FLORIDA SOLAR ENERGY CENTER

Creating Energy Independence Since 1975

Energy Efficiency

The First Priority in Solving Energy Issues

Rob Vieira, Director, Buildings Research

A Research Institute of the University of Central Florida

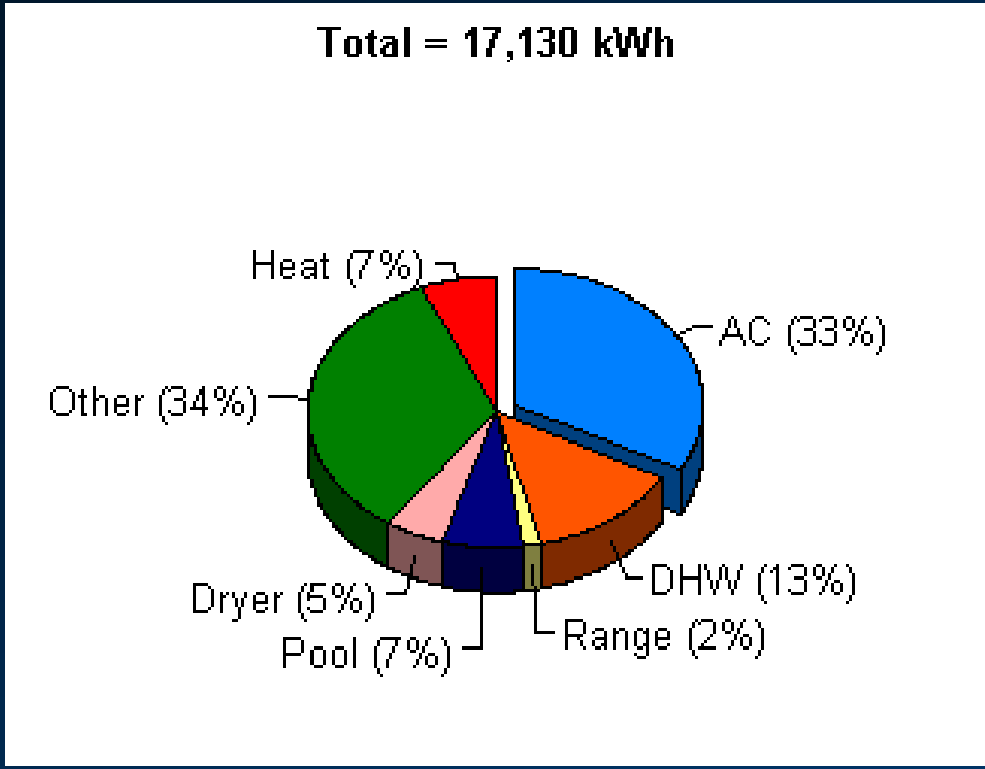
The big picture!

- Building energy is 27% of average per person carbon emissions
- More than transportation!
- Five times as much as our own energy source (food!)

Opportunity met with FESC

- 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



Reference Publication: Parker, D. S., "Research Highlights from a Large Scale Residential Monitoring Study in a Hot Climate. " Proceeding of International Symposium on Highly Efficient Use of Energy and Reduction of its Environmental Impact, pp. 108-116, Japan Society for the Promotion of Science Research for the Future Program, JPS-RFTF97P01002, Osaka, Japan, January 2002. (Also published as FSEC-PF369-02, Florida Solar Energy Center, Cocoa, FL.)

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)

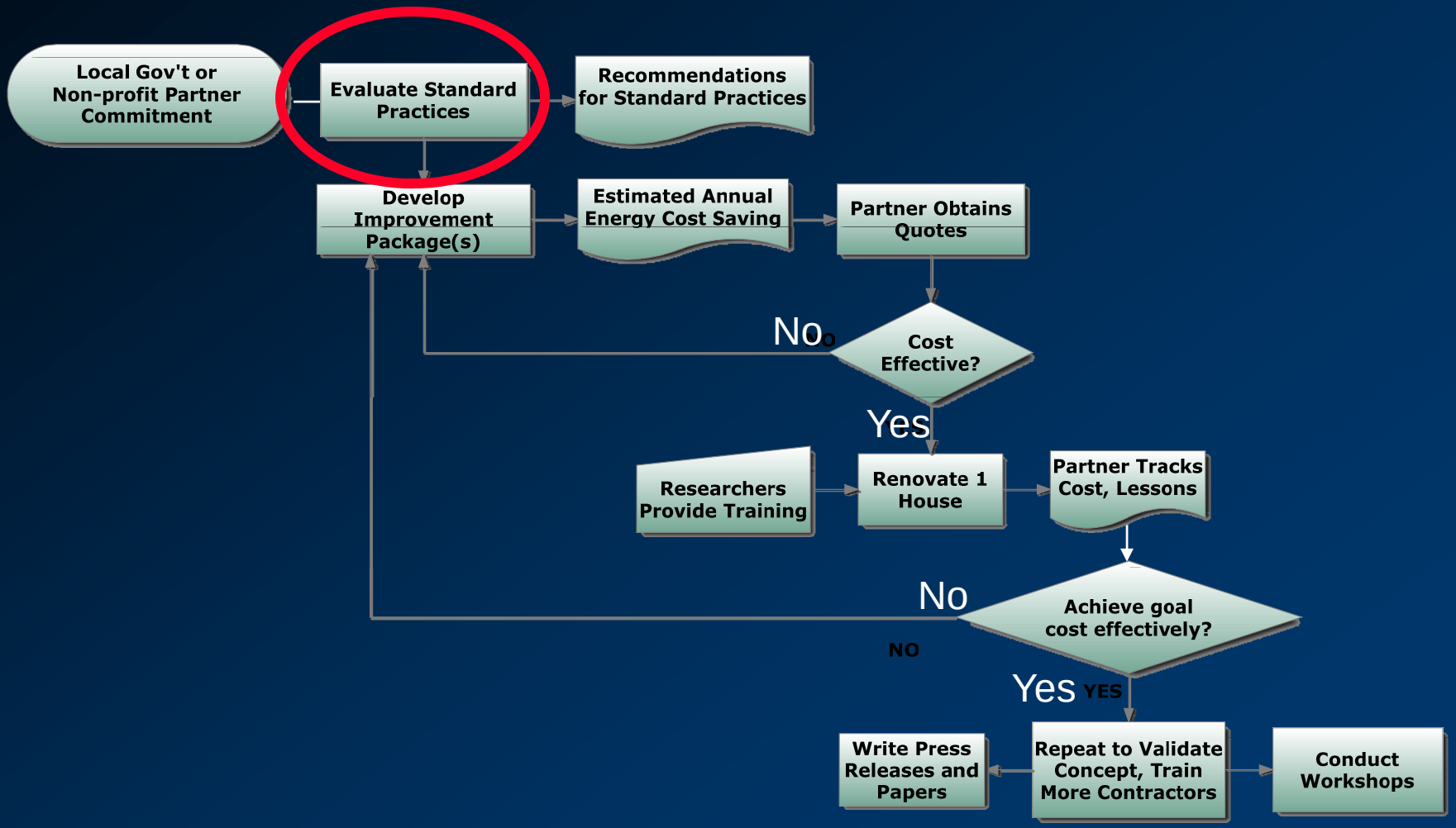
Opportunity met with FESC

- 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
    - http://www1.eere.energy.gov/buildings/challenge/

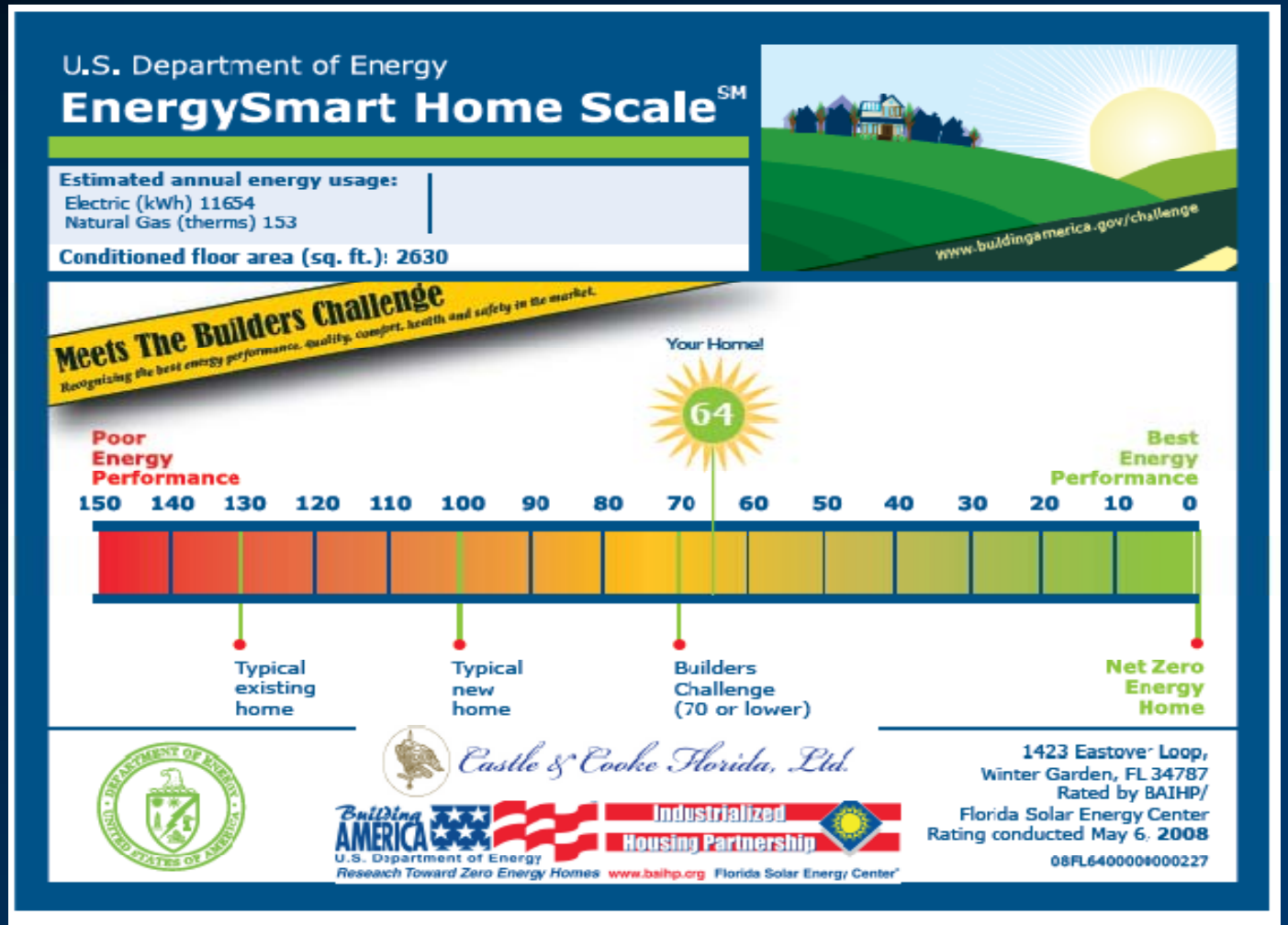
County Process



Building America Program

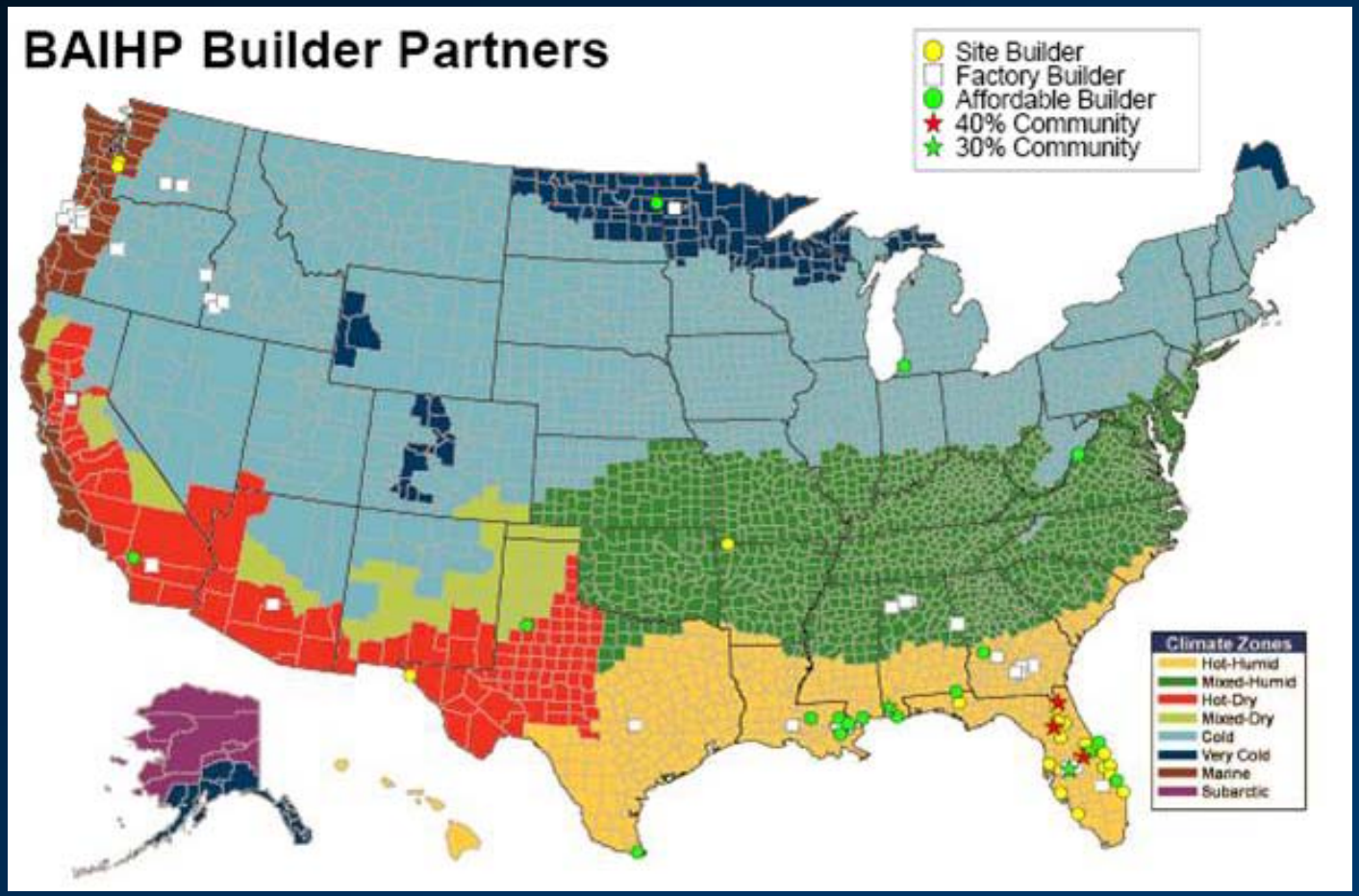
- Homes that use less energy
- Improve indoor air quality and comfort –reduce home issues…increase owner satisfaction and living environment
- Efficient home-building process
- Implement innovative energy- and material-saving technologies
- Dramatically increase the energy efficiency of existing homes

E-Scale and The Builders Challenge



BAIHP is estimated to save over $14,000,000/yr

168,000+ homes



Building America Program

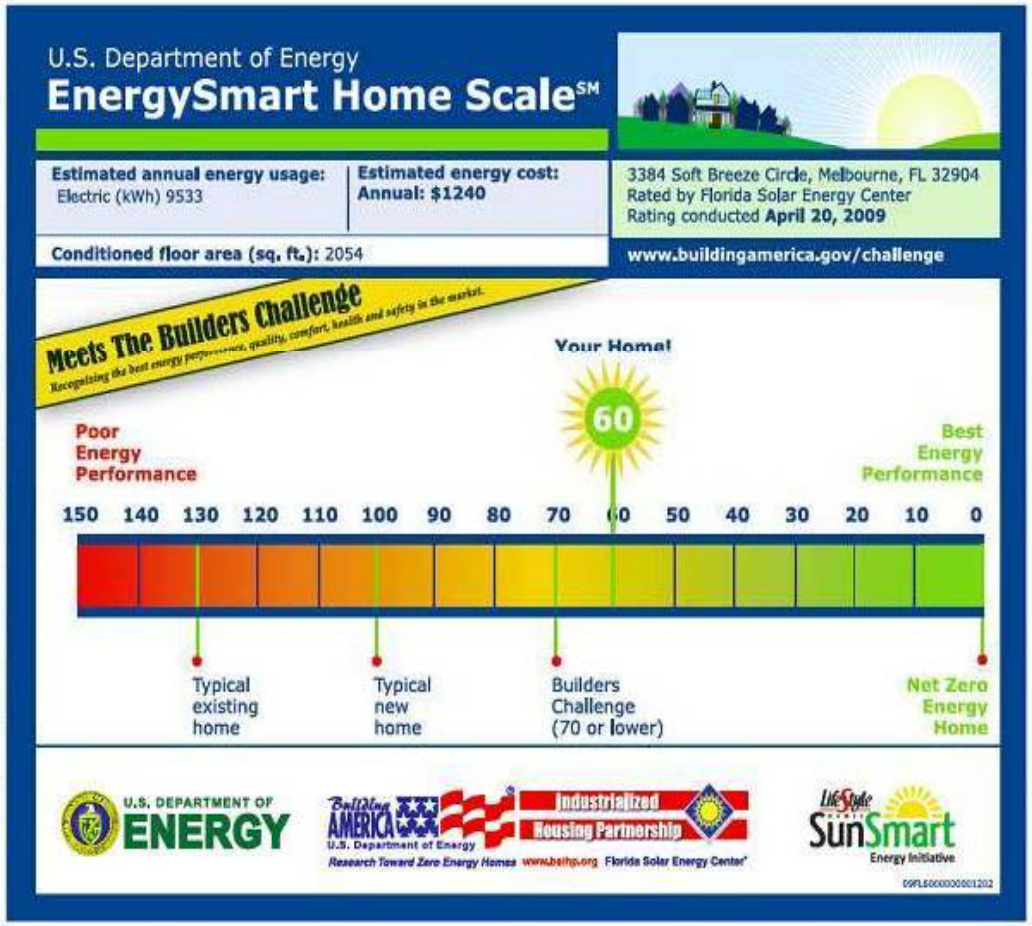
- Now DOE is looking at existing homes – can we achieve good energy efficiencies here too?

Retrofit Task

- 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



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

E-Scale = 175 and annual energy costs of $2179

Typical 1966 Existing Home Analysis

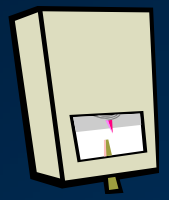
Typical Investor Improvements		
Parameter	**Description**	**Efficiency**
Roof	New Dark or Medium Shingles	Absorptance= 0.92
Exterior Walls	New Medium Paint	Absorptance = 0.75
Ceiling Insulation	--	
Windows	--	
Floors	New vinyl and carpet	
Heating System	New Elec Resistance	COP = 1
Cooling System	New Straight Cool	13 SEER
Ducts/Return	--	
Water Heater	--	
Lighting	--	
Appliances	New Typical Appliances	Default Efficiency
Infiltration	--	

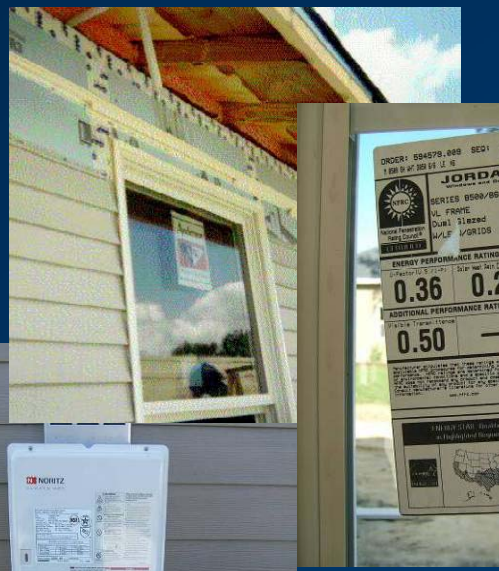
Estimated Cost of Retrofit = ~$15,208

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

Estimated INCREMENTAL Cost = $10,643

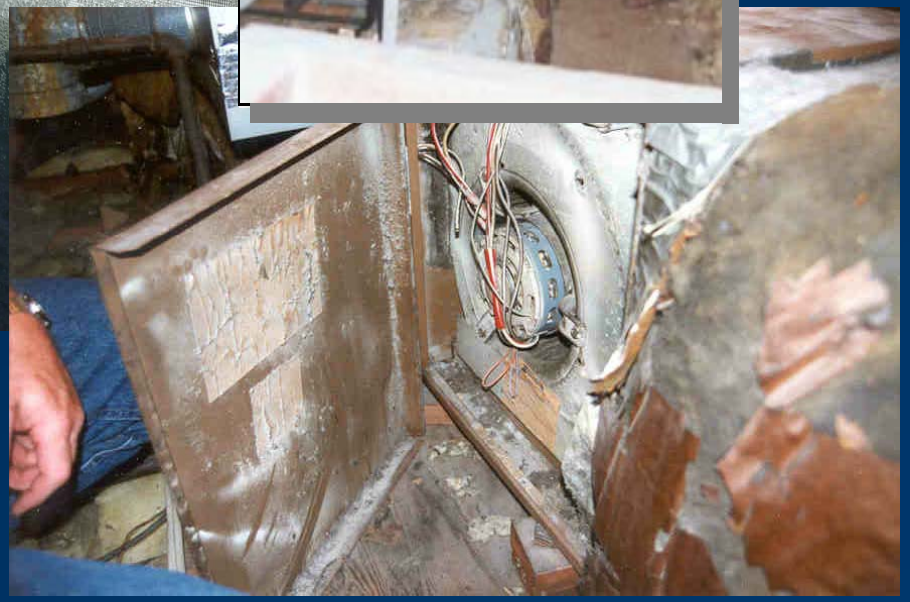
E-Scale = 69 and annual energy cost of $809 ($1,029 incremental savings)

First Year Cash Flow

	First Cost	Annual Cost (7%, 30 yr mortgage)
Total Incremental Cost	$10,643	$849
Estimated Annual Energy Savings (wrt typical)		$1,029
Net 1st Year Cash flow		$180

On-site data collection

Find the problems



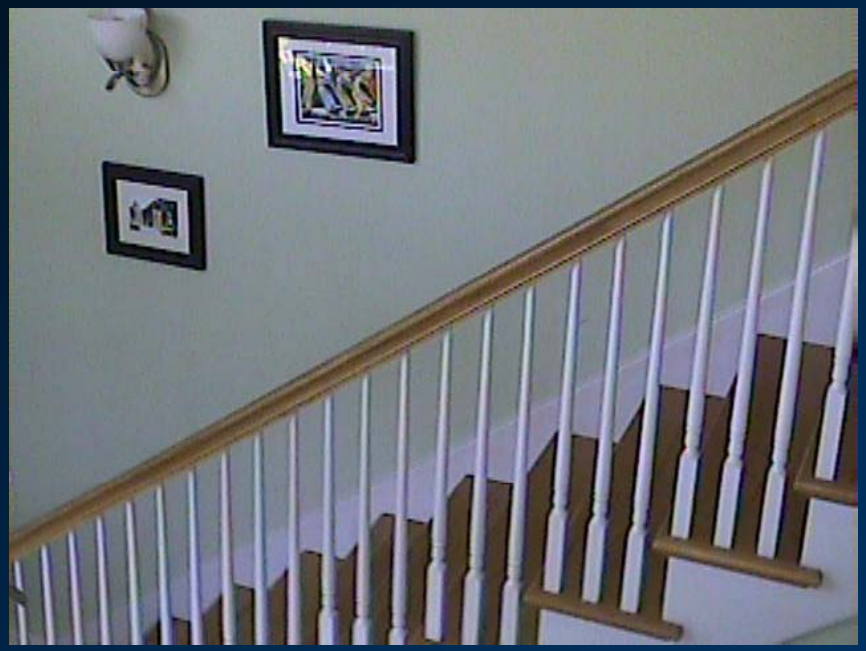
Even newer homes have quality installation issues

Floor joists open to attic

Infrared – Winter morning

Installation Deficiencies

Floor joist open to attic



Infrared -Summer

Installation Deficiencies

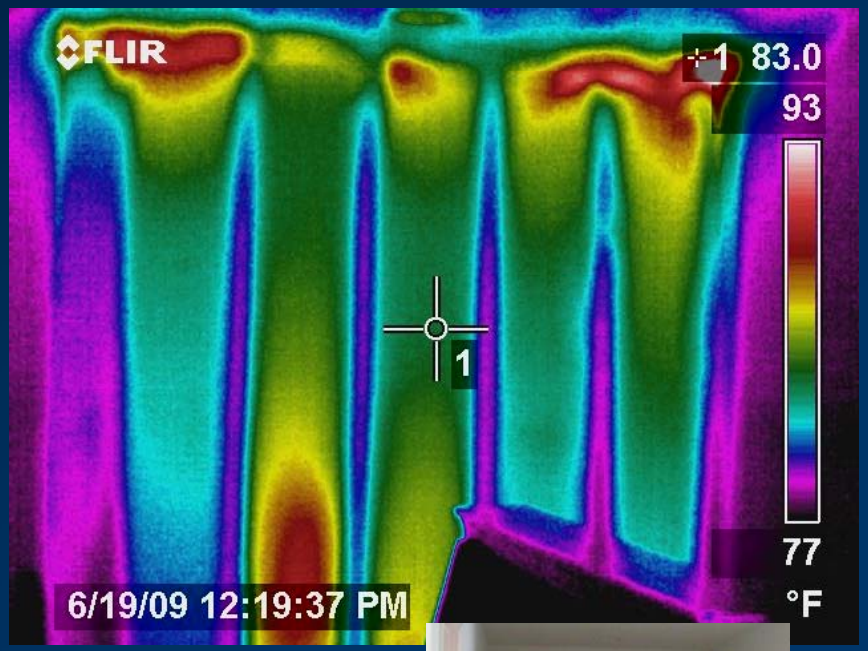
Floor joist open to attic

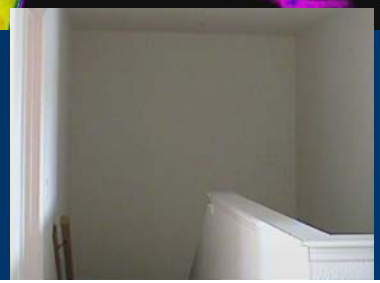
Infrared -Summer

Installation Deficiencies

Kneewall batt installation

Infrared -Summer





Laboratory Work

- 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.

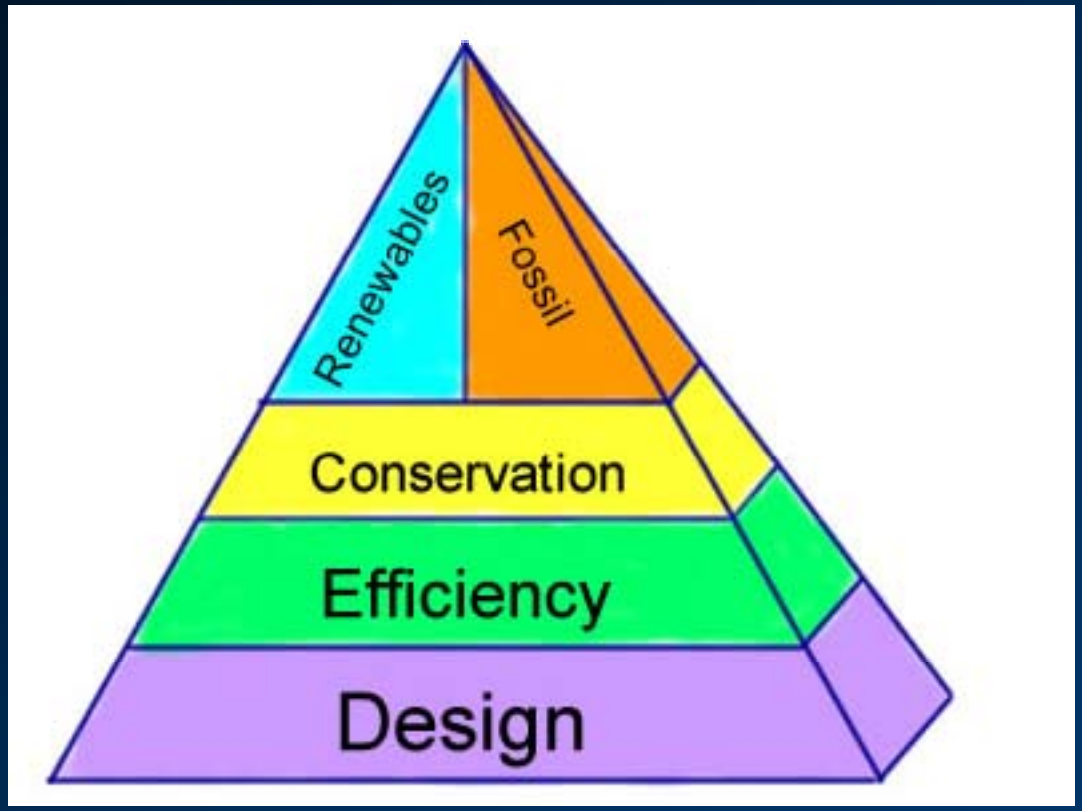
Laboratory Work

- 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

The Energy Policy Pyramid



Build the Energy Policies from the Bottom Up

FLORIDA SOLAR ENERGY CENTER

Creating Energy Independence Since 1975

Energy Efficiency

The First Priority in Solving Energy Issues

robin@fsec.ucf.edu

A Research Institute of the University of Central Florida