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MHCC Working Document from October 18-20, 2022 and November 15-17, 2022 MHCC Meetings

Showing changes made to HUD Code based on Department of Energy's (DOE) Energy Conservation Program: Energy Conservation Standards for Manufactured Housing

Changes shown in red indicate MHCC recommended changes to the HUD Code.

Text/changes shown in purple indicate MHCC approved changes made to text originating in Department of Energy's (DOE) Energy Conservation Program: Energy Conservation Standards for Manufactured Housing. Notes are included with each purple change indicating the reason for the modification.

MHCC General Comments:

- The MHCC agrees that the energy efficiency requirements need to be updated but believes the updates should be done incrementally. The recommended changes shown in this document accomplish this incremental approach.
- HUD, by statute, is the body responsible for the development and enforcement of manufactured housing standards.
- The MHCC has reviewed the DOE Final Rule and has determined DOE circumvented the standards development process prescribed in EISA which requires cost justification and consultation with HUD.
- DOE provided an energy conservation standard which was based on site-built construction and applied it to a performance-based national code. If adopted as written, the final rule would adversely impact the entire Manufactured Housing program and cost increases associated with compliance would reduce prospective purchasers (especially minorities and low-income consumers) from durable, safe, high quality and affordable housing.
- The MHCC reviewed the DOE Final Rule and is recommending modifications to the MHCSS based largely on the final rule. The recommended changes increase energy efficiency while maintaining affordability and consumer options.

- The MHCC previously recommended that DOE include the substantial cost of testing, enforcement, and regulatory compliance in its costing analysis. The final rule did not consider these costs. The recommended changes implemented into the MHCSS allow for testing, enforcement, and regulatory compliance within HUD's existing framework which helps minimize costs to manufacturers and ultimately consumers. However, there still may be a gap in enforcement between HUD's final standards and DOE's final rule, which may need to be resolved.
- The MHCC has a statutory obligation to consider the cost impacts of all recommended changes to the MHCSS and preserve affordability to increase American home ownership and this obligation is reflected in the recommended changes.
- The MHCC expects, in accordance with normal practice, the recommendations contained in this document will be subject, as required in 42 USC 5403, to publication as a proposed rule and full notice and comment rulemaking in accordance with the 1974 Act as amended.
- See Appendix A for information and data supporting recommended changes.
- The MHCC's recommendations (1) seek to align the HUD code with the DOE Energy Rule which is based on certain IECC sections, and (2) does not include certain sections as they were either not pertinent to manufactured housing or appropriate for these recommendations. The MHCC acknowledges that the International Energy Conservation Code (IECC) is a copyright protected document, published and owned by the International Code Council (ICC), and that reproduction or copying of the IECC requires written permission or license from the ICC. Copies of the IECC are available for purchase at *www.iccsafe.org*. They may also be viewed for free on ICC's public access website at: *https://codes.iccsafe.org/public/collections/I-Codes*.
  **ICC has requested that this or a similar statement be included in the preamble of the Proposed Rule.*

General Changes:

- 3280: Replace term "U_o Value Zone" with "Climate Zone"

Subpart A - General

§ 3280.1 Scope.

This standard covers all equipment and installations in the design, construction, transportation, fire safety, plumbing, heat-producing, cooling, and electrical systems of manufactured homes which are designed to be used as dwelling units. This standard seeks to the maximum extent possible to establish performance requirements.
In certain instances, however, the use of specific requirements is necessary.

§ 3280.2 Definitions.

Equipment includes materials, appliances, devices, fixtures, fittings or accessories both in the construction of, and in the fire safety, plumbing, heat-producing, cooling, and electrical systems of manufactured homes.

Subpart B - Planning Considerations

§ 3280.103 Light and ventilation.

(e) Mechanical ventilation fan efficacy

1. Whole-house mechanical ventilation system fans must meet the minimum efficacy requirements set forth in the following table except as provided in paragraph (2) of this section.

2. Mechanical ventilation fans that are integral to heating, ventilating, and air conditioning equipment, including furnace fans are not subject to the efficiency requirements in paragraph (1) of this section.

MECHANICAL VENTILATION SYSTEM FAN EFFICACY

Fan type description	Airflow rate minimum (cfm)	Minimum efficacy (cfm/watt)
Heat recovery ventilator or energy recovery Ventilator.	Any	1.2
In-line supply or exhaust fans.	Any	3.8
Other exhaust fan.	<90	2.8
Other exhaust fan.	³90	3.5

SUBPART F – THERMAL PROTECTION

§ 3280.501 Scope.

This subpart sets forth the requirements for energy conservation, condensation control, air infiltration, thermal insulation and certification for heating and cooling.

§ 3280.502 Definitions.

~~(1) *Pressure envelope* means that primary air barrier surrounding the living space which serves to limit air leakage. In construction using ventilated cavities, the pressure envelope is the interior skin.~~

Note: Replace all instances of Pressure envelope with Air Barrier

~~(2) *Thermal envelope* area means the sum of the surface areas of outside walls, ceiling and floor, including all openings. The wall area is measured by multiplying outside wall lengths by the inside wall height from floor to ceiling. The floor and ceiling areas are considered as horizontal surfaces using exterior width and length.~~

Access (to) means that which enables a device, appliance or equipment to be reached by ready access or by a means that first requires the removal or movement of a panel or similar obstruction.

Air barrier means one or more materials joined together in a continuous manner to restrict or prevent the passage of air through the building thermal envelope and its assemblies.

Automatic means self-acting or operating by its own mechanism when actuated by some impersonal influence.

Building thermal envelope means exterior walls, exterior floors, exterior ceiling, or roofs, and any other building element assemblies that enclose conditioned space or provide a boundary between conditioned space and unconditioned space.

Ceiling means an assembly that supports and forms the overhead interior surface of a building or room that covers its upper limit and is horizontal or tilted at an angle less than 60 degrees (1.05 rad) from horizontal.

Climate zone means a geographical region identified in § 3280.506.

Conditioned space means an area, room, or space that is enclosed within the building thermal envelope and that is directly or indirectly heated or cooled. Spaces are indirectly heated or cooled where they communicate through openings with conditioned space, where they are separated from conditioned spaces by uninsulated walls, floors or ceilings, or where they contain uninsulated ducts, piping, or other sources of heating or cooling.

Door means an operable barrier used to block or allow access to an entrance of a manufactured home.

Dropped ceiling means a secondary nonstructural ceiling, hung below the exterior ceiling.

Dropped soffit means a secondary nonstructural ceiling that is hung below the exterior ceiling and that covers only a portion of the ceiling.

Duct means a tube or conduit, except an air passage within a self-contained system, utilized for conveying air to or from heating, cooling, or ventilating equipment.

Duct system means a continuous passageway for the transmission of air that, in addition to ducts, includes duct fittings, dampers, plenums, fans, and accessory air-handling equipment and appliances.

Eave means the edge of the roof that overhangs the face of an exterior wall and normally projects beyond the side of the manufactured home.

Exterior ceiling means a ceiling that separates conditioned space from unconditioned space.

Exterior floor means a floor that separates conditioned space from unconditioned space.

Exterior wall means a wall, including a skylight well, that separates conditioned space from unconditioned space.

Fenestration means vertical fenestration and skylights.

Floor means a horizontal assembly that supports and forms the lower interior surface of a building or room upon which occupants can walk.

Glazed or glazing means an infill material, including glass, plastic, or other transparent or translucent material used in fenestration.

Note: *MHCC only included a portion of the definition in 16 cfr 460.2 because that definition was specific to House insulation.*

Insulation means any material mainly used to slow heat flow. It may be mineral or organic, fibrous, cellular, or reflective. It may be in rigid, semirigid, flexible, or loose-fill form.

Manual means capable of being operated by personal intervention.

Opaque door means a door that is not less than 50 percent opaque in surface area.

R-value (thermal resistance) means the inverse of the time rate of heat flow through a body from one of its bounding surfaces to the other surface for a unit temperature difference between the two surfaces, under steady state conditions, per unit area ($h \times ft^2 \times °F/Btu$).

Rough opening means an opening in the exterior wall or roof, sized for installation of fenestration.

Skylight means glass or other transparent or translucent glazing material, including framing materials, installed at an angle less than 60 degrees (1.05 rad) from horizontal, including unit skylights, tubular daylighting devices, and glazing materials in solariums, sunrooms, roofs and sloped walls.

Skylight well means the exterior walls underneath a skylight that extend from the interior finished surface of the exterior ceiling to the exterior surface of the location to which the skylight is attached.

Solar heat gain coefficient (SHGC) means the ratio of the solar heat gain entering a space through a fenestration assembly to the incident solar radiation. Solar heat gain includes directly transmitted solar heat and absorbed solar radiation that is then reradiated, conducted, or convected into the space.

Thermostat means an automatic control device used to maintain temperature at a fixed or adjustable set point.

U-factor (thermal transmittance) means the coefficient of heat transmission (air to air) through a building component or assembly, equal to the time rate of heat flow per unit area and unit temperature difference between the warm side and cold side air films (Btu/h × ft^2 × °F).

U_O (overall thermal transmittance) means the coefficient of heat transmission (air to air) through the building thermal envelope, equal to the time rate of heat flow per unit area and unit temperature difference between the warm side and cold side air films (Btu/ h × ft^2 × °F).

Ventilation means the natural or mechanical process of supplying conditioned or unconditioned air to, or removing such air from, any space.

Vertical fenestration means windows (fixed or moveable), opaque doors, glazed doors, glazed block and combination opaque and glazed doors composed of glass or other transparent or translucent glazing materials and installed at a slope of greater than or equal to 60 degrees (1.05 rad) from horizontal.

Wall means an assembly that is vertical or tilted at an angle equal to greater than 60 degrees (1.05 rad) from horizontal that encloses or divides an area of a building or room.

Whole-house mechanical ventilation system means an exhaust system, supply system, or combination thereof that is designed to mechanically exchange indoor air with outdoor air when operating continuously or through a programmed intermittent schedule to satisfy the whole house ventilation rates.

Window means glass or other transparent or translucent glazing material, including framing materials, installed at an angle greater than 60 degrees (1.05 rad) from horizontal.

Note: *MHCC did not include definition for "Zone" from DOE Rule.*
MHCC Reason: *Zone is a commonly used term in the industry, and only appears in this context once in the standard. The definition provided is typically used for HVAC zones. The term zone is used in many different places in the standard, typically referring to climate zone.*
~~*Zone means a space or group of spaces within a manufactured home with heating or cooling requirements that are sufficiently similar so that desired conditions can be maintained using a single controlling device.*~~

§ 3280.503 Materials.

(a) Installation of Insulation - Insulating materials must be installed according to the insulation manufacturer's installation instructions and the requirements set forth in table below

INSTALLATION OF INSULATION

Component	Installation requirements
General	Air-permeable insulation must not be used as a material to establish the air barrier.
Access hatches, panels, and doors	Access hatches, panels, and doors between conditioned space and unconditioned space, such as attics and crawlspaces, must be insulated to a level equivalent to the insulation of the surrounding surface, must provide access to all equipment that prevents damaging or compressing the insulation, and must provide a wood framed or equivalent baffle or retainer when loose fill insulation is installed within an exterior ceiling assembly to retain the insulation both on the access hatch, panel, or door and within the building thermal envelope.
Baffles	For air-permeable insulations in vented attics, a baffle must be installed adjacent to soffit and eave vents, when needed in order to maintain 1 inch minimum air space between insulation and roof decking. Baffles, when used in conjunction with eave venting, must be constructed using a solid material, maintain an opening equal or greater than the size of the vents, and extend over the top of the attic insulation
Ceiling or attic	The insulation in any dropped ceiling or dropped soffit must be aligned with the air barrier.

Narrow cavities	Batts to be installed in narrow cavities must be cut to fit or narrow cavities must be filled with insulation that upon installation readily conforms to the available cavity space.
Rim joists	Rim joists must be insulated such that the insulation maintains permanent contact with the exterior rim board.
Shower or tub adjacent to exterior wall	Exterior walls adjacent to showers and tubs must be insulated.
Walls	Air permeable exterior building thermal envelope insulation for framed exterior walls must completely fill the cavity, including within stud bays caused by blocking lay flats or headers.

§ 3280.505 Air infiltration.

(a) Envelope air infiltration. The opaque envelope shall be designed and constructed to limit air infiltration to the living area of the home. Any design, material, method or combination thereof which accomplishes this goal may be used. The goal of the infiltration control criteria is to reduce heat loss/heat gain due to infiltration as much as possible without impinging on health and comfort and within the limits of reasonable economics.

~~(1) Envelope penetrations. Plumbing, mechanical and electrical penetrations of the pressure envelope not exempted by this part, and installations of window and door frames shall be constructed or treated to limit air infiltration. Penetrations of the pressure envelope made by electrical equipment, other than distribution panel boards and cable and conduit penetrations, are exempt from this requirement. Cable penetrations through outlet boxes are considered exempt.~~
~~(2) Joints between major envelope elements. Joints not designed to limit air infiltration between wall-towall, wall-to-ceiling and wall-to-floor connections shall be caulked or otherwise sealed. When walls are constructed to form a pressure envelope on the outside of the wall cavity, they are deemed to meet this requirement.~~

(1) Manufactured homes must be sealed against air leakage at all joints, seams, and penetrations associated with the building thermal envelope in accordance with the component manufacturer's installation instructions and the requirements set forth in the table below Sealing methods between dissimilar materials must allow for differential expansion, contraction, and mechanical vibration, and must establish a continuous air barrier upon installation of all opaque components of the building thermal envelope. All gaps and penetrations in the exterior ceiling, exterior floor, and exterior walls, including ducts, flue shafts, plumbing, piping, electrical wiring, utility penetrations, bathroom and kitchen exhaust fans, recessed lighting fixtures adjacent to unconditioned space, and light tubes adjacent to unconditioned space, must be sealed with caulk, foam, gasket or other suitable material.

AIR BARRIER INSTALLATION CRITERIA	
Component	Air barrier criteria
Ceiling or attic	The air barrier in any dropped ceiling or dropped soffit must be aligned with the insulation and any gaps in the air barrier must be sealed with caulk, foam, gasket, or other suitable material. Access hatches, panels, and doors, drop-down stairs, or knee wall doors to unconditioned attic spaces must be weather- stripped or equipped with a gasket to produce a continuous air barrier.
Note: *MHCC changed the title of "Duct system register boots" from the DOE rule.* ***MHCC Reason:*** *Change terminology to be consistent with terms used in the MH industry. Not changing the intent of the practice.*	
Supply and return ducts	Supply and return ducts that penetrate the building thermal envelope or the air barrier must be sealed to the subfloor, wall covering or ceiling penetrated by the duct, air barrier, or the interior finish materials with caulk, foam, gasket, or other suitable material.
Electrical box or phone box on exterior walls	The air barrier must be installed behind electrical and communication boxes or the air barrier must be sealed around the box penetration with caulk, foam, gasket, or other suitable material.
Floors	The air barrier must be installed at any exposed edge of insulation. The bottom board may serve as the air barrier.
Mating line surfaces	Mating line surfaces must be equipped with a continuous and durable gasket.
Recessed lighting	Recessed light fixtures installed in the building thermal envelope must be sealed to the drywall with caulk, foam, gasket, or other suitable material.
Rim joists	The air barrier must enclose the rim joist to subfloor interface. ***Note:*** *The MHCC replaced "The air barrier must enclose the rim joists. The junctions of the rim board and the subfloor must be air sealed." From the DOE Rule with the language above.*

	MHCC reason: *Proposed language provides more clarity.*
Shower or tub adjacent to exterior wall	The air barrier must separate showers and tubs from exterior walls when interior wall surface is used as an air barrier ***Note:*** *MHCC added additional language to clarify placement, location, and proper use of air barrier.*
Walls	The junction of the top plate and the exterior ceiling, and the junction of the bottom plate and the exterior floor, along exterior walls must be sealed with caulk, foam, gasket, or other suitable material.
Windows, skylights, and exterior doors	The rough openings around windows, exterior doors and skylights must be sealed with caulk or foam, or other suitable material. ***Note:*** *MHCC added ", or other suitable material to provide more flexibility in methods used to seal rough openings.*

§ 3280.506 ~~Heat loss/heat gain~~ Building Thermal Envelope and Climate Zones.

(a) Compliance options. The building thermal envelope must meet either the performance requirements of this section or the prescriptive requirements of section 3280.507. The climate zone shall be determined from the map in figure 1 and table XX.

Note: Rename title of Figure 1 U/o Value Zone Map to Climate Zone Map and remove U values from map. Add table "US states and territories per climate zone" below climate zone map.

U.S. STATES AND TERRITORIES PER CLIMATE ZONE

Zone 1	Zone 2	Zone 3
Alabama	Arkansas	Alaska
American Samoa	Arizona	Colorado
Florida	California	Connecticut
Georgia	Kansas	Delaware
Guam	Kentucky	District of Columbia
Hawaii	Missouri	Idaho
Louisiana	New Mexico	Illinois
Mississippi	North Carolina	Indiana
South Carolina	Oklahoma	Iowa
Texas	Tennessee	Maine

The Commonwealth of Puerto Rico U.S. Virgin Islands		Maryland Massachusetts Michigan Minnesota Montana Nebraska Nevada New Hampshire New Jersey New York North Dakota Ohio Oregon Pennsylvania Rhode Island South Dakota Utah Vermont Virginia Washington West Virginia Wisconsin Wyoming

(b) The manufactured home heat loss/heat gain shall be determined by methods outlined in §§ 3280.508 and 3280.509. The ~~Uo (Coefficient of heat transmission) value~~ climate zone for which the manufactured home is acceptable and the lowest outdoor temperature to which the installed heating equipment will maintain a temperature of 70 F shall be certified as specified in § 3280.510. ~~The Uo value zone shall be determined from the map in figure 1.~~

(c) The overall coefficient of heat transmission (Uo) of the manufactured home for the respective zones and an indoor design temperature of 70 F, including internal and external ducts, and excluding infiltration, ventilation, and condensation control, shall not exceed the Btu/(hr.) (sq. ft.) (F) of the manufactured home envelope are as tabulated in the table to this paragraph (b):

TIER 1 BUILDING THERMAL ENVELOPE PERFORMANCE REQUIREMENTS	
Climate zone	Single Section Uo
1	0.110
2	0.091
3	0.074

TIER 2 BUILDING THERMAL ENVELOPE PERFORMANCE REQUIREMENTS	
Climate zone	Single Section Uo
1	~~0.082~~ 0.090
2	~~0.066~~ 0.076
3	~~0.055~~ 0.061

MHCC Reason: *Consistent with Table 2 Tier 2 Building Thermal Envelope Prescriptive Requirements.*

(2) Area-weighted average vertical fenestration U-factor must not exceed 0.48 in Climate Zone 2 or 0.40 in Climate Zone 3.

(3) Area-weighted average skylight U-factor must not exceed 0.75 in Climate Zone 2 and Climate Zone 3. Windows, skylights and doors containing more than 50 percent glazing by area must satisfy the SHGC requirements established in Section XX on the basis of an area- weighted average.

~~Table 1 to Paragraph (b)~~

~~Uo value zone~~	~~Maximum coefficient of heat transmission~~
~~1~~	~~0.116 Btu/(hr.) (sq. ft.) (F).~~
~~2~~	~~0.096 Btu/(hr.) (sq. ft.) (F).~~
~~3~~	~~0.079 Btu/(hr.) (sq. ft.) (F).~~

~~d) Manufactured homes designed for Uo Value Zone 3 shall be factory equipped with storm windows or insulating glass.~~

§ 3280.507 ~~Comfort heat gain.~~ Prescriptive Compliance Path

~~Information necessary to calculate the home cooling load shall be provided as specified in this part.~~

~~*Transmission heat gains.* Homes complying with this section shall meet the minimum heat loss transmission coefficients specified in § 3280.506(a).~~

(a) The building thermal envelope must meet the applicable minimum R-value (nominal value of insulation), and the glazing maximum U-factor and SHGC, requirements set forth in table 1 and table 2 or component U-values set forth in table 3 and table 4

TABLE 1 TIER 1 (single section) BUILDING THERMAL ENVELOPE PRESCRIPTIVE REQUIREMENTS

Climate zone	Exterior wall insulation R-value	Exterior ceiling insulation R-value	Exterior floor insulation R-value	Window U-factor	Skylight U-factor	Door U-Factor	Glazed fenestration SHGC
1	13	22	19	~~1.08~~0.55	0.75	0.40	0.6
2	13	22	22	0.5	0.55	0.40	0.7
3	19	22	22	0.35	0.55	0.40	Not Applicable

Note: *Technical Correction: Exterior Floor Insulation R value and Glazed fenestration SHGC for climate zones 1 and 2.*

TABLE 2 TIER 2 (multi-section) BUILDING THERMAL ENVELOPE PRESCRIPTIVE REQUIREMENTS

Climate zone	Exterior wall insulation R-value	Exterior ceiling insulation R-value	Exterior floor insulation R-value	Window U-factor	Skylight U-factor	Door U-Factor	Glazed fenestration SHGC
1	13	30	13	~~0.32~~0.50	0.75	0.40	~~0.33~~0.60
2	~~21~~13	30	19	~~0.30~~0.35	0.55	0.40	~~0.25~~0.33
3	~~21~~15	38	~~30~~25	~~0.30~~0.32	0.55	0.40	Not Applicable

MHCC Reason: *Reduction in insulation requirements in walls leads to being able to continue building homes with 2x4 walls in all Climate Zones. Maintains more consumer options and amenities such as: cathedral ceilings, natural lighting, and material availability. Maintains transportation height for most industry designs. Additional transportation height leads to extra costs for additional transportation vehicles. These values are much more consistent with our statutory requirements to maintain affordability while improving energy efficiency. The values shown in the table would lead to an average increase in energy efficiency of 22%. The DOE values did not provide any payback to the consumer based on additional construction costs.*

MHCC Reason: *Additional language added for clarification of how to apply R-value requirements.*

1) *For the purpose of compliance with the exterior ceiling insulation R-value requirement of ~~paragraph of~~ this section, the R-value corresponds to the unrestricted insulation depth and the truss heel height must be a minimum of 5.5 inches at the outside face of each exterior wall.*

2) A combination of R-~~21~~ 19 batt insulation and R-~~14~~ 11 blanket insulation may be used for the purpose of compliance with the floor insulation R-value requirement of table 2 Climate Zone 3. Climate zones 1 and 2 may use blanket insulation with a minimum R 5 increase above tabulated values. Compression of the insulation in the cantilevered portion of the floor is acceptable.

Note: *MHCC added additional language to allow use of blanket insulation in all climate zones. Consistent with Table 2 Tier 2 Building Thermal Envelope Prescriptive Requirements.*

3) An individual skylight that has an SHGC that is less than or equal to 0.30 is not subject to the glazed fenestration SHGC requirements established in this section.

4) U-factor alternatives to R-value requirements. Compliance with the applicable requirements of this section may be determined using the applicable maximum U-factor values set forth in table 3 and table 4 which reflect the thermal transmittance of the component, excluding fenestration, and not just the insulation of that component, as an alternative to the minimum nominal R-value requirements set forth in table 1 and table 2 respectively.

TABLE 3 *U*-FACTOR ALTERNATIVES TO TIER 1 *R*-VALUE REQUIREMENTS

Climate Zone	Exterior ceiling U-factor	Exterior wall U-factor	Exterior floor U-factor
1	0.061	0.094	0.056
2	0.061	0.094	0.049
3	0.061	0.068	0.049

Note*: MHCC corrected climate zone locations (1 And 2) for Exterior floor U factor.*

TABLE 4 *U*-FACTOR ALTERNATIVES TO TIER 2 R-VALUE REQUIREMENTS

Climate Zone	Exterior ceiling U-factor	Exterior wall U-factor	Exterior floor U-factor
1	0.043	0.094	0.078
2	0.043	~~0.063~~ 0.094	0.056
3	0.037	~~0.063~~ 0.076	~~0.032~~ 0.036

MHCC Reason: *Consistent with Table 2 Tier 2 Building Thermal Envelope Prescriptive Requirements.*

Subpart G - Plumbing Systems

§ 3280.602 Definitions.

Distribution Manifold means a manufactured device that serves as a central control hub for a water distribution system.
Note: Additional definition based on requirements in 460.203d

Heated water circulation system means a water distribution system in which one or more pumps are operated in the ~~service~~ hot water supply ~~system~~ piping to circulate heated water from the water heating equipment to fixtures and back to the water heating equipment.

~~Service~~ hot water supply means supply of hot water for purposes other than comfort heating.
Note: *MHCC wishes to keep current terminology to avoid confusion.*

§ 3280.609 Water distribution systems.

§ 3280.609(a)(2) Hot water supply. Each manufactured home equipped with a kitchen sink, and bathtub and/or shower shall be provided with a hot water supply system including a listed water heater.

~~(a) Service hot water systems installed by the manufacturer must be installed according to the service hot water manufacturer's installation instructions. Where service hot water systems are installed by the manufacturer, the manufacturer must ensure that any maintenance instructions received from the service hot water system manufacturer are provided with the manufactured home. The service hot water requirements are adapted from R403 of the 2021 IECC.~~
Note: *3280.709(a) requires that all appliances are installed by product manufacturers' listing and installation instructions. This would be a redundant requirement.*

~~(b) Any automatic and manual controls, temperature sensors, pumps associated with service hot water systems must provide access.~~
Note: *3280.709(a) and 3280.713 require that all appliances are installed by product manufacturers' listing and installation instructions and requires access. This would be a redundant requirement.*

(i) When installed, a heated water circulation systems must—
Note: *Clarifying that heated water circulation systems are not mandatory.*

(1) Be provided with a circulation pump;
(2) Ensure that the system return pipe is a dedicated return pipe or a cold water supply pipe;
(3) Not include any gravity or thermosyphon circulation systems;
(4) Ensure that controls for circulating heated water circulation pumps start the pump based on the identification of a demand for hot water within the occupancy; and
(5) Ensure that the controls automatically turn off the pump when the water in the circulation loop is at the desired temperature and when there is no demand for hot water.

(ii) All hot water pipes—
(1) Outside conditioned space must be insulated to a minimum R-value of R-3; and
(2) From a ~~service~~ hot water supply to a distribution manifold must be insulated to a minimum R-value of R-3.
Note: *Uniform terminology.*

Subpart H - Heating, Cooling and Fuel Burning Systems

§ 3280.702 Definitions.

~~Air duct means conduits or passageways for conveying air to or from heating, cooling, air conditioning or ventilation equipment, but not including the plenum.~~

Duct means a tube or conduit, except an air passage within a self-contained system, utilized for conveying air to or from heating, cooling, or ventilating equipment.

Duct system means a continuous passageway for the transmission of air that, in addition to ducts, includes duct fittings, dampers, plenums, fans, and accessory air-handling equipment and appliances.

§ 3280.704 ~~[Reserved]~~ Thermostats and Controls

(a) At least one thermostat must be provided for each separate heating and cooling system installed by the manufacturer and shall be placed a minimum of 3 feet from the vertical edge of the appliance compartment door. Thermostats shall not be located on an exterior wall or on a wall separating the appliance compartment from a habitable room.
Note: *Additional language was moved from 3280.707(e).*

(b) Any programmable thermostat installed by the manufacturer that controls the heating or cooling system must—
(1) Be capable of controlling the heating and cooling system on a daily schedule to maintain different temperature set points at different times of the day and different days of the week;
(2) Include the capability to set back or temporarily operate the system to maintain zone temperatures down to 55F (13C) or up to 85F (29C)

(c) ~~(3) Initially be programmed with a heating temperature set point no higher than 70F (21C) and a cooling temperature set point no lower than 78F (26C)~~.
Homeowner manual must include recommendation that homeowners set or program thermostat with a heating temperature set point no higher than 70F (21C) and a cooling temperature set point no lower than 78F (26C).
Note: *MHCC is modifying language of (3) because a programable thermostat is optional, so one preprogrammed from the factory is unnecessary and the MHCC believes adding the language to the homeowner's manual is a more effective method to influence homeowner behavior. Typically, power is not continuously connected to unit once its constructed and preprogrammed settings may be lost without power.*

~~(c) Heat pumps with supplementary electric-resistance heat must be provided with controls that, except during defrost, prevent supplemental heat operation when the heat pump~~

~~compressor can meet the heating load.~~

Note: *3280.709(a) requires that all appliances are installed by product manufacturers' listing and installation instructions. This would include controls.*

§ 3280.707 Heat producing appliances.

5) ~~Each space heating, cooling or combination heating and cooling system shall be provided with at least one readily adjustable automatic control for regulation of living space temperature. The control shall be placed a minimum of 3 feet from the vertical edge of the appliance compartment door. It shall not be located on an exterior wall or on a wall separating the appliance compartment from a habitable room.~~

§ 3280.714 Appliances, Cooling.

§3280.714(a)(1) (i) Electric motor-driven unitary air-cooled air conditioners and heat pumps in the cooling mode with rated capacity less than 65,000 BTU/hour (19,045 watts), when rated at ARI standard rating conditions in ARI Standard 210/240-89, Unitary Air-Conditioning and Air-Source Heat Pump Equipment, must have seasonal energy efficiency ratio (SEER2) values not less than as specified in 10 C.F.R. Part 430, Energy Conservation Program for Consumer Products: Central Air Conditioners and Heat Pumps Energy Conservation Standards.

Note: *Term updated from SEER to SEER2 to reflect EPA Final Rule 87 FR 18290 (10 CFR Part 430 Appendix M(1) Uniform Test Method for Testing for Measuring the Energy Consumption of Central Air Conditioners and Heat Pumps).*

§ 3280.715 Circulating air systems.

(a) *Supply system.*

(4)

(a) Factory installed supply ducts located partially or completely outside the building thermal envelope, with or without air handlers installed in the factory, shall demonstrate air leakage to the outside or total air leakage of less than or equal to 4 cfm per 100 ft2 of conditioned floor area when tested at a difference pressure of 0.1 inch w.g., (25pa).

(b) Factory installed supply ducts located completely inside the building thermal envelope, with or without air handlers installed in the factory, shall demonstrate air leakage to the outside or total air leakage of less than or equal to 8 cfm per 100 ft2 of conditioned floor area when tested at a difference pressure of 0.1 inch w.g., (25pa).

(c) Manufacturers must perform an IPIA witnessed duct leakage test at least once per month.

Note: *Original language from DOE rule* was modified to fit with previously approved language.

"Each manufactured home equipped with a duct system, which may include air handlers and filter boxes, must be sealed to limit total air leakage to less than or equal to four (4) cubic feet per minute per 100 square feet of conditioned floor area at a pressure differential of 0.1 inch w.g. (25 Pascals) across the system. Building framing cavities must not be used as ducts or plenums when

directly connected to mechanical systems. The duct total air leakage requirements are adapted from section R403 of the 2021 IECC."

MHCC Reason: *The suggested DOE testing method is not practical for a factory-built home. This recommendation considered previously approved MHCC language for this section. The 8 cfm testing point in section (b) was added as this is an option for ducts entirely within the thermal envelope in IECC, which DOE failed to include. The MHCC believes that a minimum of 1 IPIA witnessed test a month would be sufficient due to the controlled environment of the manufacturing process in a factory compared to a site-built home. The MHCC has no reason to disagree with the DOE estimated cost of testing per 5.3.7 of the TSD.*

§ 3280.716 Equipment Sizing.

Note: *MHCC does not recommend adopting the language shown in 10 C.F.R. § 460.205.*

MHCC Reason:

1) *Manufactured housing is transportable and typically not built for a site-specific location. The ACCA Manual J and ACCA Manual S calculations are intended for site specific code and cannot be applied to a national performance-based code. The manufacturer cannot properly complete the ACCA Manual J and ACCA Manual S calculations without the specific geographical location and design criteria. The calculations should be completed by the local AC company who selects and installs the cooling system based on the location and information on the homes' heating and cooling certificate.*
2) *The current language in the MHCSS has an adequate process, based on reference standards similar to Manual J, to calculate building loads and sizing of equipment.*

~~10 C.F.R. § 460.205~~

~~Sizing of heating and cooling equipment installed by the manufacturer must be determined in accordance with ACCA Manual S incorporated by reference; see § 460.3) based on building loads calculated in accordance with ACCA Manual J (incorporated by reference; see § 460.3). The equipment sizing criteria are adapted from section R403 of the 2021 IECC.~~

1.888.602.4663 | MHCC@HOMEINNOVATION.COM

Appendix A:
MHI Written Public Comments
November 11, 2022

November 11, 2022

The Honorable Marcia Fudge
Secretary
U.S. Department of Housing and Urban Development
451 7th Street, S.W.
Washington, DC 20410

RE: Notice of Federal Advisory Committee Meetings: Manufactured Housing Consensus Committee (FR-6348-N-01)

Dear Secretary Fudge,

As promised in its previous correspondence, the Manufactured Housing Institute (MHI) committed to providing supporting documentation to its proposal to the Manufactured Housing Consensus Committee (MHCC). As a supplement to its November 9th, 2022 Comment Letter, MHI is pleased to submit the following presentations to the MHCC for consideration ahead of the MHCC's meeting scheduled for November 15-17, 2022. The three presentations, attached as exhibits to this supplemental correspondence, further demonstrate the benefits of adopting MHI's proposal versus a wholesale adoption the DOE's Energy Rule. Such materials also provide supporting analysis behind MHI's proposal. Below, you will find a brief summary of the contents of each presentation:

1. **Economic Impact Analysis chart based on the Energy Rule and updated data regarding MHI's proposed thermal requirements (Attached hereto as Exhibit A):** The first presentation is the Economic Impact Analysis which is based upon the Energy Rule and supporting data regarding MHI's proposed thermal requirements. This analysis demonstrates the advantages and the cost savings that will benefit the consumer under MHI's proposal as compared to the greater economic impact on the consumer under the Energy Rule. The Economic Impact Analysis, which compares the current HUD standard with the proposals of MHI and DOE, establishes the following:

- DOE's Technical Support Document provided incremental cost increases for step-ups in energy efficiency measures using the HUD Code as a baseline. For example, the incremental cost increase of going from R11 to R13 to R21 insulation in the walls. Using the DOE's own data, this analysis calculates the incremental cost increase for the Energy Rule and MHI's proposal.

- Using validated energy simulation software, this analysis calculates the marginal energy savings achieved from the Energy Rule and MHI's proposal – that is– how much a consumer will save in energy costs on a monthly basis.

- This analysis further demonstrates that for all three Zones with Tier 2 homes, **MHI's proposal results in better 10-year outcomes for all consumers than the Energy Rule.** On average, consumers will experience a net cost that is less under MHI's proposal than under the Energy Rule.

2. **Analysis of DOE's Energy Conservation Standards for Manufactured Housing (Attached hereto as Exhibit B):** The second presentation demonstrates the DOE's failure to consider key cost inputs which will negatively impact both consumers and suppliers. As provided in greater detail in the attached presentation, this analysis demonstrates the DOE's failure to sufficiently consider the following factors in

formulating its conclusions and the cumulative effect of such factors:

- *Inflation and Cost Increases*: DOE failed to consider the impact of considerable cost increases and supply chain constraints because of the pandemic and related economic disruptions.

    - DOE's cost/benefit or life-cycle cost ("LCC") model took cost estimates from 2014 and applied a nominal cost increase of **2.3% annually** from 2014-2023. However, beginning with the Covid-19 pandemic, actual costs for construction materials have grown substantially, and the actual cost increase for construction materials from 2014-2021 is **6.5% annually**. Manufactured housing construction costs may be even higher.

    - DOE assumed a 5% interest rate for land-home deals and a 9% interest rate for home-only deals. The current 30-year fixed mortgage rate is now approximately 7%.

    - Fixing only these two inputs to reflect actual cost inflation and actual interest rates for land/home loans, **based on DOE's own LCC model for Tier 2 homes, approximately 95% of shipments will have a negative 10-year LCC**. In geographic terms, of the 19 "representative" cities chosen by the DOE, 16 of those representative cities will have a negative 10-year LCC for Tier 2 homes. This data accounts for the increased energy savings that result from inflation as well.

    - Assuming Tier 2 homes represent 55% of the industry producing approximately 120,000 homes annually, this means that approximately **63,000 homes would have a negative 10-year LCC based on the Energy Rule.**

- *Negative Impact*: DOE failed to consider negative impacts on low-income and minority homebuyers.

    - The Energy Rule will disparately impact minority communities even without accounting for actual cost increases. Black or African American manufactured home purchasers are approximately 22.5% more likely to finance their purchase with a home-only loan as compared with a land-home loan. Likewise, Hispanic manufactured home purchases are 11% more likely to finance their purchase with a home-only loan.

    - At a 9.5% home-only interest rate, 37% of Tier 2 shipments will have a negative 10-year LCC based on DOE's own model. Using a 11% home-only interest rate, 86% of Tier 2 shipments will have a negative 10-year LLC based on DOE's own model.

    - The Biden Administration has prioritized housing affordability and racial equity: *"The Federal Government has a critical role to play in overcoming and redressing… [its role in declining to invest in communities of color and in failing to provide equitable access,] and in protecting against other forms of discrimination by applying and enforcing Federal civil rights and fair housing laws. It can help ensure that fair and equal access to housing opportunity exists for all throughout the United States."*

- *Additional Costs.* DOE failed to consider potential costs of testing and compliance, transportation, and supply chain constraints.

- The Energy Rule failed to account for significant compliance costs. Without limitation, in rural areas, it is estimated that in-field duct testing could cost over $1,000 per home. Many Tier 2, Zone 2 & Zone 3 homes will need 2x6 walls rather than 2x4 which will increase lumber and transportation costs (due to weight). Exclusive of lumber costs, an additional axle may be needed for weight which is another $200 to $250 per floor, $400 to $500 per multisection homes. Transportation costs such as fuel have increased dramatically over the past year. And the industry is experiencing significant supply chain difficulties, especially for fiberglass insulation—a commodity for which supply must increase to comply with the DOE's Final Rule.

- Before supply chains normalize, the cost for fiberglass insulation will increase drastically and home starts may be limited if there is not enough fiberglass insulation or if plants must use alternatives such as blown insulation. Many in the industry do not believe that there will be enough fiberglass insulation to meet the demand. As such, manufacturers will be forced to pivot to spray foam insulation, which is more costly and labor-intensive. Additionally, the process for the installation of spray foam insulation requires a cooling off period, which will increase the amount of time of the home on the line, decreasing the thru-put, and will inevitably cause fewer home to be built. All of this will inevitably increase the overall cost of the homes to the consumer, none of which has been calculated by DOE.

- **These unaccounted-for costs will easily subsume the DOE's projected 10-year LCC savings for all manufactured homes.** For Tier 1 homes, DOE projected a national average of $720 10-year LCC savings and for Tier 2 homes, DOE projected a national average of $743 10-year LCC savings. If, for example, in-field duct testing is required which costs approximately $1,000 per home, then all 10-year LCC savings are eliminated.

- *Affordability and Credit Access.* DOE underestimated potential impacts on credit access and lost sales.

  - These additional costs will make home ownership unaffordable for thousands of Americans. To estimate the impact on affordability, the DOE relied upon a 2007 economic study. This study predated the Great Recession, predated the Covid-19 pandemic and the following inflation period, predated the current rise in interest rates, and predated the recent increases in retail prices for manufactured homes which may make potential customers even more price sensitive.

  - **DOE's Final Rule conceded with its sensitivity analysis that over 5,000 families annually will not be able to afford a manufactured home,** and this number is almost certainly understated for the reasons described above. Based on industry information, it is likely that the realistic impact of the implementation of the Energy Rule could actually affect twice as many families.

3. **Architectural and Design Analysis of how the Energy Rule will generally impact the design of manufactured homes as opposed to the design elements of manufactured homes based on current standards (Attached hereto as Exhibit C):** DOE's standards will negatively impact the aesthetic appearance and the design of manufactured homes. As demonstrated in the attached presentation, significant architectural modifications will be required for manufacturers to stay in compliance with the Energy Rule which will result in less aesthetically pleasing homes. Most notably, multisection homes will face substantial architectural

modifications. To meet the DOE standards, the industry will have to consider a variety of tradeoffs, including, a reduction of windows and/or significant changes in home architecture to accommodate additional insulation. Consequently, such modifications will be either be more difficult to implement and less appealing, or even prohibitive.

- To meet the U-value performance requirements for Tier 2, Zone 3 homes, assuming the home has additional insulation added without altering the framing, the windows had to be eliminated completely. As a result of the reduced windows, the requirements for egress, light and ventilation are no longer met. **Therefore, it would not be possible to manufacture this home to be in compliance with code regulations and the Energy Rule.**

    - Additionally, even if this home could be constructed in a manner to comply with code regulations and the Energy Rule, there are not enough windows in the market today to meet the demand if a lower U-value is required.

- If a manufacturer were to construct a home that met the required Tier 2, Zone 3 U-value with an insulation package that met the value under the prescriptive section of the code, which would require substantial framing changes, it would still be very difficult to construct this home using materials currently available on the market. Specifically:

    - Most manufacturers do not currently use the floor insulation technique that would be required to construct this home to meet DOE requirements.

    - There is not enough supply of R-21 insulation in the market to meet the amount necessary to comply with DOE requirements to keep up with the current demand.

    - It will be problematic to get the required insulation (R-38) in the roof cavity due to the required thickness and available attic space.

    - **To have almost the same amount of windows in the home as is allowed under current regulations, manufacturers would have to install windows that have a U-value equal to 0.30, which are not currently available on the market.**

- To construct a multi-section home in Zone 3, the shipping height will be increased due to the 5.5" heal height and the increased floor joist depth. **Because of the required insulation thickness under the Energy Rule, optional vaulted ceilings will no longer be available to the consumers.**

MHI supports energy conservation efforts, and our manufacturer members are committed to continue leading the way in energy efficient manufacturing. The analysis and presentations provided herein further demonstrate this commitment while providing a clear and conscientious basis for MHI's proposed changes to the Energy Rule. MHI remains committed to working with the MHCC, HUD and DOE to realistically improve energy efficiency that not only encourages innovation and conservation but also eliminates regulatory barriers that impede consumer access to safe, affordable manufactured housing.

Sincerely,

Lesli Gooch, Ph.D.
Chief Executive Officer

Enclosures

Exhibit A

Economic Impact Analysis

Table 1. Net Benefit (Cost)of DOE Proposal for Multi-section Homes based on DOE Costs and SBRA Energy Savings Estimates

Multi-section Home													
HUD Standards Climate Zone	Locations (heating equipment type)	Efficiency level	Level of efficiency (Uo-value)	Base average home cost (DOE TSD p. 6-2)	Marginal increase in home cost (DOE TSD)	Percent increase in cost	Marginal increase in down payment	Marginal increase in mortgage	Marginal increase in monthly mort. pay.	Marginal energy savings ($/mth)	Net Mthly. Savings (Cost)	Principal repayment	Net benefit (cost)
1	Miami (Electric)	HUD standard	0.116	$108,500	$0	0.0%	$0	$0	$0	$0	$0	$0	**$0**
		MHI proposal	0.090	$108,500	$3,077	2.8%	$308	$2,770	$25	$10	($15)	$1,967	**($4,045)**
		DOE proposal	0.082	$108,500	$4,018	3.7%	$402	$3,616	$33	$19	($14)	$2,568	**($4,644)**
	Houston (Natural gas)	HUD standard	0.116	$108,500	$0	0.0%	$0	$0	$0	$0	$0	$0	**$0**
		MHI proposal	0.090	$108,500	$3,077	2.8%	$308	$2,770	$25	$12	($13)	$1,967	**($3,845)**
		DOE proposal	0.082	$108,500	$4,018	3.7%	$402	$3,616	$33	$18	($14)	$2,568	**($4,664)**
	Atlanta (Electric)	HUD standard	0.116	$108,500	$0	0.0%	$0	$0	$0	$0	$0	$0	**$0**
		MHI proposal	0.090	$108,500	$3,077	2.8%	$308	$2,770	$25	$34	$9	$1,967	**($1,135)**
		DOE proposal	0.082	$108,500	$4,018	3.7%	$402	$3,616	$33	$39	$7	$2,568	**($2,184)**
	Charleston (Electric)	HUD standard	0.116	$108,500	$0	0.0%	$0	$0	$0	$0	$0	$0	**$0**
		MHI proposal	0.090	$108,500	$3,077	2.8%	$308	$2,770	$25	$26	$1	$1,967	**($2,115)**
		DOE proposal	0.082	$108,500	$4,018	3.7%	$402	$3,616	$33	$31	($1)	$2,568	**($3,114)**
	Jackson (Electric)	HUD standard	0.116	$108,500	$0	0.0%	$0	$0	$0	$0	$0	$0	**$0**
		MHI proposal	0.090	$108,500	$3,077	2.8%	$308	$2,770	$25	$31	$6	$1,967	**($1,505)**
		DOE proposal	0.082	$108,500	$4,018	3.7%	$402	$3,616	$33	$38	$5	$2,568	**($2,344)**
	Birmingham (Electric)	HUD standard	0.116	$108,500	$0	0.0%	$0	$0	$0	$0	$0	$0	**$0**
		MHI proposal	0.090	$108,500	$3,077	2.8%	$308	$2,770	$25	$32	$7	$1,967	**($1,395)**

		DOE proposal	0.082	$108,500	$4,018	3.7%	$402	$3,616	$33	$37	$5	$1,967	**($1,783)**
2	Phoenix (Natural gas)	HUD standard	0.096	$108,500	$0	0.0%	$0	$0	$0	$0	$0	$0	**$0**
		MHI proposal	0.076	$108,500	$2,404	2.2%	$240	$2,163	$19	$15	($4)	$1,537	**($2,303)**
		DOE proposal	0.066	$108,500	$4,317	4.0%	$432	$3,885	$35	$22	($13)	$2,759	**($4,796)**
	Memphis (Electric)	HUD standard	0.096	$108,500	$0	0.0%	$0	$0	$0	$0	$0	$0	**$0**
		MHI proposal	0.076	$108,500	$2,404	2.2%	$240	$2,163	$19	$23	$3	$1,537	**($1,413)**
		DOE proposal	0.066	$108,500	$4,317	4.0%	$432	$3,885	$35	$32	($3)	$2,759	**($3,536)**
	El Paso (Natural Gas)	HUD standard	0.096	$108,500	$0	0.0%	$0	$0	$0	$0	$0	$0	**$0**
		MHI proposal	0.076	$108,500	$2,404	2.2%	$240	$2,163	$19	$10	($9)	$1,537	**($2,903)**
		DOE proposal	0.066	$108,500	$4,317	4.0%	$432	$3,885	$35	$14	($21)	$2,759	**($5,656)**
	San Francisco (Natural Gas)	HUD standard	0.096	$108,500	$0	0.0%	$0	$0	$0	$0	$0	$0	**$0**
		MHI proposal	0.076	$108,500	$2,404	2.2%	$240	$2,163	$19	$4	($15)	$1,537	**($3,583)**
		DOE proposal	0.066	$108,500	$4,317	4.0%	$432	$3,885	$35	$7	($28)	$2,759	**($6,606)**
	Albuquerque (Electric)	HUD standard	0.096	$108,500	$0	0.0%	$0	$0	$0	$0	$0	$0	**$0**
		MHI proposal	0.076	$108,500	$2,404	2.2%	$240	$2,163	$19	$21	$2	$1,537	**($1,593)**
		DOE proposal	0.066	$108,500	$4,317	4.0%	$432	$3,885	$35	$31	($4)	$2,759	**($3,656)**
	Baltimore (Natural Gas)	HUD standard	0.079	$108,500	$0	0.0%	$0	$0	$0	$0	$0	$0	**$0**
		MHI proposal	0.061	$108,500	$2,557	2.4%	$256	$2,302	$21	$13	($7)	$1,635	**($2,765)**
		DOE proposal	0.055	$108,500	$3,997	3.7%	$400	$3,598	$32	$16	($16)	$2,555	**($4,899)**
	Salem (Electric)	HUD standard	0.079	$108,500	$0	0.0%	$0	$0	$0	$0	$0	$0	**$0**
		MHI proposal	0.061	$108,500	$2,557	2.4%	$256	$2,302	$21	$51	$30	$1,635	**$1,765**

3		DOE proposal	0.055	$108,500	$3,997	3.7%	$400	$3,598	$32	$59	$27	$2,555	**$231**
	Chicago (Natural Gas)	HUD standard	0.079	$108,500	$0	0.0%	$0	$0	$0	$0	$0	$0	**$0**
		MHI proposal	0.061	$108,500	$2,557	2.4%	$256	$2,302	$21	$19	($2)	$1,635	**($2,105)**
		DOE proposal	0.055	$108,500	$3,997	3.7%	$400	$3,598	$32	$22	($10)	$2,555	**($4,149)**
	Boise (Electric)	HUD standard	0.079	$108,500	$0	0.0%	$0	$0	$0	$0	$0	$0	**$0**
		MHI proposal	0.061	$108,500	$2,557	2.4%	$256	$2,302	$21	$38	$17	$1,635	**$135**
		DOE proposal	0.055	$108,500	$3,997	3.7%	$400	$3,598	$32	$44	$12	$2,555	**($1,549)**
	Burlington (Natural gas)	HUD standard	0.079	$108,500	$0	0.0%	$0	$0	$0	$0	$0	$0	**$0**
		MHI proposal	0.061	$108,500	$2,557	2.4%	$256	$2,302	$21	$21	$1	$1,635	**($1,815)**
		DOE proposal	0.055	$108,500	$3,997	3.7%	$400	$3,598	$32	$25	($7)	$2,555	**($3,849)**
	Helena (Electric)	HUD standard	0.079	$108,500	$0	0.0%	$0	$0	$0	$0	$0	$0	**$0**
		MHI proposal	0.061	$108,500	$2,557	2.4%	$256	$2,302	$21	$53	$32	$1,635	**$1,945**
		DOE proposal	0.055	$108,500	$3,997	3.7%	$400	$3,598	$32	$62	$29	$2,555	**$551**
	Duluth (Natural Gas)	HUD standard	0.079	$108,500	$0	0.0%	$0	$0	$0	$0	$0	$0	**$0**
		MHI proposal	0.061	$108,500	$2,557	2.4%	$256	$2,302	$21	$29	$9	$1,635	**($865)**
		DOE proposal	0.055	$108,500	$3,997	3.7%	$400	$3,598	$32	$34	$1	$2,555	**($2,789)**
	Fairbanks (Natural Gas)	HUD standard	0.079	$108,500	$0	0.0%	$0	$0	$0	$0	$0	$0	**$0**
		MHI proposal	0.061	$108,500	$2,557	2.4%	$256	$2,302	$21	$39	$19	$1,635	**$335**
		DOE proposal	0.055	$108,500	$3,997	3.7%	$400	$3,598	$32	$46	$14	$2,555	**($1,279)**

Assumptions	
Down payment	10%
Principal	90%
Mort. interest rate	9%
Loan term (yrs)	20
Occupancy term (yrs)	10
Principal recapture rate	0%

Average Benefit (Cost)		MHI	DOE
Zone	**1**	**($2,340.08)**	**($3,122.03)**
	2	**($2,358.84)**	**($4,849.82)**
	3	**($421.72)**	**($2,216.82)**

Ref.: TECHNICAL SUPPORT DOCUMENT: SUPPLEMENTAL NOTICE OF PROPOSED RULEMAKING PROPOSING ENERGY CONSERVATION STANDARDS FOR MANUFACTURED HOUSING
Estimates of energy savings provided by Ekotrope software.

Exhibit B

Analysis of DOE's Energy Conservation Standards

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Analysis of DOE's Energy Conservation Standards for Manufactured Housing

Identification of Potential Issues and Sensitivity Analyses

November 11, 2022

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Executive Summary

- Assignment
  - DOE relied upon a cost-benefit analysis for consumers of manufactured homes
  - Analysis Group assessed this cost-benefit analysis with particular focus on **important inputs that have changed** since DOE's original analysis
- Summary of Preliminary Conclusions
  1. Adjusting DOE's assumptions for recent inflation and interest rate increases invalidates DOE's conclusion that its proposed rule is cost-effective for consumers
  2. DOE's rule will have particularly negative impacts on minority and low-income homebuyers, who tend to face higher borrowing costs
  3. DOE has underestimated the number of households that will no longer be able to afford a manufactured home as a result of the rule
  4. DOE has failed to consider additional costs of compliance, such as duct testing and transportation costs, which could further negate any anticipated savings for consumers

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Qualifications

Pavel Darling, Vice President (*MBA, MIT Sloan School of Management; B.A. in Economics, Middlebury College)*

Mr. Darling is an expert on energy matters, and often consults to utilities, state and regional organizations, and global companies in his work. He focuses on projects related to cost/benefit analyses of new construction and resource retirements; environmental effects of emissions and pollution controls; economic impacts of energy projects, mergers and policies; and natural gas, biomass, and other market studies. Mr. Darling also has extensive experience working on various climate change projects, including assessments of decarbonization policy proposals and quantification of greenhouse gas emissions impacts.

He has also submitted and supported expert testimony across different venues, including state utility commissions, siting boards, the Federal Energy Regulatory Commission and the Environmental Protection Agency. Mr. Darling's prior experience working at a utility involved preparing annual filings and working with stakeholders to assess bill impacts of proposed energy efficiency changes. He has also coauthored a number of published reports and journal articles.

About Analysis Group

Analysis Group is one of the largest international economics consulting firms, with more than 1,000 professionals across 14 offices in North America, Europe, and Asia. Since 1981, we have provided expertise in economics, finance, health care analytics, and strategy to top law firms, Fortune Global 500 companies, and government agencies worldwide. Our internal experts, together with our network of affiliated experts from academia, industry, and government, offer our clients exceptional breadth and depth of expertise.

Analysis Group's Energy & Environment practice is distinguished by our deep expertise in economics, finance, regulatory issues, and public policy, as well as significant experience in environmental economics and energy infrastructure development. We have worked on energy issues for a wide variety of clients, including energy producers, energy customers, regulatory commissions and government agencies, system operators, foundations, and nongovernmental institutions.

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Background on DOE's Energy Efficiency Standards for Manufactured Housing

- Key Dates:
  - Aug. 26, 2021 — DOE issued Supplemental Notice of Proposed Rulemaking (SNOPR)
  - May 31, 2022 — Final rule and cost-benefit analyses released, relying on data from 2021 and earlier
  - May 31, 2023 — Expected compliance date

- By statute, DOE must consider cost effectiveness (42 U.S.C 17071(b)(1))
  - "The energy conservation standards established under this section shall be based on the most recent version of the International Energy Conservation Code (including supplements), **except in cases in which the Secretary finds that the code is not cost-effective**, or a more stringent standard would be more cost-effective, based on the impact of the code on the purchase price of manufactured housing and on total life-cycle construction and operating costs."

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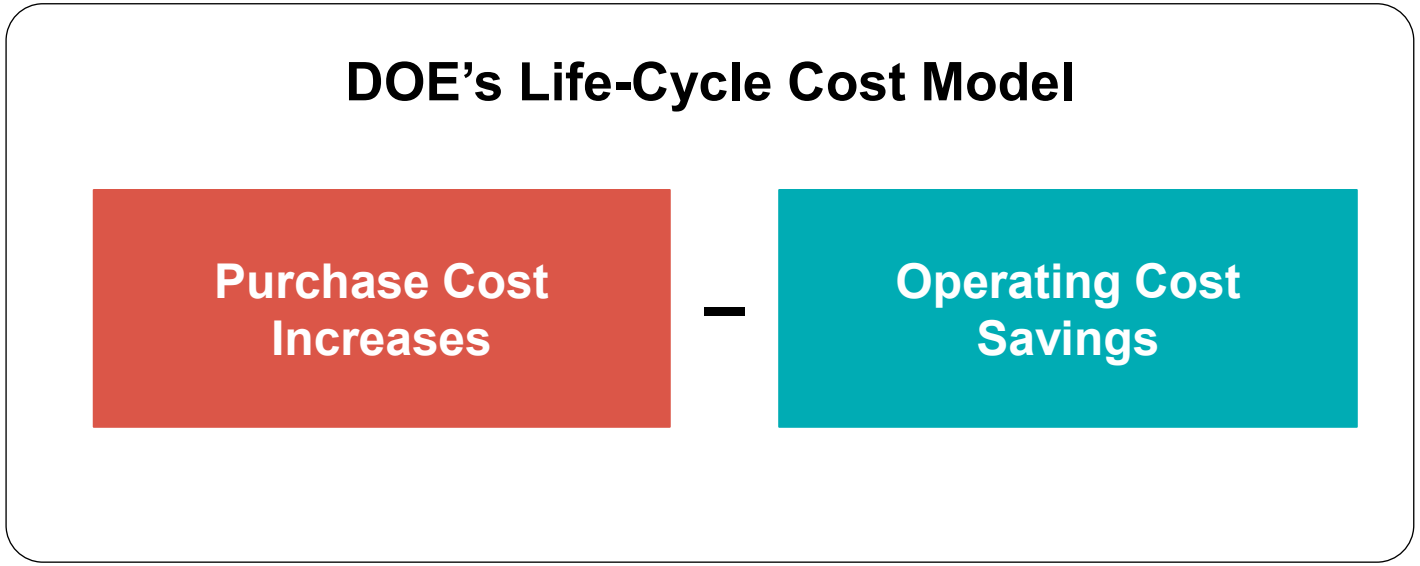
Summary of Preliminary Conclusions

DOE's conclusions on cost effectiveness disregard or do not sufficiently consider variation in key cost inputs over time and across groups for buyers and suppliers

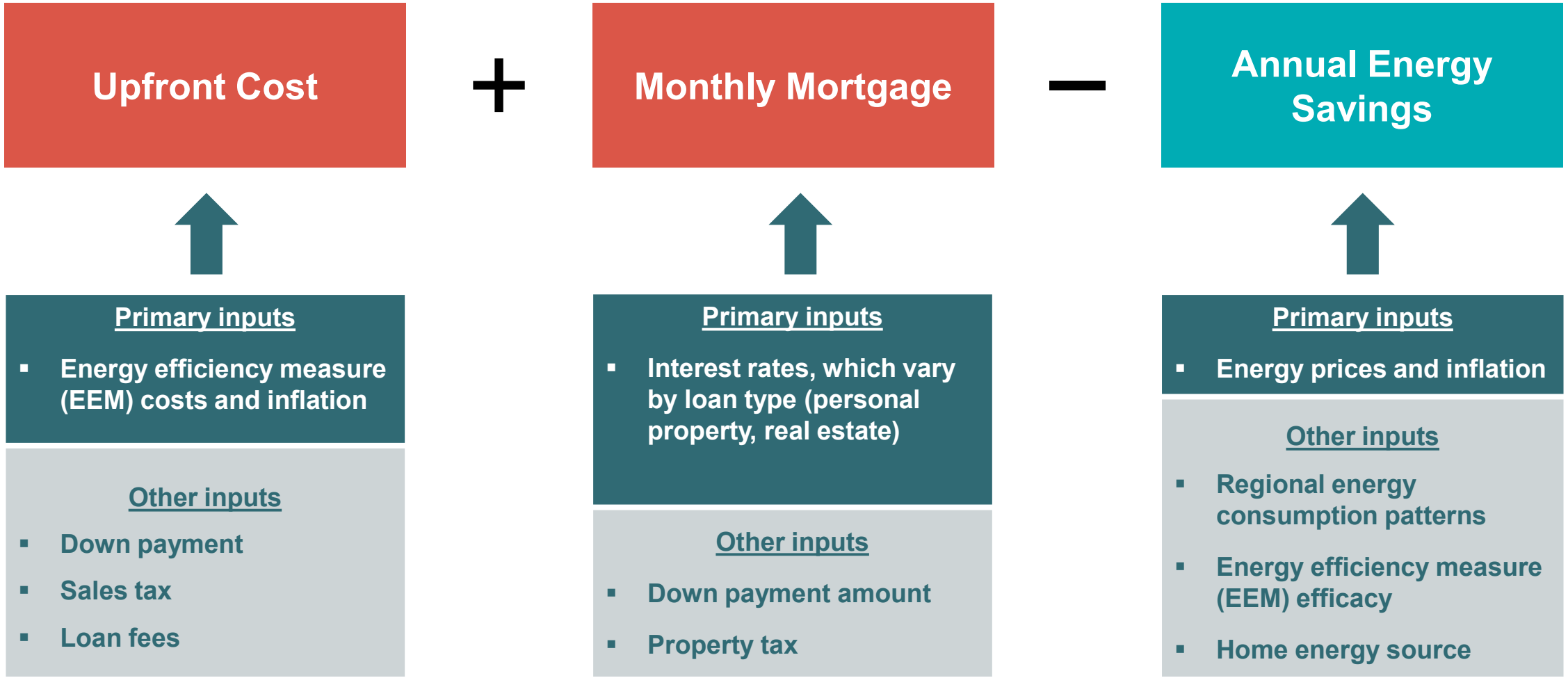
1	**Inflation and Cost Increases**	DOE has failed to consider the impacts of considerable cost increases and supply chain constraints. Taking these into account, DOE's conclusion is invalid and the rule has a net cost to consumers rather than a benefit.
2	**Negative and Inequitable Impacts**	DOE has failed to consider negative impacts on low-income and minority homebuyers.
3	**Affordability and Credit Access**	DOE has underestimated potential impacts on credit access and lost sales.
4	**Additional Costs**	DOE has failed to consider potential costs of testing and compliance, transportation, and supply chain constraints.

Background: DOE's Life-Cycle Cost (LCC) Model

- DOE estimated the **total customer cost** over the life of the manufactured home via the Life-Cycle Cost model, including:
  - **Purchase costs** (e.g., the price of additional energy efficiency measures), and
  - **Operating costs** (e.g., energy bill savings)
- Future costs and savings are discounted to their value in the present year
- Analysis occurs over both 10- and 30-year periods
- DOE also calculates a payback period, equal to the increase in upfront cost divided by the energy savings in first year



Our Focus: Evaluating DOE's Cost-Benefit Analysis by Updating Key Inputs



ANALYSIS GROUP

Summary of Preliminary Conclusions

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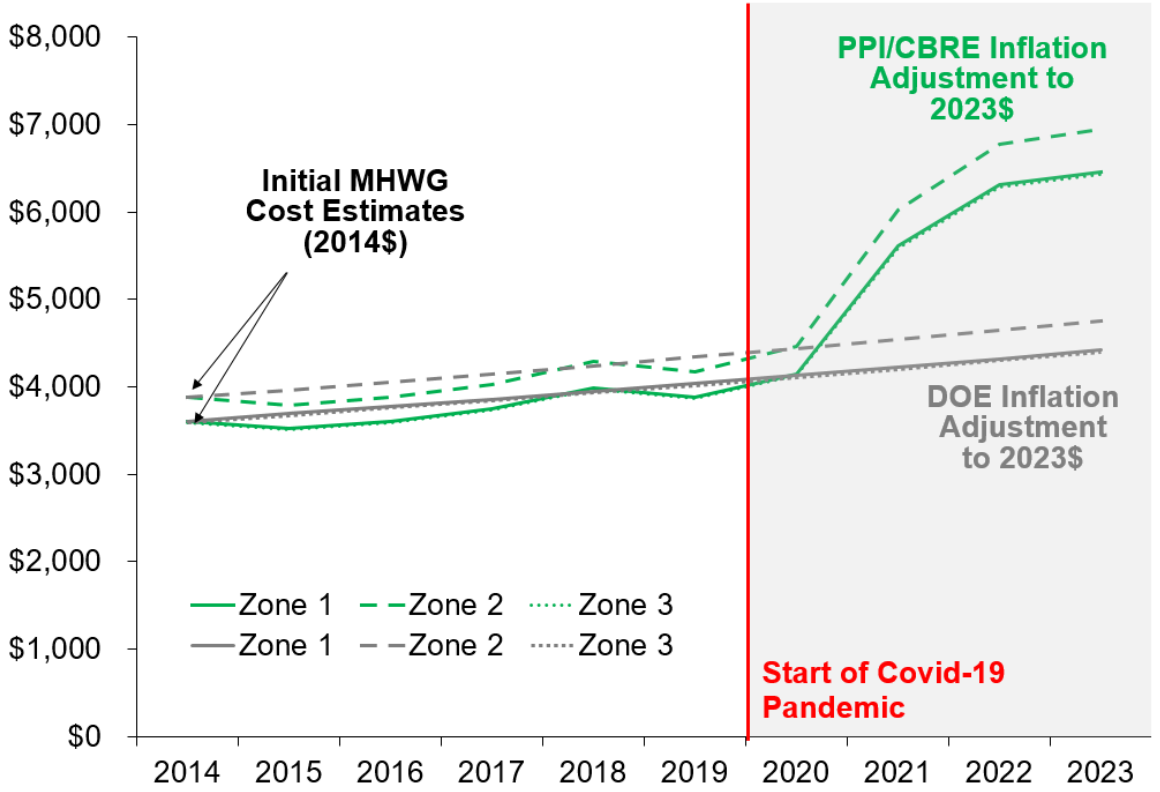
DOE Has Inadequately Adjusted EEM Cost Estimates for Inflation

- DOE calculated the costs of energy efficiency measures using cost estimates provided by the Manufactured Housing Working Group in **2014**
- To adjust for inflation, DOE assumes an annual nominal cost increase of **2.3 percent** between 2014-2023 (See gray lines)
- However, costs have increased substantially since the start of the Covid-19 pandemic. According to the BLS Producer Price Index for construction costs, materials costs have grown at an average annual rate of **6.5 percent** between 2014-2021, driven mostly by cost increases of **35.1 percent** from 2020-2021 (See green lines)
- Industry interviews suggest even higher recent increases beyond PPI, with costs at a new floor and unlikely to regress

Estimated Costs of Energy Efficiency Measures, by Inflation Adjustment Approach and Climate Zone



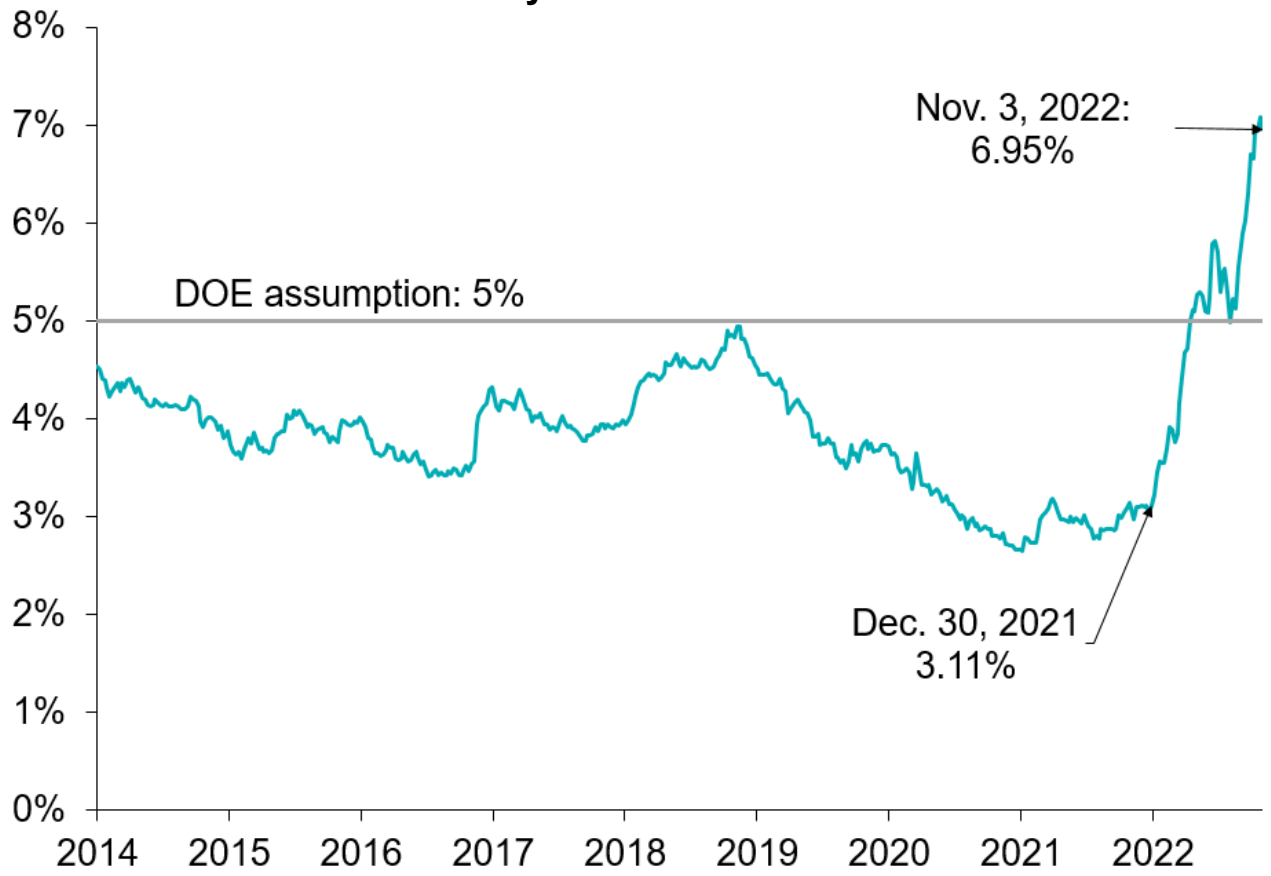
Note: Inflation estimates for PPI/CBRE series for 2022 and 2023 are from the "decreased demand" scenario of the CBRE's Construction Costs Index Forecast.

Sources: U.S. Bureau of Labor Statistics, Producer Price Index by Commodity: Special Indexes: Construction Materials [WPUSI012011], retrieved from FRED on October 30, 2022, Federal Reserve Bank of St. Louis, available at https://fred.stlouisfed.org/series/WPUSI012011; CBRE Research, "2022 U.S. Construction Cost Trends," July 2022, available at https://www.cbre.com/insights/books/2022-us-construction-cost-trends; U.S. Department of Energy, Manufactured Housing Life-Cycle Cost Analysis (LCC) Spreadsheet, May 18, 2022, available at https://www.regulations.gov/document/EERE-2009-BT-BC-0021-1996.

Mortgage Interest Rates Have Increased Above DOE's Assumptions

- DOE assumed interest rates of **5 percent** for mortgage loans and **9 percent** for personal property loans
- These assumptions were arguably conservative at the time, but mortgage rates have increased from approximately 3 to **7 percent**
- Industry interviews have suggested that personal property loan interest rates may be as high as **11.5 percent** for some borrowers
  - Moreover, DOE's own review of available evidence suggests that personal property loan interest rates are typically between 0.5 percentage points and 5 percentage points higher than real estate loan interest rates

30-Year Fixed Rate Mortgage Average in the United States
January 2014 – November 2022



Sources: Freddie Mac, 30-Year Fixed Rate Mortgage Average in the United States [MORTGAGE30US], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/MORTGAGE30US, November 3, 2022; U.S. Department of Energy, "2022-05 Technical Support Document: Final Rule Energy Conservation Standards for Manufactured Housing, May 18, 2022, available at https://www.regulations.gov/document/EERE-2009-BT-BC-0021-1999, p. 8-4.

Energy Costs Have Increased As Well, Increasing Anticipated Savings

- Over the past year, energy costs have increased due to geopolitical and pandemic related disruptions
- The U.S. Energy Information Administration has increased its forecasted energy prices for 2023 and beyond based on its *Annual Energy Outlook* (AEO)
- The DOE LCC analysis relies on energy price forecasts from 2021

U.S. Energy Information Administration's Forecasted Energy Prices, by Forecast Year

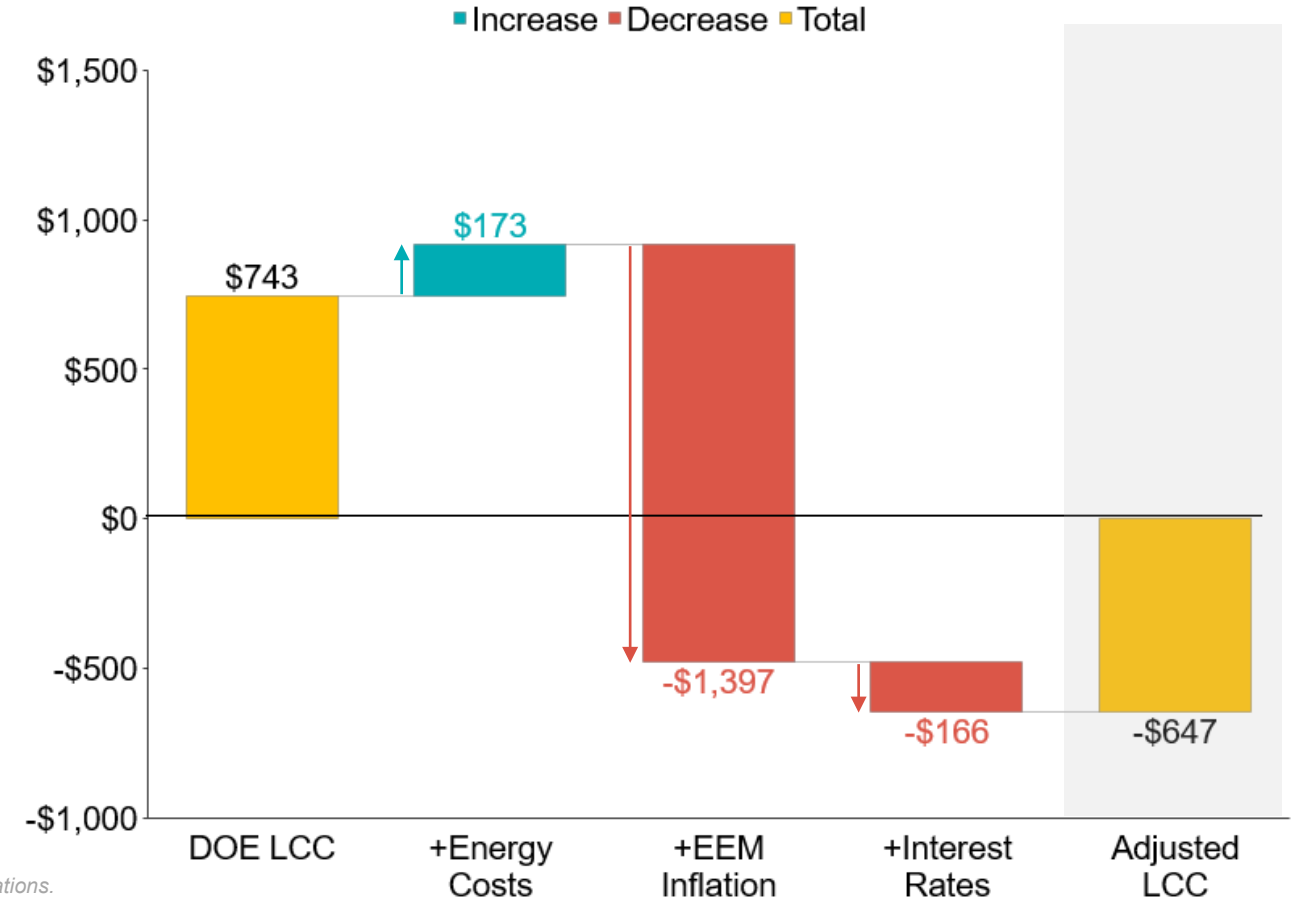
	Nominal Energy Prices			
	AEO 2021 Assumptions	AEO 2022 Assumptions	Units	% Change
Natural Gas	$10.14	$11.70	$/Mbtu	+7.1%
Propane	$17.30	$21.49	$/Mbtu	+10.8%
Elec Heat	$0.13	$0.14	$/kWh	+1.9%
Elec Cool	$0.13	$0.14	$/kWh	+1.5%
Elec Other	$0.13	$0.14	$/kWh	+1.9%
Oil	$17.75	$21.71	$/Mbtu	+10.0%

Sources: *Annual Energy Outlook 2022, Table: Table 3. Energy Prices by Sector and Source, retrieved from U.S. Energy Information ; Short-Term Energy Outlook Data Browser, 2. Energy Prices, retrieved from U.S. Energy Information Administration on November 03, 2022, available at https://www.eia.gov/outlooks/steo/data/browser/#/?v=8.*

On Net, Changes in the Recent Economic Environment Have Reversed Expected Cost Savings from the DOE Rule

- While increased energy cost forecasts have increased expected savings from the rule, the large increase in construction material costs since 2022 far outweighs these gains
- Additionally, adjusting for higher interest rates adds to expected increased costs
  - Real estate loan interest rates have been adjusted from 5 percent to **7 percent**
  - Personal property loan interest rates have conservatively been left at DOE's assumption of **9 percent**

Tier 2 LCC Adjustments - 10-Year Analysis Period



Sources: *U.S. Bureau of Labor Statistics, CBRE Research, Department of Energy, Freddie Mac, AG Calculations.*

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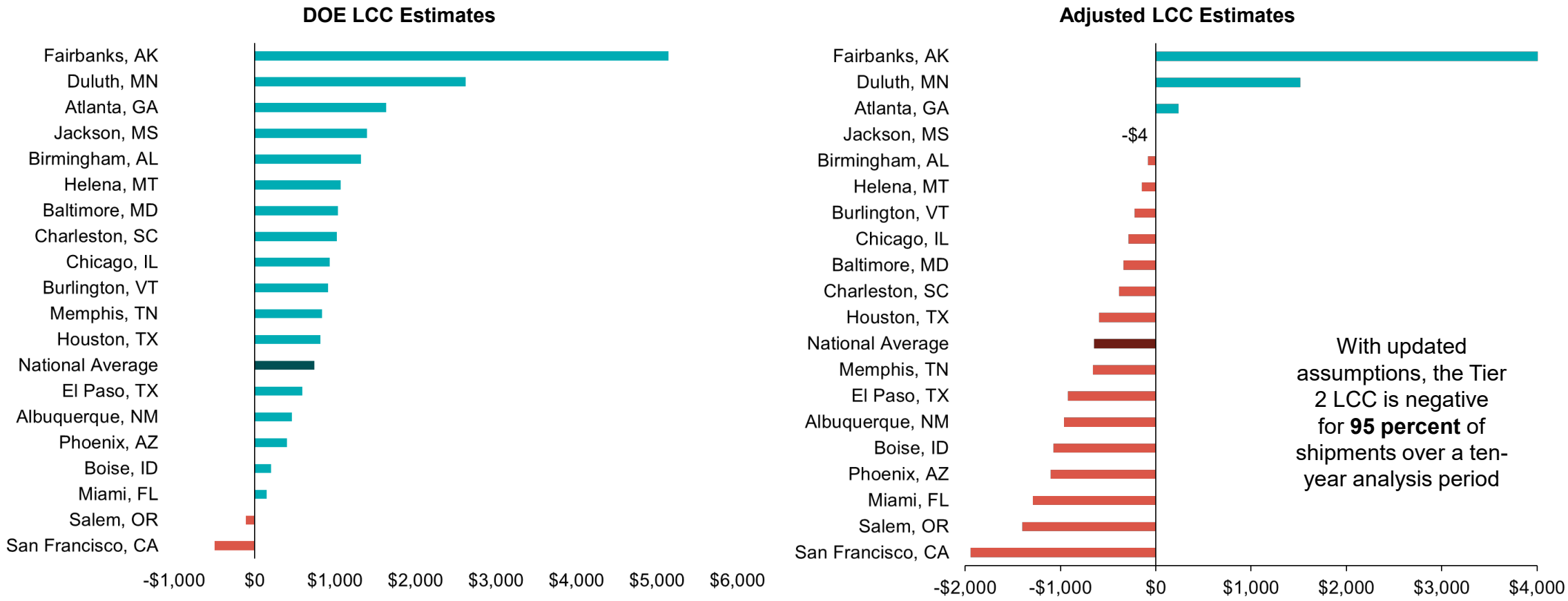
With Updated Costs, 10-Year Tier 2 LCC Negative For Most of the Country

Tier 2 LCC Adjustments, by City (10-Year Analysis Period)



Sources: *U.S. Bureau of Labor Statistics, CBRE Research, Department of Energy, Freddie Mac, AG Calculations.*

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DOE's Average Buyer Analysis Masks Negative Outcomes for a Number of Subgroups

- DOE LCC calculation is an average of the LCCs for many types of buyers
- LCC estimates vary along many dimensions, including:
  - Loan type (personal property, real estate, cash)
  - Credit score
  - Home heating fuel type (e.g., natural gas, electric resistance, heat pump)
  - Climate zone/geography
- Ultimately, low-income and minority buyers are more likely to be negatively impacted by the rule
  - The Biden Administration has prioritized housing affordability and racial equity:

    "The Federal Government has a critical role to play in overcoming and redressing… [its role in declining to invest in communities of color and in failing to provide equitable access,] and in protecting against other forms of discrimination by applying and enforcing Federal civil rights and fair housing laws. It can help ensure that fair and equal access to housing opportunity exists for all throughout the United States."

Source: "Memorandum on Redressing Our Nation's and the Federal Government's History of Discriminatory Housing Practices and Policies," *The White House*, January 26, 2021, available at https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/26/memorandum-on-redressing-our-nations-and-the-federal-governments-history-of-discriminatory-housing-practices-and-policies/.

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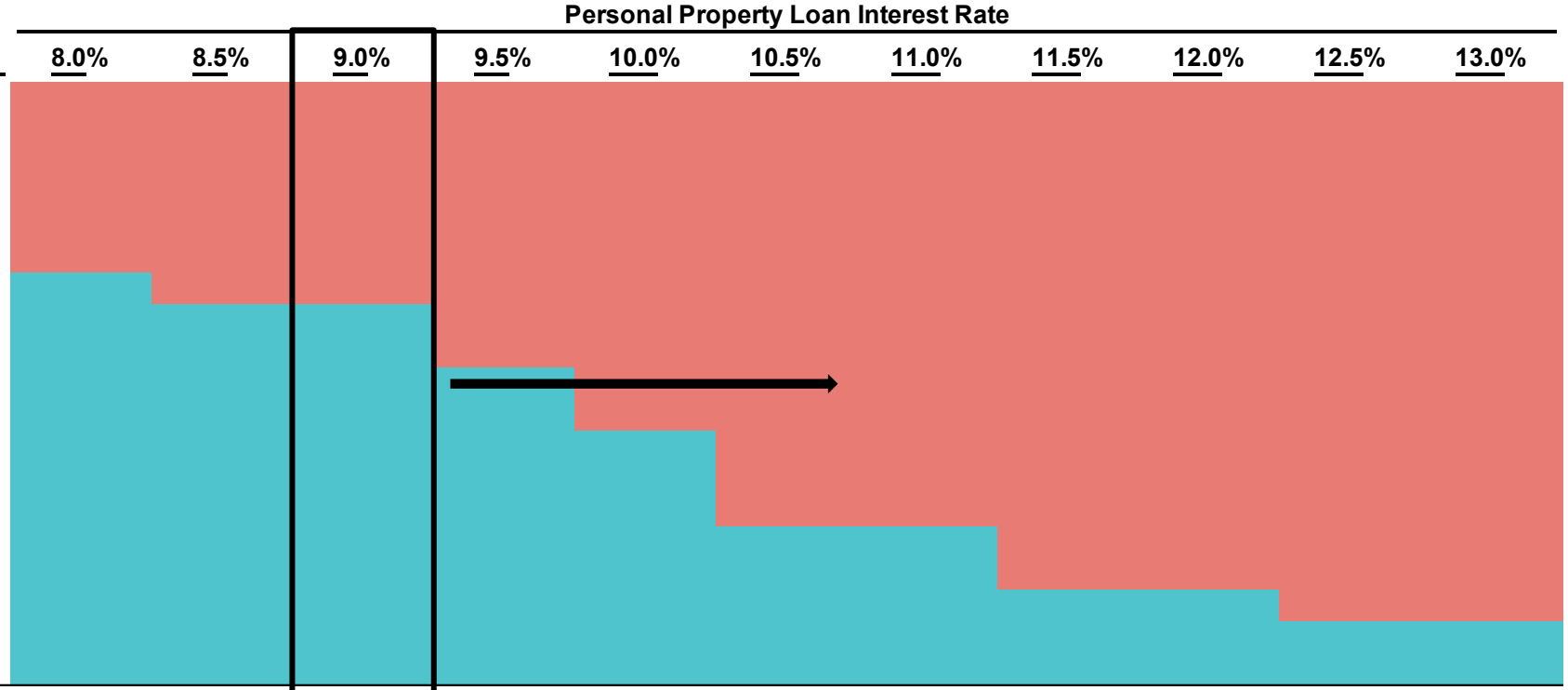
Under DOE's Original Assumptions, 10-Year LCC for Tier 2 Personal Property Loans is Negative

With Higher Interest Rates, LCC Becomes Negative for More Parts of the Country



City	Personal Property Loan Interest Rate										
	8.0%	8.5%	9.0%	9.5%	10.0%	10.5%	11.0%	11.5%	12.0%	12.5%	13.0%
San Francisco, CA											
Salem, OR											
Miami, FL											
Boise, ID											
Phoenix, AZ											
Albuquerque, NM											
El Paso, TX											
Memphis, TN											
Houston, TX											
Burlington, VT											
Chicago, IL											
Charleston, SC											
Baltimore, MD											
Helena, MT											
Birmingham, AL											
Jackson, MS											
Atlanta, GA											
Duluth, MN											
Fairbanks, AK											
Number of Cities with Negative LCC	6	7	7	9	11	14	14	16	16	17	17
Share of Shipments to Cities with Negative LCC	27%	37%	37%	60%	71%	86%	86%	95%	95%	98%	98%
Tier 2 LCC National Average	$ 211	$ 97	-$ 19	-$ 136	-$ 254	-$ 372	-$ 492	-$ 613	-$ 733	-$ 855	-$ 977

Note: Red indicates negative LCCs and blue indicates positive LCCs. Darker colors correspond with higher absolute values. ***Source:*** DOE LCC Model.

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Minority Buyers Are Relatively More Likely to Rely on Higher-Cost Personal Property Loans to Finance Purchases

- Many borrowers such as those with low credit scores or residents of Manufactured Housing communities face interest rates as high as 11.5 percent
- Minority buyers finance MH purchases with personal property loans at especially high rates compared to non-minority buyers

Share of Manufactured Home Purchases Financed by Personal Property Loans (vs. Real Estate Only), by Demographic Cohort

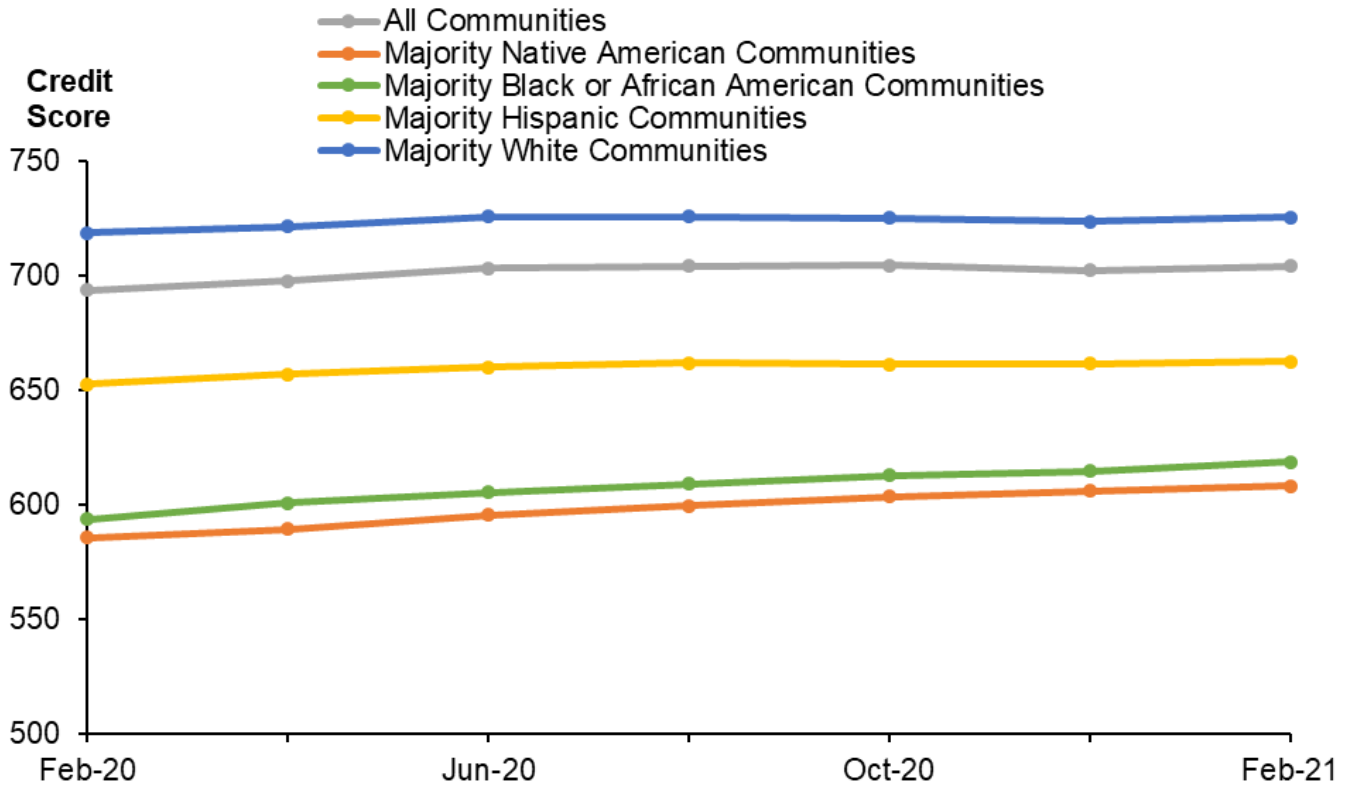
	Share of Personal Property Loans (vs Real Estate only)	Compared to All Households	Total Loans in Cohort (Personal Property and Real Estate)
All Households	42.8%	-	130,570
Low-Income Households	45.4%	*+2.6%*	65,583
Very Low-Income Households	45.1%	*+2.3%*	19,786
Hispanic	53.8%	*+11.0%*	16,224
Low-Income Hispanic Households	55.1%	*+12.3%*	8,406
Black or African American	65.1%	*+22.3%*	8,998
Low-Income Black or African American Households	66.7%	*+24.0%*	5,841
American Indian or Alaskan Native	54.7%	*+11.9%*	1,551
Low-Income American Indian or Alaskan Native Households	56.2%	*+13.4%*	840
Asian	48.6%	*+5.9%*	1,220

Sources: *2021 Home Mortgage Disclosure Act, United States Census Bureau.*

Low-Income and Minority Households Face Higher Borrowing Costs than the Median Household

- Residents of majority-minority communities tend to have lower credit scores than compared to white communities and the national average
- Low-income and minority buyers tend to face higher interest rates

Credit Scores of Residents in Majority-Minority Communities



Sources: *Urban Institute Credit Bureau Data; 2021 Home Mortgage Disclosure Act.*

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The Negative Impact of DOE's Proposed Rule Can Be Illustrated With a Few Representative Borrowers

Quoted Rates from 21st Mortgage's Payment Estimator Help to Approximate Current Loan Terms

- The following slides illustrate several groups of representative borrowers, which differ according to the following characteristics:
  - City [E.g., Memphis, TN (Climate Zone 2)]
  - Credit Score [E.g., 650-680]
  - Home Cost [E.g., $100,000]
  - Down Payment [E.g., 10%]
  - Loan Type [E.g., Home-only (Private Land)]
- 21st Mortgage's "Payment Estimator" tool estimates interest rates and loan terms, given these characteristics, which we then use to calculate LCC values
  - 21st Mortgage is the largest manufactured-home lender in the country, so rates give a general sense of terms facing a current prospective manufactured homebuyer
- Credit score and energy consumption patterns by geography are key drivers of differences in anticipated savings for prospective multi-section home buyers

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Geographic Energy Consumption Patterns Drive Considerable Differences Across Cities for Prospective Tier 2 Borrowers

Buyers with Good Credit Would Have Significantly Negative LCC in Most Cities

Profile	Memphis	Miami	El Paso	Houston	Phoenix	Baltimore
City	**Memphis (Climate Zone 2)**	**Miami (Climate Zone 1)**	**El Paso (Climate Zone 2)**	**Houston (Climate Zone 1)**	**Phoenix (Climate Zone 2)**	**Baltimore (Climate Zone 3)**
Credit score	650-680	650-680	650-680	650-680	650-680	650-680
Home cost	$110,000	$110,000	$110,000	$110,000	$110,000	$110,000
Down payment	10%	10%	10%	10%	10%	10%
Loan type	Home only (Private Land)	Home only (Private Land)	Home only (Private Land)	Home only (Private Land)	Home only (Private Land)	Home only (Private Land)
Quoted rates (21st Mortgage)						
Interest rate	9.35%	9.35%	9.35%	9.35%	9.35%	8.60%
Term	25 years	25 years	25 years	25 years	25 years	25 years
10-year LCC						
Given DOE Assumuptions	-$ 66	-$ 612	-$ 280	-$ 29	-$ 448	$ 366
Updated EEM Costs, Energy Prices	-$1,586	-$2,077	-$1,821	-$1,462	-$1,985	-$ 988
30-year LCC*						
Given DOE Assumuptions	$1,712	$ 605	$1,323	$1,638	$1,052	$2,452
Updated EEM Costs, Energy Prices	-$ 143	-$1,206	-$ 565	-$ 119	-$ 837	$ 773

Notes: Asterisk (*) indicates that estimates are from DOE's original model, i.e., without a correction for an error where loan payments after Year 15 are not included in the LCC calculation for personal property loans. Quoted rates are for a single applicant. From HMDA, roughly 58% of applications are from single applicants. ***Source:*** *21st Mortgage Corporation, Payment Estimator, accessed November 7, 2022, available at https://www.21stmortgage.com/web/payment-estimator.nsf/q1.html; U.S. Department of Energy, Manufactured Housing Life-Cycle Cost Analysis (LCC) Spreadsheet, May 18, 2022, available at https://www.regulations.gov/document/EERE-2009-BT-BC-0021-1996.*

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Excellent-Credit-Score Borrowers are the Only Credit Score Group with Positive Tier 2 10-Year LCCs (e.g., Memphis)

Based on Industry Interviews, Only 1/3 of MH Buyers Have Credit Scores Over 675

Profile	Poor Credit	Average Credit	Good Credit	Good Credit	Excellent Credit	Excellent Credit
City	Memphis	Memphis	Memphis	Memphis	Memphis	Memphis
Credit score	**Under 600**	**600-650**	**650-680**	**680-700**	**700-750**	**750+**
Home cost	$110,000	$110,000	$110,000	$110,000	$110,000	$110,000
Down payment	10%	10%	10%	10%	10%	10%
Loan type	Home only (Private Land)	Home only (Private Land)	Home only (Private Land)	Home only (Private Land)	Home only (Private Land)	Home only (Private Land)
Quoted rates (21st Mortgage)						
Interest rate	11.45%	10.10%	9.35%	9.35%	8.35%	8.35%
Term	25 years	25 years	25 years	25 years	25 years	25 years
10-year LCC						
Given DOE Assumptions	-$ 578	-$ 259	-$ 66	-$ 66	$ 209	$ 209
Updated EEM Costs, Energy Prices	-$2,202	-$1,818	-$1,586	-$1,586	-$1,252	-$1,252
30-year LCC*						
Given DOE Assumptions	$ 630	$1,288	$1,712	$1,712	$2,355	$2,355
Updated EEM Costs, Energy Prices	-$1,255	-$ 578	-$ 143	-$ 143	$ 516	$ 516

Notes: Asterisk (*) indicates that estimates are from DOE's original model, i.e., without a correction for an error where loan payments after Year 15 are not included in the LCC calculation for personal property loans. Quoted rates are for a single applicant. From HMDA, roughly 58% of applications are from single applicants. ***Source:*** *21st Mortgage Corporation, Payment Estimator, accessed November 7, 2022, available at https://www.21stmortgage.com/web/payment-estimator.nsf/q1.html; U.S. Department of Energy, Manufactured Housing Life-Cycle Cost Analysis (LCC) Spreadsheet, May 18, 2022, available at https://www.regulations.gov/document/EERE-2009-BT-BC-0021-1996.*

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Increased Costs Will Likely Impact Ability to Qualify for Financing

- Debt-to-income ratio is one of the top reasons why potential buyers of manufactured homes are denied loans
  - In 2021, **42 percent** of denied loans for MH purchases listed the applicant's debt-to-income ratio as a reason for denial
- The cost of owning a new manufactured home has increased by over 40 percent since 2020, according to an industry source
  - Additionally, the cost of construction materials has increased by at least 35 percent since 2020, increasing the cost of compliance
  - Together, these two factors are likely to increase the debt-to-income ratio for potential applicants for manufactured home loans, increasing the likelihood of loan denial
- Minority buyers tend to have lower incomes, and therefore the impacts of the rule have the potential to fall disproportionately on historically marginalized communities
  - Low-income buyers are likely to be disproportionately impacted for similar reasons

Sources: *2021 Home Mortgage Disclosure Act, Industry Interviews.*

DOE's Reliance on Elasticity of Demand Estimates Understates Likely Impact on Affordability & Housing Access

- DOE has likely underestimated the affordability impact by assuming **relatively low price-sensitivity**
  - For example, AG's updated EEM cost estimates suggest that the cost of Tier 2 homes will increase by **6.1 percent**
    - Under DOE's assumption, a 6.1 percent increase in price leads to **2.9 percent fewer sales annually**
    - However, according to 2021 estimates of price sensitivity by the National Association of Home builders, the same 6.1 percent increase in price would lead to **6.4 percent fewer sales annually**
    - DOE's own sensitivity analysis, based on a study HUD has cited in prior rulemakings, suggests that this 6.1 percent price increase would lead to **14.6 percent fewer sales annually**
- Additionally, DOE has likely underestimated impacts on affordability due to:
  - DOE has arguably **underestimated compliance costs** and the expected increases in MH prices due to the rule
  - The **recent increase in retail prices** of MHs may have made ownership unaffordable for many consumers already
    - Consumers may be increasingly sensitive to price increases at higher baseline prices
- DOE's assumption understates the decreased demand by *thousands* of potential manufactured home buyers per year, all of whom would have to choose from worse alternatives

Sources: *DOE Technical Support Document, pp. 8-3, 10-7 – 10-9; NAHB (2021); EERE-2009-BT-BC-0021-1997_content, Sheet "Price Elasticity," Cells E3:E4; AG Calculations.*

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DOE Has Not Accounted for Costs of Testing and Compliance, Which Could Entirely Offset Anticipated Life-Cycle Cost Savings

- DOE has not specified requirements for duct system testing and air leakage testing, which are required by the IECC
- The costs of these possible testing requirements were also not included in DOE's LCC analyses
- Industry interviews have suggested that the costs of compliance may range up to and possibly **over $1,000/house** for in-field testing of homes in more remote locations
- A $1,000 testing cost could nearly wipe out anticipated savings across all tiers and analysis periods

DOE and Adjusted LCC Values, by Tier and Analysis Period

	10-Year LCC		30-Year LCC*	
	Tier 1	Tier 2	Tier 1	Tier 2
DOE LCC	$720	$743	$1,594	$3,573
Adjusted LCC	$549	-$647	$1,395	$1,361
Adjusted LCC, with $1,000 Testing Cost	-$194	-$1,330	$426	$338

Note: Asterisk (*) indicates that the 30-year LCC estimates rely on DOE's original model, which erroneously excludes mortgage payments after the 15th year of personal property loans and therefore overestimates anticipated savings.

Transportation Costs May Further Reduce or Negate Anticipated Savings

- Interviews with industry experts, as well as public comments submitted to DOE, have suggested that DOE has underestimated additional transportation costs due to additional height and weight required to comply with the rule
  - Additional insulation and framing requirements may increase the weight of manufactured homes, requiring an additional axle, which may cost **at least $400 to $500/multi-section house**
  - The rule may require homes in CZ2 and CZ3 to use 2' x 6' studs instead of standard 2' x 4' studs, which increases package height. Height increases may require re-routing deliveries around areas with height restrictions, such as in the Northeast
- Additionally, transportation costs have increased in general during the pandemic, e.g., as fuel and labor costs have increased
- Incremental transportation costs were not included in DOE's LCC estimates

Pandemic-Related Supply Chain Shortages May Persist into 2023

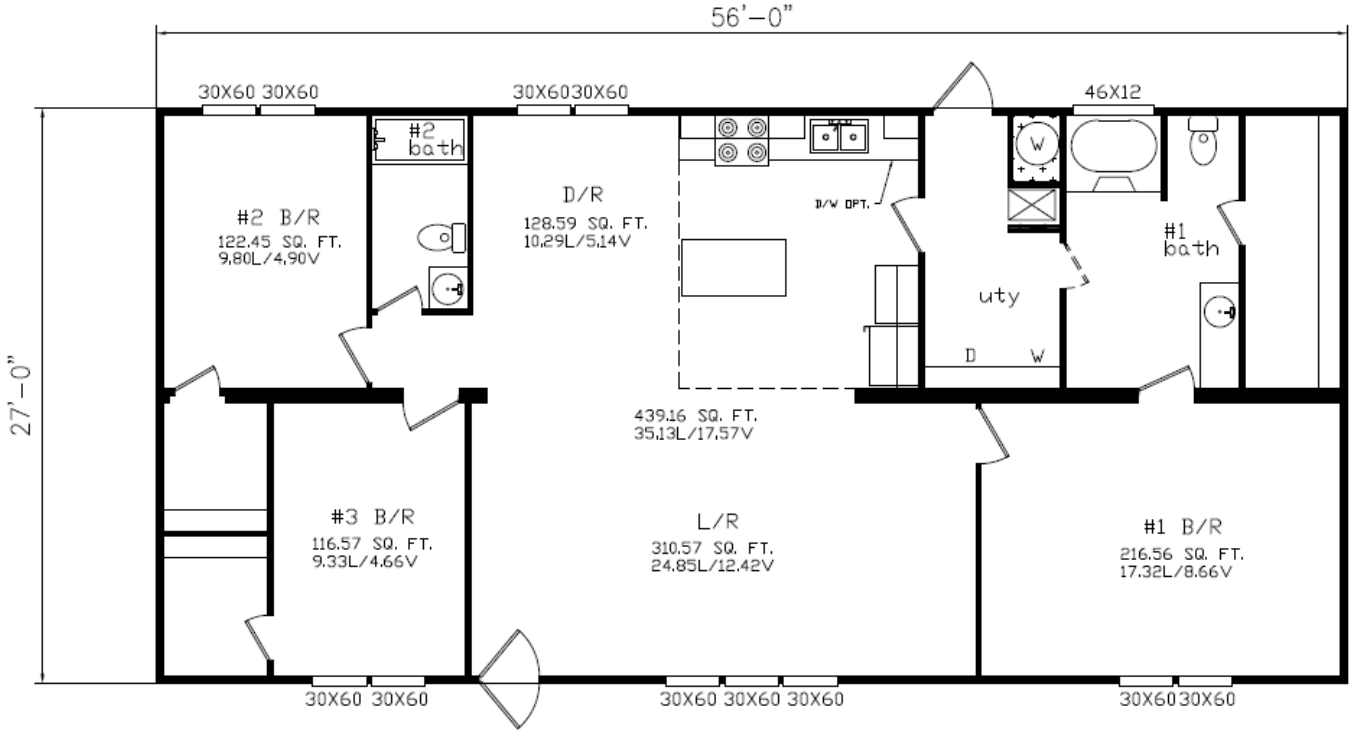
- Industry interviews have predicted that pandemic-related supply chain shortages are likely to persist into 2023
  - For example, one interview noted that there were already insulation shortages, with additional cost increases coming in January 2023
  - New fiberglass insulation plants are capital-intensive and take time to build, and therefore insulation shortages are likely to persist in the medium term
  - Therefore, increased demand from the manufactured housing sector due to the DOE rule may further exacerbate existing insulation shortages
  - Without sufficient fiberglass insulation, manufacturers may be forced to substitute to spray foam insulation for parts of the production process, increasing costs significantly and reducing the total number of homes that can be produced per day
- Additionally, CBRE has predicted that pandemic-related delays and labor shortages will continue in the short term

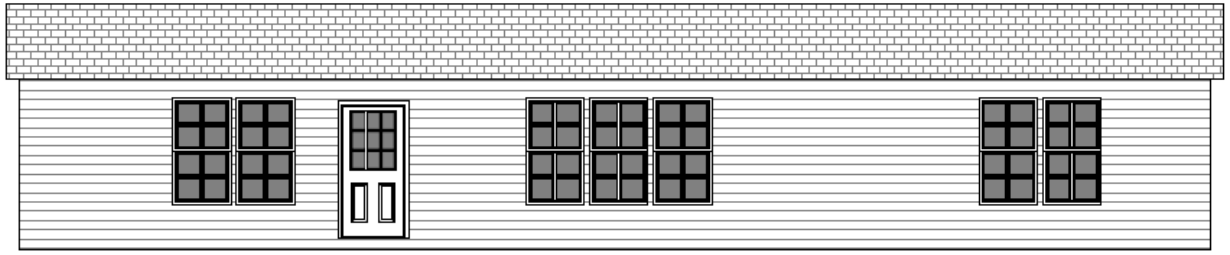
Exhibit C

Architectural Drawings

CURRENTLY BUILT MULTI WIDE – BOX SIZE 27x56

HEATED AREA – 1457 SQUARE FEET





TYPICAL ZONE 3 CONSTRUCTION

INSULATION – 22 FLOOR / 11 WALL / 28 CLG

2x4 WALLS

2x6 FLOOR JOISTS

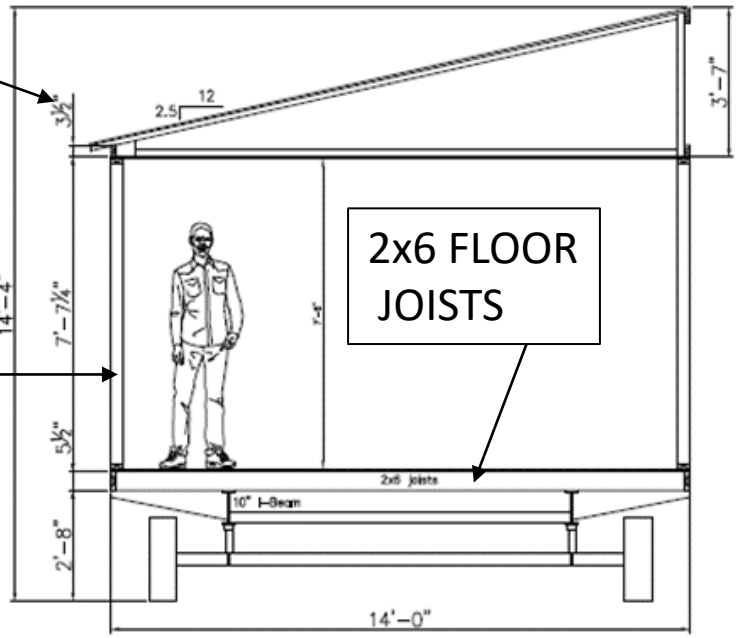
142 SQUARE FEET OF WINDOWS

WINDOW U-VALUE = 0.34

CURRENT TYPICAL CROSS SECTIONS

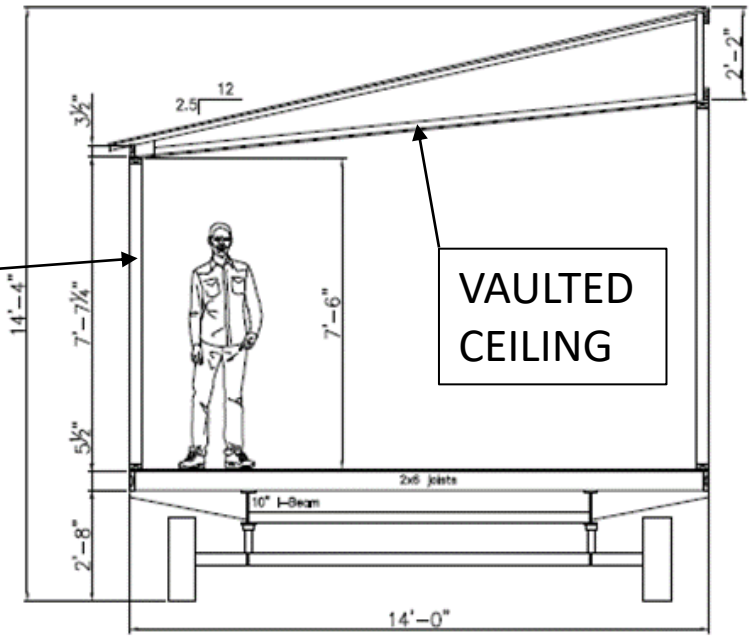
3-1/2” HEEL HEIGHT

2x4 EXT WALLS



2x6 FLOOR JOISTS

2x4 EXT WALLS

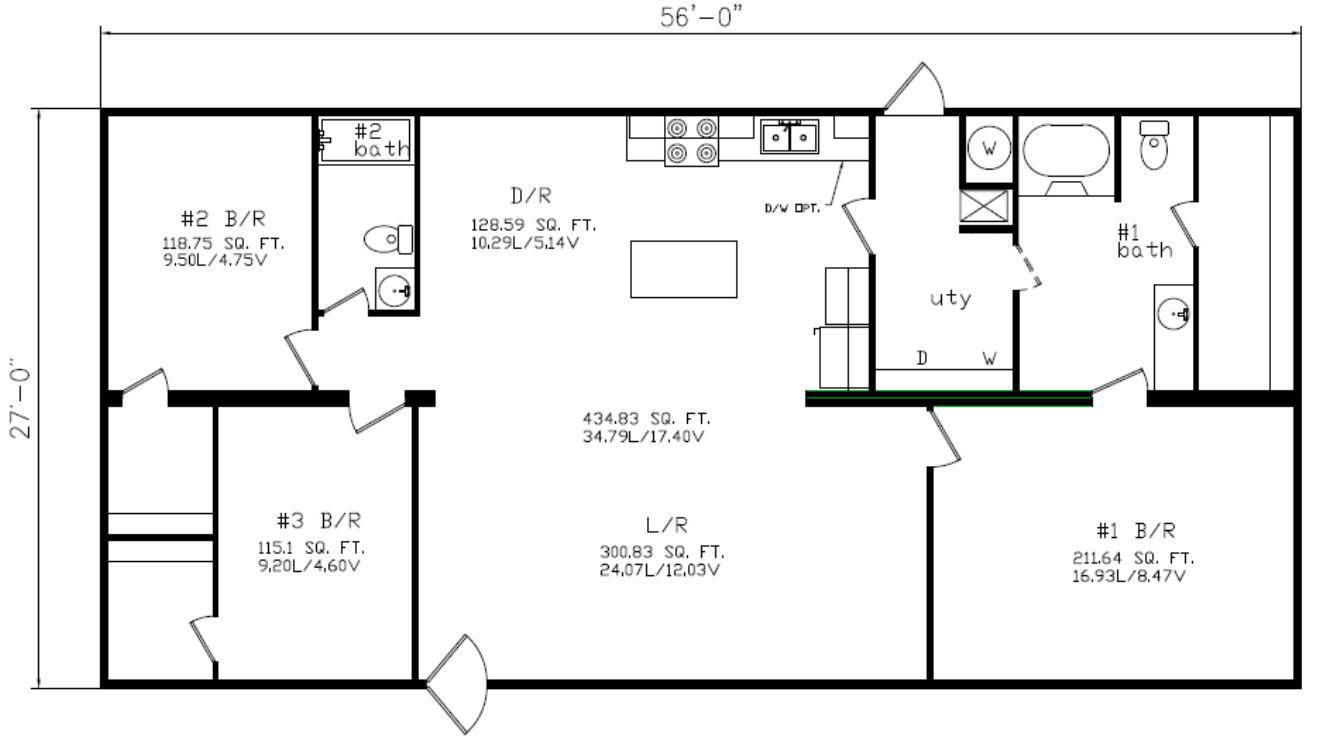


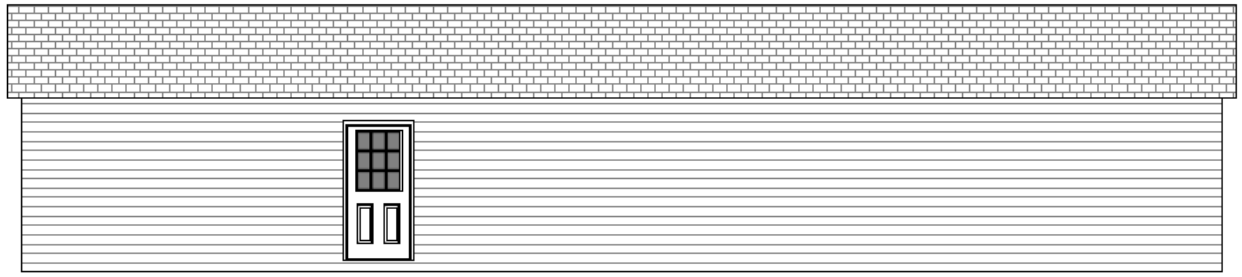
VAULTED CEILING

TYPICAL ZONE 3 CONSTRUCTION: SHIPPING HEIGHT 14’-4”
OPTIONAL VAULT CEILING
7’-6” SIDEWALL HEIGHT
3-1/2” TRUSS HEEL HEIGHT

IMPACT DUE TO DOE PROPOSED MULTI WIDE – BOX SIZE 27x56

HEATED AREA – 1457 SQUARE FEET





PROPOSED ZONE 3 CONSTRUCTION

INSULATION – 33 FLOOR / 15 WALL / 28 CEILING

2x4 WALLS

2x6 FLOOR JOISTS

ZERO WINDOWS

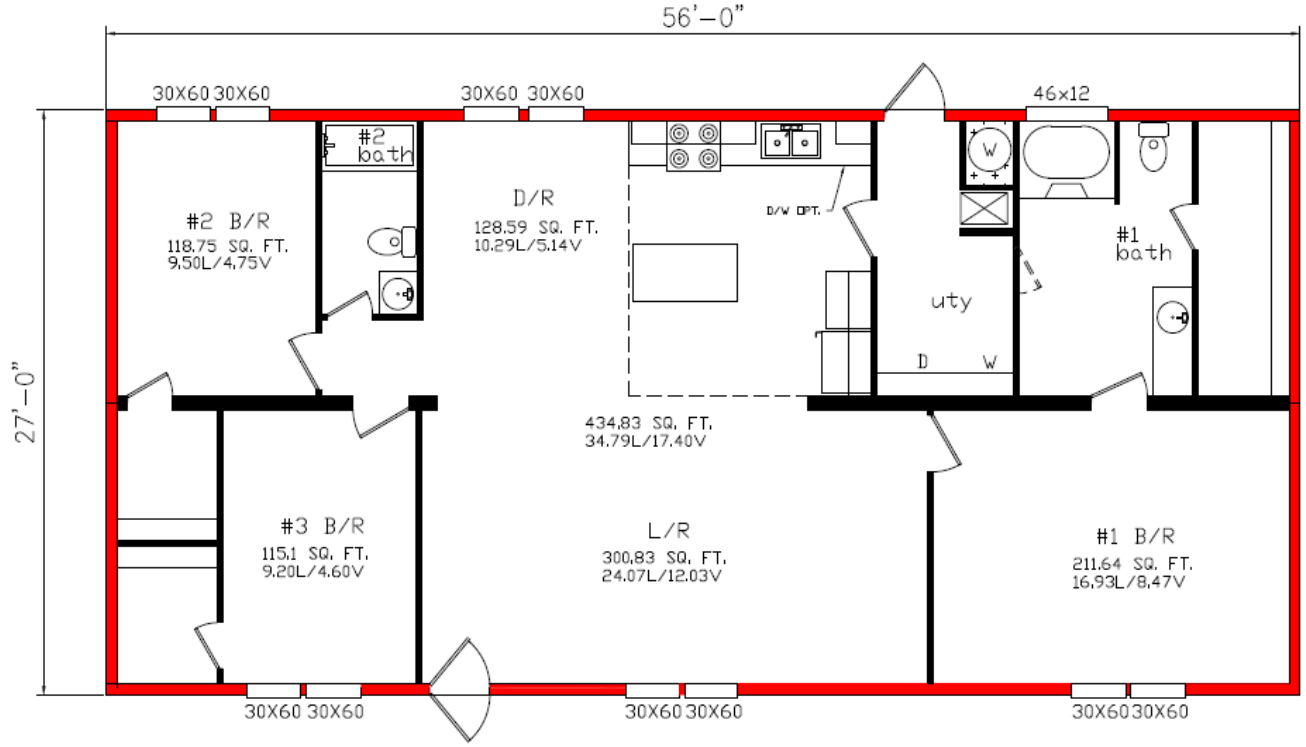
WINDOW U-VALUE = 0.32

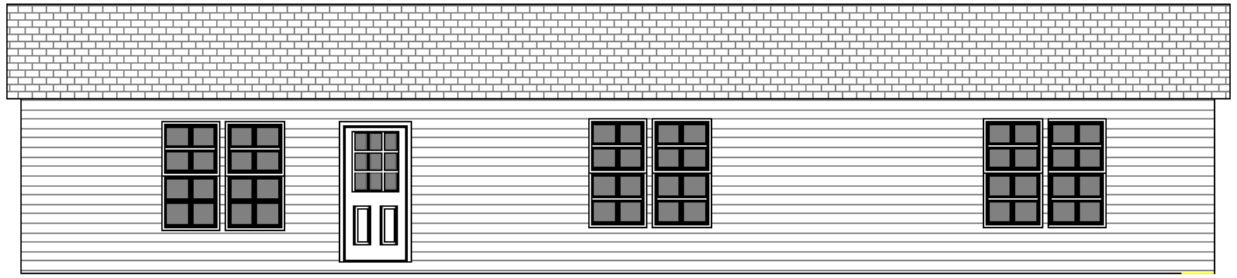
NOTES:

- THIS SLIDE SHOWS THE CHANGES REQUIRED IN ORDER TO REACH THE REQUIRED U-VALUE (0.055) WITHOUT CHANGING THE HOME CONSTRUCTION .
- FLOOR INSULATION WAS CHANGED TO R-33, WALL INSULATION WAS CHANGED TO R-15, AND CEILING INSULATION REMAINED R-28. THESE INSULATION VALUES ARE THE MAXIMUM POSSIBLE VALUES THAT CAN BE INSTALLED WITHOUT CHANGING THE HOME CONSTRUCTION FRAMING.
- WITH THIS CONSTRUCTION, I WAS ONLY ABLE TO GET THE OVERALL U-VALUE DOWN TO 0.055 IF ALL WINDOWS WERE REMOVED.
- PLEASE NOTE THAT IT IS NOT POSSIBLE TO CONSTRUCT A HOME WITHOUT WINDOWS DUE TO LIGHT, VENTILATION, and EGRESS REQUIREMENTS.

IMPACT DUE TO DOE PROPOSED MULTI WIDE – BOX SIZE 27x56

HEATED AREA – 1430 SQUARE FEET





PROPOSED ZONE 3 CONSTRUCTION

INSULATION – 30 FLOOR / 21 WALL / 38 CEILING
2x6 WALLS
2x8 FLOOR JOISTS
129 SQUARE FEET OF WINDOWS
WINDOW U-VALUE = 0.30
HEEL HEIGHT CHANGED TO 5.5 inches

NOTES:

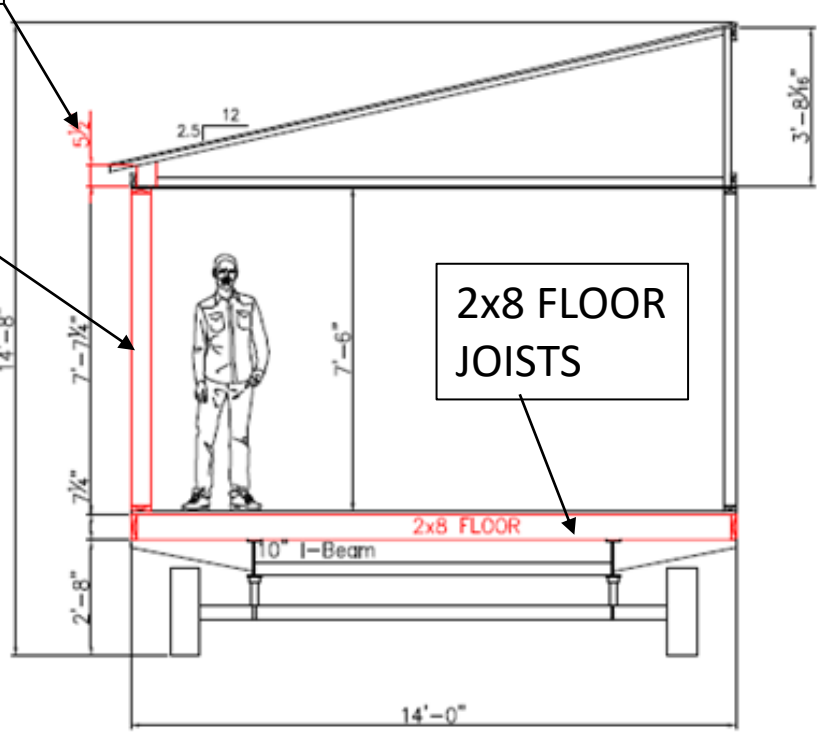
- IN ORDER TO REACH THE REQUIRED U-VALUE (0.055) THE FLOORS WERE CHANGED TO 2x8 , THE WALLS WERE CHANGED TO 2x6 AND THE INSULATION PACKAGE WAS CHANGED TO THE VALUES LISTED IN THE PRESCRIPTIVE SECTION OF THE PROPOSED CODE. HOWEVER, IT WILL BE VERY DIFFICULT TO BUILD THE HOME WITH THIS INSULATION PACKAGE USING CURRENTLY AVAILABLE MATERIALS.
- HEATED AND COOLED INTERIOR SPACE REDUCED BY 27 SQUARE FEET DUE TO THE INCREASED WALL THICKNESS.
- R-30 IN THE FLOOR WILL REQUIRE BATT INSULATION TO BE INSTALLED BETWEEN THE FLOOR JOISTS COMBINED WITH A BLANKET BELOW THE JOISTS. CURRENTLY, MOST MANUFACTUER'S DO NOT USE THIS FLOOR INSULATION TECHNIQUE.
- R-21 IS AVAILABLE, BUT IN SMALL QUANTITIES
- R-38 WILL BE PROBLEMATIC TO GET INTO THE ROOF CAVITY DUE TO THE REQUIRED THICKNESS AND AVAILABLE SPACE IN THE ATTIC.
- ADDED BACK 11 OF THE PREVIOSULY REMOVED 12 WINDOWS. UPGRADED THE WINDOWS TO U-VALUE EQUAL TO 0.30. HOWEVER, IT SHOULD BE NOTED THAT THESE UPGRADED WINDOWS ARE NOT AVAILABLE IN THE MARKET TODAY.
- SHIPPING HEIGHTS WILL BE INCREASED DUE TO TALLER FLOORS AND TALLER HEEL HEIGHT TRUSS.
- THE OPTION FOR A VAULTED CEILING WILL NOT BE POSSIBLE DUE TO THE INCREASED INSULATION THCKNESS IN THE ATTIC.
- OPTIONS FOR 8 FEET OR 9 FEET WALL HEIGHTS AND TRANSOM WINDOW WILL ALSO BE IMPACTED.

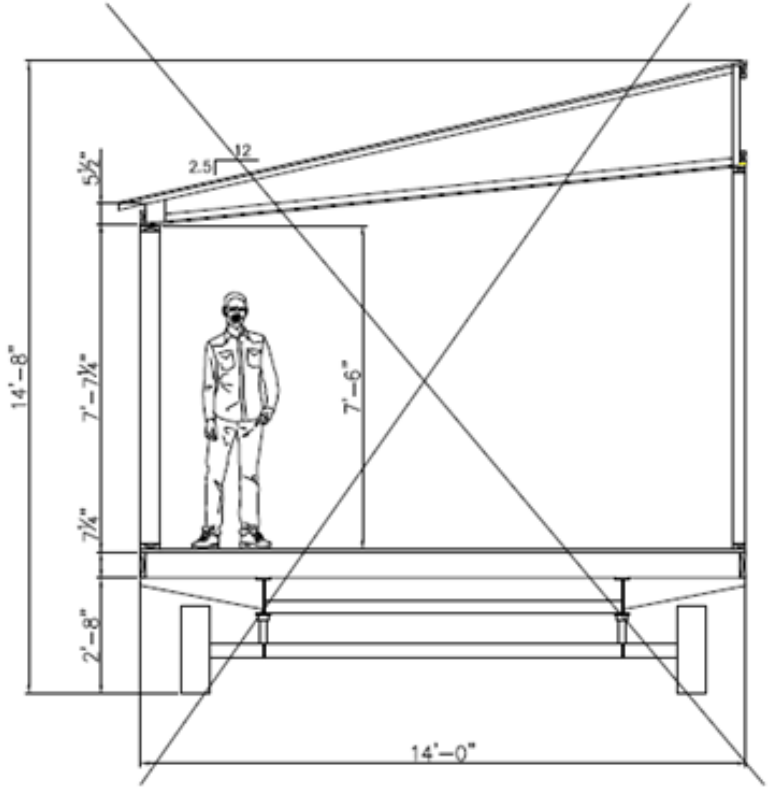
PROPOSED TYPICAL CROSS SECTIONS

5-1/2” HEEL HEIGHT

2x6 EXT WALLS

2x8 FLOOR JOISTS





ZONE 3 CONSTRUCTION:

SHIPPING HEIGHT INCREASED TO 14’-8”
OPTIONAL VAULT CEILING IS NO LONGER AVAILABE DUE TO INSULATION THICKNESS
7’-6” SIDEWALL HEIGHT
5-1/2” TRUSS HEEL HEIGHT
2x8 FLOORS

ADDITIONAL PROPOSED CHANGES

- PROPOSES USING ACCA MANUAL S AND ACCA MANUAL J FOR HEATING AND COOLING EQUIPMENT. HOWEVER, USING ACCA MANUAL J AND ACCA MANUAL S FOR THE DESIGN OF HEATING AND COOLING EQUIPMENT WILL BE PROBLEMATIC, ESPECIALLY IN THERMAL ZONE 3. ACCA MANUAL J REQUIRES KNOWLEDGE OF THE ORIENTATION OF THE HOME WITH RESPECT TO THE SUN FOR COOLING LOAD ANALYSIS. BECAUSE THE ORIENTATION OF THE HOME IS OFTEN UNKNOWN UNTIL INSTALLED, THE PROPOSED RULE MUST ESTABLISH A DEFAULT ORIENTATION. ACCA MANUAL S ESTABLISHES SIZING LIMITS FOR HEATING AND COOLING EQUIPMENT, THESE LIMITS PRESUME THAT THERMAL LOADS ARE ESTABLISHED FOR A SPECIFIC LOCATION AND SPECIFIC BUILDING ORIENTATION. THE VARIATION IN DESIGN PARAMETERS WITHIN A SINGLE THERMAL ZONE EXCEEDS THE SIZING LIMITS OF ACCA MANUAL S. ADDITIONAL GUIDANCE WILL BE REQUIRED TO PROPERLY USE ACCA MANUAL S AND ACCA MANUAL J.