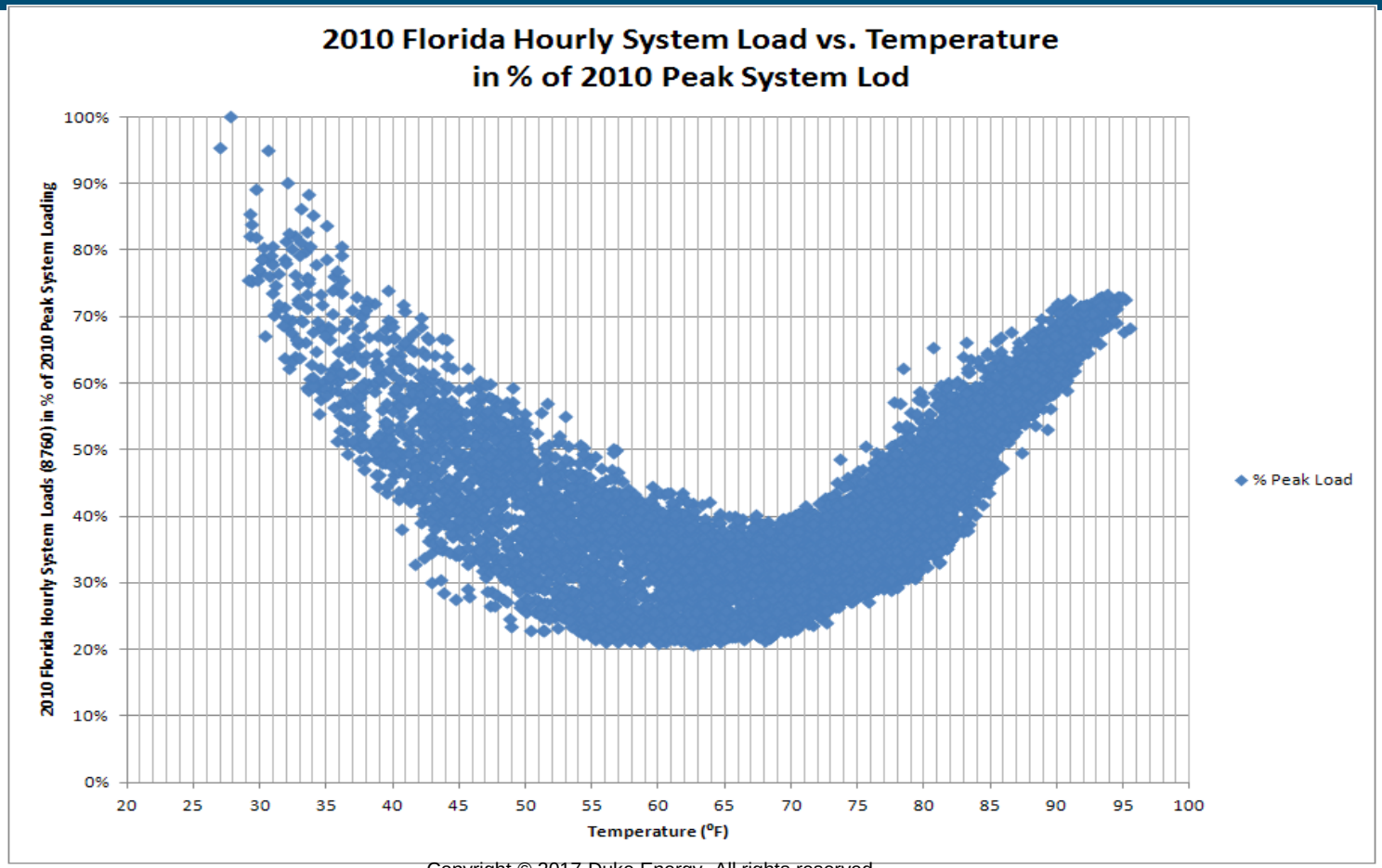
Duke Energy

Duke Energy Corporation is an energy company headquartered in Charlotte, N.C. Its Regulated Utilities business unit serves 7.4 million retail electric customers in six states in the Southeast and Midwest regions of the United States, representing a population of approximately 24 million people. Duke Energy is a Fortune 125 company traded on the New York Stock Exchange under the symbol DUK. More information about the company is available at duke-energy.com.

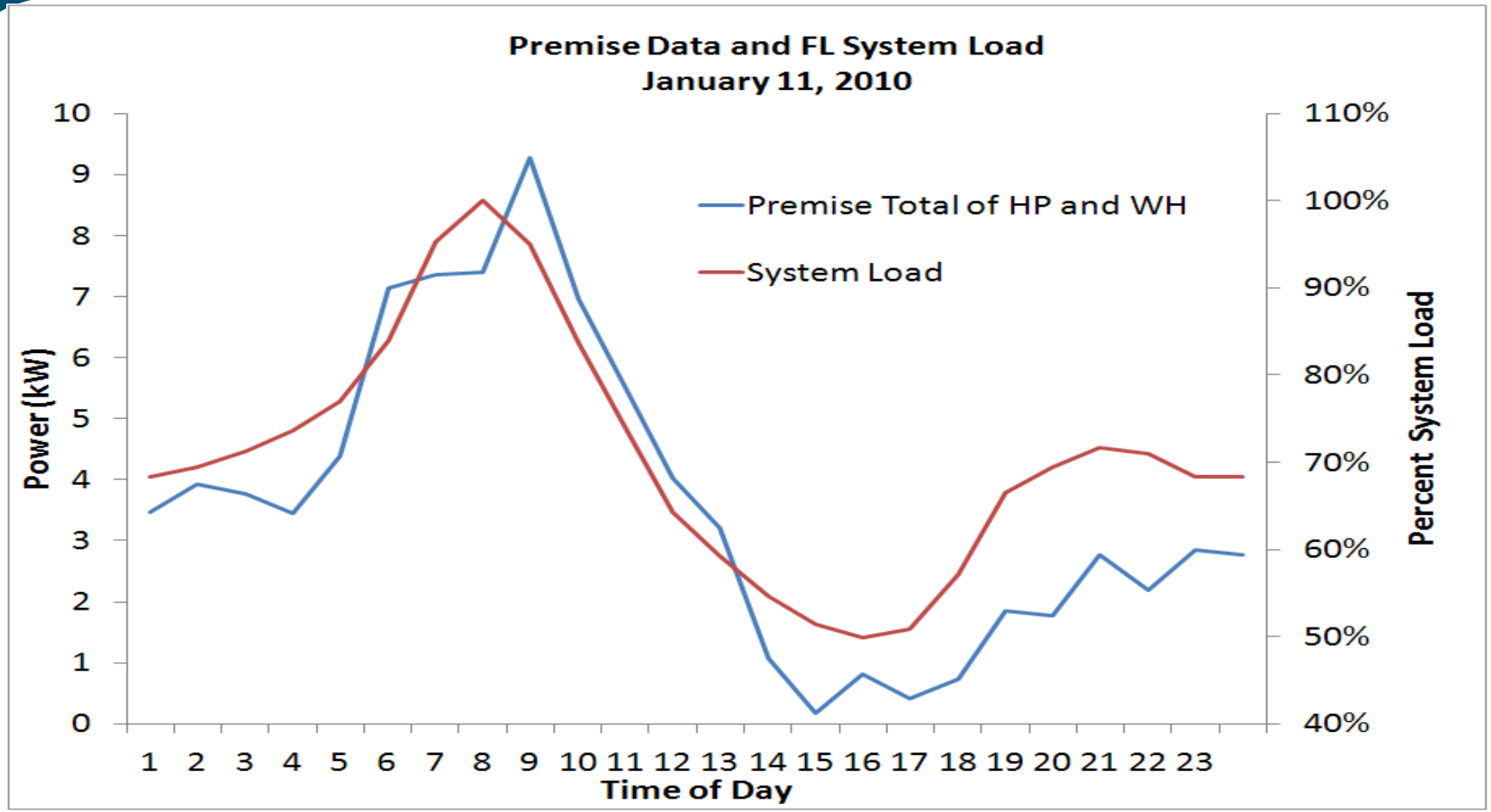
Regulated Utilities*
States Served NC, SC, IN, OH, KY, FL
Size of Service Area 95,000 square miles
Total Generation Capacity
(owned capacity)
50,200 MW
Total Transmission Lines 32,300 miles
Total Distribution Lines 263,900 miles
Total Natural Gas Mains 7,200 miles
Total Natural Gas Service Lines 5,800 miles
Total Electric Retail Customers 7.4 million
North Carolina 3.3 million
South Carolina 730,000
Ohio/Kentucky 840,000
Indiana 810,000
Florida 1.7 million



Florida System Peak Load



System Impacts of Major Premise Loads



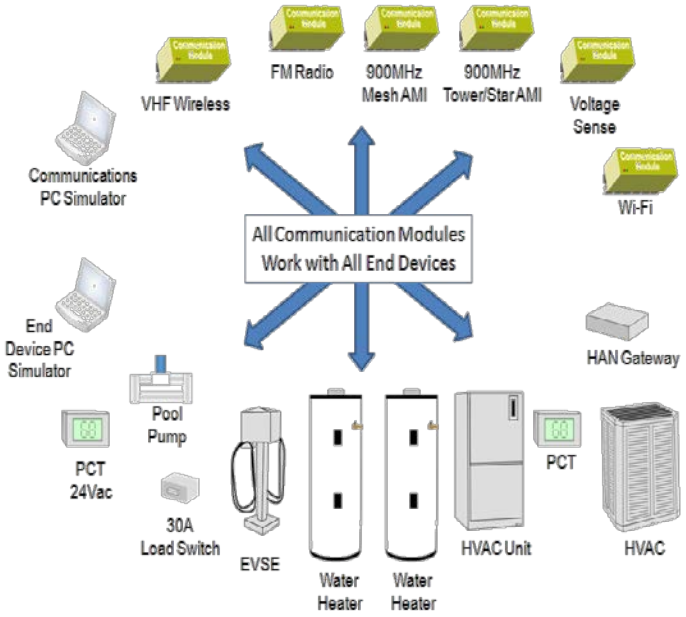
Demand Response at Duke Energy Florida

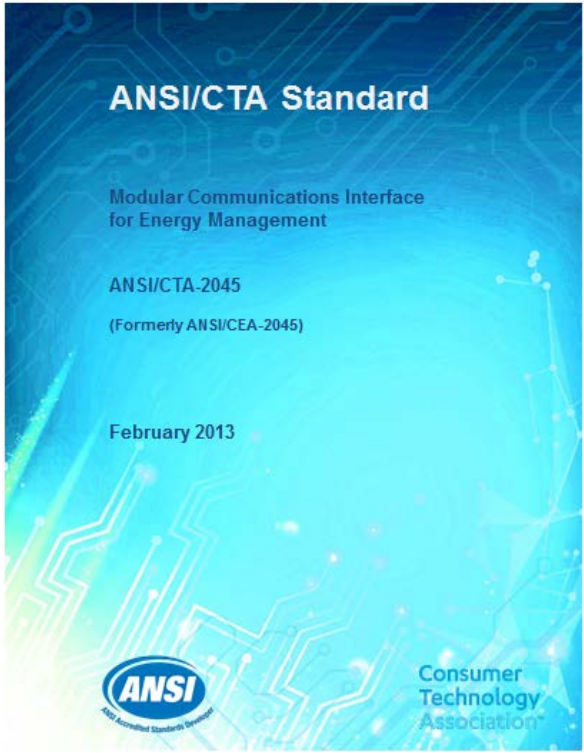
- Demand Response is very important at Duke Energy Florida
  - Winter Peak Reduction
  - Summer Peak Reduction
  - Meeting State Reserve Call obligations
  - Economic Dispatch of Generation
  - Future applications
- Large Demand Response Systems
  - 400,000+ Customer Direct Load Control System (HVAC, WH, PP)
  - New programs under development

CTA-2045 Standard Testing

CTA-2045 Opportunity – Why Test This Standard?

- Simplify Demand Response control integration for multiple appliances and improve customer experience
- Potential to lower Demand Response Program costs
- Customer choice of appliance, (brand, features, etc.)
- Utility choice of communication (technology, channel, control interface, etc.)
- Ease of upgrades or replacement of communication technology (protocol, head-end control, security, etc.) as needed
- Open technology port considered by DOE, EPA, Industry Trade Associations





Several CTA-2045 DR Value Propositions

Wi-Fi, cellular, FM radio, AMI mesh networks, PLC and potentially many more.

- CTA-2045 is an open standard which allows multiple vendors to develop any number of communication technologies (UCMs)
- Smart Grid Devices (SGDs) come from factory with CTA-2045 compatible port (just plug in UCM for control)
- CTA-2045 UCMs can control multiple types of appliances (i.e. identical modules can control water heaters, pool pumps, EVSE, thermostats, etc.) from the same or multiple head-ends.
- At production volumes, the UCMs and addition of the CTA-2045 port in the SGD will be very inexpensive
- CTA-2045 Control Functions offer much more complex DR responses than on or off.

CTA-2045 Vendor Market

Vendor market for CTA enabled appliances and communication modules looks to be gaining traction:

Appliances

A.O. Smith

Siemens

Pentair PP

Emerson

Vaughn Thermal

Communication Modules

E-Radio

Skycentrics

Nextgrid

Kitu Modules for inverters

Rainforest

Corporate Systems Engineering

Intwine

Falcom / Maestro

Landis and Gyr

Emerson CTA-2045 Load Switch – Water Heater Retrofit Field Pilot - Status

Status:

- 20 Field Sites in Orlando and St. Petersburg Areas
- Executing device response tests for advanced DR
- Ongoing response comparisons to other UCMs
- Module replacement cost / effectiveness tests

A.O. Smith CTA-2045 Water Heater Field Pilot Status

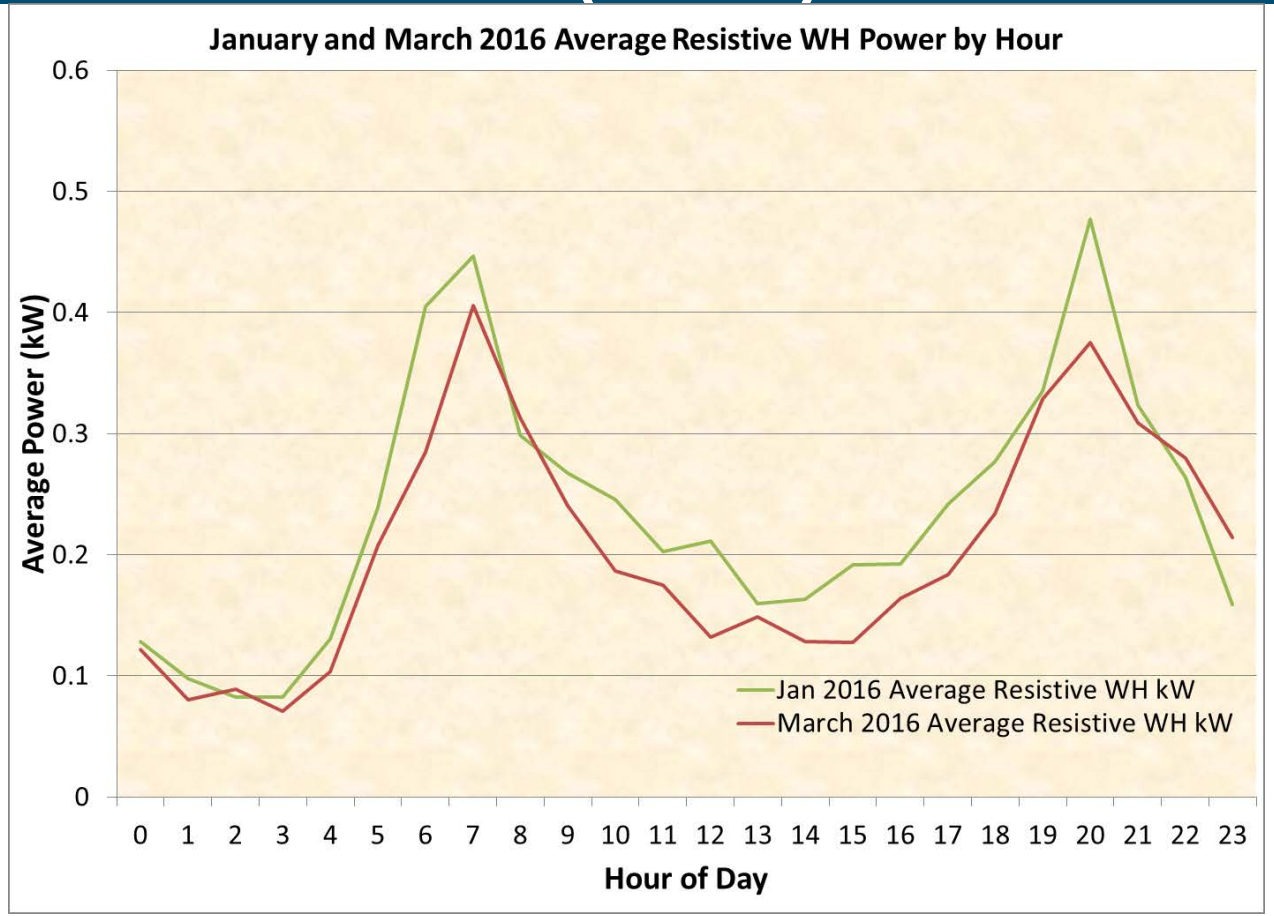
Status:

- Field Installations complete for 20 sites (7 Orlando, 13 St. Pete
- Devices are operational.
- Test regimen includes “load up” and other advanced CTA functionality.
- Module replacement cost / effectiveness tests.
- Most UCM installations with “no truck roll”

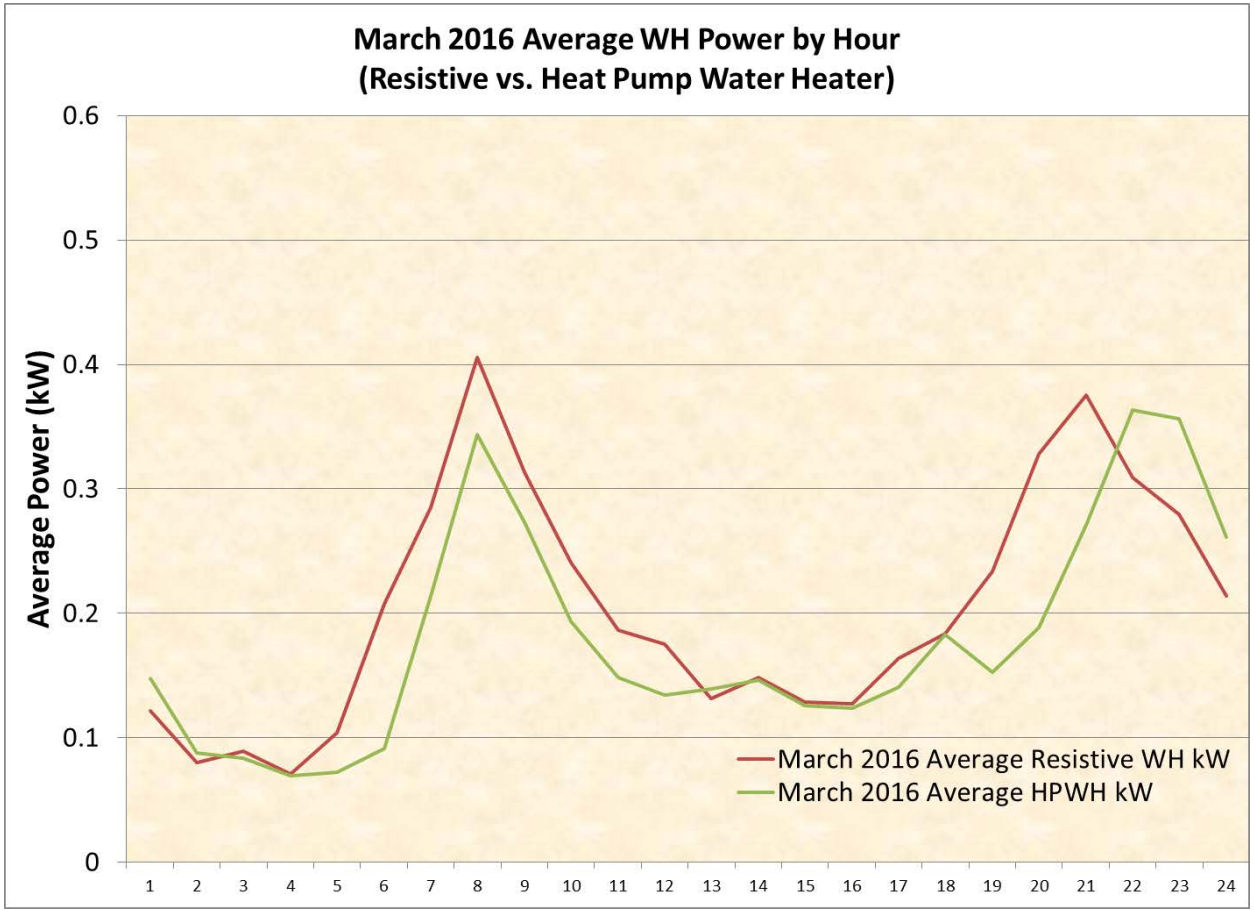
Interesting Findings from the Preliminary Data

- Average (1 minute) Water Heater Demand (when running):
  - January: Resistive 4.45 kW vs. HPWH 0.97 kW
  - March: Resistive 4.25 kW vs. HPWH 0.93 kW
  - August: Resistive 4.15 kW vs. HPWH 0.69 kW
- Run Time (Average % of time unit is heating water):
  - January: Resistive 4% vs. HPWH 25%
  - March: Resistive 3% vs. HPWH 19%
  - August: Resistive 2.5% vs. HPWH 7.0%

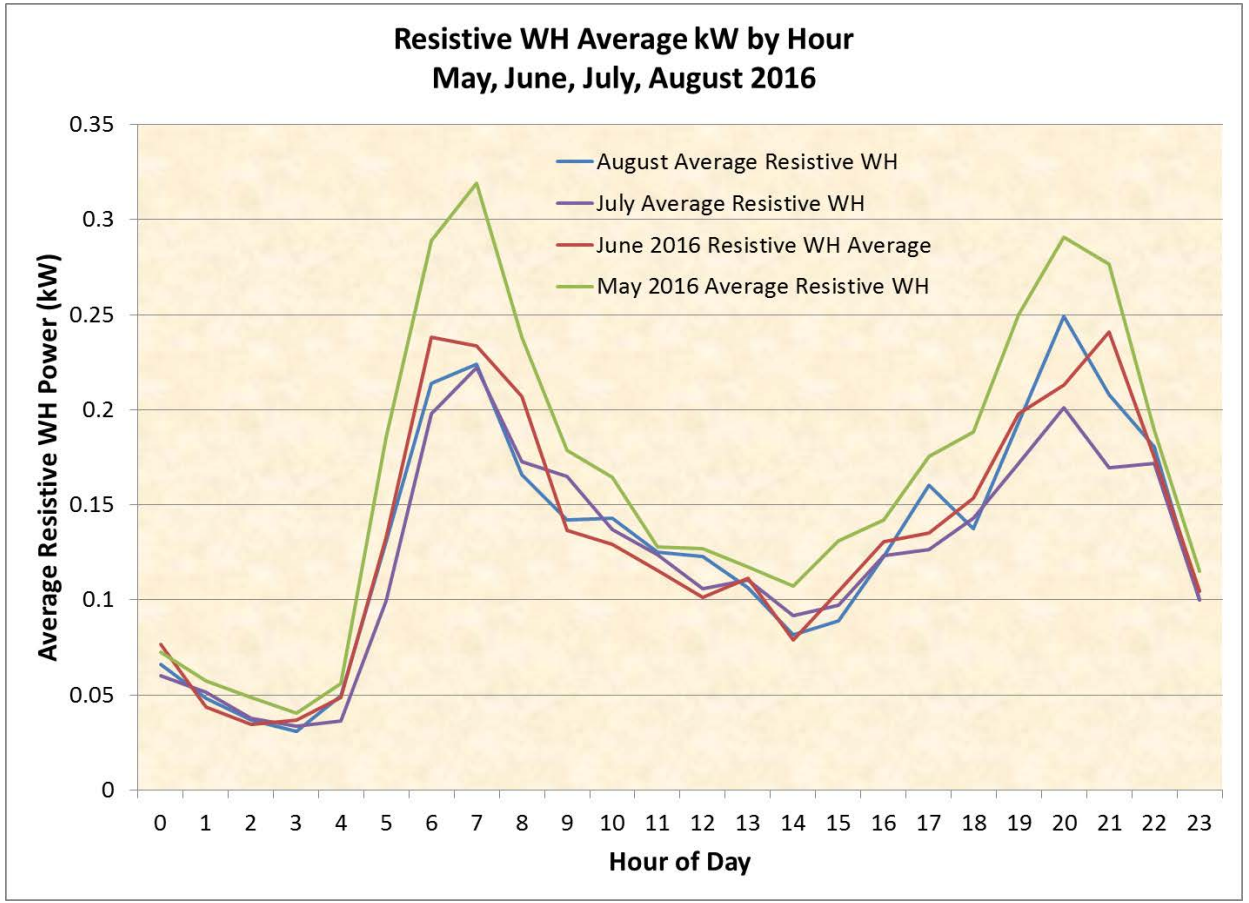
Resistive Water Heater DR Potential (Winter)



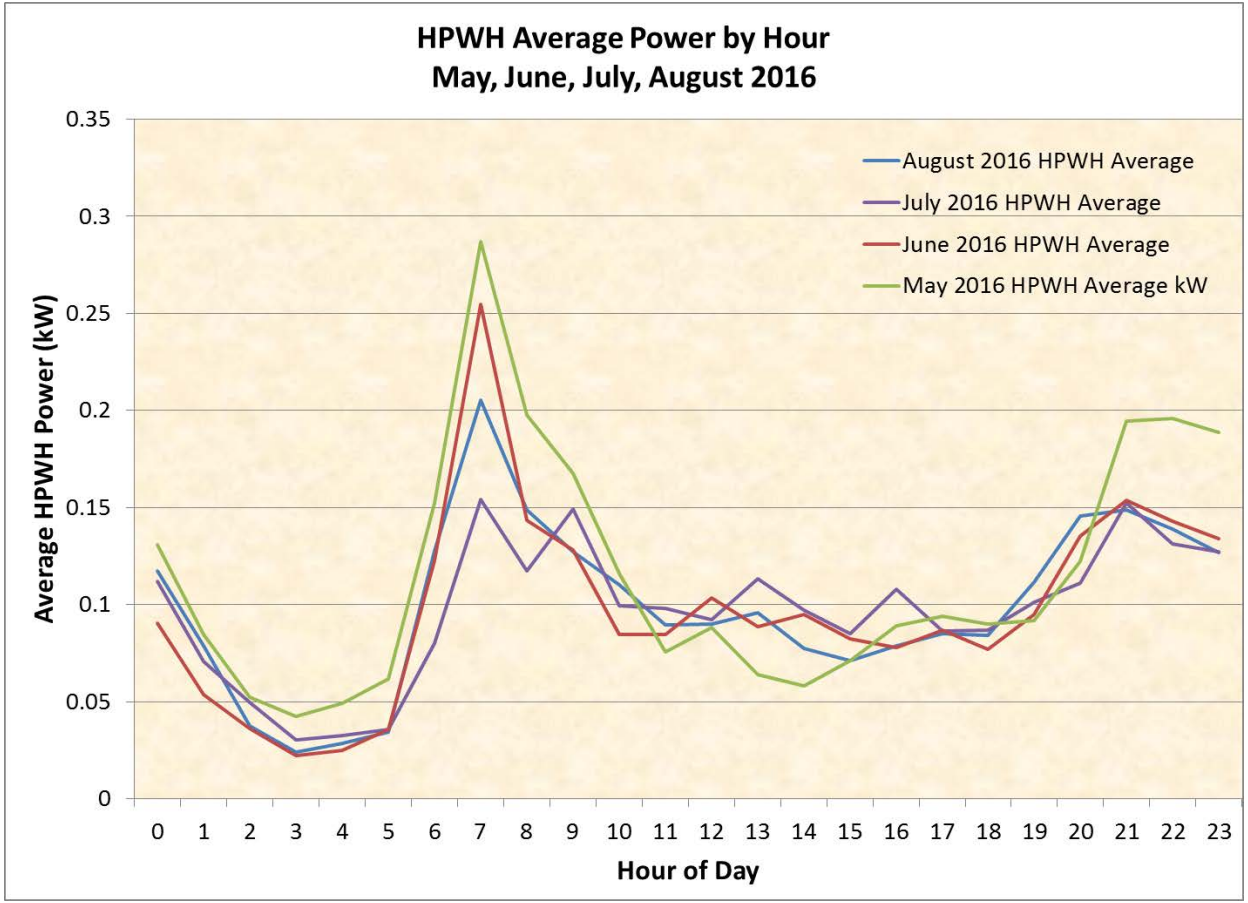
Resistive Water Heater vs. HPWH March DR Potential



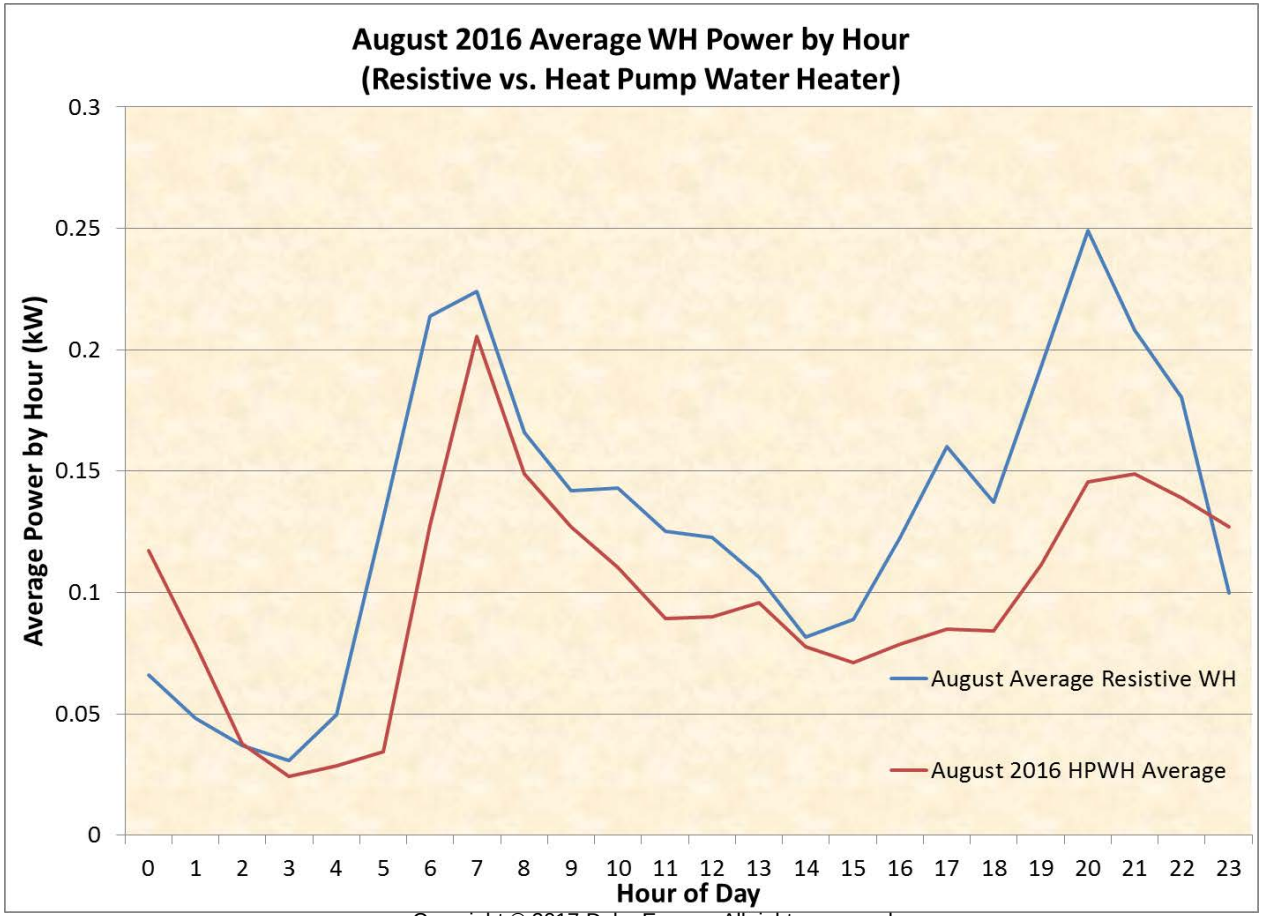
Resistive Water Heater DR Potential (Summer)



Heat Pump Water Heater DR Potential (Summer)



Resistive Water Heater vs. HPWH August DR Potential



Takeaways from Preliminary Data on Heat Pump Water Heater DR

- Both Resistive and HPWH provide valuable DR opportunities
- HPWH have lower kW, but are more likely to be running
- With CTA-2045 control, can load up (to an extent)
  - HPWH can efficiently preheat water before an event or peak
  - Resistive WH can also preheat water using electric element
- HPWH have more electric heating element use in Winter
- HPWH have more heating element use at high demand (mornings)
- Can advocate larger tanks for HPWH to take advantage of High HP COP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