

Residential Retrofits in the Southeast: A Performance Update

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for

Building America Stakeholder Meeting
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U.S. DEPARTMENT OF
ENERGY

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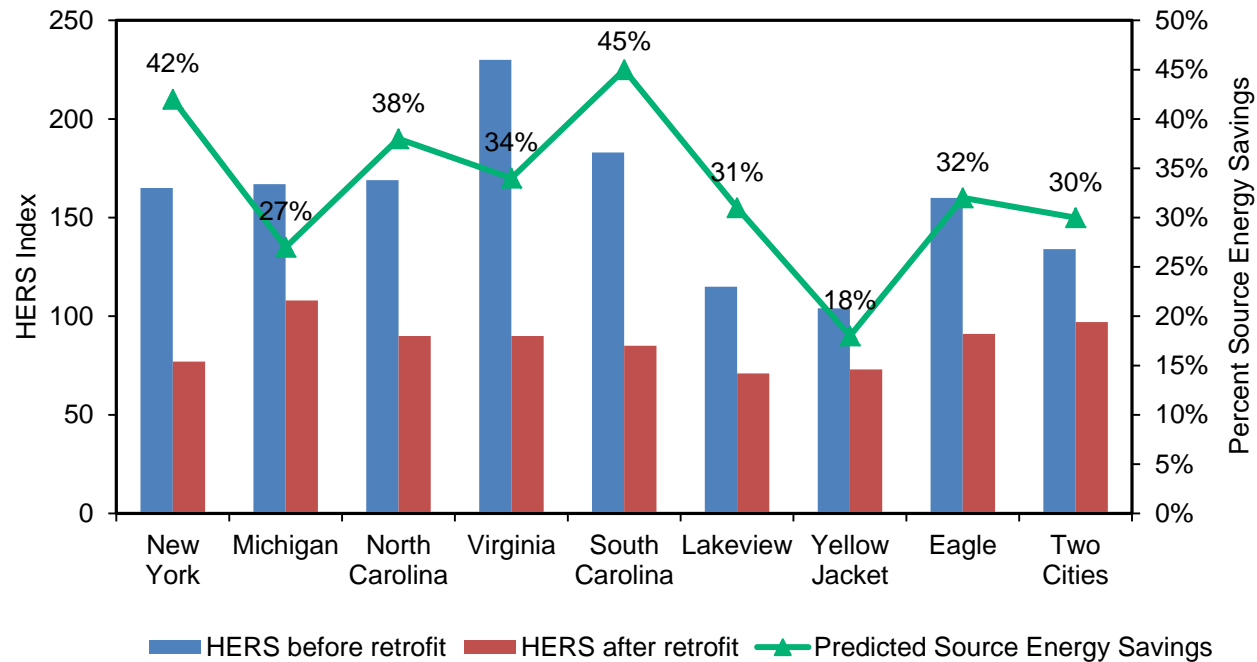
MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY

Project Goals

1. Can we retrofit existing homes to achieve energy savings of more than 30%
 2. Can we **cost effectively** retrofit existing homes to achieve energy savings of more than 30%
 3. Will homeowners pay for retrofits that achieve energy savings of more than 30%
 4. Will reality (i.e. utility bills) match the projected energy savings
- In the event any of the answers to questions 1-4 is NO, what are obstacles to YES

Project Overview

Nine homes received retrofits with projected source energy savings that ranged from 18% to 45%



Retrofit measures include: HVAC replacement and upgrade, water heater replacement and upgrade, wall cavity insulation (i.e. drill and fill), attic sealing and insulation, crawlspace sealing, air sealing, etc.

Picking up from our Last Building America Meeting

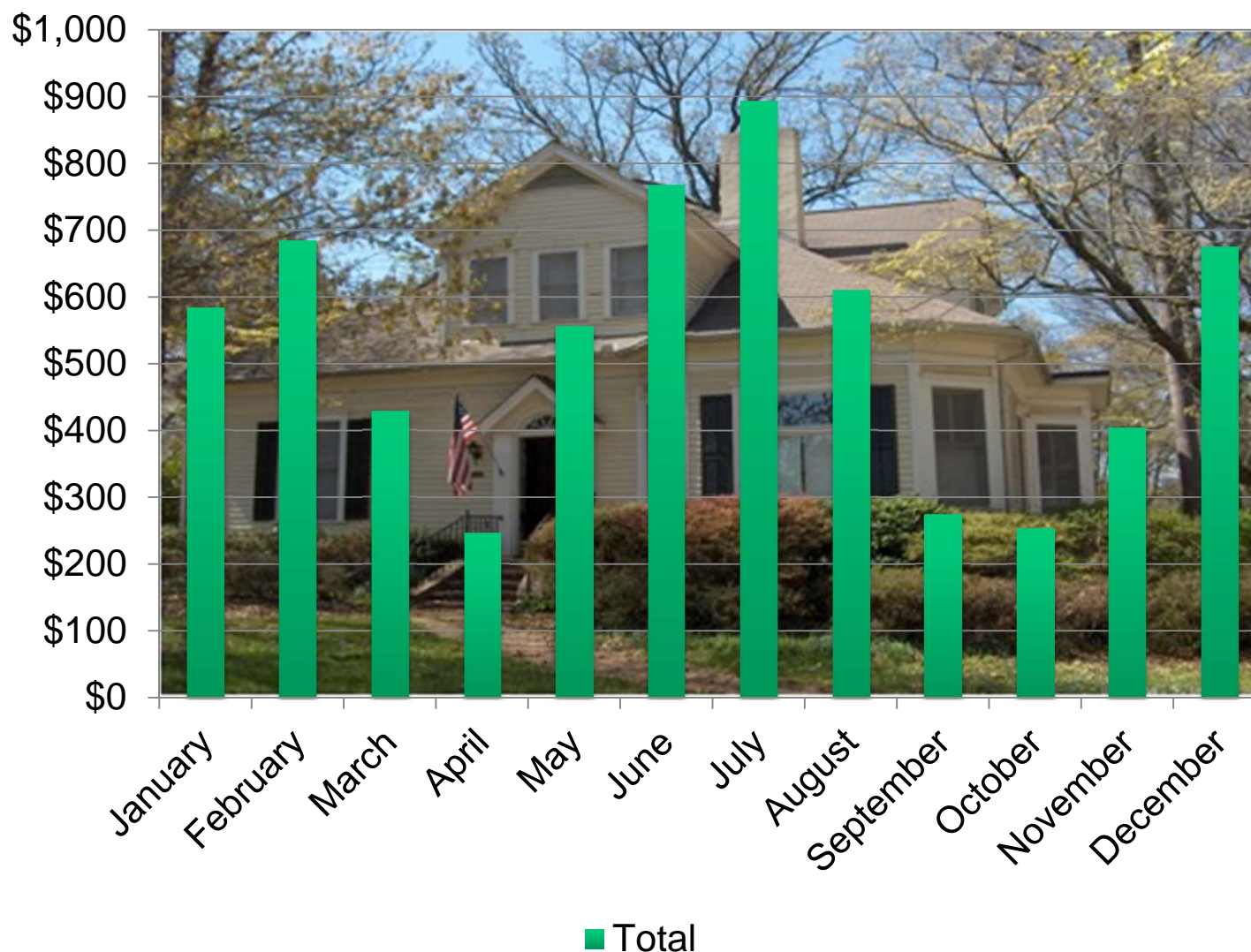
Picking up from our Last Building America Meeting



Home Type: Existing Single-Family
Location: Atlanta, GA
Size: 3,703 sq. ft.
Date Built: 1920's
IECC Climate Zone: 3
HERS: 169

Air infiltration: 12,691 cfm50 (i.e. 20.6 ACH)
Duct blaster test: 22% (attic), ?? (crawlspcace)
Cooling equipment: 3.5 ton, 9.3 SEER (crawlspcace); 2.5 ton, 9.5 SEER (attic)
Heating equipment: 0.91 AFUE (x2)
Water heating equipment: 0.59 energy factor

Tenant has Significantly High Utility Bills (\$6,380/year*)



*Utility bills are from 2/2010-1/2011

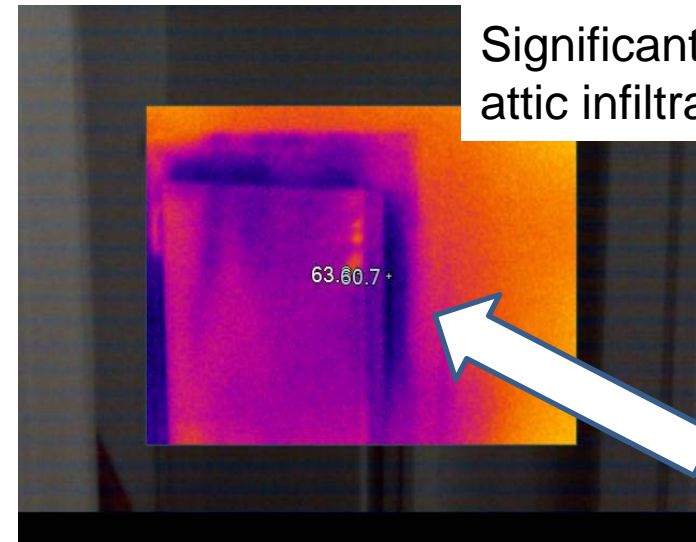
Many Problems Exist



Uninsulated knee walls



Leaky Ducts



Significant attic infiltration

The Solution,



Attic/ Knee walls	R-38 blown fiberglass and other air sealing measures / R-15 open-cell foam
Foundation Walls	R-13 (close-cell foam on walls), R-11 (open-cell foam on band), New vapor barrier
Cooling	4-ton, 16 SEER (first floor)
	2.5-ton, 16 SEER (second floor)
DHW	50 gal. Heat Pump Water Heater

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Impact on Home Diagnostics

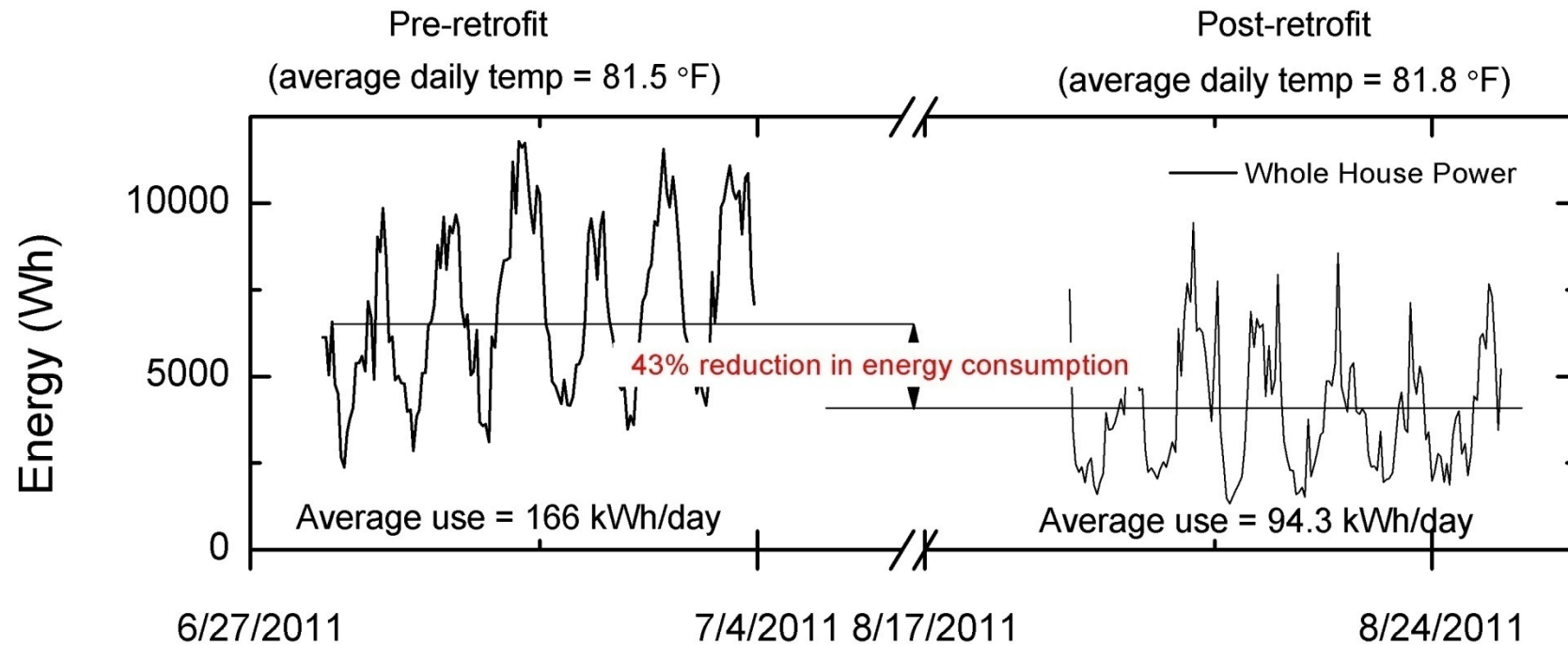
Retrofit Measure Tested	Blower Door Test Result (CFM ₅₀ /ACH ₅₀)	Percent Reduction
Initial	12,690 / 20.6	
Attic Sealing on Ceiling Plane+ Knee walls Sealed with Open Cell Foam + Window Repaired	10,400 / 16.9	18%
Crawlspace Band Sealed with Open-Cell Foam	9,651 / 15.7	7%
Foundation Wall Sealed with Closed-Cell Foam	7,688 / 12.8	18%
Final	7,688 / 12.8	39%

Duct Leakage (% to outside) –

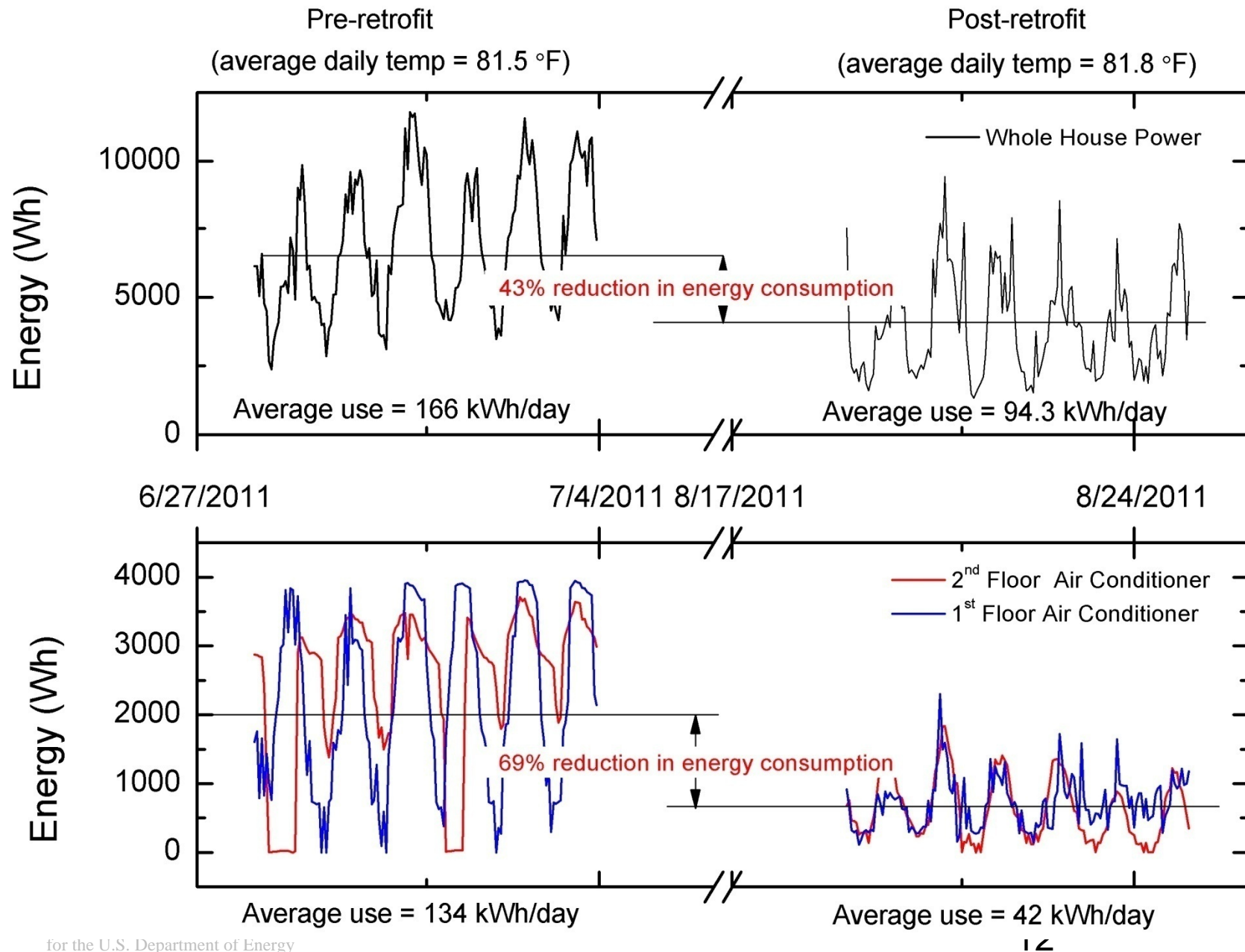
Notes: (% to outside) – CFM₂₅/conditioned area (ft²)

	System 1 (second floor)			System 2 (first floor)	
	CFM ₂₅	% Leakage to Outside		CFM ₂₅	% Leakage to Outside
Initial	283	22%		Could not pressurize	
Post	43	3%		103	4%
% Reduction	85%	85%		%	%

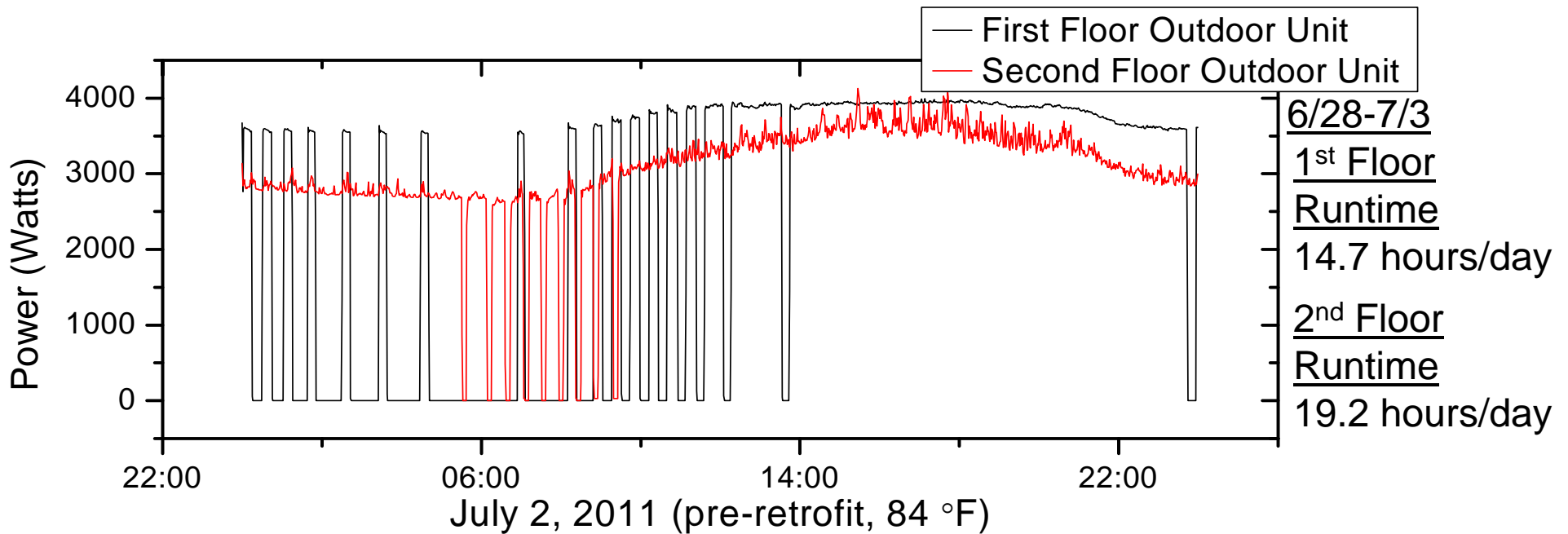
Energy Savings



Energy Savings



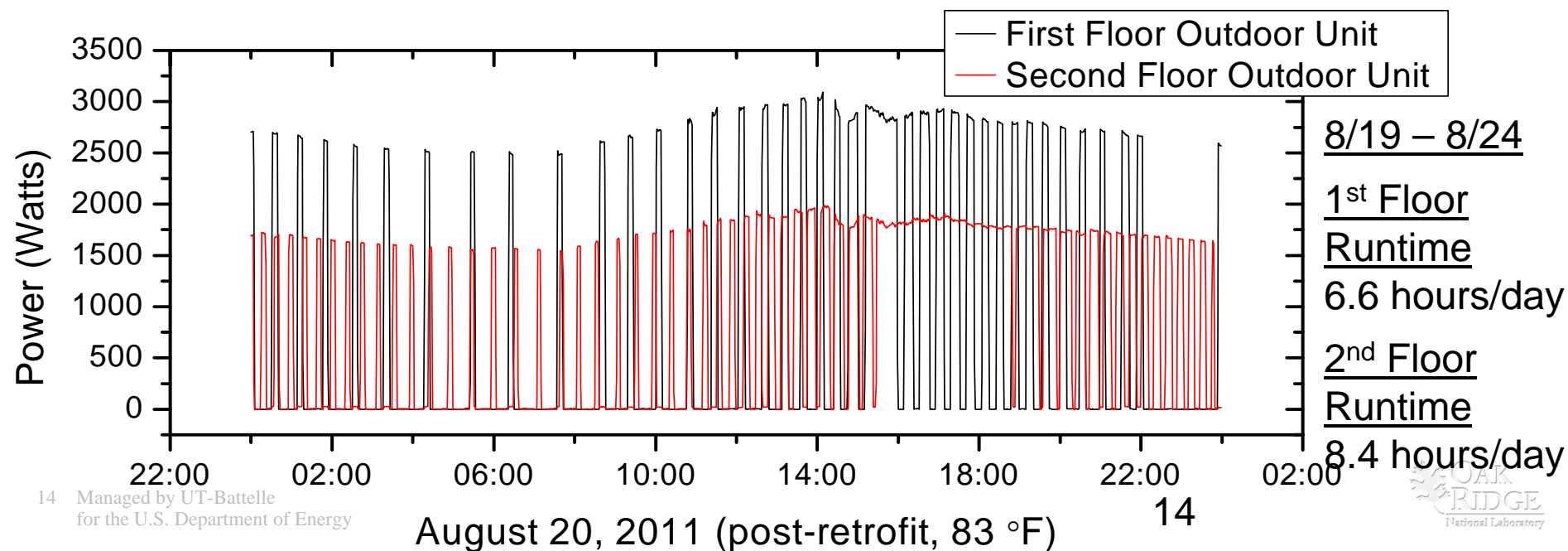
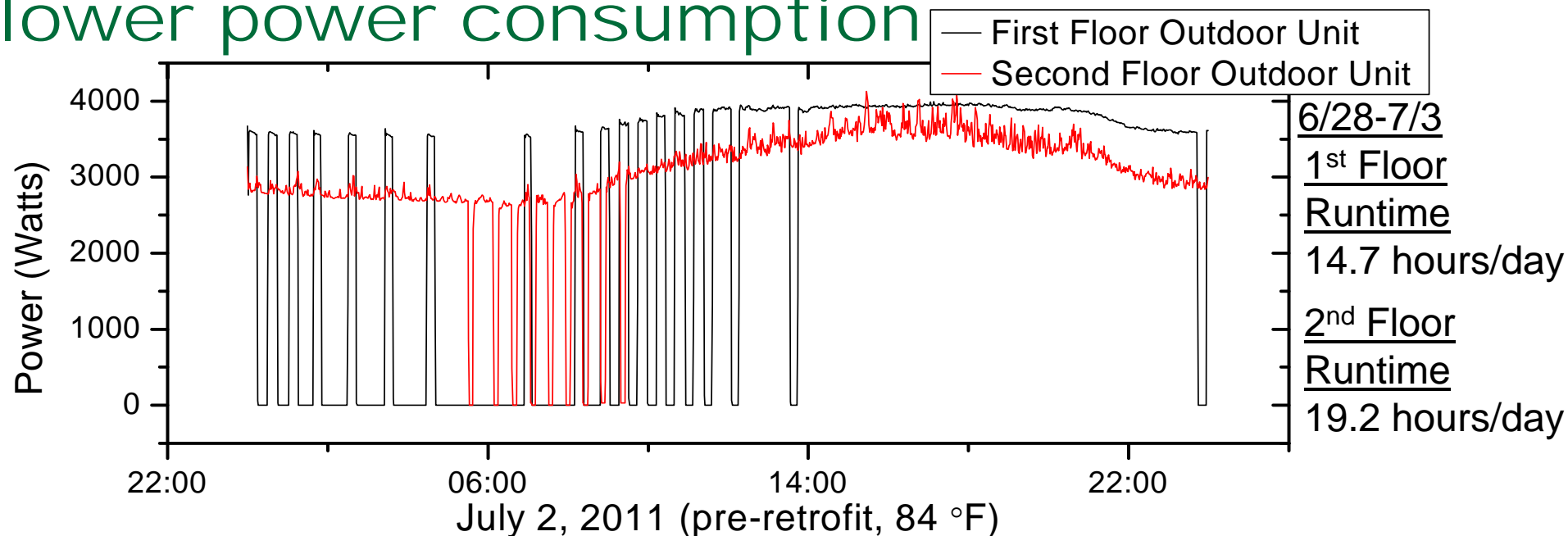
A Closer Look at HVAC Performance



Retrofit included:

- Per Manual J determination, the first floor AC capacity was increased to 4 ton from 3.5 ton
- Decreased infiltration from 20.6 ACH to 12.8 ACH
- Added insulation to knee walls
- Sealed and insulated crawlspace
- Brought the first floor ducts into the conditioned space

Retrofit Results: Shorter runtimes, lower power consumption



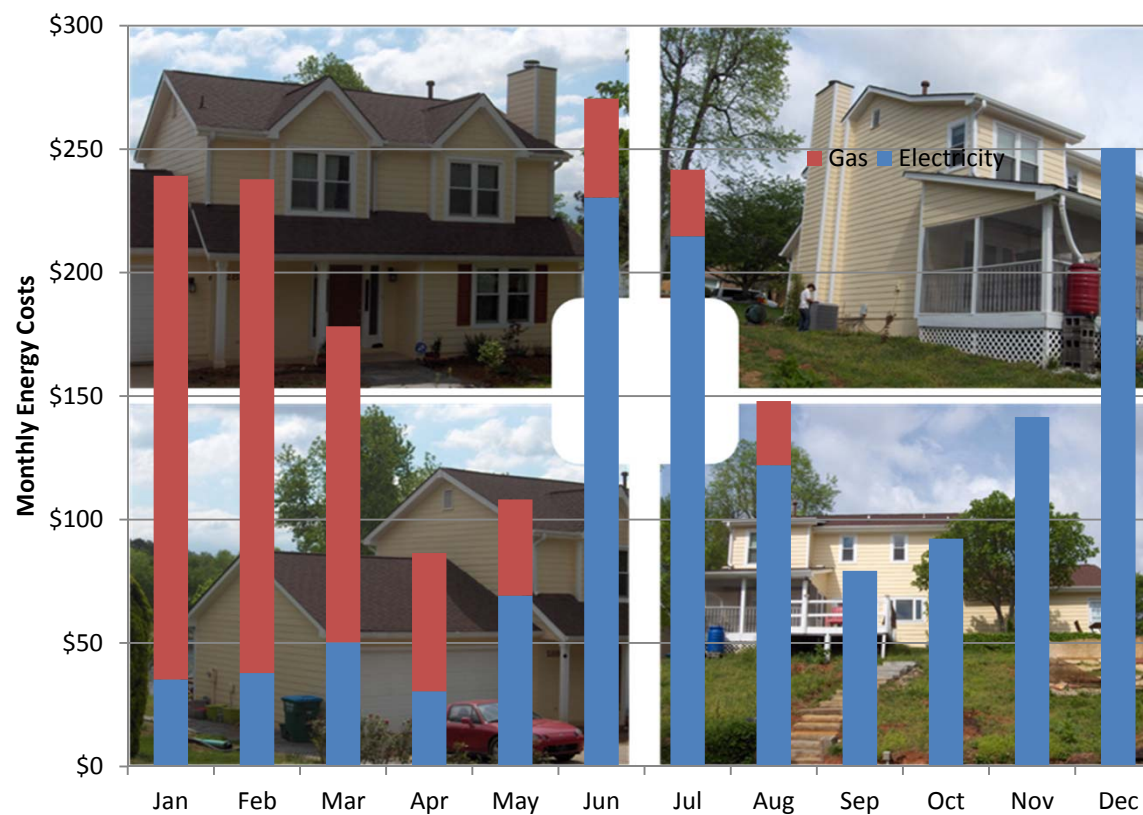
Residential Retrofit: Lakeview



Home Type: Existing Single-Family
Location: Duluth, GA
Size: 1,710 sq. ft.
Date Built: 1985
IECC Climate Zone: 3
HERS: 115

Air infiltration: 2,670 cfm50 (i.e. 11.7 ACH)
Duct blaster test: 31%
Cooling equipment: 3.5 ton, 12 SEER (attic)
Heating equipment: 0.80 AFUE
Water heating equipment: 0.9 EF

Residential Retrofit: Lakeview



Total annual energy costs of \$2,074 (~80 MMBtu of site energy)

Primary Retrofit Measures

Attic	Attic encapsulated with R-21 open-cell spray foam on roofline
Cooling	2 ton, 18 SEER (<i>original cooling unit was a 3.5 ton, 12 SEER unit</i>)
Heating	8.9 HSPF ducted inverter heat pump
Water Heating	Solar Thermal Water Heater with a 80 gallon storage tank



Primary Retrofit Measures

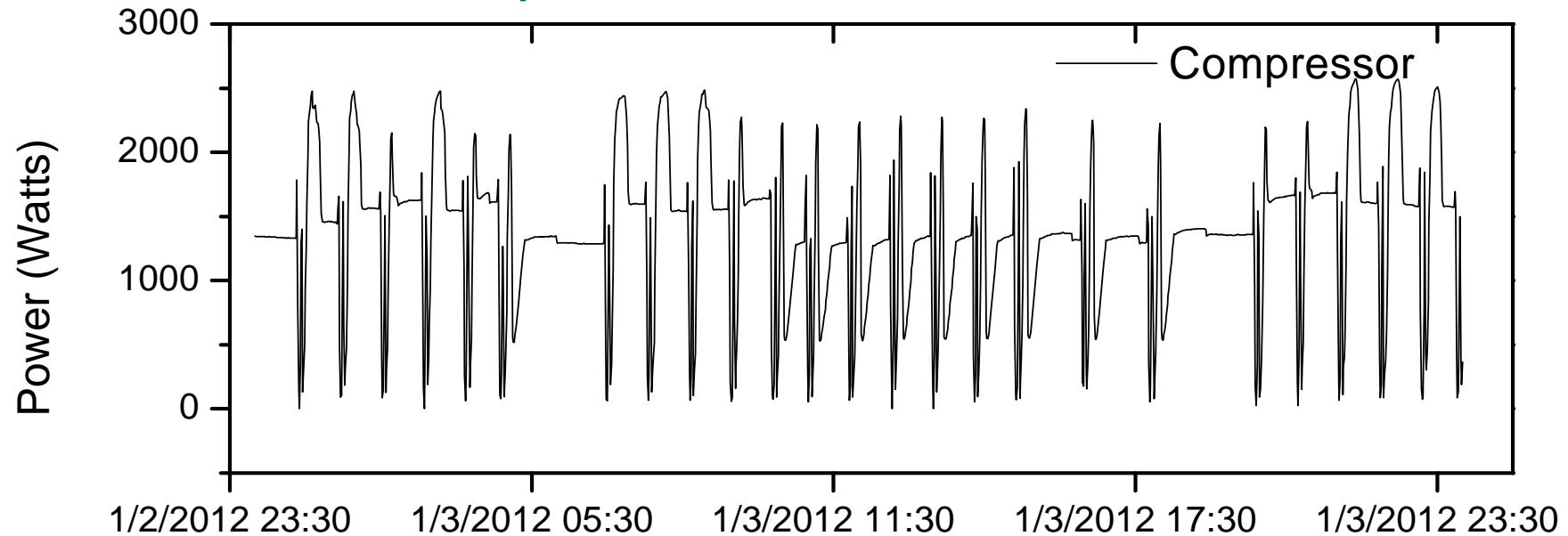
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Retrofit Measure Tested	Blower Door Test Result (CFM₅₀/ACH₅₀)	Percent Reduction
Initial	2,670/ 11.7	
Final	2,110/ 10.1	21%

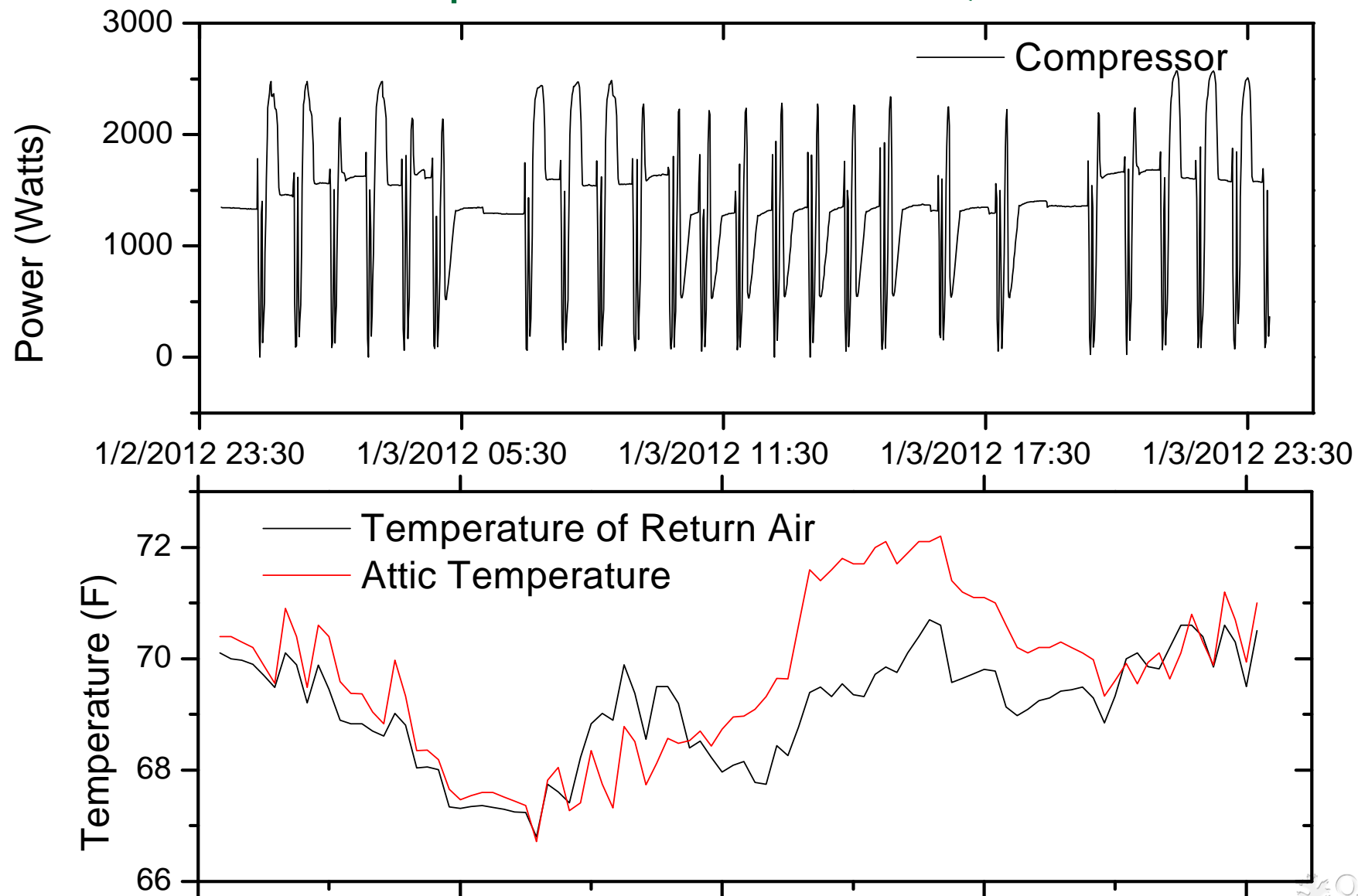
Duct Leakage (% to outside) – Notes: (% to outside) – CFM ₂₅ /conditioned area (ft ²)		
	CFM₂₅	% Leakage to Outside
Pre-Retrofit	530	31%
Post-Retrofit	110	6.4%
% Reduction	79%	79%

No Resistance Heat Needed!!!! (Mean Outdoor Temperature = 27°F)



The Daikin variable capacity heat pump is able to maintain homeowner comfort levels on one of the coldest days of the year.

No Resistance Heat Needed!!!! (Mean Outdoor Temperature = 27°F)



But What About Behavior???

But What About Behavior???

10 homeowners volunteered for deep retrofit research project in east TN

- **Despite motivation, the level of retrofit activity varied widely**
 - 5 households installed most or all recommended measures
 - 2 households installed some measures
 - 3 households have done nothing to date



WHY?

Homeowners' perspectives: key to developing a market for deep home retrofits

Why do they participate?

Multiple motivations

- Opportunism
 - Undertaking major renovations, so why not incorporate measures?
 - Marginal costs, disruption, time
- Enhance efficiency, reduce bills
 - In preparation for retirement
- Align with their principles
- Demonstrate and educate

Main drivers often are NOT energy or sustainability, or desire to lower utility bills

What do they choose to do?

Bases for choices vary

- Desired outcomes *plus* energy
 - Windows as example: aesthetics + weak link in buttressed envelope
- Rough cost/benefit calculation
 - May *not* expect financial payback
 - Make their own 'calculations'
 - No observed problem, so not worth the cost—*but* information can alter choice
- Disruption/mess
 - Not a problem when major renovation

Many measures are INVISIBLE (insulation, sealing ducts, etc.) and not easily amenable to showing off

Interim findings from homeowners— implications for expanding the market?

- Point of entry—major renovations or repairs (timing of appeal may matter)
 - How to gain that entry via information, incentives, etc.?
 - How to expand?
 - To less major renovations or repairs (e.g., new siding)
 - *Don't ignore energy/sustainability, lower utility bills*
- *Unbiased* expertise is valued highly
 - Understanding rationale, 'negotiating' which measures to adopt
 - Individual measures plus portfolio of measures
- Quality of work is major issue
 - Who assures that work is done properly?
 - Credibility of contractors
 - Variability in quality of work done...even via same contractor

Retrofit Lessons Learned:

1. Can we retrofit existing homes to achieve energy savings of more than 30% --- **I think so**
2. Can we **cost effectively** retrofit existing homes to achieve energy savings of more than 30% --- **Not today (more research is needed 😊)**
3. Will homeowners pay for retrofits that achieve energy savings of more than 30% --- **Maybe**
4. Will reality (i.e. utility bills) match the projected energy savings -- **- I don't know yet**

Questions remaining

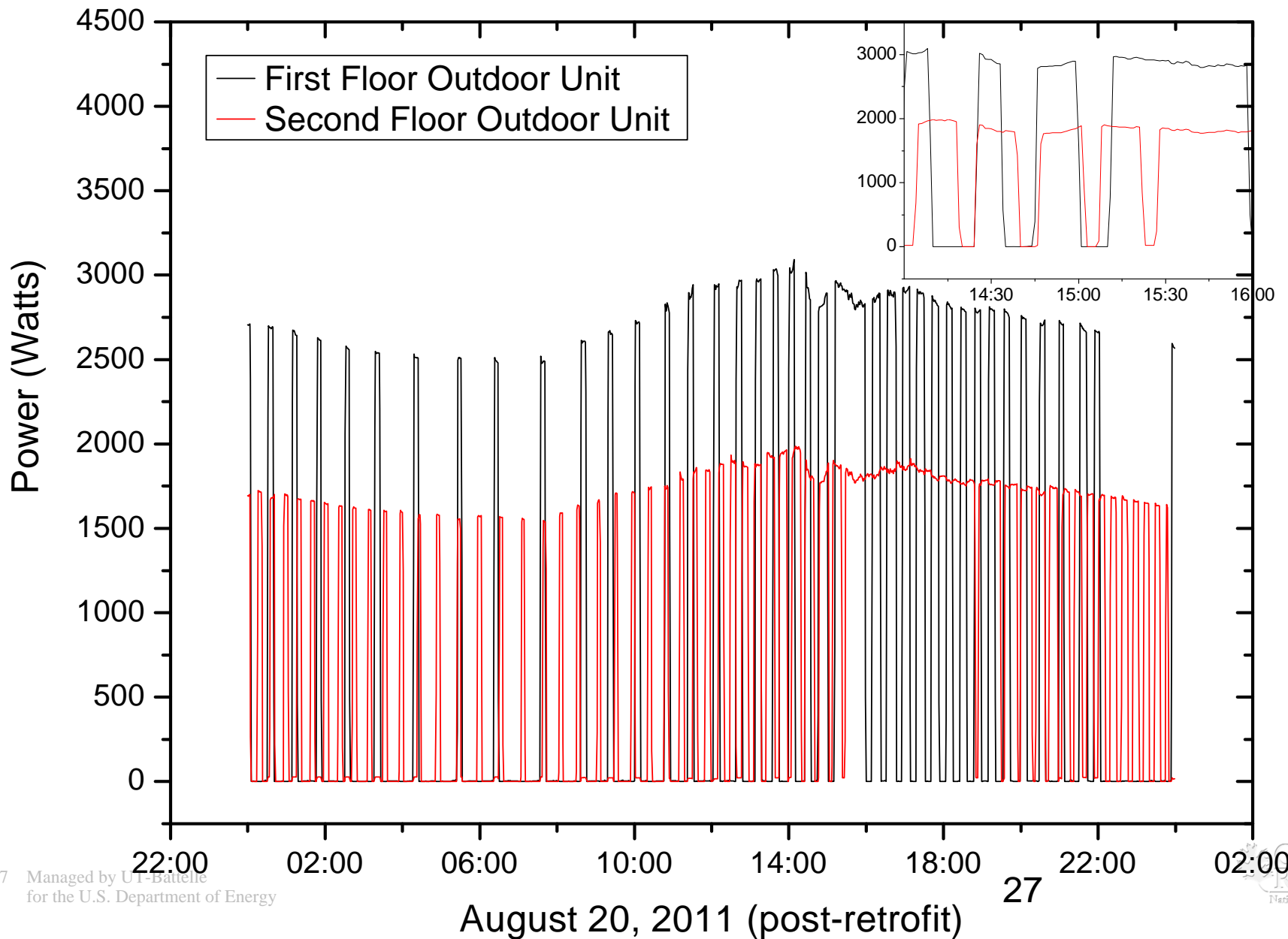
- Are “deep energy” retrofits the right approach?
 - Would a “phased” approach where envelope measures are completed first so that equipment can be better sized
 - Inconvenience to homeowners of extensive work (i.e. time away from work/pleasure)
- How can we cost-effectively commission retrofits
- How do we bring down the costs of deep energy retrofits

Thank You

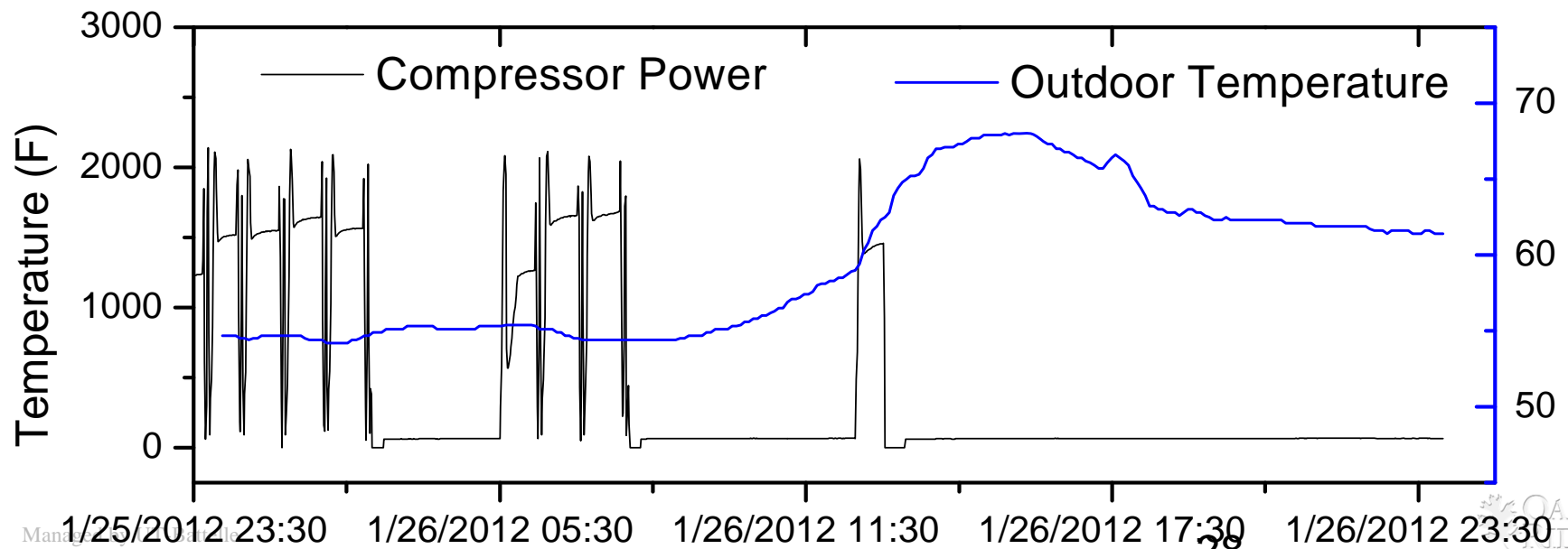
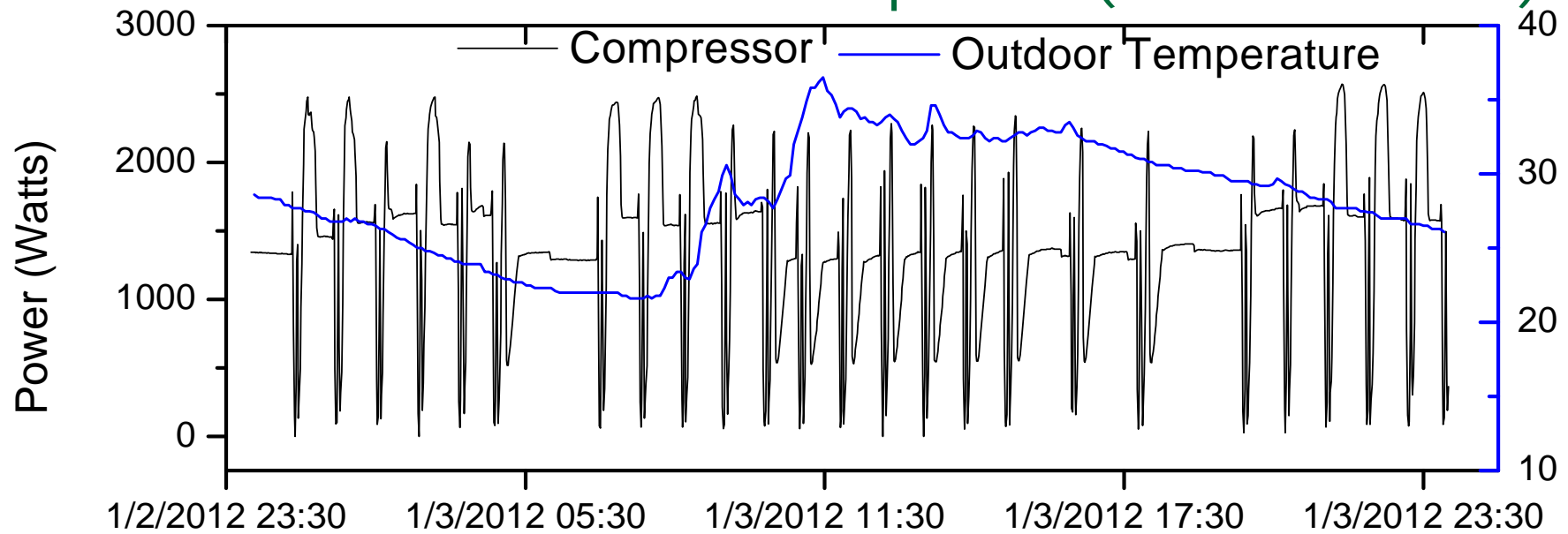
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- Florida Solar Energy Center
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North Carolina Power Consumption



Lakeview Power Consumption (Daikin VRV)



Lakeview Power Consumption (Daikin VRV)

