FLORIDA SOLAR ENERGY CENTER®

Creating Energy Independence

RESNET Summit: What's Happening With HERS Rating Software

EEBA High Performance Home Summit 2017
October 10-12, 2017

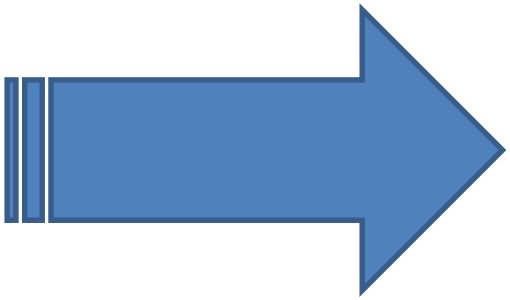
Philip Fairey

Acknowledgements

- Dave Roberts graciously gave permission to use materials from his presentation entitled "RESNET Software Accreditation Process – Benefits to Utility Efficiency Programs" given at the 2017 RESNET Conference in Scottsdale, AZ, February 27, 2017.

Some software, more software

EnergyGauge®
Energy Analysis & Rating Software



ekotrope

EnergyGauge®
Energy Analysis & Rating Software

wrightsoft®

ICF Beacon

FSEC

Some software, more software

ekotrope

EnergyGauge®
Energy Analysis & Rating Software

But they all went through the same accreditation process…

REM/Rate™

ICF Beacon

wrightsoft®

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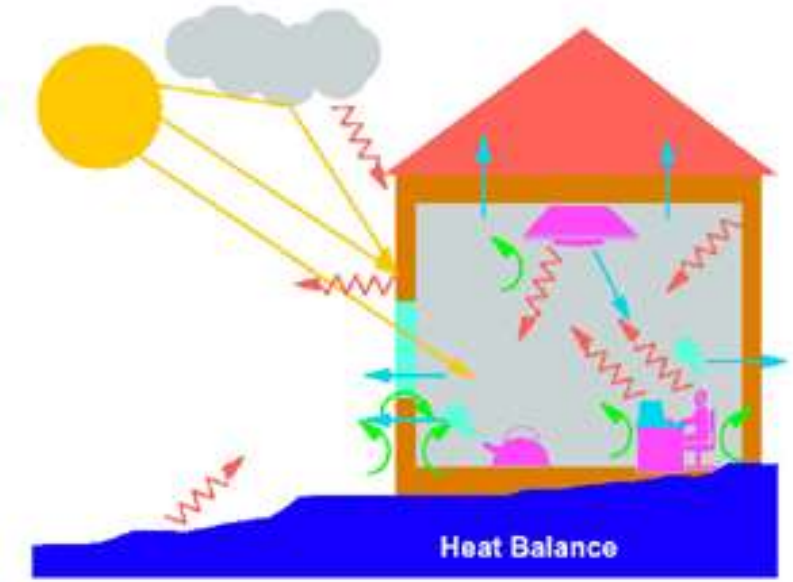
Accreditation process

1. ANSI/ASHRAE 140 Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs
2. HERS Reference Home auto-generation test
3. HERS method tests
4. HVAC test
5. Duct distribution system efficiency tests
6. Hot water system performance tests

Accreditation process - BESTEST

BESTEST

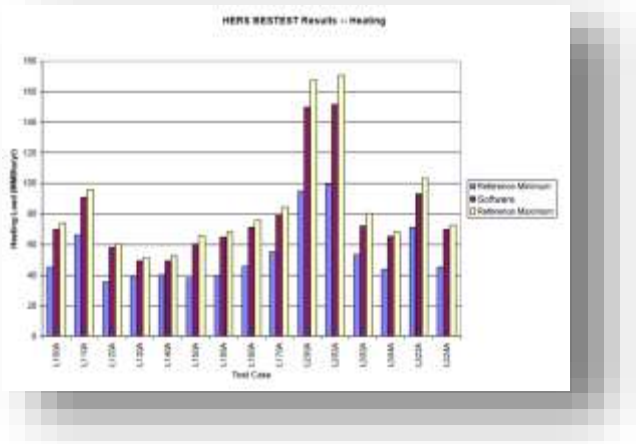
- *ANSI/ASHRAE 140 Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs*
  - Tests building physics
  - Heating/cooling climates
  - Three reference softwares
  - Absolute/delta tests
  - Stress testing
    - High/Low insulation
    - High/Low solar gain
    - High/Low infiltration
    - Etc.



Accreditation process - Results

3.3 Process for Accrediting Software Programs

The RESNET accreditation process provides a suite of verification tests to certify that rating software tools conform to the verification criteria for each test. The software developer shall be required to submit the test results, test runs, and the software program with which the tests were conducted to RESNET. This information may be released by RESNET for review by any party, including competing software developers. This process is expected to result in compliance without a costly bureaucratic review and approval process.



Anatomy of a Home Energy Assessment Tool

		Example: Air Conditioner	Estimated influence on variability**	Keys to Improvement
User Interface	Typical residential assessment inputs	 SEER: 1 input Capacity: 1 input SHR: 1 input Total: 3 inputs	40% observation and input	Training and Interface Design
Input Translator	Assumptions about building details not observed or input	Many, many lines of software code that translate simplified inputs into detailed inputs	50% input translation	Common Rules or Shared Software Code
Simulation Engine	Detailed inputs needed to drive simulation*	Air Loop: 19 inputs Coil: 28 inputs Performance Curves: 50 inputs Fan: 13 inputs Total: > 100 inputs	10% simulation engine	Validation

FSEC

*Similar inputs needed for any detailed simulation engine (e.g., EnergyPlus, DOE-2, ESP-r, etc.).

**Dave Roberts' generalized observational opinion.

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Software Testing

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Standardized operations assumptions

Standard 301

- Establishes operational assumptions
- Based on typical/average use
  - Thermostat set points
  - Lighting usage
  - Appliance usage
  - Hot water usage
- Results in average energy usage predictions
- Ideal for publicly-funded programs

Summary & key takeaways

1. All RESNET-accredited software go through same rigorous testing
2. RESNET software testing is based on energy, including energy savings
3. Standardization and additional QA checks address input anomalies
4. Process continues to improve

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Creating Energy Independence

HERS Software Analytics: New HERS Method Test Results

Taken from

RESNET Analytics Task Group Report

P. Fairey

Objective

- Determine how the change from the MINHERS 2013 Standard to the ANSI/RESNET/ICC 301-2014 Standard is likely to impact HERS Index scores
- Evaluate differences in 2 different climates:
  - Cooling dominated: Las Vegas, NV (Zone 3)
  - Heating dominated: Colorado Springs, CO (Zone 5)

What Changed?

- HERS Reference Home has been aligned with 2006 IECC
  - Instead of IECC 2004 supplement
  - Needed for Reference Home modernization, tax credits and energy code initiatives
- HERS Reference Home has become more efficient
  - Reference Home leakage: 8.9 ach50 → 6.6 ach50 *(2-sty, 2,400 ft^2 home – will vary with home design)*
  - A more efficient Reference Home results in a somewhat larger HERS Index *(climate dependent)*
  - Most impactful in cold climates, smaller to little impact in moderate and warm climates.

What Else Changed

- Hot water use has changed (Addendum A)
  - Quantity of hot water use has decreased, substantially in warm climates
  - Aligns much better with the science and available empirical data
- Hot water system opportunities added
  - Good plumbing design receives substantial credit
  - More efficient dishwashers and clothes washers get credited
  - DWHR systems and hot water recirculation systems are now included in improvement options

Ways the HERS Index is Affected

- Cold climate envelope leakage ***example*** *(typical 2-sty, 2,400 ft² home, wsf=0.7):*
  - 2013 Reference Home natural ach = 0.43
    - At 60 °F ΔT and 400 equivalent heating hours per year = 3.8 MBtu/y
  - 2014 Reference Home natural ach = 0.32
    - At 60 °F ΔT and 400 equivalent heating hours per year = 2.8 MBtu/y
- Reference Home heating load is reduced by 26% (1.0 MBtu/y)

HERS Index Evaluation Methods

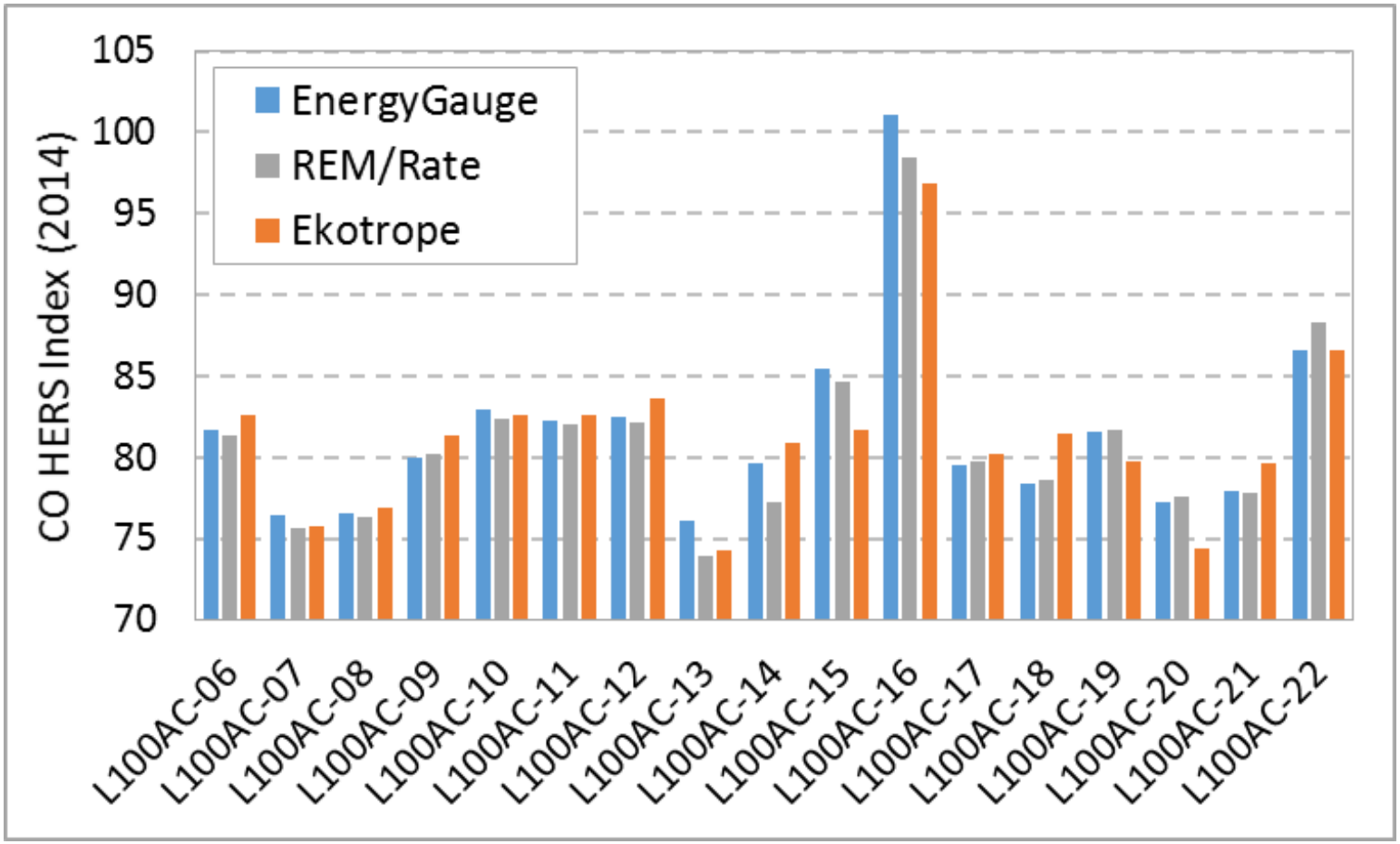
- Define a simple, well-described base case home model using minimum 2015 IECC characteristics
- Construct a suite of tests using a range of common single measure modifications to ensure that confounding, interactive modeling affects are eliminated
- Simulations conducted and results reported by HERS software tool developers to ensure that modeling inputs are as intended by tool developers
- Simulation tests conducted “in the blind”
- Compare results from accredited HERS software tools across 2013 and 2014 standards.

Test Cases (2012 IECC Envelopes)

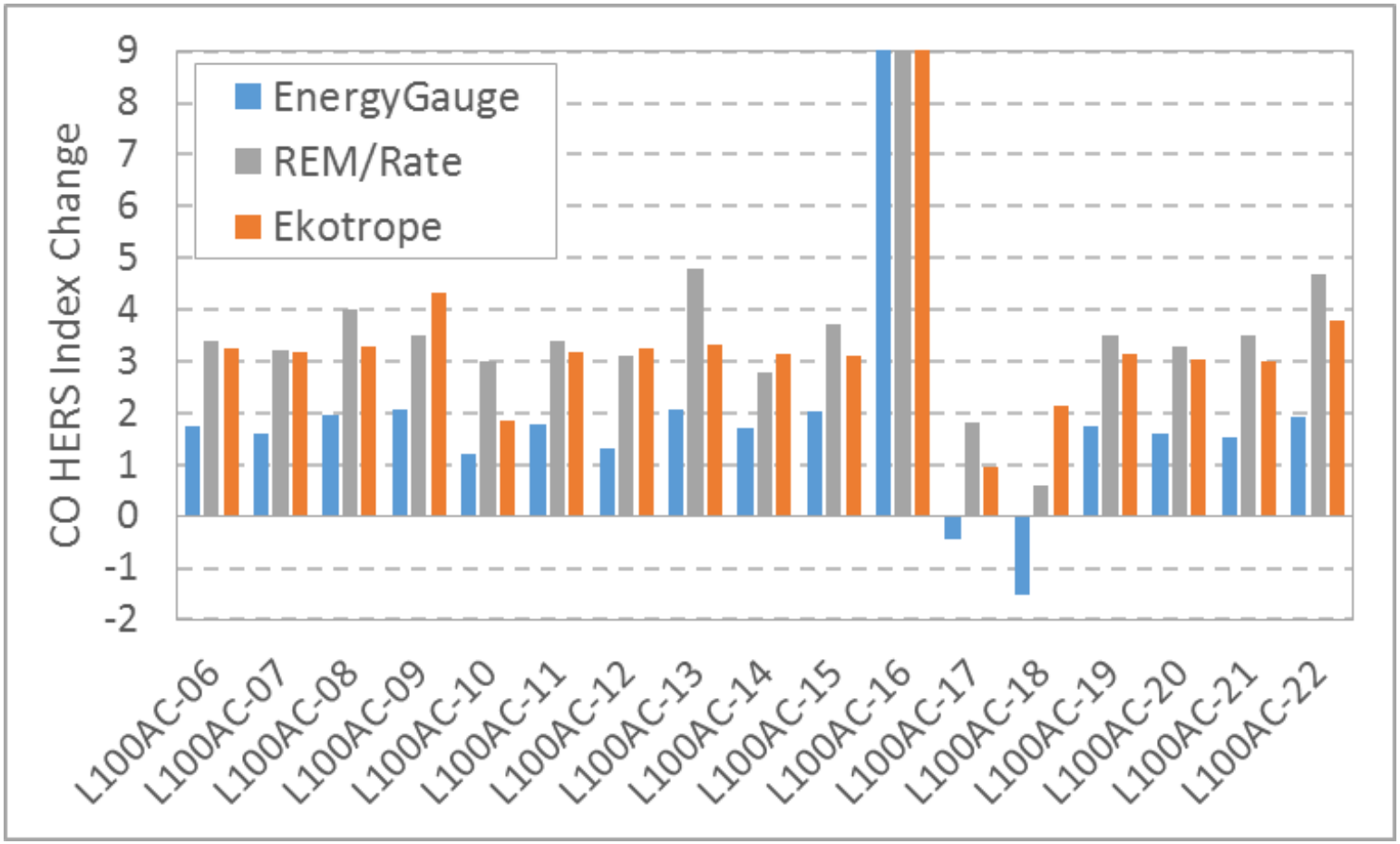
6) <u>Base Case</u>: 1,539 sf, 1-sty, 3-br, frame on crawlspace, gas furnace (80%), gas WH (0.62), default lgts. & elect appl.

7) High-eff gas furnace (96%)
8) Tankless gas WH (0.83)
9) 2-bedroom home
10) 4-bedroom home
11) Gas range/oven & dryer
12) Std. Electric WH (0.95)
13) High-eff elect HPWH (2.5)
14) SEER-21 air conditioner
15) Fan-cycler ventilation
16) DHW recirc., no control
17) DHW recirc., man control
18) DWHR, all, equal, 54%
19) Std. elect heat pump (8.2)
20) High-eff elect HP (10)
21) 75% high-eff lighting
22) Crawlspace ducts, Qn=0.04

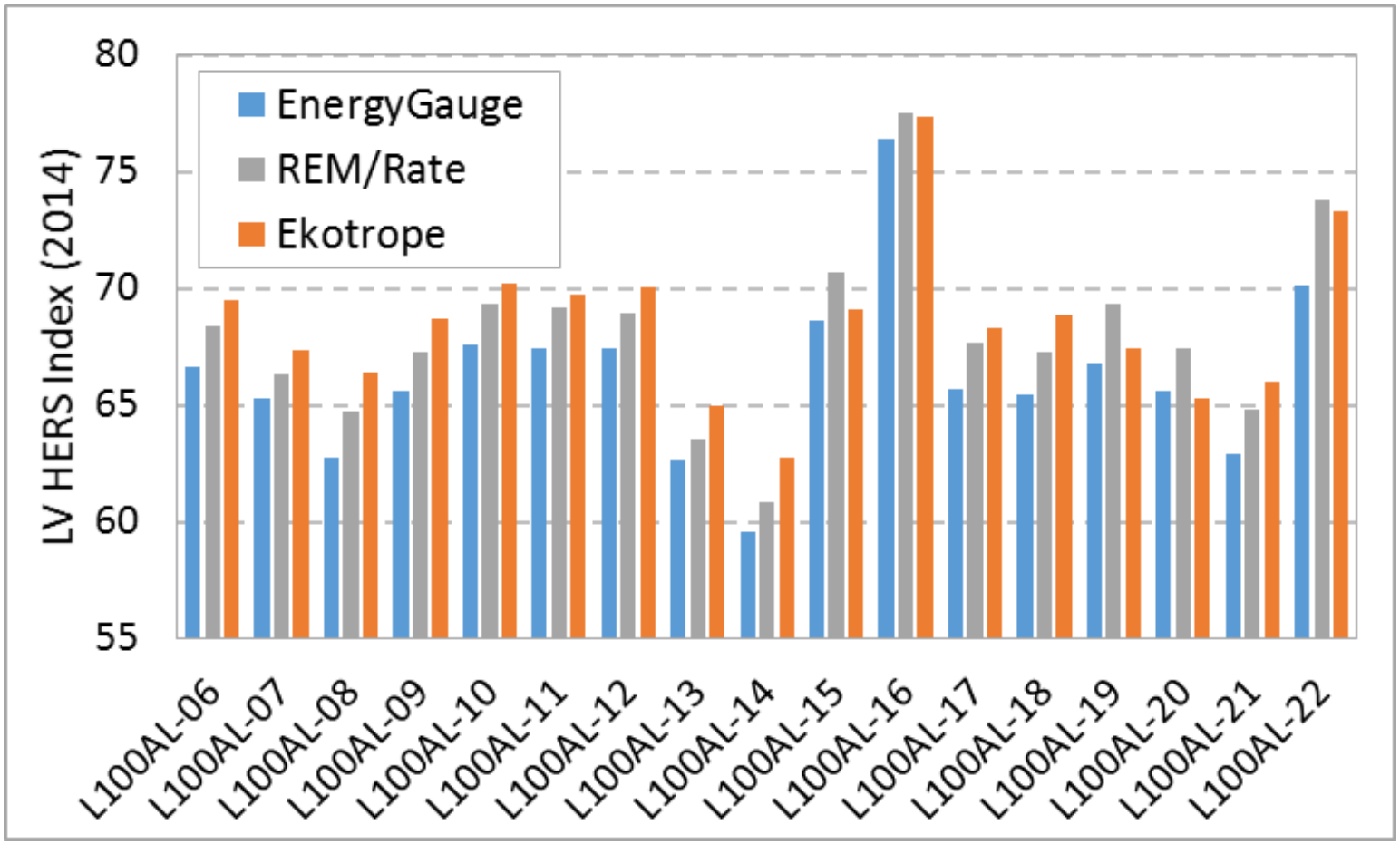
2014 HERS Index Results: CO



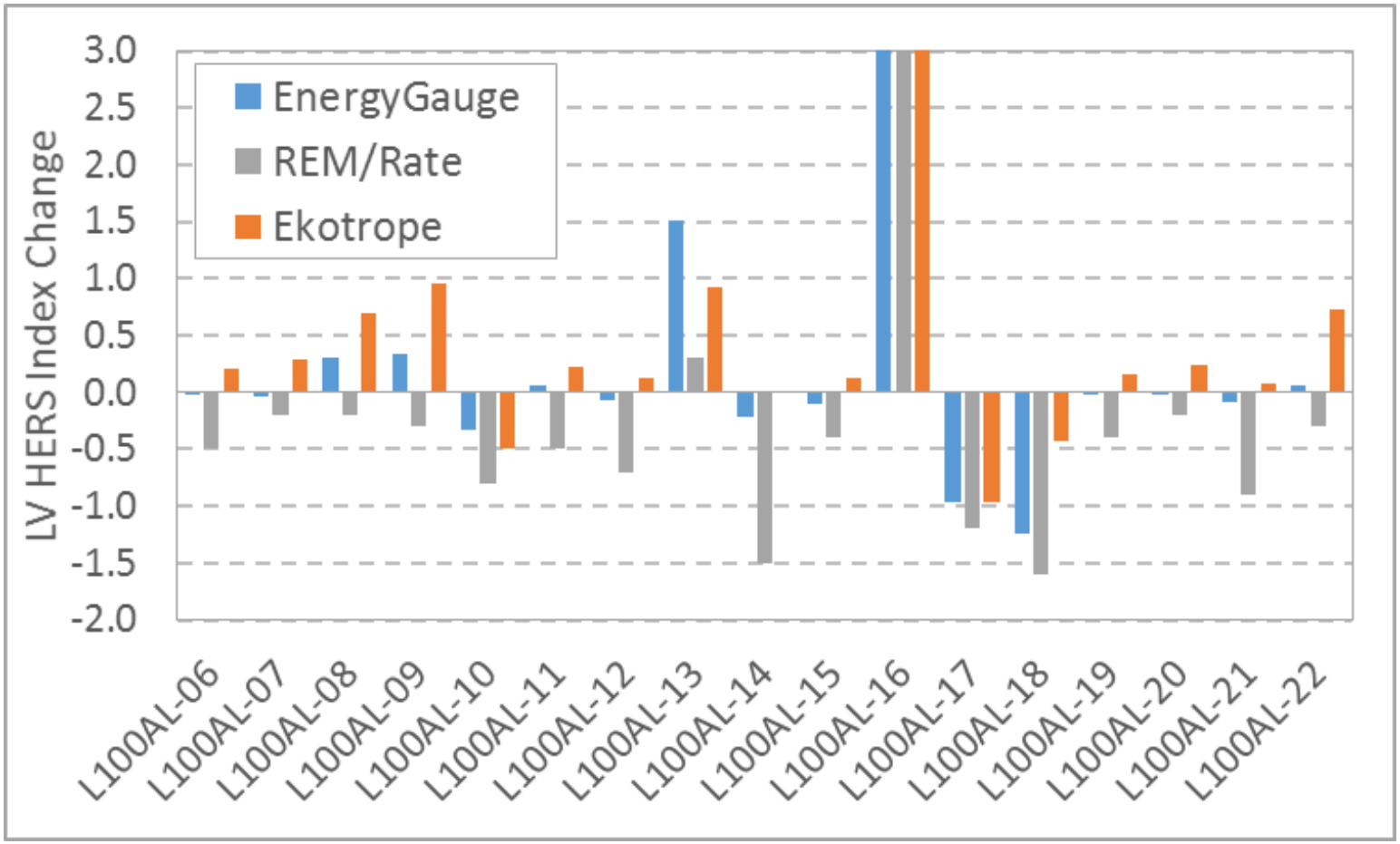
HERS Change (2014-2013): CO



2014 HERS Index Results: LV



HERS Change (2014-2013): LV



HERS Averages, Deltas & Ranges

- HERS averages across cases for each software tool for 2014 and 2013 Standards showing HERS increase (HERS Δ) and HERS range across tools
- Excludes results from cases 16-18 as these three cases have no meaning in 2013 Standard.

Colorado	HERS '14	HERS '13	HERS Δ
egUSA	80.48	78.75	1.73
Eko	80.18	76.98	3.21
REM	80.09	76.52	3.56
Range	0.40	2.23	1.83

Vegas	HERS '14	HERS '13	HERS Δ
egUSA	65.64	65.54	0.10
Eko	67.91	67.60	0.31
REM	67.46	67.93	-0.47
Range	2.27	2.38	0.78

Causes of Differences

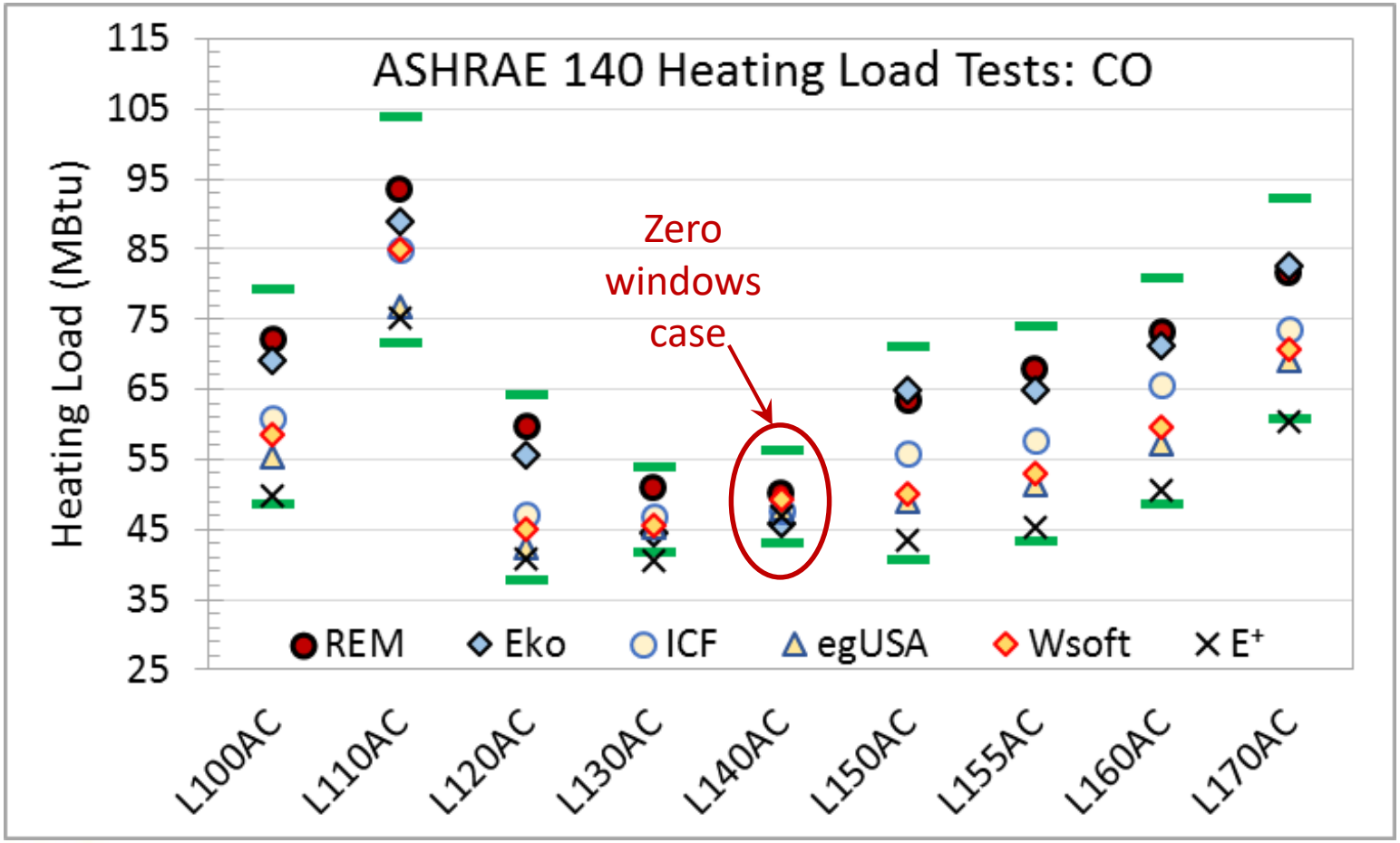
- Acceptance criteria for ASHRAE 140 test suite are quite large
- For example, heating load for 140 L100A base case is acceptable from 48.75 – 79.48 MBtu
- HERS calculation equation uses Total Reference Loads (TRL) as the denominator of the "scoring fraction."

HERS Index = PEfrac * (TnML / TRL) * 100

But . . .

- ASHRAE Std. 140 load tests show that each of the software tools is within the range of the Std. 140 test suite criteria
- Std. 140 test results also show the same relationship between the software tools with respect to the criteria range
- ICF, WrightSoft and EnergyPlus (E^{+}) Std. 140 test results are also available for comparison.

Std. 140 Heating Load Tests: CO
(It's mostly about the windows!)



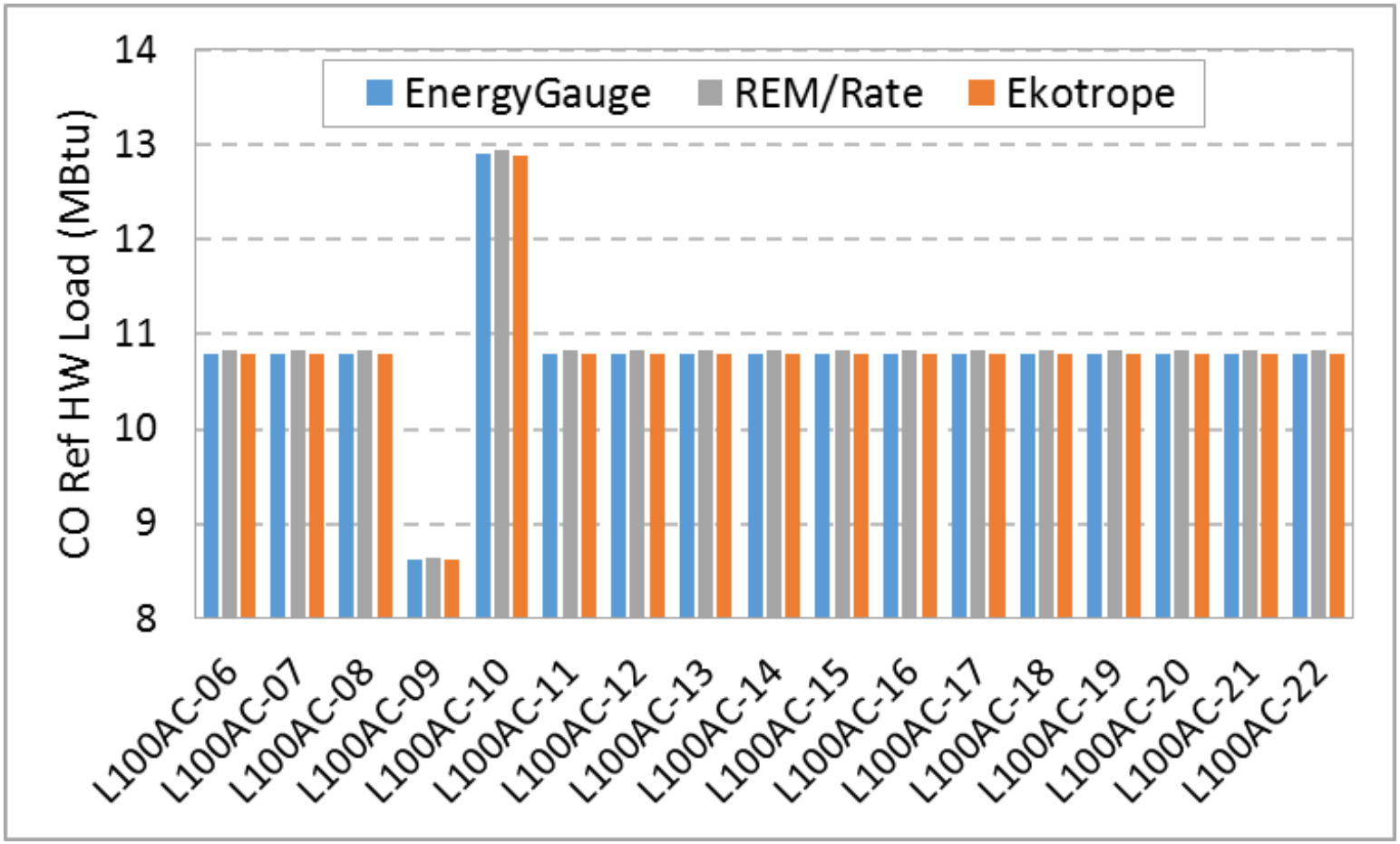
The Good News

- The HERS Rating System is quite forgiving
- The same differences in software building load simulation exist for both the Reference and the Rated Home
- The impact of these load simulation differences is a second (or third) order affect
- Therefore, the HERS Index range across software tools is small compared to the range across Std. 140 Loads tests.

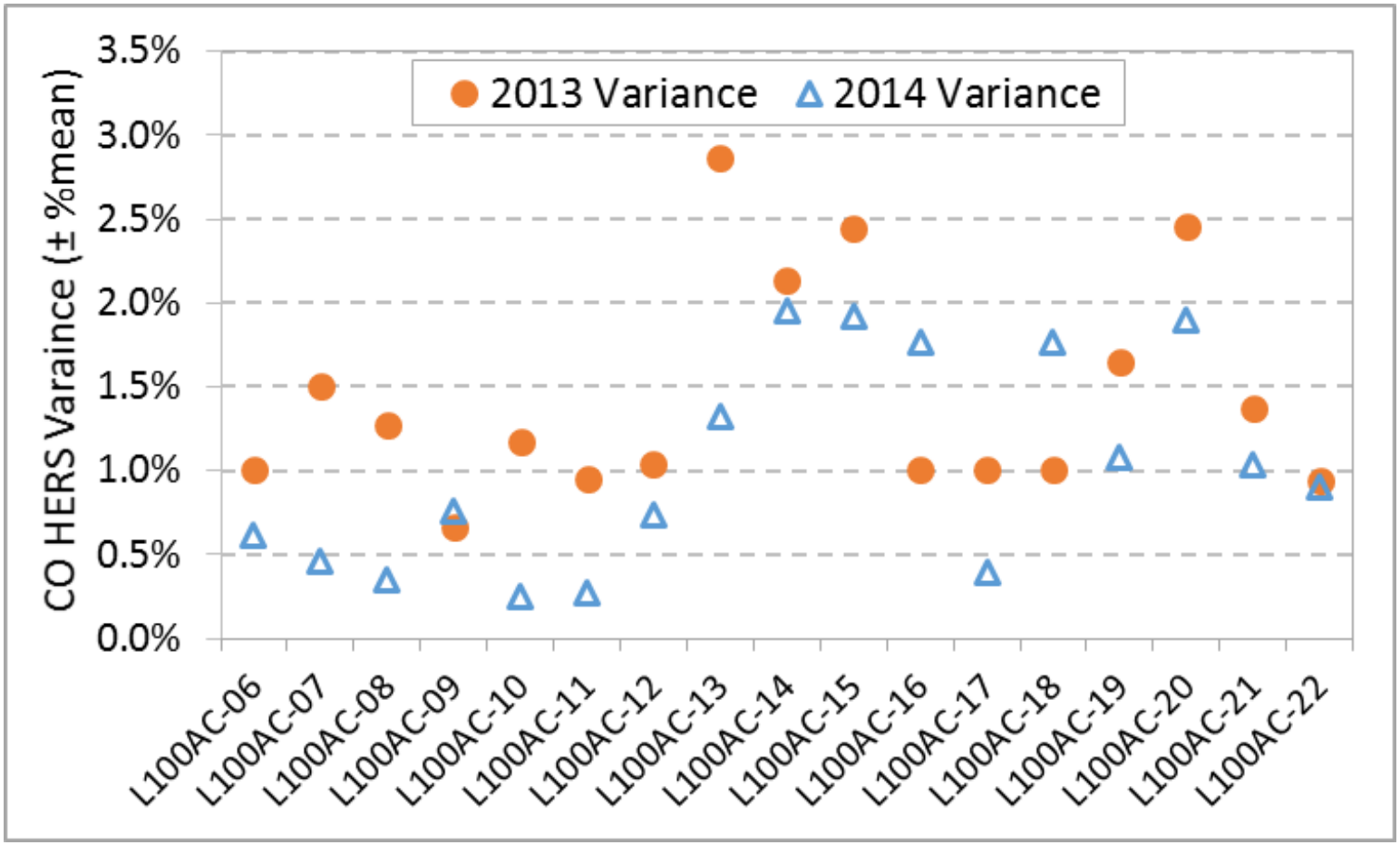
The Better News

- Hot Water loads are almost identical across software tools
- Rated Home hot water energy consumption is also very consistent across software tools
- Some small differences in Rated Home hot water energy consumption exist but can probably be aligned through software tweaks.
- Variance across softwares is reduced by ANSI/RESNET/ICC 301-2014 Standard

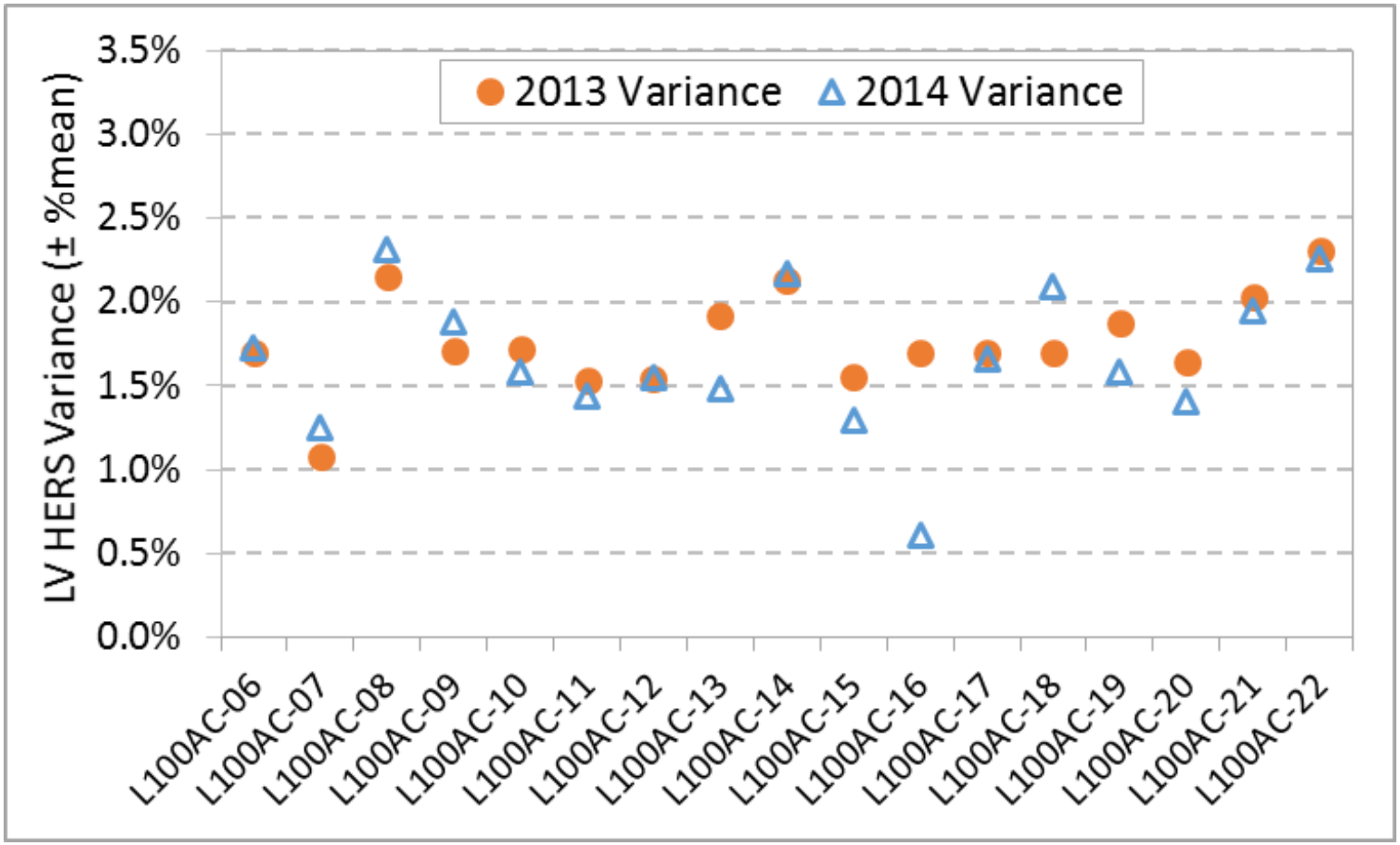
Reference Hot Water Loads: CO



HERS Variance (σ/mean): CO



HERS Variance (σ/mean): LV



Conclusions

- Increases in HERS Index are similar to projections announced in 2012
- HERS Index changes are larger for tools with larger Total Reference Loads (may be the windows?)
- Building load simulation differences are a second order impact in the HERS Index calculation method
- 2014 Standard reduced variance across software tools
- Variance in HERS Index across all tools across all tests is less than ±3% of the mean
- Test results should assist software developers in troubling-shooting software anomalies, likely bringing HERS Index results into closer alignment.

Questions?