U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Energy Conservation Standards Proposed Rulemaking for Manufactured Housing

July 13, 2016

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Building Technologies Program
EE-2009-BT-BC-0021
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Welcome

- Introductions (around the room)
- Role of the Facilitator
- Ground Rules
  - Speak one at a time.
  - Say your name for the record – there will be a complete transcript of this meeting.
  - Be concise – share the 'air-time'.
  - Keep the focus here – cell phones on silent; limit sidebar conversations.
  - Webinar participants turn phone on mute; "raise your hand" to be recognized to speak.
- Housekeeping Items
- Agenda Review
- Opening Remarks

Agenda

Welcome, Introductions, and Agenda Review

Purpose of Public Meeting, Comment Submission Instructions, Opening Statements

Regulatory Authority and History

MH Background and Current Energy Standard Codes; Climate Zones

Proposed Standards

Energy Efficiency Level Analysis

Life-Cycle Cost Analysis; Shipments

National Impact Analysis

Manufacturer Impact Analysis

Environmental Assessment and Emissions

Regulatory Impact Analysis

Closing Remarks and Adjourn

Listening Via the Webcast

- The Department is broadcasting this meeting live over the Internet.
- DOE is providing the webcast to accommodate stakeholders that are unable to attend the public meeting in person.
- The web broadcast allows stakeholders to listen in and view the slides.
- All stakeholders are encouraged to submit written comments after the public meeting.

Purpose of the Public Meeting

- Present DOE's proposed standards for manufactured housing.
- Invite comment on the notice of proposed rulemaking (NOPR) document.
- Discuss next steps in the rulemaking.
- Invite participants to provide summary comments or statements and raise additional issues for discussion.

Issues for Discussion

Issue Box: DOE welcomes comments, data, and information concerning its proposed standards for Manufactured Housing. Issues that correspond to those raised in DOE's published material will be numbered in accordance with that material. Whether invited by an issue box or not, comments are welcome on any part of DOE's analysis.

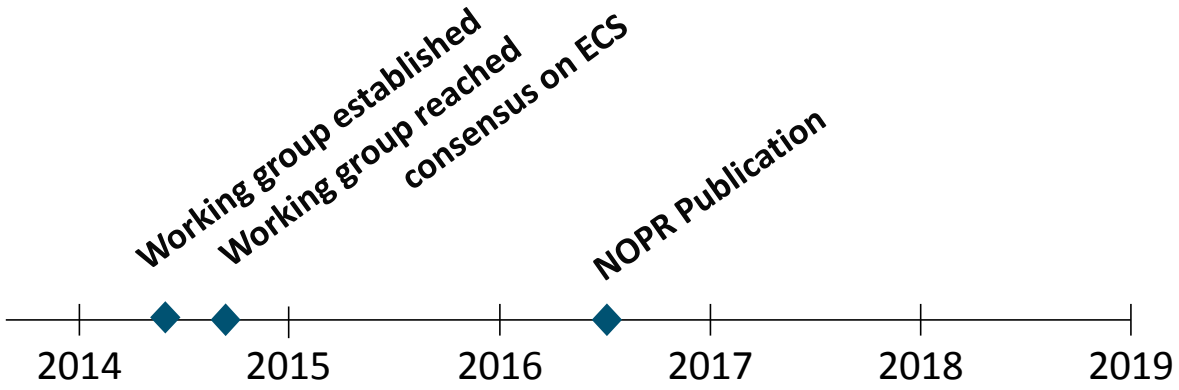
Issue box numbering corresponds to the list of issues published at the end of the NOPR document, available at: http://www1.eere.energy.gov/buildings/appliance_standards/rulemaking.aspx?ruleid=97.

The deadline for submitting comments is August 16, 2016.

Opening Remarks

Meeting participants are invited to provide opening remarks or statements at this time.

Manufactured Housing ECS Rulemaking Schedule



Milestone	Date
Working group established under the ASRAC committee	July 16, 2014
Working group reached consensus on energy conservation standards for manufactured housing	October 31, 2014
Manufactured housing NOPR published	June 17, 2016
Final rule for Manufactured housing *(projected)*	TBD
Compliance date for Manufactured housing *(projected)*	1-year after final rule publication

Public Meeting Slides Topics

1	Regulatory Authority and History
2	MH Background and Current Energy Standard Codes
3	Climate Zones
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Regulatory Authority and History

- The Energy Independence and Security Act of 2007 (EISA, Public Law 110-140) directs the U.S. Department of Energy (DOE) to establish energy conservation standards for manufactured housing (MH) based on the most recent [2015] version of the International Energy Conservation Code (IECC).
- On June 13, 2014, DOE published a notice of intent to establish the manufactured housing working group (MH working group). (79 FR 33873)
- On July 16, 2014, the MH working group was established under the Appliance Standards and Rulemaking Federal Advisory Committee (ASRAC) in accordance with the Federal Advisory Committee Act and the Negotiated Rulemaking Act. (79 FR 41456; 5 U.S.C 561-570, App. 2)
- On October 31, 2014, the MH working group reached consensus on energy conservation standards for manufactured housing, and its recommendations (see public docket EERE-2009-BT-BC-0021-0107) were approved by ASRAC on December 1, 2014. ***The MH working group's recommendations form the basis of this NOPR.***
    - The MH working group consensus was reached by manufacturers, energy efficiency advocates, homeowner advocacy groups, consumer financing advocates, trade associations, and other organizations.

Regulatory History and History

- EISA directs DOE to consult with the Secretary of the U.S. Department of Housing and Urban Development (HUD), who may seek further counsel from the Manufactured Housing Consensus Committee (MHCC). (42 U.S.C. 17071(a))
- HUD has regulated MH construction since 1976. (see 42 U.S.C 5401(b))
- In development of this NOPR, DOE's intent was to ensure compliance with the proposed requirements would not prohibit a manufacturer from complying with HUD requirements.
- The DOE-HUD consultation has consisted of several activities:
  - DOE provided a draft NOPR notice and TSD for review.
  - HUD attended all 6 DOE working group negotiation meetings in-person or by phone.
  - DOE met with HUD's MHCC twice to formally present the recommendations from the working group.
  - Many HUD MHCC members were also members of DOE's working group.
  - DOE and HUD general counsel spoke by phone several times to coordinate the consultation.
  - HUD participated in the interagency review of the NOPR coordinated by OIRA.

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Manufactured Housing Background

- A manufactured home is defined as, “a structure, transportable in one or more sections, which in the traveling mode is 8 body feet or more in width or 40 body feet or more in length or which when erected on-site is 320 or more square feet, and which is built on a permanent chassis and designed to be used as a dwelling with or without a permanent foundation when connected to the required utilities, and includes the plumbing, heating, air-conditioning, and electrical systems contained in the structure.” 24 CFR 3280.2
- The most common configurations are single-section and double-section homes.
- In 2014, MH stock consumed approximately 0.8 quads/year of primary energy, accounting for about 4 percent of total U.S. residential energy use.
- There were approximately 60,000 shipments of new manufactured homes in 2014.
- Large manufacturers provide the majority of shipments, with companies including:
  - Clayton Homes, Southern Energy Homes, Cavalier Homes, Champion Enterprises, Dutch Housing, Cavco Industries, and Skyline Corp.

Current Energy Conservation Codes

- The ***HUD*** code includes requirements related to the energy efficiency of manufactured homes within in the United States. The code contains the following:
  - Three (3) climate zones.
  - Uo requirements for the combined thermal transmittance value of walls, ceilings, floors, fenestration, and external ducts within the building thermal envelope for manufactured homes installed in different climate zones. Requirements for air leakage control through the building thermal envelope.
  - Requirements for sealing air supply ducts and for insulating both air supply and return ducts.
- The ***IECC*** sets voluntary industry standards for the "effective use of energy" in all existing buildings. The code contains the following:
  - Definitions of terms.
  - Eight (8) climate zones used in determining compliance with the standards.
  - Information required at the building site to verify insulation level and identifies National Fenestration Rating Council (NFRC) standards for rating fenestration performance.
  - Residential energy efficiency requirements, including building thermal envelope, space heating, space cooling, water heating, air leakage testing, duct system testing and maximum duct air leakage, and lighting.

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Climate Zones

- DOE establishes different standards depending on climate zone.
- The MH working group considered both the 8 IECC climate zones and 3 HUD climate zones.
- The MH working group recommended 4 climate zones to maintain as much consistency with the current HUD zones as possible.
- These 4 climate zones better represent regions with similar climate than the HUD Code climate zones, while minimizing the extensive subdivision of states by the 8 IECC climate zones.

Issue for Comment

Issue 6: Climate Zones

DOE requests comment on the proposal to establish four climate zones and the categorization of states and counties included in each climate zone.

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Proposed Rule: Prescriptive Path

- DOE proposed a prescriptive path to compliance with the proposed standard. The component requirements for the prescriptive path are as follows:

	Climate Zone			
	1	2	3	4
Wall Insulation R-value (hr-ft^2-°F/Btu)	13	13	21	21
Ceiling Insulation R-value (hr-ft^2-°F/Btu)	30	30	30	38
Floor Insulation R-value (hr-ft^2-°F/Btu)	13	13	19	30
Window U-factor	0.35	0.35	0.35	0.32
Skylight U-factor	0.75	0.75	0.55	0.55
Door U-factor	0.40	0.40	0.40	0.40
Glazed Fenestration SHGC	0.25	0.33	0.33	Not Applicable

Proposed Rule: Prescriptive Path

- For the purpose of compliance with the ceiling insulation *R*-value requirement, the truss heel height would be required to be a minimum of 5.5 inches at the outside face of each exterior wall.
- Ceiling insulation would be required to have either a uniform thickness or a uniform density.
- A combination of *R*-21 batt insulation and *R*-14 blanket insulation could be used for the purpose of compliance with the floor insulation *R*-value requirement for climate zone 4.
- An individual skylight that has an SHGC that is less than or equal to 0.30 would not subject to the glazed fenestration SHGC requirements.
- As an alternative to the minimum prescriptive *R*-value requirements, ceilings, walls, and floors could achieve compliance by achieving the following component maximum *U*-factors:

Climate Zone	Ceiling *U*-factor	Wall *U*-factor	Floor *U*-factor
1	0.0446	0.0943	0.0776
2	0.0446	0.0943	0.0776
3	0.0446	0.0628	0.0560
4	0.0377	0.0628	0.0322

Proposed Rule: Performance Path

- The performance path allows manufacturers design flexibility in creating manufactured homes while achieving equivalent thermal performance as a home designed using the prescriptive path.
- The performance path to compliance also includes SHGC, envelope leakage, duct leakage, and hot water pipe insulation requirements.

	Climate Zone			
	1	2	3	4
Single Section (U_O)	0.087	0.087	0.070	0.059
Multi Section (U_O)	0.084	0.084	0.068	0.056

- Windows, skylights ,and doors containing more than 50 percent glazing by area would be required to satisfy the SHGC requirements established in the prescriptive option on the basis of an area-weighted average.
- Area-weighted average vertical fenestration U-factor would be prohibited from exceeding 0.48 in climate zone 3 or 0.40 in climate zone 4.
- Area-weighted average skylight U-factor would be prohibited from exceeding 0.75 in climate zone 3 and climate zone 4.

Issue for Comment

Issue 8: Paths for compliance with the building thermal envelope standards
DOE requests comment on the proposal to establish prescriptive and performance options for achieving compliance with the proposed building thermal envelope requirements, the requirements of each option, and their equivalency in terms of overall thermal performance.

Issue 10: U-factor alternatives
DOE requests comment on the proposed U-factor alternatives and their equivalency with the prescriptive R-value requirements for ceiling, wall, and floor insulation.

Issue 7: Home Size
DOE requests comment on the proposal to establish separate requirements for single- and multi-section manufactured homes.

Issue 12: Calculation of average SHGC
DOE requests comment on the proposal to include an area-weighted average calculation of SHGC for compliance.

Proposed Rule: Insulation Installation

- Insulating materials would be installed according to the insulation manufacturer's installation instructions.
- Insulation must also meet other requirements such as insulating the rim joists and installing floor insulation to maintain permanent contact with the underside of the rough floor decking (with some exceptions).

Issue 13: Insulation installation requirements for floors
DOE requests comment on whether the insulation installation requirements, including installation of insulation in floors, may be readily implemented by the manufactured housing industry.

Proposed Rule: Building Thermal Envelope Air Leakage

- Manufactured homes would require sealing at all joints, seams, and penetrations associated with the building thermal envelope in accordance with the component manufacturer's installation instructions and DOE specifications.
- Mating line surfaces would be required to be equipped with a continuous and durable gasket.
- Sealing methods between dissimilar materials would be required to allow for differential expansion and contraction and establish a continuous air barrier upon installation of all opaque components of the building thermal envelope.
- All gaps and penetrations in the ceiling, 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 would require sealing with caulk, foam, gasket, or other suitable material.
- The rough openings around windows, exterior doors, and skylights would be required to be sealed with caulk or foam.

Proposed Rule: Building Thermal Envelope Air Leakage

Building Thermal Envelope Air Leakage contd.

- Duct system register boots that penetrate the building thermal envelope or the air barrier would be required to be sealed to the air barrier or the interior finish materials with caulk, foam, gasket, or other suitable material.
- Requirements would be established for the installation of air barriers in various manufactured home components, such as ceilings, walls, and floors.

Issue 14: Design criteria for envelope sealing
DOE requests comment on the effectiveness of the prescriptive building thermal envelope sealing requirements.

Proposed Rule: Ducts and Thermostats & Controls

Ducts

- Each manufactured home would be required to be equipped with a duct system which is sealed to limit total air leakage to less than or equal to four cubic feet per minute per 100 square feet of conditioned floor area.

Thermostats and Controls

- Programmable thermostats would be required for each separate heating and cooling system installed by the manufacturer.
- Supplementary electric-resistance heat would be prohibited when the heat pump compressor is capable of meeting the heating load.

Issue 16: Duct sealing
DOE requests comment on the proposed duct sealing and duct leakage requirements.

Issue 17: Thermostats and controls
DOE requests comment on the proposed requirements for thermostats and controls, and any potential inconsistencies with the HUD Code.

Proposed Rule: Service Water Heating

- Service water heating systems installed by the manufacturer would be required to be installed according to the service water heating manufacturer's installation instructions.
- DOE would require any automatic and manual controls, temperature sensors, and pumps associated with service water heating systems to be accessible
- Heated water circulation systems would be required to include a circulation pump, would be prohibited from using gravity and thermosyphon circulation systems, and would be required to use energy saving controls.
- All hot water pipes outside conditioned space or from a service water heating system to a distribution manifold would be required to be insulated to a minimum *R*-value of *R*-3.

Issue 18: Demand recirculation systems
DOE requests comment on the initial decision not to propose requirements related to demand recirculation systems in this rule.

Proposed Rule: Mechanical Ventilation Fan Efficacy

- Whole-house mechanical ventilation system fans would be required to meet the following minimum efficacy requirements:

Fan Type Description	Minimum Efficacy (cfm/Watt)
Range hoods (all air flow rates)	2.8
In-line fans (all air flow rates)	2.8
Bathroom and utility room fans (10 cfm ≤ air flow rate < 90 cfm)	1.4
Bathroom and utility room fans (air flow rate ≥ 90 cfm)	2.8

- Mechanical ventilation fans integral to heating, ventilating, and air conditioning equipment would be required to be powered by an electronically commutated motor.

Proposed Rule: Equipment Sizing

- Sizing of heating and cooling equipment installed by the manufacturer would be required to be determined in accordance with ACCA Manual S based on building loads calculated in accordance with ACCA Manual J.

Issue 20: Equipment sizing
DOE requests comment on the proposed requirements for equipment sizing and the applicability of ACCA Manuals S and J.

Issue 1: Relationship with the HUD Code 24 CFR 3280.
DOE seeks comment on potential inconsistencies or conflicts between the proposed rule and the HUD Code.

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Energy Efficiency Level Analysis: Overview

Purpose

- To determine the cost and energy use of homes built with different energy efficiency measures (EEMs) and sited in different locations.
- This cost and energy use data is then used as an input to downstream economic and environmental analyses.

Method

- Energy simulation software was used to determine energy consumption data for the set of EEMs analyzed.
- EEM options, performance characteristics, and costs were determined for all manufactured home components affected by the proposed rule.

Energy Efficiency Level Analysis: Energy Simulation

- DOE used simulation software (EnergyPlus v8.0) to determine energy consumption based on building thermal envelope, envelope air leakage and mechanical system inputs.

- DOE used these building construction assumptions for the energy simulation:

Dimension	Single-Section	Multi-Section
MH floor area	14 feet by 66 feet; 924 square feet	28 feet by 54 feet; 1,568 square feet
Floor-to-ceiling height	7.5 feet	7.5 feet
Window area	111 square feet	188 square feet
Window distribution	Equally on all four facades to yield a solar-neutral orientation. The windows are assumed to have no overhangs to represent an average manufactured home.	
Doors	Assumed to have two exterior doors with a total door area of 36 square feet, with a U-factor of 0.40.	

Energy Efficiency Level Analysis: Energy Simulation

- The energy simulation model also included assigned values for the following:
  - Lighting efficiency
  - Internal loads
  - Envelope Leakage
  - Thermal Zoning and Thermostat Set-Points
  - HVAC System Sizing
  - HVAC Equipment Efficiency
  - Duct Leakage
  - Domestic Hot Water System

- DOE assumed that the insulation and windows were presumed to last the 30-year lifetime assumed in the analysis, so there was no replacement cost.

- DOE assumed that the energy savings from improved levels would remain for the length of the 30-year analysis period.

Energy Efficiency Level Analysis: Climate Zones

- The energy analysis was conducted in a total of 19 cities to analyze each IECC climate zone and also provide additional focus on the southeastern United States (Mississippi, Alabama, Georgia, and South Carolina), which account for a large portion of manufactured home sales.

Energy Efficiency Level Analysis: EEM Ranges

- EEMs are elements of a manufactured home affecting energy use.
- The energy simulation analysis gave DOE the ability to calculated overall building energy use for a given set of EEMs.
- The following table provides the range of EEMs that were included in the analysis.

Building Component	Range of Options
Ceiling (hr-ft^2-°F/Btu)	R-22 to R-38
Wall (hr-ft^2-°F/Btu)	R-11 to R-21
Floor (hr-ft^2-°F/Btu)	R-11 to R-30
Window U-Factor (Btu/hr-ft^2-°F)	U-1.08 to U-0.30
Window SHGC	0.7 to 0.25
Duct Sealing (cfm25/100 ft^2 CFA)*	12 to 4
Envelope Sealing (ACH)	8 to 5
*CFA = conditioned floor area	

Energy Efficiency Level Analysis: EEM Cost

- Through data supplied during the MH working group, DOE assigned incremental costs to each EEM.

Example Cost Table – Wall Insulation

Wall R-Value (hr-ft2-°F/Btu)	Single-Section Cost $	Multi-Section Cost $
11	--	--
13	61.86	60.86
15	610.79	600.93
19	610.79	600.93
20	737.92	726.01
21	737.92	726.01
21+5*	2,199.75	2,176.76
* Refers to a combination of R-21 batt insulation and R-5 insulated siding.		

Issue 26: Increased costs of components

DOE requests comment on the assumptions underlying DOE's analyses associated with the increased costs of manufactured home components.

Energy Efficiency Level Analysis: Level Selection

DOE analyzed variations to the 2015 IECC to find the most cost-effective set of EEMs.

The MH working group started its analysis with the 2015 IECC

The cost-effectiveness was calculated for a manufactured home built to the 2015 IECC relative to a manufactured home constructed with the minimum requirements of the HUD code

Several EEM options were identified as potential revisions to the 2015 IECC that could increase cost-effectiveness for manufactured housing

The most cost-effective EEMs were recommended as part of this proposal

Energy Efficiency Level Analysis: Proposed Prescriptive Path Results

- DOE proposed 2 paths to compliance for the building thermal envelope, corresponding with the most cost-effective energy efficiency level.

- The **prescriptive path** gives exact EEMs to be implemented.

	Climate Zone			
	1	2	3	4
Wall Insulation R-value (hr-ft^2-°F/Btu)	13	13	21	21
Ceiling Insulation R-value (hr-ft^2-°F/Btu)	30	30	30	38
Floor Insulation R-value (hr-ft^2-°F/Btu)	13	13	19	30
Window U-factor	0.35	0.35	0.35	0.32
Skylight U-factor	0.75	0.75	0.55	0.55
Door U-factor	0.40	0.40	0.40	0.40
Glazed Fenestration SHGC	0.25	0.33	0.33	No Rating
Envelope Leakage Limit (ACH)	5	5	5	5
Duct Leakage Limit (CFM25/100ft^2 CFA)	4	4	4	4
Domestic Hot Water Pipe Insulation (*R*-value)	3	3	3	3

Energy Efficiency Level Analysis: Proposed Performance Path Results

- The **performance path** provides the performance-based overall thermal transmittance (U_o) requirements for the entire building thermal envelope, which gives flexibility in designing the building thermal envelope.

- The Uo of a manufactured home was calculated using the EEMs proposed for the prescriptive path.

Climate Zone	Single-Section Uo	Multi-Section Uo
1	0.087	0.084
2	0.087	0.084
3	0.070	0.068
4	0.059	0.056

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Life-Cycle Cost (LCC) and Payback Period (PBP) Overview

Purpose

- Provide an economic evaluation from the end-user's perspective.
- Life-Cycle Cost (LCC) is the total purchaser cost over the life of a product.
- Payback Period (PBP) is the time required to recover the increased purchase price of more energy-efficient products through reduced operating costs.

Method

- Determine incremental purchase price.
- Determine financial, economic, and fuel prices for analyses.
- Determine LCC by calculating total homeowner expense over the life of the manufactured home, consisting of purchase expenses (i.e., mortgage or cash purchase) and operating costs (i.e., energy costs).
- Calculate PBP by dividing incremental increase in purchase cost by the reduction in average annual operating costs.

Life-Cycle Cost (LCC) and Payback Period (PBP): Inputs

- The main inputs to the LCC and PBP analysis include the MH home incremental purchase price, and the financial parameters for purchasing a home.

- Approximately 70 percent of manufactured homes are purchased using a loan, and 30 percent of manufactured homes are purchased outright.
  - DOE considered two different loan structures in the analysis, which include a personal property loan (often referred to as a "chattel loan") or a real estate loan.
  - According to the MH working group, 78 percent of manufactured homes that are purchased with financing use a personal property loan, and 22 percent of financed purchases use a real estate loan.

- The LCC analysis must also sum costs and benefits occurring in different years into a common valuation, known as the present value. To translate costs and benefits occurring in future years as a present value, DOE established a discount rate.
  - Mortgage prepayment was used to establish the discount rate for this analysis, because the homebuyer has borrowed money at that rate, demonstrating that his implicit discount rate must be at least that high.

Life-Cycle Cost (LCC) and Payback Period (PBP): Inputs

- The following tables provide the MH incremental retail purchase price and financial parameter inputs to the LCC and PBP.

MH Incremental Retail Purchase Price		
	Single-Section	Multi-Section
	$	$
Climate Zone 1	2,422	3,748
Climate Zone 2	2,348	3,668
Climate Zone 3	2,041	2,655
Climate Zone 4	2,208	2,877
National Average	2,226	3,109

Finance Parameters		
	Personal Property Loans	Real Estate Loans
Mortgage interest rates	9%	5%
Loan term	15 years	30 years
Down payment	20%	20%
Loan fees and points	1%	1%
Other Rates and Times		
Discount rate (nominal)	9%	**5%**
Analysis Period	30 years and 10 years	
Property tax rate	0.9%	
Fuel Prices and Escalation Rates		
	Price	Escalation Rate
Electricity Summer Winter	 12.9 cents/kWh 12.3 cents/kWh	2.5%
Natural gas	$10.67/MBtu	3.5%
Liquid petroleum gas	$24.18/MBtu	2.3%
Oil	$26./MBtu	2.5%

Life-Cycle Cost (LCC) and Payback Period (PBP): Results

- The following table provides the net LCC savings and PBP associated with the proposed rule compared to the HUD code for a 30-year analysis period for single-section and multi-section manufactured homes.
  - The results account for the energy cost savings and mortgage payments over the entire analysis period discounted to a present value, using the discount rates.
  - The results represent a weighted average of the three different methods for purchasing the home: outright purchase with cash, financed with a personal property loan, and financed with a real estate loan.
  - The results represent the weighted average across all five heating system types: Electric resistance, electric heat pump, natural gas furnace, LPG furnace and distillate oil furnace.

Climate Zone	LCC Savings (2015$)		PBP (Years)	
	Single-Section	Multi-Section	Single-Section	Multi-Section
1	$2,078	$3,410	8.5	8.2
2	$2,792	$4,760	7.4	7.1
3	$3,000	$4,291	6.7	6.5
4	$4,643	$6,016	6.1	6.3
Nation	**$3,211**	**$4,625**	**7.1**	**6.9**

Issue for Comment

Issue 27: Lifecycle cost analysis
DOE requests comment on the methodology and initial findings of the lifecycle cost analysis.

Issue 28: Affordability
DOE requests comment on the affordability of the proposed rule with respect to the increased purchase cost, reduced operating costs (energy bills), and total lifecycle cost.

Shipments Analysis Overview

Purpose

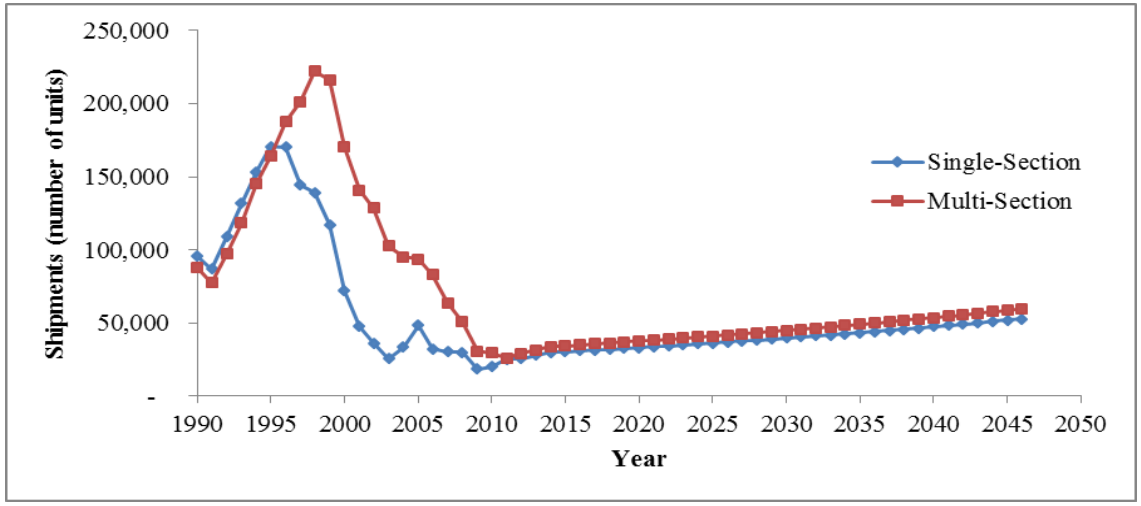
- To determine base-case shipments (with HUD standards) and standards case shipments (with proposed standards) over the analysis period (2017-2046).

Method

- DOE developed a shipment model for manufactured housing using historical data from the Manufactured Housing Institute (MHI) and using projections for growth in new housing starts from the AEO 2015 to forecast shipments into the future.

Shipments Analysis: Base-case Shipments Inputs

- DOE used historical data from MHI to develop the base-case shipments model.
  - MHI publishes an annual report of manufactured housing shipments categorized by state and by the number of home sections (*i.e.*, single-section or multi-section).
  - Because all energy use intensities and incremental home prices were analyzed for 19 different cities in the four proposed climate zones, DOE aggregated the shipments originally categorized by state in the MHI report into shipments for the 19 cities.
- To estimate future shipments of manufactured homes, DOE assumed the manufactured housing shipment growth rate was equal to the residential housing starts growth rate from AEO 2015.
- All base-case shipments are of baseline (HUD Code) efficiency.



Shipments Analysis: Standards-case Shipments Inputs

- All standards-case shipments are assumed to just meet the proposed energy conservation standard.
  - As customers shift from manufactured housing just compliant with the HUD code to manufactured housing compliant with the proposed energy conservation standard, the increase in upfront home price affects the shipment volume.

- To determine the change in shipments in the standards-case, DOE used the concept of price elasticity of demand.
  - Price elasticity of demand (price elasticity) is an economic concept that describes the change of the quantity demanded in response to a change in price. Price elasticity is typically represented as a ratio of the percentage change in quantity relative to a percentage change in price.

- DOE used the elasticity value of -0.48 in its analysis of changes to future shipments in response to the proposed energy conservation standard.
  - For a 5% increase in purchase price, shipments would decrease by 2.4%.

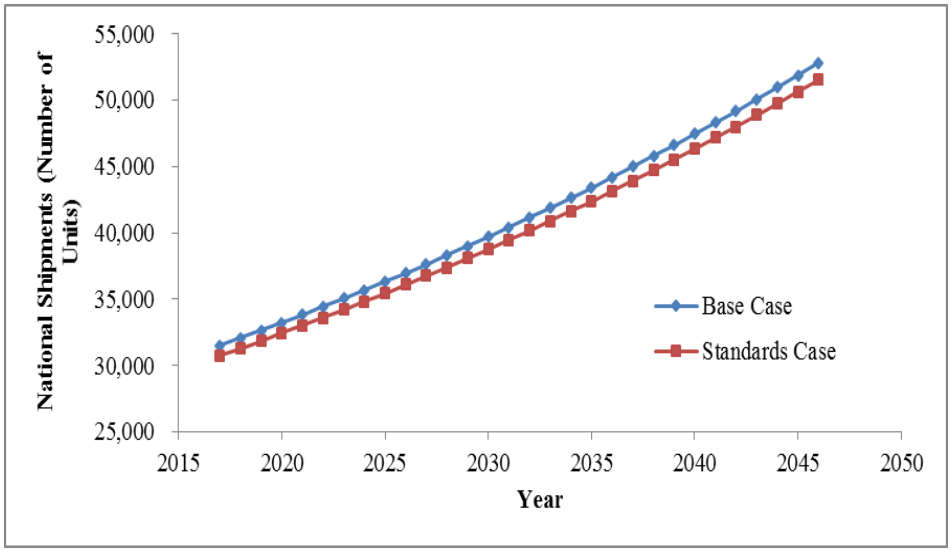
Shipments Analysis: Standards-case Shipments Inputs

$$Standards\ Case\ Shipments =$$

$$Base\ Case\ Shipments * \left(\frac{Incremental\ MH\ purchase\ price}{Average\ Sales\ Price} * (-0.48) + 1\right)$$

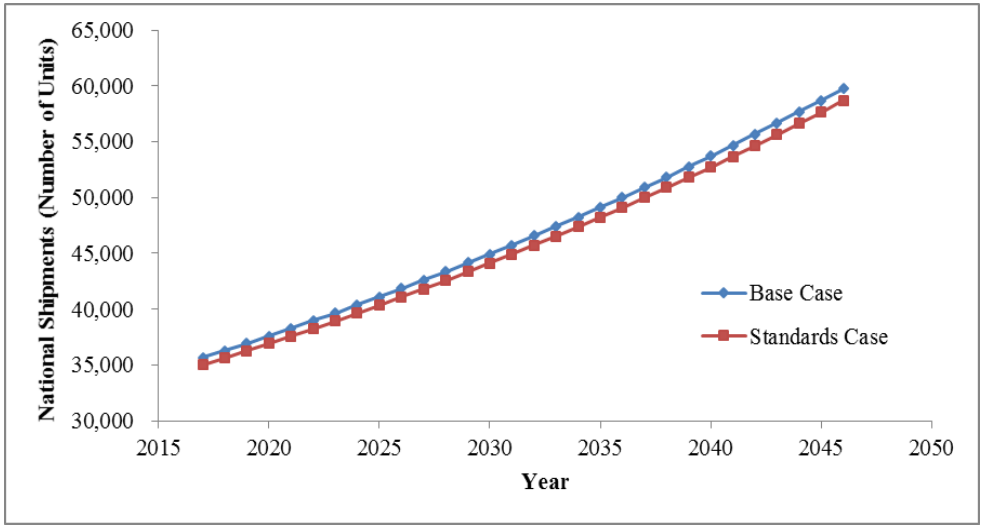
- DOE used this equations to calculate relative shipment reduction factors for single-section and multi-section homes in all 19 cities.
  - DOE applied these factors for each year of shipments in the analysis period to capture the impacts of the increased purchase price on manufactured home demand.
  - DOE assumed the overall and incremental cost increase of manufactured homes would not change over time (*i.e.,* no price learning), and therefore the shipment reduction factors do not change over time.

Shipments Analysis: Results



Single-section Shipments

Multi-section Shipments



Issue for Comment

Issue 30: Shipments analysis
DOE requests comment on the methodology and initial findings of the shipments analysis.

Issue 32: Price Elasticity
DOE requests comment on the estimate of the price elasticity of demand of manufactured homes.

Public Meeting Slides Topics

1	Regulatory Authority and History
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National Impact Analysis Overview

Purpose

- Determine the projected national energy savings (NES) and consumer national net present value (NPV) of a proposed standard.

Method

- Develop annual series of national energy and economic impacts.
- Aggregate the costs and energy use per unit in any given year.
- Report estimates for economic impact as change in NPV.
- Account for the time-value of money through defined discount rates.

National Impact Analysis: NES and NPV Calculation

- NES is calculated using the equation: $NES(y) = (AEC_{base\ case}(y) - AEC_{std}(y))$

  where:

  $NES(y)$ = National energy savings in year y (quads),

  $AEC_{no\ std}(y)$ = based case annual national energy consumption at the power plant for all affected stock in year y (quads), and

  $AEC_{std}(y)$ = standards case annual national energy consumption at the power plant for all affected stock in year y (quads).

- NPV is calculated using the equation: $NPV = PVS - PVC$

  where:

  NPV = National net present value (2015$),

  PVS = present value of savings in operating cost (in 2015$), and

  PVC = present value of increase in total installed cost (in 2015$).

National Impact Analysis: NES Method and Inputs

- DOE modeled the annual energy consumption per square foot of floor space associated with the HUD code and the proposed standard in 19 different cities.
  - The annual unit site energy consumption was determined from the energy simulation analysis.
  - The energy use intensities were analyzed with five different types of heating systems: electric resistance heaters, air-source heat pumps, natural gas furnaces, LPG furnaces, and oil furnaces.
- DOE converted the unit site energy consumption of the HUD code and the proposed standard into primary energy consumption and full fuel cycle (FFC) energy consumption.
- DOE analyzed the NES for 30 years of manufactured home shipments, and considered the entire lifetime of each shipment.
  - In a given year, the housing stock is the cumulative number of shipments up to that year less the number of homes that have exceeded their 30-year lifetime.

National Impact Analysis: NPV Method and Inputs

- DOE calculated the total incremental installed cost of 30-years of shipments of new manufactured homes compliant with the proposed rule, and the associated operating cost savings over the entire lifetime of those 30 years of shipments.
  - These costs and savings were discounted to a base year, 2015, using both a 3-percent and a 7-percent real discount rate.

- For each year of shipments, DOE calculated the incremental total installed cost and total operating costs of manufactured homes in each of the nineteen cities.
  - This incremental installed cost is a weighted average across three different methods of payment: personal property loans, real estate loans, and outright purchases.
  - DOE assumed that in its projections of future price trends, the real price of manufactured homes would remain constant (i.e., no price learning).
  - To forecast the nominal price increase of manufactured homes, DOE used the inflation rate associated with energy price forecasts in *AEO 2015*, which is 1.85 percent.

- DOE used energy price forecasts from the *AEO 2015* to calculate the energy cost savings associated with the proposed rule for the entire analysis period.
  - DOE used these forecasts for all 5 heating system types.

National Impact Analysis: NES & NPV Results

NES Results		
	Single-Section quadrillion British thermal units (BTUs) (quads)	Multi-Section quadrillion BTUs (quads)
Climate Zone 1	0.179	0.294
Climate Zone 2	0.130	0.245
Climate Zone 3	0.272	0.474
Climate Zone 4	0.303	0.416
Total	0.884	1.428

NPV Results				
	7% Discount Rate		3% Discount Rate	
	Single-Section (billion 2015$)	Multi-Section (billion 2015$)	Single-Section billion 2015$	Multi-Section billion 2015$
Climate Zone 1	0.19	0.34	0.66	1.16
Climate Zone 2	0.16	0.35	0.54	1.10
Climate Zone 3	0.39	0.74	1.22	2.26
Climate Zone 4	0.52	0.74	1.60	2.24
Total	1.26	2.18	4.03	6.75

Issue for Comment

Issue 33: National impacts analysis
DOE requests comment on the methodology and initial findings of the national impacts analysis.

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MIA Overview

Purpose

- Assess the impacts of potential energy conservation standards on manufacturers.

Method

- Calculate industry-average financial metrics.
- Estimate conversion costs.
- Use Government Regulatory Impact Model (GRIM), an industry discounted cash flow model, to estimate Industry Net Present Value (INPV).

MIA: Inputs

- Upstream Inputs
  - Incremental Retail Prices
  - Shipments Forecasts

- MIA Inputs
  - Industry Financials Metrics
  - Conversion Costs

Industry Financial Metrics

$$\frac{Retail\ Price}{Sales\ Tax \times Retail\ Markup} = Manufacturer\ Sales\ Price$$

- Average sales tax = 1.03
- Average retail markup = 1.3

$$\frac{Manufacturer\ Sales\ Price}{Manufacturer\ Markup} = Manufacturer\ Production\ Cost$$

- Manufacturer markup = 1.25

Issue 29: Manufacturer Impact Analysis - Markups
DOE requests comment on the manufacturer and retailer markups

Conversion Costs

Product Conversion Costs

- One-time, upfront investments in research, development, labeling updates, and other costs to make product designs comply with energy conservation standards.

Capital Conversion Costs

- One-time, upfront investments in property, plant and equipment to adapt or change existing manufacturing lines.

Total Industry Conversion Costs	Product Conversion Costs	Capital Conversion Costs	Total Conversion Costs
Million 2015$	1.4	0.2	1.6

MIA: Results

	Single-Section	Multi-Section	Total Industry
Base Case INPV (Million 2015$)	229	488	717
Standards Case INPV (Million 2015$)	215 to 228	465 to 486	680 to 714
Change in INPV (Million 2015$)	(14) to (1)	(23) to (2)	(37) To (3)
Change in INPV (%)	(6.1) to (1.1)	(4.7) To (0.4)	(5.1) to (0.4)
Total Conversion Costs (Million 2015$)	0.5	1.1	1.6

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Environmental Assessment Overview

Purpose

- Assess the environmental impacts of the proposed rule, especially:
  - Impacts of the proposed rule on indoor air quality (IAQ).
  - Full-fuel-cycle emissions reductions resulting from amended energy conservation standards, including carbon dioxide (CO_2), sulfur dioxide (SO_2), nitrogen oxides (NO_X), nitrous oxide (N_2O), and methane (CH_4), mercury (Hg).

Methodology

- Investigate impacts of increased air sealing on indoor air quality in manufactured homes.
- Compute full-fuel-cycle emissions reductions from annual energy savings from NIA using emissions factors derived from AEO 2015.

Environmental Assessment: Indoor Air Quality

- DOE proposes to prescribe air sealing requirements that are expected to decrease natural air infiltration on average from 8 to 5 air changes per hour when measured at a pressure difference of 50 Pa.
  - The proposed rule is not expected to change the sources of indoor air pollutants.
- DOE expects the possible impacts of the proposed rule to include:
  - Reduced infiltration into the home of outdoor air pollutants such as car exhaust.
  - Increase in indoor air pollutants due to reduction in ventilation.
- The impacts of reduced infiltration on indoor air quality depend on many factors, including:
  - Human behavior (i.e. pollutant sources present).
  - Mechanical ventilation installed in the home.
  - Climate – weather significantly impacts amount of natural infiltration.

Issue 15: Impact of envelope sealing on indoor air quality
DOE requests specific information on how the proposed rule may impact indoor air quality.

Note: The full environmental assessment is publically available at: 81 FR 42576 (June 30, 2016)

Environmental Assessment: Emissions Results

Pollutant	Home Size	
	Single-Section	Multi-Section
Source Emissions		
CO_2 (million metric tons)	56.5	91.1
Hg (metric tons)	0.0904	0.146
NOx (thousand metric tons)	223	356
SO_2 (thousand metric tons)	27.6	44.4
CH_4 (thousand metric tons)	3.78	6.09
N_2O (thousand metric tons)	0.632	1.02
Upstream Emissions		
CO_2 (million metric tons)	4.01	6.45
Hg (metric tons)	0.000944	0.00153
NOx (thousand metric tons)	51.8	83.2
SO_2 (thousand metric tons)	0.615	0.991
CH_4 (thousand metric tons)	239	385
N_2O (thousand metric tons)	0.0294	0.0474
Full-Fuel-Cycle Emissions		
CO_2 (million metric tons)	60.5	97.6
Hg (metric tons)	0.0913	0.148
NOx (thousand metric tons)	275	439
SO_2 (thousand metric tons)	28.2	45.4
CH_4 (thousand metric tons)	243	391
N_2O (thousand metric tons)	0.661	1.07

Emissions Monetization Overview

- DOE uses the most current Social Cost of Carbon (SCC) values developed by interagency process.
  - SCC is intended to be a monetary measure of the incremental damage resulting from greenhouse gas (GHG) emissions, including, but not limited to, agricultural productivity loss, human health effects, property damage from rising sea levels, and ecosystem changes.
- The most recent U.S. government interagency estimates of the SCC for emissions in 2015, per metric ton avoided (in 2015 dollars):
  - **$13.5** (average value from a distribution with a 5% discount rate)
  - **$42.9** (average value from a distribution with a 3% discount rate)
  - **$65.4** (average value from a distribution with a 2.5% discount rate)
  - **$122.9** ($95^{th}$-percentile value from a distribution with a 3% discount rate)
- The SCC in constant dollars increases over time.
- DOE also monetizes the NO_X emissions reductions resulting from amended standards.

Emissions Monetization: CO_2 Results

Global Net Present Value of Reduced Emissions of CO_2 for Each SCC Value for Manufactured Homes Shipped 2017-2046

Home Size	SCC Case			
	5% Discount Rate, Average	3% Discount Rate, Average	2.5% Discount Rate, Average	3% Discount Rate, 95th Percentile
	Million 2015$			
Site Monetized Emissions				
Single Section	344.1	1,691.9	2,732.6	5,214.5
Multi Section	555.1	2,729.1	4,407.7	8,411.2
Upstream Monetized Emissions				
Single Section	24.0	119.0	192.5	367.0
Multi Section	38.6	191.4	309.5	590.3
Full-Fuel-Cycle Monetized Emissions				
Single Section	368.2	1,810.9	2,925.0	5,581.5
Multi Section	593.7	2,920.5	4,717.3	9,001.5

Emissions Monetization: NO_X Results

Net Present Value of Reduced Emissions of NO_X for Each Discount Rate for Manufactured Homes Shipped 2017–2046

Home Size	Discount Rate	
	3%	7%
	Million 2015$	
Site Emissions		
Single Section	252.8	97.4
Multi Section	404.4	155.8
Upstream Emissions		
Single Section	58.6	22.5
Multi Section	94.3	36.1
Full-Fuel-Cycle Emissions		
Single Section	311.5	119.8
Multi Section	498.6	191.9

Issue 34: Emissions analysis

DOE requests comment on the methodology and initial findings of the emissions analysis.

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Regulatory Impact Analysis Overview

Purpose

- To analyze the impacts of the regulatory alternatives on purchase price of single-section and multi-section manufactured homes, impacts on total annualized economic costs and benefits to the nation and impacts on manufacturers.

Method

- DOE modified the NIA, Emissions and MIA Analyses to represent the following non-regulatory alternatives:
  - 2009 IECC code
  - 2012 IECC code

Regulatory Impact Analysis: Key differences

- In all but three of the analyzed cities, the 2012 IECC has a more stringent requirement of 3 ACH for the envelope leakage limit relative to the 2009 IECC (7 ACH for all cities and climate zones) and the proposed rule (5 ACH for all cities and climate zones).

- The 2012 IECC leads to the largest incremental purchase price increase compared to the 2009 IECC and the proposed rule in all but one of the 19 cities.

Regulatory Impact Analysis: Results

	Discount Rate	2009 IECC	2012 IECC	Proposed Rule
Benefits (Million 2015$/year)				
Operating (Energy Cost Savings)	7	286	636	516
	3	468	1,040	843
CO_2, Average SCC Case	5	34	77	63
CO_2, Average SCC Case	3	133	298	241
CO_2, Average SCC Case	2.5	201	451	365
CO_2, 95th Percentile SCC Case	3	410	919	744
NO_X Reduction at $2,723/metric ton	7	13	33	25
	3	22	54	41
Total (Operating Cost Savings, CO_2 Reduction and NO_X Reduction)	7 plus CO_2 range	334 to 709	746 to 1,588	604 to 1,285
	7	432	967	783
	3	623	1,392	1,126
	3 plus CO_2 range	524 to 900	1,171 to 2,013	947 to 1,628
Costs (Million 2015$/year)				
Incremental Purchase Price Increase	7	170	281	220
	3	214	355	277
Net Benefits/Costs (Million 2015$/year)				
Total (Operating Cost Savings, CO_2 Reduction and NO_X Reduction, Minus Incremental Cost Increase to Homes)	7 plus CO_2 range	164 to 539	465 to 1,307	384 to 1,065
	7	262	686	563
	3	409	1,037	849
	3 plus CO_2 range	310 to 686	816 to 1,658	670 to 1,351

Regulatory Impact Analysis: Results

	2009 IECC	2012 IECC	Propose Rule
Base Case INPV Million 2015$	716.7	716.7	716.7
Standards Case INPV Million 2015$	680.0 to 713.6	655.7 to 711.4	667.8 to 711.6
Change in INPV Million 2015$	(36.8) to (3.1)	(61.0) to (5.3)	(48.9) to (5.2)
Change in INPV %	(5.1) to (0.4)	(8.5) to (0.7)	(6.8) to (0.7)
Total Conversion Costs Million 2015$	1.6	1.6	1.6

Public Meeting Slides Topics

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Request for Closing Remarks

At this time DOE welcomes any closing remarks from interested parties

How to Submit Written Comments

In all correspondence, please refer to the manufactured housing rulemaking by:

Title	MH Energy Conservation Standard
Docket Number:	EERE-2009-BT-BC-0021
Regulation Identification Number (RIN):	1904-AC11
Email:	ManufacturedHousing2009BC0021@ee.doe.gov
Comments Due:	August 16, 2016

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