

Cost-Effective, Energy Efficient Residential Retrofit Measures for the Hot Humid Climate



Florida Housing Coalition Our Energy Economy – What Makes Cents? September 27, 2011

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Building America Partnership for Improved Residential Construction
Florida Solar Energy Center



- U.S. Department of Energy
 - Building America Program (www.buildingamerica.gov)
 - DOE National Renewable Energy Lab
 - Dr. Ren Anderson and Stacey Rothgeb
 - 15 Teams of researchers and housing industry stakeholders
 - FSEC led BA Team: Partnership for Improved Residential Construction (BA-PIRC) www.ba-pirc.org
 - Pacific Northwest National Lab
 - Dr. Subrato Chandra



- 30+ Years High Performance Residential Construction
- Research Partners
 - Developers, Builders, Suppliers, Designers, State & National Laboratories, Municipalities, Utilities
- Flexible Residential Test Facility
 - Evaluate systems and envelop changes



A Special Thanks To...

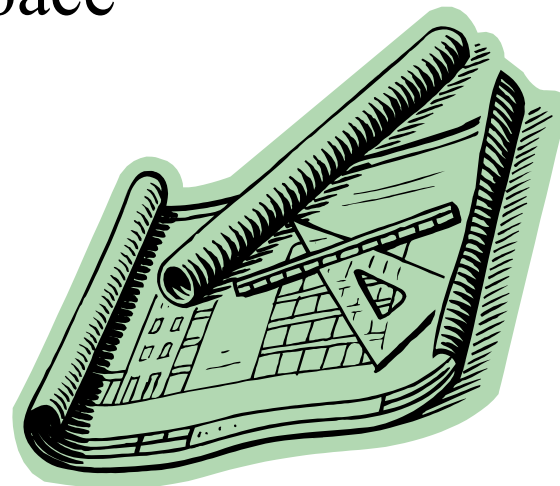
- Collaborators and Partners
 - Florida Local Government Housing Entities
 - Sarasota County and the City of Sarasota, Volusia County, Brevard County, City of Palm Bay, City of Lakeland, Orange County
 - Non-profit Housing providers
 - Florida: Sarasota Housing Trust, Newtown Housing Trust, and Habitat for Humanity Affiliates in Brevard, Lake Sumter, Leesburg, Palm Beach & Sarasota Counties
 - Alabama: Mobile & Birmingham
 - Individual Home Owners planning deep energy retrofits
 - Brevard, Duval, Orange, Osceola, Polk & Seminole Counties

- Identify Pathways for Achieving High Performance Renovations
 - Energy savings of 30%+ cost effectively
 - Off the shelf technology with existing labor pool
 - Improve indoor air quality, durability, and comfort
- Gather Typical Cost Data for Common Improvements in Florida
- Identify Gaps and Barriers to Broad Market Adoption
 - Availability of important materials, components & systems
 - Trade knowledge and skill sets
 - Code issues

- Primarily Unoccupied, Foreclosed Homes
 - Recently added occupied homes
- Test-In (Pre-Retrofit) Energy Audit & Annual Energy Cost
 - Measurements, observations, infiltration & duct leakage tests
- Technical Assistance
- Test-Out (Post-Retrofit): Repeat Audit & Analysis
- Final Analysis with Cost Data
 - Energy costs savings vs. incremental costs

Study Homes Description

- 100 Homes Initially Analyzed
 - 73 Retrofits completed, 14 Retrofits in progress, 13 Lost
- Average Size: 1365 sf Living Space
- Age Distribution:
 - 1950s: 7
 - 1960s: 21
 - 1970s: 19
 - 1980s: 25
 - 1990s: 15
 - 2000+: 13
- Typically: Single Family, Ranch, Slab-on-Grade



Typical Existing Homes HERS Indices



1960's ~150



1970's ~135



1980's ~125



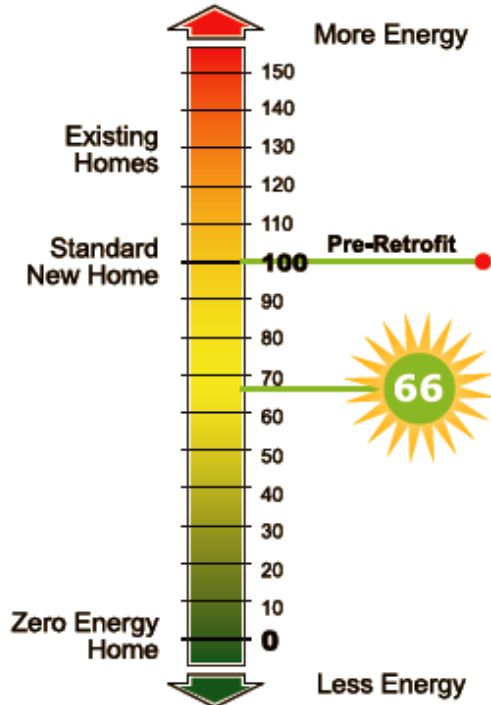
1990's ~115



2000's ~110

HOME ENERGY RATING CERTIFICATE

HERS® Index



1352 Hartsdale Street
New Port, FL 34287

Annual Estimates*:	Pre	Post
Electricity (kWh):	11,700	7,477
CO ₂ Emissions (Tons):	6.91	4.0
Savings		36%

Date of Rating: 04/29/2010
Rater: Florida Solar Energy Center

*Based on standard operating conditions



EnergyGauge
1679 Clearlake Road
Cocoa, FL 32922-5703

321-638-1492
energygauge.com

This Home has been inspected
and performance tested in
accordance with Chapter 3 of
the RESNET Standards.

RESNET
www.resnet.us

Retrofit Case Study: Sarasota Home

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Energy Efficiency &
Renewable Energy



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Partnership for Improved
Residential Construction



Retrofit Case Study: Sarasota Home

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Energy Efficiency &
Renewable Energy



- Concrete block, slab-on-grade
- Built in 1967, 1190 sf, 2 bedroom, 2 bath



Partnership for Improved

Residential Construction



Energy Gauge USA Simulation Results:

Annual Energy Use Profile by End Use				
End Use	Test-In	Test-Out	Savings (\$)	Savings (%)
Cooling	\$872			
Heating	\$86			
Hot Water	\$277			
Ceiling Fans	\$71			
Lighting	\$183			
Misc. Loads	\$203			
Appliances	\$293			
Total Annual Energy Cost	\$1,985			
HERS Index	165			

Annual Energy Cost from HERS Index Rating Guide

New HVAC System

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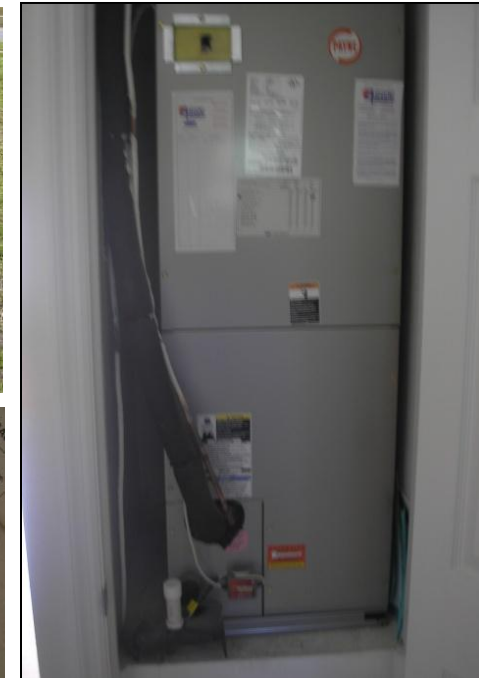
Energy Efficiency &
Renewable Energy

Pre-retrofit



SEER 8.7, HSPF 6.75 Heat Pump
($q_{n,out} = 0.05$ ~5% leakage to outside
of the home)

Post-retrofit

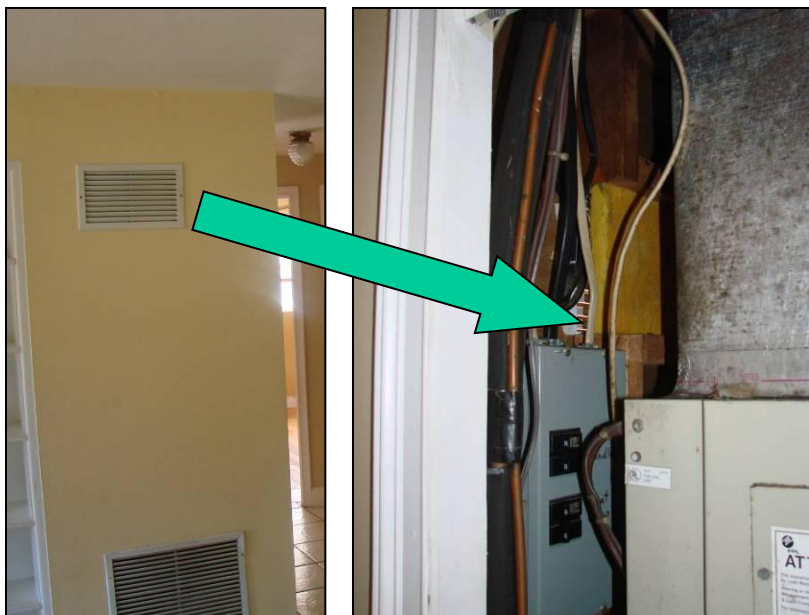


SEER 15, HSPF 8.8 Heat Pump ($q_{n,out} =$
 0.02 ~2% leakage to outside of the home)

Infiltration Reduction

AHU Closet Sealing, Return Plenum Sealing, Drywall Repair, New Windows

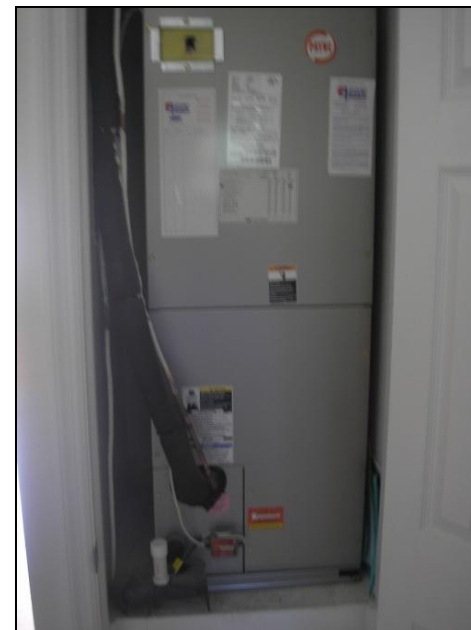
Pre-retrofit



LR side of
AHU closet

Sparse ceiling in AHU
closet, connected to
attic & LR

Post-retrofit



Closet gutted, drywalled; new return
plenum & platform constructed

Infiltration Reduction

AHU Closet Sealing, **Return Plenum Sealing**, Drywall Repair, New Windows

Pre-retrofit



LR side of AHU closet

Mysterious return plenum

Post-retrofit



Central return plenum constructed with duct board & sealed with mastic at edges, seams, & joints.

Infiltration Reduction

AHU Closet Sealing, Return Plenum Sealing, **Drywall Repair**, New Windows



Plumbing access panel & miscellaneous drywall penetrations were repaired



Infiltration Reduction

AHU Closet Sealing, Return Plenum Sealing, Drywall Repair, **New Windows**

Pre-retrofit



Note angle of window
in 'closed' position



Exceptionally leaky: $ACH(50) = 42$

Post-retrofit



Major infiltration reduction: $ACH(50) = 8$

Replaced Windows: U-Value = 0.47,
SHGC = 0.37

Ceiling Insulation

Insulated to R - 30

Pre-retrofit



Post-retrofit



Note: Image from alternate house

Pre-retrofit



Post-retrofit



Light Exterior

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Energy Efficiency &
Renewable Energy

Pre-retrofit



Post-retrofit



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End Use Predicted Savings

Case Study - Sarasota, FL Simulated Annual Energy Use (Energy Gauge USA)

End Use	Test-In	Test-Out	Savings (\$)	Savings (%)
Cooling	\$872	\$228	\$644	74%
Heating	\$86	\$34	\$52	60%
Hot Water	\$277	\$256	\$21	8%
Ceiling Fans	\$71	\$71	\$0	0%
Lighting	\$183	\$76	\$107	58%
Misc. Loads	\$203	\$203	\$0	0%
Appliances	\$293	\$244	\$49	17%
Total Annual Energy Cost	\$1,985	\$1,112	\$873	44%
HERS Index	165	73	92	56%

Annual Energy Cost from HERS Index Rating Guide

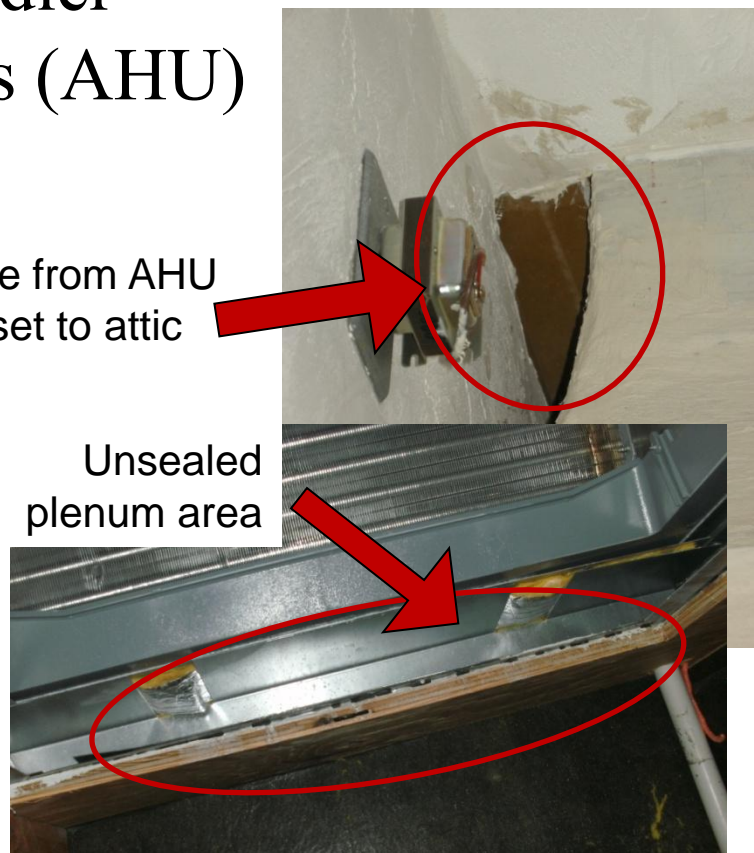
Total Incremental Cost (Based on cost reported by partner)	\$4,441
Monthly Cost (7%, 30 yr mortgage)	\$30
Estimated Monthly Energy Savings	\$58
Net Monthly Cash Flow	\$28
Net Annual Cash Flow	\$336

Mechanical Equipment Installation

- Small, Poorly Sealed Air Handler Closets & Leaky Air Handlers (AHU)
 - Pressure issues
 - Dirt build-up
 - Longer operation times
- Over Sized Equipment
 - Pressure issues
 - Shorter operation times
 - Humidity & moisture issues
- Leakier Ducts

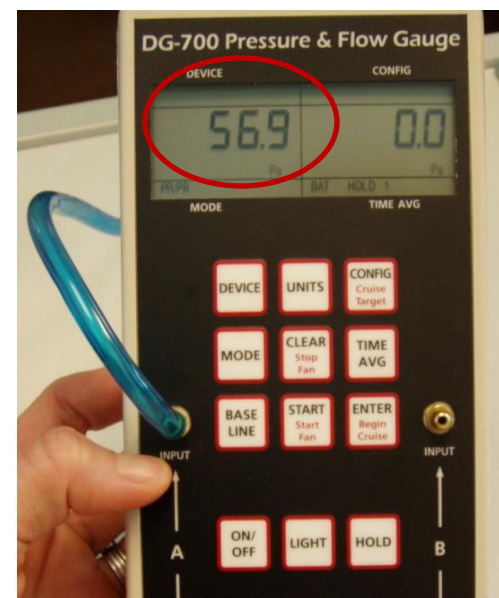
Hole from AHU closet to attic

Unsealed plenum area



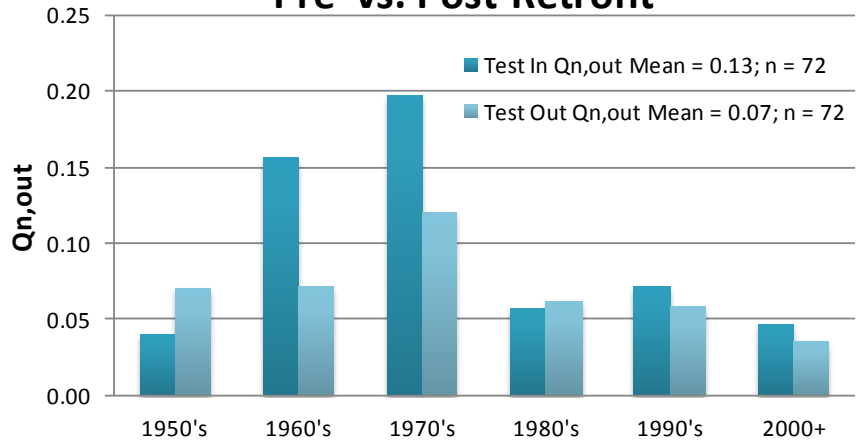
Pressure Differences

- High Pressures Differences Between Rooms
 - Combustion safety issues
 - Moisture issues (Mold)
 - Durability issues

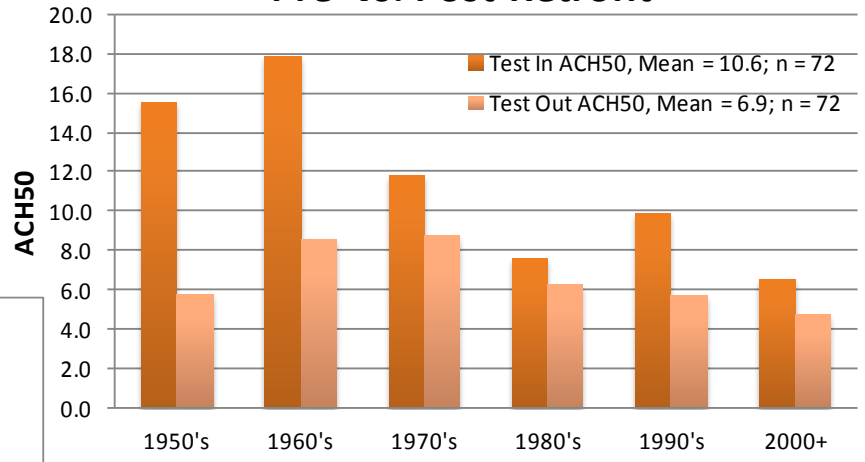


Pre- & Post-Retrofit Comparisons

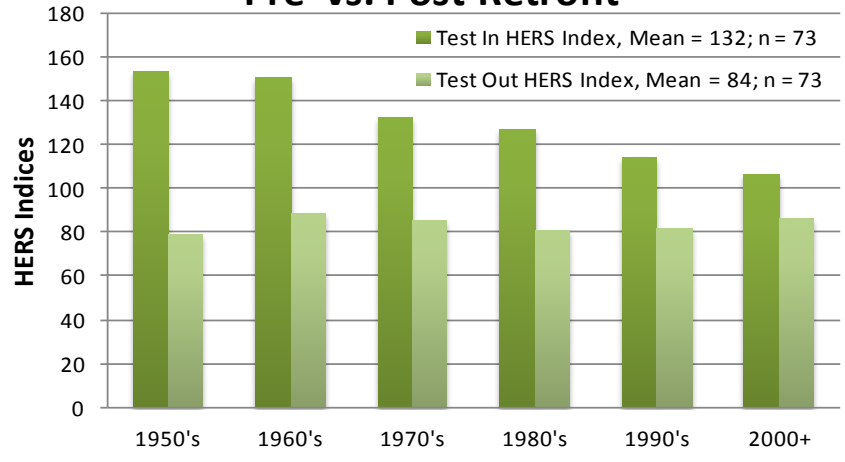
Duct Leakage Pre- vs. Post-Retrofit



Whole House Air Tightness Pre- vs. Post-Retrofit



HERS Indices Pre- vs. Post-Retrofit



- Predicted Savings in 73 Completed Homes

- A combination of retrofit measures:

- “Tune up” tasks
- Low cost, low hanging fruit
- Higher efficiency choices upon replacement

**Average Energy
Cost Savings: 33%**

- Partner’s use of standards

- Achieve a bulk of the improvement
- 3rd Party role in ensuring quality

- Cost Data Collected for 50 Homes

- Providing costs to US Dept. of Energy national database

% Improvement (HERS)	# of Homes
<15%	6
15<30%	25
30<40%	19
40<50%	21
>50%	2

- Identified Gaps and Barriers
 - Physical limitations of mechanical closets
 - Typical areas contractors need help meeting specifications
 - System sizing & Pressure differences
 - Identification of critical QA tasks
 - Mechanical contractors to identify and seal all joints and seams to reduce duct leakage
 - Testing to ensure leakage levels below threshold
 - Testing to ensure pressure differences below threshold
 - Inconsistent code perspectives
 - Gap in contracting paradigm

- Community Scale “Best Practices” Retrofit Study
 - Apply Lessons Learned in 100+ houses
 - Standard set of specifications for replacement and maintenance
 - Design, implementation, and verification
 - Apply across a whole community
 - Document problematic aspects of specifications
 - Develop and test solutions

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<http://www.ba-pirc.org/>

