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: 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

2010 Florida Hourly System Load vs. Temperature in % of 2010 Peak System Load

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System Impacts of Major Premise Loads

Premise Data and FL System Load
January 11, 2010

- Premise Total of HP and WH
- System Load

Power (kW)
Time of Day
Percent System Load

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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 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

- 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.

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

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

** Appliances **
- A.O. Smith
- Emerson
- Vaughn Thermal
- Siemens
- Pentair PP

** Communication Modules **
- E-Radio
- Nextgrid
- Kitu Modules for inverters
- Corporate Systems Engineering
- Landis and Gyr
- Intwine
- Falcom / Maestro
- Rainforest
- Falcom / Maestro
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
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)

January and March 2016 Average Resistive WH Power by Hour

- Green line: Jan 2016 Average Resistive WH kW
- Red line: March 2016 Average Resistive WH kW

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Resistive Water Heater vs. HPWH
March DR Potential

March 2016 Average WH Power by Hour
(Resistive vs. Heat Pump Water Heater)
Resistive Water Heater DR Potential (Summer)

Resistive WH Average kW by Hour
May, June, July, August 2016

- August Average Resistive WH
- July Average Resistive WH
- June 2016 Resistive WH Average
- May 2016 Average Resistive WH

Hour of Day

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Heat Pump Water Heater DR Potential (Summer)

HPWH Average Power by Hour
May, June, July, August 2016

Average HPWH Power (kW)

Hour of Day

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Resistive Water Heater vs. HPWH
August DR Potential

August 2016 Average WH Power by Hour
(Resistive vs. Heat Pump Water Heater)
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