

# SEBC 2014 Pre-conference Energy Forum



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## Results from Phased Deep Retrofits in Florida Homes

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Building America - Partnership for Improved Residential Construction

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- U.S. Department of Energy, Building America Program
  - Administration, auditing, monitoring, analysis and reporting



- Florida Power & Light
  - Retrofit equipment purchase and installation



- Detailed Residential Field Metering Project in FPL Service Territory
- 60 Homes Evaluated for over Two Years
- Establish Retrofit Impacts on Energy Reductions and Economics at Two Levels:
  - Shallow Retrofit (56 Homes – lost 4)
  - Deep Retrofit (10 Homes)

- 60 All Electric Homes

	Average	Range
Area	1,777 ft <sup>2</sup>	1,000 - 2,650 ft <sup>2</sup>
Vintage	1984	1942 - 2006
Occupancy	2.6 persons	1 - 6 persons
Ceiling Insulation	R-22	R-8 - R-38
Airtightness	8.5 ach50	4.4 – 16.4 ach50

- Typical Study Home:
  - Single-glazed windows
  - Slab-on-grade foundation
  - R-3 masonry walls
  - Asphalt shingle roof
  - Electric resistance water heating
  - 2003 Air conditioner
  - (1/3 had pools)
- Pre-Study Annual Use: ~17,000 kWh

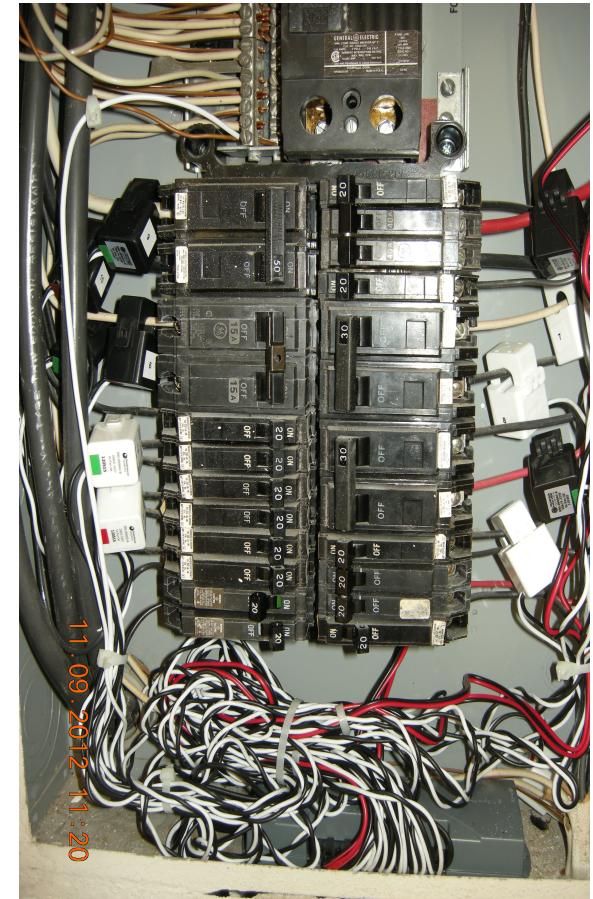
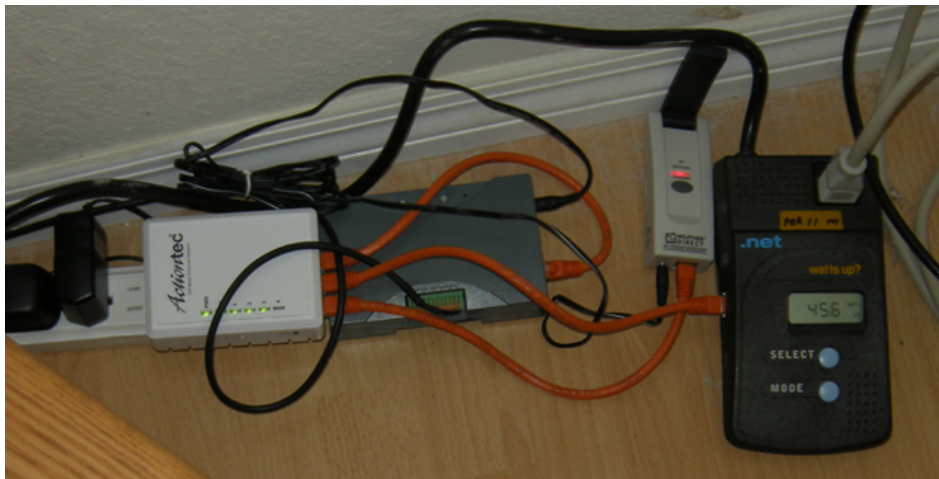


# Extensive End-Use Metering



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- Monitoring Aug 2012 - Mar 2013
- Tracking 18 Data Points, Hourly
  - Whole house power
  - All major end uses
- Plug Load Monitoring
  - E.g. TV & surrounding equipment
- Interior Temperature & Humidity



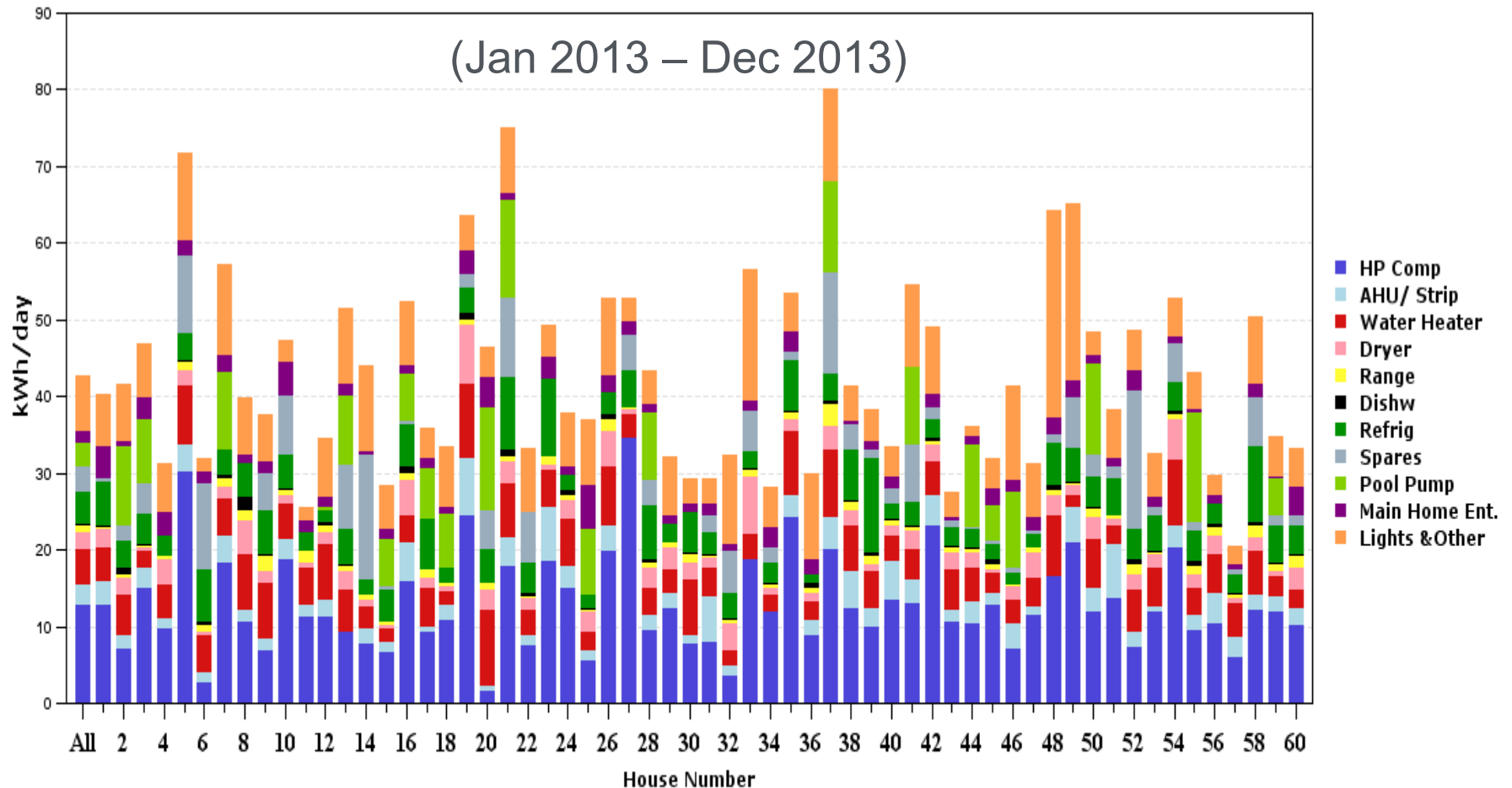


# End-Use at Each Site



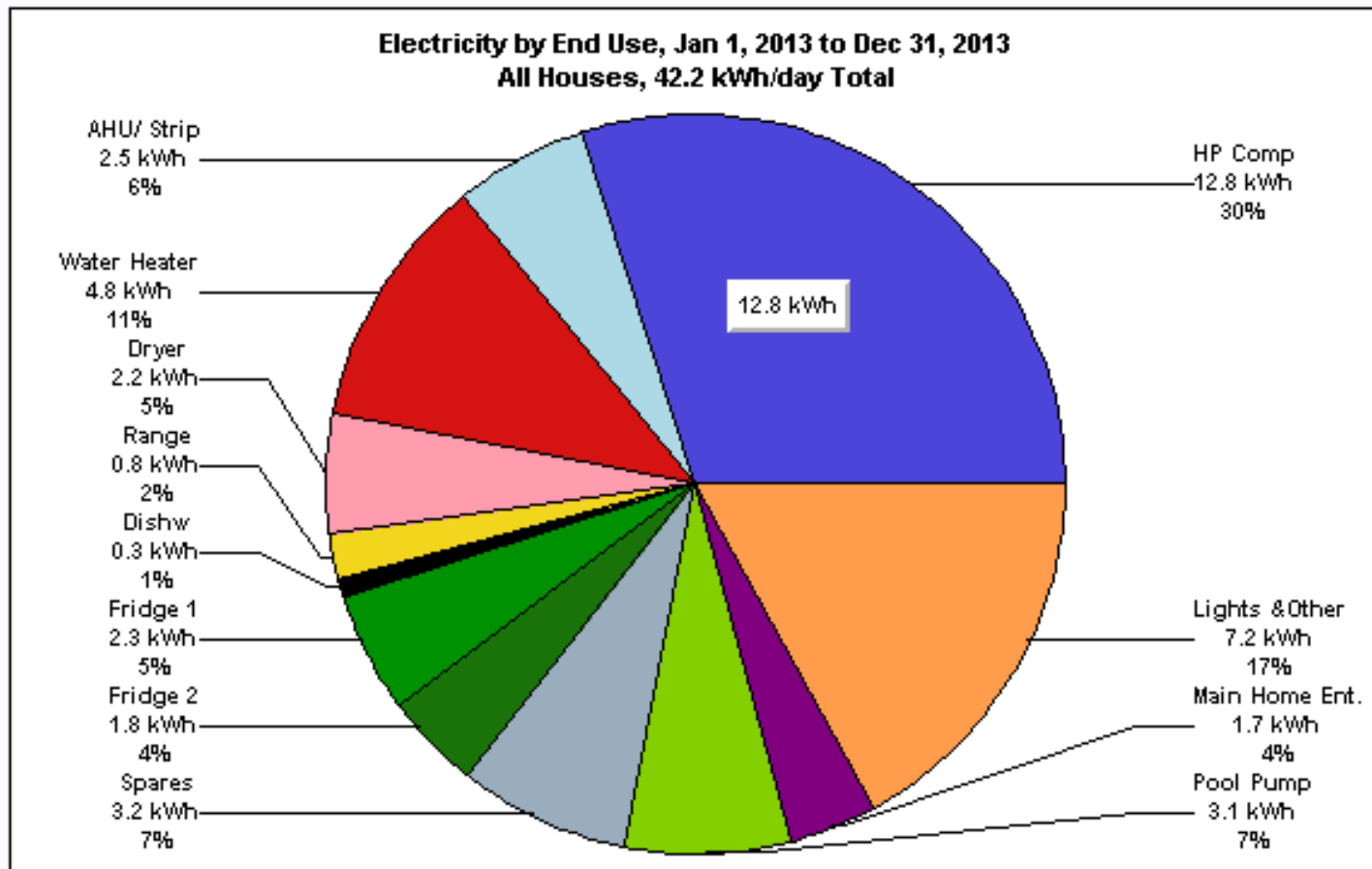
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## Vast Differences in End-Uses by Site





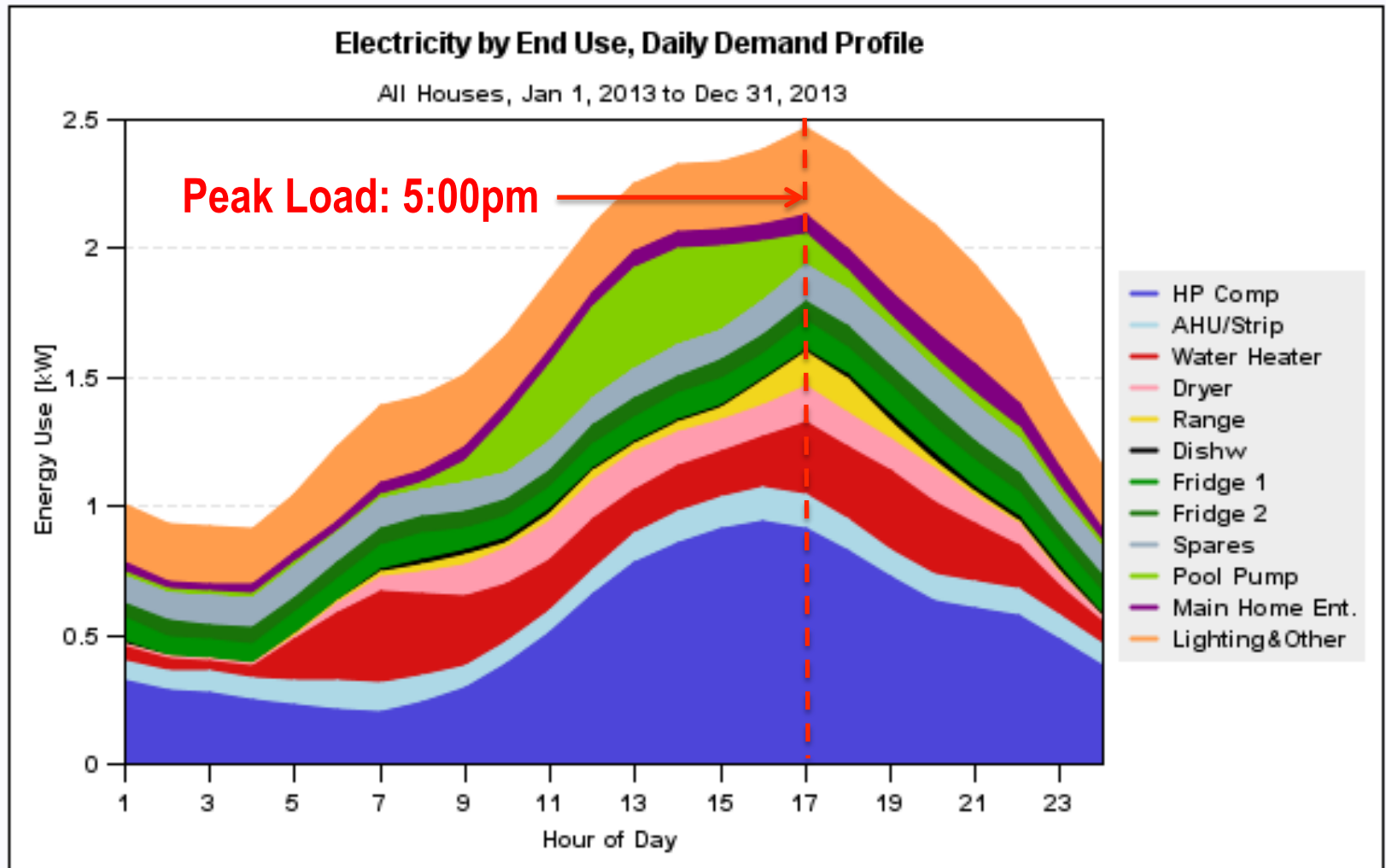
No Single End-Use Dominates  
Space Heating/Cooling/DHW only 45% of total



# What Make Up Peak Load?



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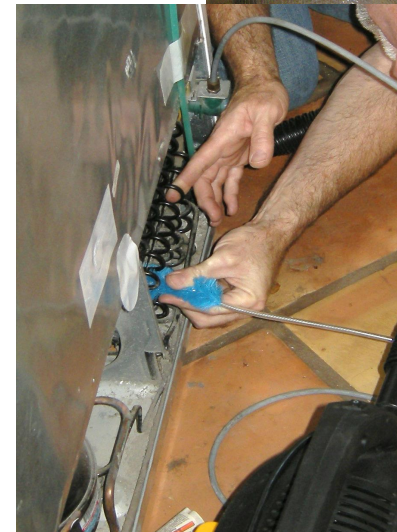


# Shallow Retrofit Measures



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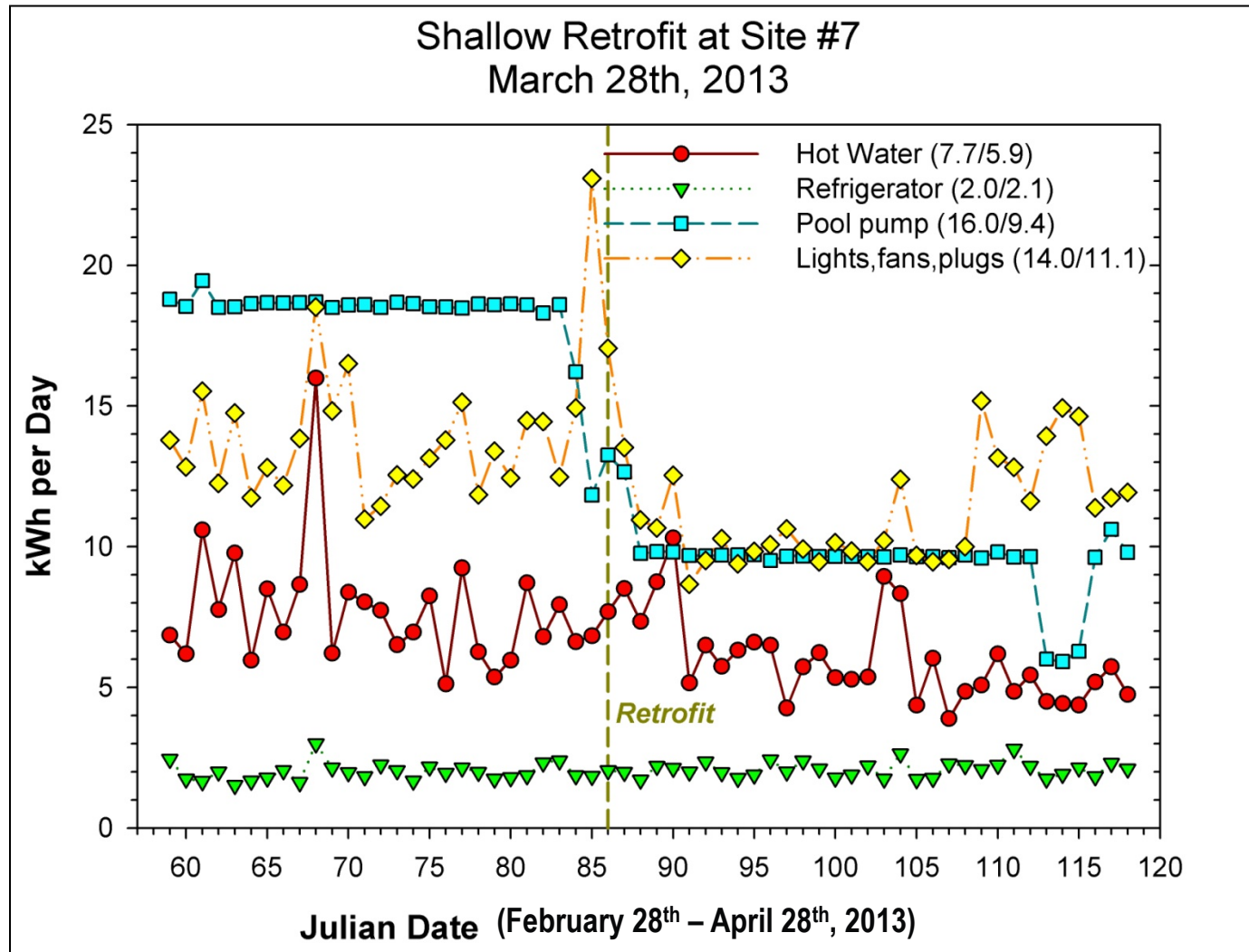
- Changed incandescent lighting to CFL or LED lighting
- Added exterior insulation to hot water tank
- Installed low-flow shower fixtures if existing flow  $> 2.2$  gpm
- Set pool pump hours to  $\leq 5$  hours/day
- Cleaned dirty refrigerator coils
- Installed smart power strip if standby power loads  $\geq 10$  Watts continuous



# Shallow Retrofit Evaluation



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- 9% Whole House Savings Among 56 Sites
- Biggest Impact: Lighting, Water Heating, Refrigerator
  - Pool pump retrofit savings reverted
- Simple Utility Pass Through Audits can Make a Difference!



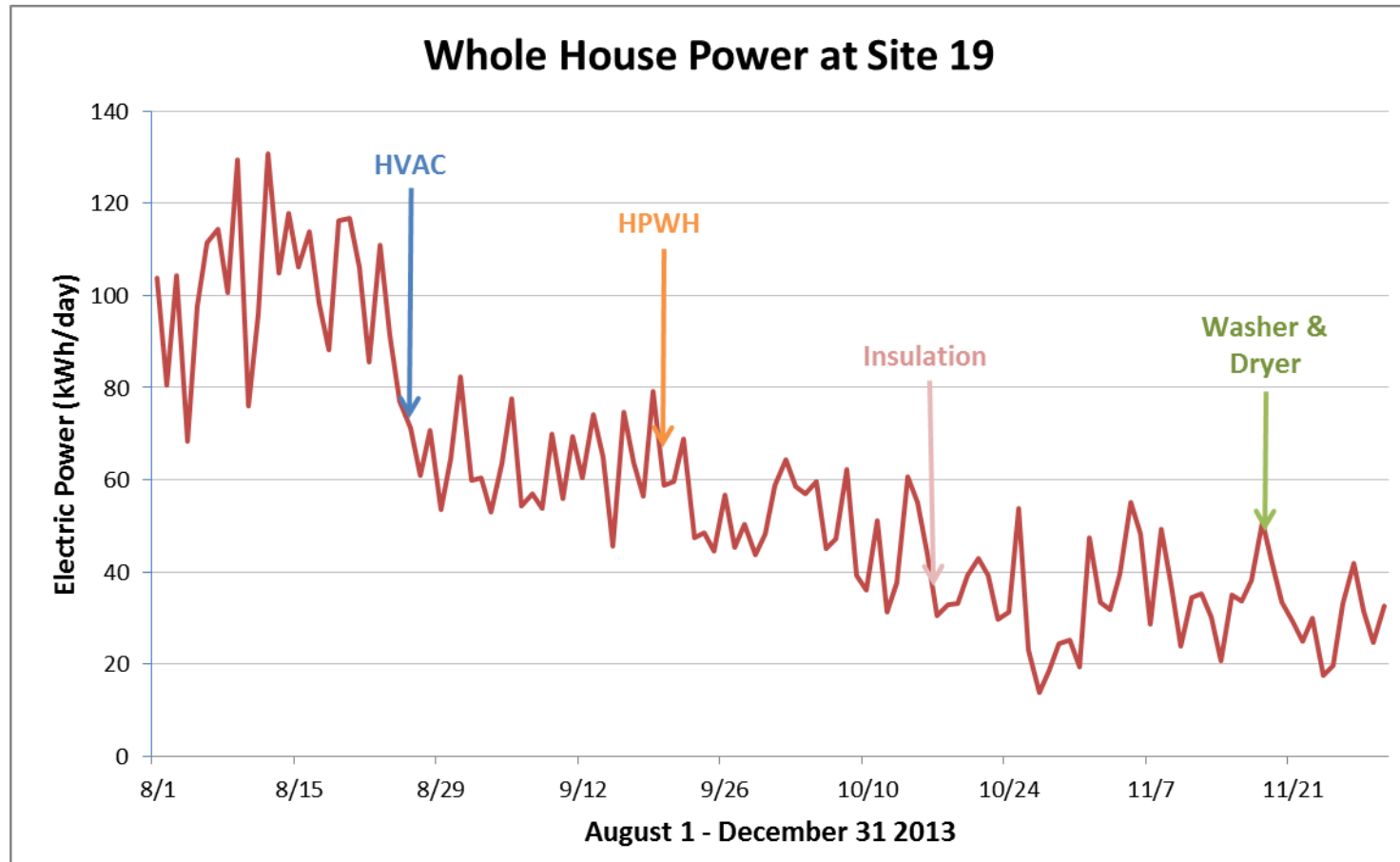
- Costs Average: \$370/site\*
- Average Hard Costs: \$250/site
  - Lighting @ \$211
  - Showerhead @ \$31 & WH Insulation @ \$23
  - Smart power strips @ \$42 (2 at some sites)
  - Refrigerator coils – labor only
- Savings: 1,310-1,530 kWh/yr (\$13-15/mon\*\*)
- **2 year payback**
- *Disadvantage: Invisible to Consumer*

\* Labor @ \$30/hr

\*\* \$0.12/kWh

- Upgrade to Existing HVAC
  - 16 or 17 SEER heat pump
  - Repair ducts
  - Learning thermostats
- Install Heat Pump Water Heater
- Replace Appliances with Energy Star
  - Washer & dryer
  - Refrigerator
  - Dishwasher
- Install Variable Speed Pool Pump
- Air Sealing and Insulation

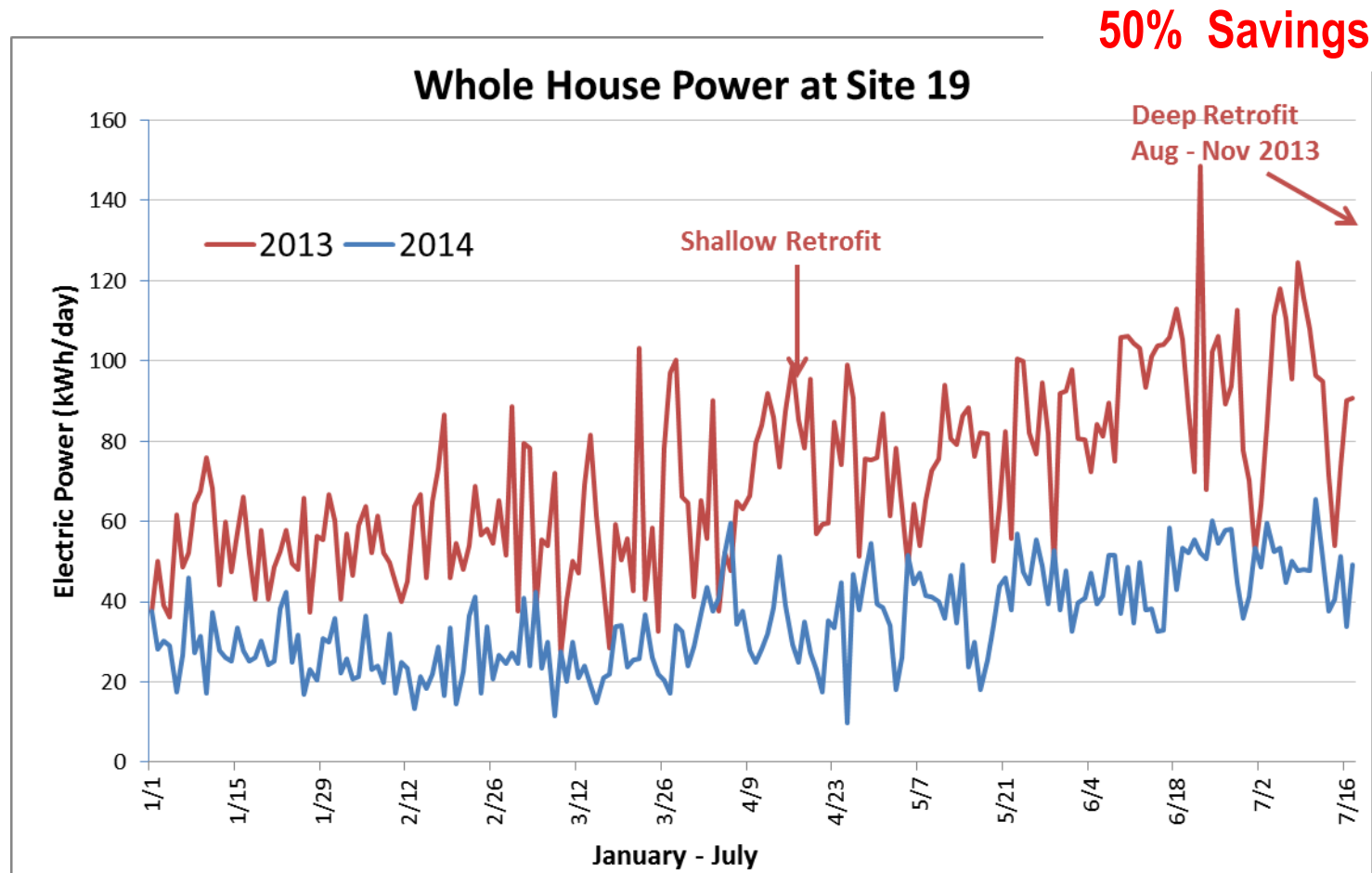
- Short-Term Total Power: 100 to 30 kWh/day





# Deep Retrofit Site #19

- Longer-Term Total Power: 70 to 35 kWh/day



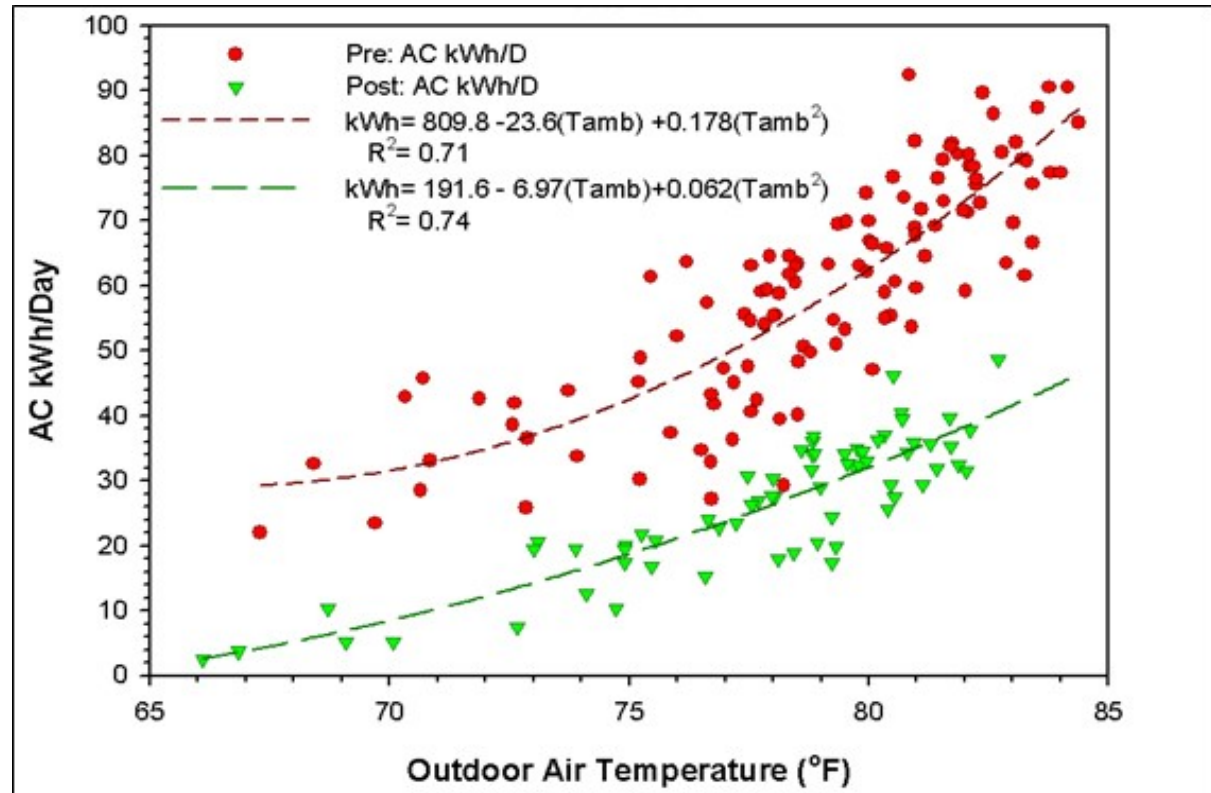
# HVAC Retrofit at Site # 19



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- 30 kWh/day Cooling Energy Savings: 50%  
(May – Oct, 2013)
- < 10 SEER to 16 SEER
- Duct Sealing  
( $Q_{n,out}$ : 0.09 to 0.05)
- NEST (3.5%)



# Learning Thermostat

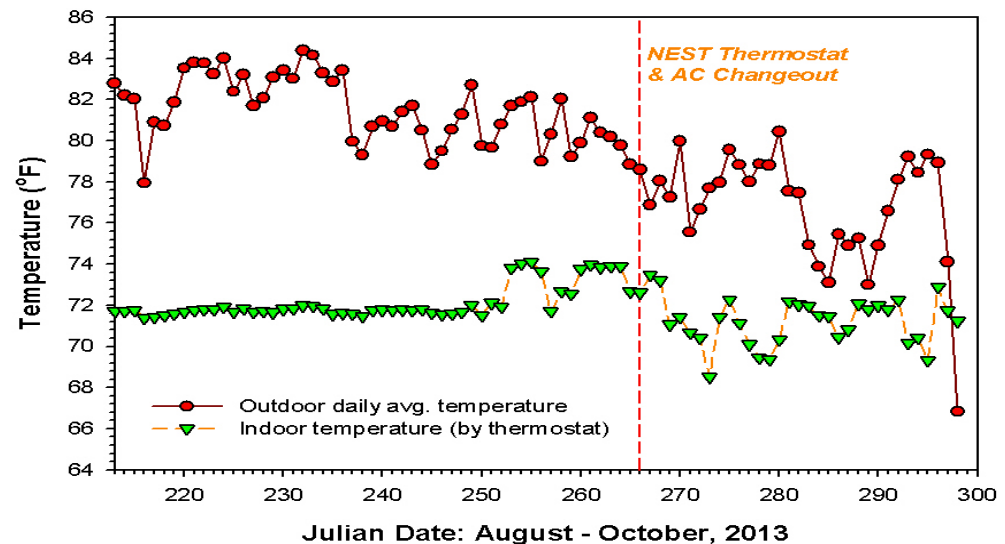
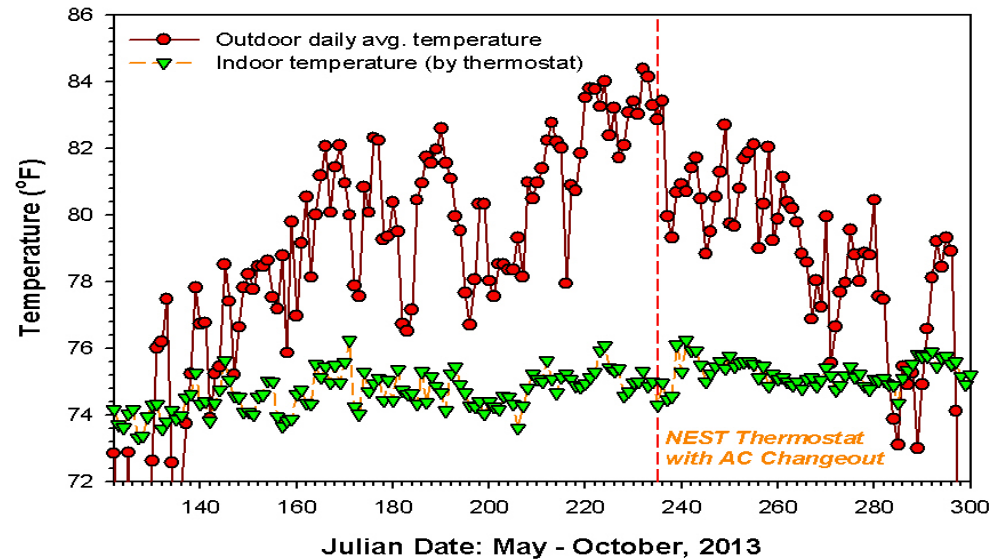


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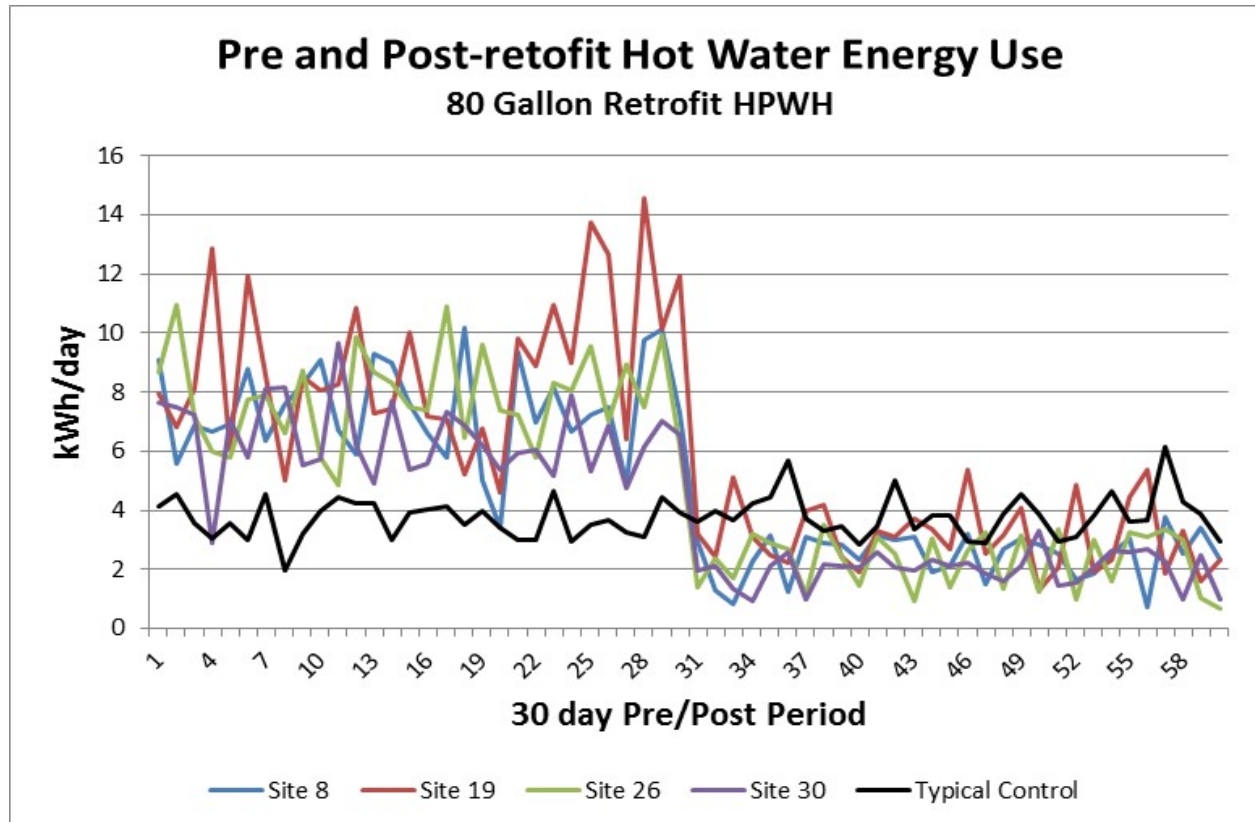


- Some Homeowners Prefer Low Temperatures
- Defeated “Auto-Away”
- Cooling Energy Savings: -8% to 4%
- Average: -0.6% negative savings



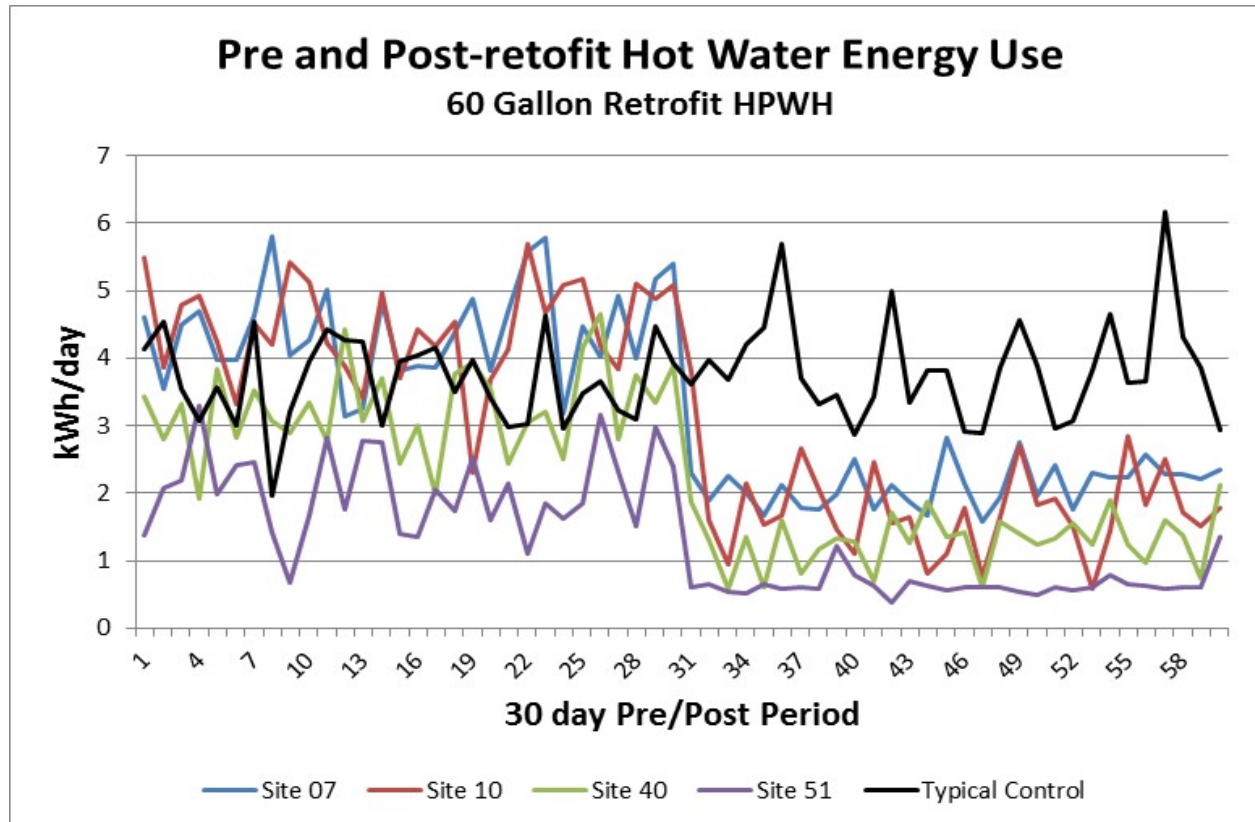
# Heat Pump Water Heaters

- Dependable Savings vs. Electric Resistance Water Heaters
- 65% Overall Savings: 5.2 kWh/day 80gal



# Heat Pump Water Heaters

- Dependable Savings vs. Electric Resistance Water Heaters
- 65% Overall Savings: 2.1 kWh/day 60gal



# Energy Star Dryer



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- 6 Months Average Dryer Energy Use Savings: 18% (0.6 kWh/day)
- 23% Savings in Heaviest Use Site
- One Home with Negative Savings (used to line dry)



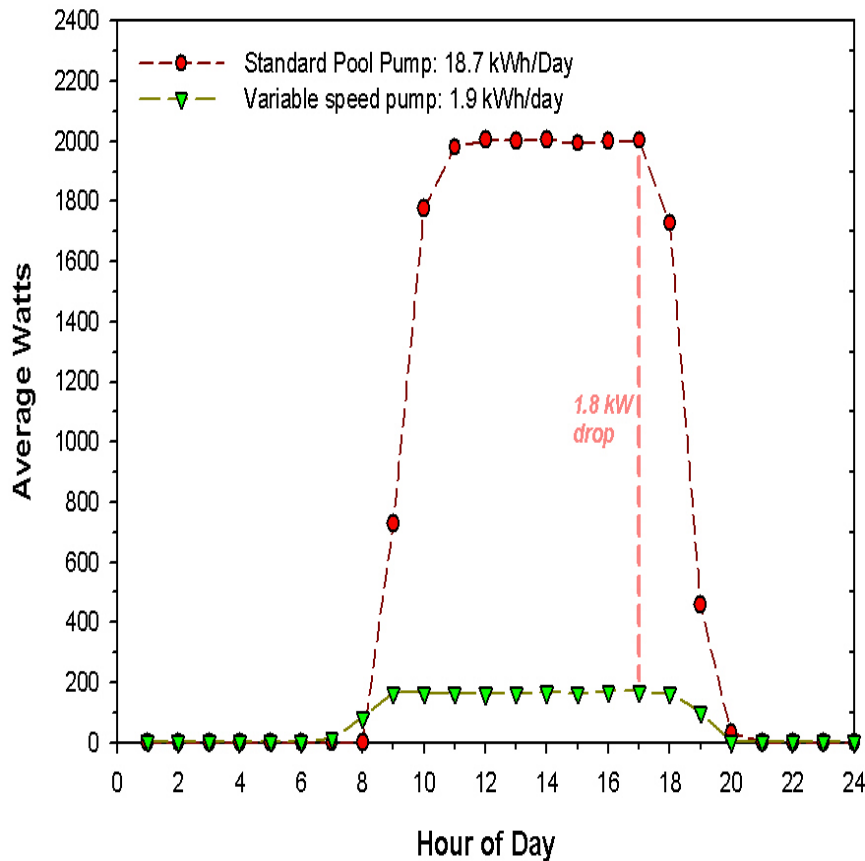


# Variable Speed Pool Pump



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Average Time of Day Pool Pump Demand:  
Site #7: Pre & Post Variable Speed Pool Pump Replacement



- Pre: 18.7 kWh/day
- Post: 1.9 kWh/day
- 90% savings
- Huge Demand Reduction
- 1.8 kW @ 5 PM!



- Pre vs. Post Retrofit for Six Homes
  - Pre: Oct 2012 - Jan 2013
  - Post: Oct 2013 - Jan 2014
- 34% Whole House Energy Savings
- Final Annual Whole House Savings Likely 35 to 40%
  - Period does not include energy intensive summer
  - Weather was more harsh in post period (both heating and cooling)
  - Not all retrofits complete over before Oct 2013

- Outright Cost Average: \$14.2K/site
- Incremental Cost Average: \$7K/site
  - Replace at burnout
- Estimated Annual Savings: ~ 7,000 kWh/yr (\$70/month)
- Highly Visible to Consumer
- Rate of Return and Simple Payback:
  - Outright: ~6%, 17 year payback
  - Incremental: ~12%, 8 year payback

- Shallow Retrofits Demonstrate:
  - Simple Utility Pass Through Audits can Make a Difference: 9% whole house savings
  - Small, very cost-effective savings
  - However, invisible to the consumer
- Deeper Retrofits Demonstrate:
  - High-level whole house savings: 35 - 40%
  - Highly effective & reliable technologies
  - Attractive economics when retrofits coincide w/ major equipment & appliance replacement