High Performance Existing Homes
Partnerships and Research

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A Research Institute of the University of Central Florida

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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
What is Building America?

- 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 is Building America?
High Performance Existing Homes Partners and Research

• 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

- Active Partnerships
- City of Lakeland
- South Sarasota Habitat for Humanity
- Palm Beach County Habitat for Humanity
- Community Enterprise Investments, Inc.

- Developing Partnerships
- Dwell Green
- Lake Sumter Habitat for Humanity
- Seminole County Habitat for Humanity
- Brevard County
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

- Exterior Supply Duct
- Limited headroom
- New ducts needed
- Very poor condition

~5’ at peak
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

1352 Hartsdale Street
New Port, FL 34287

HERS® Index

More Energy

150

140

130

120

110

Pre-Retrofit

Existing Homes

Standard New Home

100

90

80

70

60

50

40

30

20

10

0

Less Energy

Worldwide Leasing Energy Efficiency

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

Annual Estimates*

<table>
<thead>
<tr>
<th>Pre</th>
<th>Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>11,700 kWh</td>
<td>7,477 kWh</td>
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<tr>
<td>6.91 Tons CO₂ Emissions</td>
<td>4.0 Tons CO₂ Emissions</td>
</tr>
</tbody>
</table>

Savings: 36%

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

*Based on standard operating conditions

Deemed Energy Efficient Home
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
- Blocked Attic Ventilation in Low-Pitched Roofs

Insulation pulled from attic, through supply register during depressurization test.
Results

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

- Concrete block, slab on grade
- Built in 1967, 1190 ft², 2 bedroom, 2 bath
SEER 8.7, HSPF 6.75 Heat Pump with better than typical duct leakage (qn,out = 0.05)

SEER 15, HSPF 8.8 Heat Pump with sealed ducts (qn,out = 0.02)
**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.
AHU Closet Sealing, Return Plenum Sealing, **Drywall Repair**, New Windows

Plumbing access panel & miscellaneous drywall penetrations were repaired.
AHU Closet Sealing, Return Plenum Sealing, Drywall Repair, **New Windows**

Pre-retrofit

Post-retrofit

Note angle of window in ‘closed’ position

**Major Infiltration Reduction**

New Windows Exceed EnergyStar®

*U-Value = 0.47, SHGC = 0.37*
Ceiling Insulation

Insulated to R - 30

Pre-retrofit

Post-retrofit

Note: Image from alternate house
EnergyStar® Appliances & CFLs

Pre-retrofit

Post-retrofit
“White/Light” Shingles & Exterior

U.S. DEPARTMENT OF ENERGY
Energy Efficiency & Renewable Energy

[Image of a house with red exterior and white shingles]

[Image of a house with yellow exterior]

Building America
U.S. Department of Energy

Partnership for Improved Residential Construction
BA PIRC
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

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

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