FLORIDA SOLAR ENERGY CENTER®

Creating Energy Independence

RESNET HERS Index and the 2015 IECC

RESNET Building Performance Conference

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Philip Fairey

Overview

- EnergyGauge® USA v.2.8.05 analysis of HERS Index scores for the IECC Reference Design for 2006 – 2012 code cycles
- 1-story and 2-story, 3-bedroom home designs under best-case and worst-case orientations
- 16 TMY sites representing all 8 IECC climate zones
- Results used in development of Energy Rating Index (ERI) compliance values for 2015 IECC.

Base Home Characteristics

Component	1-sty	2-sty
1st floor area (ft2)	2,000	1,200
2nd floor area (ft2)	0	1,200
total floor area (ft2)	2,000	2,400
total volume (ft3)	18,000	21,000
N-S wall length (ft)	50	40
E-W wall length (ft)	40	30
1st floor wall height (ft)	9	8
height between floors (ft)	0	1.5
2nd floor wall height (ft)	0	8
door area ft2)	40	40

2006 Window Characteristics (Best-Case)

Component	1-sty	2-sty
window/floor area (%)	18%	18%
total window area (ft2)	360	432
window area per floor (ft2)	360	216
N-S window fraction (%)	35%	35%
E-W window fraction (%)	15%	15%

(Homes rotated 90 degrees for Worst-Case)

2009-2012 Window Characteristics (Best-Case; same in 2015)

Component	1-sty	2-sty
window/floor area (%)	15%	15%
total window area (ft2)	300	360
window area per floor (ft2)	300	180
N-S window fraction (%)	35%	35%
E-W window fraction (%)	15%	15%

(Homes rotated 90 degrees for Worst-Case)

2006 Envelope Values
Climate Zones 1-3

LOCATION	IECC CZ	Ceiling R-value	Wall R-value	Found. Type	Slab R-value	Floor R-value	Window U-factor	Window SHGC
Miami, FL	1A	30	13	SOG	none	n/a	1.20	0.40
Orlando, FL	2A	30	13	SOG	none	n/a	0.75	0.40
Houston, TX	2A	30	13	SOG	none	n/a	0.75	0.40
Phoenix, AZ	2B	30	13	SOG	none	n/a	0.75	0.40
Charleston, SC	3A	30	13	crawl	n/a	19	0.65	0.40
Charlotte, NC	3A	30	13	crawl	n/a	19	0.65	0.40
Ok. City, OK	3A	30	13	crawl	n/a	19	0.65	0.40
Las Vegas, NV	3B	30	13	Crawl	n/a	19	0.65	0.40

2009 Envelope Values
Climate Zones 1-3

LOCATION	IECC CZ	Ceiling R-value	Wall R-value	Found. Type	Slab R-value	Floor R-value	Window U-factor	Window SHGC
Miami, FL	1A	30	13	SOG	none	n/a	1.20	0.30
Orlando, FL	2A	30	13	SOG	none	n/a	0.65	0.30
Houston, TX	2A	30	13	SOG	none	n/a	0.65	0.30
Phoenix, AZ	2B	30	13	SOG	none	n/a	0.65	0.30
Charleston, SC	3A	30	13	crawl	n/a	19	0.50	0.30
Charlotte, NC	3A	30	13	crawl	n/a	19	0.50	0.30
Ok. City, OK	3A	30	13	crawl	n/a	19	0.50	0.30
Las Vegas, NV	3B	30	13	Crawl	n/a	19	0.50	0.30

2012 (& 2015) Envelope Values Climate Zones 1-3

LOCATION	IECC CZ	Ceiling R-value	Wall R-value	Found. Type	Slab R-value	Floor R-value	Window U-factor	Window SHGC
Miami, FL	1A	30	13	SOG	none	n/a	0.50	0.25
Orlando, FL	2A	38	13	SOG	none	n/a	0.40	0.25
Houston, TX	2A	38	13	SOG	none	n/a	0.40	0.25
Phoenix, AZ	2B	38	13	SOG	none	n/a	0.40	0.25
Charleston, SC	3A	38	13+5	Crawl	n/a	19	0.35	0.25
Charlotte, NC	3A	38	13+5	Crawl	n/a	19	0.35	0.25
Ok. City, OK	3A	38	13+5	Crawl	n/a	19	0.35	0.25
Las Vegas, NV	3B	38	13+5	Crawl	n/a	19	0.35	0.25

2006 Envelope Values
Climate Zones 4-8

LOCATION	IECC CZ	Ceiling R-value	Wall R-value	Found. Type	Slab R-value	Floor R-value	Window U-factor	Window SHGC
Baltimore, MD	4A	38	13	crawl	n/a	19	0.40	0.40
Kansas City, MO	4A	38	13	crawl	n/a	19	0.40	0.40
Chicago, IL	5A	38	13+5	UCbsmt	n/a	30	0.35	0.40
Denver, CO	5B	38	13+5	UCbsmt	n/a	30	0.35	0.40
Minneapolis, MN	6A	49	13+5	UCbsmt	n/a	30	0.35	0.40
Billings, MT	6B	49	13+5	UCbsmt	n/a	30	0.35	0.40
Fargo, ND	7A	49	21	UCbsmt	n/a	30	0.35	0.40
Fairbanks, AK	8	49	21	UCbsmt	n/a	30	0.35	0.40

2009 Envelope Values
Climate Zones 4-8

LOCATION	IECC CZ	Ceiling R-value	Wall R-value	Found. Type	Slab R-value	Floor R-value	Window U-factor	Window SHGC
Baltimore, MD	4A	38	13	crawl	n/a	19	0.35	0.40
Kansas City, MO	4A	38	13	crawl	n/a	19	0.35	0.40
Chicago, IL	5A	38	13+5	UCbsmt	n/a	30	0.35	0.40
Denver, CO	5B	38	13+5	UCbsmt	n/a	30	0.35	0.40
Minneapolis, MN	6A	49	13+5	UCbsmt	n/a	30	0.35	0.40
Billings, MT	6B	49	13+5	UCbsmt	n/a	30	0.35	0.40
Fargo, ND	7A	49	21	UCbsmt	n/a	38	0.35	0.40
Fairbanks, AK	8	49	21	UCbsmt	n/a	38	0.35	0.40

2012 (& 2015) Envelope Values
Climate Zones 4-8

LOCATION	IECC CZ	Ceiling R-value	Wall R-value	Found. Type	Slab R-value	Floor R-value	Window U-factor	Window SHGC
Baltimore, MD	4A	49	13+5	Crawl	n/a	19	0.35	0.40
Kansas City, MO	4A	49	13+5	Crawl	n/a	19	0.35	0.40
Chicago, IL	5A	49	13+5	UCbsmt	n/a	30	0.32	0.40
Denver, CO	5B	49	13+5	UCbsmt	n/a	30	0.32	0.40
Minneapolis, MN	6A	49	13+10	UCbsmt	n/a	30	0.32	0.40
Billings, MT	6B	49	13+10	UCbsmt	n/a	30	0.32	0.40
Fargo, ND	7A	49	13+10	UCbsmt	n/a	38	0.32	0.40
Fairbanks, AK	8	49	13+10	UCbsmt	n/a	38	0.32	0.40

Additional IECC Characteristics

Item	2006 IECC	2009 IECC	2012 IECC
Envelope Leakage	SLA=0.00036	7 ach50	CZ 1-2: 5 ach50 CZ 3-8: 3 ach50
Distribution System Efficiency (DSE)	DSE = 0.80	DSE = 0.88	DSE = 0.88
Programmable Thermostat	No	No	Yes
High Efficiency Lighting	10%	50%	75%
Hot Water Piping Insulation	No	No	Yes
Max Window/Floor area	18%	15%	15%
Mechanical Ventilation (per 2012 IMC)	None	None	CZ 1-2: None CZ 3-8: 60 cfm
Sealed Air Handlers	No	No	Yes

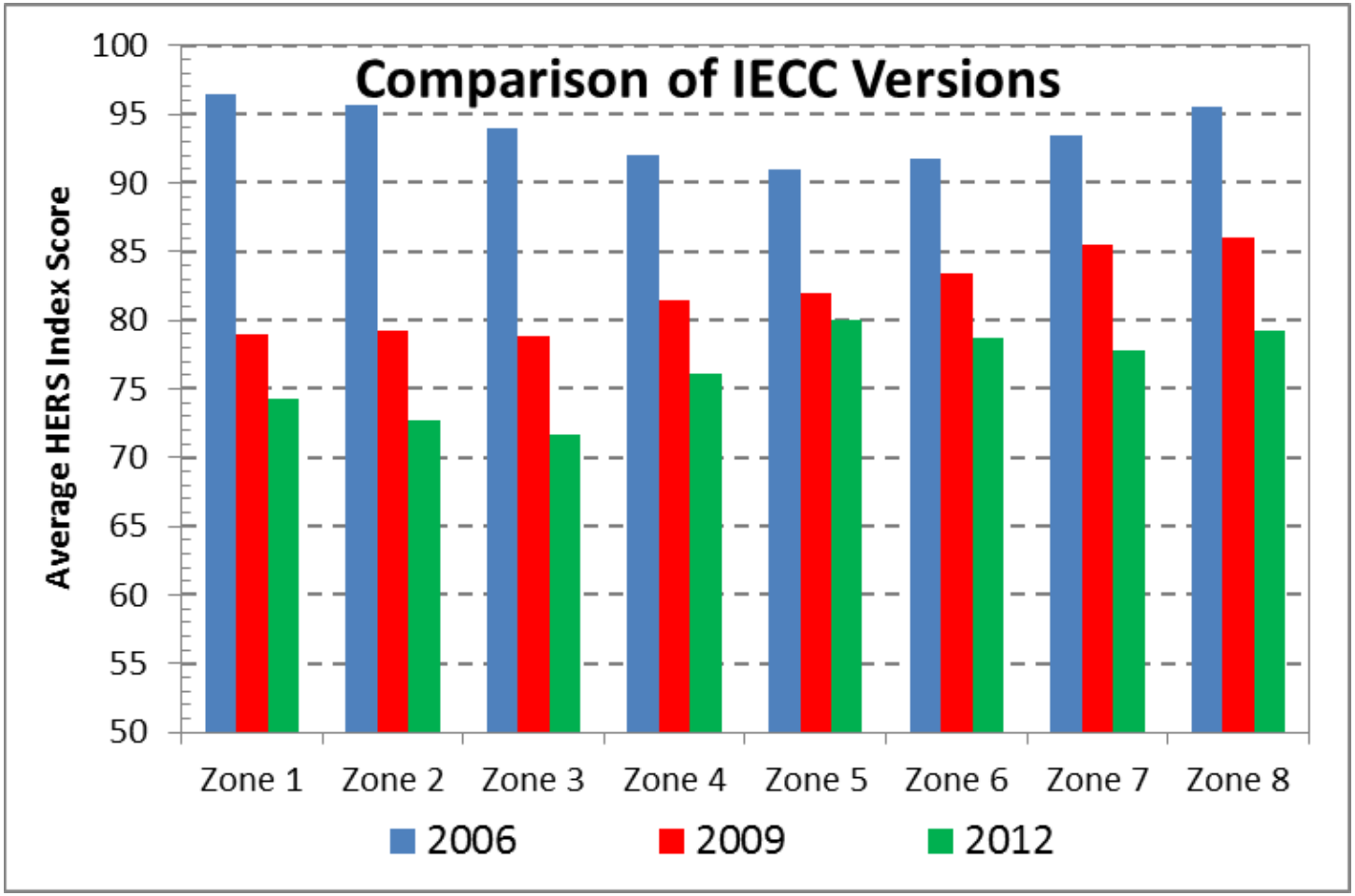
2006-2012 Equipment Standards Climate Zones 1-3

LOCATION	IECC CZ	Heating System		Cooling System		Water Heater	
		Fuel	Eff	Fuel	SEER	Fuel	EF
Miami, FL	1A	elec	7.7	elec	13	elec (50)	0.90
Orlando, FL	2A	elec	7.7	elec	13	elec (50)	0.90
Houston, TX	2A	elec	7.7	elec	13	elec (50)	0.90
Phoenix, AZ	2B	elec	7.7	elec	13	elec (50)	0.90
Charleston, SC	3A	elec	7.7	elec	13	elec (50)	0.90
Charlotte, NC	3A	gas	78%	elec	13	gas (40)	0.59
Ok. City, OK	3A	gas	78%	elec	13	gas (40)	0.59
Las Vegas, NV	3B	gas	78%	elec	13	gas (40)	0.59

2006-2012 Equipment Standards Climate Zones 4-8

LOCATION	IECC CZ	Heating System		Cooling System		Water Heater	
		Fuel	Eff	Fuel	SEER	Fuel	EF
Baltimore, MD	4A	gas	78%	elec	13	gas (40)	0.59
Kansas City, MO	4A	gas	78%	elec	13	gas (40)	0.59
Chicago, IL	5A	gas	78%	elec	13	gas (40)	0.59
Denver, CO	5B	gas	78%	elec	13	gas (40)	0.59
Minneapolis, MN	6A	gas	78%	elec	13	gas (40)	0.59
Billings, MT	6B	gas	78%	elec	13	gas (40)	0.59
Fargo, ND	7A	gas	78%	elec	13	gas (40)	0.59
Fairbanks, AK	8	gas	78%	elec	13	gas (40)	0.59

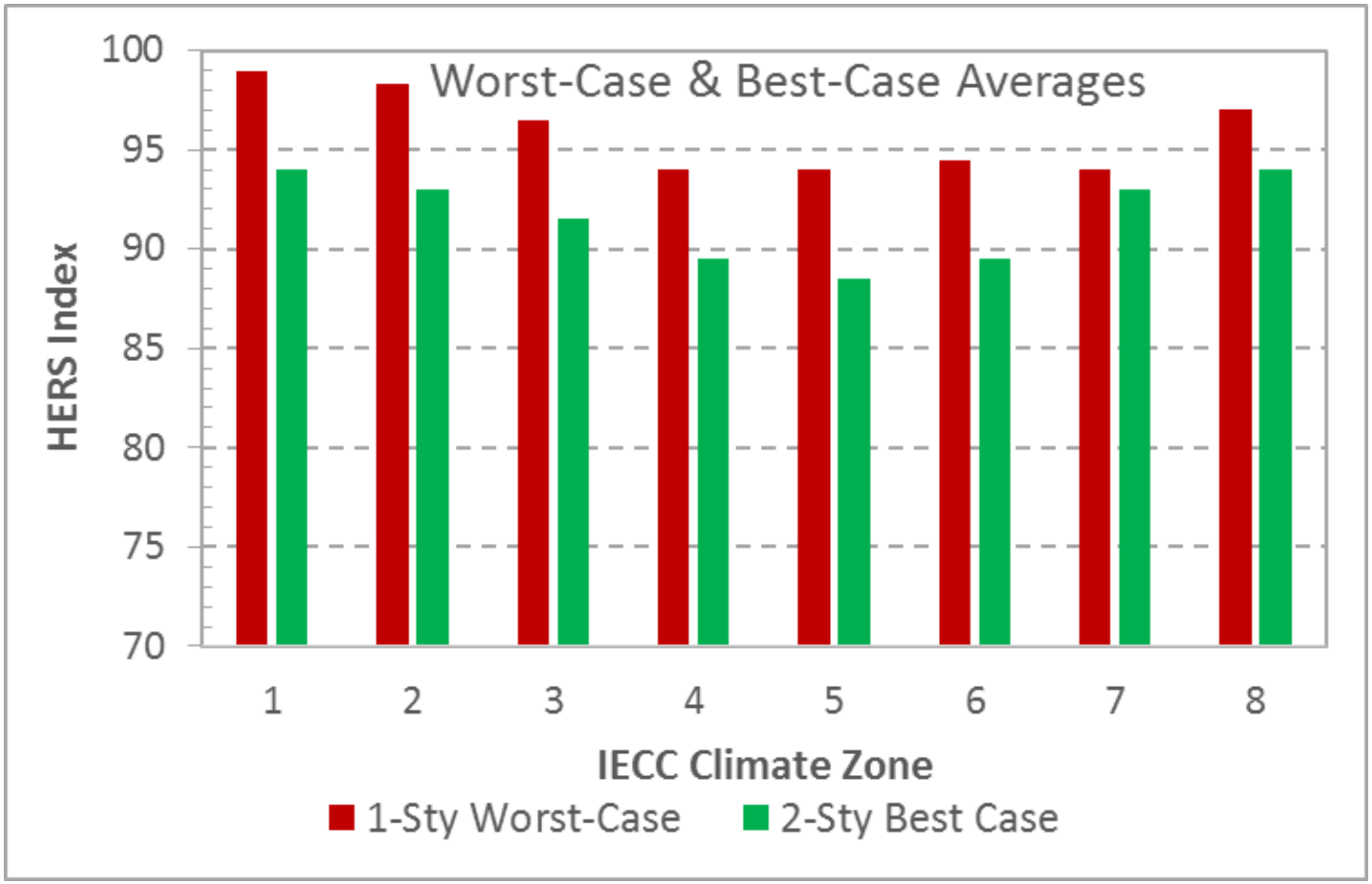
Average IECC Homes Over Time



Why is 2006 IECC not HERS-100?

- HERS Reference Home is based on 2004 IECC supplement, not on the 2006 IECC
  - 2006 IECC reference leakage is less than the HERS Reference Home leakage
  - 2006 IECC reference has different window SHGC values than the HERS Reference Home
- Analysis homes are configured to comply with 2006 IECC R-values (Table 402.1.1)
  - HERS Reference home is based on IECC Equivalent U-factors (Table 402.1.3), not the IECC R-value table
  - There is not a one-to-one correspondence between the two tables
- Configuration accounts for up to 5 HERS points.

Configuration Matters



Equipment Upgrades

- Utility, EPA and DOE high-performance home programs have moved the new home market toward higher efficiency equipment
- These high-performance home programs have resulted in heating, cooling and hot water equipment efficiencies that can be considered "on the cusp" of full market penetration.

Equipment "On the Cusp" Climate Zones 1-3

LOCATION	IECC CZ	Heating System		Cooling System		Water Heater	
		Fuel	Eff	Fuel	SEER	Fuel	EF
Miami, FL	1A	elec	8.6	elec	16	HPWH	2.00
Orlando, FL	2A	elec	8.6	elec	16	HPWH	2.00
Houston, TX	2A	elec	8.6	elec	16	HPWH	2.00
Phoenix, AZ	2B	elec	8.6	elec	16	HPWH	2.00
Charleston, SC	3A	elec	8.6	elec	16	HPWH	2.00
Charlotte, NC	3A	gas	90%	elec	16	T'less Gas	0.82
Ok. City, OK	3A	gas	90%	elec	16	T'less Gas	0.82
Las Vegas, NV	3B	gas	90%	elec	16	T'less Gas	0.82

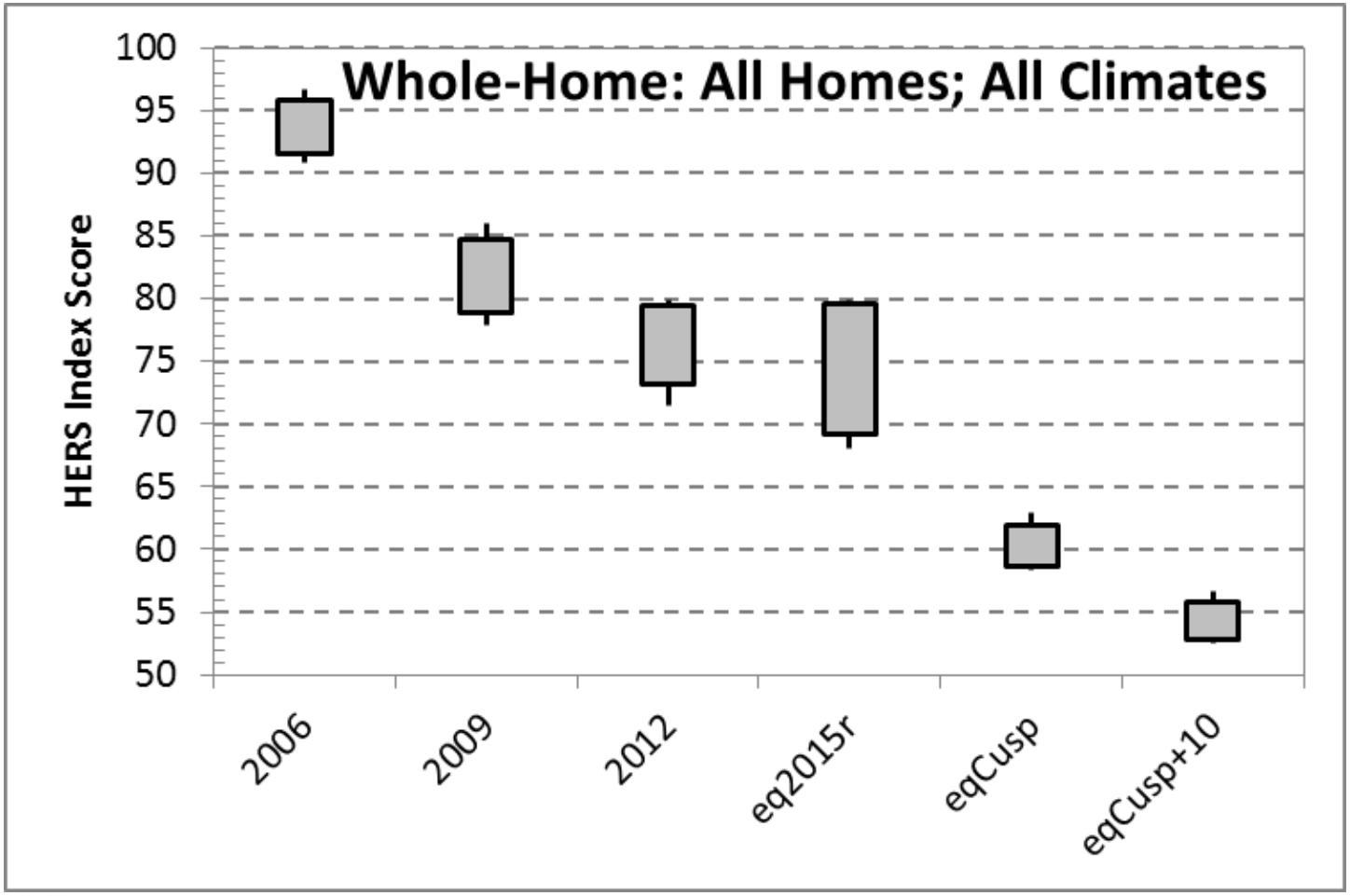
Equipment "On the Cusp" Climate Zones 4-8

LOCATION	IECC CZ	Heating System		Cooling System		Water Heater	
		Fuel	Eff	Fuel	SEER	Fuel	EF
Baltimore, MD	4A	gas	90%	elec	16	T'less Gas	0.82
Kansas City, MO	4A	gas	95%	elec	16	T'less Gas	0.82
Chicago, IL	5A	gas	95%	elec	16	T'less Gas	0.82
Denver, CO	5B	gas	95%	elec	16	T'less Gas	0.82
Minneapolis, MN	6A	gas	95%	elec	16	T'less Gas	0.82
Billings, MT	6B	gas	95%	elec	16	T'less Gas	0.82
Fargo, ND	7A	gas	95%	elec	16	T'less Gas	0.82
Fairbanks, AK	8	gas	95%	elec	16	T'less Gas	0.82

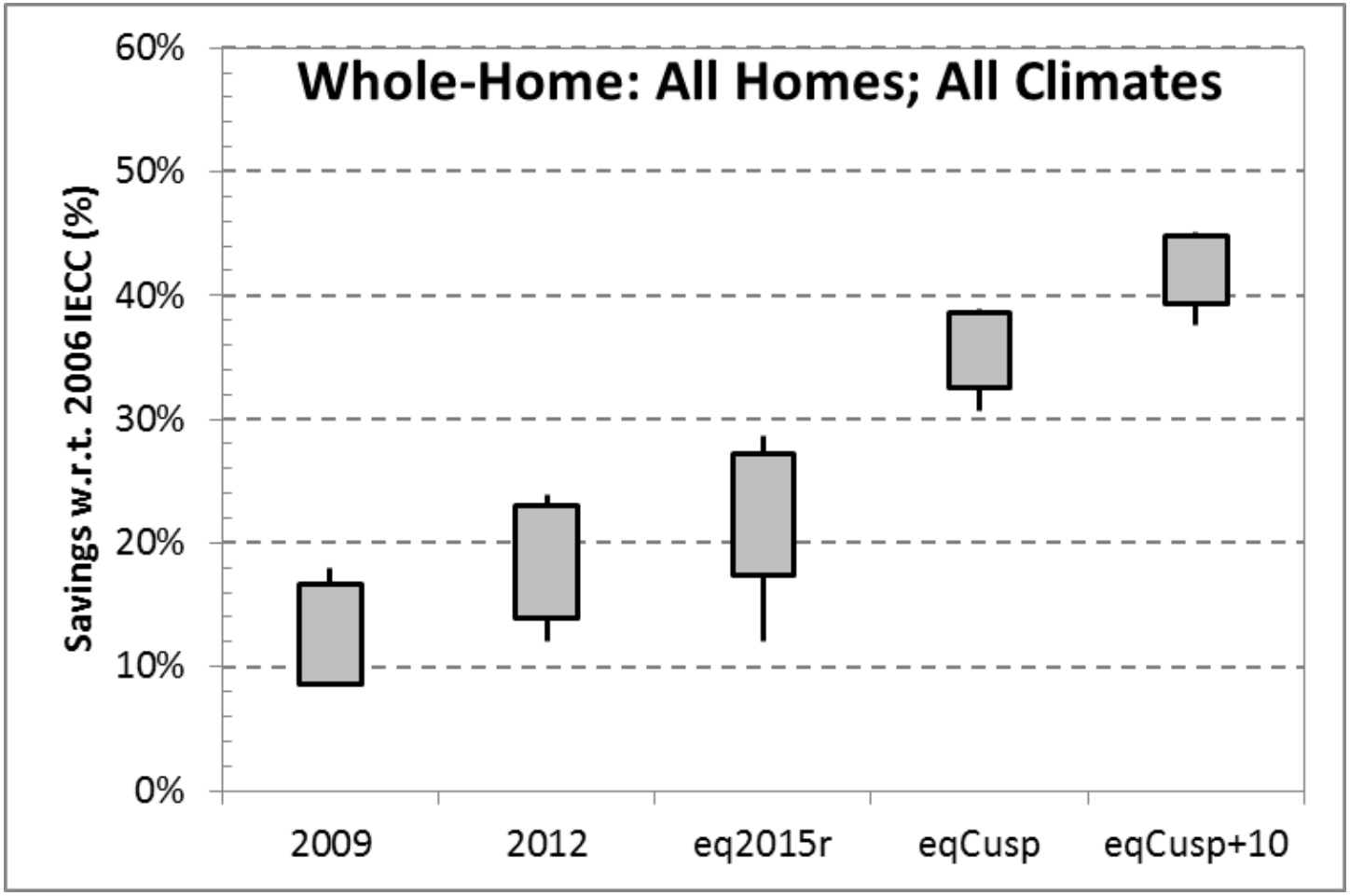
Results

- Analysis results show variation based on climate, home configuration and IECC cycle
- 2-story homes with the best window orientation (N-S) consistently outperform the 1-story homes of either orientation (as seen in a previous chart)
- Climate results vary by code cycle as a result of code changes that impact some climates more than other climates
- Scores across all climates are best characterized using box and whisker plots showing maximums, minimums and one standard deviation of the mean.

HERS Index Score Results



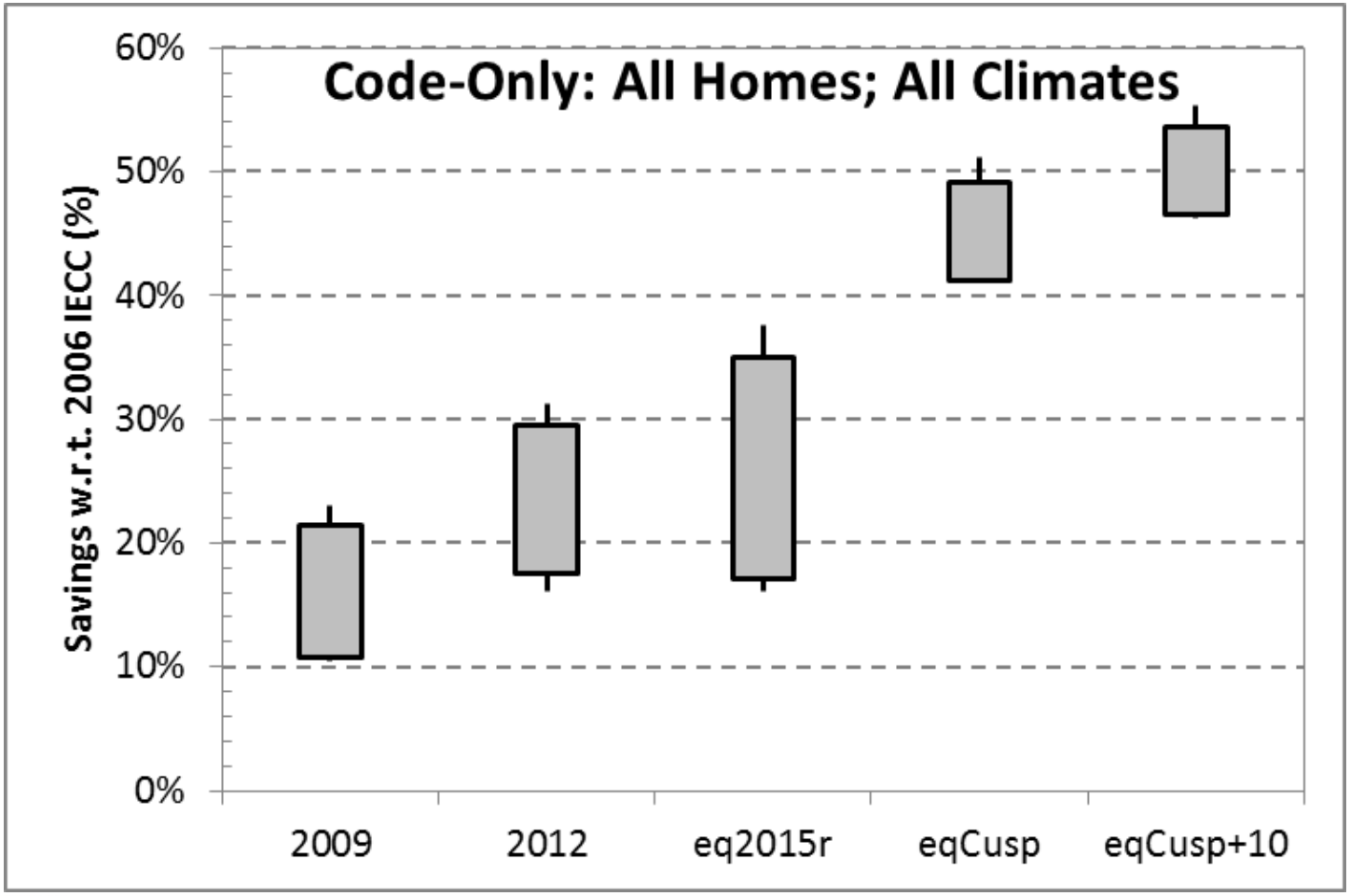
Whole-Home Savings Over 2006 IECC



Code-Only Calculations

- The HERS Index represents whole-building loads and includes all appliance loads
- Current I-Codes consider only “regulated” loads
  - For the 2006 IECC the regulated loads are only heating, cooling and hot water heating
  - For the 2009 and 2012 IECC lighting loads are added
- Code-only energy saving calculations are made to show savings for only the code-regulated loads
- Code-only energy savings are greater than whole-home savings because appliance efficiencies are not improved in the analysis.

Code-Only Savings Over 2006 IECC



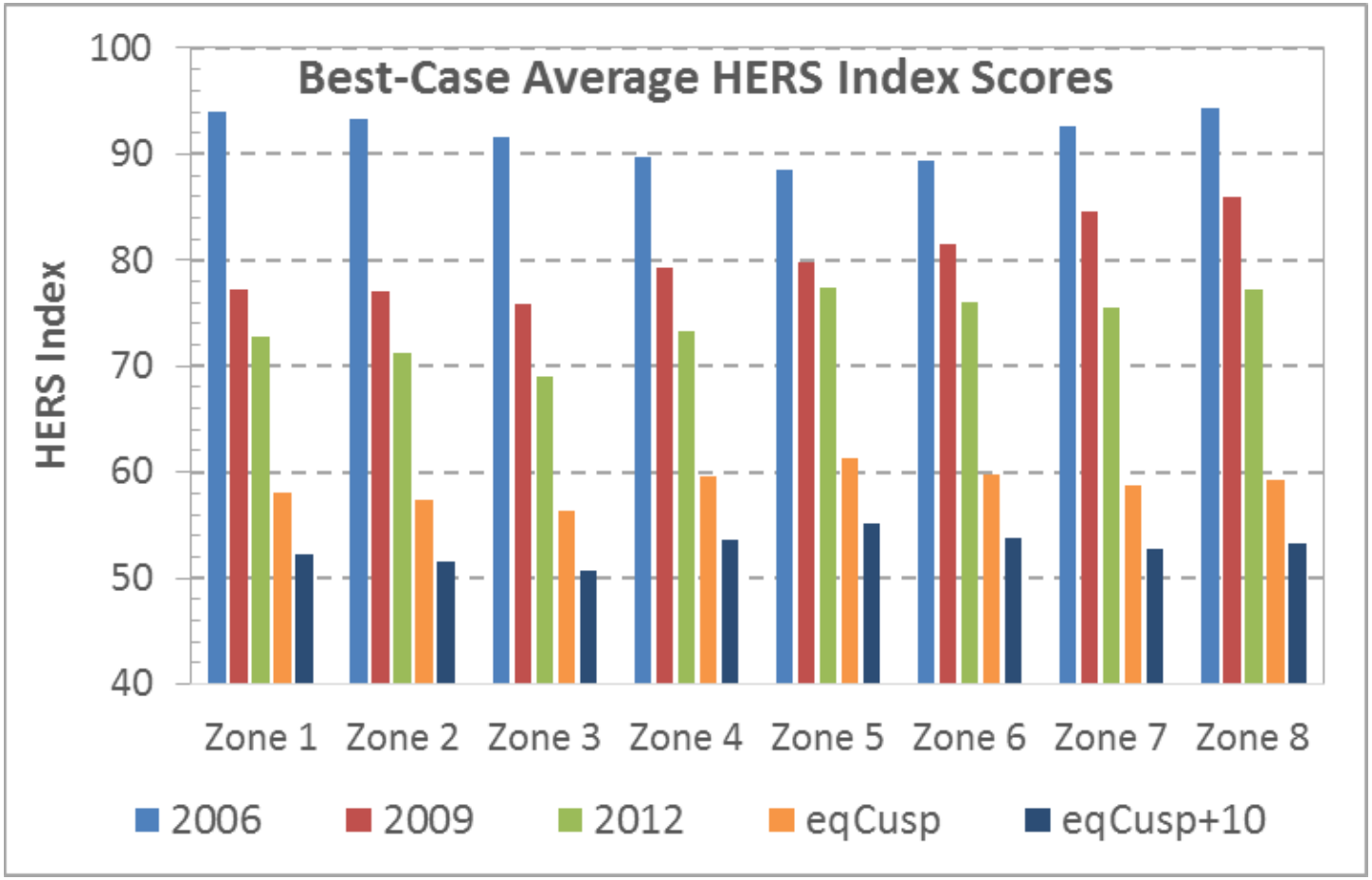
IECC RE-188 Considerations

- IECC RE-188 code change proposal submitted by Brett-Makela Group and NRDC
- Based on above study commissioned by RESNET
- Conceptually opposed by the energy efficiency collaborative because it included equipment and appliance trade-offs
- Threshold compliance values had to be quite low to overcome opposition to the proposal
- *Best-Case* home configuration with “On the Cusp” equipment + 10% additional energy savings was the *negotiated* resolution.

Best-Case Average HERS Table

Climates	2006	2009	2012	eqCusp	eqCusp+10	% Wgt
Zone 1	94	77	73	58	**52**	0.96%
Zone 2	93	77	71	57	**52**	21.43%
Zone 3	92	76	69	56	**51**	25.77%
Zone 4	90	79	73	60	**54**	22.76%
Zone 5	88	80	77	61	**55**	21.03%
Zone 6	89	82	76	60	**54**	6.79%
Zone 7	93	85	75	59	**53**	0.75%
Zone 8	94	86	77	59	**53**	0.50%
U.S. Average	**92**	**80**	**74**	**59**	**53**	**---**
US Wgt'd Average	**91**	**78**	**73**	**59**	**53**	**99.99%**

Best-Case Average HERS Chart



Source Report Document

Fairey, P., "Analysis of HERS Index Scores for Recent Versions of the International Energy Conservation Code (IECC)." Rpt. No. FSEC-CR-1941-13, Florida Solar Energy Center, Cocoa, FL, January 21, 2013 (http://www.fsec.ucf.edu/en/publications/pdf/FSEC-CR-1941-13_R01.pdf)

Questions?