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DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
DEPARTMENT OF AGRICULTURE

[Docket No. FR-6271-N-01]

RIN 2506-AC55

Adoption of Energy Efficiency Standards for New Construction of HUD- and USDA-Financed Housing: Preliminary Determination and Solicitation of Comment

AGENCIES: Department of Housing and Urban Development, Department of Agriculture.

ACTION: Notice of preliminary determination.

SUMMARY: The Energy Independence and Security Act of 2007 (EISA) establishes procedures for the U.S. Department of Housing and Urban Development (HUD) and the U.S. Department of Agriculture (USDA) to adopt periodic revisions to the International Energy Conservation Code (IECC) and to ANSI/ASHRAE/IES Standard 90.1: Energy Standard for Buildings, Except Low-Rise Residential Buildings (ASHRAE 90.1), subject to a determination by HUD and USDA that the revised codes do not negatively affect the availability or affordability of new construction of single and multifamily housing covered by EISA, and a determination by the Secretary of Energy that the revised codes "would improve energy efficiency." This Notice announces the preliminary determination of HUD and USDA, as required under section 481(d)(1) of EISA, that the 2021 IECC and ASHRAE 90.1-2019 will not negatively affect the affordability and availability of housing covered by EISA. In making this preliminary determination, the first step to ultimately requiring compliance with these standards in HUD and USDA housing covered by EISA, this Notice relies on several studies that show that these codes are cost effective in that the incremental cost of the additional efficiency measures pays for themselves with energy cost savings on a life-cycle basis.

DATES: Comment Due Date: **[INSERT DATE THAT IS 60 DAYS AFTER PUBLICATION IN THE FEDERAL REGISTER.**]

ADDRESSES: Interested persons are invited to submit comments regarding this Notice. There are two methods for submitting public comments, listed below. All submissions must refer to the above-referenced docket number (FR-6271-N-01) and title of this Notice.

Electronic Submission of Comments. Interested persons may submit comments electronically through the Federal eRulemaking Portal at www.regulations.gov. HUD and USDA strongly encourage commenters to submit comments electronically. Electronic submission of comments allows the commenter maximum time to prepare and submit a comment, ensures timely receipt, and enables HUD and USDA to make them immediately available to the public. Comments submitted electronically through the www.regulations.gov website can be viewed by other commenters and interested members of the public. Commenters should follow the instructions provided on that site to submit comments electronically.

Submission of Comments by Mail. Comments may be submitted by mail to the Regulations Division, Office of General Counsel, Department of Housing and Urban Development, 451 7th Street, SW, Room 10276, Washington, DC 20410-0500.

Note: To receive consideration as public comments, comments must be submitted through one of the two methods specified above. Again, all submissions must refer to the docket number and title of this Notice.

No Facsimile Comments. Facsimile comments are not acceptable.

Public Inspection of Public Comments. All properly submitted comments and communications submitted to HUD will be available for public inspection and copying between 8 a.m. and 5 p.m., weekdays, at the above address. Due to security measures at the HUD Headquarters building, an appointment to review the public comments must be scheduled in advance by calling the Regulations Division at 202-708-3055 (this is not a toll-free number). HUD welcomes and is prepared to receive calls from individuals who are deaf or hard of hearing, as well as individuals with speech or communication disabilities. To learn more about

how to make an accessible telephone call, please visit www.fcc.gov/consumers/guides/telecommunications-relay-service-trs.

FOR FURTHER INFORMATION CONTACT: HUD: Michael Freedberg, Office of Environment and Energy, Department of Housing and Urban Development, 451 7th Street, SW, Room 7282, Washington, DC 20410; telephone number 202-402-4366 (this is not a toll-free number). USDA: Meghan Walsh, Rural Housing Service, Department of Agriculture, 1400 Independence Avenue, SW, Washington, DC 20250; telephone number (202) 573-3692 (this is not a toll-free number). HUD welcomes and is prepared to receive calls from individuals who are deaf or hard of hearing, as well as individuals with speech or communication disabilities. To learn more about how to make an accessible telephone call, please visit www.fcc.gov/consumers/guides/telecommunications-relay-service-trs.

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I. INTRODUCTION

Statutory Requirements

Section 481 of the Energy Independence and Security Act of 2007 ("EISA," Pub. L. 110-140) amended section 109 of the Cranston-Gonzalez National Affordable Housing Act of 1990 (Cranston-Gonzalez) (42 U.S.C. 12709), which establishes procedures for setting minimum energy standards for the following three categories of housing financed or assisted by HUD and USDA:

(A) New construction of public and assisted housing and single-family and multifamily residential housing (other than manufactured homes) subject to mortgages insured under the National Housing Act; [1]

(B) New construction of single-family housing (other than manufactured homes) subject to mortgages insured, guaranteed, or made by the Secretary of Agriculture under title V of the Housing Act of 1949;[2] and,

(C) Rehabilitation and new construction of public and assisted housing funded by HOPE VI revitalization grants under section 24 of the United States Housing Act of 1937 (42 U.S.C. 1437v).

In addition to these EISA-specified categories, other HUD programs apply EISA to new construction projects through their program statutes and regulations, including the HOME Investment Partnerships Program (HOME) and the Housing Trust Fund. Sections 215(a)(1)(F) and (b)(4) of Cranston-Gonzalez (42 U.S.C. 12745(a)(1)(F) and (b)(4)) make new construction of rental housing and homeownership housing assisted under the HOME program subject to section 109 of Cranston-Gonzalez (42 U.S.C. 12709) and, therefore, to section 481 of EISA. From the beginning of the HOME program, the regulation at 24 CFR 92.251 implemented section 109 of Cranston-Gonzalez (42 U.S.C. 12709). However, compliance with section 109 of Cranston-Gonzalez (42 U.S.C. 12709) was omitted from the July 2013 HOME program final rule because HUD planned to update and implement energy efficiency standards through a separate proposed rule (see the discussion in the preamble to the HOME proposed rule published on December 16, 2011 (76 FR 78344)). Although the energy standards at 24 CFR 92.251(a)(2)(ii) are reserved in the July 2013 HOME final program rule, the statutory requirements of section 109 of Cranston-Gonzalez (42 U.S.C. 12709) continue to apply to all newly-constructed housing funded by the HOME program.

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[1] This subsection of EISA refers to HUD programs. See Table 1 for specific HUD programs covered by the Act.
[2] This subsection of EISA refers to USDA programs. See Table 1 for specific USDA programs covered by the Act.

With regard to the Housing Trust Fund, program regulations at 24 CFR 93.301(a)(2)(ii) Property Standards, require compliance with the minimum standards required under Cranston Gonzalez section 109 (42 U.S.C. 12709).

EISA references two standards: the International Energy Conservation Code (IECC) and ANSI/ASHRAE/IES Standard 90.1.[3] The IECC standard applies to single-family homes and multifamily low-rise buildings (up to 3 stories), while the ASHRAE 90.1 standard applies to multifamily residential buildings with 4 or more stories.[4] For both agencies, applicability is limited to newly constructed housing and does not include the purchase or repair of existing housing.[5]

Sections 109(c) and (d) of Cranston-Gonzalez, as amended by EISA, establish procedures for updating HUD and USDA energy standards following periodic revisions to the IECC and ASHRAE 90.1 codes, typically every three years. Specifically, section 109(d) of Cranston-Gonzalez (42 U.S.C. 12709) provides that revisions to the IECC or ASHRAE codes will apply to the three categories of housing financed or assisted by HUD or USDA described above if: (1) either agency "make(s) a determination that the revised codes do not negatively affect the availability or affordability" of such housing, and (2) the Secretary of Energy has made a determination under section 304 of the Energy Conservation and Production Act (42 U.S.C. 6833) that the revised codes would improve energy efficiency (42 U.S.C. 12709(d)). The Department of Energy (DOE) has published Final Determinations that the 2021 IECC and ASHRAE 90.1-2019 standards would improve energy efficiency (86 FR 40529; July 28, 2021, and 86 FR 40543; July 28, 2021).

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[3] ANSI – American national Standards Institute; ASHRAE – American Society of Heating, Refrigerating, and Air-Conditioning Engineers; IES – Illuminating Electrical Society.

[4] Note the IECC addresses both residential and commercial buildings. ASHRAE 90.1 covers commercial buildings only, including multifamily buildings four or more stories above grade. IECC Section C 401.2 adopts, by reference, ASHRAE 90.1; that is, compliance with ASHRAE 90.1 qualifies as compliance with the IECC for commercial buildings.

[5] The statute covers rehabilitation as well as new construction of housing assisted by HOPE VI revitalization grants; however, as noted below, the HOPE VI program is no longer funded.

Note that DOE issued a separate final rule under EISA section 413 that establishes energy conservation standards for manufactured housing (42 USC 17071).[6] Those standards are based on the 2021 version of the International Energy Conservation Code ("IECC") and feedback received during interagency consultation with HUD.

Energy Codes Overview

There are two primary benefits of adopting energy-saving building codes: a private benefit for residents – either homeowners or renters - in the form of lower energy costs, and the external social value of reducing the emission of greenhouse gases (GHGs). Additional benefits may include improved health and resilience against extreme hot or cold weather events. As discussed in more detail below, states or localities typically adopt the IECC and ASHRAE standards on a voluntary basis one or more years after their publication. DOE has determined that the 2021 IECC represents an approximately 40 percent improvement in energy efficiency for residential and commercial buildings compared to the 2006 edition. The 2021 IECC also for the first time includes a Zero Energy Appendix. The Appendix is an optional add-on to the 2021 IECC that—if adopted by a state or local jurisdiction—will result in residential buildings having net zero energy consumption over the course of a year. The current state adoption of the IECC and ASHRAE standards is as follows:

Distribution of State Adoption of IECC and ASHRAE 90.1 Standards

IECC* Single Family and Low-Rise Multifamily		ASHRAE 90.1* Mid-Rise and High-Rise Multifamily	
Year	**Number of States**	**Year**	**Number of States**
IECC 2021	3	ASHRAE 90.1 - 2019	6
IECC 2018	9	ASHRAE 90.1 - 2016	2
IECC 2015	2	ASHRAE 90.1 - 2013	19
IECC 2012	0	ASHRAE 90.1 - 2010	6
IECC 2009	26	ASHRAE 90.1 - 2007	8
Less stringent than IECC 2009, No Statewide Code or Home Rule	11	Less stringent than ASHRAE 90.1-2007, No Statewide Code or Home Rule	10

*As of September 2022

Covered HUD and USDA Programs

[6] 87 FR 32728 (May 31, 2022); 10 CFR part 460.

Table 1 lists the specific HUD and USDA programs covered by EISA, with certain exclusions noted, as discussed below. Apart from the HOPE VI program, where rehabilitation is referenced, only new construction of housing financed or assisted under these programs is covered by EISA.

Table 1. Covered HUD and USDA Programs

HUD Programs	Legal Authority	Regulations Or Notices
Public Housing Capital Fund	Section 9(d) and Section 30 of the U.S. Housing Act of 1937 (42 U.S.C. 1437g(d) and 1437z-2)	24 CFR parts 905
Capital Fund Financing Program	Section 9(d) and Section 30 of the U.S. Housing Act of 1937 (42 U.S.C. 1437g(d) and 1437z-2).	24 CFR part 905 subpart E
*HOPE VI Revitalization of Severely Distressed Public Housing	Section 24 of the U.S. Housing Act of 1937 (42 U.S.C. 1437v)	FR-5415-N-07
Choice Neighborhoods Implementation Grants	Section 24 of the U.S. Housing Act of 1937 (42 U.S.C. 1437v)	FR-5800-N-11
Section 202 Supportive Housing for the Elderly	Section 202 of the Housing Act of 1959 (12 U.S.C. 1701q), as amended.	24 CFR part 891
Section 811 Supportive Housing for Persons with Disabilities	Section 811 of the Cranston-Gonzalez National Affordable Housing Act (42 U.S.C. 8013) as amended.	24 CFR part 891
Rental Assistance Demonstration (RAD)	Consolidated and Further Continuing Appropriations Act of 2012 (Public Law 112-55), as amended by Consolidated Appropriations Act, 2014 (Public Law 113-76) and subsequent Consolidated Appropriations Acts.	RAD Notice Revision 4 (H 2019-09 PIH 2019-23)
FHA Single-family Mortgage Insurance Programs	National Housing Act, Sections 203(b) (12 U.S.C. 1709(b)), Section 251 (12 U.S.C. 1715z-16), Section 247 (12 U.S.C. 1715z-12), Section 203(h) (12 U.S.C. 1709(h)), Housing and Economic Recovery Act of 2008 (Public Law 110-289), Section 248 of the National Housing Act (12 U.S.C. 1715z-13)	24 CFR part 203, subpart A; 203.18(i); 203.43i; 203.49; 203.43h.
FHA Multifamily Mortgage Insurance Programs	Sections 213, 220, 221, 231, and 232 of the National Housing Act (12 U.S.C.1715e, 12 U.S.C.1715v, 12 U.S.C.1715k, 12 U.S.C.17151, 12 U.S.C.1715w).	24 CFR parts 200, subpart A, 213; 220; 221, subparts C and D; 231; and 232
HOME Investment Partnerships (HOME)	Cranston-Gonzalez sections 215(b)(4) and 215(a)(1)(F) (42 U.S.C. 12745(b)(4) and 42 U.S.C. 12745(a)(1)(F))require HOME units to meet minimum energy efficiency standards promulgated by the Secretary in accordance with Cranston Gonzalez section 109 (42 U.S.C12745).	Final HOME Rule at www.onecpd.info/home/home-final-rule/ reserves the energy standard for a separate rulemaking at 24 CFR 92.251.
Housing Trust Fund [By regulation]	Title I of the Housing and Economic Recovery Act of 2008, Section 1131 (Public Law 110-289, 12 U.S.C. 4568.)	24 CFR 93.301(a)(2)(ii) Property Standards, requires compliance with Cranston Gonzalez section 109 (42 U.S.C. 12709).

USDA Programs	Legal Authority	Regulations
Section 502 Guaranteed Housing Loans	Section 502 of Housing Act (42 U.S.C. 1472)	7 CFR part 3550
Section 502 Rural Housing Direct Loans	Section 502 of Housing Act (42 U.S.C. 1472)	7 CFR part 3550
Section 523 Mutual Self Help Technical Assistance Grants , homeowner participants	Section 523 of Housing Act (42 U.S.C. 1472)	7 CFR part 1944 Subpart -I

*Program no longer funded or no longer funds new construction.

Several exclusions are worth noting. These include the following programs which, while classified as public or assisted housing, or may be specified in the statute, are no longer funded, or do not fund new construction:

(1) HOPE VI. While EISA references the "rehabilitation and new construction of public and assisted housing funded by HOPE VI revitalization grants," funding for HOPE VI revitalization grants has been discontinued, so the program is therefore not covered by this Notice.

(2) Project-Based Rental Assistance (PBRA). HUD is no longer authorized to provide funding for new construction of units assisted under the Section 8 PBRA program, except under the Rental Assistance Demonstration (RAD). Apart from RAD, current authorization and funding that Congress provides for the PBRA program is for the limited purpose of renewing expiring Section 8 rental-assistance contracts. Accordingly, this Notice does not apply to the Section 8 PBRA program except through RAD, as referenced in Table 1.

Other HUD programs that provide financing for new construction are not covered because they do not constitute assisted housing as specified in EISA and/or are authorized under statutes not specifically referenced in EISA:

(1) Indian Housing. Indian housing programs are excluded because they do not constitute assisted housing and are not authorized under the National Housing Act (12 U.S.C. 1701 et seq.) as specified in EISA. For example, the Section 184 guaranteed loan program is authorized under Section 184 of the Housing and Community Development Act of 1992 (42 U.S.C. 1715z-13a).

(2) Community Development Block Grants. Housing financed with Community Development Block Grant (CDBG) funds is excluded since CDBG, which is authorized by the Housing and Community Development Act of 1974 (42 U.S.C. 5301 et seq.), is neither an assisted housing program nor a National Housing Act mortgage insurance program.

Current Above-Code Standards or Incentives

Some HUD and USDA competitive grant programs covered by EISA (as well as other programs) already require grantees to comply with energy efficiency standards or green building requirements with energy performance requirements that exceed state or locally-adopted IECC and ASHRAE 90.1 standards, while other programs provide incentives to do so. A list of current programs that require or incentivize a green building standard is shown in Table 2. This standard is typically Energy Star Certified New Homes for single-family properties, Energy Star for Multifamily New Construction, or a green building standard recognized by HUD that includes a minimum energy efficiency requirement. Nothing in this Notice will preclude HUD or USDA competitive programs from maintaining these higher standards or raising them further, or for HUD or USDA programs to provide incentives for above-code energy requirements.

Table 2 includes a listing of current HUD and USDA programs with requirements or incentives for funding recipients to build to standards above the current 2009 IECC and/or ASHRAE 90.1 standards (see "Already Exceeds Current Energy Standard" column). Contingent on the energy efficiency or green building standard selected, and the minimum energy efficiency requirements established for each standard, projects built to these above-code standards may also exceed the proposed 2021 IECC and ASHRAE 90.1-2019 standards discussed in this Notice (see "Meets or Exceeds Proposed Energy Standard" column). HUD and USDA are requesting comments in this Notice on the current energy efficiency requirements included in the green building standards incentivized or required by these programs. (See Section V. Implementation, Alternate Compliance Pathways, and Section VI, Request for Public Comment, Question 8). These green building or energy performance typically have multiple certification levels with

varying energy baselines and these baselines change over time at varying points after publication of newer editions of the energy codes. HUD and USDA will seek certifications from the standard-setting bodies that each of these programs meet the requirements of this Notice.

Table 2. Current Energy Standards and Incentives for HUD and USDA Programs (New Construction)[7]

Program	Type	Current Energy Efficiency Requirements and Incentives	Exceeds Current Energy Standards	Already Meets or Exceeds Proposed Energy Standards
Programs Covered by EISA				
HUD				
Choice Neighborhoods Implementation	Competitive Grant	Required: Requirements of Energy Star Single Family New Homes or Multifamily New Construction. Plus certification by recognized green rating such as Energy Star Indoor Air Plus, Enterprise Green Communities, National Green Building Standard, LEED-H, LEED-NC, or regional standards such as Earthcraft or Built Green. Use Energy Star products.	Exceeds 2009 IECC/ASHRAE 90.1-2007	May meet or exceed proposed 2021 IECC/ ASHRAE 90.1-2019 standard
Choice Neighborhoods – Planning	Competitive Grant	Required: Eligible for Stage 1 Conditional Approval LEED for Neighborhood Development (LEED-ND) or equivalent. Plus certification by recognized green rating program.	Exceeds 2009 IECC/ASHRAE 90.1-2007	May meet or exceed proposed 2021 IECC/ ASHRAE 90.1-2019 standard
Section 202 Supportive Housing for the Elderly	Competitive Grant	Required: 2021 IECC and ASHRAE 90.1-2019. Incentive: Additional competitive rating points for developments that meet a green building or energy performance standard that includes a Zero Energy Ready or Net Zero Energy requirement.	Exceeds 2009 IECC/ASHRAE 90.1-2007	Meets and may exceed proposed 2021 IECC/ ASHRAE 90.1-2019 standard
Section 811 for Persons with Disabilities	Competitive Grant	Energy Star Certified New Construction	Exceeds 2009 IECC/ASHRAE 90.1-2007	
Rental Assistance Demonstration (RAD)	Conversion of Existing Units	2009 IECC or ASHRAE 90.1-2007 or any successor code adopted by HUD; applicants encouraged to build to Energy Star Certified New Construction. Minimum WaterSense and Energy Star appliances required and the most cost-effective measures identified in the Physical Condition Assessment..		

[7] Table 2 includes HUD and USDA programs supporting new construction with energy code requirements. Does not include other HUD or USDA programs that may have appliance or product standards or requirements only.

FHA Multifamily Mortgage Insurance	Mortgage Insurance	Incentive: Discounted Mortgage Insurance Premium (MIP) for a recognized Green Building Standard. Energy Star Score of at least 75 in EPA Portfolio Manager.	Incentives exceed 2009 IECC/ASHRAE 90.1-2007	May meet or exceed proposed 2021 IECC/ ASHRAE 90.1-2019 standard
FHA Single Family Mortgage Insurance	Mortgage Insurance	2009 IECC		
HOME Investment Partnerships Program	Formula Grant	2009 IECC/ASHRAE 90.1-2007		
Housing Trust Fund	Formula Grant	2009 IECC/ASHRAE 90.1-2007		
Public Housing Capital Fund	Formula Grant	2009 IECC/ASHRAE 90.1-2010 or successor standards. Energy Star appliances also required unless not cost effective.		
USDA				
Section 502 Guaranteed Housing Loans	Loan Guarantee	2009 IECC at minimum.. Stretch ratio of 2 percent on mortgage qualifications for complying with above-code standards.		
Section 502 Rural Housing Direct Loans	Direct Loan	2009 IECC at minimum. Stretch ratio of 2 percent on mortgage qualifications for complying with above-code standards.		
Section 523 Mutual Self Help	Grant Program	2009 IECC at minimum. State adopted versions of more recent codes vary.		
Programs Not Covered by EISA				
HUD CDBG -DR, CDBG-MIT	Grants to states or localities	For new construction of substantially damaged buildings, meet a minimum energy standard and green building standard recognized by HUD	Exceeds 2009 IECC/ASHRAE 90.1-2007 requirements	May meet or exceed proposed 2021 IECC/ ASHRAE 90.1-2019 standard
USDA Multifamily Sec. 515 New Construction, Sec 514/516 Farmworker Housing, Sec 538 Guaranteed Loans	Direct Loans, Guaranteed Loans and Grants	Meet minimum state or local energy codes Incentive for Secs 514/515/516: Energy Star Certified New Homes, Enterprise Green Communities, NGBS, DOE Zero Energy Ready, LEED, Passive House, Living Building Challenge.	Incentives exceed 2009 IECC/ASHRAE 90.1-2007	May meet or exceed proposed 2021 IECC/ ASHRAE 90.1-2019 standard

II. 2021 IECC AFFORDABILITY DETERMINATION

A. Overview

The IECC is a model energy code developed by the International Code Council (ICC) through a public hearing process involving national experts for single-family and low-rise residential buildings as well as commercial buildings.[8] The code contains minimum energy efficiency provisions for residential buildings, defined as single-family homes and low-rise multifamily buildings (up to three stories). The code offers both prescriptive and performance-based approaches. The efficiency standards associated with the IECC set benchmarks for a structure's walls, floors, ceilings, lighting, windows, doors, duct leakage, and air leakage

Revised editions of the IECC are typically published every three years. Full editions of its predecessor, the Model Energy Code, were first published in 1989, and new editions of the IECC were published every three years beginning in 1998. The residential portion of the IECC was heavily revised in 2004: the Climate Zones were completely revised (reduced from 17 Zones to the current eight primary Zones) and the building envelope requirements were restructured into a different format.[9] The post-2004 code became much more concise and simpler to use, but these changes complicate comparisons of State codes based on pre-2004 versions of the IECC to the more recent editions.

For single family housing, the IECC is one component of the larger International Residential Code (IRC). Each version of the IRC, beginning with the 2015 edition, has the corresponding version of the IECC embedded directly into that code (Chapter 11). A majority of states have adopted some version of the IRC. For other building types, including multifamily housing, the equivalent building code is the International Building Code (IBC), which also refers to other codes such as the International Plumbing Code, the International Electrical Code or, in

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[8] The IECC covers both residential and commercial buildings. States that adopt the IECC (or portions thereof) may choose to adopt the IECC for residential buildings only or may extend the code to commercial buildings (which include multifamily residential buildings of four or more stories). Chapter 4 of the IECC Commercial Code allows compliance with ASHRAE 90.1 as an optional compliance path.

[9] In the early 2000s, researchers at the U.S. Department of Energy's Pacific Northwest National Laboratory prepared a simplified map of U.S. climate zones. The map was based on analysis of the 4,775 U.S. weather sites identified by the National Oceanic and Atmospheric Administration, as well as widely accepted classifications of world climates that have been applied in a variety of different disciplines. This PNNL-developed map divided the United States into eight temperature-oriented climate zones. See https://www1.eere.energy.gov/buildings/publications/pdfs/building_america/4_3a_ba_innov_buildingscienceclimatemaps_011713.pdf.

this case, the IECC. Those codes also then embody or refer to other codes in the industry, such as ASHRAE 90.1. In this hub and spoke model, there is even more differentiation between states regarding which versions of which codes are adopted as a suite of codes at any given point in time. Even with the adoption of the IRC, the all-in-one code that is focused on single-family housing, states and local areas sometimes make adjustments to the code, removing and in some cases adding requirements for some building elements.

Current HUD-USDA Standard and Subsequent Revisions

In May 2015, HUD and USDA published a Final Determination that established the 2009 IECC as the minimum standard for both new single-family housing built with HUD and USDA assistance and new HUD-assisted or FHA-insured low-rise multifamily housing.[10] HUD and USDA estimated that 3,200 multifamily units and 15,000 single family units per year could potentially be impacted in the 16 states that had not yet adopted either of these codes. The average incremental cost of the higher standard was estimated to be $1,019 per unit, with average annual savings of $215, for a 5-year payback and a 1.3-year net positive cash flow. HUD and USDA determined that adoption of the 2009 IECC would not negatively impact the affordability and availability of the covered housing. The 2009 IECC represented a significant increase in energy efficiency of 7.9 percent and a 10.8 percent cost savings over the previous (2006) code.

Since HUD and USDA's adoption of the 2009 IECC, there have been four revisions to the IECC.[11] No action was taken by the prior Administration to comply with the statutory requirements to consider or adopt these updated codes.

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[10] Federal Register Notice 80 FR 25901, May 6, 2015.
[11] IECC 2012, 2015, 2018, and 2021.

The figure below shows the average national energy cost savings estimated with each version of the IECC. The greatest incremental savings come from the 2012 IECC (23.9%), followed by the 2009 IECC (10.8% over the 2006 IECC), followed by the 2021 IECC (8.7%). The Department of Energy's Pacific Northwest National Laboratory (PNNL) provided HUD with cost and benefit estimates for adopting the 2021 IECC from a baseline of the 2009 IECC and has made publicly available estimates for adopting the 2021 IECC from a 2018 IECC baseline. For states that have adopted standards equivalent to the 2012 or 2015 IECC, HUD and USDA use the estimates for the adoption from the 2018 to the 2021 IECC, as the 2012 and 2015 IECC both are closer to the 2018 IECC than the 2009 IECC.

Incremental Energy Savings Associated with Each IECC Version - 2006 to 2021[12]

Year of code	Comparison year	National weighted energy cost savings (%)
2009	2006	10.8
2012	2009	23.9
2015	2012	0.7
2018	2015	2.0
2021	2018	8.7

Each successor edition since the 2009 IECC has increased energy efficiency and offered cost savings to consumers in varying degrees:

(1) The 2012 IECC was published in May 2011, representing a significant increase of 23.9 percent in energy cost savings over the 2009 IECC. [13] [14] Key changes in the 2012 edition included: increased stringency for opaque thermal envelope components; clarification that sun rooms enclosing conditioned spaces must meet the thermal envelope provisions; requirements for a blower door test to determine the air leakage rate and limits for the number of prescribed air

[12] Sources: DOE, 2012: https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-22068.pdf; 2015: https://www.energycodes.gov/sites/default/files/2021-07/2015_IECC_FinalDeterminationAnalysis.pdf; 2018: https://www.energycodes.gov/sites/default/files/2021-07/EERE-2018-BT-DET-0014-0008.pdf, 2021: https://www.regulations.gov/document/EERE-2021-BT-DET-0010-0006

[13] U.S. Department of Energy, "*Updating State Residential Building Energy Efficiency Codes: Notice of Final Determination.*" Federal Register Notice 77FR 29322, May 17, 2012. http://www.gpo.gov/fdsys/pkg/FR-2012-05-17/pdf/2012-12000.pdf.

[14] Pacific Northwest National Laboratory, *Cost-Effectiveness Analysis of the 2009 and 2012 IECC Residential Provisions – Technical Support Document*, U.S. Department of Energy, PNNL-22068, April 2013. https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-22068.pdf

changes per hour (ACH) per climate zone; insulation to at least R-3 for hot water piping; and an increase in the minimum number of high-efficacy electrical lighting sources from 50 percent to 75 percent of permanent fixtures or lamps in permanent fixtures.[15] [16] This translated into an estimated $500 or 32.1 percent annual cost savings per unit over the 2006 IECC.[17]

(2) The 2015 IECC was substantially the same as the 2012 edition, with a modest increase in energy efficiency of just 0.87 percent over the 2012 IECC.[18] Revisions in this edition included: revised provisions for existing buildings; removal of exemption for historic buildings; revised requirements for building envelope and duct leakage testing and hot water distribution efficiency. The most notable innovation was the introduction of a new Energy Rating Index (ERI) performance path that utilizes the Home Energy Rating System (HERS) Index.

(3) The 2018 IECC also saw limited changes to the prior edition. In its efficiency determination for the 2018 IECC, DOE found site energy savings over the prior code of just 1.68 percent; 1.91 percent source energy savings; and 1.97 percent annual energy cost savings.[19] Of the 47 changes in this edition, most were expected to have a neutral impact on energy efficiency, with two changes making up most of the energy savings associated with the updated code: (1) lower fenestration U-factors in Climate Zones 3 through 8, and (2) an increase in high-efficacy lighting from 75 percent to 90 percent of permanently installed fixtures in all climate zones.

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[15] Pacific Northwest National Laboratory, *Guide to the Changes between the 2009 and 2012 International Energy Conservation Code*, U.S. Department of Energy, PNNL-21435, May 2012. http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-21435.pdf.

[16] Pacific Northwest National Laboratory, *Energy savings for a Typical New Residential Dwelling Unit Based on the 2009 and 2012 IECC as Compared to the 2006 IECC*, Letter Report, PNNL-88603, April 2013, Table 1.

[17] Pacific Northwest National Laboratory, *Cost-Effectiveness Analysis of the 2009 and 2012 IECC Residential Provisions – Technical Support Document*, U.S. Department of Energy, PNNL-22068, Tables 8.1 and 8.4, April 2013.

[18] U.S. Department of Energy, *Determination Regarding Energy Efficiency Improvements in the 2015 International Energy Conservation Code*, EERE-2014-BT-DET-0030-0007, June 2015. 80 FR 33250,June 11, 2015. http://www.regulations.gov/#!documentDetail;D=EERE-2014-BT-DET-0030-0007.

[19] DOE, "*Final Determination Regarding energy efficiency Improvements in the 2018 International Energy Conservation Code*," Federal Register Notice, 84 FR 67435 (December 10, 2019). https://www.federalregister.gov/documents/2019/12/10/2019-26550/final-determination-regarding-energy-efficiency-improvements-in-the-2018-international-energy; also PNNL for DOE, *Energy Savings Analysis: 2018 IECC for Residential Buildings*, November 2019, https://www.energycodes.gov/sites/default/files/2021-07/EERE-2018-BT-DET-0014-0008.pdf.

As required by statute, this Notice addresses the most recent edition of the IECC, the 2021 IECC.[20] In its efficiency determination for this standard, DOE determined that this edition would result in significant savings relative to the 2018 IECC: 9.4 percent savings in annual site energy use intensity (EUI); 8.8 percent in annual source EUI; 8.7 percent in annual energy cost savings; and 8.7 percent reduction in carbon emissions.[21] The 2021 standard will yield a national weighted energy cost savings of 34.4 percent over the current USDA-HUD baseline 2009 standard.

In their qualitative assessment of the code, PNNL identified a total of 114 approved code changes or addenda in this edition of the code over the prior edition, of which 35 will have a direct impact on energy use in residential buildings. Of these, 29 are expected to reduce energy use, while six are expected to increase energy use.[22]

The following are the primary technical changes in the 2021 IECC over the previous edition:

- Building Envelope. Building envelope revisions include increased insulation requirements; more efficient U factors and Solar Heat Gain Coefficients (SHGCs) for windows and fenestration; maximum air leakage rate of 5 Air Changes per Hour (ACH) at 50 pascals for all compliance paths, with 3 ACH for Climate Zones 3-8 following the prescriptive path. Testing alternatives are provided for smaller homes and attached single-family and multifamily buildings.[23]

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[20] International Code Council, *2021 International Energy Conservation Code*, January 29, 2021. https://codes.iccsafe.org/content/IECC2021P1

[21] 86 FR 40529 (July 28, 2021), *Analysis Regarding Energy Efficiency Improvements in the 2021 International Energy Conservation Code (IECC)* https://www.federalregister.gov/documents/2021/07/28/2021-15969/analysis-regarding-energy-efficiency-improvements-in-the-2021-international-energy-conservation-code; also PNNL, *Preliminary Energy Savings Analysis: 2021 IECC for Residential Buildings*, April 2021, https://www.energycodes.gov/sites/default/files/2021-07/2021_IECC_PreliminaryDetermination_TSD.pdf

[22] 79 additional changes were determined to be administrative or impact non-energy portions of the code.

[23] AMCA International, *International Energy Conservation Code: 2021 Changes, Getting Involved in the 2024 Process*, May 5, 2021, https://www.amca.org/assets/resources/public/assets/uploads/FINAL-_ICC_Webinar-_presentation_May_5__2021.pdf

- Heating, Ventilation and Air Condition (HVAC). Mechanical ventilation in Climate Zones 7 and 8 provided by a Heat Recovery Ventilator (HRV) or Energy Recovery Ventilator (ERV) is required for the prescriptive compliance path.[24]
- Additional Efficiency Options. Additional efficiency options in the 2021 IECC include an enhanced envelope performance option – a 5 percent improvement in proposed home UA value (R408.2.1); a more efficient HVAC equipment option (highlighted above); a reduced energy use in service water heating option 0.82 EF for fossil fuel, 2.0 EF for electric fuels or 0.4 solar fraction water heater (R405.2.3); a more efficient duct thermal distribution system option – 100 percent of ducts in conditioned space or ductless systems (R405.2.4); and an improved air sealing and efficient ventilation option – air leakage at 3.0 ACH50 with ERV or HRV with 75 percent Sensible Recovery Efficiency (SRE) (R405.2.5).
- Lighting Changes. The efficacy value of high-efficacy lamps increases to 70 lumens/watt (100 percent of lighting), a 10 percent increase over the 2018 standard.
- Renewables. The 2021 IECC revises the definition for "on-site renewables" for consistency with other national standards; adds a definition for biogas and biomass; requires that Renewable Energy Certificates (RECS) be retired with the homeowner when using the ERI compliance approach.[25]
- Zero Energy Appendix. In addition to these technical changes, the 2021 IECC for the first time includes a Zero Energy Appendix that requires compliance with an ERI score without considering renewables and then achieving a score of "0" with renewables. This provides jurisdictions with an opportunity to adopt a base or stretch code that achieves zero energy in homes and low-rise multifamily buildings.[26]

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[24] Northeast Energy Efficiency Partnerships, *Key Changes in the 2021 IECC for the Northeast and Mid-Atlantic*, https://neep.org/sites/default/files/media-files/2021_iecc_one-pager_.pdf
[25] New Buildings Institute, *2021 IECC National Model Energy Code (Base Codes).* https://newbuildings.org/code_policy/2021-iecc-base-codes/
[26] Ibid.

- Building Electrification.

  While the 2021 IECC did not include building electrification provisions in the final version of the code, provisions are available for adoption by states as amendments to the 2021 IECC: RE147-19, Electrification-Ready; RE126-19. Energy Efficient Water Heating, RE107-19, Eliminate Continuous Burning Pilot Light.

- Compliance Pathways.

  There are three compliance pathways in the 2021 IECC: Prescriptive, Performance, and Energy Rating Index or ERI, which reverted to IECC 2015 levels. The prescriptive paths can follow the R-value minimum table, the U-Factor equivalent table, or the UA equivalent alternative. All compliance pathways now have required Additional Efficiency Options (AEOs) to achieve five percent greater energy efficiency than base levels. The 2021 IECC lowers the performance path ERI scores compared to the 2018 IECC.

Current State Adoption of the 2021 IECC

There is typically a lag time between the publication of a new edition of the IECC and state adoption of the code: Table 3 and Figure 1 show that, as of September 2022, while all but eight states have adopted a version of the IECC, only three states (California, Washington, and Vermont) have adopted the 2021 IECC or its equivalent. [27]

Overall, thirty-nine states plus the District of Columbia have adopted a version of the code that is equivalent to or higher than the current HUD-USDA standard of the 2009 IECC. Of these, only 11 states plus the District of Columbia have adopted a code above the 2009 IECC (the 2018 IECC, the 2015 IECC or equivalent to the 2021 IECC),[28] while 26 states have set their codes at

[27] California's Title 24 2019 Building Energy Efficiency standard, Washington's 2018 State Energy Code, and Vermont's amendments to the 2018 IECC were determined to meet or exceed the 2021 IECC.

[28] PNNL, *State Level Residential Codes Energy Use Index, FY 2023Q2*, Excel File at https://www.energycodes.gov/state-portal. Note that as of March 2023, two additional states have adopted the 2021 IECC.

the equivalent of the 2009 IECC. The remaining 11states have either adopted standards that pre-date the 2009 IECC (3 states) or have no state-wide codes (8 states).

Based on historical experience, and the fact that an additional six states are currently considering the adoption of the 2021 IECC for adoption in 2023, it is anticipated that over time additional states are likely to adopt the 2021 IECC, either as published by the ICC or with amendments.

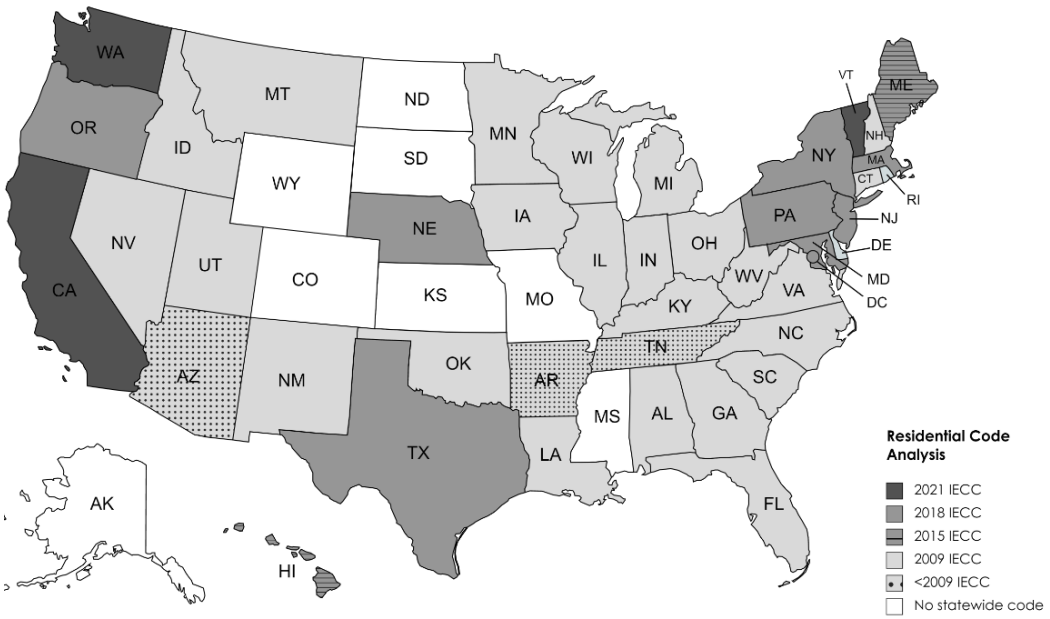
Table 3. Current Adoption of the IECC
(As of September 2022)

Above Current HUD-USDA Standard (14 states +DC)	
2021 IECC or Equivalent (3)	
California Washington	Vermont
2018 IECC or Equivalent (8 states + DC)	
Oregon	Nebraska
Maryland	Delaware
Massachusetts	New York
District of Columbia	New Hampshire
Pennsylvania	
2015 IECC (3)	
Maine	Hawaii*
Texas	
Current HUD-USDA Standard 2009 IECC or Equivalent (25)	
Alabama	Oklahoma
Connecticut	Nevada
Florida	New Jersey
Georgia	New Mexico
Idaho	North Carolina
Illinois	Ohio
Indiana	Rhode Island
Iowa	South Carolina
Kentucky	Virginia
Louisiana	West Virginia
Michigan	Wisconsin
Minnesota	Utah
Montana	
Older than 2009 IECC Or No Statewide Codes (11)	
Less Than 2009 IECC (3)	
Arkansas	Tennessee
Arizona*	
Home Rule/No statewide code (8)	
Alaska	Colorado
Missouri	Kansas
Wyoming	North Dakota
South Dakota	Mississippi
U.S. Territories	
American Samoa - No Code	N. Mariana Islands (2003 IECC equivalent)
Guam - 2009 IECC U.S. Virgin Islands - 2009 IECC	Puerto Rico (2011 PR Building Standard)

*A review of the codes in place across the state indicates that 86 percent (Hawaii) and 82 percent (Arizona) of the population is covered by codes at this level.

This tabulation is drawn from DOE's tracking of state adoptions of the IECC, available at DOE's state portal at https://www.energycodes.gov/state-portal. For the purpose of this Notice, HUD and USDA rely on the status map maintained by DOE at this site. Figure 1 displays the state IECC adoption status shown in Table 3.

Figure 1 – IECC Adoption Map (Residential)
Status as of September 2022



Note that states often adopt amendments to the code as published by the ICC. In some cases, these amendments will sufficiently alter the IECC code as published, such that the energy performance of buildings meeting the amended code provisions may be equivalent to that of a prior code. The DOE code adoption map, and the adopted codes listed in Table 3, reflect DOE/PNNL's analysis of state codes as amended and DOE/PNNL's assessment of their equivalent code. Accordingly, 22 states have adopted the 2012, 2015 or 2018 IECC with

amendments and were determined by PNNL to be equivalent to the 2009 IECC. These are therefore shown in Table 3 and Figure 1 as at the 2009 IECC level.[29] Ohio, for example, adopted the 2018 IECC with amendments to basement and crawl space wall R-values, air leakage rates and the allowance to utilize framing cavities as return ducts.[30] DOE/PNNL determined that the Ohio code as adopted with amendments is equivalent to the 2009 IECC.[31] New Mexico adopted the New Mexico Energy Conservation Code, based on the 2018 IECC, with state-specific amendments which were determined by DOE/PNNL to yield a performance standard equivalent to the 2009 IECC. On the other hand, if the new code is less than one percent more efficient than the prior code then DOE counts the newer code as equivalent to the previous code – hence Texas is credited here with the 2018 standard rather than the code they adopted (2015 IECC). California has adopted its own standard, Title 24, which DOE has determined meets or exceeds the 2021 IECC.

In certain cases, home rule cities or counties within a State may adopt a different code from the rest of the State. For example, Austin, Texas has adopted the 2021 IECC energy code, thereby exceeding the minimum Texas statewide code of the 2015 IECC, equivalent to the 2018 IECC.[32] In instances where a local entity has a more stringent standard, the affordability impacts within a State will differ. [33]

Estimated Impacts

Table 4 provides an estimate of the average number of units that may be impacted annually by adoption of the 2021 IECC. HUD and USDA used prior-year production for these

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[29] The 21 states deemed equivalent to the 2009 IECC are: CT, FL, GA, IA, ID, IL, IN, MI, MN, MT, NC, NH, NJ, NM, NV, OH, PA, RI, UT, VA. See Tab1e for a listing of these code equivalents at https://www.energycodes.gov/state-portal and "Residential State Level Results" Excel file at "Available Data" for detailed DOE/PNNL analysis.

[30] ACEEE, State Scorecard Ranking, https://database.aceee.org/state/ohio.

[31] See "Residential State Level Results" at https://www.energycodes.gov/state-portal.

[32] City of Austin, *Building Technical Codes*. https://www.austintexas.gov/department/building-technical-codes

[33] HUD and USDA do not maintain a list of local communities that may have adopted a different code than their state code. See ACEEE, State and Local Policy Database for codes adopted by individual cities. https://database.aceee.org/city/energy-code-stringency

programs in order to estimate future annual production for these programs.[34] Based on average annual production for the past three years (2019-21), the agencies estimate that a total of approximately 161,700 units of HUD- and USDA-financed or insured housing may be impacted by the 2021 IECC, of which 151,300 are in the 47 states plus DC and U.S. territories that have not yet adopted this standard.

Table 4. Estimated Number of Units Impacted Annually by 2021 IECC

State or Territory	FHA Single Family	USDA Guaranteed Loan Program	USDA Direct Loan Program	FHA Single Family - Condos	Public Housing	HOME	Housing Trust Fund*	RAD	Low-Rise Multi-family	Total
AK	42	27	19	3	0	35	19	25	0	170
AL	1,975	611	27	0	52	60	0	0	321	3,046
AR	1,024	453	52	0	0	145	12	16	164	1,866
AZ	4,595	391	90	54	0	97	0	38	432	5,697
CA (2021)	5,629	136	339	803	12	880	0	12	166	7,977
CO	2,701	151	42	65	13	199	1	10	682	3,864
CT	70	9	0	7	23	42	0	0	125	276
DC	17	0	0	8	12	0	0	0	137	174
DE	584	179	25	20	0	5	0	48	0	860.5
FL	19,178	1,119	189	24	146	366	87	21	1,477	22,607
GA	7,977	731	45	17	32	139	0	0	795	9,736
HI	77	61	39	40	3	33	0	0	0	253
IA	224	44	5	0	0	16	5	0	0	294
ID	812	134	13	0	0	56	29	73	11	1,128
IL	750	10	2	4	35	96	0	0	404	1,301
IN	1,890	205	137	1	0	121	0	0	49	2,403
KS	161	29	1	0	0	39	30	0	55	315
KY	798	277	66	13	0	71	0	2	188	1,415
LA	2,181	1,036	42	0	12	189	2	3	124	3,589
MA	174	7	7	11	0	20	0	35	491	745
MD	2,073	171	5	150	0	143	0	0	849	3,391
ME	116	48	16	0	0	40	30	24	15	288.5
MI	227	73	32	234	16	93	0	0	102	777
MN	542	99	16	1	3	120	0	5	607	1,393
MO	896	306	6	2	0	236	2	0	444	1,892
MS	1,048	304	43	2	1	0	0	0	0	1,398
MT	120	50	22	0	0	35	3	21	68	318.5
NC	4,977	1,211	165	2	7	724	25	0	1,321	8,432
ND	112	14	1	0	0	27	13	0	0	167
NE	177	9	1	0	0	17	0	0	297	501

[34] Three-year averages were used (2019-21) for all programs, except for public housing which used 2016-2020 averages since limited data were available for the three-year period. Prior-year production data provided by program offices using internal tracking or reporting systems.

NH	69	5	1	2	0	50	6	46	106	285
NJ	477	8	3	43	42	151	0	0	50	774
NM	751	21	26	0	0	11	15	12	115	950.5
NV	1,642	52	6	101	4	408	3	1	92	2,309
NY	233	5	6	3	15	262	0	27	1,445	1,996
OH	1,339	51	17	25	10	229	0	0	105	1,776
OK	1,464	288	41	0	0	34	13	10	81	1,931
OR	703	127	31	22	0	142	12	30	38	1,105
PA	697	78	13	4	43	90	0	0	85	1,010
RI	64	0	3	1	0	3	23	2	35	130.5
SC	4,169	992	87	3	0	44	0	0	236	5,531
SD	148	49	16	1	0	124	75	37	12	461.5
TN	3,355	644	55	9	2	39	30	103	751	4,988
TX	32,070	1,670	98	325	83	243	57	0	6,684	41,230
UT	1,679	417	127	103	0	7	0	17	476	2,826
VA	2,119	416	71	178	12	85	45	0	924	3,850
VT (2021)	10	4	2	0	0	59	24	0	9	108
WA (2021)	1,529	128	81	45	15	107	6	31	413	2,355
WI	168	24	7	0	5	85	0	0	173	462
WV	298	221	3	0	0	12	10	5	71	620
WY	55	32	3	0	0	16	1	0	18	125
Territories										
Guam			8			18				26
Mariana Isl.			9			3				12
Puerto Rico	186	284	53		53	5				581
Total	**114,372**	**13,411**	**2,214**	**2,326**	**651**	**6,271**	**578**	**645**	**21,243**	**161,711**
47 states	107,204	13,143	1,792	1,478	624	5,225	548	603	20,655	151,272

Table 4 includes both single-family and low-rise multifamily housing. Of the total, in the 47 states and the U.S. territories that have not yet adopted the 2021 IECC, approximately 107,200 units are estimated to be FHA-insured new single-family homes; approximately 13,100 units are USDA Section 502 direct loans, and 1,800 units are Section 502 guaranteed loans. The remaining single-family units are financed through the HOME program (5,200 units), HUD's Public and Indian Housing (PIH) programs (approximately 600 units through the Choice Neighborhoods and Capital Fund Financing Programs, and 500 units through the Housing Trust Fund program). Also included in Table 4 are some 20,600 FHA-insured multifamily housing units financed with FHA multifamily insurance that are estimated to be low-rise multifamily and

therefore covered under the 2021 IECC.[35] When adjusted to exclude units in states that have already adopted codes equivalent to the 2021 IECC (California, Vermont, Washington), the total potential number of estimated units potentially impacted decreases to around 151,000 units.

Note that the volume of estimated production is not evenly distributed across the states but reflects historic demand for FHA and USDA financing for one or more of the agencies' programs: two states, Texas (24 percent) and Florida (14 percent), account for almost 40 percent of potentially impacted units based on prior-year production. Along with Georgia (6 percent), North Carolina (6 percent) and California (5 percent), five states account for more than half of all potentially impacted units (56 percent). Note that historical production is used as a guide to future production; actual state by state unit counts in the future may vary from these estimates, based on actual supply and demand.

B. 2021 IECC Affordability Analysis

In this Notice, HUD and USDA address two aspects of housing affordability in assessing the impact that the revised code will have on housing affordability. As described further below, the primary affordability test is a life-cycle cost savings (LCC) test, i.e., the extent to which the additional, or incremental, investments required to comply with the revised code are cost effective inasmuch as the additional measures pay for themselves with energy cost savings over a typical 30-year mortgage period. A second test is whether the incremental cost of complying with the code as a share of total construction costs — regardless of the energy savings associated with the investment — is affordable to the borrower or renter of the home.

Note that there may be other benefits associated with energy efficient homes in addition to energy cost savings. A study by the University of North Carolina (UNC) Center for Community Capital and the Institute for Market Transformation (IMT) shows a correlation between greater

[35] In order to derive the number of low-rise multifamily units, the following assumptions were made: for FHA units, 50 percent of all multifamily units are assumed to be low-rise; for public housing units, all units coded as "multifamily/walkup apartments" are assumed to be low-rise; and for HOME units, all units in multifamily developments with less than 100 units are assumed to be low-rise, as well as 50 percent of all units in developments with more than 100 units.

energy efficiency and lower mortgage default risk for new homes. The UNC study surveyed 71,000 Energy Star-rated homes and found that mortgage default risks are 32 percent lower for these more energy efficient homes than homes without Energy Star ratings.[36] In addition, studies show that added energy efficiency may also yield improved health outcomes.[37]

Cost Benefit Analysis and Results

The core analysis used for this Determination is the PNNL study prepared for DOE, *National Cost Effectiveness of the Residential Provisions of the 2021 IECC,* published in June 2021. This analysis estimates annual energy and cost savings as well as life-cycle cost (LCC) savings that assume initial costs are mortgaged over 30 years.[38] The study provides an assessment of both the initial costs as well as the long-term estimated savings and cost-benefits associated with complying with the 2009 IECC.

The LCC method used by DOE is a "robust cost-benefit metric that sums the costs and benefits of a code change over a specified time frame. LCC is a well-known approach to assessing cost-effectiveness"[39] and reflects extensive prior public comment and input. In September 2011, DOE solicited input on their proposed cost-benefit methodology[40] and this input was incorporated into the final methodology posted on DOE's website in April 2012 and further updated in August 2015.[41] [42]

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[36] UNC Center for Community Capital, Institute for Market Transformation, "Home Energy Efficiency and Mortgage Risks," March 2013, Available at: http://www.imt.org/uploads/resources/files/IMT_UNC_HomeEEMortgageRisksfinal.pdf.

[37] See, for example, DOE, Jonathan Wilson et al, Home Rx: *The Health Benefits of Home Performance*, December 2016; HUD, *BRIGHT Study Finds Improved Health at Boston Housing Authority's Old Colony Homes,* https://www.huduser.gov/portal/casestudies/study-05042017.html

[38] PNNL, Salcido et al, *National Cost Effectiveness of the Residential Provisions of the 2021 IECC,* June 2021. https://www.energycodes.gov/sites/default/files/2021-07/2021IECC_CostEffectiveness_Final_Residential.pdf

[39] Department of Energy, *National Energy and Cost Savings for new Single- and Multifamily Homes: A Comparison of the 2006, 2009 and 2012 Editions of the IECC*. April 2012. p. A-1 Available at: . https://www.energycodes.gov/sites/default/files/2020-06/NationalResidentialCostEffectiveness_2009_2012.pdf

[40] 76 FR 56413 (September 13, 2011).

[41] Pacific Northwest National Laboratory for the Department of Energy (Z. Taylor, R. Lucas, N. Fernandez) *Methodology for Evaluating Cost-Effectiveness of Residential Energy Code Changes.* April 2012. Available at: http://www.energy.sc.gov/files/view/Taylor%202012.pdf

[42] Pacific Northwest National Laboratory for the Department of Energy (V. Mendon, R. Lucas, S. Goel), *Cost-Effectiveness Analysis of the 2009 and 2012 IECC Residential Provisions – Technical Support Document. April 2013,* Available at https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-22068.pdf.

For this analysis, DOE calculates energy use for new homes using EnergyPlus™ energy modeling software, Version 9.4.[43] Two buildings are simulated: (1) a two-story single-family home, with 2,376 square feet of conditioned floor area, excluding the conditioned basement (if any), and a window area equal to 15 percent of the conditioned floor area; and (2) a low-rise apartment building (a three-story multifamily prototype with six 1,200 square-foot dwelling units per floor) with a window area of approximately 23 percent of the exterior wall area. DOE combines the results into a composite average dwelling unit based on Census building permit data for each State and for eight Climate Zones. Single-family home construction is more common than low-rise multifamily construction; the results are weighted accordingly to reflect this for each Climate Zone as well as each state.

Four heating systems are considered for modeling the energy savings in these building prototypes: natural gas furnaces, oil furnaces, electric heat pumps, and electric resistance furnaces. The market share of heating system types is obtained from the U.S. Department of Energy Residential Energy Consumption Survey (2015). Domestic water heating systems are assumed to use the same fuel as the space heating system.

Limitations of Cost Savings Models

HUD and USDA are aware of studies that discuss limitations associated with cost-savings models such as those developed by PNNL for DOE. For example, Allcott and Greenstone suggest that "it is difficult to take at face value the quantitative conclusions of the engineering analyses" associated with these models, as they suffer from several empirical problems. The authors cite two problems in particular. First, engineering costs typically incorporate upfront capital costs only and omit opportunity costs or other unobserved factors. For example, one study found that nearly half of the investments that engineering assessments showed in energy audits for medium-size businesses that would have short payback periods were

[43] Pacific Northwest National Laboratory for the Department of Energy (Z. Taylor, V. Mendon, N. Fernandez), *Methodology for Evaluating Cost-Effectiveness of Residential Energy Code Changes.* August 2015, Available at https://www.energycodes.gov/sites/default/files/2021-07/residential_methodology_2015.pdf.

not adopted due to unaccounted physical costs, risks, or opportunity costs. Second, engineering estimates of energy savings can overstate true field returns, sometimes by a large amount, and some engineering simulation models have still not been fully calibrated to approximate actual returns.[44] HUD and USDA nevertheless believe that the PNNL-DOE model used to estimate the savings shown in this Notice represents the current state-of-the art for such modeling, is the product of significant public comment and input, is now the standard for all of DOE's energy code simulations and models, and presents a reliable and validated methodology for estimating energy code costs and benefits.

Estimated Costs and Savings

For all 50 states and the District of Columbia, DOE estimates that for a weighted average of both single-family and low-rise multifamily housing, the 2021 IECC saves 9.38 percent of energy costs for heating, cooling, water heating, and lighting over the 2018 IECC.[45] For the purposes of this Notice, DOE provided HUD and USDA with a special tabulation that disaggregates this analysis into each building type (single family and low-rise multifamily). The disaggregated data are shown in Tables 5A (single family) and 5B (low-rise multifamily) for the following data points: LCC savings, incremental cost, annual mortgage increase, down-payment and other up-front costs, net first year annual cash flow, years to positive cash flow and simple payback for the 2021 IECC in relation to the current HUD-USDA baseline of the 2009 IECC. Tables 5A and 5B provide both national average costs and benefits, as well as for each climate zone.

Figure 2 provides a map of the Climate Zones. There are eight Climate Zones, further subdivided to represent moist, dry or marine climates, that are listed here with representative cities: 1A Very hot humid; 2A Hot Humid; 2B Hot Dry; 3A Warm Humid; 3B Warm Dry; 3C Warm Marine; 4A Mixed Humid, 4B Mixed Dry; 4C Mixed Marine; 5A Cool Humid; 5B Cool

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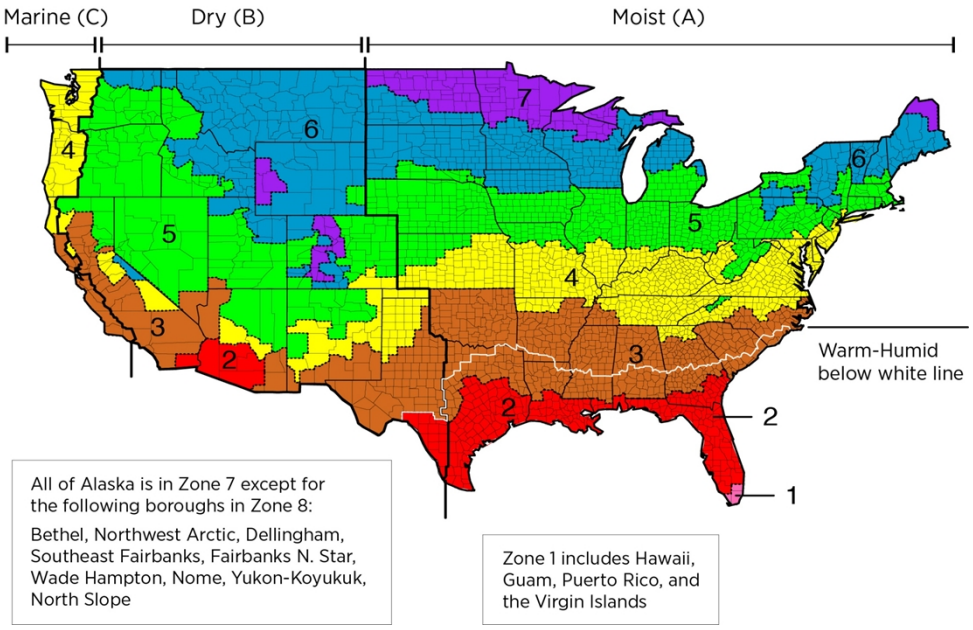
[44] Hunt Allcott and Michael Greenstone, "*Is there an energy efficiency gap*?" Journal of Economic Perspectives, Volume 26, Number 1,Winter 2012, pp. 3–28.

[45] PNNL, Salcido et al., 2021

Dry; 6A Cold Humid; 6B Cold Dry; 7 Very Cold; and 8 Subarctic/Arctic. Zone 1 includes Hawaii, Guam, Puerto Rico and the Virgin Islands. Almost all of Alaska is in Zone 7.

Figure 2. Climate Zone Map



Tables 5A and 5B show the economics of adopting the 2021 IECC nationally and in each Climate Zone, relative to the 2009 IECC baseline. Table 5C shows costs and savings against the 2018 IECC baseline. Data points provided include, incremental or first costs, annual energy savings, increased debt service on a thirty-year mortgage, estimated down payment and closing costs, net annual cash flow in the first year, and simple payback on the initial investment. [46]

Incremental or Added Costs

Tables 5A shows the average per-unit incremental cost of adopting the 2021 IECC over the current HUD-USDA 2009 IECC baseline for single family homes, both nationally and for each Climate Zone: a national average of an estimated $5,554 per unit for single family housing,[47] ranging from a low of $2,813 in Climate Zone 1, to a high of almost $6,800 in Climate Zones 7 and 8. Cost data sources used to derive these costs include: Building

[46] The 2009 standard is used as the primary baseline for this analysis since, as shown in Table 3, 36 states are still at the 2009 baseline, which is also the most recent baseline established by HUD and USDA, while only eight states have adopted the 2018 standard. (Note that Table 6 below shows 2018 baseline data for individual states, per data provided by DOE/PNNL).

[47] Source: Data provided by DOE to HUD and USDA showing disaggregated LCC Savings, Incremental Cost, and Annual Energy Savings for single-family and low-rise multifamily homes.

Component Cost Community (BC3) data repository; construction cost data collected by Faithful+Gould under contract with PNNL; RS Means Residential Cost Data; National Residential Efficiency Measures Database; and price data from nationally recognized home supply stores.[48]

Table 5A. National Costs and Benefits – 2021 IECC vs. 2009 IECC (Single Family)

	LCC savings ($)	Incremental Cost ($)	Annual Energy Savings ($)	Annual Mortgage Increase ($)	Down Payment and other up-front Costs ($)	Net Annual Cashflow for year one ($)	Years to Positive Cashflow (Years)	Simple Payback (Years)
National	**14,536.42**	5,554.63	**751.78**	**247.30**	**715.44**	**422.76**	**2**	**7.6**
Climate Zone 1	9,080.84	2,813.49	474.75	125.26	362.38	308.10	2	6.1
Climate Zone 2	7,536.81	4,176.67	474.92	185.95	537.96	227.52	3	9.1
Climate Zone 3	13,753.10	6,175.22	750.85	274.93	795.37	385.08	3	8.5
Climate Zone 4	19,730.66	6,617.71	956.49	294.63	852.36	564.50	2	7.1
Climate Zone 5	17,368.88	5,954.78	851.84	265.12	766.98	499.12	2	7.2
Climate Zone 6	27,560.65	5,290.90	1,179.24	235.56	681.47	865.84	1	4.6
Climate Zone 7	35,673.62	6,794.41	1,544.15	302.50	875.12	1,141.69	1	4.5
Climate Zone 8	46,836.58	6,796.21	1,926.36	302.58	875.35	1,523.79	1	3.6

Annual Cost Savings

Table 5A summarizes the first-year annual energy cost savings per single family dwelling unit for the 2021 IECC compared to the 2009 IECC, aggregated over 16 single family residential prototype buildings modeled by DOE/PNNL.[49] Modeled energy savings are converted to cost savings using the most recent residential fuel prices from DOE's Energy Information Administration (EIA).[50] Cost savings stated are time zero dollars not adjusted for inflation or fuel price escalation. The per-unit annual energy cost savings for single-family homes is

[48] See for example, PNNL, *Alaska Cost Effectiveness Analysis,* https://www.energycodes.gov/sites/default/files/2021-06/AlaskaResidentialCostEffectiveness_2018.pdf

[49] For residential buildings, PNNL uses two base prototypes to simulate (1) a single-family detached house and (2) a multifamily low-rise apartment building. These prototypes are modified to accommodate four different heating system types and four foundation types typically found in residential new construction. The result is an expended set of 32 models (16 for each building type) which is then simulated across 18 climate locations for each edition of the IECC. This results in a set of 3,552 energy models in EnergyPlus Version 9.5)

[50] U.S. Energy Information Administration, Washington, D.C. Natural Gas Prices, https://www.eia.gov/dnav/ng/ng_pri_sum_a_EPG0_PRS_DMcf_m.htm. Electric Power Monthly, https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_5_06_b . Petroleum and Other Liquids. https://www.eia.gov/dnav/pet/PET_PRI_WFR_A_EPD2F_PRS_DPGAL_W.htm

estimated to be $752 per unit, ranging from $474/unit in Climate Zones 1 and 2, to a high of $1,926 in Climate Zone 8.

Simple Payback

Simple payback is a commonly used measure of cost effectiveness, defined as the number of years required for the sum of the annual returns on an investment to equal the original investment. The simple payback for adoption of the 2021 IECC code is an estimated 7.6 years for single-family homes, ranging from 3.6 years in Climate Zone 8 to 9.1 years in Climate Zone 2.

Total Life Cycle Cost Savings

LCC analysis computes overall cost savings per dwelling unit resulting from implementing efficiency improvements. LCC savings are based on the net change in overall cash flows (energy savings minus additional costs) resulting from implementing the new code. LCC savings are a sum over an analysis period of 30 years: future cash flows vary from year to year and are discounted to present values using a discount rate that accounts for the changing value of money over time. LCC is the primary metric used by DOE to determine the cost effectiveness of the code or specific code changes. The economic analysis assumes that initial costs are mortgaged, that homeowners take advantage of the mortgage interest deduction, that short-lived efficiency measures are replaced at the end of the useful life of the equipment, and that all efficiency measures with useful life remaining at the end of the 30-year period of analysis retain a residual value at that point.[51]

Life cycle cost savings shown in Table 5A averages $14,536 per housing unit for adoption of the latest 2021 IECC. LCC savings vary considerably by climate zone, from as low as $7,536 in Climate Zone 2, to a high of $46,836 in Climate Zone 8.

Consumer Cash Flows

[51] PNNL, Salcido et al., 2021

Converting first costs and annual savings to Consumer Cash Flows is an important component of the affordability analysis. Consumer Cash Flow results are derived from the year-by-year calculations that underlie LCC savings and provide an assessment of how annual cost outlays are compensated by annual energy savings and the time required for cumulative energy savings to exceed cumulative costs, including both increased mortgage payments and down payment and other up-front costs.

The financial and economic parameters used by DOE/PNNL in calculating LCC savings and annual cash flow are based on the latest DOE cost-effectiveness methodology; these are shown in Figure 3 below.

Figure 3 – Economic Parameters for Consumer Cash Flows.

Mortgage interest rate (fixed rate)	5.0%
Loan fees	1% of mortgage amount
Loan term	30 years
Down payment	12% of home value
Nominal discount rate (equal to mortgage rate)	3.0%
Inflation rate	1.4%
Marginal Federal income tax	12%
Marginal State income tax	% varies by State
Property tax	% varies by State

Source: PNNL, Salcido et al., 2021

Annual cash flow is defined as the net difference between annual energy savings and annual cash outlays (mortgage payments, etc.), including all tax effects but excluding up-front costs (mortgage down payment, loan fees, etc.). Only first year net cash flow is reported: subsequent years' cash flow will differ due to the effects of inflation and fuel price escalation, changing income tax effects as the mortgage interest payments decline, etc. Assuming a five percent, 30-year fixed mortgage, and a 10 percent down payment, increased annual debt service is shown in Table 5A to be an average of $247/unit, or $20.58/month, with annual energy savings three times that amount: $751, or $62.50/month. This translates into an annual positive cash flow in Year One of $422 or $35.10/month. Years to Positive Cash Flow, *i.e.*, the number of years needed to recoup the cost of the initial down payment and first-year debt service with annual savings, is just two years on average.

Low-rise Multifamily Buildings

Table 5B shows costs and savings for low-rise multifamily housing similar to those shown in Table 5A for single family homes. The costs and savings shown are aggregated over 16 low-rise multifamily residential prototype buildings modeled by DOE/PNNL.[52] The incremental costs for this housing type, as well as associated savings, are generally lower than for single family homes, as a result of both differences in unit size and building type. Incremental costs average $2,306/unit nationally, approximately half of the $5,556 per unit cost for single family housing only. LCC savings of $5,265 for low-rise multifamily housing are also projected to be significantly lower than for single-family housing only ($14,536/unit).

First year increased debt service for low-rise multifamily housing is estimated to be $102/unit, while savings are three times that amount: $314/year, for a net annual cash flow of $178/year. While costs and savings differ, Years to Positive Cash Flow are similar to that of single-family homes (2 years), and the national Simple Payback average of 7.5 years is also comparable. Simple paybacks range from a low of 5.1 years in Climate Zone 8 to a high of 8.1 years in Climate Zones 2 and 3. LCC savings vary considerably from $4,064 in Climate Zone 2 to a high of $15,452 in Climate Zone 8. Higher incremental or added costs typically translate into higher annual savings, with annual positive cash flows ranging from $145 to $525.

Table 5B. National Cost and Benefits - 2021 vs. 2009 IECC (Low-Rise Multifamily)

	LCC savings ($)	Incremental Cost ($)	Annual Energy Savings ($)	Annual Mortgage Increase ($)	Down Payment and other up-front Costs ($)	Net Annual Cashflow for year one ($)	Years to Positive Cashflow (Years)	Simple Payback (Years)
National	**5,265.55**	**2,306.50**	**314.77**	**102.69**	**297.08**	**178.15**	**2**	**7.5**
Climate Zone 1	4,798.90	1,685.89	280.05	75.06	217.14	180.19	2	6.2
Climate Zone 2	4,064.66	2,138.91	271.97	95.23	275.49	145.27	2	8.1
Climate Zone 3	4,983.81	2,472.83	312.80	110.09	318.50	166.32	2	8.1
Climate Zone 4	5,994.21	2,372.29	339.34	105.62	305.55	198.82	2	7.2
Climate Zone 5	5,156.91	2,309.78	307.22	102.83	297.50	170.41	2	7.7
Climate Zone 6	8,231.86	2,147.46	407.58	95.61	276.59	280.38	1	5.4
Climate Zone 7	11,082.93	3,647.16	592.12	162.38	469.75	376.09	2	6.3
Climate Zone 8	15,452.48	3,646.44	741.63	162.34	469.66	525.64	1	5.1

[52] See Footnote 47 for methodology for prototype buildings.

Table 5C shows the energy savings and incremental costs of construction for the average housing unit (average of single family and multifamily). First costs average $2,372 per unit, well below the average first cost of $5,550 against the 2009 baseline. As would be expected, annual savings are similarly lower, and the resulting average payback is higher than the 2009 IECC - at 10.5 years vs. 7.6 years against the 2009 IECC. Simple paybacks vary considerably across Climate Zones, from 4.7 years in Climate Zone 1 to 16.5 years in Climate Zone 5.

Table 5C. Incremental Costs and Energy Savings of IECC 2018 to IECC 2021[53]

Area	Upfront Cost for Single-Family ($)	Upfront Cost for Condo ($)	Upfront Cost for Average Unit ($)	First Year Energy Savings for Average Unit ($)	Simple Payback for Average Unit (years)
National Average	2,372	1,316	2,013	191	10.5
Climate Zone 1: Very Hot	936	933	935	200	4.7
Climate Zone 2: Hot	1,530	1,146	1,400	192	7.3
Climate Zone 3: Warm	1,859	1,192	1,632	200	8.2
Climate Zone 4: Mixed	3,687	1,533	2,956	205	14.4
Climate Zone 5: Cool	3,569	1,487	2,862	173	16.5
Climate Zone 6: Cold	1,477	1,102	1,350	123	11.0
Climate Zone 7: Very Cold	2,980	2,603	2,852	306	9.3
Climate Zone 8: Subarctic/Arctic	2,982	2,603	2,853	411	6.9

Notes: Single Family cost and condo cost and average energy savings from PNNL. Upfront cost derived by HUD and simple payback calculated by HUD. HUD does not have disaggregated estimates for single family and multifamily units for the update from 2018, only the average across single family and low-rise multifamily

State-level Results

Table 6 provides a state-by-state breakout of estimated costs and savings, for single family homes only. This Table provides a more granular breakout of estimated costs and savings than the national and Climate Zone averages shown in Table 5A above, using the HUD-USDA 2009 IECC baseline for those states that have not yet adopted this standard or its equivalent as

[53] HUD does not have PNNL estimates of energy savings disaggregated by single-family and multifamily for the 2021 IECC relative to the 2018 standard. HUD computed a weighted average of the incremental cost of construction. The weights used by PNNL in their analysis are 66 percent for single-family units and 34 percent for low-rise multifamily units.

well as a 2018 IECC baseline for the 12 states plus the District of Columbia that have adopted the 2018 IECC or its equivalent.[54] [55]

Table 6. State by State Costs and Benefits (Single Family)
2021 IECC vs. 2009 or 2018 IECC

State	Baseline Code	Incremental Cost ($)	Increase Down Payment ($)	Annual Mortgage ($)	Annual Energy Savings ($)	LCC savings ($)	Payback (Years)
AK	No Code	8,854	1,140	394	2,225	53,213	4.1
AL	2009	4,865	627	217	727	15,778	6.9
AR	<2009	5,358	690	239	775	16,713	7.1
AZ	<2009	4,163	536	185	499	9,125	8.6
CA	2021	-	-	-	-	-	-
CO	No Code	5,788	746	258	549	9,699	10.9
CT	2009	6,616	852	295	1,028	21,114	6.6
DC	2018	397	13	138	397	6,864	8.0
DE	2018	424	16	146	298	4,636	11.4
FL	2009	3,369	434	150	440	7,818	7.9
GA	2009	5,228	673	233	756	15,657	7.1
HI	2015	2,340	301	104	1,057	27,120	2.3
IA	2009	5,694	733	253	998	22,037	5.9
ID	2009	5,291	682	236	493	8,485	11.1
IL	2009	6,487	836	289	679	11,067	9.8
IN	2009	6,207	800	276	696	13,176	9.2
KS	No Code	5,842	753	260	925	19,859	6.5
KY	2009	6,373	821	284	959	20,899	6.8
LA	2009	3,955	509	176	448	8,397	9.1
MA	2018	6,680	860	297	1,142	25,281	6.0
MD	2018	395	30	136	324	5,224	9.7
ME	2009	4,933	635	220	1,155	27,551	4.4
MI	2009	5,807	748	259	936	19,542	6.4
MN	2009	5,826	750	259	1,141	26,059	5.3
MO	No Code	6,701	863	298	827	16,518	8.4
MS	No Code	4,865	627	217	669	13,865	7.5
MT	2009	4,935	636	220	562	10,617	9.0
NC	2009	5,188	668	231	749	15,680	7.1
ND	No Code	5,123	660	228	976	21,463	5.4

[54] Cost benefit data are not available for three states (California, Washington and Oregon). According to DOE, these codes "deviate significantly from the model codes" and as a result DOE has historically not analyzed those states.
[55] The 2018 data shown in Table 6 are aggregated single family and low-rise multifamily data adjusted for the weighted averages used by PNNL for the 2009 IECC.

NE	2018	427	61	148	211	1,040	16.2
NH	2009	5,542	714	247	995	21,242	5.7
NJ	2009	7,473	963	333	989	18,531	7.8
NM	2009	5,888	758	262	549	9,746	11.1
NV	2009	6,685	861	298	608	9,778	11.3
NY	2018	473	49	164	386	5,369	9.8
OH	2009	5,973	769	266	699	12,845	8.8
OK	2009	5,368	691	239	826	17,831	6.7
OR	2018	-	-	-	-	-	-
PA	2018	4,144	539	187	426	2,535	10.1
PR		-	-	-	-	-	-
RI	2009	6,372	821	284	1,090	23,668	6.0
SC	2009	4,885	629	217	732	15,816	6.9
SD	No Code	4,492	579	200	971	22,501	4.8
TN	<2009	5,561	716	248	748	15,424	7.7
TX	2015	195	32	68	216	3,311	7.2
UT	2009	5,238	675	233	519	9,414	10.4
VA	2009	5,897	759	263	904	19,799	6.7
VT	2021	-	-	-	-	-	-
WA	2021	-	-	-	-	-	-
WI	2006	5,823	750	259	862	17,198	7.0
WV	2009	6,423	827	286	943	20,790	7.0
WY	None	4,913	633	219	712	15,193	7.1

Incremental costs for adoption of the 2021 IECC in those states currently at the 2009 IECC or its equivalent range from a low of $2,340 (Hawaii) to a high of $8,854 (Alaska), with most states typically in the $5,000 range. Annual energy savings exceed added debt service in all states.

Both incremental costs and savings for the 2021 IECC in the 11 states plus the District of Columbia that have adopted the 2018 IECC are typically lower than for those at the 2009 IECC baseline. Incremental first costs are less than $500 first cost/unit against the 2018 baseline in these states. New York, for example, shows an added cost of $473/unit for adoption of the 2021 IECC relative to its current 2018 baseline, $386 in annual estimated savings, yielding LCC savings of $5,369. Delaware shows an added cost of $424/unit, an annual savings of $298, and a LCC savings of $4,636.

Total Costs and Benefits

Table 7 provides estimated up-front costs, annual energy cost savings and life cycle cost savings for the 2021 IECC for all 50 states and the District of Columbia, weighted by the estimated share of single-family and low-rise multifamily units potentially impacted by the adoption of the 2021 IECC. As previously shown in Table 4, an estimated 140,000 single-family and low-rise multifamily units would be impacted annually by this code if adopted today. By multiplying the incremental cost/unit per state by the number of units estimated likely to be impacted, the total cost of implementing the 2021 IECC is preliminarily estimated at $420.5 million, yielding an estimated annual savings of $64 million and a life-cycle cost savings of $1.14 billion.

Table 7. Aggregate Estimated Cost and Savings for 2021 IECC (Single Family and Low-Rise Multifamily)

State	Baseline Code	Total Incremental Cost Per State ($)	Total Energy Cost Savings Per State ($ Per Year)	Life-Cycle Cost (LCC) Savings ($)	Simple Payback (Years)
AK	NC	1,127,393	283,309	6,775,768	4.0
AL	2009	18,057,816	2,704,469	55,917,230	6.7
AR	<2009	8,288,783	1,202,143	23,974,946	6.9
AZ	<2009	19,883,153	2,386,661	39,378,344	8.3
CA	2021	0	0	0	0.0
CO	NC	16,940,650	1,608,095	24,607,251	10.5
CT	2009	979,129	149,471	3,309,762	6.6
DC	2018	95,717	96,264	845,064	1.0
DE	2018	727,164	509,989	7,590,775	1.4
FL	2009	59,952,314	7,876,622	125,801,672	7.6
GA	2009	41,644,334	6,039,069	109,876,655	6.9
HI	2015	492,777	217,851	4,856,670	2.3
IA	2009	2,201,675	383,939	7,431,325	5.7
ID	2009	4,962,175	461,960	6,750,699	10.7
IL	2009	7,824,969	819,313	10,407,259	9.6
IN	2009	11,586,682	1,299,580	21,741,652	8.9
KS	NC	3,009,893	476,735	7,966,904	6.3
KY	2009	11,142,041	1,678,812	28,628,785	6.6
LA	2009	9,255,670	1,054,429	20,336,338	8.8
MA	2018	2,678,880	450,003	8,594,306	6.0
MD	2018	1,077,820	888,574	13,922,015	1.2
ME	2009	1,060,695	247,256	5,297,721	4.3
MI	2009	3,963,075	631,850	14,160,179	6.3
MN	2009	5,459,528	1,018,941	27,561,549	5.4
MO	NC	8,703,440	1,078,725	19,861,036	8.1
MS	NC	6,258,788	860,339	16,896,275	7.3
MT	2009	1,195,888	136,034	2,232,087	8.8

NC	2009	31,297,407	4,545,258	88,763,865	6.9
ND	NC	1,052,232	200,451	3,162,698	5.2
NE	2018	128,294	62,463	356,167	2.1
NH	2009	1,035,284	183,401	4,007,029	5.6
NJ	2009	4,441,704	588,565	7,189,226	7.5
NM	2009	5,754,766	538,116	9,352,990	10.7
NV	2009	14,142,779	1,286,230	17,406,347	11.0
NY	2018	200,168	162,163	2,611,431	1.2
OH	2009	8,873,994	1,037,565	16,123,974	8.6
OK	2009	8,877,981	1,365,072	28,580,458	6.5
OR	2018	0	0	0	0.0
PA	2009	6,180,500	819,910	14,047,324	7.5
RI	2009	518,212	87,987	1,876,922	5.9
SC	2009	23,184,247	3,483,230	71,411,236	6.7
SD	NC	1,207,381	259,053	4,908,339	4.7
TN	<2009	22,760,783	3,072,624	58,511,424	7.4
TX	2018	6,304,697	6,980,223	96,334,751	0.9
UT	2009	12,810,311	1,271,438	21,270,223	10.1
VA	2009	17,825,103	2,760,236	58,859,601	6.5
VT	2021	0	0	0	0.0
WA	2021	0	0	0	0.0
WI	2006	1,388,510	204,039	3,760,117	6.8
WV	2009	3,521,350	517,015	10,091,785	6.8
WY	None	560,916	80,664	1,688,720	7.0

This LCC figure covers a single year's cohort of HUD and USDA financed housing. Annual effects will increase as more cohorts are added to the stock of new HUD- and USDA-assisted, insured or guaranteed energy-efficient housing. In the second year, with two cohorts in place, there could be a stream of almost $150 million (future value) of energy savings. The number of units affected every year will decline as states update their standards to the 2021 IECC, or industry adopts the prescribed above-code standards. Thus, we expect the aggregate annual incremental effects to taper off. The maximum annual effect of all cohorts is not likely to exceed somewhere between three or four times the annual effect of a single-year cohort. While a new code edition is typically published every three years, since HUD and USDA must consider the affordability and availability impacts of each edition when it is published, this Notice LCC savings cover one year's cohort. See "Aggregate Incremental Impacts of IECC Update" in the Regulatory Impact Analysis (p.39) for further discussion.

The Regulatory Impact Analysis at www.regulations.gov provides an estimated first cost of $553 million, annual energy savings of $73 million and net LCC savings that range from $971 million (7% discount factor) to $1.48 billion (3% discount factor). (See RIA Figures 20 and 21).

C. Preliminary Affordability Determination – 2021 IECC

Based on the analysis provided above, HUD and USDA have determined that adoption of the 2021 IECC will not negatively impact the affordability of homes covered by the statute. This conclusion recognizes the profile of FHA borrowers, who according to FHA's 2021 Annual Report are typically first-time home buyers (84 percent) who are more likely than repeat buyers to be especially price sensitive. While the national average cost shown in Table 5 of adopting this standard is $5,500, this represents a 2.1 percent increase in the average cost of a new FHA-insured home in 2020, and the incremental costs (shown in Table 6) exceed $5,000/unit relative to the 2009 IECC baseline in only nine states. In all cases this translates into a relatively modest increase in down payment and other first costs: a national average of $715, which represents approximately 0.3 percent of the average FHA-insured new home mortgage, or an average USDA-guaranteed loan.[56] For qualifying purposes, a hypothetical borrower earning $5,000/month with a 4.5 percent down payment will require an additional income of $85 (1.7 percent) a month to qualify for the average new home; and monthly payments will increase by $31/month on a 30-year 4.25 percent fixed rate mortgage, from $1,800/month to $1,831/month.[57]

Unlike other added costs associated with the home purchase transaction, these incremental costs yield significant costs savings to the borrower. In all Climate Zones, annual energy savings in Year One exceeds increases in debt service. Debt service increases average just $20/month for net positive cash flows of $35/month after debt service. While there is likely

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[56] Average USDA Section 502 Direct Loan 2018-20 of $191,100, and of Section 502 Guaranteed Loan of $210,700. Incremental cost of $5,500 equals 2.9 percent and 2.6 percent respectively of these loans; down payment costs are .27 percent and .34 percent. For average FHA new home mortgage of $263,000 (2020), added first cost equals 2.1 percent, average down payment equals 2.1 percent.

[57] See Fannie Mae Financial Calculator, front-end Debt to Income ratio, monthly payment includes Principal, Interest, Property Taxes of $1,500/year, Insurance of $1,200/year and HOA payment of $50/month. https://fm.fanniemae.com/homeownership/resources/financial-calculators

to be variability in actual cash flows depending on energy use associated with family size and behavior, the data shows that on average the adoption of these measures are likely to improve overall affordability in light of these positive cash flows.

An additional affordability consideration is whether increased down payment costs due to the added or incremental cost will negatively impact home buyers with regard to qualifying for a a mortgage, or down payment requirements. This is especially important for first-time home buyers who typically have lower cash availability for down payments. PNNL estimates increased down payment and other up-front costs range from $362 to $875 for conventional mortgages. [58] Note that these down payments assume an average of 10 percent down, whereas the typical FHA borrower is likely to pay only 4.5 percent down;[59] the incremental down payment cost is therefore likely to be lower for FHA borrowers than the typical homeowner modeled by PNNL, with down payment increases ranging from as low as $163 to $393, which represent 0.06 - 0.15 percent of the average cost of an FHA new home in 2020, of $263,000. At 5% down, the average downpayment increase is estimated to be $278.

Note that energy costs and savings are generally not factored into current underwriting practices for single family mortgages, i.e. while positive cash flows related to improved energy efficiency will be realized, they are not specifically included in the Principal Interest, Taxes and Insurance (PITI) debt-to-income ratios typically used by lenders to qualify borrowers. Conversely, despite the significant cost savings likely to be realized from adoption of more efficient energy codes, there are generally no direct incentives for borrowers to purchase more efficient homes either through lower Mortgage Insurance Premiums or lower interest rates. Multifamily financing, on the other hand, does take into account energy savings: FHA offers the Green Mortgage Insurance Premium to multifamily borrowers who build to a green building

[58] Average price in 2021 for all FHA-insured purchases, including existing homes, was $239,000.
[59] HUD, *Annual Report to Congress Regarding the Financial Status of the Federal Housing Administration Mutual Mortgage Insurance Fund*, November 2021.
https://www.hud.gov/sites/dfiles/Housing/documents/2021FHAAnnualReportMMIFund.pdf

standard, which may include the most recent energy code as a mandatory element, or may offer additional points if the building meets or exceeds the latest IECC or ASHRAE 90.1 standard.

Equity Impacts

The Regulatory Impact Analysis (RIA) that accompanies this Notice includes an extensive equity analysis, which discusses the disproportionate energy burden experience by low-income borrowers – and conversely the increased benefits likely to be realized by low-income borrowers from increased efficiency. See the Equity Impacts section of the RIA (p.84) at www.regulations.gov.

Lower-income households face disproportionately higher energy burdens; they spend a higher share of their gross household income on energy costs.[60] Two-thirds of low-income households earning up to 200 percent of the federal poverty level face high energy burdens, spending more than 6 percent of their income on energy bills. Black, Hispanic, Native American, and older adult households, as well as families residing in manufactured housing and low-income households with a person with a disability, experience disproportionately high energy burdens.

Since increasing energy efficient codes will lower the energy burden for buyers of energy efficient homes; more efficient codes will at the same time be most beneficial to lower-income households. These codes typically require added first costs, but HUD and USDA single family insured or guaranteed programs include mitigating factors which may make this investment more affordable to eligible borrowers, e.g., lower down payment requirements (3.5% for FHA-backed mortgages compared to 20 percent required for conventional financing), as well as more flexible underwriting requirements such as lower allowable credit scores. USDA's Direct Loan program serves an underserved market, very low or extremely low-income borrowers in rural areas, through no- or low-down payment requirements, as well as significant interest rate subsidies. FHA's low-rise multifamily housing serves a renter population that is not directly responsible for any additional first costs.

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[60] https://www.energy.gov/scep/slsc/low-income-community-energy-solutions.

The overall conclusion provided in the RIA concerning the equity impacts of a minimum energy standard are that lower-income households will benefit more from the existence of energy-efficient housing but may be challenged in their ability to address first costs. Empirical work has shown that residential energy is a necessary good, but that reducing its cost through energy efficiency requires an additional investment that lower-income households may not have the disposable income to accommodate. If, however, the Notice encourages the supply of energy efficiency in the affordable housing stock, then low- households will gain. Precise impacts are likely to vary by housing market and climate zone.

III. ASHRAE 90.1-2019 AFFORDABILITY DETERMINATION

A. Overview

EISA requires HUD to consider the adoption of revisions to ASHRAE 90.1 for HUD-assisted multifamily programs.[61] Published and revised every three years in coordination with the publication schedule of the IECC, the standard provides minimum requirements for the energy-efficient design of commercial buildings, including residential buildings with more than three stories.[62]

ASHRAE 90.1 includes several compliance pathways. The first is the prescriptive path, which establishes energy-related criteria for individual building components, including minimum insulation levels, maximum lighting power, and controls for lighting and heating, ventilation, air conditioning, and refrigeration systems. Some requirements are considered mandatory, even when one of the optional paths is utilized.

ASHRAE 90.1 also includes two optional whole-building performance paths. The first is the Energy Cost Budget method, which allows the designer to trade off compliance among

[61] USDA multifamily programs are not covered by the Act.
[62] Standard 90.1 is published in October of the year two years before the year listed for the IEC, to allow the latest version of standard 90.1 to be submitted to the IECC for inclusion in the commercial chapter of the IECC.

various code requirements, using established energy modeling protocols. A building is deemed in compliance when the annual energy cost of the proposed design is no greater than the annual energy cost of the reference building design (baseline). ASHRAE 90.1 also includes a second performance approach, the Performance Rating Method in Appendix G. Appendix G has been used to rate the performance of buildings that exceed the requirements of Standard 90.1 for above-code programs, such as LEED, Green Globes, ASHRAE Standard 189.1, the International Green Construction Code, the National Green Building Standard, and other above-code programs.

Current HUD-USDA Standard and Subsequent Revisions

In their May 2015 Final Determination, HUD and USDA established the 2007 edition of ASHRAE 90.1 (ASHRAE 90.1-2007) as the minimum standard for HUD-assisted multifamily properties. ASHRAE has revised the code four times since the publication of the 2007 edition. ASHRAE 90.1-2010 was published in October 2010. There were 56 positive changes to the 2007 edition code, including revised requirements for the building envelope, HVAC systems, commissioning, lighting, and power.[63] DOE determined that the 2010 ASHRAE code would yield national energy cost savings of 7.72 percent in mid-rise apartment buildings and 6.99 percent in high-rise apartment buildings over the previous 2007 code.[64]

The next edition, ASHRAE 90.1-2013, published in October 2013, included 52 changes over the 2010 edition, most of which were determined by DOE to be relatively minor. Only six were applicable to residential buildings, including improved lighting controls and decreased lighting power densities, increased building envelope requirements for "opaque assemblies and fenestration," and increased efficiency requirements for smaller air conditioners and heat

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[63] A "positive change" is defined as a change to the code that results in increased energy efficiency. Other changes might include items that are either savings-neutral, or, in rare cases, may lower energy efficiency.

[64] Pacific Northwest National Laboratory for the Department of Energy, *Cost-effectiveness of ASHRAE Standard 90.1-2010 Compared to ASHRAE Standard 90.1-2007,* May 2013, Tables C.2. See http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-22043.pdf.

pumps.[65] These amendments resulted in an average energy savings of 5.4 percent in mid-rise apartment buildings and 6.9 percent in high-rise multifamily buildings (site energy) over ASHRAE 90.1-2010.[66] Cost savings were estimated by DOE to be 5.0 percent for mid-rise apartments and 8.7 percent for high-rise apartments.

The following edition, ASHRAE 90.1-2016, yielded an additional 3.6 percent site energy savings for mid-rise apartment buildings, and 4.0 percent for high-rise apartment buildings.[67] Energy cost savings were estimated by DOE to be 3.9 percent and 5.1 percent respectively over the 2013 edition for these two building types.

DOE's quantitative analysis concluded that ASHRAE 90.1-2019 for mid-rise and high-rise multifamily buildings (representing 11.65 percent of all commercial buildings) would yield an additional site energy savings of 2.65 percent over the 2016 edition, and energy cost savings (Energy Cost Index (ECI)) of 2.5 percent.[68] [69] [70]

Tables 8 and 9 show the changes in incremental costs for each code cycle since the 2007 edition. Table 8 shows that per square foot costs increased for the first two cycles (2010 and 2013) in a prototype mid-rise apartment building modeled by PNNL in five representative climate zones. In 2013, for example, the incremental cost of complying with ASHRAE 90.1 ranged from just 0.17 $/sf to 0.69 $/sf, or 0.14 to 0.59 percent of total building costs. In contrast, the last two code cycles (both 2016 and 2019) have seen incremental cost savings rather than

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[65] PNNL, *National Cost-effectiveness of ANSI/ASHRAE/IES Standard 90.1-2013*, January 2015. See https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-23824.pdf.

[66] U.S. Department of Energy, *Determination Regarding Energy Efficiency Improvements in ANSI/ASHRAE/IES Standard 90.1–2013: Energy Standard for Buildings, Except Low-Rise Residential Building,* September 26, 2014. Table IV.5. See https://www.federalregister.gov/documents/2014/09/26/2014-22882/determination-regarding-energy-efficiency-improvements-in-ansiashraeies-standard-901-2013-energy. For more detailed analysis, see PNNL, *ANSI/ASHRAE/IES Standard 90.1-2013 Determination of Energy Savings: Quantitative Analysis,* August 2014. Available at https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-23479.pdf.

[67] PNNL/DOE *Preliminary Energy Savings Analysis, ANSI/ASHRAE/IES Standard 90.1-2016*, June 2017. Available at https://www.energy.gov/sites/default/files/2017/07/f35/Preliminary_90.1-2016_Energy_Savings_Analysis.pdf.

[68] *Op cit.,* PNNL, *Energy Savings Analysis*, July 2021.

[69] PNNL, Impacts *of Model Building Energy Codes – Interim Update*, July 21, 2021. https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-31437.pdf. For all commercial buildings, DOE estimates national site energy savings of 4.7 percent and energy cost savings of approximately 4.3 percent.

[70] 86 FR 40543 (July 28, 2021), *Final Determination Regarding Energy Efficiency Improvements in ANSI/ASHRAE/IES Standard 90.1-2019*, https://www.federalregister.gov/documents/2021/07/28/2021-15971/final-determination-regarding-energy-efficiency-improvements-in-ansiashraeies-standard-901-2019

cost increases as a result of complying with these codes. In all cases, the incremental cost, whether a cost increase or a cost savings, is a small fraction of the total per building first cost (111 $/sf in 2010 to $218 $/sf in 2019).

Table 8. Incremental ASHRAE 90.1.-2019 Construction Costs ($/sf and %/sf)

Year	Building	2A	3A	3B	4A	5A
	First Cost	Tampa	Atlanta	El Paso	New York	Buffalo
	($/ft^2)	$/ft^2)	($/ft^2)	($/ft^2)	($/ft^2)	($/ft^2)
2019	$218	($0.36)	($0.37)	($0.40)	($0.30)	($0.29)
		-0.16%	-0.17%	-0.19%	-0.14%	-0.13%
2016	$194	($0.54)	($0.51)	($0.53)	($0.37)	($0.73)
		-0.28%	-0.27%	-0.27%	-0.19%	-0.38%
2013	$117	$0.17	$0.69	$0.69	$0.38	$0.58
		0.14%	0.59%	0.59%	0.33%	0.50%
2010	$111	$0.62	$0.62	$0.62	$0.62	$0.62
		0.56%	0.56%	0.56%	0.56%	0.56%

Table 9 shows building-level incremental cost or cost savings for each code cycle since 2007. In Climate Zone 2A (Tampa) for example, the incremental cost for the prototype mid-rise building was estimated to be $20,858 and $5,711 for the 2010 and 2013 editions respectively, followed by a combined savings of $30,167 in the following 2016 and 2019 codes.

Table 9 - Incremental ASHRAE 90.1 Construction Costs ($/Prototype 32-Unit Building)

Code	Prototype Bldg First Cost	2A	3A	3B	4A	5A
		Tampa	Atlanta	El Paso	New York	Buffalo
	$/bldg	$/Bldg	$/Bldg	$/Bldg	$/Bldg	$/Bldg
2019	$7.36 million	($11,992)	($12,389)	($13,661)	($9,966)	($9,674)
2016	$6.55 million	($18,175)	($17,353)	($17,944)	($12,430)	($24,614)
2013	$3.95 million	$5,711	$23,214	$23,358	$12,891	$19,577
2010	$3.75 million	$20,858	$20,858	$20,858	$20,858	$20,858

ASHRAE 90.1-2019 Overview

This Notice addresses the most recent published edition of ASHRAE 90.1, ASHRAE 90.1-2019. In its qualitative analysis of the code, DOE identified a total of 88 changes, or

addenda, to ASHRAE 90.1-2016.[71] [72] Twenty-nine changes were determined to have a positive impact on energy efficiency (*i.e.*, yield energy savings). These include: increased requirement for building vestibules, removal of data processing centers from exceptions to HVAC requirements, removal of hotel room exceptions to HVAC requirements, modification of demand-controlled ventilation requirements, modification of fan power limitations, modification of retail lighting requirements, modification of cooling tower testing requirements, modification of commercial boiler requirements, modification of part load fan requirements, modification of opaque envelope requirements, and modification of fenestration envelope requirements.

Current State Adoption of ASHRAE 90.1-2019

Table 10 shows the current adoption status of ASHRAE 90.1 for mid-rise or high-rise multifamily buildings. As of September 2022, five states have adopted ASHRAE 90.1-2019. A total of 32 states and the District of Columbia have adopted an ASHRAE standard that is equivalent to or above the current HUD-USDA standard (one of the 2010, 2013, 2016 or 2019 editions), while 18 states have adopted codes that are currently equivalent to or below the current HUD-USDA standard or have no statewide codes.[73]

Table 10. Current Adoption of ASHRAE 90.1 (September 2022)
Multifamily Mid- and High-Rise Buildings

Above Current HUD-USDA Standard (32 states and DC)	
ASHRAE 90.1 2019 (5 states plus DC)	
Washington	Oregon
California	Vermont
Massachusetts	District of Columbia
ASHRAE 90.1 2016 (2 states)	
New Jersey	New York
ASHRAE 90.1-2013 (19)	

[71] Pacific Northwest National Laboratory for the U.S. Department of Energy, *Energy Savings Analysis: ANSI/ASHRAE/IES Standard 90.1-2019, July 21, 2021.* https://www.energycodes.gov/sites/default/files/2021-07/Standard_90.1-2019_Final_Determination_TSD.pdf

[72] DOE determined that 59 of the 88 addenda will have a neutral impact on overall building efficiency; these included editorial changes, changes to reference standards, changes to alternative compliance paths, and other changes to the text of the standard that may improve the usability of the standard, but do not generally improve or degrade the energy efficiency of the building. Changes with impacts which do not become effective within three years from the publication of Standard 90.1-2019 (*i.e.*, until a cutoff date of December 31, 2022), are also considered as having no impact within the context of this analysis.

[73] DOE, *Status of State Energy Code Adoption – Commercial*, https://www.energycodes.gov/status/commercial. Note that the codes shown in Table 10 and Figure 4 represent DOE/PNNL's Determination of the standard that the state-adopted code is equivalent to, reflecting amendments that may have been adopted by each state.

Alabama	Montana
Delaware	Nebraska
Florida	Nevada
Georgia	New Mexico
Idaho	Pennsylvania
Illinois	Texas
Michigan	Utah
Maryland	Virginia
Maine	Hawaii
Rhode Island	
ASHRAE 90.1-2010 (6)	
Connecticut	Minnesota
New Hampshire	West Virginia
North Carolina	Wisconsin
At or Below Current HUD-USDA Standard (18)	
ASHRAE 90.1-2007 (8)	
Arkansas	Louisiana
Iowa	Ohio
Indiana	South Carolina
Kentucky	Tennessee
No Statewide Code (8)	
Alaska	Missouri (Home Rule)
Colorado (Home Rule)	North Dakota (Home Rule)
Kansas (Home Rule)	South Dakota (Home Rule)
Mississippi	Wyoming (Home Rule)
Older Than ASHRAE 90.1-2007 (2)	
Arizona (Home Rule)	Oklahoma
U.S Territories	
Guam	N. Mariana Islands (2001)
Puerto Rico	American Samoa
U.S. Virgin Islands	

Figure 4. ASHRAE 90.1 Adoption Map (Mid-Rise and High-Rise Multifamily) Status as of September 2022

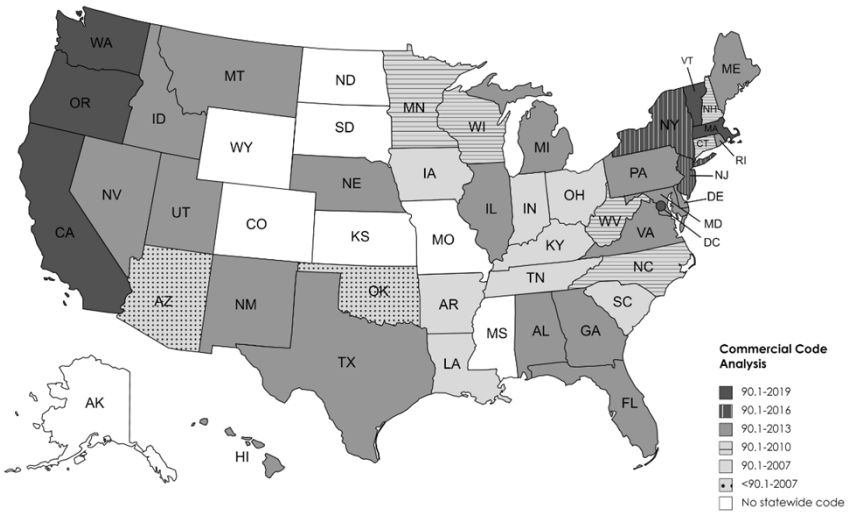

Table 11, below, provides the estimated number of new mid-rise or high-rise multifamily units that are estimated to be impacted annually by the proposed Determination on ASHRAE 90.1-2019. Using a three-year average (2019 to 2021) annual production for each program, HUD preliminarily estimates that a total of 17,900 new mid- or high-rise multifamily units (four or more stories) will be impacted annually in the states that had not yet adopted this version of ASHRAE 90.1. This includes approximately 13,700 FHA-insured multifamily units, 400 public housing units, and approximately 2,800 HOME- and 300 HTF-financed units. No USDA-guaranteed multifamily units are impacted since these are not covered under this Notice.

Table 11. High Rise Multifamily Units Potentially Impacted by ASHRAE 90.1-2019

State	PIH	HOME	Housing Trust Fund	RAD	FHA Multifamily	Total
AK	0	18	13	25	0	56
AL	34	29	0	0	207	270
AR	0	67	8	16	105	196
AZ	0	58	0	38	278	374
CA (2019	8	378	0	12	107	505
CO	8	72	0	10	440	530
CT	15	22	0	0	81	118
DC (2019)	7	0	0	0	89	96
DE	0	2	0	48	0	50
FL	94	124	56	21	953	1248
GA	21	80	0	0	513	614
HI	2	0	0	0	0	2
IA	0	3	3	0	0	6
ID	0	25	17	73	7	122
IL	22	56	0	0	260	338
IN	0	60	0	0	32	92
KS	0	4	19	0	36	59
KY	0	34	0	2	122	158

LA	8	105	1	3	80	197
MA	0	9	0	35	316	360
MD	0	77	0	0	547	624
ME	0	21	19	24	10	74
MI	11	54	0	0	65	130
MN	2	73	0	5	391	471
MO	0	138	1	0	286	425
MS	0	0	0	0	0	0
MT	0	19	2	21	44	86
NC	4	79	0	0	852	935
ND	0	17	8	0	0	25
NE	0	0	0	0	191	191
NH	0	33	4	46	69	152
NJ	27	75	0	0	32	134
NM	0	5	9	12	74	100
NV	3	216	2	1	59	281
NY	10	156	0	27	932	1125
OH	7	83	0	0	68	158
OK	0	0	7	10	52	69
OR (2019)	0	92	8	30	24	154
PA	27	45	0	0	54	126
RI	0	2	15	2	23	42
SC	0	10	0	0	152	162
SD	0	63	47	37	8	155
TN	1	9	16	103	484	613
TX	54	114	36	0	4,310	4514
UT	0	1	0	17	307	325
VA	8	38	9	0	596	651
VT (2019)	0	38	16	0	5	59
WA (2019)	10	47	4	31	266	358
WI	4	41	0	0	111	156
WV	0	5	6	5	46	62
WY	0	10	1	0	12	23
Territories						
Puerto Rico	41	86				127
Total	**428**	**2,793**	**327**	**645**	**13,696**	**17,889**
45 states + DC	417	2,229	299	538	13,067	16,550

B. ASHRAE 90.1-2019 Affordability Analysis

Cost Benefit Analysis

In its Final Determination of improved energy efficiency for commercial buildings, including multifamily buildings, DOE completes both a "qualitative" analysis and a

"quantitative" analysis to assess increased efficiency of ASHRAE Standard 90.1.[74] In addition to a quantitative and qualitative analysis of the new code, PNNL publishes a cost benefit analysis of each of the codes, which considers the added, or incremental cost for the new standard. In addition, PNNL has published its methodology for evaluating the cost-effectiveness of commercial energy code changes, including multifamily buildings, and that methodology is used by HUD and USDA for this determination.[75] For more detail on the methodology developed by DOE for their cost-benefit analysis, see PNNL's 2015 cost-effectiveness report.[76]

Evaluating cost-effectiveness requires three primary steps: 1) evaluating the energy and energy cost savings of code changes, 2) evaluating the incremental and replacement costs related to the changes, and 3) determining the cost-effectiveness of energy code changes based on those costs and savings over time. The DOE methodology estimates the energy impact by simulating the effects of the code change(s) on typical new buildings, assuming both old and new code provisions are implemented fully and correctly. The methodology does not estimate rates of code adoption or compliance. Cost-effectiveness is defined primarily in terms of LCC evaluation, although the DOE methodology includes several metrics intended to assist states considering adoption of new codes.

Building Prototypes

The basis for DOE's ASHRAE cost-benefit analysis are 16 prototype building models representing different commercial sector building types. Of the 16 prototypes modeled by DOE, two are multifamily buildings—a 4-floor mid-rise apartment building and a 10-floor high-rise apartment building. Table 12 provides detailed characteristics of the mid-rise prototype.

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[74] 86 FR 40543 (July 28, 2021), *Final Determination Regarding Energy Efficiency Improvements in ANSI/ASHRAE/IES Standard 90.1–2019*. https://www.govinfo.gov/content/pkg/FR-2021-07-28/pdf/2021-15971.pdf
[75] PNNL, *Methodology for Evaluating Cost-Effectiveness of Commercial Energy Code Change*s, January 2015. https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-23923.pdf
[76] Ibid.

Table 12. Mid-Rise Apartment Building Prototype Characteristics[77]

GENERAL	
Building Type	Multifamily residential building
Gross Floor Area	33,700 sf
Building Shape	Rectangle
Aspect Ratio	2.75 (152 ft x 56 ft)
Number of Floors	4
Activity Area	Each floor has 8 (25'x38') apartments, except ground floor which has 7 apartments and one lobby/office
Window-to-Wall Ratio	15% (4ft high view windows)
Floor Height	10 ft
Floor-to-Ceiling Height	10 ft (for the office area only)
Exterior Wall	Steel-framed wall
Roof	Insulation entirely above deck, metal deck roof
Floor	8" Slab-on-grade
INTERNAL LOADS	
Occupancy	
Number of People	78 persons total (average 2.5 persons per apartment unit)
Lighting	
Average Power Density	• Apartment units: 0.36 w/sf
	• Corridors: 0.5 w/sf
	• Office area: 1.1 w/sf
Plug Load	
Average Power Density	0.62 w/sf
HVAC	
Heating Type	Gas furnace
Cooling Type	Split system DX (one per apartment)
Fan Control	Constant volume
Distribution/Terminal Units	Single zone/direct air
Cooling T-stat	75°F (no setback assumed)
Heating T-stat	70°F (no setback assumed)
WATER HEATER	
Water Heater Type	Individual residential electric storage water heater
Tank Capacity, gallons	20 (per apartment unit)
Supply Temperature, °F	120

[77] PNNL, *Impacts of Standard 90.1-2007 for Commercial Buildings at State Level.* https://www.pnnl.gov/main/publications/exter00nal/technical_reports/PNNL-18544.pdf

ASHRAE 90.1-2019 Incremental Costs

Table 13 provides annual cost savings, added construction costs, and net LCC savings for the mid-rise multifamily prototype building.[78] Cost estimates typically use current national average prices. Labor costs are based on estimated hours and current crew labor rates from RS Means. In some cases, cost estimates completed for a prior code cycle are still applicable and are adjusted for inflation rather than creating a new cost estimate or obtaining current unit prices throughout the cost estimate. Where cost estimates are updated, inflation factors specific to the equipment are used. These inflation factors are developed for each specific equipment or insulation type by comparing RS Means from the time of the estimate with the current RS Means.

Added construction costs average $574/building, or just $18/unit. This low average per-unit increase in cost is because in two of the climate zones analyzed, construction costs are expected to be lower for ASHRAE 90.1-2019 relative to the USDA-HUD 2007 baseline: construction costs for ASHRAE 90.1-2019 are projected to decrease by $257/unit in Climate Zone 2A, and by $142/unit in Climate Zone 4A. Conversely, the highest increase is projected to be $285/unit in Climate Zone 3B, followed by $274 per unit in Climate Zone 3A. Added or incremental construction cost can be negative for some building types for some of the following reasons:

- Fewer light fixtures are required when the allowed lighting power is reduced. Also, changes from fluorescent to LED technology result in reduced lighting costs in many cases and longer lamp lives, requiring fewer lamp replacements.
- Smaller heating, ventilating, and air-conditioning (HVAC) equipment sizes can result from the lowering of heating and cooling loads due to other efficiency measures, such as better building envelopes. For example, Standard 90.1-2019 has more stringent

[78] Special tabulation provided by DOE/PNNL to HUD of costs and savings for mid-rise multifamily buildings only, 9/2/21.

fenestration U-factors for some climate zones. This results in smaller equipment and distribution systems, resulting in a negative first cost.[79]

Annual energy cost savings average $7,153 per building, or $224 per unit, yielding LCC savings of an estimated $188,337 per building or $5,886 per unit. Simple paybacks are immediate in two of the five climate zones analyzed, and 0.4 to 1.5 years in the remaining climate zones, resulting in an extremely fast average payback of just 0.1 years.

Table 13 – ASHRAE 90.1-2019 Added Costs and Savings – National (2019 Edition vs. 2007 Baseline)

	Per Square Foot			
Climate Zone	Annual Cost Savings, $/ft^2	Added Construction Cost, $/ft^2	Net LCC Savings, $/ft^2	Simple Payback Years
2A	0.253	-0.244	6.37	Immediate
3A	0.213	0.260	5.42	1.2
3B	0.186	0.270	4.89	1.5
4A	0.206	-0.135	5.68	Immediate
5A	0.207	0.075	5.44	0.4
National Weighted Average	0.212	0.017	5.58	0.1

	Per Building			Per Unit		
Climate Zone	Annual Savings $/bldg..	Added Construction Cost, $/bldg.	Net LCC Savings $/bldg.	Annual Savings $/unit	Added Construction Cost, $/unit	Net LCC Savings $/unit
2A	8,536	(8,233)	214,924	267	-257	6,716
3A	7,187	8,772	182,871	225	274	5,715
3B	6,276	9,110	164,989	196	285	5,156
4A	6,950	(4,555)	191,643	217	-142	5,989
5A	6,984	2,531	183,546	218	79	5,736
National Weighted Average	7,153	574	188,337	224	18	5,886

State-level Results

Table 14 provides multifamily added costs and savings for ASHRAE 90.1-19 over the 2007 edition for individual states.[80] Most states (38 states plus the District of Columbia) show lower per-unit added costs for adoption of ASHRAE 90.1-2019 compared to the 2007 standard. Incremental cost savings per unit range from a low of $44 in Illinois to a high of $425 in Oregon.

[79] See, for example, PNNL: https://www.energycodes.gov/sites/default/files/2021-07/Cost-effectiveness_of_ASHRAE_Standard_90-1-2019-NorthCarolina.pdf
[80] Ibid., DOE/PNNL Special Tabulation provided to HUD 9/2/21.

Only 13 states show increased incremental costs: Alabama, California, Georgia, Mississippi, Montana, North Carolina, Nevada, Oklahoma, South Carolina, South Dakota, Tennessee, Vermont, Wisconsin. For these 13 states, increased costs average $169/unit, ranging from $22/unit in Nevada to $381/unit in California. The average incremental cost for all states is just $18/unit.

Table 14- ASHRAE 90.1-2019 Added Costs and Savings – States

State	Current Code	Incremental Cost $/Unit	Energy Cost Savings $/bldg/yr	Energy Cost Savings, $/unit/yr	Net LCC Savings, Scenario 1 (Publicly-Owned), $/unit	Net LCC Savings, Scenario 2 (Privately-Owned), $/unit	Simple Payback (Years)
AK	No Code	(319)	7,828	245	9,652	8,604	Immediate
AL	2013	210	10,493	328	6,275	5,705	0.9
AR	2007	(23)	5,736	179	5,321	4,835	Immediate
AZ	Home Rule	(234)	5,702	178	6,466	5,938	Immediate
CA	2016	381	9,211	288	6,523	6,041	1.6
CO	No Code	(72)	6,208	194	5,630	5,201	Immediate
CT	2010	(122)	7,322	229	8,055	7,423	Immediate
DC	2016	(314)	6,748	211	6,959	6,189	Immediate
DE	2013	(347)	6,208	194	6,537	5,778	Immediate
FL	2013	(127)	5,871	183	6,657	6,039	Immediate
GA	2013	229	9,515	297	5,693	5,213	1.1
HI	Home Rule	(297)	5,938	186	11,457	10,357	Immediate
IA	2007	(117)	5,601	175	5,975	5,458	Immediate
ID	2013	(60)	7,592	237	5,135	4,698	Immediate
IL	2013	(44)	8,536	267	6,450	6,028	Immediate
IN	2007	(182)	5,770	180	6,527	5,970	Immediate
KS	No Code	(308)	5,972	187	6,655	6,113	Immediate
KY	2007	(328)	9,211	288	5,947	5,377	Immediate
LA	2007	(172)	6,782	212	6,237	5,627	Immediate
MA	2016	(148)	6,208	194	8,424	7,549	Immediate
MD	2013	(303)	5,263	164	6,445	5,848	Immediate
ME	No Code	(56)	4,994	156	7,160	6,461	Immediate
MI	2013	(88)	6,782	212	6,475	5,978	Immediate
MN	2010	(54)	7,659	239	6,915	6,271	Immediate
MO	No Code	(333)	7,457	233	6,434	5,902	Immediate
MS	No Code	161	8,199	256	5,985	5,527	0.7
MT	2013	94	14,744	461	5,620	5,114	0.5
NC	2010	157	4,859	152	5,125	4,699	0.9
ND	No Code	(57)	6,276	196	6,220	5,584	Immediate
NE	2013	(124)	7,085	221	5,546	5,072	Immediate
NH	2010	(6)	7,018	219	7,022	6,394	Immediate
NJ	2016	(285)	7,254	227	7,477	6,812	Immediate
NM	2013	(305)	7,794	244	5,807	5,300	Immediate
NV	2013	22	6,613	207	5,150	4,758	0.1
NY	2016	(305)	6,917	216	8,454	7,754	Immediate
OH	2007	(192)	6,984	218	6,151	5,640	Immediate
OK	No Code	150	7,389	231	5,330	4,836	0.8
OR	2016	(425)	6,276	196	5,878	5,421	Immediate
PA	2013	(256)	5,061	158	6,524	5,811	Immediate
PR	2007	0	8,098	253	-	-	0.0
RI	2010	(200)	5,668	177	8,171	7,518	Immediate
SC	2007	186	6,276	196	5,684	5,221	0.9
SD	No Code	297	6,343	198	5,359	4,945	1.6
TN	2007	118	5,061	158	6,086	5,525	0.5

TX	2013	(155)	6,276	196	5,581	5,182	Immediate
UT	2013	(104)	-	0	5,366	4,930	Immediate
VA	2013	(275)	6,006	188	5,297	4,754	Immediate
VT	2016	137	7,187	225	7,341	6,652	0.5
WA	2016	(432)	8,772	274	5,992	5,481	Immediate
WI	2010	59	5,027	157	6,400	5,909	0.3
WV	2010	(96)	6,343	198	6,093	5,479	Immediate
WY	No Code	(180)	5,736	179	5,952	5,426	Immediate
Average		18	7,153	224	6,394	5,886	0.1

Key: No Code=No statewide code; Home Rule = Home Rule state.

All states show energy cost savings, both those with incremental cost increases as well as those that show lower incremental costs. Annual energy cost savings average $224/unit, ranging from $156/unit (Maine) to $461/unit (Montana). For the prototype 32-unit mid-rise building, this translates into an average annual cost savings of $7,153/building, ranging from $4,994 annual cost savings in Maine to $14,744 in Montana.

The annual energy cost savings relative to lower incremental costs in many states yield "negative" simple paybacks in these states; where that is the case, Table 15 shows these paybacks as "immediate." Average simple payback for all states is just 0.1 years, or 1.2 months. The states showing lower incremental costs show immediate paybacks: For example, Ohio shows a decrease in first costs of $192 per unit, but annual energy cost savings of $218, in which case the payback on this investment is immediate.

Table 14 also shows life cycle cost savings for this investment. Average Life Cycle Cost savings for privately owned buildings are $5,886/unit, with LCC savings estimated to be highest in Hawaii ($10,357 per building) and lowest in North Carolina ($4,699 per building).

Total Life Cycle Cost Savings

Table 15 shows total estimated LCC Savings for ASHRAE 90.1-2019 relative to ASHRAE 90.1-2007. For the total estimated units that could be impacted by the adoption of this code, incremental costs will be an estimated $1.76 million lower than the cost of construction to the 2007 baseline. Annual energy costs savings are estimated to be $3.37 million, and national LCC savings $90.87 million for privately owned buildings.

Table 15 – Total Life Cycle Savings – States (2020$)
ASHRAE 90.1-2019 against 90.1-2007 baseline

	Total Units	Annual Energy Cost Savings, $/state	Added Construction Cost, $/state	Net LCC Savings, Scenario 1 (Publicly-Owned), $/state	Net LCC Savings, Scenario 2 (Privately-Owned), $/state	Simple Payback (Years)
AK	56	18,199	(17,731)	535,672	477,505	Immediate
AL	270	66,046	56,652	1,694,138	1,540,410	0.9
AR	196	35,042	(4,535)	1,040,340	945,314	Immediate
AZ	374	87,032	(87,426)	2,415,231	2,217,933	Immediate
CA	505					
CO	530	94,351	(37,964)	2,981,277	2,754,052	Immediate
CT	118	33,966	(14,432)	950,540	875,890	Immediate
DC	96					
DE	50	9,603	(17,171)	323,588	286,010	Immediate
FL	1,248	319,626	(157,840)	8,305,011	7,534,226	Immediate
GA	614	129,477	140,483	3,495,238	3,200,678	1.1
HI	2	922	(595)	22,914	20,714	Immediate
IA	6	1,164	(702)	35,851	32,751	Immediate
ID	122	18,523	(7,332)	626,446	573,192	Immediate
IL	338	66,286	(14,968)	2,179,969	2,037,417	Immediate
IN	92	20,371	(16,781)	600,445	549,228	Immediate
KS	59	12,939	(18,165)	392,658	360,683	Immediate
KY	158	28,987	(51,810)	939,575	849,615	Immediate
LA	197	44,545	(33,771)	1,225,497	1,105,745	Immediate
MA	360					
MD	624	128,954	(188,826)	4,021,926	3,648,880	Immediate
ME	74	17,902	(4,107)	526,279	474,899	Immediate
MI	130	28,099	(11,377)	841,739	777,180	Immediate
MN	471	102,798	(25,327)	3,256,772	2,953,840	Immediate
MO	425	83,348	(141,603)	2,734,363	2,508,516	Immediate
MS	-	-	-	-	-	#DIV/0!
MT	86	15,866	8,023	480,495	437,223	0.5
NC	935	168,579	146,890	4,792,171	4,393,892	0.9
ND	25	4,903	(1,423)	155,494	139,599	Immediate
NE	191	33,430	(23,764)	1,059,288	968,665	Immediate
NH	152	38,464	(962)	1,067,365	971,847	Immediate
NJ	134	31,789	(38,147)	1,001,861	912,850	Immediate
NM	100	17,625	(30,319)	577,846	527,384	Immediate
NV	281	44,442	6,222	1,447,028	1,337,109	0.1
NY	1,125	299,968	(342,651)	9,506,499	8,719,231	Immediate
OH	158	31,319	(30,320)	971,893	891,097	Immediate
OK	69	12,784	10,256	365,096	331,295	0.8
OR	154					
PA	126	24,710	(32,283)	822,084	732,143	Immediate
PR	127	-	-	-	-	0.0
RI	42	11,946	(8,314)	339,113	311,984	Immediate
SC	162	34,333	30,062	920,830	845,845	0.9
SD	155	28,996	45,938	828,025	764,005	1.6
TN	613	137,556	72,330	3,727,585	3,384,017	0.5

TX	4,514	875,739	(699,639)	25,191,762	23,392,691	Immediate
UT	325	53,375	(33,872)	1,741,174	1,599,869	Immediate
VA	651	101,587	(179,150)	3,448,464	3,094,969	Immediate
VT						
WA						
WI	156	33,061	9,211	998,409	921,760	0.3
WV	62	12,290	(5,949)	377,780	339,669	Immediate
WY	23	4,123	(4,147)	136,895	124,794	Immediate
National	17,889	3,365.065	(1,757,336)	99,102,626	90,886,616	Immediate

The Regulatory Impact Analysis at www.regulations.gov provides a more granular analysis of the estimated cost benefits associated with building to the ASHRAE 90.1-2019 standard, taking into account each state's current baseline code. Using current state baselines, RIA Figure 28 estimates a total incremental cost savings of $10.8 million, and a LCC savings of $48.1 million (at a 3 percent discount rate).

Incremental Costs and Energy Savings Resulting from Adoption of 2019 ASHRAE 90.1

Current ASHRAE 90.1 Standard	Number of States	Annual Number of Units Affected*	Total Incremental Costs	Net Present Value of Energy Savings	
				3% Discount Rate	7% Discount Rate
No Statewide Code	10	1,596	-$662,487	$21,397,225	$14,072,666
2007	8	1,458	-404,258	6,188,735	4,070,248
2010	6	1,838	-697,586	5,048,570	3,320,376
2013	19	9,569	-8,452,990	14,840,737	9,760,552
2016	2	1,232	-622,624	609,372	400,776
2019	6	1,424	0	0	0
Total	**51**	**17,117**	**-$10,839,945**	**$48,084,639**	**$31,624,618**

C. Preliminary Affordability Determination – ASHRAE 90.1-2019

In light of the significant estimated savings, both annual and LCC savings, and the nominal cost increase shown in Tables 13 and 14, HUD and USDA have determined that the adoption of ASHRAE 90.1-2019 will not negatively impact the affordability of the multifamily housing covered by this Notice. As shown in Table 14, the weighted national average incremental cost for adoption of this edition is just $18/unit, while the annual energy cost savings per unit averages $224/unit. In all but 13 states, the incremental costs of building to this standard have in fact decreased, not increased, relative to the current HUD-USDA ASHRAE 90.1-2007 standard: in none of these states is the added construction cost more than $381/unit, and in that state (California), annual energy cost savings are estimated to be $288/year, yielding a rapid Simple Payback of just 1.6 years. Average (unweighted) payback for all states is 0.1 years (1.2

months), with most states showing an immediate payback due to the lower incremental/first costs. Estimated first costs are also a nominal fraction of total construction costs: the weighted national average of 0.017 $/sf (less than two cents) in added costs represents just 0.16 percent of the estimated total building cost of $218/sf. Finally in every state analyzed, the net LCC savings are positive, with a weighted national average of $5,886 for privately owned buildings.

IV. IMPACT ON AVAILABILITY OF HOUSING

EISA requires that HUD and USDA assess both the affordability and availability of housing covered by the Act. This section of this Notice addresses the impact that the EISA requirements would have on the "availability" of housing covered by the Act. "Affordability" is assumed to be a measure of whether a home built to the updated energy code is affordable to potential homebuyers or renters, while "availability" of housing is a measure associated with whether builders will make such housing available to consumers at the higher code level; *i.e.*, whether the higher cost per unit as a result of complying with the revised code will impact whether that unit is likely to be built or not. A key aspect of determining the impact on availability is the proportion of affected units in relation to total units funded by HUD and USDA or total for sale units. These issues are discussed below.

2009 IECC – Single Family

In its 2015 Final Determination adopting the 2009 IECC, HUD concluded "[t]hough both higher construction costs and hedonic increases in demand for more energy-efficient housing are expected to contribute to an increase in housing prices or contract rents, HUD and USDA do not project such higher prices to decrease the quantity of affordable housing exchanged in the market."[81]

The current proposed update of IECC requirements constitutes a more expansive impact. The per unit cost is greater than for the previous rule. PNNL's estimate of the upfront cost of building to 2021 IECC is approximately $5,500, ranging from a low upfront incremental cost of

[81] 80 FR 25901 at 25918 (May 6, 2015).

$3,000 in Climate Zone 1 to a high of $6,800 in Climate Zone 8. Likewise, the geographic scope of the impact of the proposed rule is also more extensive than in 2015. In 2015, construction only in those 16 states that had not yet adopted the 2009 IECC or its equivalent was directly affected. Conversely, only three jurisdictions have adopted the 2021 IECC. Under this Notice, approximately 100,000 newly built units would have to comply with the 2021 IECC standard, compared to an estimate of 10,000 annually for the 2015 notice that required IECC 2009 as a minimum standard. This merits a more detailed discussion of the potential impacts on the availability of housing to program participants as well as the housing market overall. As set forth in this section of this Notice, HUD and USDA preliminarily find that there would be no noticeable impact on the supply of housing covered by this Notice; there are many ways for both homebuyers and builders to address the costs of the Notice if buying or building to the 2021 IECC is not advantageous; but that, under very specific conditions, availability could be constrained.

The focus of this availability analysis is on the purchase of newly built homes by FHA-insured borrowers. While other covered programs are important, FHA-insured single-family purchases represent the overwhelming majority of units that would be affected by final adoption of the proposed standards. Homebuyers and builders of single-family homes will be more sensitive to the IECC requirement than renters and builders affected by the ASHRAE update because the estimated incremental cost for single-family homes is greater than the incremental cost of updating ASHRAE.

Builder Impacts

Builders are required to build to the 2021 IECC standard only if they wish to sell the new home to a borrower who has a mortgage insured by FHA or guaranteed by USDA. If builders predict that the construction costs outweigh the expected private benefits of building to the 2021 IECC standard, then the supply of newly built homes for FHA-financed borrowers would

contract. FHA-insured borrowers would still be able to find housing within the existing housing stock, but their opportunities could be restricted.

One incentive for builders to build to the 2021 IECC standard is to preserve FHA-insured borrowers as potential customers. As shown below, in 2020, FHA-insured loans financed 1 percent of the purchases of newly built homes in the Northeast, 8.3 percent in the Midwest, 11 percent in the West, and 24.5 percent of purchases in the South. FHA-insured borrowers can be a large portion of potential buyers of new construction in some markets.

The regions where construction activity is high (*e.g.*, South and West) are also areas where a higher share of buyers of new construction are FHA-insured. In such markets, builders would be more inclined to build to the energy code required by this Notice. Having more potential customers increases competition for a home and would reduce the opportunity costs of time on market.

Table 16. Type of Financing of New Single-Family Homes
(Homes Sold in the United States, 2020)

	Thousands of Homes					Percent Financed			
	Conven-tional	**FHA**	**VA**	**Cash**	**Total**	**Conven-tional**	**FHA**	**VA**	**Cash**
Northeast	25	(Z)	1	2	28	89.3	**1.0**	3.6	7.1
Midwest	60	6	2	4	72	83.3	**8.3**	2.8	5.6
South	244	96	31	21	392	62.2	**24.5**	7.9	5.4
West	128	19	18	8	173	74.0	**11.0**	10.4	4.6
U.S.	457	122	52	35	665	68.6	**18.3**	7.8	5.3

Source: Annual Characteristics of New Housing, U.S. Census
Z = Less than 500 units or less than 0.5percent.

The cost to a developer of adopting the standard includes the added building costs, loss of potential customers unwilling to pay the additional price, and any other distortions in design introduced by the regulation. The builder can reasonably be expected to build an affordable home to the 2021 IECC standard if: FHA-insured borrowers are a significant part of the market for newly built homes; there is a sufficient market return from energy efficiency; and the builder is able to pass on some of the cost to the buyer. Under these conditions, which will vary by

climate zone and the state of the housing market, availability is not likely expected to be adversely affected.

A second possibility is that the builder continues to build affordable homes but not to the 2021 IECC. This would be the case when and where there are significant profits from building new homes for low-income homebuyers, even if not FHA-insured; FHA-insured borrowers are not a major part of the market, perhaps because conventional loans are relatively more affordable; the unlikely case that lower-income homebuyers do not place a significant premium on energy efficiency; or the builder is unable to pass on costs to the buyer. Under this scenario, the total supply of affordable housing would not necessarily be adversely affected, but new construction for FHA borrowers could decline.

A third possibility is that the profit margin from building affordable housing is so slim that any change to the market would lead to a very different development decision. One alternative may be for builders to build housing for higher-income buyers. This strategy could place the home out of reach of FHA-insured borrowers and thus reduce the availability of affordable housing, albeit not housing for higher-income borrowers.

Single Family Market Impacts

The change in market quantity depends not only on the decisions of builders and the real estate industry more broadly but also on the willingness of buyers to absorb a price change. The percentage reduction of quantity is greater as demand and supply are more responsive to price changes and as the incremental cost constitutes a larger portion of the sales price.

The impact on availability, as measured by the quantity of housing, would be given by:

$$\frac{\Delta Q}{\mathrm{Q}} = \left(\frac{E_S \cdot E_D}{E_S - E_D}\right) \cdot \left(\frac{\Delta C}{P}\right)$$

The percentage change in the quantity of housing, ΔQ/Q, depends on the price elasticity of demand E_D (the percentage change in quantity demanded from a percentage change in price),

the price elasticity of supply E_S, and the incremental cost ΔC, as a fraction of the pre-regulation sales price P. The percentage reduction of quantity is greater as demand and supply are more responsive to price changes (more price elastic), and the incremental cost constitutes a larger portion of the sales price before the introduction of the cost.[82]

Estimates from studies of the price elasticities of demand and supply vary due to differences in methods, data, and geographies and time periods examined. Generally, the estimate of the price elasticity of demand for housing is below -1, as low as -0.2 for low-income households, but has been estimated to be above -1. Generally, lower income households have a lower measured price elasticity of demand for housing. The positive association between income and the absolute value of price elasticity stems from shelter being a necessary good.[83]

The price elasticity of supply and demand has been estimated at a wide variety of levels for different housing markets, primarily due to differences in the ease of building additional units, depending on the metropolitan area, neighborhood and even type of housing.[84] The incremental cost of adopting the 2021 IECC is expected to be approximately 2 percent of the pre-regulation sales price (a $5,500 incremental cost and $250,000 sales price). Our most cautious estimate is that the approximately 2 percent increase in construction cost would reduce the production of homes for FHA-insured borrowers by 1.5 percent, which represents a 0.2 percent reduction of all homes available to FHA-insured homebuyers.

This estimate is considered a "worst-case" scenario because it does not account for any of the positive effects of energy-efficiency. Any adverse impacts on availability would be diminished when there is a perceptible demand for energy-efficient homes.

In addition, there would be no adverse effects on availability if FHA-insured homebuyers were able to find close substitutes in other submarkets. Finding a close substitute may be more

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[82] The pass-through rate is the proportion of the cost paid by buyers, which is higher as demand is less price elastic and supply is more price elastic.
[83] Mayo (1981) shows this to be the case when a household must consume a minimum amount of housing (a Stone-Geary utility function).
[84] Gyourko and Saiz (2006) attribute the local variation in construction activity to more than the cost of materials but also to local wages, local topography, and the local regulatory environment.

difficult in rural areas where there is less available housing stock. USDA guaranteed and direct loans are limited to eligible areas as defined by USDA and exclude central cities. Thus, there could be a greater relative burden on Section 502 guaranteed loans: about half of USDA's guaranteed and direct home loans are to borrowers in rural areas as defined by the 2010 Census as compared to about one-fifth of FHA mortgages (AHS, 2019).

However, adoption of the new code is not expected to have any spillover impacts on other housing submarkets given the relatively small size of the directly affected FHA and USDA submarkets. The purchase of new homes by FHA-insured borrowers represents only 2.3 percent of all residential sales in 2020. As a portion of all home purchases (all homebuyers, new and existing homes), FHA-financed purchases of new construction range from slightly more than 0 percent in the Northeast to slightly less than 3.6 percent in the South.

Energy efficiency has also been shown to impart an economic value to buildings. The willingness to pay for this benefit will vary among homebuyers. If there is a sufficient proportion who expect to realize those gains, then there will be a demand for housing built to the 2021 IECC that could partially counteract any adverse impacts on availability. See the discussions in the Regulatory Impact Analysis at www.regulations.gov in the "Capitalization of Energy Efficiency Standard" section (p.74).

Empirical studies cited in the RIA suggest there is a statistically significant and positive influence of energy efficiency on real estate values.[85] One study examining the residential market in California found that a green label adds about 2.1 percent to the value of a home. This premium is slightly above the costs of bringing a home in compliance with the green labels (Energy Star, LEED, and EnergyPoint).

Another study examined the premium placed on the Energy Star certification on homes in Gainesville, Florida and found that there is a premium for these homes but that the premium diminishes when the home is resold; this finding could suggest that energy efficiency is a

[85] Laquatra, J., *Housing Market Capitalization of Energy Efficiency Revisited*, 2002.

motivator for buying newly built homes[86]. Another two studies examined the effects of a label, which would be a voluntary option for the builder, rather than a code, which is obligatory.[87] In another study, researchers found that energy performance certificates do not play a role in determining market value but that energy efficiency itself is capitalized into housing sales prices (about 2 percent for every 10 percent reduction of energy consumption).[88]

A survey by the National Association of Home Builders found that the median borrower was willing to pay an extra $5,000 upfront to save $1000/year in utility bills.[89] This tradeoff would be equivalent to the resident receiving 10 years of benefits at a 20 percent discount rate or 30 years of benefits at 25 percent discount rate. A recent survey of the National Association of Realtors found that sixty five percent of realtors believed that energy efficiency was valuable in promoting residential units. (However, the majority of realtors (57 percent) were "not sure" as to the impact of energy efficiency on sales price.)[90]

A study of commercial buildings showed that a study with an Energy Star certification will rent for about 3 percent more per square foot and sell for as much as 16 percent more. The authors were able to disentangle the value of the label itself from the value of energy savings stemming from increased energy efficiency. Energy savings were important: a 10 percent decrease in energy consumption led to an increase in value of about one percent over and above the rent and value premium for a labeled building.[91]

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[86] Bruegge, C., Deryugina, T. and Myers, E., 2019. The distributional effects of building energy codes. Journal of the Association of Environmental and Resource Economists, 6(S1), pp. S95-S127.
[87] Bruegge et al., 2016; Kahn, Matthew E., and Nils Kok. "The capitalization of green labels in the California housing market." Regional Science and Urban Economics 47 (2014): 25-34.
[88] Aydin, Erdal, Dirk Brounen, and Nils Kok. "The capitalization of energy efficiency: Evidence from the housing market." Journal of Urban Economics 117 (2020): 103243.
[89] Ford, Carmel. "How Much Are Buyers Willing to Pay for Energy Efficiency?" Eye on Housing: National Association of Home Builders Discusses Economics and Housing Policy. April 12, 2019. https://eyeonhousing.org/2019/04/how-much-are-buyers-willing-to-pay-for-energy-efficiency/.
[90] National Association of Realtors, REALTORS and Sustainability Report – Residential, 2021, https://www.nar.realtor/sites/default/files/documents/2021-realtors-and-sustainability-report-04-20-2021.pdf
[91] Eichholz, P., N. Kok and J. Quigley, ''Doing Well by Doing Good? Green Office Buildings,'' American Economic Review 100:5 (2010): 2492–2509.

All of this empirical research shows that there are profit incentives to providing energy efficiency. Such a price gain would diminish any adverse effects on the supply of housing, although it is also evidence that bidding for energy efficiency could reduce affordability.

Evidence from Prior (2009 IECC) Code Adoption

Examining FHA new construction loans by the level of a state's energy-efficiency standards can provide a rough indicator of the potential impact of the IECC on availability. Having required a minimum standard equal to the 2009 IECC (in 2015), the FHA-insured purchase of new construction could depend on the strictness of the state-wide code relative to the 2009 IECC. However, as shown in Table 17, in states where the state-wide standard is lower than that required by HUD and USDA, the proportion of FHA loans for new construction appears similar to states that have adopted stricter codes. For the group where the state-wide code is at least as stringent as the 2009 IECC, the proportion of FHA-insured new construction loans is 16.9 percent, which is slightly higher than the 15.1 percent for the states where energy codes are below IECC 2009. Despite the cyclical nature of new construction, there is no compelling evidence that the availability of newly built owner-occupied housing will be adversely affected.

Table 17
FHA-Insured Single Family Forward Loans, 2021
Grouped by Region and Strictness of State-wide Standard
United States

State-wide Energy Standard	New Construction	All Purchase Loans	Percent New (%)
Less than IECC 2009	14,800	98,300	15.1
Same as IECC 2009	61,900	445,800	13.9
Higher then IECC 2009	47,000	226,700	21.0
South			
State-wide Energy Standard	**New Construction**	**All Purchase Loans**	**Percent New**
Less than IECC 2009	5,400	32,600	16.6
Same as IECC 2009	49,390	225,000	21.9
Higher then IECC 2009	37,900	116,000	32.7
West			
State-wide Energy Standard	**New Construction**	**All Purchase Loans**	**Percent New**
Less than IECC 2009	8,090	42,275	19.1
Same as IECC 2009	5,490	32,500	16.9
Higher then IECC 2009	9,050	73,900	12.3
Midwest			
State-wide Energy Standard	**New Construction**	**All Purchase Loans**	**Percent New**
Less than IECC 2009	1,310	23,400	5.6
Same as IECC 2009	5,650	122,000	4.6
Higher then IECC 2009	165	3,270	5.1
Northeast			
State-wide Energy Standard	**New Construction**	**All Purchase Loans**	**Percent New**
Less than IECC 2009	0	0	---
Same as IECC 2009	1,410	66,000	2.1
Higher then IECC 2009	500	33,660	1.5

There is some regional variation. In the South, the proportion of new construction is much higher in states above the IECC 2009 (32.7 percent) than in states below (16.6 percent). In the West, the proportion of FHA new construction is lower in states with energy codes above the IECC 2009 (12.3 percent) than in states below (19.1 percent). A clear pattern is not identifiable in either the Northeast or Midwest. Diverse climate zones and housing markets could explain why different regions appear to respond differently to the energy standard.

Variability in building practices in relation to energy codes

Note that there is wide variability in enforcement of, or compliance with, building codes in general. Some states do not adopt statewide building codes, others adopt for only certain building types that may exclude single family housing, some states adopt codes with

amendments, while others that have adopted building codes may not enforce them, either in their entirety or only for certain building types.[92]

Conversely, there are a number of above-code energy efficiency or green building standards that meet or exceed the 2021 IECC that a growing number of builders are incorporating as standard building practice. Energy Star for New Homes, historically set at 10 percent above the current state energy code, but as of January 2023 set at 10 percent over the 2015 IECC across all states, has a new construction adoption rate of nine percent of all single-family homes nationally. There are also a smaller number built to the DOE's Zero Energy Ready Home (ZERH) standards. In addition, certain green building standards set Energy Star as a minimum requirement. With Infrastructure Reduction Act tax credits of $2,500 now available for Energy Star Certified Homes, and $5,000 for DOE Zero Energy Ready Homes, the market share for these above-code standards is likely to increase.

There is widespread regional variation in adoption of these standards are not typically mandated by municipalities for single family home construction. There are regional variations in above-code standards among builders as well. For example, for Energy Star New Homes, adoption rates in most states are below five percent, with very little in the northeast, while in the southwest the share of Energy Star new homes is much higher, e.g., Arizona is around 40 percent.[93]

In the multifamily sector, some builders build to above code standards like LEED, Enterprise Green Communities, ICC 700 National Green Building Standard, PHIUS, the Living Building Challenge or regional programs like Earthcraft. Most of these programs embed Energy Star New Construction within their standards while also addressing other areas of health and disaster resilience requirements. Some municipalities may require one of these above-code

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[92] Lawrence Berkeley National Laboratory, *The Cost of Enforcing Building Codes, Phase I*, April 2013. Table 1 shows varying compliance rates: https://www.researchgate.net/publication/282136731_The_Cost_of_Enforcing_Building_Energy_Codes_Phase_1

[93] https://www.energystar.gov/newhomes/energy_star_certified_new_homes_market_share

standards for new construction of multifamily housing. In the affordable housing sector, each state may also drive the choice of compliance with above-code standards through their Low-Income Housing Tax Credit Qualified Allocation Plans (QAPs). State QAPs may call out these above-code standards specifically or may allocate points to other matching funding streams that incentivize or require specific above-code standards.

ASHRAE 90.1-2019 – Rental Housing

USDA and HUD have preliminarily determined that in light of the extremely small incremental first costs, or, in many cases, negative first costs, adoption of ASHRAE 90.1-2019 will not negatively impact the availability of multifamily units financed or insured through these programs. Simple paybacks times are extremely low for the small number of states that will see an increase in first costs, in most cases less than one year. The estimate of the direct cost of construction of moving to this code is not greater than zero. Even if there were a slight increase in construction costs, the estimates of energy savings are sizeable enough such that the benefits would offset the costs for property managers. There could be some builders of multi-family properties who are doubtful of the return and so view the ASHRAE 90.1-2019 requirement as a net burden. For the hesitant developer, there remain other incentives to comply: FHA multifamily loans allow a higher LTV than is common and Low-Income Housing Tax Credits that are frequently used by developers in conjunction with HUD financing often carry a requirement or incentive for energy efficiency. In addition, FHA's lower Green Mortgage Insurance Premium provides a strong incentive for developers to adopt an above-code standard.

V. IMPLEMENTATION

Section 109(d) of Cranston-Gonzalez (42 U.S.C. 12709) automatically applies to all covered programs upon completion and publication of the specified affordability and availability determinations by HUD and USDA. Accordingly, once a Final Determination has been made by HUD and USDA under section 109(d) (42 U.S.C. 12709(d)) and published, additional notice and comment rulemaking will not be required for the covered programs. The new codes, if found not

to negatively affect both the availability and affordability of covered housing, will automatically apply, subject to administrative actions such as mortgagee letters, notices, or amendments to handbooks and conforming regulations that may be required by individual programs.

Based on DOE findings on improvements in energy efficiency and energy savings, and a subsequent HUD and USDA Final Determination with respect to both housing affordability and availability, HUD and USDA programs specified under EISA will implement procedures to ensure that recipients of HUD and USDA funding, assistance, or insurance comply with the 2021 IECC and ASHRAE 90.1-2019 code requirements, commencing no later than 30 days after the date of publication of a Notice of Final Determination. HUD and USDA will take such administrative actions as are necessary to ensure timely implementation of and compliance with the energy codes, to include Mortgagee Letters, Notices, Notices of Funding Opportunity (NOFOs), Builder's Certification Form HUD-92541, and amendments to relevant handbooks. Conforming rulemaking will be required to update FHA's single family minimum property standards at 24 CFR 200.926d, Public Housing Capital Fund energy standards at 24 CFR 905, and HOME property standards at 24 CFR 92.251, though as noted above, this would not entail notice and comment rulemaking. USDA will update minimum energy requirements at 7 CFR part 1924.

To enable these administrative and conforming rulemaking procedures to be implemented and to provide the industry with adequate time to prepare for these requirements and incorporate them in project plans and specifications, proposals or applications, adoption of the new construction standards described in this Notice will take effect as follows:

(1) For FHA-insured multifamily programs, the standards set forth by this Notice are applicable to those properties for which mortgage insurance pre-applications are received by HUD 90 days after the effective date of this Final Determination;

(2) For FHA-insured and USDA-guaranteed single family loan programs, the standards set forth by this Notice are applicable to properties for which building permits are issued 180 days after the effective date of a Final Determination.

(3) For the HOME program, the standards set forth by this Notice are applicable to residential new construction projects for which HOME funds applications are committed by Participating Jurisdictions no later than 180 days after the effective date of a Final Determination.

(4) For Public Housing Capital Fund new construction projects for which approvals are submitted the standards set forth by this Notice are applicable no later than 180 days after the effective date of a Final Determination.

Alternate Compliance Paths

HUD and USDA will accept certain energy and green building certifications as evidence of compliance with the standards addressed in this Notice, provided that they require energy efficiency levels that meet or exceed the 2021 IECC or ASHRAE 90.1-2019. These may include standards referenced in one or more HUD or USDA programs, such as the ICC-700 National Green Building Standard, Enterprise Green Communities, Energy Star Certified New Homes, Energy Star Indoor Air Plus, DOE Zero Energy Ready Homes, Leadership in Energy and Environmental Design (LEED), Living Building Challenge or Passive House, as well as one or more regional or local standards such as Earthcraft, Earth Advantage, or Greenpoint Rated New Home.[94] HUD and USDA will publish a list of those standards that comply with the minimum energy efficiency requirements of this Notice. HUD and USDA will also accept certifications of compliance of state or local codes or standards for which credible third-party documentation exists that these meet or exceed the 2021 IECC and ASHRAE 90.1-2019.

VI. REQUEST FOR PUBLIC COMMENT

[94] Energy Star Certified New Homes Version 3.2 and DOE's Zero Energy Ready Homes set the 2021 IECC as the baseline standard.

HUD and USDA welcome comments on all aspects of this Preliminary Determination, but are especially interested in comments on the following subjects:

(1) HUD and USDA are requesting comments on whether the higher first-costs associated with adopting the 2021 IECC over the current 2009 IECC standard for USDA- or HUD-assisted housing, or relative to the most recent 2018 IECC, may lower homebuyer options, despite the significant life-cycle cost savings over the life of the mortgage described in this Notice, i.e. whether adoption of the 2021 IECC may limit the availability of such housing to otherwise-qualified buyers or renters.

(2) HUD and USDA request comments from code officials on the current status of code adoption in their states, and the anticipated timetable for adopting the next revision of the IECC and/or ASHRAE codes, their equivalent, or higher, as well as from code officials in home rule jurisdictions that may adopt the codes independently of state action. HUD and USDA wish to establish the extent to which adoption of the latest IECC and ASHRAE 90.1 standards aligns with state or local home rule adoption of these codes.

(3) HUD and USDA request comments on the cost benefit analysis utilized by PNNL as described in Sections II.B and III.B of this Preliminary Determination.

(4) Anecdotal reports suggest that because manually operated bathroom fans allowed under the IECC to meet ventilation requirements rely on occupant action to operate them, these may impact indoor air quality and the health of occupants. HUD and USDA request comments on this possible health concern.

(5) HUD and USDA are requesting comment on the extent to which the 2021 IECC air leakage requirements (3 air changes per hour or 5 air changes per hour at 50 pascals depending on Climate Zone) may present fire code issues for attached single family homes or low-rise multifamily properties, and, if such issues exist, cost-effective solutions that have been developed in the field or are currently being developed to address them.

(6) HUD and USDA seek comment on the time required for builders and building designers to familiarize themselves with the new codes, the training or technical support that may be required by building professionals and local code officials on the new requirements of the 2021 IECC and ASHRAE 90.1-2019 standards, workforce training needs, and any other issues related to implementation of these standards. Comments on particular challenges or issues facing rural areas in adoption and/or implementation of these codes are also requested.

(7) The construction industry has experienced COVID-related supply chain challenges for certain products and materials, particularly but not exclusively for lumber products, leading to significant price increases in such products as framing lumber, plywood, and oriented strand board (OSB).[95] HUD and USDA solicit comments on the duration, persistence and intensity of these price increases, the extent to which they may impact the cost of energy related products or materials covered by the IECC or ASHRAE energy codes addressed in this Notice, and to what extent these supply chain issues may impact implementation of the codes addressed by this Notice.

(8) HUD and USDA currently provide incentives or require green building standards for some programs. The agencies are seeking to maximize alignment between the 2021 IECC and ASHRAE 90.1-2019 and those green building standards that are encouraged or incentivized through these programs. During the implementation phase of this Notice, HUD and USDA will seek certifications from all green building or above-code energy performance standard-setting bodies as to their establishing 2021 IECC and ASHRAE 90.1-2019 standards as the baseline against which they measure above-code energy performance. The agencies seek preliminary comments from current green building or above-code energy performance standard-setting bodies on their (1) current minimum IECC and ASHRAE 90.1 requirements; and/or (2) proposed establishment of the 2021 IECC and ASHRAE 90.1-2019 as the baseline for such standards.

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[95] Softwood lumber prices in North America, https://www.nrcan.gc.ca/our-natural-resources/domestic-and-international-markets/current-lumber-pulp-panel-prices/13309#panel

VII. ENVIRONMENTAL IMPACT

A Finding of No Significant Impact with respect to the environment has been made in accordance with HUD regulations at 24 CFR part 50 and USDA Rural Development regulations at 7 CFR part 1970, which implement section 102(2)(C) of the National Environmental Policy Act of 1969 (42 U.S.C. 4332(2)(C)). That finding is posted at www.regulations.gov and is also available for public inspection between the hours of 8 a.m. and 5 p.m. weekdays in the Regulations Division, Office of General Counsel, Department of Housing and Urban Development, 451 7th Street, SW, Room 10276, Washington, DC 20410-0500. Due to security measures at the HUD Headquarters building, please schedule an appointment to review the finding by calling the Regulations Division at 202-402-3055 (this is not a toll-free number). HUD welcomes and is prepared to receive calls from individuals who are deaf or hard of hearing, as well as individuals with speech or communication disabilities. To learn more about how to make an accessible telephone call, please visit https://www.fcc.gov/consumers/guides/telecommunications-relay-service-trs.

Adrianne Todman,
Deputy Secretary,
U.S. Department of Housing and Urban Development.

Anthony Shea,
Acting Deputy Secretary,
U.S. Department of Agriculture.

[BILLING CODE 4210-67]

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