FLORIDA SOLAR ENERGY CENTER®

Creating Energy Independence

Measured Residential Energy Code-Related Energy Reduction in Florida

Charles Withers, Jr.

Building Energy Codes Conference 2016

March 23, 2016

Florida Residential Energy Code Study 2012

Do homes built to a newer energy code deliver measurable energy savings compared to homes built to a much earlier energy code?

Florida Residential Energy Code Study Sample

- US DOE Building Energy Code Program-resources
- Code era: 1985 “old” vs 2009 “new” (25 years)
- Single family detached 1,500-2,300 ft^2.
- Goal 44 homes each group; across Central FL
- Potential candidates from public databases; mail postcard invitation to participate in study.
- Owner occupied; no move or home change 1 yr.
- Sign homeowner agreement; $200 incentive

FORM 1100A-08

FLORIDA ENERGY EFFICIENCY CODE FOR BUILDING CONSTRUCTION

Florida Department of Community Affairs Residential Performance Method A

Project Name:
Street:
City, State, Zip:
Owner:
Design Location:

Builder Name:
Permit Office:
Permit Number:
Jurisdiction:

Residential Method A summary pg.

1. New construction or existing		New (From Plans)
2. Single family or multiple family		Single-family
3. Number of units, if multiple family		1
4. Number of Bedrooms		5
5. Is this a worst case?		Yes
6. Conditioned floor area (ft²)		2272
7. Windows	Description	Area
a. U-Factor: SHGC:	Dbl, U=0.60 SHGC=0.32	232.67 ft²
b. U-Factor: SHGC:	Sgl, U=1.17 SHGC=0.74	68.50 ft²
c. U-Factor: SHGC:	N/A	ft²
d. U-Factor: SHGC:	N/A	ft²
e. U-Factor: SHGC:	N/A	ft²

8. Floor Types	Insulation	Area
a. Slab-On-Grade Edge Insulation	R=0.0	1136.00 ft²
b. N/A	R=	ft²
c. N/A	R=	ft²

9. Wall Types	Insulation	Area
a. Frame - Wood, Exterior	R=11.0	1088.00 ft²
b. Concrete Block - Int Insul, Exterior	R=4.1	1073.30 ft²
c. Frame - Wood, Adjacent	R=11.0	205.33 ft²
d. N/A	R=	ft²

10. Ceiling Types	Insulation	Area
a. Under Attic (Vented)	R=30.0	1136.00 ft²
b. N/A	R=	ft²
c. N/A	R=	ft²

11. Ducts
a. Sup: Attic Ret: Attic AH: Interior Sup. R= 6, 406.4 ft²

12. Cooling systems
a. Central Unit — Cap: 39 kBtu/hr SEER: 14

13. Heating systems
a. Electric Heat Pump — Cap: 39 kBtu/hr HSPF: 8.2

14. Hot water systems
a. Electric — Cap: 50 gallons EF: 0.9

b. Conservation features
None

15. Credits — Pstat

Glass/Floor Area: 0.133

Total As-Built Modified Loads: 51.66
Total Baseline Loads: 65.26

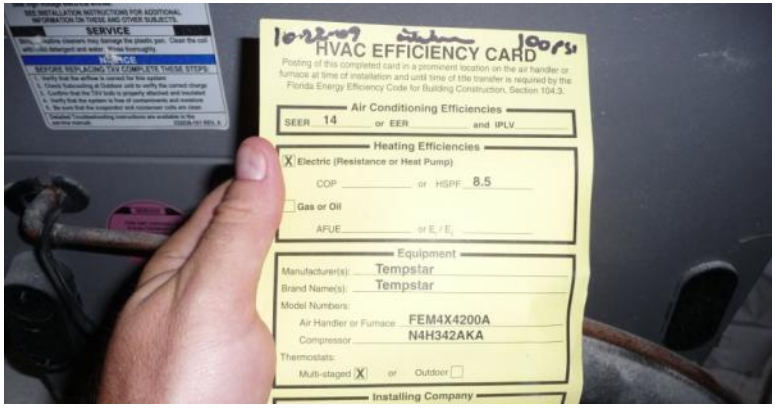
PASS

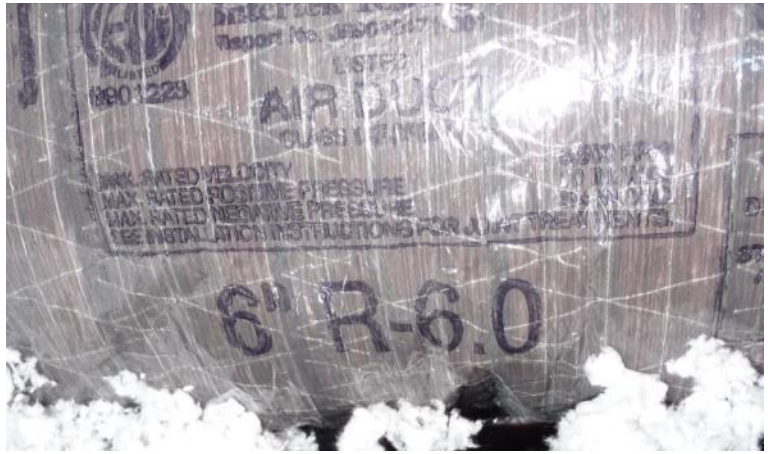
I hereby certify that the plans and specifications covered by this calculation are in compliance with the Florida Energy

Review of the plans and specifications covered by this

E-ratio = As-built/base
51.66/65.26
0.79
0.79<=0.85

Detailed Energy Audits Completed





Electric Energy Monitoring Installed

1) Whole House, 2) Space Heating, 3) Space Cooling, and 4) DHW

Results (% Savings New vs Old)

Analysis Method	Space Cooling	Space Heating	DHW	3 Combined
1 Measured available	4.4%	37%	9%	7%
2 Measured/model	12.3%	20.5%	5.2%	11.2%
3 Measured/model & Utility Billing	**12.8%**	**38.9%**	**5.2%**	**13.0%**

1-Measured available & normalized: several homes lacked full seasons

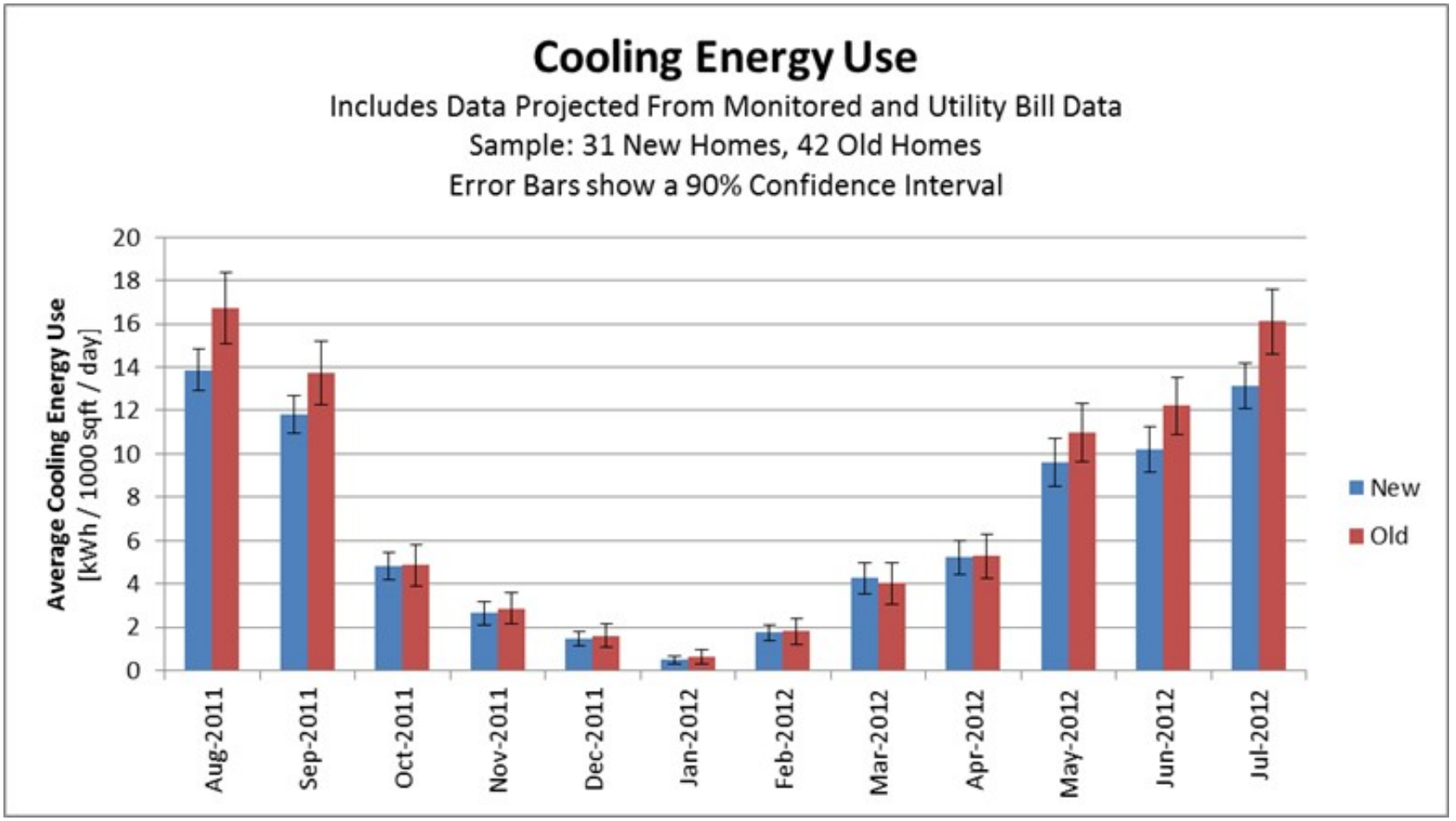
2-Model based on meas. vs temperature

3- Improved confidence particularly for heating; mild winter

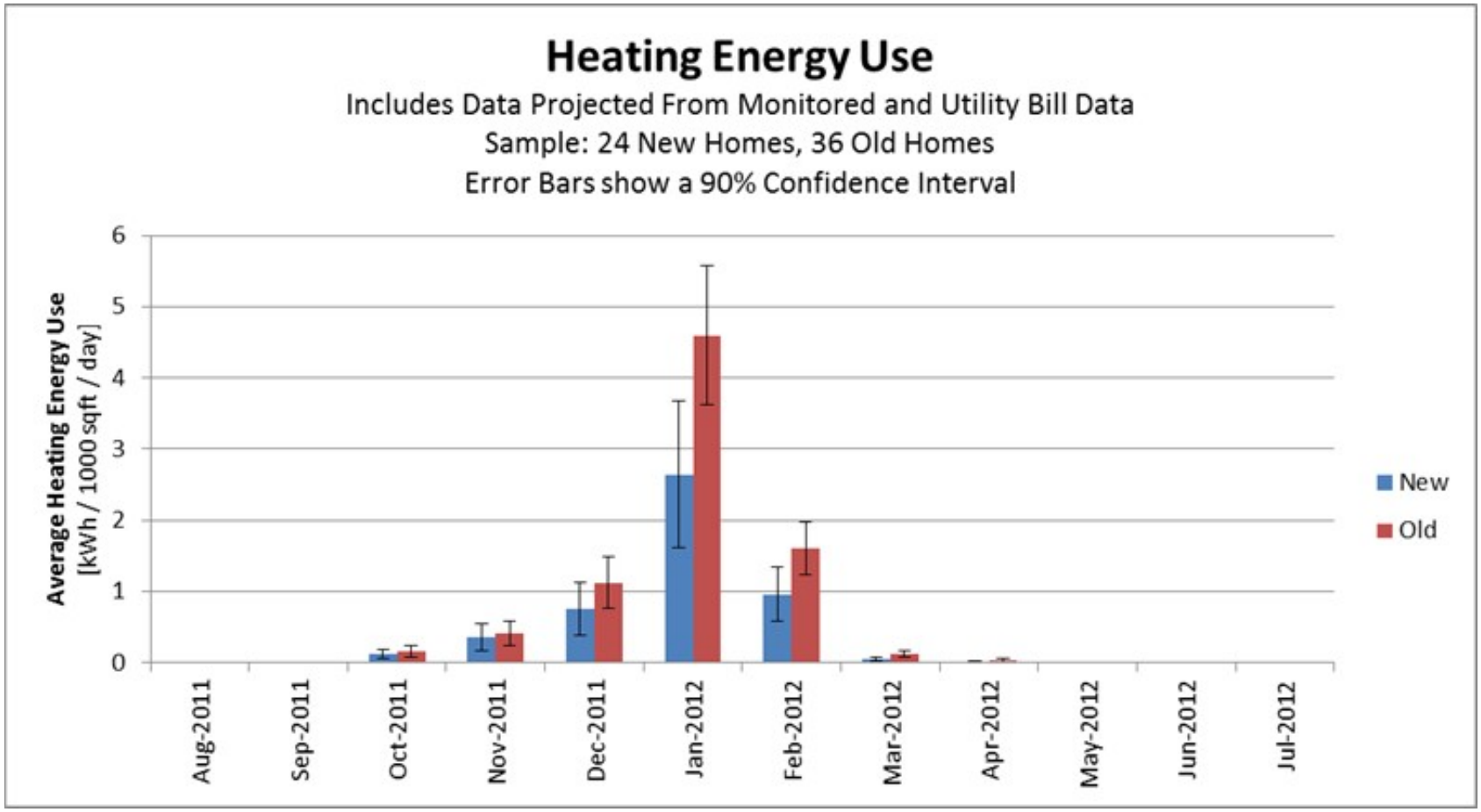
First Use Meas. data, then use model for missing periods;

If inadequate meas. data for model, then use utility data.

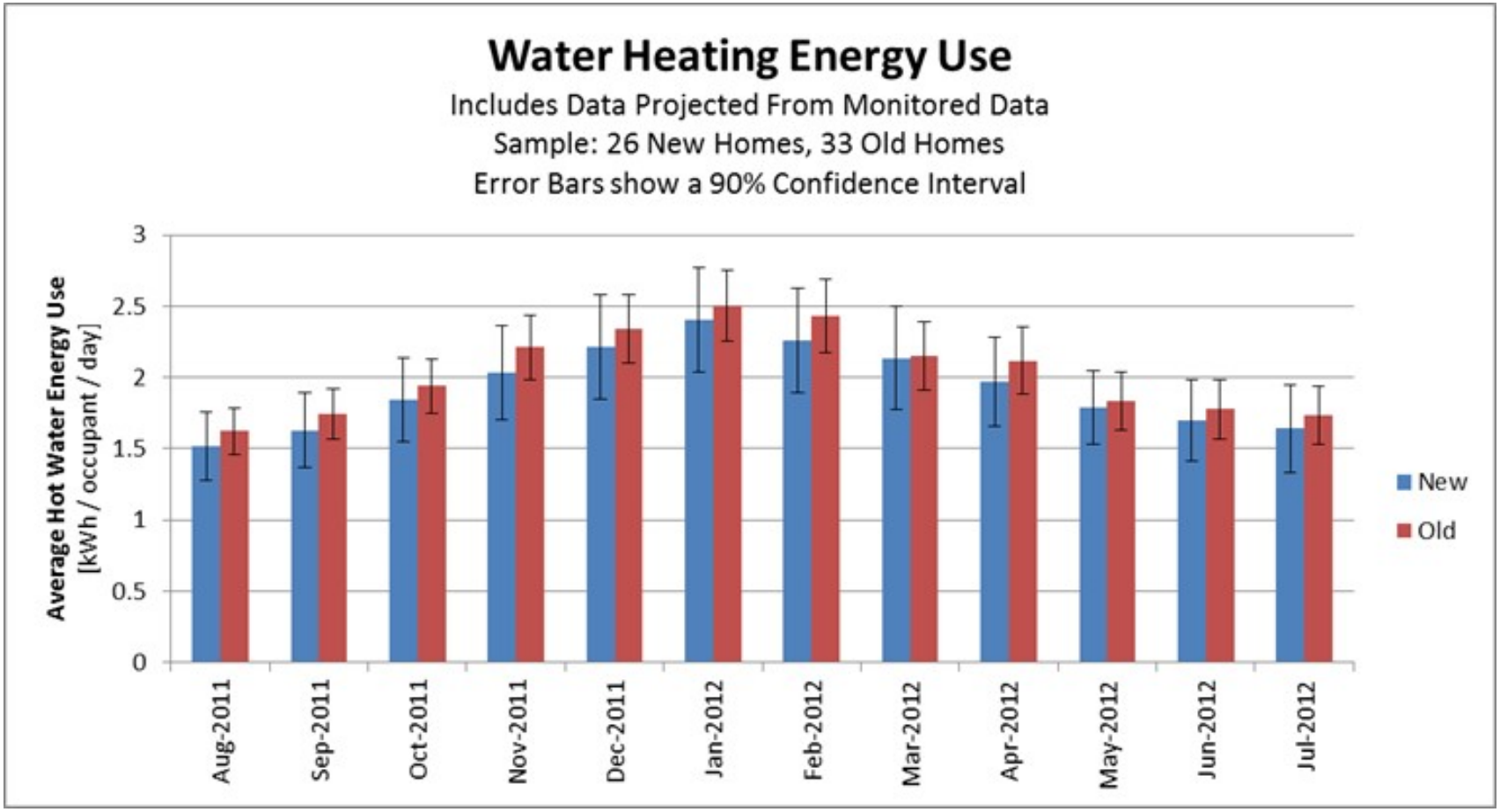
Method 3 Results



Method 3 Results



Method 3 Results



Why Were Measured Savings Low?

- Residential 1985 FL Code era “Old” vs 2010 era “New”
- Simulation 50% savings vs measured 13% savings

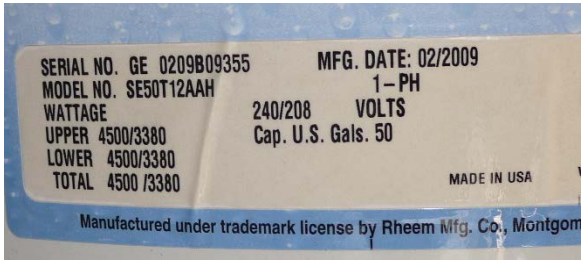
Simulation (Fairey, 2009) compared as-built min. code efficiency “old” to “new”.

"Old Home" vs "New Home" Envelope Efficiency (as found 2011)

	Averages	
	New	Old
Stories	1.1	1.1
Floor Area [ft^2]	1,829	1,833
Volume [ft^3]	16,137	15,305
Attic Insulation [R]	**31**	**24**
Single Pane Window [ft^2]	29	197
Double Pane Area [ft^2]	182	59
Infiltration (ACH50)	5.6	9.1

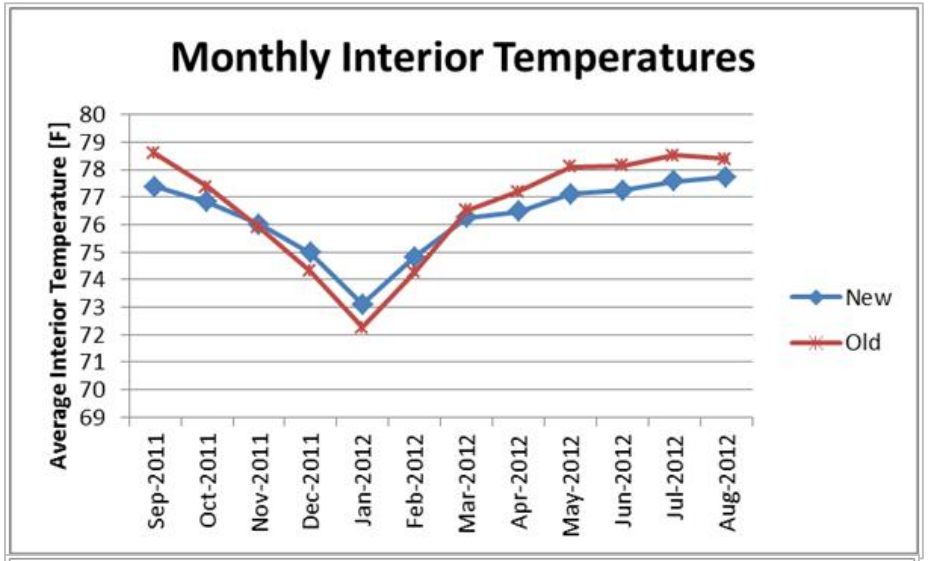
“Old Home” vs “New Home” Equipment Efficiency (as found 2011)

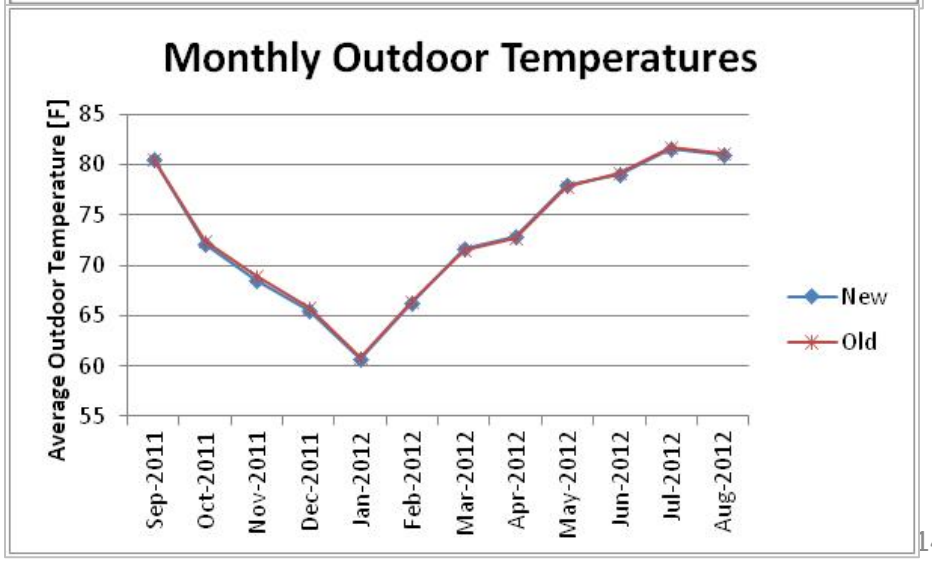
	Averages	
	New	Old
A/C Efficiency [SEER]	**14.1**	**12.9**
Electric Heat Pump [HSPF]	**8.3**	**7.6**
Electric Water Heater Efficiency	**0.92**	**0.92**
Gas Water Heater Efficiency	**0.66**	**0.64**
Number of Ceiling Fans	3.3	4.1
% Fluorescent Bulbs	26	13



“Old” vs “New” Indoor Temperature

Is there any behavioral aspect to indoor temperature set-point differences?





Adjusted Simulation to Match As-Found Qualities of "Old" Homes.

- Simulation inputs were modified to account for average "as-found" qualities in old code and new code homes in study.
- Equipment efficiency
- Interior summer temperatures
- Baseline loads*
  - New code study homes 14.8% higher than Old code group.

**energy use other than space heat/cool or DHW energy*

Adjusted Simulation to Match As-Found Qualities of "Old" Homes.

- Resulted in only 9.4% savings (instead of 50%).
- Much closer to the annual measured savings of 7%-13%.

Older Homes Became More Efficient Over Time

Old home behavior related impacts?

- Replaced old appliances with more efficient options (than lowest avail. Efficiency)
- More conservative heat & cool setpoints
- Added ceiling insulation
- Used less baseline energy
- Some window replacement.

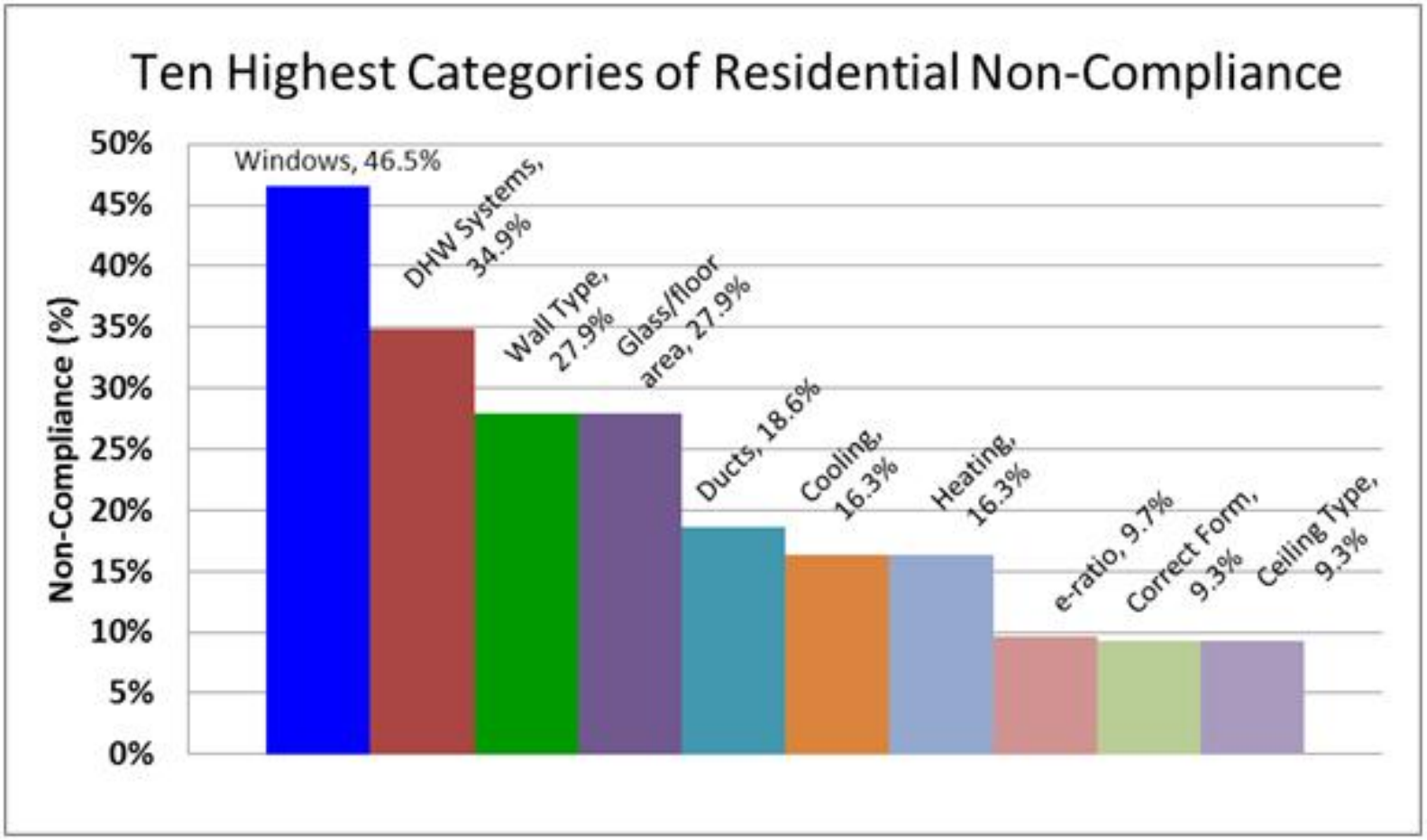
Some Influences on Implementation of Energy Efficiency/Conservation

- Increased awareness of benefits
- Increased energy cost
- Utility conservation programs and tax incentives
- Federal mandated minimum appliance efficiency standards
- Technological advances in efficiency

Impact of Non-Compliance in New code Homes

- New residential code (2009) compliance 90%.
  Performance Method
- Study did not measure impact of specific non-compliance items.
- However, specific items expected to have minor energy impact.
  (minimal impact ~ 1% energy impact in Florida study)
  Example: DHW EF 0.90 instead of EF=0.92

Florida 2009 Code Study Homes



Summary

- Sub-meter space heat energy high uncertainty improved using billing data
- Behavior matters
  - New homes used 14.8% more baseline energy (interior loads) (house kWh hr. interval)
  - New homes had less conservative set-points lower summer and higher winter

Summary

- Energy codes have had significant impacts.
- 50% energy reduction over 25 years is a reasonable expectation in Florida.
- Appliance efficiency standards and cost-effective conservation measures have resulted in significant energy-code related energy use reduction in older homes.

Thank You

Chuck Withers

chuck@fsec.ucf.edu

Search publications at:

www.fsec.ucf.edu

"Why Doesn't 25 Years of an Evolving Energy Code Make More of a Difference?"
By C. Withers Jr. and R. Vieira 2015.

"**A Comparison of Homes Built to the 2009 and 1984 Florida Energy Codes**".
By C. Withers, et. al 2012. FSEC-CR-1934-12