FLORIDA SOLAR ENERGY CENTER®

Creating Energy Independence

Cost Effectiveness of IECC 2015 ERI

RESNET Building Performance Conference

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Philip Fairey

Overview

- EnergyGauge® USA v.3.1.02 analysis of present value life-cycle investment costs and energy cost savings to meet the 2015 IECC Energy Rating Index (ERI) compliance scores
- 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
- Comparison basis is the 2012 IECC minimum compliance home configuration
- Cost effectiveness calculations in accordance with Section 4.6 of ANSI/RESNET 301-2014 Standard.

2012 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

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)

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	SOG	none	n/a	0.35	0.25
Charlotte, NC	3A	38	13+5	SOG	none	n/a	0.35	0.25
Ok. City, OK	3A	38	13+5	SOG	none	n/a	0.35	0.25
Las Vegas, NV	3B	38	13+5	SOG	none	n/a	0.35	0.25

(Red values indicate changes from 2009 IECC)

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	SOG	10, 2ft	n/a	0.35	0.40
Kansas City, MO	4A	49	13+5	SOG	10, 2ft	n/a	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

(Red values indicate changes from 2009 IECC)

Additional 2012 IECC Characteristics

Item	2012 IECC
Envelope Leakage	CZ 1-2: 5 ach50 CZ 3-8: 3 ach50
Programmable Thermostat	Yes
High Efficiency Lighting	75%
Hot Water Piping Insulation	Yes
Max Window/Floor area	15%
Mechanical Ventilation (per 2012 IMC)	CZ 1-2: None CZ 3-8: 60 cfm
Sealed Air Handlers	Yes

2012 IECC Air Distribution System Standards

Foundation Type	ADS location	Duct R-value	Duct leakage
Slab on grade	Attic	8	4 cfm25/100 ft^2
Basement	Basement	6	4 cfm25/100 ft^2

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

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

2015 ERI Compliance

An additional 64 home configurations were created to comply with the 2015 IECC Energy Rating Index (ERI) compliance criteria:

Climate Zone	ERI
Zone 1	52
Zone 2	52
Zone 3	51
Zone 4	54
Zone 5	55
Zone 6	54
Zone 7	53
Zone 8	53

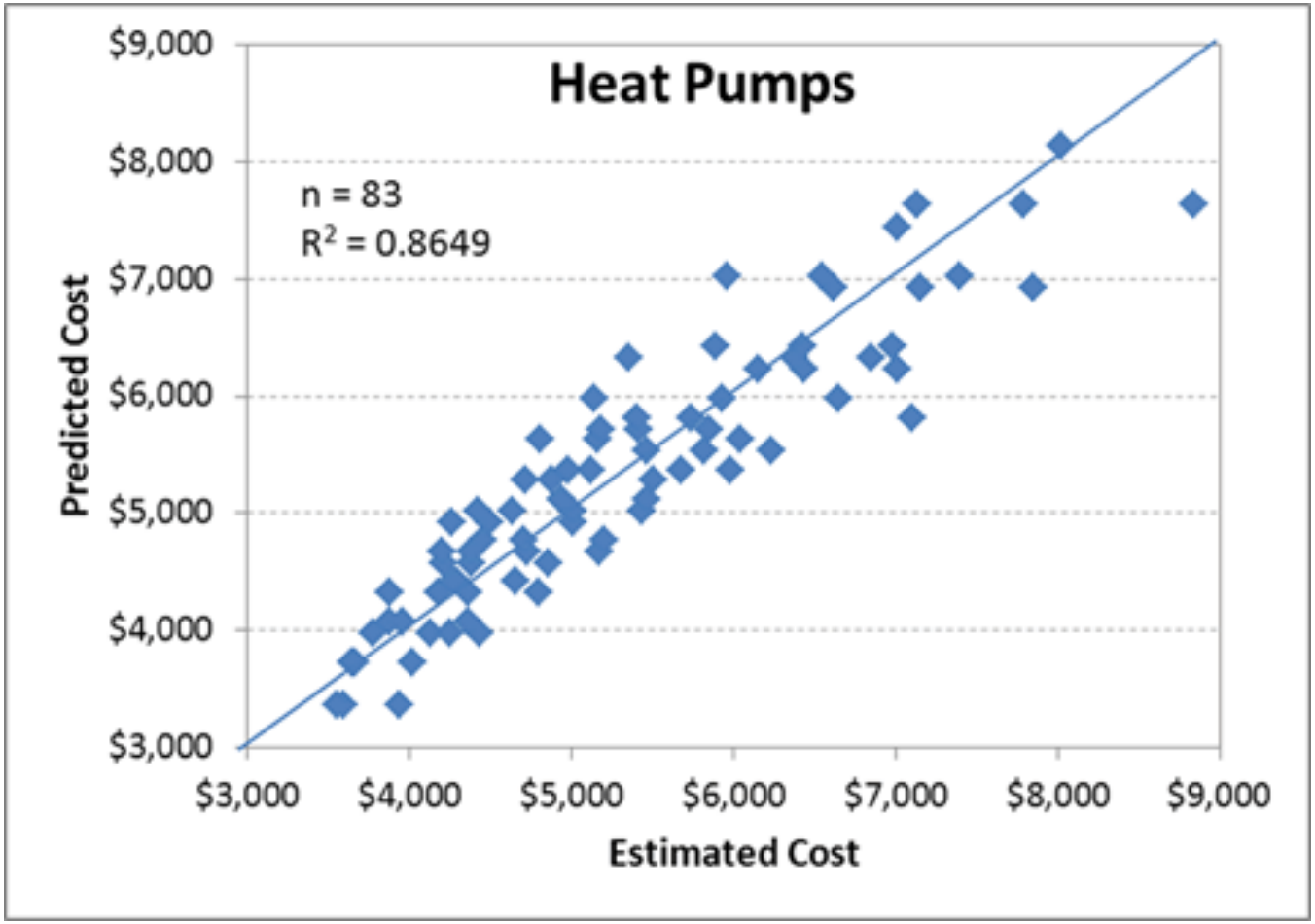
Improvement Costs

- Incremental improvement costs determined using methods developed for Building America program study (Fairey and Parker 2012)
- Largely the same as costs provided by NREL cost database (www. nrel.gov/ap/retrofits)
- HVAC equipment computed differently from NREL equipment costs to account for fixed costs associated with HVAC equipment installation.

HVAC Costs

- Formula-based regressions developed from on-line retail costs of various equipment
  - Heat pumps: -5539 + 604*SEER + 6.99*tons
  - Air conditioners: -1409 +292*SEER + 520*tons
  - Gas furnace/AC: -6067 + 568*SEER + 517*tons + 4.04*kBtu + 1468*AFUE
  - Gas furnace: -3936 + 14.95*kBtu + 5865*AFUE

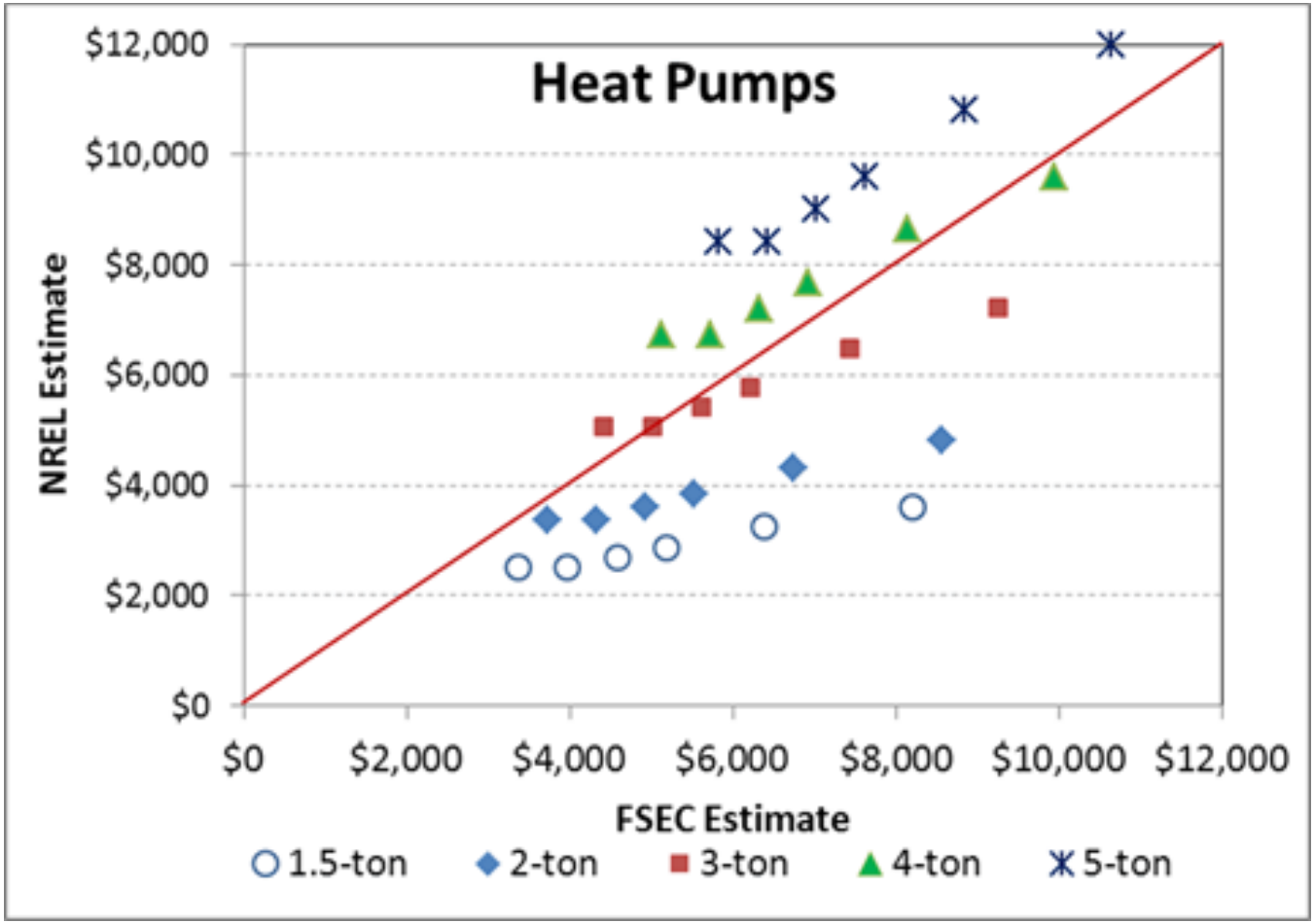
Heat Pump Cost Regression



NREL Cost Database

NREL Heat Pump Replacement Costs				
SEER	Low $/kBtu	High $/kBtu	Average $/kBtu	± %
13	97	170	140	26%
14	110	180	140	25%
15	110	190	150	27%
16	120	200	160	25%
17	130	210	170	24%
18	140	220	180	22%
19	140	230	180	25%
20	150	230	190	21%
21	160	240	200	20%

Comparison with NREL Database



Cost Effectiveness Calculations

Economic Cost Effectiveness is calculated in accordance with Section 4.6, ANSI/RESNET 301-2014 using the RESNET-specified 2013 Economic Parameter Values as follows:

Life-Cycle Analysis Period	**30 years**
General Inflation Rate (GR)	2.53%
Discount Rate (DR)	4.53%
Mortgage Interest Rate (MR)	5.42%
Down payment Rate (DnPmt)	10.00%
Energy Inflation Rate (ER)	4.18%
Effective Income Tax Rate (iTR)	25.0%
Property Tax Rate (pTR)	4.0%

Key Economic Indicators

- Savings to Investment Ratio (SIR): the present value of the life-cycle savings divided by the present value of the life-cycle investments. *If this value is greater than unity, the investment is cost effective to the consumer.*
- Net Present Value (NPV): the present value of the life-cycle savings minus the present value of the life-cycle investments. *If this value is positive, the investment is cost effective to the consumer.*

Results by Climate Zone Average

Climate Zone	IECC ERI	Avg HERS	Avg 1st cost	Avg LC Cost	Avg Savings	Avg LC Save	SIR	NPV
1	52	50	$3,435	$7,725	$532	$14,543	1.88	$6,818
2	52	51	$4,009	$9,181	$498	$13,606	**1.48**	$4,425
3	51	50	$3,302	$7,423	$465	$12,707	1.71	$5,284
4	54	53	$2,951	$6,647	$460	$12,569	1.89	$5,922
5	55	54	$3,356	$7,617	$442	$12,072	1.58	$4,455
6	54	53	$2,695	$6,134	$461	$12,602	2.05	$6,467
7	53	51	$2,813	$6,417	$503	$13,734	2.14	$7,317
8	53	52	$2,727	$6,211	$700	$19,143	**3.08**	$12,931
Average across all climates		52	$3,263	$7,399	$488	$13,347	1.80	$5,948
US weighted averages		**52**	**$3,338**	**$7,565**	**$468**	**$12,784**	**1.69**	**$5,219**

Conclusions

- Achieving the 2015 IECC ERI compliance values is cost effective in all 64 cases evaluated, including for homes with worst-case orientations
- These results are achieved with relatively easy to make improvements that are already widely employed in high-performance building programs across the nation
- Average first cost of the improvements is relatively small, ranging from $2,700 to $4,000
- Even in the worst case, SIR is approximately 1.5 with a NPV of $4,425 (greater than the initial $4,000 cost of the investment).

Additional Resources

- Fairey, P., M. Waltner, D. Goldstein and E. Makela (2014), "Cost Effectiveness of 2015 IECC Compliance using the HERS Index." Rpt. No. FSEC-CR-1981-14, Florida Solar Energy Center, Cocoa, FL.

  http://fsec.ucf.edu/en/publications/pdf/FSEC-CR-1981-14.pdf
- Fairey, P. and D. Parker (2012), "Cost Effectiveness of Energy Retrofits in Pre-Code Vintage Homes in the United States." Rpt. No. FSEC-CR-1939-12, Florida Solar energy Center, Cocoa, FL.

  http://www.fsec.ucf.edu/en/publications/pdf/FSEC-CR-1939-12.pdf