



FLORIDA SOLAR ENERGY CENTER

Creating Energy Independence

High Performance Existing Homes Partnerships and Research

Janet McIlvaine

Research Analyst, Florida Solar Energy Center

A Research Institute of the University of Central Florida



A Research Institute of the University of Central Florida



What is Building America?

- U.S. Department of Energy Program
- 15 Research Teams Nationwide
- FSEC Leads Building America Partnership for Improved Residential Construction
- Public-Private Research Initiative



- Cost Shared Research
 - Home Builder partners pay for construction costs
 - Researchers provide technical assistance
 - Goal: Cost Effective High performance houses
 - Progressively higher efficiency goals
 - Needed equipment, components, and materials



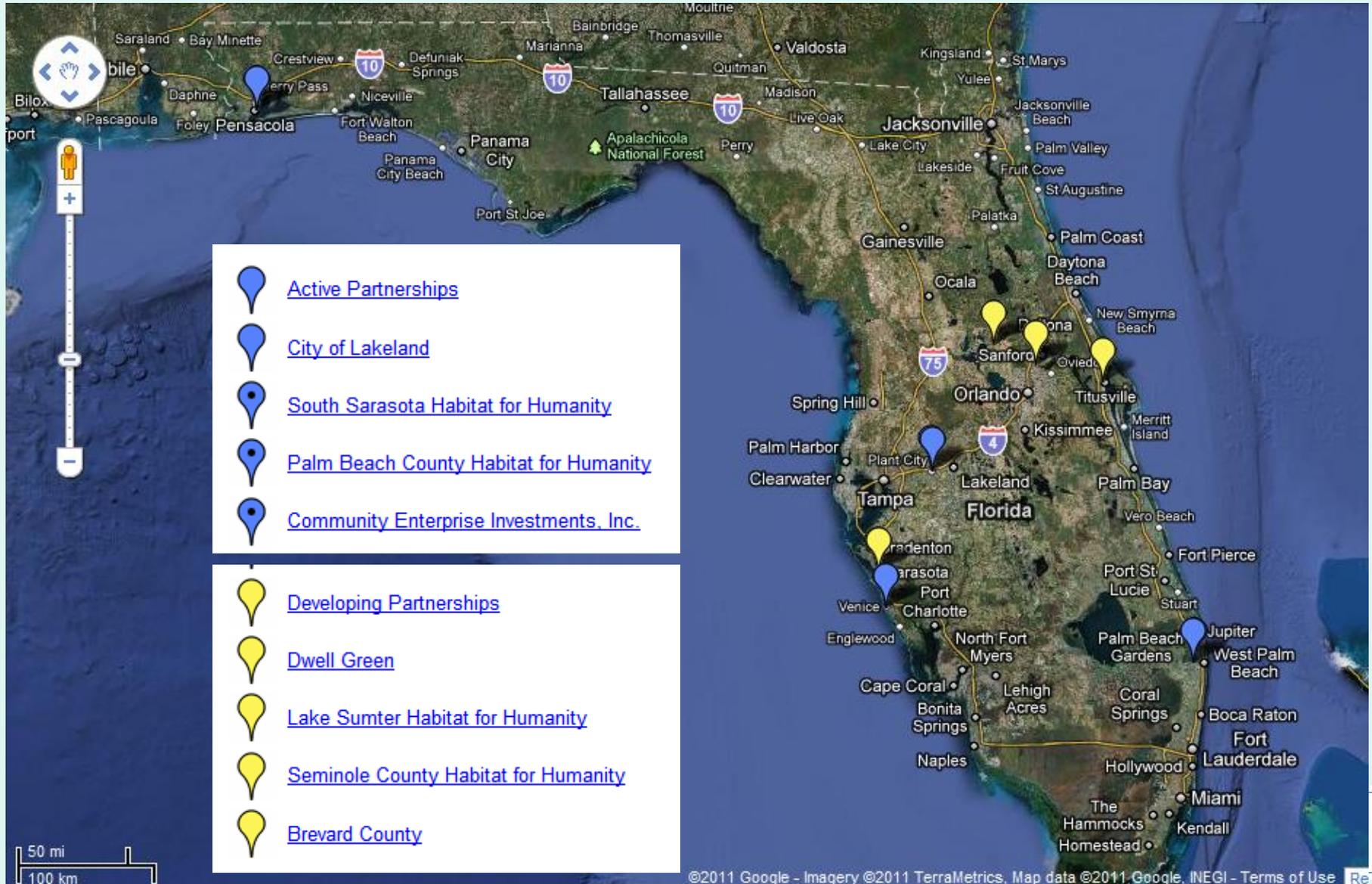
- What savings can be achieved?
 - Off-the-shelf technology
 - Conventional construction
 - Existing labor pool
 - Best opportunities in typical existing homes
- What are the challenges?
 - Availability of products
 - Implementation barriers
 - Training needs
- Affordable housing focus

- Technical and Cost Goals
 - 30-50% improvement in post-renovation house
 - Unoccupied homes – standardized HERS Index method
 - Occupied homes – measured + utility bills
 - First year positive cash flow
 - Collect cost data
 - Enhance IAQ, Durability, and Comfort

Existing Homes Partnerships



New Existing Homes Partners



Partnership

- Local governments, non-profit housing providers, remodeling contractors
- Foreclosed homes under HUD Neighborhood Stabilization Program
 - Neglected homes
 - Extensive renovation
 - Sold after renovation as affordable housing
 - Total cost of renovation set by program guidelines
- Test-in, Test-out, HERS Index, Analysis of Energy Options, QA During Rehab



Typical Pre-Retrofit Issues

- Neglected coils
- Leaky return and supply plenums
- Poorly sealed AHU closets
- Restricted return air flow
- High levels of duct leakage
- Missing & compressed attic insulation
- Large wall penetrations
- Windows unable to fully close
- Porches and garages converted to living space



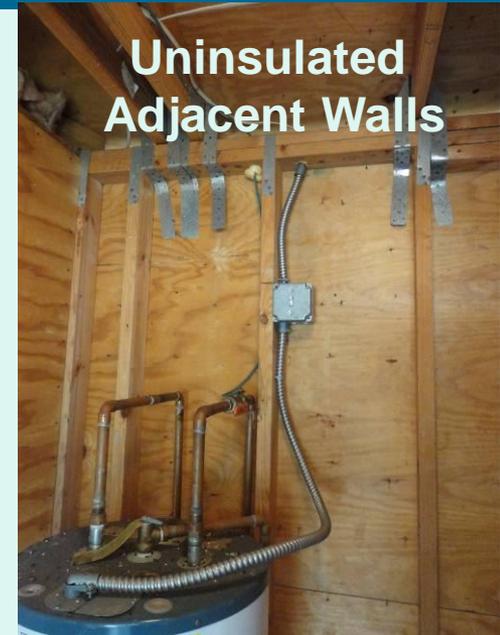
Pre-Retrofit Example

- 1250 ft², 1960 3 bed/2 bath
- Central Florida
- Slab on grade, block construction
- Test-In HERS Index 178
- Target HERS Index 89
- **Projected 50% Improvement**
 - Attic insulation, window and HVAC replacement, appliances, & lighting



Pre-Retrofit Example

- 1373 ft², 2003 3 bed/2 bath
- South Florida
- Slab on grade, frame construction
- Test-In HERS Index 97
- Target HERS Index 63
- **Projected 35% Improvement**
 - HVAC, HP water heater, window film, appliances, lighting



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

66

**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.

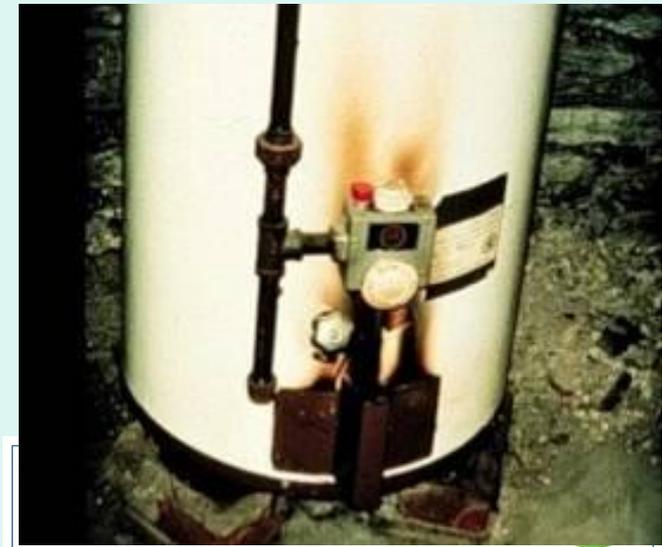
RESNET®
 www.resnet.us

Typical Elements of Deep Retrofit Improvement Package

- **Typically concrete block, slab on grade, single story homes**
- **Mechanical system**
 - Adequate return air pathways
 - Passive outside air ventilation
 - If not replacing - complete system service and duct sealing
 - If replacing
 - Properly sized SEER 15 heat pump (straight cool in south florida)
 - Sealed and tested ducts
- **Water heating systems**
 - Solar, tankless gas, or heat pump water heaters
- **Lighting and Appliances**
 - Energy star appliances, fans, and windows
 - High performance window film, if not replacing
 - Compact fluorescent light bulbs
- **Insulation and Air Sealing**
 - R-38 attic insulation
 - Air sealing measures
 - Roof & exterior finish: light or white finishes
 - Thermal bypass and other inspections in gut rehab

Post-Retrofit Issues: Pressure Differences

- The house CAN get worse
 - Quality assurance is **CRITICAL**
- Pressure dynamics can cause potentially deadly conditions and severe moisture damage
- Training for remodeling and heating/cooling labor is **CRITICAL**
- Drivers
 - Inadequate return air pathways
 - Duct leakage
 - Uncontrolled air flow



Post-Retrofit Issues: Mechanical Equipment Installation

- Small, Poorly Sealed AHU Closets & Leaky Return and Supply Plenums
 - Pressure Issues
 - Longer Run Times
- Over Sized Equipment
 - Pressure Issues
 - Shorter Run Times
 - Humidity

*Holes connecting
AHU closet to attic*

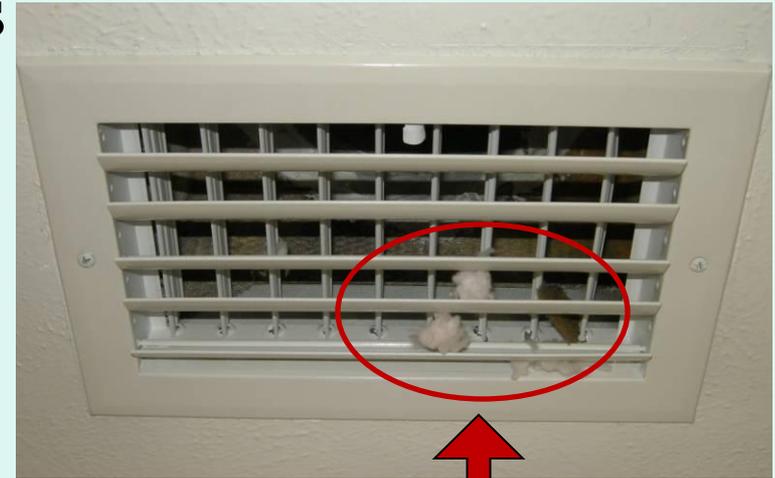


*Unsealed joints in
return plenum*



Post-Retrofit Issues: Ducts & Ceiling Insulation

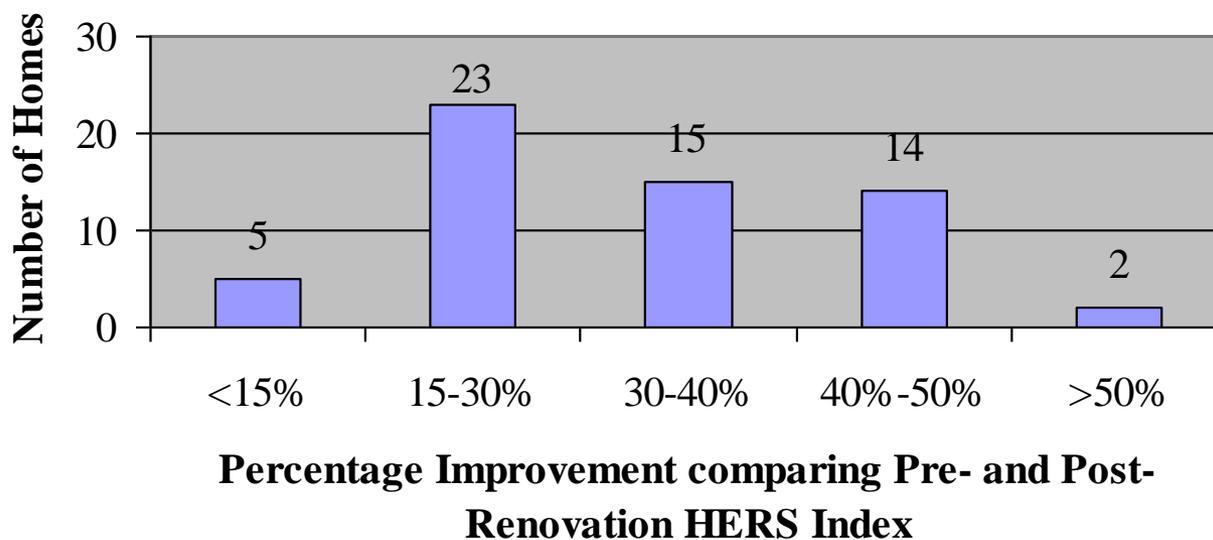
- Unsealed/Poorly Sealed Ducts
- Ducts Buried by Insulation



Insulation pulled from
attic, through supply
register during
depressurization test

- Blocked Attic Ventilation in Low-Pitched Roofs

Energy Efficiency Improvement Levels in 59 Homes Existing Homes



- What savings can be achieved?
 - Goal 30-50+% savings = 21 Houses
 - 15-30% = 23 Houses

Retrofit Case Study: Sarasota Home

U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy



Retrofit Case Study: Sarasota Home

U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy



- Concrete block, slab on grade
- Built in 1967, 1190 ft², 2 bedroom, 2 bath

New HVAC System

Pre-retrofit



SEER 8.7, HSPF 6.75 Heat Pump with
better than typical duct leakage
($q_{n,out} = 0.05$)

Post-retrofit



SEER 15, HSPF 8.8 Heat Pump with
sealed ducts
($q_{n,out} = 0.02$)

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

Post-retrofit



LR side of AHU closet

Mysterious return plenum



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**

Pre-retrofit

Windows

Post-retrofit



Major Infiltration Reduction

New *Windows Exceed EnergyStar®*
U-Value = 0.47, SHGC = 0.37

Note angle of window in 'closed' position

Ceiling Insulation

Insulated to R - 30

Pre-retrofit



Post-retrofit



Note: Image from alternate house

Pre-retrofit



Post-retrofit



“White/Light” Shingles & Exterior

U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy



- Cooling and Heating System
 - SEER 15, HSPF 8.8 Heat Pump, sealed ducts
- Envelope
 - Replace single pane metal windows with Energy Star rated
 - Infiltration reduction (repair holes in drywall, AHU closet)
 - Ceiling insulation increased to R-30
 - “White/Light” Exterior Paint
- Appliances & Lighting:
 - Energy Star® refrigerator & dishwasher
 - Fluorescent lighting (CFLs) in 13 fixtures
- Total Cost of Features impacting energy efficiency = \$19,939
- Incremental Cost for Higher Efficiency choices = \$3,958

Cash Flow Analysis

Goal: Positive First Year Cash Flow

	Total First Cost	Annual Cost (7%, 30 yr mortgage) & Energy Savings
Actual Cost for Efficiency Related Features¹	\$19,939	
Incremental Cost for Higher Efficiency Choices²	\$3,958	\$324
Estimated Annual Energy Cost Savings³		\$567
<i>Net 1st year cash flow to owner</i>		<i>\$254</i>

¹ Cost for bath fixtures, interior doors and paint, cabinets, etc are excluded.

² For example, choosing a SEER 15 heat pump instead of a SEER 13 unit.

³ Based on \$0.13/kWh.

In summary

- Deep energy improvement is possible
 - Cost effectiveness based on preliminary cash flow analysis
 - Off the shelf technology
 - Current labor pool
 - Must be done thoughtfully
 - Awareness of risks
 - Quality control practices
 - Carbon monoxide poisoning
 - Moisture failure and other durability issues
- Next step – implement a standardize package of improvements with new partners

Retrofitting 3% of the Homes per Year

(3% of the existing 6.2 million existing single-family homes = 186,000)

**Savings
Per Year**



\$1,536
Household



\$285 Million
Statewide



1.05 Million
Tons of CO₂

**Economic
Activity
Per Year**



\$3.8 Billion
Economic
Activity



42,026
Direct Jobs



15,282
Indirect Jobs