U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Home Energy Rating Variability Study

2018 National Energy Codes Conference

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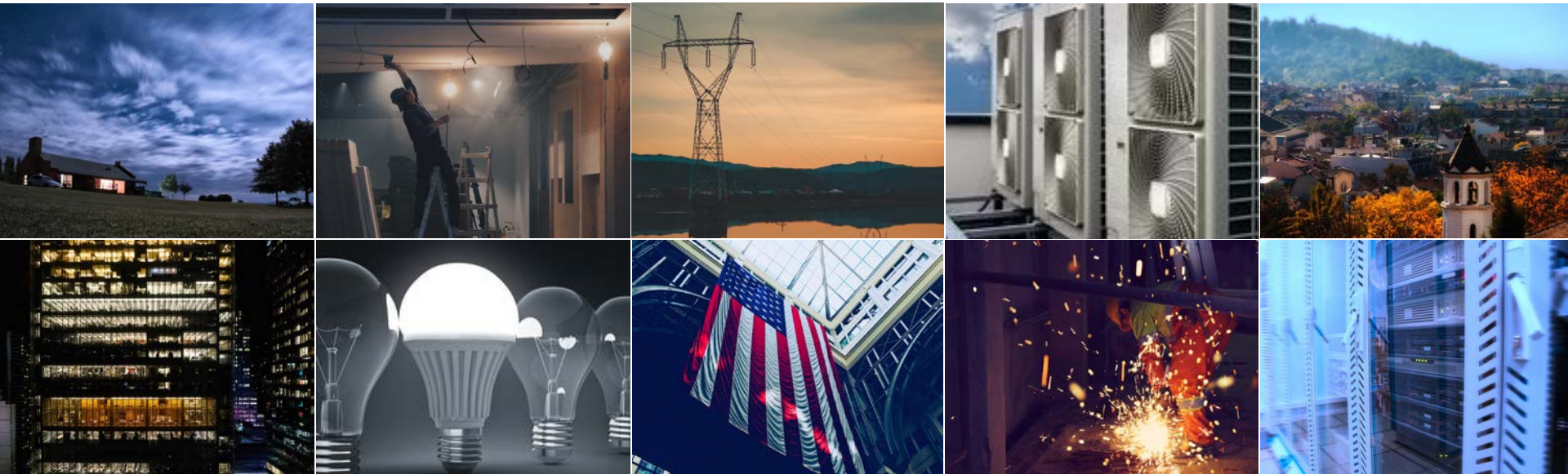

INTRODUCTION

Overview

Question: What variability might be expected under the Energy Rating Index (ERI) path of the IECC?

Summary:

- DOE conducted a study looking at the consistency of home energy ratings
- Targeted limited number of new single-family homes
- Across U.S. climates, as represented across respective REEO regions
- HERS Index was chosen as focus of study

What is a HERS Rating?

- Home Energy Rating System (HERS) is an index used to measure home energy efficiency
- Developed and administered by the Residential Energy Services Network (RESNET)
- Used in both new construction and existing home applications
- A HERS Index portrays the basic energy efficiency of the home, including basic performance and expected energy costs
- Certified HERS Rater assess the efficiency—renders a relative performance score (Rating)
- As energy use decreases, so does the HERS Index—about one point for every one percent improvement (baseline 100)

SOURCE: RESNET; https://www.resnet.us/hers-index

What Does HERS Have to Do with Codes?

- HERS has seen increasing popularity—in recent years several states have added a HERS compliance option
- Common format: HERS Index Score that must be met (or exceeded) in lieu of traditional compliance paths
- HERS Index has also been incorporated directly into the model code
- 2015 IECC introduced new performance path via Section R406—*Energy Rating Index*, or ERI
- Bolstered in 2018 IECC with incorporation of RESNET Standard 301 (by reference)

How to Comply via ERI

CZ	1	2	3	4	5	6	7	8
2015 IECC	52	52	51	54	55	54	53	53
2018 IECC	57	57	57	62	61	61	58	58

- Many stakeholders played a role in establishing the ERI—multiple variations considered as part of ICC process
- IECC settled on approach where home must achieve an ERI at or below (better) than target threshold for each CZ
- Specified targets vary by only one point between most climate zones, and by a range of just five points across all climates
- In addition, must meet at least *mandatory* requirements as well as *prescriptive* envelope requirements of the 2009 IECC

Study Purpose

- Attempt to understand how home energy ratings might function as a compliance mechanism
- Recognizing the ERI (like any new path) introduces new questions, risks and uncertainties to the compliance process
- ERI; shifting roles and responsibilities (third party)
- The precision of the ERI targets established in the IECC underscores the need for consistency in practice
- Specifically, the question of variability expected if enlisting the HERS Index to demonstrate compliance via the ERI path

Study Limitations

- Study should not be considered statistically representative
- Limited number of states and homes
- Blind nature of the study came with certain limitations:
  - Asked raters for a non-confirmed rating
  - Timeframe did not allow for multiple site visits
  - Certain home attributes unobservable in the field
- Study did not attempt to understand the *why* behind the ratings (e.g., input variables that may be the cause of variability)

Methodology

- REEO's sampled eleven homes across each of their six regions—total of **56 individual ratings**
- Identified a house ready for (or near) final inspections
- Each home was assessed by 4-6 different local RESNET-certified HERS raters
- Ratings scheduled over a one-week period (or less) to assure consistent field conditions and no overlap onsite
- The methodology required a blind study and raters were not aware that they were evaluating the same home
- Blindness was crucial to ensuring objectivity and to replicate conditions that could be present when following the ERI path

Methodology

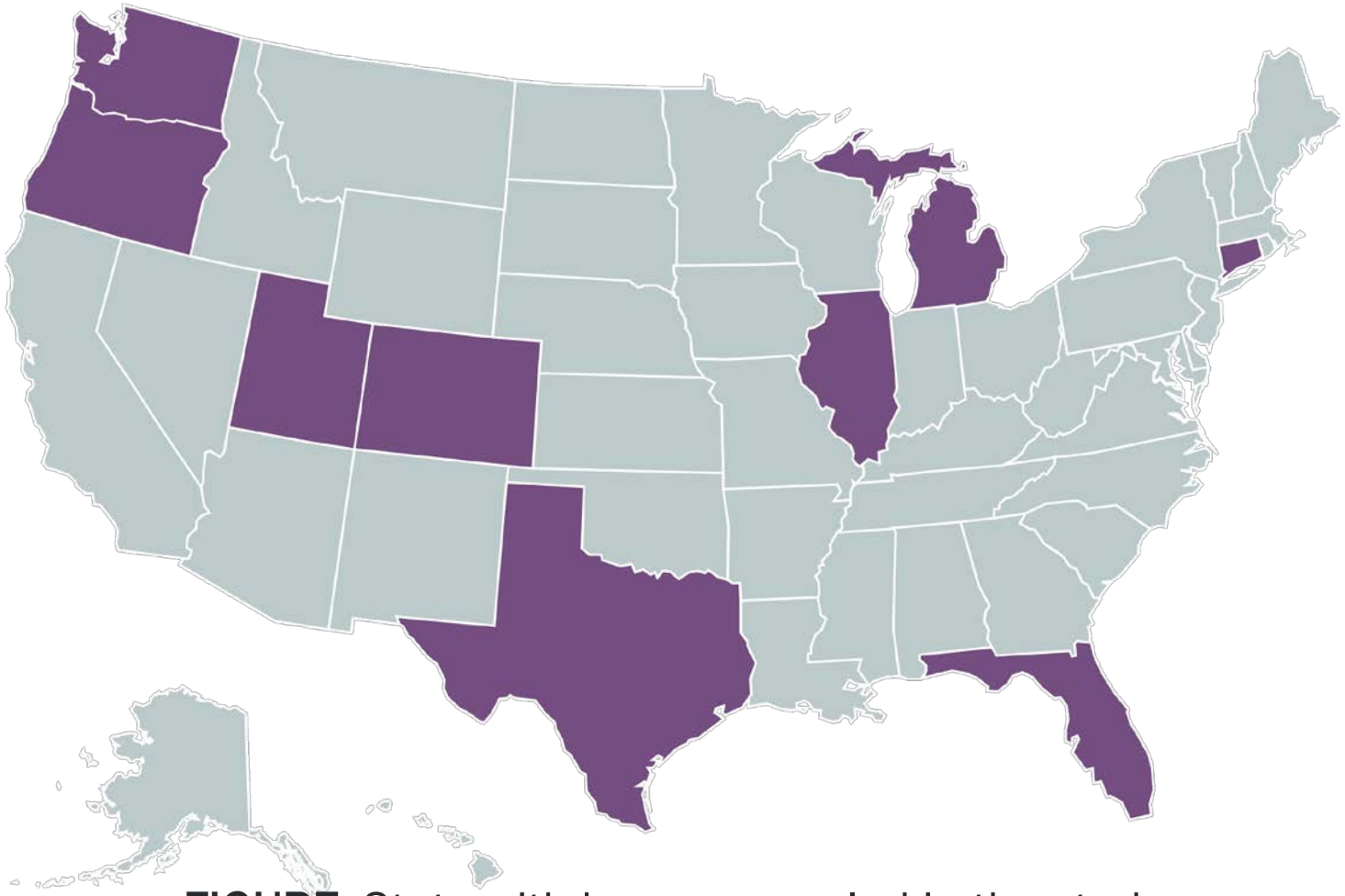

FIGURE: State with homes sampled in the study

Methodology

- Raters were provided construction documentation and conducted onsite verification
- Conducted both plan review and field inspection
- Targeted outputs included the projected *HERS Score* and *annual energy* usage for each home
- Additional data and inputs also summarized
- REEO's coordinated individual home assessments and provided quality control—also coordinated site procedures
- Aggregated data and reported findings to DOE

RESULTS

Results: HERS Score by Home and Location

Location		A	B	C	D	E	F
Seattle, WA		76	71	79	75	74	-
Portland, OR		83	82	86	86	88	-
Orlando, FL		70	74	71	59	-	-
Tallahassee, FL		71	62	72	74	-	-
Dallas-Fort Worth, TX		78	71	79	67	65	64
Austin, TX		69	64	55	75	64	-
Denver, CO		67	70	79	68	99	-
Salt Lake City, UT		42	51	43	50	-	-
Chicago, IL		44	42	51	44	49	40
Grand Rapids, MI		65	60	58	60	-	-
Derby, CT	(with PV)	N/A	55	43	N/A	50	45
	(without PV)	19	N/A	N/A	28	30	22

Results: Project Annual Energy Use (MMBtu)

Location	A	B	C	D	E	F
Seattle, WA	55.01	82.37	83.17	69.80	64.57	
Portland, OR	52.99	55.69	46.26	47.36	54.98	
Dallas-Fort Worth, TX	97.1	89	66	84.5	53.4	78.6
Austin, TX	68.5	50.3	49.4	58.8	62.1	
Denver, CO	141.4	157.4	121.7	105.4	203.4	
Salt Lake City, UT	39.0	44.5	41.8	45.3		
Chicago, IL	61.4	80.2	92.2	83.0	77.3	55.4
Grand Rapids, MI	93.2	60.8	85.0	79.0		
Derby, CT (without PV)	28.4	80.2	44.2	59.3	60.9	

Results: Summary

- Average per-house variability observed in the study was approximately 13 points on the HERS Index
- Single-home variability (max vs. min) ranged from as low of 6 points (Portland) to high of 32 points (Denver)
- The majority of homes (7 of the 11) experienced variability of 10 or more points
- Similarly, projected annual energy consumption ranged from a low of 6.3 MMBtu to a high of 98 MMBtu—averaging 36 MMBtu for an individual home

Other Observations (examples)

- Several inconsistencies span items directly observed by the rater as well as those that were provided as part of the home's construction documents
- Notable examples: Geometry (e.g. floor area), HVAC, equipment set points, number of bedrooms, duct location,
- A wide range of software was noted:
  - The average home being rated using three different versions of software.
  - One home was rated with five different versions of REM/Rate software amongst six raters

NEXT STEPS

Future Research

- Need for a broader study to more fully assess the variability that can be expected under the ERI path
- Address the related question of what levels of variability are ultimately acceptable to the industry
- Help inform areas for targeted training, QA, as well as future ERI targets

- Several individual variables could also benefit from further exploration, including:
  - Delineation of inputs that are prone to subjectivity
  - Variability due to the chosen software package
  - Issues inherent to the rating system and calculation methodology

Study Contributors

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Thanks for attending the 2018 National Energy Codes Conference!