Energy Efficiency

The First Priority in Solving Energy Issues

Rob Vieira, Director, Buildings Research

A Research Institute of the University of Central Florida
Building energy is 27% of average per person carbon emissions

More than transportation!

Five times as much as our own energy source (food!)
Use past research funded by DOE and utilities to guide direction.

Assist local governments and non-profits in performing retrofits to housing stock.

Leverage new funds from USDOE’s Building America program for new research and implementation efforts.
Where energy is used

Methodologies

- Field Research/Implementation with counties/cities
- Run Simulations to estimate savings
- Laboratory Research
  - New flex lab buildings
Opportunity met with FESC

- Government Partners
  - Sarasota (City & County)
  - Brevard County
  - Orange County
  - Alachua County
  - Volusia County (Potential Partner)
Non Profits

- Habitat for Humanity International
  - 3 Site “Weatherization” Pilot – Dallas, Chicago, and Philadelphia
  - NSP2 Proposal - 4 Florida sites

- HFH Partners Participating in NSP1
  - HFH Broward County (FL)
  - HFH of Lakeland FL
  - Sarasota HFH
How it works

- Counties purchase houses (NSP, HOME, or other funds)
- Counties Renovate or Partner with Non-profits who Renovate
- Houses returned to market
- Building America Goal
  - Cost effectively reach
  - DOE’s Builders Challenge
    - HERS Index of 70
    - Mandatory Quality Criteria
    - 3rd party certification
Building America Program

- Homes that use less energy
- Improve indoor air quality and comfort – reduce home issues... increase owner satisfaction and living environment
- Efficient home-building process
- Implement innovative energy- and material-saving technologies
- Dramatically increase the energy efficiency of existing homes
E-Scale and
The Builders Challenge

U.S. Department of Energy
EnergySmart Home Scale℠

Estimated annual energy usage:
Electric (kWh) 11,634
Natural Gas (therms) 13.3
Conditioned floor area (sq. ft.): 2,630

Meets The Builders Challenge
Recognizing the best energy performance—quality, comfort, health and safety in the market.

Poor Energy Performance
150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0

Typical existing home
Typical new home
Builders Challenge (70 or lower)

Best Energy Performance
Net Zero Energy Home

1423 Eastove Loop,
Winter Garden, FL 34787
Rated by BAUHP™
Florida Solar Energy Center
Rating conducted May 6, 2008
08FL6400000000227

Castle & Cooke Florida, Ltd.
BAIHP is estimated to save over $14,000,000/yr
168,000+ homes
Now DOE is looking at existing homes – can we achieve good energy efficiencies here too?
Current housing stock is often far less efficient than new homes.

We’re in the fact finding stage – modeling 1960’s, 1970’s, 1990’s and 2000’s built homes to:

- Determining basic home envelopes
- Modeling efficiencies to determine best energy efficient scenarios
“Scoring” existing homes

Typical Existing Homes HERS Indices

1960’s ~175

1970’s ~150

1990’s ~120

2000’s ~100

U.S. Department of Energy
EnergySmart Home Scale℠

- Estimated annual energy usage: Electric (kWh) 9533
- Estimated energy cost: Annual: $1240
- Conditioned floor area (sq. ft): 2054

3384 Soft Breeze Circle, Melbourne, FL 32904
Rated by Florida Solar Energy Center
Rating conducted April 20, 2005

www.buildingamerica.gov/challenge
Why look at existing homes?

- 108 million homes
- Low hanging fruit:
  - Cost-effective measures can be implemented
  - Put subcontractors to work
Find the Problems

- Existing Housing Typical Challenges
  - Combustion safety
  - Mold, rot, wet materials
  - Asbestos, unsafe electrical, lead paint
  - Broken equipment, appliances, windows, pipes
  - Worn out roof, flooring, fixtures, cabinets

- Financial challenge
  - Improvement Cost vs Selling Price
    - Homes will be sold to buyers at 50% AMI
    - Sale price = Purchase + Repairs
    - Little money left for efficiency improvements
    - FSEC will provide analysis of improvements
Hypothetical Existing Homes Analysis

- For 4 Hypothetical Houses
  - 1960’s, 1970’s, 1990’s Large, 1990 Medium
- Characterized “Typical” Existing Homes
  - Energy audits, past research, historic code requirements, input from realtors
- Characterized “Typical” Improvement Level
  - Market ready with minimum investment
- Developed Builders Challenge Package
- Reviewed with Each Partner
## Hypothetical 1966 Existing Home Analysis

### As-Found Characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof</td>
<td>Dark color, past useful life</td>
<td>Absortance = 0.92</td>
</tr>
<tr>
<td>Exterior Walls</td>
<td>Concrete Block, Medium Color</td>
<td>Absortance = 0.75</td>
</tr>
<tr>
<td>Ceiling Insulation</td>
<td>Minimal Insulation</td>
<td>R –11</td>
</tr>
<tr>
<td>Windows</td>
<td>Single, clear glass</td>
<td>U value 1.2, SHGC 0.8</td>
</tr>
<tr>
<td>Floors</td>
<td>70/30 Carpet/vinyl</td>
<td>0</td>
</tr>
<tr>
<td>Heating System</td>
<td>Electric Heat Strip</td>
<td>COP 1</td>
</tr>
<tr>
<td>Cooling System</td>
<td>Straight cool, need replacement</td>
<td>SEER = 10</td>
</tr>
<tr>
<td>Ducts/Return</td>
<td>Leaky ducts – unsealed return plenum</td>
<td>QN = 0.2</td>
</tr>
<tr>
<td>Water Heater</td>
<td>Old, electric</td>
<td>EF = 0.81</td>
</tr>
<tr>
<td>Lighting</td>
<td>100% incandescent lighting</td>
<td>N/A</td>
</tr>
<tr>
<td>Appliances</td>
<td>Old and need replacement</td>
<td>N/A</td>
</tr>
<tr>
<td>Infiltration</td>
<td>Very leaky</td>
<td>ACH50=13</td>
</tr>
</tbody>
</table>

E-Scale = 175 and annual energy costs of $2179
## Typical 1966 Existing Home Analysis

### Typical Investor Improvements

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof</td>
<td>New Dark or Medium Shingles</td>
<td>Absorptance = 0.92</td>
</tr>
<tr>
<td>Exterior Walls</td>
<td>New Medium Paint</td>
<td>Absorptance = 0.75</td>
</tr>
<tr>
<td>Ceiling Insulation</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Windows</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Floors</td>
<td>New vinyl and carpet</td>
<td>--</td>
</tr>
<tr>
<td>Heating System</td>
<td>New Elec Resistance</td>
<td>COP = 1</td>
</tr>
<tr>
<td>Cooling System</td>
<td>New Straight Cool</td>
<td>13 SEER</td>
</tr>
<tr>
<td>Ducts/Return</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Water Heater</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Lighting</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Appliances</td>
<td>New Typical Appliances</td>
<td>Default Efficiency</td>
</tr>
<tr>
<td>Infiltration</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
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**Estimated Cost of Retrofit** = $\sim15,208

**E-Scale** = 144 and annual energy cost of $1,838 ($341 savings)
Now... identify priorities for energy efficiency improvement...

- New A/C?
- Attic Insulation?
- High efficiency Windows?
- Reflective roofing?
- Solar hot water?
- Ceiling fans?
- Seal ducts?
- Weatherizing?
Select alternatives

- Improve household element from top to bottom
- But include flexibility

Choose from a list:
Eg. Roof/hot climate
- Radiant barrier with attic ventilation
- More insulation
- Reflective surfaces with sealed attic & deck insulation
## Typical 1966 Existing Home Analysis

### Builders Challenge Improvement Package

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof</td>
<td>Choose Light Color Shingle</td>
<td>Absorptance= 0.75</td>
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<tr>
<td>Ceiling Insulation</td>
<td>Add insulation to Reach</td>
<td>R – 30</td>
</tr>
<tr>
<td>Windows</td>
<td>New Energy Star Windows</td>
<td>U 0.40, SHGC 0.35</td>
</tr>
<tr>
<td>Floors</td>
<td>Replace Vinyl with Tile</td>
<td>Improved heat transfer</td>
</tr>
<tr>
<td>Heating System</td>
<td>New Heat Pump</td>
<td>HSPF 8.2</td>
</tr>
<tr>
<td>Cooling System</td>
<td>New Heat Pump</td>
<td>14 SEER</td>
</tr>
<tr>
<td>Ducts/Return</td>
<td>New Duct System</td>
<td>QN = 0.03</td>
</tr>
<tr>
<td>Water Heater</td>
<td>New Electric Tank + ICS Solar DWH</td>
<td></td>
</tr>
<tr>
<td>Lighting</td>
<td>75% CFL</td>
<td>--</td>
</tr>
<tr>
<td>Appliances</td>
<td>New EnergyStar Refrigerator &amp; Dishwasher</td>
<td></td>
</tr>
<tr>
<td>Infiltration</td>
<td>Seal Exterior Envelope</td>
<td>ACH50 = 6</td>
</tr>
<tr>
<td>Ventilation</td>
<td>Passive Runtime Ventilation System</td>
<td>30cfm</td>
</tr>
</tbody>
</table>

Estimated INCREMENTAL Cost = $10,643  
E-Scale = 69 and annual energy cost of $809 ($1,029 incremental savings)
<table>
<thead>
<tr>
<th></th>
<th>First Cost</th>
<th>Annual Cost (7%, 30 yr mortgage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Incremental Cost</td>
<td>$10,643</td>
<td>$849</td>
</tr>
<tr>
<td>Estimated Annual Energy Savings (wrt typical)</td>
<td></td>
<td>$1,029</td>
</tr>
<tr>
<td>Net 1st Year Cash flow</td>
<td></td>
<td>$180</td>
</tr>
</tbody>
</table>
On-site data collection
Find the problems
Even newer homes have quality installation issues.

Floor joists open to attic

Infrared – Winter morning
Floor joist open to attic  

Infrared - Summer
Installation Deficiencies

Floor joist open to attic

Infrared - Summer
Installation Deficiencies

Kneewall batt installation

Infrared - Summer
Two identical residential scale buildings to be built at UCF's Cocoa facility.
Laboratory Work

- Each will be able to be reconfigured. Structure for supporting roof will be independent of thermal walls.
- Windows distributed on four sides
Laboratory Work

- Initial configuration:
  - Each will be set to typical 1960s residence.
  - One will be kept as control
  - Other will receive retrofits.

- Detailed monitoring plan consistent with BA NREL protocol.
Laboratory Work

- Later configurations:
  - Control set to Florida code
  - Experiment set to 50 - 70% efficiency improvement
Laboratory Work

- Experiments:
  - Windows
  - Walls
  - Floor Covering
  - Equipment combinations — HVAC/duct
  - Internal loads
Build the Energy Policies from the Bottom Up
Energy Efficiency

The First Priority in Solving Energy Issues

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