Energy Savings of Michigan's Proposed 2021 MRC relative to the 2015 MRC for Single-Family Homes

Prepared for:

Home Builders Association of Michigan

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Background

The objective of this analysis was to estimate the annual energy savings of Michigan's proposed 2021 MRC energy code relative to Chapter 11 of the 2015 MRC for single-family detached homes designed in accordance with Prescriptive compliance requirements.

Methodology

Home Innovation estimated annual savings using energy modeling software and a standard reference house with multiple configurations and in two representative locations in Michigan.

The Reference House is a 2-story, 2,400 sq. ft. single-family detached home with a 40' x 30' footprint, adapted from the single-family prototype building used by the U.S. Department of Energy. Additional details on house geometry are provided in Appendix A.

The representative locations and house configurations for this study were as follows:

- Locations (2): Ann Arbor (IECC Climate Zone 5A); Gaylord (CZ-6A)
- Foundation types (3): slab-on-grade; finished basement; unvented crawlspace
- Fuels for heating and hot water (3): natural gas; electric; propane gas

Energy costs were estimated using Ekotrope Rater Version 4.0.1[1] modeling software and fuel prices from PNNL[2] for natural gas ($0.721/therm) and electricity ($0.164/kWh) and from the U.S. Energy Information Agency[3] for propane gas (Michigan average residential, Jan 2024: $2.287/gal).

The Reference Houses were modeled using the prescriptive compliance requirements of the 2015 MRC and 2021 MRC. The specific insulation and fenestration values used are provided in Appendix A. For this analysis, HVAC ducts were assumed to be located 50% inside conditioned space for the 2015 MRC; the 2021 MRC prescriptively requires ducts 100% inside conditioned space. Additional parameters used for energy modeling are also provided in Appendix A.

The modeling results provided a basis to compare annual operating costs and energy use of the 2015 MRC and 2021 MRC for each configuration of reference house. The results were also aggregated within climate zones using weighted averages by fuel type and foundation type, and across climate zones using weighted averages by housing starts. The weighted averages were based on market construction data for Michigan, adapted from Home Innovation's 2024 Builder Practices Data (summarized in Table 4).

The intent of this study was to show a range of estimated energy savings. Results are relative to the reference house characteristics, configurations, and locations. Results could vary considerably for other house designs and locations.

Results

Annual energy costs ($/yr) and percentage savings (2021 MRC vs 2015 MRC) are shown by location and house configuration in Table 1. Table 2 shows results for annual energy use (MBtu/yr) and savings. Table 3 quantifies where the 2021 MRC reference houses did not meet 2021 IECC performance-based compliance. The aggregated results shown in these tables were based on the Michigan market construction data shown in Table 4.

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[1] Ekotrope energy modeling software: Ekotrope.com

[2] Pacific Northwest National Laboratory report PNNL- 31604 *Cost-Effectiveness of the 2021 IECC for Residential Buildings in Michigan*, July 2021.

[3] Energy Information Agency: https://www.eia.gov/

Table 1. Annual Operating Cost for Reference Houses, $/yr

	CZ-5A Ann Arbor			CZ-6A Gaylord		
Configuration	**2015 MRC**	**2021 MRC**	**Savings**	**2015 MRC**	**2021 MRC**	**Savings**
Basement, Nat Gas	2,302	2,012	12.6%	2,408	2,133	11.4%
Basement, Elec	3,996	3,239	18.9%	4,381	3,579	18.3%
Basement, Propane	4,414	3,688	16.4%	4,796	4,106	14.4%
Slab, Nat Gas	1,867	1,671	10.5%	1,977	1,784	9.8%
Slab, Elec	3,240	2,783	14.1%	3,576	3,097	13.4%
Slab, Propane	3,626	3,147	13.2%	4,001	3,527	11.8%
Crawlspace, Gas	1,851	1,614	12.8%	1,974	1,781	9.8%
Crawlspace, Elec	3,202	2,663	16.8%	3,818	3,092	19.0%
Crawlspace, Propane	3,576	2,964	17.1%	3,993	3,519	11.9%
Weighted Average	2,511	2,169	13.6%	3,392	2,942	13.3%
State Average 2015 MRC	2,717					
State Average 2021 MRC	2,349					
State Average Savings	13.5%					

Table 2. Annual Energy Use for Reference Houses, MBtu/yr

	CZ-5A Ann Arbor			CZ-6A Gaylord		
Configuration	**2015 MRC**	**2021 MRC**	**Savings**	**2015 MRC**	**2021 MRC**	**Savings**
Basement, Nat Gas	148.0	121.4	18.0%	163.4	138.0	15.5%
Basement, Elec	83.2	67.4	19.0%	91.2	74.5	18.3%
Basement, Propane	148.0	121.4	18.0%	163.4	138.0	15.5%
Slab, Nat Gas	122.3	104.8	14.3%	137.2	119.8	12.7%
Slab, Elec	67.4	57.9	14.1%	74.4	64.5	13.3%
Slab, Propane	122.3	104.8	14.3%	137.2	119.8	12.7%
Crawlspace, Gas	120.3	97.6	18.9%	136.8	119.5	12.6%
Crawlspace, Elec	66.6	55.4	16.8%	79.5	64.4	19.0%
Crawlspace, Propane	120.3	97.6	18.9%	136.8	119.5	12.6%
Weighted Average	141.7	116.2	18.0%	151.8	128.9	15.0%
State Average 2015 MRC	144.0					
State Average 2021 MRC	119.2					
State Average Savings	17.2%					

Table 3. 2021 MRC Reference House Comparison to 2021 IECC Performance-based Compliance, not met by percentage

	CZ-5A	CZ-6A
Configuration	**2021 MRC**	**2021 MRC**
Basement, Nat Gas	2.1%	2.6%
Basement, Elec	0.8%	1.4%
Basement, Propane	2.1%	2.6%
Slab, Nat Gas	2.1%	2.2%
Slab, Elec	1.2%	1.7%
Slab, Propane	2.2%	2.2%
Crawlspace, Gas	2.5%	2.1%
Crawlspace, Elec	1.7%	1.7%
Crawlspace, Propane	2.7%	2.2%
Weighted Average	2.0%	2.4%
State Average	2.1%	

Table 4. Michigan Market Construction Data[1]

Metric	CZ-5A	CZ-6A[2]
Housing Starts	76.7%	23.3%
Foundation		
Basement	94.2%	75.1%
Slab-on-grade	2.3%	3.3%
Crawlspace	3.3%	21.6%
Total	99.9%	100.0%
Fuel, heating & hot water		
Natural Gas	86.0%	50.8%
Propane	7.8%	42.3%
Electric[3]	5.5%	6.6%
Total	99.3%	99.7%
1. Source: BUILDER PRACTICES DATA, 2024, Home Innovation Research Labs		
2. Michigan CZ-6A data includes IECC CZ-7 data		
3. Includes conventional heat pump, geothermal heat pump, and electric furnace data		

Key Results

1. The average annual operating cost savings of the 2021 MRC relative to the 2015 MRC was 13.5% statewide: 13.6% in CZ-5A (ranged 10.5% - 18.9%) and 13.3% in CZ-6A (ranged 9.8% - 19.0%).
2. The average annual energy use savings of the 2021 MRC relative to the 2015 MRC was 17.2% statewide: 18.0% in CZ-5A (ranged 14.1% - 19.0%) and 15.0% in CZ-6A (ranged 12.6% - 19.0%).
3. The 2021 MRC reference house did meet 2021 IECC performance-based compliance by a statewide average of 2.1%: by 2.0% in CZ-5A (ranged 0.8% - 2.7%) and by 2.4% in CZ-6A (ranged 1.4% - 2.6%).
4. Cost results are relative to the reference house characteristics, configurations, and locations. Results could vary considerably for other house designs and locations.

Appendix A: Reference House Characteristics

The standard reference house for this analysis was defined as a 2-story, 2,400 sq. ft., 4-bedroom single-family detached home with a 40’ x 30’ footprint (Figure 1). This house was adapted from the single-family prototype building created by Pacific Northwest National Laboratory (PNNL) for the U.S. Department of Energy. The parameters represent typical values for building areas and features not dictated by the IECC. The geometric characteristics of the reference house are shown in Table A-1.

The prescriptive insulation and fenestration values used for this study are provided in Table A-2. Additional parameters used for energy modeling for this study are provided in Table A-3.

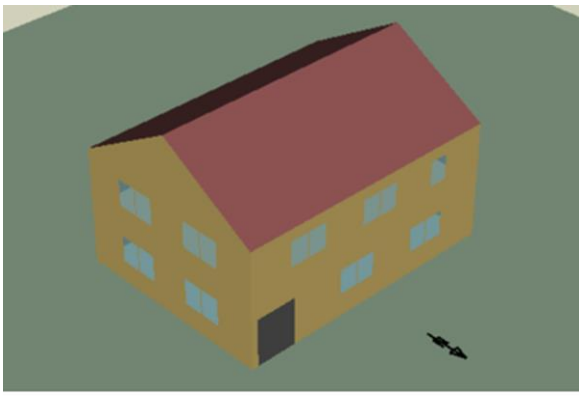

Figure 1. Simulation Model of Standard Reference House

Table A-1. Reference House Geometry

Conditioned floor area, excluding basement	2,400
1st floor CFA	1,200
2nd floor CFA	1,200
Ceiling area, adjacent to vented attic	1,200
Ceiling height, ft.	8.5
Gable Roof slope	7:12 (30.3°)
Gable roof area	1,392
Gable attic wall area	263
Foundation footprint, ft. x ft.	40x30
Foundation perimeter, linear ft.	140
Gross Wall area, excluding rim areas	2,380
Window area, 15% of CFA, equally distributed	360
Door area	42

Table A-2. Insulation and Fenestration Values for Energy Modeling

	CZ-5A (Ann Arbor)		CZ-6A (Gaylord)	
Component	**2015 MRC**	**2021 MRC**	**2015 MRC**	**2021 MRC**
Fenestration, U-factor/SHGC	0.32/NR	0.30/NR	0.32/NR	0.30/NR
Ceiling insulation, R-value	38	49	49	49
Walls (modeled measure in bold)	20 or **13+5**	20 or **13+5**	20 or **13+5**	20 or **13+5**
Basement wall insulation	10/**13**	15ci or **13+5**	15/**19**	15ci or **13+5**
Slab-on-grade, perimeter insulation, depth	10, 2-ft.	10, 4-ft.	10, 4-ft.	10, 4-ft.
Crawlspace, vented, floor insulation	30	30	30	30
Crawlspace, unvented, foundation wall	15/19	15/19/13+5	15/19	15/19/13+5

Table A-3. Reference House Parameters for Energy Modeling

Insulation & fenestration	2015 MRC & 2021 MRC Prescriptive requirements
House tightness	4 ACH50 2015; 3 ACH50 2021
Duct insulation; total duct leakage	R-8; 4 cfm25/100sf cfa
Duct location, % in conditioned space	50% 2015; 100% 2021
Fuel for heat and hot water	Natural Gas, Electric, Propane Gas
HVAC & Water Heater efficiency	2023 Federal minimum
Gas Furnace	80 AFUE
Air Conditioner	14 SEER
Heat Pump	15 SEER, 8.8 HSPF
Gas water heater	50-gallon, 0.56 UEF
Electric water heater	50-gallon, 0.92 UEF
Whole-house mechanical ventilation	Bath exhaust fan, 2.8 cfm/w, ASHRAE 62.2-2010 rate
Thermostat set points	72°F heating, 75°F cooling, no setback
RESNET HVAC Installation Quality, Grade	Grade 1
Lighting, % high efficacy (LED)	75% 2015; 90% 2021
Appliances, kitchen and laundry	ENERGY STAR qualified; all electric
Window interior shade fraction	0.75 summer; 0.85 winter
Exterior overhangs and shading	None
Natural Gas price	PNNL-31604 report, July 2021: $0.721/therm
Electricity price	PNNL-31604 report, July 2021: $0.164/kWh
Propane Gas price	Michigan residential, Jan 2024: $2.287/gal (eia.gov)


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