R1968 RNC Baseline and Code Compliance

Final Presentation

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Objectives

1

Characterize non-program baseline homes; represented in energy modeling software as the User-Defined Reference Home (UDRH), the baseline against which program home savings are calculated.

Assess code compliance of non-program and program homes.

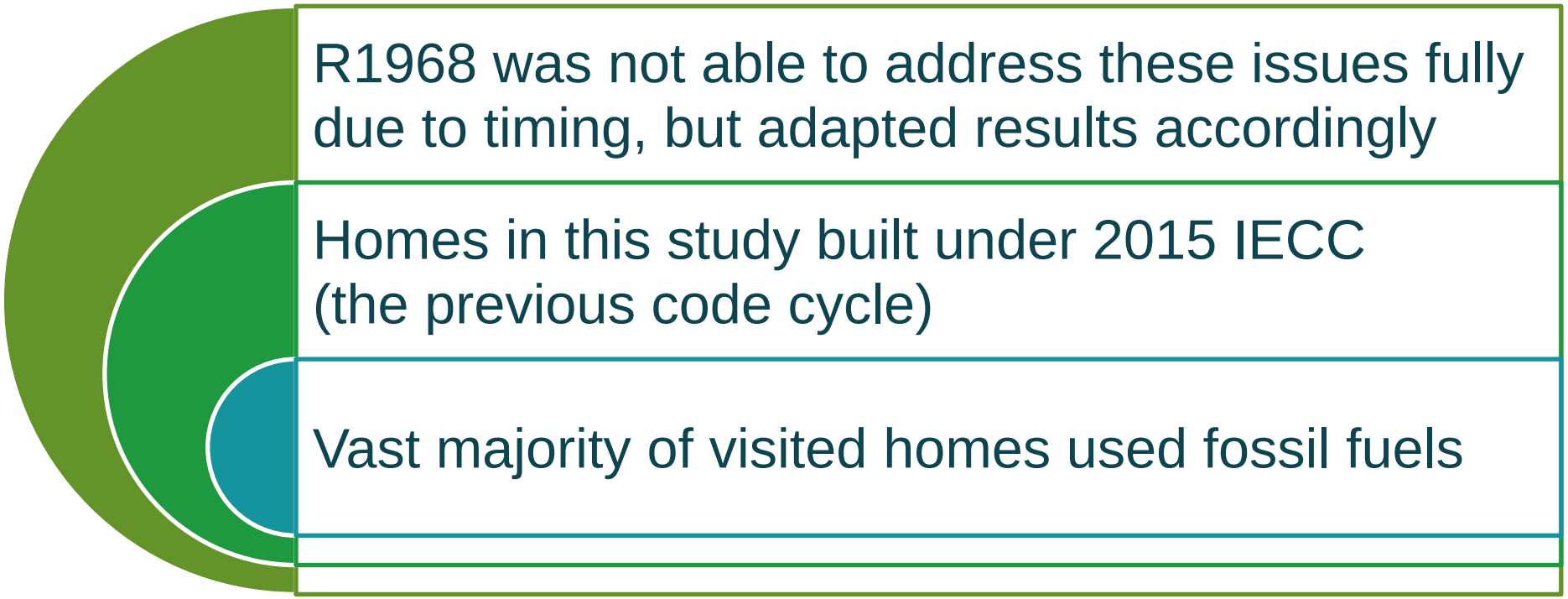
2

Disclaimer due to Mid-Study Market Changes

Code Change:
2015 to 2021 IECC

+

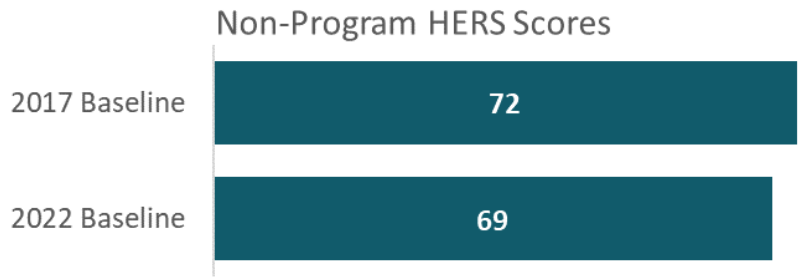
RNC Program Change:
Shift to All-Electric



KEY FINDINGS: Comparisons

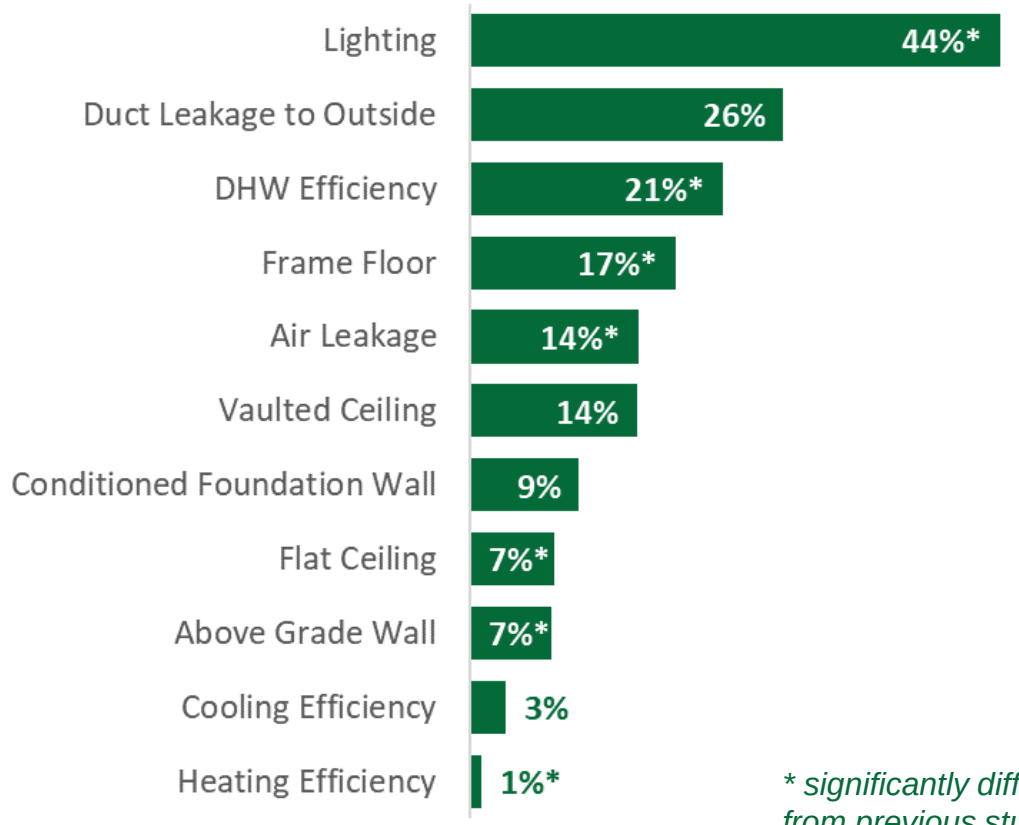
Since the 2017 Baseline (2009 IECC Homes)…

- Non-program HERS index values have improved from 72 to 69 (lower is better)



- All measure level efficiencies have improved, including building shell and mechanical equipment

Measure Level % Improvement

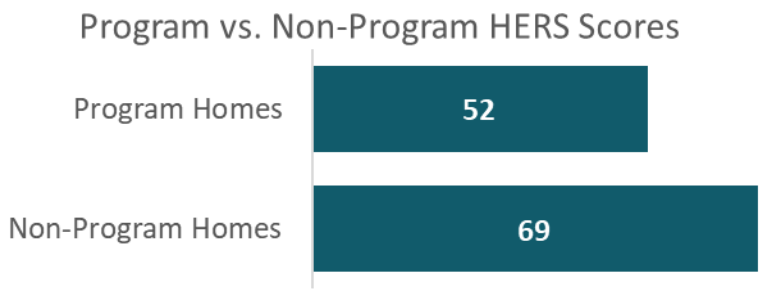


** significantly different from previous study*

KEY FINDINGS: Comparisons

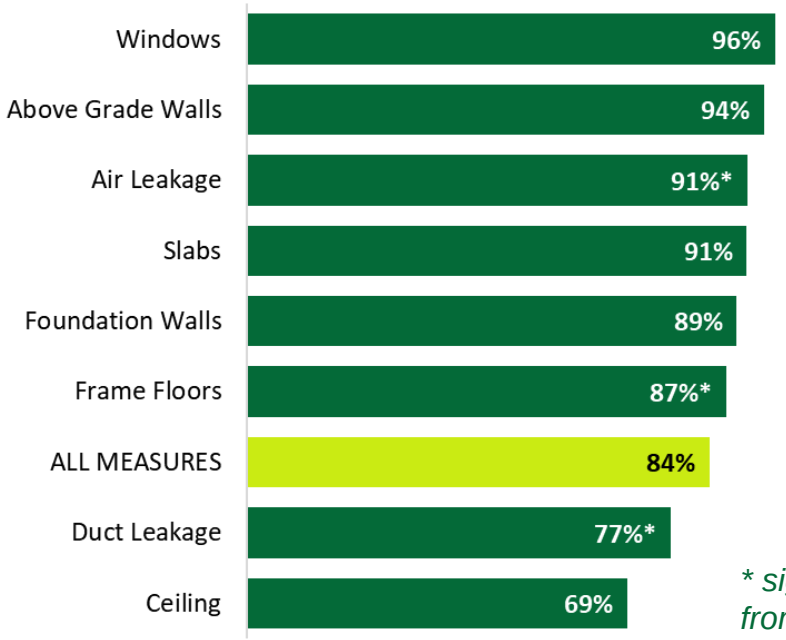
Program vs. Non-Program

- Program home HERS index values are 25% better than non-program on average (lower is better)
- Program homes outperform non-program homes in all individual measure level efficiencies



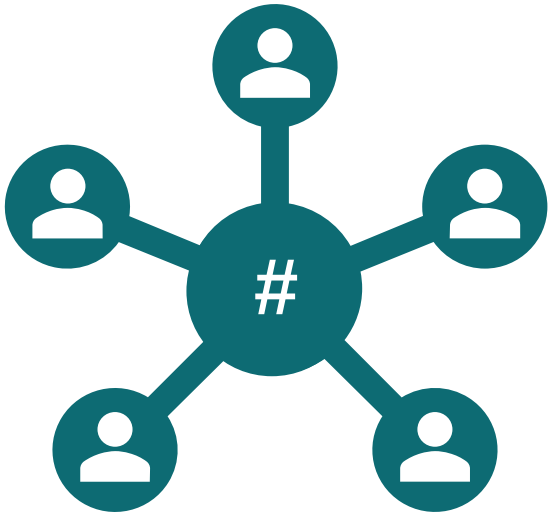
Measure Level Code Compliance

- Non-program code compliance is slightly lower than the previous study
- Lowest levels of compliance are ceilings and duct leakage



** significantly different from previous study*

RECOMMENDATION: Consensus Approach



If allowed, establish a consensus approach to adopting UDRH values

- Allow program administrators, implementers, technical consultants, etc. to weigh-in on UDRH values, in process overseen by EA Team
- UDRH recommendations from this study are best estimates based on available data, but are subject to uncertainty due to program change and new code

Recommended SF UDRH Inputs

Measure		Current	Recommended	
			Pre All-Electric	Post All-Electric
Exterior Wall R-value		20.8	22.3	
Exterior Wall U-value		0.062	0.057	
Flat Ceiling R-value		36.9	39.7	
Flat Ceiling U-value		0.042	0.04	
Vaulted Ceiling R-value		36.7	42.5	
Vaulted Ceiling U-value		0.038	0.031	
Framed Floor R-value		25.6	31	
Framed Floor U-value		0.061	0.05	
Conditioned Foundation Wall R-value		10.9	12	
Window U-factor		0.3	0.29	
Heating System Efficiency	Gas/propane forced air	93.8 AFUE	95.1 AFUE	
	Gas/propane hydronic	89.6 AFUE	95.0 AFUE	10.3 HSPF
	ASHP	10.0 HSPF	10.3 HSPF	
	GSHP	4.0 COP	4.0 COP	4.0 COP
Cooling System Efficiency	GSHP	12.2 EER	12.3 EER	12.3 EER
	All others	14.6 SEER	14.9 SEER	14.9 SEER
Water Heater EF	Gas/propane storage	0.65	0.71	
	Gas/propane integrated	0.89	0.89	1.25 UEF
	Gas/propane tankless	0.94	0.94	
	Electric	1.42	2.03	
Air Infiltration (ACH50)		4.9	4.2	
Duct Leakage to Outside (CFM25/100 ft^2)		6.2	4.6	
% Efficient Lighting (LED and CFL)		54%	100%	

UDRH Methodology

10.3 HSPF Baseline

- Average of all non-program heating systems regardless of fuel
- Fossil fuel systems converted from AFUE to HSPF

MF Adjustment Factors

- Established SF to MF ratio based on program energy models
- Applied ratio to SF results to get MF UDRH inputs

UDRH vs. Code

Measure	Units	Value from Baseline	2015 IECC Requirement	2021 IECC Requirement
Exterior wall	R-value	22.3	20 or 13+5[1]	30 or 20+5 or 20ci[2]
	U-value	0.057	0.060	0.045
Flat ceiling	R-value	39.7	49[3]	60
	U-value	0.04	0.026	0.024
Vaulted ceiling	R-value	42.5	49[3]	60
	U-value	0.031	0.026	0.024
Frame floor over basement	R-value	31	30[4]	30
	U-value	0.05	0.033	0.033
Conditioned foundation wall	R-value	12	15/19[5]	15/19, or 13+5[5]
Air leakage	ACH50	4.2	3.0	3.0
Duct leakage	LTO	4.6	8.0	4.0

[1] Requires R-20 or R-13 in the cavity with R-5 continuous.
[2] 20ci refers to continuous R-20.
[3] R-38 satisfies R-49 requirement where uncompressed R-38 batt extends over wall plates at eaves.
[4] R-19 satisfies requirement if it fills the entire cavity.
[5] R-15 continuous or R-19 cavity, or R-13 cavity and R-5 continuous.

Additional Recommendations

- Conduct additional baseline research for all-electric program
- Make a concerted effort to maintain program participation levels
- Encourage increased compliance with energy code
- Promote the adoption of high-efficiency cold climate heat pumps
- Leverage code compliance enhancement trainings to improve building department documentation
- Increase builders' comfort with continuous wall insulation

Thank You

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Methodology

59 site visits to newly constructed, non-program homes

Collected all data needed to perform a HERS Rating

County targets and custom/spec soft targets

Building department visits focused on multifamily

Multifamily Adjustment Factors

Fuel and System Type	SF Input	MF Adjustment Factor	Suggested MF Input
Above Grade Walls			
Conditioned to Ambient U-value	0.057	1.077	**0.061**
Conditioned to Garage U-value	0.065	NA	**0.065**
Conditioned to Attic U-value	0.063	0.898	**0.057**
Conditioned to Unconditioned Basement and Enclosed Crawl Spaces U-value	0.091	NA	**0.091**
All Unconditioned to Any U-value	0.062	NA	**0.062**
Frame Floors			
Conditioned over Unconditioned Basement and Enclosed Crawl Spaces U-value	0.050	NA	**0.050**
Conditioned over Garage U-value	0.040	0.788	**0.032**
Conditioned over Ambient U-value	0.046	2.094	**0.096**
Conditioned over Open Crawl U-value	0.047	NA	**0.047**
Ceilings			
Flat Attic U-value	0.040	1.000	**0.040**
Vaulted U-value	0.031	0.893	**0.028**
Foundation Walls			
All Conditioned R-Value	12.0	0.566	**6.8**
All Unconditioned R-Value	0.8	NA	**0.8**
Slab Floors			
On Grade Unheated Slab Under R-Value	0	NA	**0**
On Grade Unheated Slab Perim R-Value	5	NA	**5**
On Grade Heated Slab Under R-Value	15	NA	**15**
On Grade Heated Slab Perim R-Value	10	NA	**10**
Below Grade Unheated Slab Under R-Value	0	NA	**0**
Below Grade Unheated Slab Perim R-Value	0	NA	**0**
Below Grade Heated Slab Under R-Value	15	NA	**15**
Below Grade Heated Slab Perim R-Value	10	NA	**10**
Windows			
U-value	0.29	0.967	**0.280**
SHGC	0.29	0.906	**0.263**
Skylights			
U-value	Same as rated home	NA	**Same as rated home**
SHGC	Same as rated home	NA	**Same as rated home**
Doors			
Door U-value	Same as rated home	NA	**Same as rated home**
Air Infiltration			
ACH50	4.2	2.180	**9.16**
Shelter Class	Same as rated home	NA	**Same as rated home**

Heating Systems			
Natural Gas Air Distribution AFUE	94.9	0.987	**93.7**
Natural Gas Hydronic Distribution AFUE	95.0	0.997	**94.7**
Natural Gas Unit Heater AFUE	NA	NA	**NA**
Propane Air Distribution AFUE	95.3	NA	**95.3**
Propane Hydronic Distribution AFUE	95.0	NA	**95.0**
Propane Unit Heater AFUE	NA	NA	**NA**
Oil Air Distribution AFUE	85.0	NA	**85.0**
Oil Hydronic Distribution AFUE	87.0	NA	**87.0**
Oil Fired Unit Heater AFUE	NA	NA	**NA**
Wood Fuel Fired Unit Heater % EFF	NA	NA	**NA**
Kerosene Fuel Fired Unit Heater AFUE	NA	NA	**NA**
ASHP & Ductless Mini-Splits HSPF	10.3	1.019	**10.5**
GSHP COP	4.0	NA	**4.0**
Dual Fuel Heat Pump HSPF (AFUE)	NA	NA	**NA**
Cooling Systems			
Air conditioner SEER (CAC, ASHP, Ductless Mini-spit)	14.9	1.000	**14.9**
GSHP EER	12.3	NA	**12.3**
Water Heaters			
Natural Gas Conventional EF	0.74	NA	**0.74**
Natural Gas Integrated EF	0.87	NA	**0.87**
Natural Gas Instantaneous EF	0.94	1.00	**0.94**
Propane Conventional EF	0.68	NA	**0.68**
Propane Integrated EF	0.87	NA	**0.87**
Propane Instantaneous EF	0.93	NA	**0.93**
Oil Conventional EF	0.65	NA	**0.65**
Oil Integrated EF	NA	NA	**NA**
Oil Instantaneous EF	NA	NA	**NA**
Heat Pump	NA	NA	**NA**
Electric Conventional EF	NA	NA	**NA**
Electric Integrated EF	NA	NA	**NA**
Electric Instantaneous EF	NA	NA	**NA**
Heat Pump and Electric Conventional EF	2.03	NA	**0.88**
Duct Insulation			
Attic Supply Ducts	6.7	NA	**6.7**
All Other Ducts in Unconditioned Space	5.9	NA	**5.9**
Duct Leakage			
Leakage to Outside CFM25/100Sqft	4.6	1.563	**7.19**
Lighting			
% Efficient Lamps	100%	NA	**100%**
Thermostats			
Set Points	68.7, 72.3	NA	**68.7, 72.3**