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[6450-01-P]

DEPARTMENT OF ENERGY

10 CFR Part 430

[EERE-2021-BT-STD-0031]

RIN 1904-AF19

Energy Conservation Program: Energy Conservation Standards for Oil, Electric, and Weatherized Gas Consumer Furnaces

AGENCY: Office of Energy Efficiency and Renewable Energy, Department of Energy.

ACTION: Notification of proposed determination and request for comment.

SUMMARY: The Energy Policy and Conservation Act, as amended ("EPCA"), prescribes energy conservation standards for various consumer products and certain commercial and industrial equipment, including non-weatherized oil-fired furnaces ("NWOFs"), mobile home oil-fired furnaces ("MHOFs"), weatherized gas furnaces ("WGFs"), weatherized oil-fired furnaces ("WOFs"), and electric furnaces ("EFs"). EPCA also requires the U.S. Department of Energy ("DOE") to periodically review its existing standards to determine whether more-stringent, amended standards would be technologically feasible and economically justified, and would result in significant energy savings. In this notification of proposed determination ("NOPD"), DOE has initially determined that amended energy conservation standards for EFs, NWOFs,

MHOFs, WOFs, and WGFs do not need to be amended. DOE requests comment on this proposed determination and the associated analyses and results.

DATES: *Meeting*: DOE will hold a public meeting webinar upon request. Please request a public meeting webinar no later than **[INSERT DATE 14 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER]**. *See* section VI, "Public Participation," for webinar registration information, participant instructions, and information about the capabilities available to webinar participants.

Comments: Written comments and information are requested and will be accepted on or before [**INSERT DATE 60 DAYS AFTER DATE OF PUBLICATION IN THE *FEDERAL REGISTER***].

ADDRESSES: Interested persons are encouraged to submit comments using the Federal eRulemaking Portal at *www.regulations.gov* under docket number EERE–2021–BT–STD-0031. Follow the instructions for submitting comments.

Alternatively, interested persons may submit comments, identified by docket number EERE-2021-BT-STD-0031 and/or RIN 1904-AF19, by any of the following methods:

Email: *OEWGFurnaces2021STD0031@ee.doe.gov*. Include the docket number EERE-2021-BT-STD-0031 and/or RIN 1904-AF19 in the subject line of the message.

Postal Mail: Appliance and Equipment Standards Program, U.S. Department of Energy, Building Technologies Office, Mailstop EE-5B, 1000 Independence Avenue, SW, Washington, DC 20585-0121. Telephone: (202) 287-1445. If possible, please submit all items on a compact disc ("CD"), in which case it is not necessary to include printed copies.

Hand Delivery/Courier: Appliance and Equipment Standards Program, U.S. Department of Energy, Building Technologies Office, 950 L'Enfant Plaza, SW, 6th Floor, Washington, DC 20024. Telephone: (202) 287-1445. If possible, please submit all items on a CD, in which case it is not necessary to include printed copies.

No telefacsimiles ("faxes") will be accepted. For detailed instructions on submitting comments and additional information on this process, see section VII of this document (Public Participation).

Docket: The docket, which includes *Federal Register* notices, public meeting attendee lists and transcripts, comments, and other supporting documents/materials, is available for review at *www.regulations.gov*. All documents in the docket are listed in the *www.regulations.gov* index. However, not all documents listed in the index may be publicly available, such as information that is exempt from public disclosure.

The docket webpage can be found at *www.regulations.gov/docket/EERE-2021-BT-STD-0031*. The docket webpage contains instructions on how to access all documents, including public comments, in the docket. See section VII, "Public Participation," for further information on how to submit comments through *www.regulations.gov*.

FOR FURTHER INFORMATION CONTACT: Ms. Julia Hegarty, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Office, EE-5B, 1000 Independence Avenue, SW, Washington, DC 20585-0121. Telephone: (240) 597-6737. Email: *ApplianceStandardsQuestions@ee.doe.gov*.

Mr. Eric Stas, U.S. Department of Energy, Office of the General Counsel, GC-33, 1000 Independence Avenue, SW, Washington, DC 20585-0121. Telephone: (202) 586-5827. Email: *Eric.Stas @hq.doe.gov*.

For further information on how to submit a comment or review other public comments and the docket contact the Appliance and Equipment Standards Program staff at (202) 287-1445 or by email: *ApplianceStandardsQuestions@ee.doe.gov*.

SUPPLEMENTARY INFORMATION:

Table of Contents

I. Synopsis of the Proposed Determination
II. Introduction
  A. Authority
  B. Background
    1. Current Standards
    2. History of Standards Rulemakings for Consumer Furnaces
  C. Deviation from Appendix A
III. General Discussion and Rationale
  A. General Comments
    1. Comments Supporting Amended Standards
    2. Comments Opposing Amended Standards

3. Standby Mode and Off Mode
B. Scope of Coverage and Product Classes
C. Test Procedure
D. Technological Feasibility
1. General
2. Maximum Technologically Feasible Levels
E. Cost-Effectiveness
F. Energy Savings
1. Determination of Savings
2. Significance of Savings
G. Additional Considerations
IV. Methodology and Discussion of Related Comments
A. Market and Technology Assessment
1. Scope of Coverage
a. Electric Furnaces
b. Weatherized Oil-fired Furnaces
c. Fuel-fired Heat Pumps
2. Technology Options
3. Screening Analysis
a. Screened-Out Technologies
b. Remaining Technologies
4. Product Classes
B. Engineering Analysis
1. Efficiency Analysis
a. Baseline Efficiency
b. Intermediate Efficiency Levels
c. Maximum Technology ("Max-Tech") Efficiency Levels
d. Summary of Efficiency Levels Analyzed
2. Cost Analysis
a. Teardown Analysis
b. Cost Estimation Method
3. Cost-Efficiency Results
C. Markups Analysis
D. Energy Use Analysis
E. Life-Cycle Cost and Payback Period Analysis
1. Product Cost
2. Installation Cost
3. Annual Energy Consumption
4. Energy Prices
5. Maintenance and Repair Costs
6. Product Lifetime
7. Discount Rates
8. Energy Efficiency Distribution in the No-New-Standards Case
9. Payback Period Analysis
F. Shipments Analysis

G. National Impact Analysis
1. Product Efficiency Trends
2. National Energy Savings
3. Net Present Value Analysis
V. Analytical Results and Conclusions
A. Economic Impacts on Individual Consumers
B. National Impact Analysis
1. Significance of Energy Savings
2. Net Present Value of Consumer Costs and Benefits
C. Proposed Determination
1. Technological Feasibility
2. Cost-Effectiveness
3. Significant Conservation of Energy
4. Further Considerations
5. Summary
VI. Procedural Issues and Regulatory Review
A. Review Under Executive Orders 12866, 13563, and 14094
B. Review Under the Regulatory Flexibility Act
C. Review Under the Paperwork Reduction Act of 1995
D. Review Under the National Environmental Policy Act of 1969
E. Review Under Executive Order 13132
F. Review Under Executive Order 12988
G. Review Under the Unfunded Mandates Reform Act of 1995
H. Review Under the Treasury and General Government Appropriations Act, 1999
I. Review Under Executive Order 12630
J. Review Under the Treasury and General Government Appropriations Act, 2001
K. Review Under Executive Order 13211
L. Review Under the Information Quality Bulletin for Peer Review
VII. Public Participation
A. Participation in the Public Meeting Webinar
B. Submission of Comments
C. Issues on Which DOE Seeks Comment
VIII. Approval of the Office of the Secretary

I. Synopsis of the Proposed Determination

The Energy Policy and Conservation Act, Pub. L. 94-163, as amended ("EPCA"),[1] among other things, authorizes DOE to regulate the energy efficiency of a number of consumer products and certain industrial equipment. (42 U.S.C. 6291–6317, as codified) Title III, Part B of EPCA[2] established the Energy Conservation Program for Consumer Products Other Than Automobiles. (42 U.S.C. 6291-6309) These products include oil, electric, and weatherized gas consumer furnaces, the subject of this NOPD. (42 U.S.C. 6292(a)(5))

Pursuant to EPCA, DOE is required to review the existing energy conservation standards for covered consumer products, at a minimum, every six years after issuance of any final rule establishing or amending a standard (42 U.S.C. 6295(m)(1)). DOE is conducting this review of the energy conservation standards for oil, electric, and weatherized gas consumer furnaces under EPCA's six-year-lookback authority. (*Id.*) Pursuant to that statutory provision, DOE must publish either a notification of determination that standards for the product do not need to be amended, or a notice of proposed rulemaking ("NOPR") including new proposed energy conservation standards (proceeding to a final rule, as appropriate). (*Id.*) For the reasons explained in the paragraphs that follow and elsewhere in this document, DOE has tentatively determined it appropriate to issue this NOPD for the consumer furnaces subject to this rulemaking.

[1] All references to EPCA in this document refer to the statute as amended through the Energy Act of 2020, Pub. L. 116-260 (Dec. 27, 2020), which reflect the last statutory amendments that impact Parts A and A-1 of EPCA.
[2] For editorial reasons, upon codification in the U.S. Code, Part B was redesignated Part A.

For this proposed determination, DOE analyzed oil, electric, and weatherized gas consumer furnaces subject to energy conservation standards specified in 10 CFR 430.32(e)(1).

DOE first analyzed the technological feasibility of more energy-efficient oil, electric, and weatherized gas furnaces and determined that amended standards for electric furnaces are not technologically feasible. For those oil and weatherized gas furnaces for which DOE determined higher standards to be technologically feasible, DOE evaluated whether higher standards would be cost-effective by conducting life-cycle cost ("LCC") and payback period ("PBP") analyses. In addition, DOE estimated energy savings that would result from potential energy conservation standards by conducting a national impacts analysis ("NIA"), in which it estimated the net present value ("NPV") of the total costs and benefits experienced by consumers.

Based on the results of the analyses, including the consideration of impacts on manufacturers and product availability as summarized in section V of this document, DOE has tentatively determined that current standards for oil, electric, and weatherized gas furnaces do not need to be amended.

II. Introduction

The following section briefly discusses the statutory authority underlying this proposed determination, as well as some of the historical background relevant to the establishment of energy conservation standards for oil, electric, and weatherized gas furnaces.

A. Authority

Among other things, EPCA, Pub. L. 94-163 (42 U.S.C. 6291-6317, as codified) authorizes DOE to regulate the energy efficiency of a number of consumer products and certain industrial equipment. Title III, Part B of EPCA established the Energy Conservation Program for Consumer Products Other Than Automobiles. These products include consumer furnaces, the subject of this document. (42 U.S.C. 6292(a)(5)) EPCA prescribed the initial energy conservation standards for these products (42 U.S.C. 6295(f)(1)-(2)), and directs DOE to conduct future rulemakings to determine whether to amend these standards. (42 U.S.C. 6295(f)(4) and 42 U.S.C. 6295(m)(1))

The energy conservation program under EPCA consists essentially of four parts: (1) testing, (2) labeling, (3) the establishment of Federal energy conservation standards, and (4) certification and enforcement procedures. Relevant provisions of EPCA specifically include definitions (42 U.S.C. 6291), test procedures (42 U.S.C. 6293), labeling provisions (42 U.S.C. 6294), energy conservation standards (42 U.S.C. 6295), and the authority to require information and reports from manufacturers (42 U.S.C. 6296).

Subject to certain criteria and conditions, DOE is required to develop test procedures to measure the energy efficiency, energy use, or estimated annual operating cost of each covered product. (42 U.S.C. 6295(o)(3)(A) and 42 U.S.C. 6295(r))

Manufacturers of covered products must use the prescribed DOE test procedure as the basis for certifying to DOE that their products comply with the applicable energy conservation standards adopted under EPCA and when making representations to the public regarding the energy use or efficiency of those products. (42 U.S.C. 6293(c) and 42 U.S.C. 6295(s)) Similarly, DOE must use these test procedures to determine whether the products comply with standards adopted pursuant to EPCA. (42 U.S.C. 6295(s)) The DOE test procedures for consumer furnaces appear at title 10 of the Code of Federal Regulations ("CFR") part 430, subpart B, appendix N.

Federal energy conservation requirements for covered products established under EPCA generally supersede State laws and regulations concerning energy conservation testing, labeling, and standards. (42 U.S.C. 6297(a)-(c)) DOE may, however, grant waivers of Federal preemption in limited circumstances for particular State laws or regulations, in accordance with the procedures and other provisions set forth under EPCA. (42 U.S.C. 6297(d))

Pursuant to the amendments to EPCA contained in the Energy Independence and Security Act of 2007 (EISA 2007), Pub. L. 110-140, any final rule for new or amended energy conservation standards promulgated after July 1, 2010, is required to address standby mode and off mode energy use. (42 U.S.C. 6295(gg)(3)) Specifically, when DOE adopts a standard for a covered product after that date, it must, if justified by the criteria for adoption of standards under EPCA (42 U.S.C. 6295(o)), incorporate standby mode and off mode energy use into a single standard, or, if that is not feasible, adopt a separate standard for such energy use for that product. (42 U.S.C. 6295(gg)(3)(A)-(B))

DOE's current test procedures for oil, electric, and weatherized gas furnaces address standby mode and off mode energy use. DOE's energy conservation standards address standby mode and off mode energy use only for non-weatherized oil-fired furnaces (including mobile home furnaces) and electric furnaces. 10 CFR 430.32(e)(1)(iii). In this analysis, DOE considers such energy use in its determination of whether energy conservation standards need to be amended.

EPCA also requires that DOE must periodically review its already established energy conservation standards for a covered product no later than six years from the issuance of a final rule establishing or amending a standard for a covered product. (42 U.S.C. 6295(m)) This six-year-lookback provision requires that DOE publish either a notice of determination that standards do not need to be amended or a NOPR, including new proposed standards (proceeding to a final rule, as appropriate). (42 U.S.C. 6295(m)(1)) EPCA further provides that, not later than 3 years after the issuance of a final determination not to amend standards, DOE must publish either a notification of determination that standards for the product do not need to be amended, or a NOPR including new proposed energy conservation standards (proceeding to a final rule, as appropriate). (42 U.S.C. 6295(m)(3)(B)) DOE must make the analysis on which a determination is based publicly available and provide an opportunity for written comment. (42 U.S.C. 6295(m)(2))

A determination that amended standards are not needed must be based on consideration of whether amended standards will result in significant conservation of energy, are technologically feasible, and are cost-effective. (42 U.S.C. 6295(m)(1)(A) and 42 U.S.C. 6295(n)(2)) Additionally, any new or amended energy conservation standard prescribed by the Secretary for any type (or class) of covered product shall be designed to achieve the maximum improvement in energy efficiency which the Secretary determines is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A)) Among the factors DOE considers in evaluating whether a proposed standard level is economically justified includes whether the proposed standard at that level is cost-effective, as defined under 42 U.S.C. 6295(o)(2)(B)(i)(II). Under 42 U.S.C. 6295(o)(2)(B)(i)(II), an evaluation of cost-effectiveness requires DOE to consider savings in operating costs throughout the estimated average life of the covered products in the type (or class) compared to any increase in the price, initial charges, or maintenance expenses for the covered products that are likely to result from the standard. (42 U.S.C. 6295(n)(2) and 42 U.S.C. 6295(o)(2)(B)(i)(II)) DOE is publishing this NOPD in satisfaction of the six-year-lookback review requirement in EPCA.

B. Background

1. Current Standards

DOE most recently completed a review of its consumer furnace standards in a direct final rule ("DFR") published in the *Federal Register* on June 27, 2011 ("June 2011 DFR"), through which DOE amended the existing energy conservation standards for non-weatherized gas furnaces ("NWGFs"), mobile home gas furnaces ("MHGFs"), weatherized gas furnaces ("WGFs"), NWOF, MHOFs, and weatherized oil furnaces ("WOFs").[3] 76 FR 37408. The June 2011 DFR amended the existing energy

[3] This rulemaking was undertaken pursuant to the voluntary remand in *State of New York, et al.* v. *Department of Energy, et al.*, 08-311-ag(L); 08-312-ag(con) (2d Cir. Filed Jan. 17, 2008).

conservation standards for NWGFs, MHGFs, and NWOFs (which are specified in terms of annual fuel utilization efficiency "AFUE"), and amended the compliance date (but left the existing standards in place) for WGFs. The June 2011 DFR also established electrical standby mode and off mode standards for NWGFs, MHGFs, NWOFs, MHOFs, and electric furnaces. As a result of a settlement agreement approved by the Court of Appeals for the D.C. Circuit, the standards established by the June 2011 DFR for NWGFs and MHGFs did not go into effect.[4] However, the court order left in place the standards for WGFs, NWOFs, MHOFs, WOFs, and electric furnaces, which are the subject of this NOPD.

The AFUE standards currently applicable to all consumer furnaces, including the product classes for which DOE is conducting analyses in this NOPD, are set forth in DOE's regulations at 10 CFR 430.32(e)(1)(ii). Table II.1 presents the currently applicable standards for oil, electric, and weatherized gas furnaces and the date on which compliance with each such standard was required.

[4] DOE confirmed the standards and compliance dates promulgated in the June 2011 DFR in a notice of effective date and compliance dates published in the *Federal Register* on October 31, 2011 ("October 2011 notice"). 76 FR 67037. After publication of the October 2011 notice, the American Public Gas Association ("APGA") sued DOE to invalidate the rule as it pertained to NWGFs and MHGFs. Petition for Review, *American Public Gas Association, et al.* v. *Department of Energy, et al*., No. 11-1485 (D.C. Cir. filed Dec. 23, 2011). On April 24, 2014, the Court granted a motion that approved a settlement agreement that was reached between DOE, APGA, and the various intervenors in the case, in which DOE agreed to a remand of the non-weatherized gas furnace and mobile home gas furnace portions of the June 2011 DFR in order to conduct further notice-and-comment rulemaking. Accordingly, the Court's order vacated the June 2011 DFR in part (*i.e.*, those portions relating to non-weatherized gas furnaces and mobile home gas furnaces) and remanded to the agency for further rulemaking. NWGFs and MHGFs are being addressed in a separate rulemaking proceeding *(see* Docket No. EERE-2014-BT-STD-0031).

Table II.1 Federal AFUE Standards for Oil, Electric, and Weatherized Gas Furnaces

Product Class	AFUE (percent)	Compliance Date
Non-weathered oil-fired furnaces (not including mobile home furnaces)	83	May 1, 2013
Mobile home oil-fired furnaces	75	September 1, 1990
Weatherized gas furnaces	81	January 1, 2015
Weatherized oil-fired furnaces	78	January 1, 1992
Electric furnaces	78	January 1, 1992

Table II.2 Federal Standby Mode and Off Mode Standards for Oil and Electric Furnaces

Product Class	Maximum Standby Mode Electrical Power Consumption, $P_{W,SB}$ (watts)	Maximum Off Mode Electrical Power Consumption, $P_{W,OFF}$ (watts)	Compliance Date
Non-weatherized oil-fired furnaces (including mobile home furnaces)	11	11	May 1, 2013
Electric furnaces	10	10	May 1, 2013

2. History of Standards Rulemakings for Consumer Furnaces

Amendments to EPCA in the National Appliance Energy Conservation Act of 1987 ("NAECA"; Pub. L. 100-12) established EPCA's original energy conservation standards for furnaces, consisting of the minimum AFUE levels for mobile home furnaces and for all other furnaces except "small" gas furnaces. (42 U.S.C. 6295(f)(1)-(2)) The original standards established a minimum AFUE of 75 percent for mobile home furnaces and 78 percent for all other furnaces. Pursuant to authority conferred under 42 U.S.C. 6295(f)(1)(B), DOE subsequently adopted a mandatory minimum AFUE level for "small" furnaces through a final rule published in the *Federal Register* on November 17, 1989 ("the November 1989 Final Rule"). 54 FR 47916. The standards established by

NAECA and the November 1989 Final Rule for "small" gas furnaces are still in effect for MHOFs, WOFs, and EFs.

Pursuant to EPCA, DOE was required to conduct two rounds of rulemaking to consider amended energy conservation standards for all consumer furnaces, and an additional round of rulemaking for mobile home furnaces. (42 U.S.C. 6295(f)(4)(A), (B), and (C)) In satisfaction of the first round of amended standards rulemaking under 42 U.S.C. 6295(f)(4)(B), on November 19, 2007, DOE published in the *Federal Register* a final rule ("November 2007 Final Rule") that revised the standards for most furnaces but left them in place for two product classes (*i.e.*, MHOFs and WOFs)[5]. The standards amended in the November 2007 Final Rule were to apply to furnaces manufactured or imported on and after November 19, 2015. 72 FR 65136 (Nov. 19, 2007). The energy conservation standards in the November 2007 Final Rule consist of a minimum AFUE level for each of the six classes of furnaces. *Id*. at 72 FR 65169. Based on the market analysis for the November 2007 Final Rule and the standards established under that rule, the November 2007 Final Rule eliminated the distinction between furnaces based on their certified input capacity, (*i.e.*, the standards applicable to "small" furnaces were established at the same level and as part of their appropriate class of furnace generally). *Id*.

[5] The November 2007 Final Rule adopted amended standards for "oil-fired furnaces" generally. However, on July 28, 2008, DOE published a technical amendment final rule in the *Federal Register* that clarified that the amended standards adopted in the November 2007 Final Rule for oil-fired furnaces did not apply to mobile home oil-fired furnaces and weatherized oil-fired furnaces; rather they were only applicable for non-weatherized oil-fired furnaces. 73 FR 43611, 43613 (July 28, 2008).

Following DOE's adoption of the November 2007 Final Rule, several parties jointly sued DOE in the United States Court of Appeals for the Second Circuit ("Second Circuit") to invalidate the rule. Petition for Review, *State of New York, et al. v. Department of Energy, et al.*, Nos. 08–0311–ag(L); 08–0312–ag(con) (2d Cir. filed Jan. 17, 2008). The petitioners asserted that the standards for furnaces promulgated in the November 2007 Final Rule did not reflect the "maximum improvement in energy efficiency" that "is technologically feasible and economically justified" under 42 U.S.C. 6295(o)(2)(A). On April 16, 2009, DOE filed with the Court a motion for voluntary remand that the petitioners did not oppose. The motion did not state that the November 2007 Final Rule would be vacated, but it indicated that DOE would revisit its initial conclusions outlined in the November 2007 Final Rule in a subsequent rulemaking action. DOE also agreed that the final rule in that subsequent rulemaking action would address both regional standards for furnaces and the effects of alternate standards on natural gas prices. The Second Circuit granted DOE's motion on April 21, 2009. DOE notes that the Second Circuit's order did not vacate the energy conservation standards set forth in the November 2007 Final Rule, and during the remand, the standards went into effect as originally scheduled.

On June 27, 2011, DOE published a direct final rule ("DFR") in the *Federal Register* ("June 2011 DFR") revising the energy conservation standards for residential furnaces pursuant to the voluntary remand in *State of New York, et al. v. Department of Energy, et al*. 76 FR 37408. In the June 2011 DFR, DOE considered the amendment of the same six product classes considered in the November 2007 Final Rule analysis plus electric furnaces. As discussed previously, the June 2011 DFR amended the existing

AFUE energy conservation standards for NWGFs, MHGFs, and NWOFs and amended the compliance date (but left the existing standards in place) for WGFs. The June 2011 DFR also established electrical standby mode and off mode energy conservation standards for NWGFs, MHGFs, NWOFs, MHOFs, and EFs. DOE confirmed the standards and compliance dates promulgated in the June 2011 DFR in a notice of effective date and compliance dates published in the *Federal Register* on October 31, 2011 ("October 2011 Notice"). 76 FR 67037. The November 2007 Final Rule and the June 2011 DFR represented the first and the second rounds, respectively, of the two rulemakings required under 42 U.S.C. 6295(f)(4)(B)-(C) to consider amending the energy conservation standards for consumer furnaces.

The June 2011 DFR and October 2011 Notice of effective date and compliance dates amended, in relevant part, the AFUE energy conservation standards and compliance dates for three product classes of consumer furnaces (*i.e.*, NWGFs, MHGFs, and NWOFs).[6] The existing AFUE standards were left in place for three classes of consumer furnaces (*i.e.*, WOFs, MHOFs, and EFs). For WGFs, the existing standard was left in place, but the compliance date was amended. Electrical standby mode and off mode energy consumption standards were established for non-weatherized gas and oil-fired furnaces (including mobile home furnaces) and EFs. Compliance with the energy conservation standards promulgated in the June 2011 DFR was to be required on May 1, 2013, for non-weatherized gas furnaces, mobile home gas furnaces, and non-weatherized

[6] For NWGFs and MHGFs, the standards were amended to a level of 80-percent AFUE nationally with a more-stringent 90-percent AFUE requirement in the Northern Region. For NWOF furnaces, the standard was amended to 83-percent AFUE nationally. 76 FR 37408, 37410 (June 27, 2011).

oil furnaces, and on January 1, 2015, for weatherized furnaces. 76 FR 37408, 37547-37548 (June 27, 2011); 76 FR 67037, 67051 (Oct. 31, 2011). The amended energy conservation standards and compliance dates in the June 2011 DFR superseded those standards and compliance dates promulgated by the November 2007 Final Rule for NWGFs, MHGFs, and NWOFs. Similarly, the amended compliance date for WGFs in the June 2011 DFR superseded the compliance date in the November 2007 Final Rule.

Following DOE's adoption of the June 2011 DFR, the American Public Gas Association ("APGA") filed a petition for review with the United States Court of Appeals for the District of Columbia Circuit ("D.C. Circuit") to invalidate the DOE rule as it pertained to NWGFs and MHGFs. Petition for Review, *American Public Gas Association, et al. v. Department of Energy, et al.*, No. 11-1485 (D.C. Cir. filed Dec. 23, 2011). The parties to the litigation engaged in settlement negotiations, which ultimately led to filing of an unopposed motion on March 11, 2014, seeking to vacate DOE's rule in part and to remand to the agency for further rulemaking.

On April 24, 2014, the Court granted the motion and ordered that the standards established for NWGFs and MHGFs be vacated and remanded to DOE for further rulemaking. As a result, the standards established by the June 2011 DFR for NWGFs and MHGFs did not go into effect, and, thus, required compliance with the standards established in the November 2007 Final Rule for these products began on November 19, 2015. As stated previously, the AFUE standards for WOFs, MHOFs, and EFs were unchanged, and as such, the original standards for those product classes remain in effect. Further, the amended standard for NWOFs was not subject to the Court order and went into effect as specified in the June 2011 DFR. The AFUE standards currently applicable to all residential furnaces,[7] including the five product classes for which DOE is analyzing amended standards in this NOPD, are set forth in DOE's regulations at 10 CFR 430.32(e)(1)(ii) and (iii).

On January 28, 2022, DOE published in the *Federal Register* a request for information ("January 2022 RFI") to initiate a review to determine whether any new or amended standards would satisfy the relevant requirements of EPCA for a new or amended energy conservation standard for oil, electric, and weatherized gas consumer furnaces. 87 FR 4513. On November 29, 2022, DOE published in the *Federal Register* a notice of availability of a preliminary technical support document ("TSD") ("the November 2022 Preliminary Analysis") that presented initial technical analyses in the following areas: (1) market and technology; (2) screening; (3) engineering; (4) markups to determine product price; (5) energy use; (6) life-cycle cost ("LCC") and payback period ("PBP"); and (7) national impacts. 87 FR 73259. DOE held a public meeting webinar on December 19, 2022 in order to receive public input and information related to the November 2022 Preliminary Analysis for the subject furnaces.

DOE received comments in response to the November 2022 Preliminary Analysis from the interested parties listed in Table II.3.

[7] DOE divides consumer furnaces into seven classes for the purpose of setting energy conservation standards: (1) NWGFs, (2) MHGFs, (3) WGFs, (4) NWOFs, (5) MHOFs, (6) WOFs, and (7) electric furnaces. 10 CFR 430.32(e)(1)(ii). As noted previously, DOE has been analyzing amended standards for NWGFs and MHGFs as part of a separate, ongoing rulemaking (*see* Docket No. EERE-2014-BT-STD-0031).

Table II.3 November 2022 Preliminary Analysis Public Comments

Commenter(s)	Reference in this NOPD	Comment No. in the Docket	Commenter Type
Air-Conditioning, Heating, & Refrigeration Institute	AHRI	23	Manufacturer Trade Association
American Gas Association	AGA	28*	Utility Trade Association
American Gas Association, American Public Gas Association, National Propane Gas Association, Spire Inc., Spire Missouri Inc.	Joint Commenters	24	Utilities and Utility Trade Associations
Appliance Standards Awareness Project, American Council for an Energy-Efficiency Economy, Consumer Federation of America, Natural Resources Defense Council	Joint Advocates	22	Efficiency Advocacy Organizations
Johnson Controls International	JCI	25	Manufacturer
Lennox International	Lennox	26	Manufacturer
New York State Energy Research and Development Authority	NYSERDA	19	State Agency
Northwest Energy Efficiency Alliance	NEEA	21	Efficiency Advocacy Organization

*Comment No. 28 corresponds to the transcript for the webinar held on December 19, 2022. These commenters made oral comments during the public meeting that are summarized and discussed in this document.

Any oral comments provided during the webinar that are not substantively the same as those presented in written comments are summarized and cited separately. throughout this NOPD. A parenthetical reference at the end of a comment quotation or paraphrase provides the location of the item in the public record.[8]

C. Deviation from Appendix A

In accordance with section 3(a) of 10 CFR part 430, subpart C, appendix A ("appendix A"), DOE notes that it is deviating from the provision in appendix A

[8] The parenthetical reference provides a reference for information located in the docket. (Docket No. EERE-2021-BT-STD-0031, which is maintained at *www.regulations.gov*). The references are arranged as follows: (commenter name, comment docket ID number, page of that document).

regarding the pre-NOPR and NOPR stages for an energy conservation standards rulemaking.

Section 6(a)(2) of the Process Rule states that if DOE determines it is appropriate to proceed with a rulemaking, for the preliminary stages of a rulemaking to issue or amend an energy conservation standard, DOE will undertake a framework document and preliminary analysis, or an advance notice of proposed rulemaking. While DOE published a preliminary analysis for this rulemaking (*see* 87 FR 73529 (Nov. 29, 2022)), DOE did not publish a framework document in conjunction with the preliminary analysis. DOE notes, however, that chapter 2 of the preliminary technical support document that accompanied the preliminary analysis—titled *Analytical Framework, Comments from Interested Parties, and DOE Responses*—describes the general analytical framework that DOE uses in evaluating and developing potential amended energy conservation standards.[9] Further, DOE provided an overview of the analysis it would use to evaluate new or amended energy conservation standards in the January 2022 RFI (*see* 87 FR 4513 (Jan. 28, 2022)). As such, publication of a separate Framework Document would be largely redundant of previously published documents.

III. General Discussion and Rationale

DOE developed this proposed determination after a review of the market for the subject furnaces, including product listings in the DOE Compliance Certification

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[9] The preliminary technical support document is available at *www.regulations.gov/document/EERE-2021-BT-STD-0031-0011*.

Database ("CCD") database.[10] DOE also considered comments, data, and information from interested parties that represent a variety of interests. This NOPD addresses issues raised by these commenters.

A. General Comments

1. Comments Supporting Amended Standards

In response to the November 2022 Preliminary Analysis, several commenters expressed their support of amended energy conservation standards for oil, electric, and weatherized gas consumer furnaces.

The Joint Advocates stated that DOE's preliminary analysis demonstrates that condensing-level standards for NWOFs are technologically feasible and could result in significant consumer savings. The Joint Advocates further commented that fuel regulations in many northern States have helped to reduce the sulfur content in heating oil, adding that this results in condensing NWOFs becoming technologically feasible and commercially available. (Joint Advocates, No. 22 at p. 1) The Joint Advocates pointed out that Adams Manufacturing commented on the January 2022 RFI in support of a 95-percent AFUE standard for NWOFs.[11] (Joint Advocates, No. 22 at p. 2)

NYSERDA stated support for DOE increasing the furnace standards, particularly for oil furnaces and for standby and off modes. NYSERDA argued that there are cost-

[10] U.S. Department of Energy Compliance Certification Database. (Available at: *www.regulations.doe.gov/certification-data/*) (Last accessed Sept. 1, 2023).
[11] The comment from Adams Manufacturing, Co. in response to the January 2022 RFI can be found at: *www.regulations.gov/comment/EERE-2021-BT-STD-0031-0010*.

effective and beneficial energy and associated greenhouse gas savings available through improvements to electric, weatherized gas, and particularly oil furnaces. (NYSERDA, No. 19 at p. 1)

As part of the rulemaking process, DOE carefully considers the benefits and burdens of amended energy conservation standards to determine whether such standards are the maximum standard levels that are technologically feasible and economically justified and would conserve a significant amount of energy, as required by EPCA (*see* 42 U.S.C. 6295(o)(2)-(3)). Section IV of this document outlines DOE's approach to analyzing various potential amended energy conservation standard levels, and section V of this document provides the results of those analyses, as well as a detailed explanation of DOE's weighing of the benefits and burdens. Based upon its analysis and consideration of the relevant statutory criteria, DOE is proposing not to amend the existing standards for oil, electric, and weatherized gas furnaces at this time. The rationale for DOE's proposed determination is discussed in detail in section V of this document.

2. Comments Opposing Amended Standards

In response to the November 2022 Preliminary Analysis, several commenters expressed opposition to amended energy conservation standards for oil, electric, and weatherized gas consumer furnaces.

The Joint Commenters stated that they are guided by the congressional mandate that appliance efficiency standards should not impose unjustified costs on consumers or deprive consumers of gas products that are suitable for their needs. The Joint Commenters stated that such standards are not authorized by statute and would be harmful to fuel gas providers and the consumers they serve. (Joint Commenters, No. 24 at p. 2) AHRI commented that DOE should adopt a no-new-standards determination for mobile home oil-fired and non-weatherized oil-fired furnaces, given the burden placed on manufacturers to meet more-stringent standards that will provide insubstantial energy savings. (AHRI, No. 23 at pp. 3–4)

AHRI also commented that DOE should adopt a no-new-standards determination for weatherized gas-fired furnaces. The commenter argued that DOE should adopt the same determination for consumer weatherized gas furnaces as was done for commercial warm air furnaces, given that they are technologically similar. AHRI and Lennox commented that a move to an AFUE greater than 90 percent for weatherized gas furnaces is unjustified, adding that EL 1 showed a 9.1-year payback period and 45.8 percent of consumers experiencing a net cost. (AHRI, No. 23 at p. 3; Lennox, No. 26 at p. 2)

Lennox urged DOE to consider the cumulative regulatory burden of all ongoing rulemakings on furnace manufacturers. (Lennox, No. 26 at p. 9) The commenter also stated that weatherized gas, non-weatherized oil, and electric furnaces are niche products and total less than 10 percent of the consumer furnace market. More specifically, Lennox stated that weatherized gas furnaces comprise approximately 7 percent of the market, and non-weatherized oil and electric furnaces each account for less than 1 percent of the market. (Lennox, No. 26 at p. 1) Lennox acknowledged that technologies exist that could advance the efficiency of gas and oil furnaces included in the preliminary TSD.

However, Lennox stated that consumer cost and utility issues render more-stringent standards unjustified for the subject oil and gas furnaces. In particular, for weatherized gas products, Lennox recommended that DOE find that a no-new-standards determination is warranted for these product categories. (*Id*. at p. 6)

Lennox stated that the market adoption of condensing weatherized furnaces has been minimal. Lennox estimated that condensing weatherized furnaces are at less than 0.12 percent of the weatherized gas market and that there is no indication of growth in the market. Therefore, Lennox surmised that condensing efficiency levels would not be appropriate for DOE to consider as a basis for a national efficiency standard for weatherized gas furnaces and that DOE should not seek to mandate WGF condensing technology. (Lennox, No. 26 at p. 7)

Lennox stated that many consumers have been adversely impacted by the ongoing COVID pandemic and high inflation, particularly consumers who might already be struggling to afford new furnace equipment. Accordingly, Lennox argued that DOE increasing furnace equipment costs with new efficiency standards is not economically justified at this juncture. (Lennox, No. 26 at p. 2)

In response, as discussed in section II.A of this document, DOE must periodically review its already established energy conservation standards for consumer furnaces no later than six years from the issuance of a final rule establishing or amending a standard for consumer furnaces. This six-year-lookback provision requires that DOE publish either a determination that standards do not need to be amended or a NOPR, including new proposed standards (proceeding to a final rule, as appropriate). (42 U.S.C. 6295(m)(1)) As part of the rulemaking process, DOE carefully considers the benefits and burdens of amended standards to determine whether the amended standards are the maximum standard levels that are technologically feasible and economically justified and would conserve a significant amount of energy, as required by EPCA (*see* 42 U.S.C. 6295(o)(2)-(3)). Section IV of this document outlines DOE's approach to analyzing various potential amended standard levels, and section V of this document provides the results of those analyses. Section V also provides a detailed explanation of DOE's weighing of the benefits and burdens and the rationale for proposing not to amend standards for oil, electric, and weatherized gas furnaces at this time. Regarding DOE's consideration of cumulative regulatory burden, DOE is not proposing to amend the energy conservation standards for oil, electric, and weatherized gas furnaces, so, therefore, the Department does not expect this rulemaking to contribute to the cumulative regulatory burden of manufactures.

3. Standby Mode and Off Mode

As discussed in section II.A of this document, EPCA requires any final rule for new or amended energy conservation standards promulgated after July 1, 2010 to address standby mode and off mode energy use. (42 U.S.C. 6295(gg)(3))

"Standby mode" and "off mode" energy use are defined in the DOE test procedure for residential furnaces and boilers (*i.e.*, "Uniform Test Method for Measuring the Energy Consumption of Consumer Furnaces Other Than Boilers," 10 CFR part 430, subpart B, appendix N; "appendix N"). In that test procedure, DOE defines "standby mode" as any mode in which the furnace is connected to a mains power source and offers one or more of the following space heating functions that may persist: (a) To facilitate the activation of other modes (including activation or deactivation of active mode) by remote switch (including thermostat or remote control), internal or external sensors, and/or timer; and (b) Continuous functions, including information or status displays or sensor based functions. 10 CFR part 430, subpart B, appendix N, section 2. "Off mode" for consumer furnaces is defined as a mode in which the furnace is connected to a mains power source and is not providing any active mode or standby mode function, and where the mode may persist for an indefinite time. The existence of an off switch in off position (a disconnected circuit) is included within the classification of off mode. 10 CFR part 430, subpart B, appendix N, section 2. An "off switch" is defined as the switch on the furnace that, when activated, results in a measurable change in energy consumption between the standby and off modes. 10 CFR part 430, subpart B, appendix N, section 2. Currently, the standby mode and off mode energy conservation standards for NWOFs and EFs are outlined in 10 CFR 430.32 (e)(1)(iii) and are shown in Table II.2 of this document. Compliance with the Federal standards for standby mode and off mode electricity consumption for NWOFs, MHOFs, and EFs, as measured by standby power consumption in watts ("$P_{W,SB}$") and off mode power consumption in watts ("$P_{W,OFF}$"), was required on May 1, 2013.

In the November 2022 Preliminary Analysis, DOE analyzed amended standby/off mode standards for NWOFs, MHOFs and EFs. DOE did not consider amended standby mode and off mode standards for WGFs and WOFs, because DOE has previously concluded in a direct final rule published in the *Federal Register* on June 27, 2011 that these products are packaged with either an air conditioner or heat pump and that the standards for those products, specified in terms of power consumption in watts and Seasonal Energy Efficiency Ratio ("SEER"), already account for the standby mode and off mode energy consumption for these classes of furnaces. 76 FR 37408, 37433. Based on market analysis conducted for the November 2022 Preliminary Analysis, DOE tentatively concludes that WGFs and WOFs continue to be packaged with an air conditioner or heat pump.

In the analysis for the November 2022 Preliminary Analysis, DOE established the baseline for NWOFs, MHOFs, and EFs as the current Federal standby mode and off mode standards (see Table II.2). DOE also defined and identified baseline components as those that consumed the most electricity during standby mode and off mode operation. For intermediate efficiency levels, DOE utilized a design-option approach to identify design options that could be applied to the baseline design to reduce standby mode and off mode energy consumption. Above the baseline efficiency level, DOE implemented design options in the order of incremental energy savings relative to baseline until all available design options were employed (*i.e.*, at a max-tech level). DOE identified two design options between the baseline and max-tech design that were used as the basis for intermediate standby mode and off mode design options. Specifically, DOE replaced the linear transformer found in models at the baseline with a low-loss transformer ("LL-LTX") for the first intermediate efficiency level and replaced the linear power supply found in baseline models with a switching mode power supply ("SMPS") for the second intermediate efficiency level.

The max-tech standby mode and off mode efficiency level in the November 2022 Preliminary Analysis was based on a combination of the two design options that were analyzed for the intermediate efficiency levels. To reach max-tech, DOE analyzed using an LL-LTX in combination with an SMPS to reach the minimum standby mode or off mode power consumption (without eliminating other consumer- or performance-related electronic features). For this design option, a transformer is only needed to step down the voltage for the thermostat because the SMPS is able to step down the voltage for the other components of the furnace. As such, a smaller, lower-cost LL-LTX is used at the max-tech level, as compared to the LL-LTX used at EL 1 (*i.e.*, the first intermediate efficiency level).

In response to the November 2022 Preliminary Analysis, Lennox commented that it is not aware of new or improved technology options regarding standby mode and off mode energy use beyond those previously identified that significantly impact the range of efficiencies for the product covered in this rulemaking. (Lennox, No. 26 at p. 4) However, Lennox also pointed out that consumers, utilities, third-party aggregators, and regulators through programs such as EPA ENERGY STAR are looking to further deploy features that enable installation verification, ongoing monitoring, diagnostics, and prognostic features that can save significantly more energy than *de minimis* standby power limits achieve. (*Id.*)

AHRI and Lennox stated that the following functions and components utilize the furnace's power supply in the on, standby, and off modes: indoor and outdoor air conditioner ("AC")/ heat pump ("HP") Motors ("ECM"); AC/HP outdoor control board;

heat pump defrost control; indoor and outdoor electronic expansion valve; heat pump reversing valve; zoning systems; UV germicidal light; humidifier; communicating controls that aid in proper commissioning, system performance monitoring and reporting, identification of faults, and consumer interface; temperature sensors; air pressure sensors; refrigerant pressure sensors; gas pressure sensors; and proprietary diagnostic–prognostic sensors. (AHRI, No. 23, at p. 2; Lennox, No. 26 at p. 5) Lennox further added that thermostats utilize the furnace's power supply in the on, standby, and off modes. (Lennox, No. 26 at p. 5) AHRI added that integrated furnace controls, gas valves, and combustion air inducers utilize the furnace power in on, standby, and off modes. (AHRI, No. 23, at p. 2) AHRI and Lennox commented that additional safety-related sensors are being considered for furnaces that could further render more-stringent standby power limits impractical, including refrigerant leak detection mitigation sensors and CO sensors. (Lennox, No. 26 at p. 5; AHRI, No. 23, at p. 2) Lennox also added CO_2 sensors to the list of potential future diagnostic features and stated that this list is likely to grow over time. (Lennox, No. 26 at p. 5)

Lennox commented that increased stringency in standards for standby power levels would inhibit other innovations that save energy and benefit consumers. Lennox further stated that increased stringency would also inhibit implementation of additional safety features. (Lennox, No. 26 at p. 2) In addition, Lennox stated that the energy savings for standby mode and off mode standards for all of the products considered in this rulemaking do not meet the DOE criteria of significant energy savings. (*Id.*) AHRI commented that DOE should consider the standby mode and off mode requirements of higher technology features when evaluating the standby mode and off mode efficiency levels. (AHRI, No. 23 at p. 3) AHRI and Lennox commented that overly stringent standby mode and off mode standards would inhibit the integration of smart communicating controls, installation and diagnostic features, and zoning that can enable much larger energy savings than the minor savings achieved by the standby power limit itself. Lennox stated that these advanced features have entered the market for fully featured communicating products and require more standby mode and off mode energy than the baseline products. (Lennox, No. 26 at p. 4; AHRI, No. 23 at p. 3)

Lennox and AHRI agreed that standby mode and off mode power consumption for WGFs that are part of a single-package air conditioner or heat pump are captured in the $P_{W,OFF}$ and SEER metrics for these products. (Lennox, No. 26 at p. 3; AHRI, No. 23 at p. 4) Lennox stated that the current DOE metrics capture the standby energy regardless of the mode of operation. (Lennox, No. 26 at p. 3) Lennox commented that it is not aware of seasonal differences in standby mode and off mode energy consumption. Further, Lennox commented that a condensing standard for WGF may force additional factory- or field-installed components to prevent freezing (*i.e.*, heat tape or other) of the condensate system, which may increase standby energy consumption in heating mode. (Lennox, No. 26 at p. 3)

AHRI commented that an 8.5 W maximum standard for standby mode and off mode power does not allow for the addition of the aforementioned communication, diagnostic, and safety features. (AHRI, No. 23 at p. 2) AHRI recommended that DOE re-evaluate the necessary power draw for communication and safety-related features and the max-tech level based upon the use of a 20 VA LL-LTX transformer and SMPS to meet these utilities. (*Id.* at p. 3) AHRI commented that a 20 VA transformer cannot supply the needs of all interconnected controls for all types of systems. AHRI added that if the transformer cannot power the necessary internal functions, then DOE must reconsider the proposed 8.5-watt standby power limit and whether the 11-watt baseline is sufficient. AHRI further commented that if DOE must go higher than 11 watts, DOE may need to make allowance in future test procedures so that the effects of safety and other control measures do not count against the proposed 11-watt limit. (*Id.*)

AHRI commented that an incorrectly set minimum standard will drive connected products such as thermostats, WIFI controls, *etc*. to use add-on power supplies and cause an additional economic burden on consumers, asserting that this would defeat the purpose of the proposed maximum watts limit. AHRI commented that there are already auxiliary power supplies on the market for thermostats and other devices. (*Id.* at p. 3)

NYSERDA commented that the technology options for standby mode that rely on switching mode power supply with a low-loss linear transformer have been considered by DOE for several years and are anticipated to be transferable across furnace types, including the oil and electric furnaces addressed in this rulemaking. NYSERDA explained that as switch-mode power supply and low-loss linear transformers become the standard for much of the furnace market, it becomes more feasible for those technologies to apply to oil and electric furnaces as well. (NYSERDA, No. 19 at p. 2)

NYSERDA recommended that DOE propose the max-tech levels for standby mode and off mode at the NOPR stage. NYSERDA explained that, as this rulemaking is finalized, the broader furnace manufacturing industry is anticipated to evolve toward technology for standby mode that relies on switching mode power supply with a low-loss linear transformer. (NYSERDA, No. 19 at p. 2)

After considering this feedback, DOE understands that typical and baseline levels of power consumption of consumer furnaces in standby mode or off mode are likely to increase in the future as manufacturers continue to build increasingly complex controls into consumer furnaces, and that many of the likely changes are related to features such as safety sensors or to other improvements in functionality that would provide utility for the consumer. Based on these comments, DOE has found that there is some degree of uncertainty that exists with respect to the appropriateness of the standby mode/off mode efficiency levels analyzed in the November 2022 Preliminary Analysis—particularly for products that are in development but also possibly in some products already on the market. There is also uncertainty related to the potential impacts that standby mode and off mode power consumption standards could have on overall system energy consumption and consumer utility. Consequently, DOE has determined that it lacks the necessary information to amend the standby mode and off mode standards at this time. Particularly, since some of the functionalities at issue could have significant safety or energy-savings benefits, DOE does not wish to stymie such developments through well-intentioned but ultimately counterproductive standby mode/off mode standards. Instead, DOE needs to have a better understanding of the legitimate power consumption needs of the subject furnaces when operating in standby mode and off mode. Although DOE remains cognizant of the relevant requirements of 42 U.S.C. 6295(gg)(3), DOE has concluded that it does not currently have the requisite evidence to support amended standby mode and off mode standards under the applicable statutory criteria in EPCA. Therefore, DOE is not proposing to amend the standby mode/off mode power standards for NWOFs, MHOFs, and EFs this time, but instead, DOE will continue to investigate these issues and may consider such standards in a future rulemaking.

B. Scope of Coverage and Product Classes

This proposed determination covers certain product classes of consumer furnaces (*i.e.*, ones for oil, electric, and weatherized gas furnaces). A consumer "furnace" is defined as a product which utilizes only single-phase electric current, or single-phase electric current or DC current in conjunction with natural gas, propane, or home heating oil, and which—

(A) Is designed to be the principal heating source for the living space of a residence;

(B) Is not contained within the same cabinet with a central air conditioner whose rated cooling capacity is above 65,000 Btu per hour;

(C) Is an electric central furnace, electric boiler, forced-air central furnace, gravity central furnace, or low-pressure steam or hot water boiler; and

(D) Has a heat input rate of less than 300,000 Btu per hour for electric boilers and low-pressure steam or hot water boilers and less than 225,000 Btu per hour for forced-air central furnaces, gravity central furnaces, and electric central furnaces.

10 CFR 430.2. The scope of coverage is discussed in further detail in section IV.A.1 of this document.

When evaluating and establishing/amending energy conservation standards, DOE divides covered products into product classes by the type of energy used or by capacity or other performance-related features that justify differing standards. In making a determination whether a performance-related feature justifies a different standard, DOE must consider such factors as the utility of the feature to the consumer and other factors DOE determines are appropriate. (42 U.S.C. 6295(q)) The product classes for this proposed determination are discussed in further detail in section IV.A.4 of this document.

C. Test Procedure

EPCA sets forth generally applicable criteria and procedures for DOE's adoption and amendment of test procedures. (42 U.S.C. 6293) Manufacturers of covered products must use these test procedures to quantify the efficiency of their product and as the basis for certifying to DOE that their product complies with energy conservation standards and when making representations to the public regarding the energy use or efficiency of the product. (42 U.S.C. 6295(s) and 42 U.S.C. 6293(c)) Similarly, DOE must use these test procedures to determine whether the product complies with standards adopted pursuant to EPCA. (42 U.S.C. 6295(s)) DOE’s current energy conservation standards for consumer furnaces are expressed in terms of AFUE for all furnace product classes (*i.e.*, active mode) and, for NWOFs, MHOFs, and electric furnace product classes, also in terms of $P_{W,SB}$ and $P_{W,OFF}$ (*i.e.*, standby mode and off mode). (*See* 10 CFR 430.32(e)(1))

The test procedure for determining AFUE, $P_{W,SB}$, and $P_{W,OFF}$ is established at 10 CFR part 430, subpart B, appendix N. AFUE is an annualized fuel efficiency metric that accounts for fossil fuel consumption in active, standby, and off modes. $P_{W,SB}$ and $P_{W,OFF}$ are measurements of the standby mode and off mode electrical power consumption, respectively, in watts. The test procedure for consumer furnaces was last amended by a final rule published in the *Federal Register* on January 15, 2016 ("January 2016 TP Final Rule"). 81 FR 2628.[12]

The revisions to the consumer furnaces test procedure in the January 2016 TP Final Rule included:

- Clarification of the electrical power term "PE";
- Adoption of a smoke stick test for determining use of minimum default draft factors;
- Allowance for the measurement of condensate under steady-state conditions;

[12] On March 13, 2023, DOE published in the *Federal Register* a test procedure final rule for consumer boilers, which are a type of furnace under EPCA (*see* 42 U.S.C. 6291(23)) but are not included within the scope of this rulemaking (*see* section IV.A.1 of this document). 88 FR 15510. This test procedure final rule separated the test method for consumer boilers from the test method for other types of furnaces and moved the boilers test method to a new appendix EE to 10 CFR part 430, subpart B. Accordingly, it amended appendix N so as to remove provisions applicable only to boilers, but it did not materially change the test method for the oil, electric, and weatherized gas furnaces that are the subject of this rulemaking.

- Reference to manufacturer's installation and operation manual and clarifications for when that manual does not specify test set-up;
- Specification of duct-work requirements for units that are installed without a return duct;
- Specification of testing requirements for units with multi-position configurations; and
- Revision of the requirements regarding AFUE reporting precision.

81 FR 2628, 2629-2630 (Jan. 15, 2016).

The changes in the January 2016 TP Final Rule were mandatory for representations of furnace efficiency made on or after July 13, 2016. As such, the most current version of the test procedure (published in January 2016) has now been in place for several years.

D. Technological Feasibility

1. General

In evaluating potential amendments to energy conservation standards, DOE conducts a screening analysis based on information gathered on all current technology options and prototype designs that could improve the efficiency of the products or equipment that are the subject of the determination. As the first step in such an analysis, DOE develops a list of technology options for consideration in consultation with manufacturers, design engineers, and other interested parties. DOE then determines which of those means for improving efficiency are technologically feasible. DOE considers technologies incorporated in commercially-available products or in working prototypes to be technologically feasible. 10 CFR part 430, subpart C, appendix A, sections 6(b)(3)(i) and 7(b)(1).

After DOE has determined that particular technology options are technologically feasible, it further evaluates each technology option in light of the following additional screening criteria: (1) practicability to manufacture, install, and service; (2) adverse impacts on product utility or availability; (3) adverse impacts on health or safety; and (4) unique-pathway proprietary technologies. 10 CFR part 430, subpart C, appendix A, sections 6(b)(3)(ii)-(v) and 7(b)(2)-(5). Section IV.A.3 of this document discusses the results of the screening analysis for oil, electric, and weatherized gas furnaces, particularly the design options DOE considered, those it screened out, and those that are the basis for the potential standards considered in this proposed determination.

2. Maximum Technologically Feasible Levels

As when DOE proposes to adopt a new or amended standard for a type or class of covered product, in this NOPD analysis, DOE must determine the maximum improvement in energy efficiency or maximum reduction in energy use that is technologically feasible for the product under consideration. (42 U.S.C. 6295(p)(1)) Accordingly, in the engineering analysis, DOE determined the maximum technologically feasible ("max-tech") improvements in energy efficiency for oil, electric, and weatherized gas furnaces, using the design parameters for the most efficient products available on the market or in working prototypes. The max-tech levels that DOE determined for this analysis are described in section IV.B.1.c of this proposed determination.

E. Cost-Effectiveness

In making a determination of whether amended energy conservation standards are needed, EPCA requires DOE to consider the cost-effectiveness of amended standards in the context of the savings in operating costs throughout the estimated average life of the covered product compared to any increase in the price of, or in the initial charges for, or maintenance expenses of, the covered product that are likely to result from a standard. (42 U.S.C. 6295(m)(1)(A); 42 U.S.C. 6295(n)(2)(C); 42 U.S.C. 6295(o)(2)(B)(i)(II))

In determining cost-effectiveness of potential amended standards for oil, electric, and weatherized gas furnaces, DOE conducted LCC and PBP analyses that estimate the costs and benefits to users from those potential standards. To further inform DOE's consideration of the cost-effectiveness of potential amended standards, DOE considered the NPV of total costs and benefits estimated as part of the NIA. The inputs for determining the NPV of the total costs and benefits experienced by consumers are: (1) total annual installed cost, (2) total annual operating costs (energy costs and repair and maintenance costs), and (3) a discount factor to calculate the present value of costs and savings. The results of this analysis are discussed in section V.C.2 of this NOPD.

F. Energy Savings

1. Determination of Savings

For each efficiency level ("EL") evaluated, DOE projected anticipated energy savings from application of the EL to the oil, electric, and weatherized gas furnace purchased in the 30-year period that begins in the assumed year of compliance with the potential standards (2030–2059). The savings are measured over the entire lifetime of the oil, electric, and weatherized gas furnaces purchased in the previous 30-year period. DOE quantified the energy savings attributable to each EL as the difference in energy consumption between each standards case and the no-new-standards case. The no-new-standards case represents a projection of energy consumption that reflects how the market for a product would likely evolve in the absence of amended energy conservation standards. DOE used its NIA spreadsheet model to estimate national energy savings ("NES") from potential amended or new standards for oil, electric, and weatherized gas furnaces. The NIA spreadsheet model (described in section IV.G of this document) calculates energy savings in terms of site energy, which is the energy directly consumed by products at the locations where they are used. For electricity, DOE reports NES in terms of primary energy savings, which is the savings in the energy that is used to generate and transmit the site electricity. DOE also calculates NES in terms of full-fuel-cycle ("FFC") energy savings. The FFC metric includes the energy consumed in extracting, processing, and transporting primary fuels (*i.e.*, coal, natural gas, petroleum fuels), and, thus, presents a more complete picture of the impacts of energy conservation standards.[13] DOE's approach is based on the calculation of an FFC multiplier for each of the energy types used by covered products or equipment. For more information on FFC energy savings, see section IV.G of this document.

2. Significance of Savings

In determining whether amended standards are needed, DOE must consider whether such standards will result in significant conservation of energy. (42 U.S.C.

[13] The FFC metric is discussed in DOE's statement of policy and notice of policy amendment. 76 FR 51281 (August 18, 2011), as amended at 77 FR 49701 (August 17, 2012).

6295(m)(1)(A)) The significance of energy savings offered by a new or amended energy conservation standard cannot be determined without knowledge of the specific circumstances surrounding a given rulemaking.[14] For example, some covered products and equipment have most of their energy consumption occur during periods of peak energy demand. The impacts of these products on the energy infrastructure can be more pronounced than products with relatively constant demand. Accordingly, DOE evaluates the significance of energy savings on a case-by-case basis. The significance of energy savings is further discussed in section V.B.1 of this NOPD.

G. Additional Considerations

Pursuant to EPCA, absent DOE publishing a notification of determination that energy conservation standards for the subject furnaces do not need to be amended, DOE must issue a NOPR that includes new proposed standards. (42 U.S.C. 6295(m)(1)(B)) The new proposed standards in any such NOPR must be based on the criteria established under 42 U.S.C. 6295(o) and follow the procedures established under 42 U.S.C. 6295(p). (42 U.S.C. 6295(m)(1)(B)) The criteria in 42 U.S.C. 6295(o) require that standards be designed to achieve the maximum improvement in energy efficiency, which the Secretary determines is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A)) In deciding whether a proposed standard is economically justified, DOE must determine whether the benefits of the standard exceed its burdens. (42 U.S.C. 6295(o)(2)(B)(i)) DOE must make this determination after receiving comments on the

[14]The numeric threshold for determining the significance of energy savings established in a final rule published in the *Federal Register* on February 14, 2020 (85 FR 8626, 8670-8672) was subsequently rescinded through a final rule published in the *Federal Register* on December 13, 2021 (86 FR 70892, 70901-70906).

proposed standard, and by considering, to the greatest extent practicable, the following seven statutory factors:

(1) The economic impact of the standard on manufacturers and consumers of the products subject to the standard;

(2) The savings in operating costs throughout the estimated average life of the covered products in the type (or class) compared to any increase in the price, initial charges for, or maintenance expenses of the covered products that are likely to result from the standard;

(3) The total projected amount of energy (or as applicable, water) savings likely to result directly from the standard;

(4) Any lessening of the utility or the performance of the covered products likely to result from the standard;

(5) The impact of any lessening of competition, as determined in writing by the Attorney General, that is likely to result from the standard;

(6) The need for national energy and water conservation; and

(7) Other factors the Secretary considers relevant.

(42 U.S.C. 6295(o)(2)(B)(i)(I)–(VII))

IV. Methodology and Discussion of Related Comments

This section addresses the analyses DOE has performed for this proposed determination with regard to oil, electric, and weatherized gas furnaces. Separate subsections address each component of DOE's analyses. DOE used several analytical tools to estimate the impact of potential energy conservation standards. The first tool is a spreadsheet that calculates the LCC savings and PBP of potential energy conservation standards. The NIA uses a second spreadsheet set that provides shipments projections and calculates NES and net present value of total consumer costs and savings expected to result from potential energy conservation standards. These spreadsheet tools are available on the website: *www.regulations.gov/docket /EERE-2021-BT-STD-0031*.

The Joint Commenters stressed the importance of implementing the recommendations of the recent National Academies of Sciences, Engineering, and Medicine ("NAS") report into all appliance rulemakings. Specifically, the Joint Commenters highlighted three recommendations from the report that they argued should be implemented in rulemakings impacting WGFs: (1) DOE should pay greater attention to the justification for the standards, adding that DOE should attempt to find significant failures of private markets or irrational behavior by consumers in the no-new-standards case to conclude that the standards are economically justified; (2) DOE should place greater emphasis on providing an argument for the plausibility and magnitude of any market failure related to the energy efficiency gap in DOE's analysis; and (3) DOE should give greater attention to a broader set of potential market failures on the supply side, further commenting that this would include not just how standards might reduce the number of competing firms but also how they might impact price discrimination, technological diffusion, and collusion. The Joint Commenters suggested DOE should address these recommendations before analyzing whether new efficiency standards are warranted. (Joint Commenters, No. 24 at pp. 2–3)

In response, DOE is addressing the recommendations of the NAS report in a separate rulemaking in parallel with other ongoing rulemakings, including this oil, electric, and weatherized gas furnace NOPD. As discussed in section V.C of this document, DOE is tentatively proposing that standards do not need to be amended, and the Department has made this tentative determination consistent with EPCA's requirements, including evaluation of economic justification of standards, and applicable Executive orders.

A. Market and Technology Assessment

DOE develops information in the market and technology assessment that provides an overall picture of the market for the products concerned, including the purpose of the products, the industry structure, manufacturers, market characteristics, and technologies used in the products. This activity includes both quantitative and qualitative assessments, based primarily on publicly-available information. The subjects addressed in the market and technology assessment for this proposed determination include: (1) a determination of the scope and product classes, (2) manufacturers and industry structure, (3) existing efficiency programs, (4) shipments information, (5) market and industry trends, and (6) technologies or design options that could improve the energy efficiency of consumer furnaces. The key findings of DOE's market assessment are summarized in the following sections.

1. Scope of Coverage

In this analysis, DOE relied on the definition of a furnace in 10 CFR 430.2, which defines a consumer "furnace" as a product which utilizes only single-phase electric current, or single-phase electric current or DC current in conjunction with natural gas, propane, or home heating oil, and which—

(A) Is designed to be the principal heating source for the living space of a residence;

(B) Is not contained within the same cabinet with a central air conditioner whose rated cooling capacity is above 65,000 Btu per hour;

(C) Is an electric central furnace, electric boiler, forced-air central furnace, gravity central furnace, or low-pressure steam or hot water boiler; and

(D) Has a heat input rate of less than 300,000 Btu per hour for electric boilers and low-pressure steam or hot water boilers and less than 225,000 Btu per hour for forced-air central furnaces, gravity central furnaces, and electric central furnaces.

Any product meeting the definition of a "furnace" is included in DOE's scope of coverage. In the analysis for this NOPD, DOE focused only on oil, electric, and weatherized gas furnaces. Non-weatherized gas furnaces and mobile home gas furnaces are considered in a separate rulemaking.[15]

a. Electric Furnaces

A basic electric furnace comprises an electric resistance heating element and blower assembly. (Additionally, there are products that include electrically-powered heat pumps, but these are separately covered products not addressed here.) The electric resistance heating elements of electric furnaces are highly efficient, and the efficiency of these units already approaches 100 percent. DOE is unaware of any technology options that can improve the efficiency of electric furnaces, so DOE has tentatively determined that more-stringent standards for electric furnaces would not be technologically feasible. Therefore, DOE anticipates that the energy savings potential from amended standards for EFs would be minimal. Consequently, DOE did not consider amended AFUE standards for electric furnaces in the current analysis.

b. Weatherized Oil-fired Furnaces

DOE is not aware of any WOFs on the market, and, therefore, DOE did not analyze amended standards for that product class. DOE has tentatively determined that

[15] *See* Docket No. EERE-2014-BT-STD-0031 which can be accessed at *www.regulations.gov*.

because there are no WOFs on the market, there would be no potential energy savings from amended standards.

c. Fuel-fired Heat Pumps

NEEA commented that DOE should consider fuel-fired heat pumps within the broader WGF product category by updating the definition of "central forced-air furnace" in the Code of Federal Regulations. (NEEA, No. 21 at p. 1) NEEA argued that fuel-fired heat pumps with a heat input rate of less than 225,000 Btu per hour meet all the criteria in the EPCA definition for a residential "furnace" with the exception that the terms, "electric central furnace, electric boiler, forced-air central furnace, gravity central furnace, or low-pressure steam or hot water boiler" do not currently cover fuel-fired heat pumps. NEEA commented that DOE has the authority to change those definitions and stated that redefining "forced-air central furnace" would allow fuel-fired heat pumps to be regulated under the energy conservation standards for oil, electric, and weatherized gas consumer furnaces. (*Id.* at p. 2) Specifically, NEEA suggested that DOE should change the definition of "forced air central furnace" to a gas or oil burning furnace designed to supply heat through a system of ducts with air as the heating medium. The combustion of gas or oil generates heat that is either transferred to the air within a casing by conduction through heat exchange surfaces or utilized to run a refrigeration cycle that transfers heat to the air and is circulated through the duct system by means of a fan or blower. NEEA commented that this definition covers the two main fuel-fired heat pump technologies: fuel-fired absorption heat pumps and engine-driven heat pumps. (*Id.*) NEEA also commented that weatherized fuel-fired heat pumps should be considered as another technology option within the WGF product category. NEEA requested that DOE consider all possible technology options for gas-fired furnaces to be on an even playing field. (*Id.* at p. 3)

NEEA argued that fuel-fired heat pumps are designed to replace existing furnaces and boilers without the need to update existing infrastructure and to provide flexibility for decarbonized fuels. However, NEEA stated that fuel-fired heat pumps are not direct replacements for heat pumps, since the primary fuel sources are different. (NEEA, No. 21 at p. 3) NEEA commented that a 2020 case study[16] of a pre-commercial residential fuel-fired heat pump prepared for DOE showed that the system can achieve over 140-percent AFUE, and field demonstrations show 36–43 percent fuel savings compared to a condensing furnace and 46–50 percent fuel savings compared to a non-condensing furnace. (*Id.*) NEEA further commented that the 2020 case study showed that there is significant potential in the residential market for a reasonably priced, gas-fired absorption heat pump product. (*Id.*)

NEEA encouraged DOE to consider the building energy simulation and comparison to field-derived results for fuel-fired heat pumps, published by Purdue University in 2021.[17] NEEA commented that this report demonstrates that fuel-fired heat pumps provided the lowest operating cost and highest carbon emissions savings compared to furnaces, boilers, electric heat pumps, and various water heating options. NEEA commented that fuel-fired heat pumps provide the same primary heating function

[16] The case study, titled "Pre-Commercial Scale-Up of a Gas-Fired Absorption Heat Pump" is available at *www.osti.gov/biblio/1726247* (Last accessed June 14, 2023).
[17] The Purdue report, titled "Pathways to Decarbonization of Residential Heating," is available at *docs.lib.purdue.edu/ihpbc/354/* (Last accessed June 14, 2023).

as conventional fuel-to-air furnaces with the potential for significant energy savings. (*Id.*)

In response to the comments by NEEA, DOE notes that fuel-fired heat pumps do not meet the current definition of "furnace," as they do not meet criteria (C) in the definition outlined in section IV.A of this document. As such, they were not considered in the scope of this analysis. Further, the current test procedure for consumer furnaces, as outlined in appendix N, does not include provisions for testing fuel-fired heat pumps. Therefore, DOE is not considering amending the consumer "furnace" definition to include these products at this time. However, DOE will continue to investigate fuel-fired heat pumps and may evaluate test procedure provisions for related to fuel-fired heat pumps in a future rulemaking.

2. Technology Options

DOE has identified the following components as technology options that have the potential to improve the AFUE rating of oil and weatherized gas furnaces:

- Condensing secondary heat exchanger
- Heat exchanger improvements
  - Increased heat exchanger surface area
  - Heat exchanger surface features

  - Heat exchanger baffles and turbulators
- Two-stage and modulating combustion
- Pulse combustion
- Premix burners
- Burner derating
- Insulation improvements
  - Increased jacket insulations
  - Advanced forms of insulation
- Off-cycle dampers
  - Electromechanical flue damper
  - Electromechanical burner inlet damper
- Direct venting
- Concentric venting

- Low-pressure, air-atomized oil burner

- High-static oil burner

- Delayed-action oil pump solendoid valve

These technology options are described in more detail of chapter 3 of the November 2022 Preliminary Analysis TSD.[18] As discussed in section IV.A.1.a of this document, DOE did not identify any technology options that would improve the AFUE of electric furnaces.

In response to the November 2022 Preliminary Analysis, AHRI, Lennox, and JCI commented that WGF accounts for a relatively small share of the overall furnace market (~7 percent). (AHRI, No. 23 at p. 5; Lennox, No. 26 at p. 1; JCI, No. 25 at p. 2)[19] AHRI and JCI stated that the maximum feasible AFUE for WGF is 81 percent. (AHRI, No. 23 at p. 5; JCI, No. 25 at p. 2)

JCI commented that further improvements in systems efficiency of WGFs would require the product class use of condensing technology. JCI commented that this change in the product offering is not practical and, based on observed market share, not justified due to system design and application constraints. (JCI, No. 25 at p. 2) JCI argued that

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[18] For this NOPD, DOE will not publish a Technical Support Document (TSD) because no amended standard is proposed. The methodology for the analyses conducted for the NOPD is largely the same as in the Preliminary Analysis, and, thus, DOE references the Preliminary Analysis TSD throughout this document.

[19] JCI's comments stated that WGFs are 7 percent of the WGF market, but DOE interprets this comment to mean that WGFs are 7 percent of the overall furnace market.

the practical application of condensing WGFs creates condensation in the heat exchangers within the unit, which is not readily drained. JCI added that the retained condensate will freeze in the off cycle, preventing further operation of the furnace. (*Id.)*

Lennox stated that applicable furnace technology has not significantly improved to overcome barriers to deploying higher-efficiency noncondensing and condensing technologies that would justify more-stringent AFUE standards for WGFs. (Lennox, No. 26 at p. 4)

In response to comments regarding condensing WGFs, DOE notes that it has identified WGFs available on the market that use condensing technology to achieve AFUE ratings up to 95 percent. Because these types of products are available on the market, DOE finds them to be technologically feasible and considers condensing secondary heat exchangers to be an appropriate technology option to analyze for these products. Additionally, in response to JCI, when evaluating the cost of implementing technologies such as condensing heat exchangers, DOE aims to include the additional costs of other components that may be associated with installing a unit with such technology, such as a condensate pump and drain hoses. The analyses of these costs are discussed in subsequent sections of this document (*e.g.*, the LCC and PBP analyses and the NIA (*see* sections IV.E and IV.G of this document, respectively)).

During the public meeting webinar, AGA requested clarification on how vent dampers were applied in the analysis for weatherized gas furnaces and noted that the test procedure would not give credit for a vent damper on an outdoor weatherized gas furnace. (AGA, Public Meeting Transcript, No. 28 at pp. 20-22) In response, dampers were not considered for WGFs and are not part of the design pathway for improving AFUE for those products. (*See* section IV.B.1.d of this document for the efficiency levels and associated technology options for WGFs.) DOE notes that Tables ES.3.2, ES.3.3, ES.3.19, and 7.4.1 in the November 2022 Preliminary Analysis TSD indicated that vent dampers were included for NWOFs and MHOFs; however, this was a typographical error. DOE clarifies that vent dampers also were not part of the design pathway considered for improving AFUE of NWOFs and MHOFs for the preliminary analysis (nor are they for this NOPD analysis).

In chapter 3 of the November 2022 Preliminary Analysis TSD, DOE also considered three technology options that could potentially reduce the standby mode and off mode energy consumption of NWOFs, MHOFs, and EFs. However, for the reasons explained in section III.A.3 of this document, DOE has tentatively determined that it cannot establish standby mode and off mode standards that meet the criteria of EPCA at this time, so such technologies and standards are not considered further.

3. Screening Analysis

DOE uses the following five screening criteria to determine which technology options are suitable for further consideration in an energy conservation standards rulemaking:

(1) Technological feasibility. Technologies that are not incorporated in commercial products or in commercially-viable, existing prototypes will not be considered further.

(2) Practicability to manufacture, install, and service. If it is determined that mass production of a technology in commercial products and reliable installation and servicing of the technology could not be achieved on the scale necessary to serve the relevant market at the time of the projected compliance date of the standard, then that technology will not be considered further.

(3) Impacts on product utility. If a technology is determined to have a significant adverse impact on the utility of the product to subgroups of consumers, or result in the unavailability of any covered product type with performance characteristics (including reliability), features, sizes, capacities, and volumes that are substantially the same as products generally available in the United States at the time, it will not be considered further.

(4) Safety of technologies. If it is determined that a technology would have significant adverse impacts on health or safety, it will not be considered further.

(5) Unique-pathway proprietary technologies. If a technology has proprietary protection and represents a unique pathway to achieving a given efficiency level, it will not be considered further, due to the potential for monopolistic concerns.

10 CFR part 430, subpart C, appendix A, sections 6(b)(3) and 7(b).

In summary, if DOE determines that a technology, or a combination of technologies, fails to meet one or more of the listed five criteria, it will be excluded from further consideration in the engineering analysis.

a. Screened-Out Technologies

DOE eliminated the technologies listed in Table IV.1 from further consideration as options to improve the AFUE (as measured by the DOE test procedure) of NWOFs, MHOFs, and WGFs. The reasons for exclusion associated with each technology are marked with an *X*. Additional details about the reasons for exclusion are discussed in this section.

Table IV.1 Screened-Out Technologies

Excluded Technology Options	**Applicable Product Class(es)**	**Reasons for Exclusion**				
		Technological Feasibility	**Practicability to Manufacture, Install, and Service**	**Adverse Impacts on Product Utility**	**Adverse Impacts on Health or Safety**	**Unique-Pathway Proprietary Technology**
Pulse combustion	WGF				X	
Burner derating	WGF, NWOF, MHOF			X		
Low-pressure, air-atomized oil burner	NWOF, MHOF	X				

Pulse Combustion

Pulse combustion burners operate on self-sustaining resonating pressure waves that alternately rarefy the combustion chamber (drawing a fresh fuel–air mixture into the chamber) and pressurize it (causing ignition by compression heating of the mixture to its flash point). Pulse combustion systems are capable of direct venting without the assistance of mechanical draft. Because the pulse combustion process is very efficient, pulse combustion is generally used in condensing appliances.

In contrast to natural draft and induced draft furnaces, pulse combustion furnaces generate positive pressure in the heat exchanger. Although these products are generally safe, this could create a potential safety problem if the heat exchanger breeches, because combustion products can contaminate the circulation air stream.

Pulse combustion gas furnaces were available in the United States for more than two decades. However, they were withdrawn from the market within the past 20 years because manufacturers found that competing technologies, such as condensing secondary heat exchangers, cost significantly less to manufacture and operate. In light of the ability of furnace manufacturers to cost-effectively achieve high efficiencies without the use of pulse combustion, the technology's risks do not outweigh its benefits for consumer furnace applications. Accordingly, DOE did not further analyze this technology option as part of this NOPD.

Burner Derating

Decreasing the burner size to increase the ratio of heat transfer area to fuel input, or burner derating, can increase the AFUE rating of furnaces. However, because heat output rate is directly related to burner size, derating also reduces the amount of heated air available to the consumer. This reduction in heat output adversely affects the utility to consumers. Therefore, DOE did not consider this technology option.

Low-Pressure, Air-Atomized Oil Burner

To overcome the low input limitations of conventional oil burners, Brookhaven National Laboratory developed a low-pressure, air-atomized oil burner that can operate at firing rates as low as 0.25 gallons of oil per hour (10 kW). In addition, it can operate with low levels of excess combustion air (less than 10 percent) for lean-burning, ultra-clean combustion. A lower level of excess air generally improves AFUE rating. This burner design is also capable of firing fuel at a high or low input rate, which is manually actuated by a switch, allowing the burner to closely match the smaller heating loads of well-insulated modern homes.

While tests performed at the Brookhaven National Laboratory seem to have successfully demonstrated enhanced oil boiler AFUE performance per the DOE test procedure for furnaces and boilers, the prototype was never tested on a furnace. Therefore, the technological feasibility of the burner prototype for incorporation into a residential oil-fired furnace remains unknown, so DOE does not consider low-pressure, air-atomized oil burners to be a viable technology for efficiency improvement at this time.

b. Remaining Technologies

After reviewing each technology, DOE did not screen out the following technology options and considers them as design options in the engineering analysis:

(1) Condensing secondary heat exchanger

(2) Heat exchanger improvements

(a) Increased heat exchanger surface area

(b) Heat exchanger surface area

(c) Heat exchanger baffles and turbulators

(3) Two-stage and modulating combustion

(4) Premix burners

(5) Insulation improvements

(a) Increased jacket insulations

(b) Advanced forms of insulation

(6) Off-cycle dampers

(a) Electromechanical flue damper

(b) Electromechanical burner inlet damper

(7) Direct venting

(8) Concentric venting

(9) High-static oil burner

(10) Delayed-action oil pump solenoid valve

DOE determined that these technology options are technologically feasible because they are being used or have previously been used in commercially-available products or working prototypes. DOE also finds that all of the remaining technology options meet the other screening criteria (*i.e.*, practicable to manufacture/install/service, do not result in adverse impacts on consumer utility, product availability, health, or safety, and do not utilize unique-pathway proprietary technologies).

In response to the November 2022 Preliminary Analysis, Lennox commented that DOE has adequately captured most of the technology options and screened appropriately for gas and oil products. (Lennox, No. 26 at p. 4) However, Lennox stated that the alternatives for insulation improvement generally have not been demonstrated in furnace applications and may not be suitable for use in high-temperature applications near combustion surfaces. The commenter stated that insulation used in furnace applications must meet temperature, flame spread, and smoke requirements per the applicable safety standards, and that toxicity and off-gassing must also be considered. Lennox argued that just because an insulation material has better insulating characteristics does not mean that it is suitable for high-temperature furnace applications. (Lennox, No. 26 at p. 6)

In response, DOE notes that insulation improvements may be achieved with thicker layers of existing insulation materials as opposed to necessarily requiring new insulating materials. Therefore, DOE is not screening out insulation improvements in this NOPD. Additionally, as outlined in section IV.B.1 of this document, insulation improvements are not required to meet any of the efficiency levels analyzed in this NOPD.

4. Product Classes

In general, when evaluating and establishing energy conservation standards for a type (or class) of covered product, DOE divides the covered product into classes by: (1) the type of energy used; (2) the capacity of the product, or (3) any other performance-related feature which other products within such type (or class) do not have that affects energy efficiency and justifies different standard levels, considering factors such as consumer utility and any other factors the Secretary deems appropriate. (42 U.S.C. 6295(q))

In this case, DOE divides furnaces into seven product classes based on fuel type (gas, oil, or electric), whether the furnace is weatherized or not, and whether the furnace is designed for use only in mobile homes or not. The current product classes for furnaces are (1) non-weatherized gas furnaces, (2) mobile home gas furnaces, (3) non-weatherized oil-fired furnaces, (4) mobile home oil-fired furnaces, (5) weatherized gas furnaces, (6) weatherized oil-fired furnaces, and (7) electric furnaces. 10 CFR 430.32(e)(1)(ii). As noted previously, non-weatherized gas furnaces and mobile home gas furnaces are being addressed in a separate rulemaking process.[20] Therefore, the product classes that DOE

[20] See Docket No. EERE-2014-BT-STD-0031.

considered for this NOPD are NWOFs, MHOFs, WGFs, WOFs, and EFs. However, for the reasons discussed in sections IV.A.1.a and IV.A.1.b of this document, potential amended energy conservation standards were not analyzed for EFs or WOFs.

In summary, DOE assessed potential amended energy conservation standards in terms of AFUE for the NWOF, MHOF, and WGF product classes in this NOPD. Again, for the reasons discussed in section III.A.3 of this document, DOE did not analyze new or amended standby mode/off mode power standards for any product classes this time.

B. Engineering Analysis

The purpose of the engineering analysis is to establish the relationship between the efficiency and cost of NWOFs, MHOFs, and WGFs. There are two elements to consider in the engineering analysis: (1) the selection of efficiency levels to analyze (*i.e.*, the "efficiency analysis") and (2) the determination of product cost at each efficiency level (*i.e.*, the "cost analysis"). In determining the performance of higher-efficiency products, DOE considers technologies and design option combinations not eliminated by the screening analysis. For each product class, DOE estimates the baseline cost, as well as the incremental cost for the product at efficiency levels above the baseline efficiency. The output of the engineering analysis is a set of cost-efficiency "curves" that are used in downstream analyses (*i.e.*, the LCC and PBP analyses and the NIA).

1. Efficiency Analysis

DOE typically uses one of two approaches to develop energy efficiency levels for the engineering analysis: (1) relying on observed efficiency levels in the market (*i.e.*, the efficiency-level approach), or (2) determining the incremental efficiency improvements associated with incorporating specific design options to a baseline model (*i.e.*, the design-option approach). Using the efficiency-level approach, the efficiency levels established for the analysis are determined based on the market distribution of existing products (in other words, based on the range of efficiencies and efficiency level "clusters" that already exist on the market). Using the design option approach, the efficiency levels established for the analysis are determined through detailed engineering calculations and/or computer simulations of the efficiency improvements from implementing specific design options that have been identified in the technology assessment. DOE may also rely on a combination of these two approaches. For example, the efficiency-level approach (based on actual products on the market) may be extended using the design option approach to interpolate to define "gap fill" levels (*i.e.*, to bridge large gaps between other identified efficiency levels) and/or to extrapolate to the "max-tech" level (particularly in cases where the "max-tech" level exceeds the maximum efficiency level currently available on the market).

For the current analysis, DOE generally employed an efficiency-level approach.

a. Baseline Efficiency

For each product class, DOE generally selects a baseline model as a reference point for each class, and measures anticipated changes to the product resulting from potential energy conservation standards against the baseline model. The baseline model in each product class represents the characteristics of a product typical of that class (*e.g.*, capacity, physical size). Generally, a baseline model is one that just meets current energy conservation standards, or, if no standards are in place, the baseline is typically the most common or least-efficient unit on the market.

A basic consumer gas furnace comprises a hot surface or direct spark ignition system, tubular in-shot burners, noncondensing heat exchanger, blower assembly (including motor and forward-swept fan blade), mechanical draft combustion fan assembly, and automatic controls. A basic consumer oil-fired furnace comprises an interrupted spark ignition system, power burner, noncondensing heat exchanger, and blower assembly. Details and descriptions of each of these components can be found in chapter 3 of the November 2022 Preliminary Analysis TSD.

The identification of baseline units requires establishing the baseline efficiency level. In cases where there is an existing standard, DOE typically defines baseline units as units with efficiencies equal to the current Federal energy conservation standards. However, for MHOFs, DOE did not identify any currently available units at the minimum standard level (75-percent AFUE), and, therefore, DOE analyzed 80-percent AFUE as the baseline level for MHOFs, as it was the lowest efficiency available on the market. The baseline AFUE levels analyzed for the subject NWOFs, MHOFs, and WGFs, as measured by AFUE, along with the typical characteristics of a baseline unit, are shown in Table IV.2.

Table IV.2 Baseline AFUE Levels Analyzed

Product Class	Baseline AFUE Level (%)	Typical Characteristics
NWOF	83	- Single-stage burner - Electronic ignition - Aluminized-steel heat exchanger - Indoor blower fan including PSC motor* and forward-curved blower impeller blade
MHOF	80	- Single-stage burner - Electronic ignition - Aluminized-steel heat exchanger - Indoor blower fan including PSC motor* and forward-curved blower impeller blade - Direct venting system - Built-in evaporator coil cabinet
WGF	81	- Draft inducer - Single-stage burner - Electronic ignition - Aluminized-steel tubular heat exchanger - Indoor blower fan including BPM* motor and forward-curved blower impeller blade

* Residential furnace fans incorporated into NWOFs, MHOFs, and WGFs manufactured on and after July 3, 2019 must meet fan energy rating ("FER") standards specified in 10 CFR 430.32(y). The blower fan motor (among other factors) can affect FER. Brushless permanent magnet ("BPM") motors have become the predominant motor type at the baseline AFUE levels for WGFs, and permanent split capacitor ("PSC") motors, which are less efficient than BPM motors, are common for NWOFs and MHOFs.

Typically, baseline units are representative of the minimum technology and lowest-cost product that manufacturers can produce. Accordingly, in the teardown analysis, DOE examined a variety of baseline units that incorporate the various baseline design options for furnace components.

b. Intermediate Efficiency Levels

DOE also analyzed intermediate efficiency levels for NWOFs and MHOFs. However, for WGFs, DOE has not found any models on the market between the baseline (81-percent AFUE) and max-tech level (95-percent AFUE) and has, therefore, not analyzed any intermediate efficiency levels for this product class. The intermediate efficiency levels analyzed for NWOFs are 85-percent and 87-percent AFUE, and the intermediate efficiency levels analyzed for MHOFs are 83-percent and 85-percent AFUE. To improve efficiency from the baseline to these intermediate efficiency levels, manufacturers generally increase the surface area of the heat exchanger, which increases the heat transfer area and, thus, allows manufacturers to achieve higher efficiencies. The intermediate efficiency levels analyzed are representative of common efficiency levels available on the market. DOE reviewed its own Compliance Certification Database ("CCD"), as well as AHRI's product certification directories[21], California Energy Commission's ("CEC's") database[22], manufacturer catalogs, and other publicly-available literature to inform its selection of intermediate efficiency levels.

In response to the November 2022 Preliminary Analysis, NYSERDA encouraged DOE to consider an additional efficiency level (EL) between 87-percent and 96-percent AFUE for oil-fired furnaces. NYSERDA stated it anticipates that an AFUE above 90 percent may maximize savings for consumers. NYSERDA added that based on its review of the preliminary TSD material, the DOE Compliance Certification Management System, and AHRI's database, NYSERDA has seen availability of oil furnaces above DOE's proposed EL 2. (NYSERDA, No. 19 at p. 2)

The Joint Advocates similarly encouraged DOE to evaluate an intermediate condensing EL for NWOFs. The Joint Advocates commented that they strongly support

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[21] AHRI's Directory of Certified Product Performance (Available at: *www.ahridirectory.org/Search/SearchHome*) (Last accessed Sept. 1, 2023).
[22] California Energy Commission's MAEDbs (Available at: *cacertappliances.energy.ca.gov/Pages/ApplianceSearch.aspx*) (Last accessed Sept. 1, 2023)

DOE's decision to include a max-tech EL at 96-percent AFUE and that DOE should also consider an EL between EL 2 (*i.e.*, 87-percent AFUE) and EL 3 (*i.e.*, 96-percent AFUE). The Joint Advocates further commented that the CCD shows condensing models suggesting that an intermediate EL with condensing technology is feasible for condensing NWOFs. (Joint Advocates, No. 22 at pp. 2-3)

As discussed previously, DOE's choice of intermediate efficiency levels was informed by publicly-available databases and manufacturer literature, and the chosen efficiency levels were intended to be representative of common efficiency levels available on the market. In contrast, as discussed in section III.D.2 of this document, DOE is statutorily obligated to analyze the efficiency level that corresponds to the maximum improvement in energy efficiency or maximum reduction in energy use that is technologically feasible for each product class. (42 U.S.C. 6295(p)(1)) However, because there are very few condensing-level NWOFs on the market, efficiency levels between 87-percent and 96-percent AFUE would not be representative of typical efficiency levels. Therefore, DOE is not analyzing an EL between 87-percent and 96-percent AFUE for NWOFs in this NOPD.

c. Maximum Technology ("Max-Tech") Efficiency Levels

As part of DOE's analysis, the maximum available efficiency level is the highest efficiency unit currently available on the market. DOE also defines a "max-tech" efficiency level to represent the maximum possible efficiency for a given product.

DOE conducted an analysis of the market and a technology assessment and researched current product offerings to determine the max-tech efficiency levels. The max-tech level identified in each product class corresponds to the highest-AFUE furnace available on the market, which DOE tentatively concludes corresponds to the maximum technologically feasible levels at this time. For NWOFs, DOE identified a design that achieves a max-tech efficiency level of 96-percent AFUE. For MHOFs, the maximum efficiency level that DOE identified was 87-percent AFUE. For WGFs, DOE identified a max-tech efficiency level design that achieves 95-percent AFUE. For WGFs and NWOFs, the max-tech efficiency level is currently achieved by use of a condensing secondary heat exchanger. A constant-airflow BPM indoor blower motor was also implemented as the motor design option for the max-tech efficiency level for NWOFs because the only NWOF model on the market available at this level includes a constant-airflow BPM motor, and it is unclear if this level is achievable without a constant-airflow fan. For MHOFs, the max-tech efficiency level is currently achieved by use of a heat exchanger with increased surface area.

Lennox stated that the DOE weatherized gas furnace standard of 81-percent AFUE is at the maximum practical level that is economically justified and provides reliable performance. (Lennox, No. 26 at p. 6) Lennox stated that, as the AFUE of weatherized gas furnace products is increased, heat exchanger and flue temperatures are reduced, which increases the risk of condensing operation and corrosion to the heat exchanger. (*Id.*) Lennox stated that while condensing weatherized gas furnaces are feasible, they require secondary heat exchangers that increase static pressure in the airstream and pressure drop within the heat exchanger. Further, Lennox stated that the additional resistance must be overcome with increased electrical power at all operating conditions, including cooling and ventilation mode. (*Id.* at pp. 6–7) Lennox stated that the measures to prevent freezing of condensate in weatherized gas furnaces and condensate disposal add cost and consume additional energy. (*Id.* at p. 7) Lennox commented that these methods include maintaining the temperature of the condensate system above freezing by either conditioning the condensate system using electric heat tape or routing the condensate disposal system through conditioned space. The commenter stated that the use of heat tape consumes additional energy. Lennox stated that routing the condensate disposal system through conditioned space is not technically feasible or economically viable for a weatherized product that is contained outdoors. (*Id.*) Lennox further commented that another method to prevent freezing in weatherized gas furnaces is to install a pit or trench condensate drainage system that extends below the frostline and also neutralizes the acidic condensate created during combustion. Lennox stated that the frost line in the United States varies greatly by region from 5″ in Georgia to 80″ in Minnesota. Lennox stated that the method of installing a pit or trench condensate drainage system that extends below the frostline and neutralizes the acidic condensate created during condensing combustion may work in some mild climates at a reasonable cost but would be expensive to install and maintain in colder climates. (*Id.*)

In response, the Department notes the fact that condensing weatherized gas furnaces currently exist on the market demonstrates that they are technologically feasible. DOE accounts for costs that may be associated with the installation of condensing systems, including additional costs of heat tape and/or a condensate pump suitable to meet the need of an unconditioned space, which is discussed further in section IV.E of this document. The financial feasibility of higher efficiency levels is discussed further in section V of this document.

JCI commented it is unaware of any condensing MHOFs commercially available today. (JCI, No. 25 at p. 2) AHRI also commented that it is unaware of any commercially-available condensing MHOFs. (AHRI, No. 23 at p. 5) AHRI commented that the feasibility of moving to a condensing heat exchanger for MHOFs is low. AHRI added that there are challenges with maintaining airflow options and footprint size to allow for an easy replacement. (*Id.*)

In response, DOE agrees that there are currently no condensing MHOFs on the market, and the Department has not considered an efficiency level for MHOFs that requires a condensing heat exchanger as there are no data to indicate that it would be feasible for use in MHOFs.

d. Summary of Efficiency Levels Analyzed

DOE presents AFUE efficiency levels analyzed along with the technologies that are expected to be used to increase energy efficiency above the baseline efficiency level for NWOFs, MHOFs, and WGFs in Table IV.3, Table IV.4 and Table IV.5, respectively.

Table IV.3 AFUE Efficiency Levels and Technologies Used at Each Efficiency Level Above Baseline for NWOFs

Efficiency Level	AFUE (%)	Description of Technologies Typically Incorporated
0 – Baseline	83	See Table IV.2 for baseline features
1	85	Baseline EL + Increased heat exchanger area
2	87	EL 1 + Increased heat exchanger area
3 – Max-tech	96	EL 2 + Addition of condensing secondary heat exchanger (and associated components, sensors, *etc*.) + Constant-airflow BPM motor

Table IV.4 AFUE Efficiency Levels and Technologies Used at Each Efficiency Level Above Baseline for MHOFs

Efficiency Level	AFUE (%)	Description of Technologies Typically Incorporated
0 – Baseline	80	See Table IV.2 for baseline features
1	83	Baseline EL + Increased heat exchanger area
2	85	EL 1 + Increased heat exchanger area
3 – Max-tech	87	EL 2 + Increased heat exchanger area

Table IV.5 AFUE Efficiency Levels and Technologies Used at Each Efficiency Level Above Baseline for WGFs

EL	AFUE (%)	Description of Technologies Typically Incorporated
0 – Baseline	81	See Table IV.2 for baseline features
1 – Max-tech	95	Baseline EL + Addition of condensing secondary heat exchanger (and associated components, sensors, *etc*.)

2. Cost Analysis

The cost analysis portion of the Engineering Analysis is conducted using one or a combination of cost approaches. The selection of cost approach depends on a suite of factors, including the availability and reliability of public information, characteristics of the regulated product, and the availability and timeliness of purchasing the product on the market. The cost approaches are summarized as follows:

- *Physical teardowns: Under this approach, DOE physically dismantles a commercially-available product, component-by-component, to develop a detailed bill of materials for the product.*

- *Catalog teardowns: In lieu of physically deconstructing a product, DOE identifies each component using parts diagrams (available from manufacturer websites or appliance repair websites, for example) to develop the bill of materials for the product.*

- *Price surveys: If neither a physical nor catalog teardown is feasible (e.g., for tightly integrated products such as fluorescent lamps, which are infeasible to disassemble and for which parts diagrams are unavailable), cost-prohibitive, or otherwise impractical (e.g., large commercial boilers), DOE conducts price surveys using publicly-available pricing data published on major online retailer websites and/or by soliciting prices from distributors and other commercial channels.*

In the present case, DOE conducted the analysis using a combination of physical and catalog teardowns. DOE estimated the manufacturer production cost ("MPC") associated with each efficiency level to characterize the cost-efficiency relationship of improving consumer furnace performance, in terms of AFUE.

The units selected for the teardown analysis spanned a range of manufacturers and efficiencies for commercially-available products that are the subject of this rulemaking. Products were selected that have characteristics of typical products on the market at a representative input capacity. WGFs selected for physical teardown generally had input capacities of approximately 80 thousand British thermal units per hour ("kBtu/h"), while oil units selected for physical teardown generally had input capacities of approximately 105 kBtu/h. These capacities were determined to be a representative input capacity for WGFs and for NWOFs and MHOFs, respectively, based on information gathered as part of the market and technology assessment (*see* section IV.A of this document), as well as discussions with manufacturers. Where needed, catalog teardowns were also conducted to supplement the physical teardowns. DOE estimated the manufacturing cost for each furnace selected for teardown by disassembling the furnace and developing a bill of materials ("BOM"). The resulting BOM provides the basis for the MPC estimates for products at various efficiency levels spanning the full range of efficiencies from the baseline to max-tech.

To account for manufacturers' non-production costs and profit margin, DOE applies a non-production cost multiplier (the manufacturer markup) to the MPC. The resulting manufacturer selling price ("MSP") is the price at which the manufacturer distributes a unit into commerce. DOE developed an average manufacturer markup by examining the annual Securities and Exchange Commission ("SEC") 10-K reports filed by publicly-traded manufacturers primarily engaged in heating, ventilation, and air conditioning ("HVAC") manufacturing whose combined product range includes oil and weatherized gas furnaces. The manufacturer markup estimates are consistent with the manufacturer markups developed for a final rule for furnace fan energy conservation standards published in the *Federal Register* on July 3, 2014. 79 FR 38130. Specifically, DOE estimates the industry average manufacturer markup to be 1.35 for NWOFs, 1.29 for MHOFs, and 1.27 for WGFs.

a. Teardown Analysis

For the teardown analysis, DOE used a total of 31 teardowns of consumer furnaces as the basis for calculating industry MPCs. The units DOE selected for teardown are manufactured in considerable volume, are commonly available, and have features that DOE believes are representative of the most common characteristics (*i.e.*, input capacity, configuration, and heat exchanger type) of each product class. As discussed previously, most physical teardown units had input capacities of approximately 80 kBtu/h for WGFs or 105 kBtu/h for NWOFs and MHOFs, which DOE considers to be representative of those furnace product classes. To the extent possible, all major efficiency levels and technologies were captured in the selection of models for the teardown analysis. WGF and NWOF teardowns were considered separately.

Due to the similarity observed in NWOF and MHOF designs available in the market, DOE tentatively concluded that the costs associated with increasing the energy efficiency of MHOFs are equivalent to the costs for NWOFs. A MHOF teardown was used to examine key differences between NWOFs and MHOFs and confirmed that the MPCs of MHOFs could be estimated based on the NWOF teardowns. Therefore, DOE based MPC estimates for MHOFs at each efficiency level analyzed largely on teardowns of NWOFs at that efficiency level.

Whenever possible, DOE examined multiple models from a given manufacturer that capture different design options and used them as direct points of comparison. The teardown selections also minimized the incorporation of non-efficiency-related premium features, which otherwise could inflate the incremental manufacturing cost of achieving higher efficiency levels.

DOE examined products with a variety of indoor blower motor technologies and combustion systems (*i.e.*, single-stage, two-stage, or modulating). DOE also examined products with PSC, constant-torque BPM, and constant-airflow BPM indoor blower motors. As further discussed in section IV.B.2.b of this document, cost adders were developed for these technologies and applied in the downstream analyses to estimate the manufacturing cost of going from one technology to another with higher efficiency (*e.g.*, using a constant-airflow BPM instead of a constant-torque BPM, or two-stage combustion instead of single-stage combustion).

b. Cost Estimation Method

DOE assigned costs of labor, materials, and overhead to each part, whether purchased or produced in-house. DOE then aggregated single-part costs into major assemblies (*e.g.*, packaging, cabinet assembly, heat exchanger, burner system/gas train, exhaust subassembly, fan system, controls) and summarized these costs in a spreadsheet BOM. DOE repeated this same process for every physical and catalog teardown in the engineering analysis.

Analytical inputs related to manufacturer practices and cost structure play an important role in estimating the final cost of a product. DOE used inputs regarding the manufacturing process parameters (*e.g.*, equipment use, labor rates, tooling depreciation, and cost of purchased raw materials) to determine the value for each furnace component. DOE collected information on labor rates, tooling costs, raw material prices, and other factors to use as inputs into the cost estimates. DOE determined values for these parameters using internal expertise and confidential information available to its contractors, some of which was obtained via confidential interviews with manufacturers. For purchased parts, DOE estimates the purchase price based on volume-variable price quotations and detailed discussions with manufacturers and component suppliers. DOE then summed the values of the furnace components into assembly costs and, finally, the total MPC for the entire furnace.

The MPC includes material, labor, and depreciation costs, as well as the overhead costs associated with the manufacturing facility. Material costs include both raw materials and purchased-part costs. Labor costs include fabrication, assembly, and indirect and overhead (burdened) labor rates. Depreciation costs include production equipment depreciation, tooling depreciation, and building depreciation. The overhead costs associated with the manufacturing facility include indirect process costs, utilities, equipment and building maintenance, and reworking defective parts/units.

DOE determined the costs of raw materials based on manufacturer interviews, quotes from suppliers, and secondary research. Past results are updated periodically and/

or inflated to present-day prices using indices from resources such as MEPS Intl.,[23] PolymerUpdate,[24] the U.S. Geologic Survey ("USGS"),[25] and the Bureau of Labor Statistics ("BLS").[26] Metal raw material prices, such as stainless steel and other sheet metals, are estimated on the basis of five-year averages to smooth out spikes in demand. Other "raw" materials such as plastic resins, insulation materials, *etc.* are estimated on a current-market basis. For non-metal raw material prices, DOE used prices based on current market data (as of December 2022), rather than a 5-year average, because non-metal raw materials have not experienced the same level of price volatility in recent years as metal raw materials.

DOE characterized parts based on whether manufacturers fabricated them in-house or purchased them from outside suppliers. For fabricated parts, DOE estimated the price of intermediate materials (*e.g.*, tube, sheet metal) and the cost of forming them into finished parts. For purchased parts, DOE estimated the purchase prices paid to the original equipment manufacturers ("OEMs") of these parts, based on discussions with manufacturers during confidential interviews. Whenever possible, DOE obtained price quotes directly from the component suppliers used by furnace manufacturers whose products were examined in the engineering analysis. DOE determined that the components in Table IV.6 are generally purchased from outside suppliers.

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23 For more information on MEPS Intl, please visit: *www.meps.co.uk/* (Last accessed Sept. 5, 2023).
24 For more information on PolymerUpdate, please visit: *www.polymerupdate.com* (Last accessed Sept. 5, 2023).
25 For more information on the USGS metal price statistics, please visit *www.usgs.gov/centers/nmic/commodity-statistics-and-information* (Last accessed Sept. 5, 2023).
26 For more information on the BLS producer price indices, please visit: *www.bls.gov/ppi/* (Last accessed Sept. 5, 2023).

Table IV.6 Purchased Furnace Components

Assembly	Purchased Sub-Assemblies
Burner/Exhaust	Gas valve
	Spark igniter
	Draft inducer assembly
Blower	Indoor blower fan blade
	Indoor blower fan motor
Controls	Control boards
	Capacitors, transformers, contactors, switches, *etc.*

Certain factory parameters, such as fabrication rates, labor rates, and wages, also affect the cost of each unit produced. DOE factory parameter assumptions were based on internal expertise and manufacturer feedback. Table IV.7 lists the factory parameter assumptions used in the analysis. For the engineering analysis, these factory parameters, including production volume, are the same at every efficiency level. The production volume used at each efficiency level corresponds with the average production volume, per manufacturer, if 100 percent of all units manufactured were at that efficiency level. This production volume was estimated based on historical shipments. These assumptions are generalized to represent typical production and are not intended to model a specific factory.

Table IV.7 Factory Parameter Assumptions

Parameter	Oil Furnace Estimate	WGF Estimate
Actual Annual Production Volume (units/year)	5,000 units / year	500,000 units / year
Purchased Parts Volume	5,000 units / year	100,000 units / year
Workdays Per Year (days)	250	250
Assembly Shifts Per Day (shifts)	1	2
Fabrication Shifts Per Day (shifts)	2	2
Fabrication Labor Wages ($/h)	16	16

Assembly Labor Wages ($/h)	16	16
Length of Shift (hrs)	8	8
Average Equipment Installation Cost (% of purchase price)	10%	10%
Fringe Benefits Ratio	50%	50%
Indirect to Direct Labor Ratio	33%	33%
Average Scrap Recovery Value	30%	30%
Worker Downtime	10%	10%
Burdened Assembly Labor Wage ($/h)	24	24
Burdened Fabrication Labor Wage ($/h)	24	24
Supervisor Span (workers/supervisor)	25/1	25/1
Supervisor Wage Premium (over fabrication and assembly wage)	30%	30%

Indoor Blower Motor Costs

As discussed in section IV.B.1.a of this document, the baseline design for WGFs includes a BPM motor. DOE research suggests that the predominant BPM indoor blower motors sold on the market today are either a constant-torque ("CT-BPM") or a constant-airflow ("CA-BPM") design. Both types of motors rely on electronic variable-speed motor systems that are typically mounted in an external chassis to the back of the motor. CA-BPM motors utilize feedback control to adjust torque based on ESP in order to maintain a desired airflow. This differentiates them from CT-BPM motors, which will maintain torque and likely decrease airflow output in environments with high ESPs. CT-BPMs are capable of achieving airflows similar to CA-BPMs but are generally less expensive. Therefore, DOE considered the baseline design to include a CT-BPM motor for the WGF product class and determined the incremental cost of a CA-BPM motor.

DOE's review of the market showed that PSC motors are still being used in some NWOFs and MHOFs, so the final MPC results are presented based on a PSC motor at the baseline through 87-percent AFUE. To account for the variety of motor technologies available on the market, DOE determined the incremental cost associated with use of various types of more-efficient BPM fan motors as compared to baseline PSC motors for NWOFs and MHOFs. Additionally, for NWOFs, a constant-airflow BPM indoor blower motor was implemented as the motor design option for the max-tech efficiency level because the only NWOF model on the market available at this level includes a constant-airflow BPM motor, and it is unclear if this level is achievable without a constant-airflow fan. For the NWOF efficiency levels below max-tech and for all MHOF efficiency levels, DOE calculated the additional cost to switch from a PSC blower motor to either a constant-torque or a constant-airflow BPM motor. As discussed in Chapter 8 of the November 2022 Preliminary Analysis TSD, these costs are applied in the LCC and PBP analyses to determine the MPC of a furnace with each motor technology in order to better represent typical costs to consumers for NWOFs and MHOFs. Constant-airflow BPM blower motors are sometimes used as a utility-enhancing feature on units below the max-tech efficiency level. The adders are outlined in Table IV.8.

Table IV.8 Cost Adders for BPM Blower Motors

Product Class	Input Capacity (kBtu/h)	Incremental Cost Increase for BPM-CT (2022$)	Incremental Cost Increase for BPM-CA (2022$)
NWOF, MHOF	105	$30.65	$80.48
WGF	80	$37.94	$59.92

Multistage Furnaces

The market for WGFs contains a significant number of two-stage furnaces that are rated at the same efficiency as single-stage furnaces. DOE believes consumers sometimes choose to purchase two-stage products for the additional thermal comfort offered by furnaces with multiple stages of heating output. DOE determined that oil units with multi-staging were rare and, thus, not representative of the market, so adders were not developed for the NWOF and MHOF product classes. Where applicable, the additional cost to change to a two-stage furnace includes the added cost of a two-stage gas valve, a two-speed inducer assembly, an additional pressure switch, and additional controls and wiring. The additional cost to change to a modulating furnace includes the added cost of a modulating gas valve, an inducer assembly, an upgraded pressure switch, and additional controls and wiring. The incremental costs to implement multi-staging in WGFs are outlined in Table IV.9.

Table IV.9 Multi-staging Incremental Cost Increase

Adder	**Incremental Cost Increase for Multi-staging (2022$)**
Two-Stage	$21.07
Modulating	$75.36

Low-NOX and Ultralow-NOx Furnaces

Some furnaces are marketed as "low-NO_X," which indicates that their NO_X emissions are less than 40 nanograms of NO_X per joule of useful heat energy ("ng/J"). Certain local jurisdictions require natural gas furnaces to comply with NO_X emissions restrictions as low as 14 ng/J,[27] which is referred to as "ultralow-NO_X." A common method of reducing furnace NO_X emissions is to slightly delay the natural gas combustion process, which in turn produces a cooler flame and results in suppressed formation of NO_X.[28] DOE has observed during its teardown analysis that to achieve low-NO_X operation, manufacturers implement low-NO_X baffles. For ultralow-NO_X operation, DOE used NWGF teardowns to approximate the cost to implement this technology option in WGFs, as DOE understands that the methodology would be the same for both product classes. Through these teardowns of NWGFs, DOE has observed that in order to achieve ultralow-NO_X operation, the in-shot burners typically used in residential furnaces were replaced with a mesh premix burner. In addition, the model used a variable-speed BPM inducer fan motor. DOE identified an ultralow-NO_X WGF on the market and compared the burner construction for the torn-down NWGF and the ultralow-NO_X WGF. DOE found that the approach used for achieving ultralow-NO_X in WGFs is similar to that used in NWGFs. DOE also determined that oil units with ultralow-NO_X operation were rare and, thus, not representative of the market, so adders were not developed for the NWOF and MHOF product classes.

Using raw material price data, teardown data from NWGFs, and manufacturing expertise DOE estimated the manufacturing cost difference between standard NO_X burners and low-NO_X and ultralow-NO_X burners. For low-NO_X, MPC cost values were developed for the implementation of low-NO_X baffles in WGFs at the representative

[27] Rule 1111 of the South Coast Air Quality Management District ("SCAQMD") of southern California currently requires that all NWGF and MHGF not exceed a 14 ng/J restriction on NO_X emissions. For more information on Rule 1111, see *www.aqmd.gov/docs/default-source/rule-book/reg-xi/rule-1111.pdf?sfvrsn=4* (Last accessed Sept. 5, 2023).

[28] U.S. Environmental Protection Agency. Natural Gas Combustion (Available at: *www3.epa.gov/ttnchie1/ap42/ch01/final/c01s04.pdf*) (Last accessed June 28, 2023).

input capacity of 80 kBtu/h. For ultralow-NO_X, MPC values were developed for the implementation of a mesh premix burner and variable-speed BPM inducer fan (along with other related components necessary). The resulting MPC estimates to achieve low-NO_X and ultralow-NO_X operation are shown in Table IV.10.

In the LCC and PBP analysis (*see* section IV.E of this document), DOE estimated the fractions of furnaces that are installed in jurisdictions that require low-NO_X or ultralow-NO_X compliance and applied these cost adders to those fractions of furnace installations accordingly. The application of these adders is discussed in more detail in Chapter 8 of the November 2022 Preliminary Analysis TSD.

Table IV.10 Additional MPCs for Low-NO_X and Ultralow-NO_X WGFs

Adder	Value (2022$)
Low-NO_X	$3.10
Ultralow-NO_X	$113.68

Shipping Costs

Freight is not a manufacturing cost, but because it is a substantial cost incurred by the manufacturer, DOE accounts for shipping costs separately from other costs. DOE calculated shipping costs based on a typical 53-foot straight-frame trailer with a storage volume of 4,240 cubic feet.

DOE first calculated the cost per cubic foot of space on a trailer based on a cost of $3,643 per shipping load and the standard dimensions of a 53-foot trailer. This cost was determined based on a combination of full truck load ("FTL") freight quotations, manufacturer feedback, and BLS producer price indices for the "fuels and related products and power" grouping.[29] Then, DOE examined the average sizes of products in each product class at each efficiency and capacity combination analyzed. DOE estimated the shipping costs by multiplying the product volume by the cost per cubic foot of space on the trailer. Furnace dimensions typically do not change as a result of increases in efficiency, and accordingly, DOE's shipping costs show no change across efficiency levels. In determining volumetric shipping costs, DOE also used manufacturer feedback regarding product mix on each trailer, packing efficiency, and methods and equipment used to load the trailers to revise the shipping costs. Table IV.11 shows the shipping costs for the products analyzed in this rulemaking.

Table IV.11 Shipping Costs Per Unit

Product Class	Representative Capacity (kBtu/h)	Per-Unit Shipping Cost (2022$)
WGF	80	55.69
NWOF	105	19.92
MHOF	105	19.92

3. Cost-Efficiency Results

Using the MPCs for individual teardowns and adders described in section IV.B.2.b of this document, DOE develops aggregated MPCs for each product class. The final results of the AFUE engineering analysis are the MPCs for WGFs, NWOFs, and MHOFs at each efficiency level. The cost-efficiency results are shown in tabular form in Table IV.12 through Table IV.14 as efficiency versus MPC and MSP. These results

[29] U.S. Department of Labor, Bureau of Labor Statistics, *Producer Price Indices* (Available at: *data.bls.gov/timeseries/WPU057303?data_tool=XGtable*) (Last accessed Feb. 17, 2022).

include the furnace fan and combustion system staging incorporated into most furnace designs.

Table IV.12 Cost-Efficiency Data for WGFs with a Constant-Torque BPM Indoor Blower Motor and a Single-Stage Burner

AFUE	MPC (2022$)	MSP (2022$)
81	$1,412.32	$1,793.65
95	$1,505.40	$1,911.85

Table IV.13 Cost-Efficiency Data for NWOFs with a PSC Indoor Blower Motor and a Single-Stage Burner

AFUE	MPC (2022$)	MSP (2022$)
83	$ 700.73	$ 945.98
85	$ 730.94	$ 986.77
87	$ 761.16	$ 1,027.57
96	$1,334.85	$ 1,802.05

Table IV.14 Cost-Efficiency Data for MHOFs with a PSC Indoor Blower Motor and a Single-Stage Burner

AFUE	MPC (2022$)	MSP (2022$)
80	$ 664.47	$ 857.16
83	$ 709.79	$ 915.63
85	$ 740.01	$ 954.61
87	$ 770.23	$ 993.59

C. Markups Analysis

The markups analysis develops appropriate markups (*e.g.*, retailer markups, distributor markups, contractor markups) in the distribution chain and sales taxes to convert the MSP estimates derived in the engineering analysis to consumer prices, which are then used in the LCC and PBP analysis. At each step in the distribution channel, companies mark up the price of the product to cover business costs and profit margin. Before developing markups, DOE defines key market participants and identifies distribution channels.

For the subject consumer furnaces, the main parties in the distribution chains are: (1) manufacturers; (2) wholesalers or distributors; (3) retailers; (4) mechanical contractors; (5) builders; (6) manufactured home manufacturers, and (7) manufactured home dealers/retailers. For this NOPD, DOE maintained the same approach as in the preliminary analysis. DOE characterized two distribution channel market segments to describe how NWOFs, MHOFs, and WGFs pass from the manufacturer to residential and commercial consumers:[30] (1) replacements and new owners[31] and (2) new construction.

In replacement and new owner market, the primary distribution channel for NWOFs, MHOFs, and WGFs is characterized as follow:

Manufacturer → Wholesaler → Mechanical Contractor → Consumer

DOE estimates that the above distribution channel applies to a majority of the shipment of the subject consumer furnaces.[32] However, the retail distribution channel (including Internet sales) has grown significantly in the last five years (previously it was

[30] DOE estimates that five percent of WGFs and three percent of NWOFs are installed in commercial buildings.
[31] New owners are new furnace installations in buildings that did not previously have a NWOF, MHOF, or WGF, or existing owners that are installing an additional consumer furnace. These primarily consist of households that add or switch to these furnaces during a major remodel.
[32] In the residential sector, DOE estimates that this distribution channel is applicable to 90 percent of the shipments for NWOFs and MHOFs, and 80 percent for WGFs; in commercial sector, it is applied to 75 percent of NWOF and 70 percent of WGF distributions.

negligible), and some consumers purchase the appliance directly and then have contractors install it. Accordingly, DOE considered the following additional distribution channels:[33]

Manufacturer → Retailer → Consumer

Manufacturer → Retailer → Mechanical Contractor → Consumer

For mobile home applications, there is another distribution channel considered on top of the aforementioned, where the MHOF or WGF is purchased via a mobile home specialty retailer or dealer:[34]

Manufacturer → Mobile Home Specialty Retailer/Dealer → Consumer

In the new construction market, DOE identified three primary distribution channels that involve builders, or manufactured home builders when considering mobile home applications:

Manufacturer → Wholesaler → Mechanical Contractor → Builder → Consumer

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[33] In the residential sector, DOE estimates that these two distribution channels combined are applicable to 5 percent of the shipments for NWOFs and MHOFs, and 15 percent for WGFs (in mobile home applications, 10 percent of the WGFs distributed to mobile homes is assumed to go through these channels); in the commercial sector, they are applied to 10 percent of NWOF and 15 percent of WGF distributions.
[34] DOE estimates that 5 percent of MHOFs and 10 percent of WGFs that go to mobile homes are distributed through this channel.

Manufacturer → Wholesaler → Builder → Consumer

Manufacturer → Mobile Home Manufacturer → Mobile Home Dealer → Consumer

For both the replacements and new owners and the new construction markets, DOE additionally considered the national accounts or direct-from-manufacturer distribution channel, where the manufacturer through a wholesaler sells directly to consumers.[35]

Manufacturer → Wholesaler (National Account) → Buyer → Consumer

DOE developed baseline and incremental markups for each participant in the distribution chain to ultimately determine the consumer purchase cost. Baseline markups are applied to the price of products with baseline efficiency, while incremental markups are applied to the difference in price between baseline and higher-efficiency models (the incremental cost increase). The incremental markup is typically less than the baseline

[35] The national accounts channel where the buyer is the same as the consumer is mostly applicable to NWOFs and WGFs installed in small to mid-size commercial buildings, where on-site contractors purchase equipment directly from wholesalers at lower prices due to the large volume of equipment purchased, and perform the installation themselves. DOE's analysis assumes that approximately 5 and 15 percent of NWOFs and WGFs installed in the residential and commercial sector, respectively, use national accounts distribution channel for replacements. For new construction, DOE assumes 10 percent of the subject furnaces installed in residential sector and 20 percent installed in commercial are distributed through national accounts.

markup and is designed to maintain similar per-unit operating profit before and after new or amended standards.[36]

Lennox stated that the application of lower incremental markups for increased consumer furnace standard levels considered in the TSD should be reviewed. Lennox stated that a significantly discounted incremental markup for high EL levels from baseline markup is not logical or aligned with business practices. (Lennox, No. 26 at p. 8) Lennox added that the assumption of reduced incremental markups for higher efficiency standards is contrary to normal industry practice and the expectations of its shareholders. (Lennox, No. 26 at p. 8)

In response, DOE's incremental markup approach assumes that an increase in profitability, which is implied by keeping a fixed markup when the product price goes up, is unlikely to be viable over time in reasonably competitive markets. DOE recognizes that actors in the distribution chains are likely to seek to maintain the same markup on appliances in response to changes in manufacturer sales prices after an amendment to energy conservation standards. However, DOE believes that retail pricing is likely to adjust over time as those actors are forced to readjust their markups to reach a medium-term equilibrium in which per-unit profit is relatively unchanged before and after standards are implemented.

[36] Because the projected price of standards-compliant products is typically higher than the price of baseline products, using the same markup for the incremental cost and the baseline cost would result in higher per-unit operating profit. While such an outcome is possible, DOE maintains that in markets that are reasonably competitive, it is unlikely that standards would lead to a sustainable increase in profitability in the long run.

DOE acknowledges that markup practices in response to amended standards are complex and vary with business conditions. However, DOE's analysis necessarily only considers changes in appliance offerings that occur in response to amended standards. DOE continues to maintain that its assumption that standards do not facilitate a sustainable increase in profitability is reasonable. Chapter 6 of the November 2022 Preliminary Analysis TSD provides details on DOE's development of markups for oil and weatherized gas furnaces.[37]

D. Energy Use Analysis

The purpose of the energy use analysis is to determine the annual energy consumption of oil and weatherized gas furnaces at different efficiencies in representative U.S. residential buildings, commercial buildings, and residential mobile homes, and to assess the energy savings potential of increased oil and weatherized gas furnace efficiency. The energy use analysis estimates the range of energy use of oil and weatherized gas furnaces in the field (*i.e.*, as they are actually used by consumers). The energy use analysis provides the basis for other analyses DOE performed, particularly assessments of the potential energy savings and the savings in consumer operating costs that could result from adoption of amended or new standards.

DOE estimated the annual energy consumption of oil and weatherized gas consumer furnaces at specific energy efficiency levels across a range of climate zones, building characteristics, and space heating needs. The annual energy consumption

[37] In this NOPD, DOE is referencing the November 2022 Preliminary TSD for general methodology; note that some inputs have been updated for this NOPD.

includes the natural gas, liquid petroleum gas ("LPG"), oil, and electricity, as applicable, used by the furnace.

To determine the field energy use of the subject furnaces, DOE developed a building sample based on the Energy Information Administration's ("EIA") 2015 Residential Energy Consumption Survey ("RECS 2015")[38] and 2012 Commercial Building Energy Consumption Survey ("CBECS 2012").[39,40] DOE used RECS 2015-reported or CBECS 2012-reported heating energy consumption (based on the existing heating system) to calculate the heating load of each household or building. The heating load represents the amount of heating required to keep a housing unit or building comfortable throughout an average year. DOE assigned the energy efficiency of existing systems based on the design of the distribution systems, a historical distribution of energy efficiencies for NWOFs, MHOFs, and WGFs, and data about the age of the existing furnace. The estimation of heating loads also required calculating the electricity consumption of the blower, because heat from the operation of the blower contributes to space heating. In addition, DOE made adjustments based on historical weather data, projections of building shell efficiency, and building square footage, as well as for homes that had secondary heating equipment that used the same fuel as the furnace. To complete the analysis, DOE calculated the anticipated energy consumption of alternative

[38] Energy Information Administration (EIA), 2015 Residential Energy Consumption Survey (RECS). (Available at: *www.eia.gov/consumption/residential/*) (Last accessed August 1, 2023).
[39] Energy Information Administration (EIA), 2012 Commercial Buildings Energy Consumption Survey (CBECS). (Available at: *www.eia.gov/consumption/commercial/*) (Last accessed August 1, 2023).
[40] At the time DOE performed the analyses underlying this proposed determination, the RECS 2015 and CBECS 2012 were the latest available full data releases.

(more energy-efficient) products if they were to replace existing systems in each housing unit or commercial building.

DOE also included the electricity use of auxiliary equipment, such as condensate pumps and heat tape, which are sometimes installed with higher-efficiency products. The electricity consumption of the auxiliary equipment (“$ElecUse_{Aux}$”) is added to the total electricity consumption.

Chapter 7 of the November 2022 Preliminary Analysis TSD provides details on DOE’s energy use analysis for oil and weatherized gas furnaces.

AHRI commented that standard heat tape has an average energy consumption of 9 W/ft, adding that this additional load would increase energy use and is not accounted for in DOE’s energy use analysis for these products. AHRI stated that there are additional challenges surrounding prevention of freezing condensate for WGF units, and although AHRI suggested that electric strip heating could be used to overcome this problem, such solution would add electrical losses. (AHRI, No. 23 at p. 5)

In response, DOE accounted for heat tape use in cases when a WGF is installed in an outdoor environment that could face freezing conditions. DOE assumed that such installations would occur in locations facing freezing conditions based on the outdoor heating design temperature (or the 99th percentile). For the WGF sample, which is largely in warmer parts of the country, DOE estimated that about 5 percent of those installations would require heat tape, and DOE assumed that a larger fraction (around 50 percent) would deal with freeze protection through other methods, such as running the condensate lines through the ground or inside the WGF unit and into the building. For the energy use analysis, DOE used on average 45 watts (or 9 W/ft times 5 feet) for the energy consumption of installations requiring heat tape. For another 5 percent of installations, DOE accounted for the use of a condensate pump with an average energy consumption of 60 watts. DOE notes that any additional installation costs would not change DOE's tentative decision not to amend standards for the subject products.

E. Life-Cycle Cost and Payback Period Analysis

DOE conducted LCC and PBP analyses to evaluate the economic impacts on individual consumers of potential energy conservation standards for oil and weatherized gas furnaces. The effect of new or amended energy conservation standards on individual consumers usually involves a reduction in operating cost and an increase in purchase cost. DOE used the following two metrics to measure consumer impacts:

- *Life-Cycle Cost (LCC) is the total consumer expense of an appliance or product over the life of that product, consisting of total installed cost (manufacturer selling price, distribution chain markups, sales tax, and installation costs) plus operating costs (expenses for energy use, maintenance, and repair). To compute the operating costs, DOE discounts future operating costs to the time of purchase and sums them over the lifetime of the product.*

- *Payback Period (PBP) is the estimated amount of time (in years) it takes consumers to recover the increased purchase cost (including installation) of a* *more-efficient product through lower operating costs. DOE calculates the PBP by dividing the change in purchase cost at higher efficiency levels by the change in annual operating cost for the year that amended or new standards are assumed to take effect.*

For any given efficiency level, DOE measures the change in LCC relative to the LCC in the no-new-standards case, which reflects the estimated efficiency distribution of oil and weatherized gas furnaces in the absence of new or amended energy conservation standards. In contrast, the PBP for a given efficiency level is measured relative to the baseline product.

For each considered efficiency level in each product class, DOE calculated the LCC and PBP for a nationally representative set of housing units and, where appropriate, commercial buildings. As stated previously, DOE developed household and commercial building samples from RECS 2015 and CBECS 2012. For each sample household or commercial building, DOE determined the energy consumption for the oil and weatherized gas furnaces and the appropriate energy price. By developing a representative sample of households and commercial buildings, the analysis captured the variability in energy consumption and energy prices associated with the use of oil and weatherized gas furnaces.

Inputs to the LCC calculation include the installed cost to the consumer, operating expenses, the lifetime of the product, and the discount rate that applies to projected expenses. Inputs to the calculation of total installed cost include the cost of the product—

which includes MPCs, manufacturer markups, retailer and distributor markups, and sales taxes (where appropriate) —and installation costs. Inputs to the calculation of operating expenses include annual energy consumption, energy prices and price projections, repair and maintenance costs, product lifetimes, and discount rates. Inputs to the payback period calculation include the installed cost to the consumer and first year operating expenses. DOE created distributions of values for installation cost, repair and maintenance, product lifetime, and discount rates with probabilities attached to each value, to account for their uncertainty and variability.

The computer model DOE uses to calculate the LCC and PBP relies on a Monte Carlo simulation to incorporate uncertainty and variability into the analysis. The Monte Carlo simulations randomly sample input values from the probability distributions and oil, electric, and weatherized gas furnace user samples. For this determination, the Monte Carlo approach is implemented in MS Excel together with the Crystal Ball™ add-on.[41] The model calculated the LCC and PBP for products at each efficiency level for 10,000 furnace installations in housing units or commercial buildings per simulation run. The analytical results include a distribution of 10,000 data points showing the range of LCC savings for a given efficiency level relative to the no-new-standards case efficiency distribution. In performing an iteration of the Monte Carlo simulation for a given consumer, product efficiency is chosen based on its probability. If the chosen product efficiency is greater than or equal to the efficiency of the standard level under

[41] Crystal Ball™ is a commercially-available software tool to facilitate the creation of these types of models by generating probability distributions and summarizing results within Excel (Available at: *www.oracle.com/middleware/technologies/crystalball.html*) (Last accessed August1, 2023).

consideration, the LCC and PBP calculation reveals that a consumer is not impacted by the standard level. By accounting for consumers who are projected to purchase more-efficient furnaces than the baseline furnace in the simulation, DOE avoids overstating the potential benefits from increasing product efficiency.

DOE calculated the LCC and PBP for all consumers of oil and weatherized gas furnaces as if each were to purchase a new product in the expected first year of required compliance with new or amended standards. Any amended standards would apply to oil and weatherized gas furnaces manufactured five years after the date on which any new or amended standard is published in the *Federal Register*. (42 U.S.C. 6295(m)(4)(A)(ii)) For purposes of its analysis, DOE used 2030 as the first year of compliance with any amended standards for oil and weatherized gas furnaces.

Table IV.15 summarizes the approach and data DOE used to derive inputs to the LCC and PBP calculations. The subsections that follow provide further discussion. Details of the spreadsheet model, and how all inputs to the LCC and PBP analyses are applied, are contained in chapter 8 of the November 2022 Preliminary Analysis TSD and its appendices.

Table IV.15 Summary of Inputs and Methods for the LCC and PBP Analysis*

Input	Source/Method
Product Cost	Derived by multiplying MPCs by manufacturer and distribution chain markups and sales tax, as appropriate. Used historical data to derive a price-scaling index to project product costs.
Installation Costs	Baseline installation cost determined with data from RSMeans 2023, manufacturer literature, and expert consultant. DOE assumed increased installation costs for condensing furnaces.
Annual Energy Use	The annual energy consumption per unit at each efficiency level (see section IV.D of this document). Variability: Based on RECS 2015 and CBECS 2012.
Energy Prices	Natural Gas: Based on EIA's Natural Gas Navigator data for 2022 and RECS 2015 and CBECS 2012 billing data. Propane and Fuel Oil: Based on EIA's State Energy Data System ("SEDS") for 2021. Electricity: Based on EIA's Form 861 data for 2022 and RECS 2015 and CBECS 2012 billing data. Variability: State energy prices determined for residential and commercial applications. Marginal prices used for natural gas, propane, and electricity prices.
Energy Price Trends	Residential and commercial prices were escalated by using EIA's 2023 *Annual Energy Outlook* (*AEO 2023*) forecasts to estimate future energy prices. Escalation was performed at the Census Division level.
Repair and Maintenance Costs	Baseline installation cost determined with data from RSMeans 2023, manufacturer literature, and expert consultant. DOE assumed increased repair and maintenance costs for condensing furnaces.
Product Lifetime	Based on shipments data, multi-year RECS, American Housing Survey, American Home Comfort Survey data. Average: 20.2–22.5 years
Discount Rates	For residential end users, approach involves identifying all possible debt or asset classes that might be used to purchase the considered appliances or might be affected indirectly. Primary data source was the Federal Reserve Board's Survey of Consumer Finances. For commercial end users, DOE calculates commercial discount rates as the weighted average cost of capital using various financial data.
Compliance Date	2030

* Note: References for the data sources mentioned in this table are provided in the sections following the table or in chapter 8 of the November 2022 Preliminary Analysis TSD.

1. Product Cost

To calculate consumer product costs, DOE multiplied the MPCs developed in the engineering analysis by the markups described previously (along with sales taxes). DOE used different markups for baseline products and higher-efficiency products, because DOE applies an incremental markup to the increase in MSP associated with higher-efficiency products.

DOE estimated product prices in the year of compliance by using a least-squares power-law fit on the inflation-adjusted, unified price index (historical Producer Price Index ("PPI") data for warm-air furnaces from the Bureau of Labor Statistics ("BLS") spanning the time period 1990–2018 versus cumulative shipments.[42]

In order to improve real-world representativeness, NYSERDA recommended that DOE consider using piecewise power-law curves for different time intervals to estimate the learning rate parameter in the LCC analysis. NYSERDA provided data to explain that prices decreased until 2017 and then started to increase. NYSERDA added that one possible explanation for this is that growing economies are consuming more raw materials that go into manufacturing furnaces, and such an increase in global aggregate demand for raw materials exerts upward pressure on product prices. The commenter explained that piecewise power-law curves are a common approach in cases where there is a reversal in directionality of trends and cited an example journal article. NYSERDA commented that using one power-law curve before 2017 and another after would more accurately capture the reduction in furnace prices in the future. (NYSERDA, No. 19 at pp. 3-4)

DOE reviewed NYSERDA's suggestion for an alternative price learning approach; however, insufficient data are available to implement the approach for the products considered in this rulemaking. In addition, the recommendation to segment the curve before and after 2017 is similar to the alternative price scenarios that DOE typically

[42] U.S. Department of Labor, Bureau of Labor Statistics, Produce Price Indices Series ID PCU333415333415C (Available at: *www.bls.gov/ppi/*) (Last accessed August 1, 2023).

explores when proposing or finalizing amended standards, but in this case, DOE has tentatively determined not to amend standards. For these reasons, DOE has not changed its methodology for this NOPD.

2. Installation Cost

The installation cost is the expense to the consumer of installing the furnace, in addition to the cost of the furnace itself. Installation cost includes all labor, overhead, and any miscellaneous materials and parts needed that are associated with the replacement of an existing furnace or the installation of a furnace in a new home, as well as delivery of the new furnace, removal of the existing furnace, and any applicable permit fees. Higher-efficiency furnaces may require a consumer to incur additional installation costs. DOE used data from RSMeans,[43] manufacturer literature, and expert consultants to estimate the installation cost, including labor costs, for oil and weatherized gas furnaces. DOE's analysis of installation costs accounted for regional differences in labor costs by aggregating city-level labor rates from RSMeans into the 50 distinct State plus Washington DC to match RECS 2015 and CBECS 2012 data. The installation cost methodology accounts for all potential installation cases, including when a noncondensing furnace is replaced with a condensing furnace, with particular attention to venting issues in replacement applications (*see* descriptions which follow). The installation cost also depends on the furnace installation location, which DOE determined using information from RECS 2015 and CBECS 2012.

[43] RSMeans Company Inc., RSMeans Cost Data. Kingston, MA (2023) (Available at: *www.rsmeans.com/products/books/2023-cost-data-books*) (Last accessed August 1, 2023).

For NWOF *replacement* installations, DOE included a number of additional costs ("adders") for a fraction of the sample households that have particular features. For noncondensing furnaces, these additional costs included updating flue vent connectors, vent resizing, and chimney relining. For condensing furnaces, these additional costs included adding a new flue vent (PVC), adding combustion air vent for direct vent installations (PVC), adding concealing vent pipes for indoor installations, addressing an orphaned water heater (by updating flue vent connectors, vent resizing, or chimney relining), and removing condensate, all based on manufacturer installation manuals and expert consultant input. Freeze protection (heat tape) is accounted for in the cost of condensate removal for a fraction of NWOFs installed in unconditioned attics.

For WGF installations, DOE included additional cost adders for condensing WGFs to dispose of the condensate created and to prevent freezing of the condensate, as the entire product is outdoors based on manufacturer installation manuals, field study reports, and expert consultant input. DOE also accounted for a fraction of installations in colder climates that could require freeze protection (heat tape), a condensate line being buried below the frost line, or a condensate pump.

AHRI commented that for WGFs installed in rooftop applications, heated drain lines are needed for winter use to avoid building water damage. AHRI added that condensate lines running within the unit are difficult to access and could have the potential to trap condensate. (AHRI, No. 23 at p. 5) JCI stated that while DOE considered the use of heat tape, the practical application/maintenance of heat tape internal to installed systems poses an undue installation and maintenance burden. (JCI, No. 25 at p. 2)

As explained in section IV.D of this document, DOE accounted for heat tape use in cases when a WGF is installed in an outdoor environment that could face freezing conditions. DOE assumed that the installation location would be facing freezing conditions based on the outdoor heating design temperature (or the 99th percentile). For the WGF sample, which is largely in warmer parts of the country, DOE estimated that about five percent would require heat tape. For another five percent of installations, DOE accounted for the use of a condensate pump. Furthermore, DOE accounts for other condensate costs such as adding condensate piping, running condensate lines through the ground or inside the WGF unit and into the building, using condensate neutralizer, adding an electrical outlet for heat tape or condensate pump, adding a drain pan, and adding a non-corrosive drain. On average, the installation cost adder across these scenarios is $110.

For further information on the derivation of installation costs, see chapter 7 of the November 2022 Preliminary Analysis TSD.

3. Annual Energy Consumption

For each sampled household or commercial building, DOE determined the energy consumption for oil and weatherized gas furnace at different efficiency levels using the approach described previously in section IV.D of this document.

4. Energy Prices

DOE derived 2022 annual residential and commercial electricity prices by State from EIA Form 861M data.[44] DOE obtained 2022 annual residential and commercial natural gas prices by State from EIA's Natural Gas Navigator.[45] DOE collected 2021 average LPG and fuel oil prices by State from EIA's 2021 State Energy Consumption, Price, and Expenditures Estimates ("SEDS") and scaled to 2022 prices using *AEO2023* data.[46] To determine monthly prices for use in the analysis, DOE developed monthly energy price factors for each fuel based on long-term monthly price data. Monthly electricity and natural gas prices were adjusted using seasonal marginal price factors to determine monthly marginal electricity and natural gas prices. These marginal energy prices were used to determine the cost to the consumer of the change in energy consumed. Because marginal price data is only available for residential electricity and natural gas, DOE only developed marginal monthly prices for these fuels. For LPG and fuel oil, DOE used average monthly prices.

To estimate energy prices in future years, DOE multiplied the 2022 energy prices by the projection of annual average price changes for each State from the Reference case in *AEO2023*, which has an end year of 2050.[47] To estimate price trends after 2050, DOE

[44] U.S. Department of Energy-Energy Information Administration, Form EIA-861M (formerly EIA-826) detailed data (2022) (Available at: *www.eia.gov/electricity/data/eia861m/)* (Last accessed August 1, 2023).
[45] U.S. Department of Energy-Energy Information Administration, Natural Gas Navigator (2022) (Available at: *www.eia.gov/naturalgas/data.php*) (Last accessed August 1, 2023).
[46] U.S. Department of Energy-Energy Information Administration, 2021 State Energy Data System (SEDS) (2021) (Available at: *www.eia.gov/state/seds/*) (Last accessed August 1, 2023).
[47] EIA, *Annual Energy Outlook 2023 with Projections to 2050* (Available at: *www.eia.gov/forecasts/aeo/*) (Last accessed June 1, 2023).

used the average annual rate of change in prices from 2046 through 2050. See chapter 8 of the November 2022 Preliminary Analysis TSD for details.

NYSERDA recommended that DOE consider applying a correction factor to account for potential gaps between forecasted prices and actual prices for energy, particularly in oil and natural gas. NYSERDA provided data depicting the heating oil prices within New York over a 23-year period and noted that there is significant variation in the time series. The commenter encouraged DOE to assemble multiple *AEO* reports for historic forecasts to determine a correction factor based on the comparison of actual prices to forecasted prices. NYSERDA added that this correction factor could then be applied to future forecasted prices to produce a more accurate result while still using EIA’s price forecasts. (NYSERDA, No. 19 at pp. 4–5)

In response to NYSERDA, DOE acknowledges that forecasted prices do not always accurately predict future prices. However, DOE does not agree that past discrepancies between the two can reliably be used to adjust EIA’s forecasts, as there is not a firm basis for assuming that historic factors will develop in the same way in the future. For this reason, DOE is maintaining its practice of relying on *AEO*'s energy price forecasts.

The Joint Commenters reiterated their comments made in response to DOE’s 2022 Request for Information pertaining to concerns with DOE’s reliance on allegedly incorrect projections of natural gas price trends, marginal residential natural gas prices, and systematic problems with DOE’s economic analysis. The Joint Commenters added that these earlier comments highlight flaws in DOE's process and stated that these flaws must be addressed both in this and future rulemakings before proposing any new minimum efficiency standards for appliances. (Joint Commenters, No. 24 at p. 3)

In response to the Joint Commenters, DOE acknowledges that past projections of natural gas prices have not matched actual prices in recent years, but DOE maintains that this is due to factors that were difficult to predict and not to any flaws in the model that is used to develop *AEO* energy price projections, or to biases with regard to assumptions.

5. Maintenance and Repair Costs

Repair costs are associated with repairing or replacing product components that have failed in an appliance; maintenance costs are associated with maintaining the operation of the product. The maintenance and repair costs (including labor hours, component costs, and frequency) at each considered efficiency level are derived based on *2023 RSMeans Facilities Maintenance and Repair Data*,[48] manufacturer literature, consultant input, and industry reports. DOE also accounted for regional differences in labor costs based on these 2023 RSMeans data.

DOE assumes that condensing furnaces have a higher maintenance cost than noncondensing furnaces, but that this maintenance cost is the same at all noncondensing or condensing efficiency levels within each product class. The additional maintenance cost for condensing furnaces includes maintenance tasks related to the condensate

[48] RSMeans Company Inc., *RSMeans Facilities Maintenance & Repair Cost Data* (2023) (Available at: *www.rsmeans.com/*) (Last accessed August 1, 2023).

withdrawal system (such as condensate pump or condensate neutralizer filter) and additional maintenance related to the cleaning or checking of the heat exchanger (in particular, for condensing oil-fired furnaces using high-sulfur fuel oil).

DOE also assumes that condensing furnaces have a higher repair cost than noncondensing furnaces, but the repair cost is the same at all non-condensing or condensing efficiency levels within each product class.

For more details on DOE's methodology for calculating maintenance and repair costs, including all online resources reviewed, *see* appendix 8E of the November 2022 Preliminary Analysis TSD.

6. Product Lifetime

Product lifetime is the age at which an appliance is retired from service. DOE conducted an analysis of furnace lifetimes based on the methodology described in a recent journal paper.[49] For this analysis, DOE relied on RECS 1990, 1993, 2001, 2005, 2009, and 2015.[50] DOE also used the U.S. Census's biennial American Housing Survey ("AHS"), from 1974-2021, which surveys all housing, noting the presence of a range of appliances.[51] DOE used the appliance age data from these surveys, as well as the

[49] Lutz, J., A. Hopkins, V. Letschert, V. Franco, and A. Sturges, Using national survey data to estimate lifetimes of residential appliances, *HVAC&R Research* (2011) 17(5): p. 28. (Available at: *www.tandfonline.com/doi/abs/10.1080/10789669.2011.558166)* (Last accessed August 1, 2023).

[50] U.S. Department of Energy: Energy Information Administration, *Residential Energy Consumption Survey ("RECS"),* Multiple Years (1990, 1993, 1997, 2001, 2005, 2009, and 2015). (Available at: *www.eia.gov/consumption/residential/)* (Last accessed August 1, 2023).

[51] U.S. Census Bureau: Housing and Household Economic Statistics Division, *American Housing Survey*, Multiple Years (1974, 1975, 1976, 1977, 1978, 1979, 1980, 1981, 1983, 1985, 1987, 1989, 1991, 1993, 1995, 1997, 1999, 2001, 2003, 2005, 2007, 2009, 2011, 2013, 2015, 2017, 2019, and 2021). (Available at: *www.census.gov/programs-surveys/ahs/)* (Last accessed August 1, 2023).

historical furnace shipments, to generate an estimate of the survival function. The survival function provides a lifetime range from minimum to maximum, as well as an average lifetime. For oil and weatherized gas furnaces, DOE developed Weibull distributions resulting in an average lifetime of 20.2 to 22.5 years (based on region).

Appendix 8F of the November 2022 Preliminary Analysis TSD provides further details on the methodology and sources DOE used to develop the subject furnace lifetimes.

7. Discount Rates

The discount rate is the rate at which future expenditures and savings are discounted to establish their present value. DOE estimates discount rates separately for residential and commercial end users.

For residential end users, DOE applies weighted-average discount rates calculated from consumer debt and asset data, rather than marginal or implicit discount rates. DOE identified all relevant household debt or asset classes in order to approximate a consumer's opportunity cost of funds related to appliance energy cost savings. It estimated the average percentage shares of the various types of debt and equity by household income group using data from the Federal Reserve Board's Survey of Consumer Finances ("SCF"). Using the SCF and other sources, DOE developed a distribution of rates for each type of debt and asset by income group to represent the rates that may apply in the year in which amended standards would take effect. DOE assigned each sample household a specific discount rate drawn from one of the distributions.

For commercial end users, DOE estimated the weighted-average cost of capital using data from various financial sources. The weighted-average cost of capital is commonly used to estimate the present value of cash flows to be derived from a typical company project or investment. Most companies use both debt and equity capital to fund investments, so their cost of capital is the weighted average of the cost to the firm of equity and debt financing.

See appendix 8G of the November 2022 Preliminary Analysis TSD for further details on the development of discount rates.

8. Energy Efficiency Distribution in the No-New-Standards Case

To accurately estimate the share of consumers that would be affected by a potential energy conservation standard at a particular efficiency level, DOE's LCC analysis considered the projected distribution (*i.e.*, market shares) of product efficiencies under the no-new-standards case (*i.e.*, the case without amended or new energy conservation standards) in the compliance year (2030). This approach reflects the fact that some consumers may purchase products with efficiencies greater than the baseline levels, such that even in a no-new-standards case, consumers will be purchasing higher-efficiency furnaces.

For consumer furnaces, DOE had limited historical-shipments data by efficiency level. For NWOFs/MHOFs, DOE reviewed market shares from HARDI 2013–2022 data and BRG 2007–2022 data [52,53]. The shipments data are not disaggregated between NWOFs and MHOFs, but DOE assigned all shipments data below 83-percent AFUE to MHOFs. For WGFs, DOE had insufficient historical shipments data by efficiency level to develop a reliable efficiency distribution. To cover the lack of available shipments data, DOE referred to the DOE's Compliance Certification Database ("CCD")[54] for furnaces to develop efficiency distributions based on available models for WGFs.

The estimated market shares for the no-new-standards case for oil and weatherized gas furnaces are shown in Table IV.16. See chapter 8 of the November 2022 Preliminary Analysis TSD for further information on the derivation of the efficiency distributions.

Table IV.16 No-New-Standards Case Energy Efficiency Distributions in 2030 for Oil and Weatherized Gas Furnaces

Product Class	Efficiency Level	Distribution
NWOF	Baseline	37.2%
	1	60.0%
	2	1.5%
	3	1.3%
MHOF	Baseline	95%
	1	2%
	2	3%
	3	0%
WGF	Baseline	96%
	1	4%

[52] Heating, Air-conditioning and Refrigeration Distributors International (HARDI), DRIVE portal (HARDI Visualization Tool managed by D+R International until 2022), proprietary Gas Furnace Shipments Data from 2013–2022 provided to Lawrence Berkeley National Laboratory (LBNL).
[53] BRG Building Solutions. The North American Heating & Cooling Product Markets (2022 Edition) (Available at: *www.brgbuildingsolutions.com/reports-insights*) (Last accessed August 1, 2023).
[54] U.S. Department of Energy Compliance Certification Database ("CCD") (Available at: *www.regulations.doe.gov/certification-data/*) (Last accessed August 1, 2023).

AHRI and Lennox stated that model counts from the public database do not reflect model or sales volume and that a high number of models at a specific efficiency level does not imply a large market share of those products. (AHRI, No. 23 at p. 4; Lennox, No. 26 at p. 3) Lennox stated that industry data for condensing weatherized gas furnaces indicate that the market adoption of these products has been *de minimis*. (Lennox, No. 26 at p. 8) NYSERDA commented that within New York's relatively cold climate, new sales of electric and weatherized gas furnaces are minimal. However, NYSERDA noted that oil furnaces continue to be sold and installed throughout the State, with a 2019 study suggesting that most oil furnaces being installed are of low efficiency. (NYSERDA, No. 19 at p. 1)

In response to AHRI and Lennox, as stated previously, to develop an efficiency distribution in the no-new-standards case, DOE used available historical shipments data by efficiency for NWOFs/MHOFs and made assumptions to disaggregate between NWOFs and MHOFs by AFUE. Due to limited information for WGF, DOE referred to CCD to develop efficiency distributions. DOE projected that condensing WGFs will continue to account for a minimal share of the WGF market in the no-new-standards case, which aligns with Lennox's characterization of the industry data for condensing weatherized gas furnaces. In response to NYSERDA, DOE's estimates of efficiency distribution align with the findings that most oil furnaces being installed are of low efficiency. DOE received no other data with which to further refine the estimates of the efficiency distribution, and as such, DOE has not changed its existing methodology.

9. Payback Period Analysis

The payback period is the amount of time it takes the consumer to recover the additional installed cost of more-efficient products, compared to baseline products, through energy cost savings. Payback periods are expressed in years. Payback periods that exceed the life of the product mean that the increased total installed cost is not recovered in reduced operating expenses.

The inputs to the PBP calculation for each efficiency level are the change in total installed cost of the product and the change in the first-year annual operating expenditures relative to the baseline. The PBP calculation uses the same inputs as the LCC analysis, except that discount rates are not needed.

EPCA establishes a rebuttable presumption that a standard is economically justified if the Secretary finds that the additional cost to the consumer of purchasing a product complying with an energy conservation standard level will be less than three times the value of the first year's energy savings resulting from the standard, as calculated under the applicable test procedure. (42 U.S.C. 6295(o)(2)(B)(iii)) For each considered efficiency level, DOE determined the value of the first year's energy savings by calculating the energy savings in accordance with the applicable DOE test procedure, and multiplying those savings by the average energy price projection for the year in which compliance with the amended standards would be required.

F. Shipments Analysis

DOE uses projections of annual product shipments to calculate the national impacts of potential amended or new energy conservation standards on energy use, NPV, and future manufacturer cash flows.[55] The shipments model takes an accounting approach in tracking market shares of each product class and the vintage of units in the stock. Stock accounting uses product shipments as inputs to estimate the age distribution of in-service product stocks for all years. The age distribution of in-service product stocks is a key input to calculations of both the NES and NPV, because operating costs for any year depend on the age distribution of the stock.

Lennox commented that DOE likely overstates shipments for gas furnaces. Lennox commented that the NWGF rulemaking and this rulemaking may significantly reduce the market shares of these products. (Lennox, No. 26 at p. 2) Lennox commented that NWOFs and EFs are each less than one percent of the consumer furnace market. (*Id.* at p. 1) Lennox stated that DOE's projections of a growing market for residential furnaces are inconsistent with Federal and State policy efforts to electrify space heating in residences. (Lennox, No. 26 at p. 2) Lennox commented that decarbonization efforts to electrify space heating will have impacts on both the total market for furnaces, as well as the categories thereof. (*Id.*) Lennox commented that States such as California and New York, which represent approximately 8 to 12 percent of the annual furnace shipments, are implementing plans to completely electrify space heating as soon as 2030. (*Id.*) In addition, Lennox stated that furnace costs are likely to increase, resulting in a

[55] DOE uses data on manufacturer shipments as a proxy for national sales, as aggregate data on sales are lacking. In general, one would expect a close correspondence between shipments and sales.

reduction in the market. (*Id.* at p. 3) Lennox commented that the information presented in the preliminary TSD similarly indicates a growing market for furnaces, in contrast to Federal, State, and local efforts to decarbonize space heating. Lennox commented that gas furnace shipments will decline in the time period associated with this rulemaking, and further DOE action should reflect a substantial reduction in the market for furnaces that consume fossil fuels. (*Id.* at p. 8)

In response, DOE notes that assumptions made in the November 2022 Preliminary Analysis regarding future policies encouraging electrification of households were speculative at that time, so such policies were not incorporated into the shipments projection. Consequently, DOE's market share and shipments projections in the November 2022 Preliminary Analysis reflected the best information available to DOE at that time. For the NOPD, DOE accounted for the 2022 update to Title 24 in California[56] and also the decision of the California Public Utilities Commission to eliminate ratepayer subsidies for the extension of new gas lines beginning in July 2023. Together, these policies are expected to lead to the eventual phase-out of gas furnaces in new single-family homes in California. The California Air Resources Board has adopted a 2022 State Strategy for the State Implementation Plan that would effectively ban sales of new

[56] The 2022 update includes heat pumps as a performance standard baseline for water heating or space heating in single-family homes, as well as space heating in multi-family homes. Under the California Code, builders will need to either include one high-efficiency heat pump in new constructions or subject those buildings to more-stringent energy efficiency standards.

gas furnaces beginning in 2030.[57] However, because a final decision on a rule would not happen until 2025, DOE did not include this latter policy in its analysis for this NOPD.

DOE understands that ongoing electrification policies at the Federal, State, and local levels are likely to encourage installation of heat pumps in some new homes and adoption of heat pumps in some homes that currently use gas or oil-fired furnaces. However, there are many uncertainties about the timing and effects of these policies that make it difficult to fully account for their likely impact on gas or oil furnaces market shares in the time frame for this analysis (*i.e.*, 2030 through 2059). Nonetheless, DOE has modified some of its projections to attempt to account for impacts that are most likely in the relevant time frame.[58] These changes result in a decrease of shipments in the no-new-standards case in 2030 compared to the November 2022 Preliminary Analysis, with a corresponding decrease in estimated energy savings resulting from the standards. DOE acknowledges that electrification policies may result in a larger decrease in shipments of gas furnaces than projected in this NOPD, especially if stronger policies are adopted in coming years. However, this would occur in the no-new amended standards case and, thus, would only reduce the energy savings estimated in this NOPD.

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[57] See *ww2.arb.ca.gov/resources/documents/2022-state-strategy-state-implementation-plan-2022-state-sip-strategy* (Last accessed June 2, 2023).

[58] Based on currently adopted policies and incentives, DOE estimated a lower saturation in the new construction market and a higher product switching rate for the replacement market for gas and oil furnaces for the NOPD shipments analysis. This change resulted in a decrease of 11 percent for WGFs, 62 percent for NWOF, and 68 percent for MHOF for the no-new-standards case projection of total shipments between 2030 and 2059 compared to the preliminary analysis.

G. National Impact Analysis

The NIA assesses the NES and the NPV from a national perspective of total consumer costs and savings that would be expected to result from new or amended energy conservation standards at specific efficiency levels.[59] ("Consumer" in this context refers to consumers of the product being regulated.) DOE calculates the NES and NPV for the potential standard levels considered based on projections of annual product shipments, along with the annual energy consumption and total installed cost data from the energy use and LCC analyses.[60] For the present analysis, DOE projected the energy savings, operating cost savings, product costs, and NPV of consumer benefits over the lifetime of oil and weatherized gas furnaces sold from 2030 through 2059.

DOE evaluates the effects of new or amended standards by comparing a case without such standards with standards-case projections. The no-new-standards case characterizes energy use and consumer costs for each product class in the absence of new or amended energy conservation standards. For this projection, DOE considers historical trends in efficiency and various forces that are likely to affect the mix of efficiencies over time. DOE compares the no-new-standards case with projections characterizing the market for each product class if DOE adopted new or amended standards at specific energy efficiency levels (*i.e.*, the ELs or standards cases) for that class. For the standards

[59] The NIA accounts for impacts in the U.S. and U.S. territories.

[60] For the NIA, DOE adjusts the installed cost data from the LCC analysis to exclude sales tax, which is a transfer.

cases, DOE considers how a given standard would likely affect the market shares of products with efficiencies greater than the standard.

DOE uses a spreadsheet model to calculate the energy savings and the national consumer costs and savings from each EL. Interested parties can review DOE's analyses by changing various input quantities within the spreadsheet. The NIA spreadsheet model uses typical values (as opposed to probability distributions) as inputs.

Table IV.17 summarizes the inputs and methods DOE used for the NIA analysis for the NOPD. Discussion of these inputs and methods follows the table. *See* chapter 10 of the November 2022 Preliminary Analysis TSD for details.

Table IV.17 Summary of Inputs and Methods for the National Impact Analysis

Input	Method
Shipments	Annual shipments from shipments model.
Modeled Compliance Date of Standard	2030.
Efficiency Trends	No-new-standards case: Based on historical data. Standards cases: Roll-up in the compliance year and then DOE estimated growth in shipment-weighted efficiency in all the standards cases, except max-tech.
Annual Energy Consumption per Unit	Annual weighted-average values are a function of energy use at each EL. Incorporates projection of future energy use based on *AEO2023* projections for HDD/CDD and building shell efficiency index.
Total Installed Cost per Unit	Annual weighted-average values are a function of cost at each EL. Incorporates projection of future product prices based on historical data.
Annual Energy Cost per Unit	Annual weighted-average values as a function of the annual energy consumption per unit and energy prices.
Repair and Maintenance Cost per Unit	Annual weighted-average values increase for condensing levels.
Energy Prices	*AEO2023* projections (to 2050) and extrapolation after 2050.
Energy Site-to-Primary and FFC Conversion	A time-series conversion factor based on *AEO2023*.
Discount Rate	Three percent and seven percent.
Present Year	2023.

1. Product Efficiency Trends

A key component of the NIA is the trend in energy efficiency projected for the no-new-standards case and each of the standards cases. Section IV.E.8 of this document describes how DOE developed an energy efficiency distribution for the no-new-standards case (which yields a shipment-weighted average efficiency) for each of the considered product classes for the year of anticipated compliance with an amended or new standard (2030).

For the standards cases, DOE used a "roll-up" scenario to establish the shipment-weighted efficiency for the year that standards are assumed to become effective (2030). In this scenario, the market shares of products in the no-new-standards case that do not meet the standard under consideration would "roll up" to meet the new standard level, and the market share of products above the standard would remain unchanged.

To develop standards case efficiency trends after 2030, DOE estimated growth in shipment-weighted efficiency in the standards cases, except in the max-tech standards case.

2. National Energy Savings

The NES analysis involves a comparison of national energy consumption of the considered products between each potential standards case (EL) and the case with no new or amended energy conservation standards. DOE calculated the national energy consumption by multiplying the number of units (stock) of each product (by vintage or age) by the unit energy consumption (also by vintage). DOE calculated annual NES based on the difference in national energy consumption for the no-new-standards case and for each higher-efficiency standard case. DOE estimated energy consumption and savings based on site energy and converted the electricity consumption and savings to primary energy (*i.e.*, the energy consumed by power plants to generate site electricity) using annual conversion factors derived from *AEO2023*. For natural gas and LPG, DOE assumed that site energy consumption is the same as primary energy consumption. Cumulative energy savings are the sum of the NES for each year over the timeframe of the analysis.

Use of higher-efficiency products is sometimes associated with a direct rebound effect, which refers to an increase in utilization of the product due to the increase in efficiency. For oil and weatherized gas furnaces, DOE applied a rebound effect of 15 percent for residential applications by reducing the site energy savings (and the associated primary and FFC energy savings). However, for commercial applications, DOE applied no rebound effect in order to be consistent with other recent standards rulemakings.

In 2011, in response to the recommendations of a committee on "Point-of-Use and Full-Fuel-Cycle Measurement Approaches to Energy Efficiency Standards" appointed by the National Academy of Sciences, DOE announced its intention to use FFC measures of energy use and greenhouse gas and other emissions in the NIA and emissions analyses included in future energy conservation standards rulemakings. 76 FR 51281 (August 18, 2011). After evaluating the approaches discussed in the August 18, 2011 notice, DOE published a statement of amended policy in which DOE explained its determination that EIA's National Energy Modeling System ("NEMS") is the most appropriate tool for its FFC analysis and its intention to use NEMS for that purpose. 77 FR 49701 (August 17, 2012). NEMS is a public domain, multi-sector, partial equilibrium model of the U.S. energy sector[61] that EIA uses to prepare its *Annual Energy Outlook*. The FFC factors incorporate losses in production and delivery in the case of natural gas (including fugitive emissions) and additional energy used to produce and deliver the various fuels used by power plants. The general approach used for deriving FFC measures of energy use and emissions is described in appendix 10B of the November 2022 Preliminary Analysis TSD.

3. Net Present Value Analysis

The inputs for determining the NPV of the total costs and benefits experienced by consumers are: (1) total annual installed cost; (2) total annual operating costs (energy costs and repair and maintenance costs), and (3) a discount factor to calculate the present value of costs and savings. DOE calculates net savings each year as the difference between the no-new-standards case and each standards case in terms of total savings in operating costs versus total increases in installed costs. DOE calculates operating cost savings over the lifetime of each product shipped during the projection period.

As discussed in section IV.E.1 of this document, DOE developed oil and weatherized gas furnace price trends based on historical PPI data and cumulative

[61] For more information on NEMS, refer to *The National Energy Modeling System: An Overview May 2023*, DOE/EIA, May 2023 (Available at: *www.eia.gov/analysis/pdfpages/0581(2009)index.php*) (Last accessed June 27, 2023).

shipments. DOE applied the same trends to project prices for each product class at each considered efficiency level. By 2059, which is the end date of the projection period, the average oil and weatherized gas furnace price is projected to drop 17 percent relative to 2022. DOE's projection of product prices is described further in chapter 10 of the November 2022 Preliminary Analysis TSD.

The operating cost savings are calculated as energy cost savings minus any repair and maintenance cost increases. Energy cost savings are calculated using the estimated energy savings in each year and the projected price of the appropriate form of energy. To estimate energy prices in future years, DOE multiplied the national-average energy prices derived in the LCC analysis by the projection of annual national-average residential (or commercial, as appropriate) energy price changes in the Reference case from *AEO2023*, which has an end year of 2050. To estimate price trends after 2050, DOE used the average annual rate of change in prices from 2046 through 2050. Repair and maintenance cost for each of the efficiency levels is calculated in the LCC, and repair and maintenance cost increases are calculated as the repair and maintenance cost differential between efficiency levels.

In calculating the NPV, DOE multiplies the net savings in future years by a discount factor to determine their present value. For this NOPD, DOE estimated the NPV of consumer benefits using both a 3-percent and a 7-percent real discount rate. DOE uses these discount rates in accordance with guidance provided by the Office of Management and Budget ("OMB") to Federal agencies on the development of regulatory analysis.[62] The discount rates for the determination of NPV are in contrast to the discount rates used in the LCC analysis, which are designed to reflect a consumer's perspective. The 7-percent real value is an estimate of the average before-tax rate of return to private capital in the U.S. economy. The 3-percent real value represents the "social rate of time preference," which is the rate at which society discounts future consumption flows to their present value.

V. Analytical Results and Conclusions

The following section addresses the results from DOE's analyses with respect to the considered energy conservation standards for oil and weatherized gas furnaces. It addresses the ELs examined by DOE (see section IV.B.1 of this document) and the projected impacts of each of these levels if adopted as energy conservation standards for the subject furnaces. Additional details regarding DOE's analyses are contained in the November 2022 Preliminary Analysis TSD supporting this document.

A. Economic Impacts on Individual Consumers

DOE analyzed the cost-effectiveness (*i.e.,* the savings in operating costs throughout the estimated average life of oil and weatherized gas furnaces compared to any increase in the price of, or in the initial charges for, or maintenance expenses of, oil and weatherized gas furnaces which are likely to result from the imposition of a standard)

[62] United States Office of Management and Budget, *Circular A-4: Regulatory Analysis* (Sept. 17, 2003) Section E (Available at: *www.whitehouse.gov/omb/information-for-agencies/circulars/*) (Last accessed June 28, 2023).

at an EL by considering the LCC and PBP at each EL. These analyses are discussed in the following sections.

In general, higher-efficiency products can affect consumers in two ways: (1) purchase price increases and (2) annual operating costs decrease. Inputs used for calculating the LCC and PBP include total installed costs (*i.e.*, product price plus installation costs), and operating costs (*i.e.*, annual energy use, energy prices, energy price trends, repair costs, and maintenance costs). The LCC calculation also uses product lifetime and a discount rate. Chapter 8 of the November 2022 Preliminary Analysis TSD provides detailed information on the LCC and PBP analyses.

Table V.1 to Table V.6 show the average LCC and PBP results for the ELs considered in this analysis for oil and weatherized gas furnaces, respectively. In the first of each pair of tables, the simple payback is measured relative to the baseline product. In the second table, the impacts are measured relative to the efficiency distribution in the in the no-new-standards case in the compliance year (see section IV.E.8 of this document). The LCC and PBP results for oil and weatherized gas furnaces include both residential and commercial users. Because some consumers purchase products with higher efficiency in the no-new-standards case, the average savings are less than the difference between the average LCC of the baseline product and the average LCC at each EL. The savings refer only to consumers who are affected by a standard at a given EL. Those who already purchase a product with efficiency at or above a given EL are not affected. Consumers for whom the LCC increases at a given EL experience a net cost.

Table V.1 Average LCC and PBP Results by Efficiency Level for NWOF

Efficiency Level	Average Costs (*2022$*)				Simple Payback (*years*)	Average Lifetime (*years*)
	Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
Baseline	4,333	2,132	32,211	36,544	-	22.2
1	4,392	2,086	31,528	35,920	1.3	22.2
2	4,451	2,043	30,876	35,327	1.3	22.2
3	5,898	1,920	29,212	35,110	7.4	22.2

Note: The results for each EL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product.

Table V.2 Average LCC Savings Relative to the No-New-Standards Case for NWOF

Efficiency Level	Life-Cycle Cost Savings	
	Average LCC Savings* (*2022$*)	Percentage of Consumers that Experience Net Cost
1	608	0.5%
2	820	1.4%
3	1015	37.0%

Note: The savings represent the average LCC for affected consumers.

Table V.3 Average LCC and PBP Results by Efficiency Level for MHOF

Efficiency Level	Average Costs (*2022$*)				Simple Payback (*years*)	Average Lifetime (*years)*
	Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
Baseline	3,377	1,142	17,913	21,290	-	22.6
1	3,465	1,107	17,371	20,836	2.5	22.6
2	3,523	1,085	17,030	20,553	2.5	22.6
3	3,581	1,063	16,705	20,286	2.6	22.6

Note: The results for each EL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product.

Table V.4 Average LCC Savings Relative to the No-New-Standards Case for MHOF

Efficiency Level	Life-Cycle Cost Savings	
	Average LCC Savings* (*2022$*)	Percentage of Consumers that Experience Net Cost
1	452	0.8%
2	724	0.9%
3	971	1.0%

Note: The savings represent the average LCC for affected consumers.

Table V.5 Average LCC and PBP Results by Efficiency Level for WGF

Efficiency Level	Average Costs (*2022$*)				Simple Payback (*years*)	Average Lifetime (*years)*
	Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
Baseline	5,533	471	7,215	12,748	-	20.6
1	5,822	433	6,698	12,519	7.5	20.6

Note: The results for each EL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product.

Table V.6 Average LCC Savings Relative to the No-New-Standards Case for WGF

Efficiency Level	Life-Cycle Cost Savings	
	Average LCC Savings* (*2022$*)	Percentage of Consumers that Experience Net Cost
1	223	40.4%

Note: The savings represent the average LCC for affected consumers.

NYSERDA commented that DOE does not specifically mention the types of consumer subgroups to be included in the analysis of this rulemaking. NYSERDA recommended that DOE include low-income customers as one of the subgroups for this analysis and include the percentage of monthly income spent on energy bills. (NYSERDA, No. 19 at p. 2) NYSERDA mentioned that the NWGF/MHGF rulemaking analysis found that a more-stringent standard was especially beneficial to low-income and senior-only households as compared to the overall population. The commenter argued that renters who pay their own energy bills will particularly benefit. NYSERDA encouraged DOE to continue such analysis for this rulemaking, as it anticipates a similar outcome to the NWGF/MHGF rulemaking. (*Id.* at pp. 2–3)

In response, because DOE has tentatively determined that amended standards for the products considered in this NOPD would not be economically justified, DOE has not conducted a consumer subgroup analysis.

NYSERDA encouraged DOE to report the fraction of customers who pay less than six percent of their monthly income in energy bills at each EL. The commenter asserted that such fraction would continue to increase at each EL with more-stringent standards, adding that this approach presents a more comprehensive framework to look at energy burdens reduced by appliance standards. NYSERDA recommended that this statistic should be a routine part of DOE's LCC subgroups analysis, especially for appliances involving natural gas and oil. (NYSERDA, No. 19 at p. 3)

As noted previously, DOE is not conducting a consumer subgroup analysis for this NOPD, but the Department may consider NYSERDA's recommendation as part of a future rulemaking.

B. National Impact Analysis

This section presents DOE's estimates of the NES and the NPV of consumer benefits that would result from each of the ELs considered as potential amended standards.

1. Significance of Energy Savings

To estimate the energy savings attributable to potential amended standards for oil and weatherized gas furnaces, DOE compared their energy consumption under the no-new-standards case to their anticipated energy consumption under each EL. The savings are measured over the entire lifetime of products purchased in the 30-year period that begins in the year of anticipated compliance with amended standards (2030–2059). Table V.7 presents DOE's projections of the NES for each EL considered for oil and weatherized gas furnaces. The savings were calculated using the approach described in section IV.G of this document.

Table V.7 Cumulative National Energy Savings for Oil and Weatherized Gas Furnaces; 30 Years of Shipments (2030–2059)

Product Class	Efficiency Level		
	1	2	3
	FFC Energy Savings (*quads*)		
Non-Weatherized Oil Furnace	0.004	0.01	0.05
Mobile Home Non-Weatherized Oil Furnace	0.0004	0.001	0.001
Weatherized Gas Furnace	0.66		

OMB Circular A-4[63] requires agencies to present analytical results, including separate schedules of the monetized benefits and costs that show the type and timing of benefits and costs. Circular A-4 also directs agencies to consider the variability of key elements underlying the estimates of benefits and costs. For this proposed determination, DOE undertook a sensitivity analysis using nine years, rather than 30 years, of product shipments. The choice of a nine-year period is a proxy for the timeline in EPCA for the review of certain energy conservation standards and potential revision of and compliance with such revised standards.[64] The review timeframe established in EPCA is generally not synchronized with the product lifetime, product manufacturing cycles, or

[63] U.S. Office of Management and Budget, *Circular A-4: Regulatory Analysis* (Sept. 17, 2003) (Available at: *https://www.whitehouse.gov/omb/information-for-agencies/circulars/*) (Last accessed June 1, 2023).
[64] EPCA requires DOE to review its standards at least once every 6 years, and requires, for certain products, a 3-year period after any new standard is promulgated before compliance is required, except that in no case may any new standards be required within 6 years of the compliance date of the previous standards. (42 U.S.C. 6295(m)) If DOE makes a determination that amended standards are not needed, it must conduct a subsequent review within three years following such a determination. As DOE is evaluating the need to amend the standards, the sensitivity analysis is based on the review timeframe associated with amended standards. While adding a 6-year review to the 3-year compliance period adds up to 9 years, DOE notes that it may undertake reviews at any time within the 6-year period and that the 3-year compliance date may yield to the 6-year backstop. A 9-year analysis period may not be appropriate given the variability that occurs in the timing of standards reviews and the fact that for some products, the compliance period is 5 years rather than 3 years.

other factors specific to oil and weatherized gas furnaces. Thus, such results are presented for informational purposes only and are not indicative of any change in DOE's analytical methodology. The NES sensitivity analysis results based on a nine-year analytical period are presented in Table V.8. The impacts are counted over the lifetime of oil and weatherized gas furnaces purchased in 2030–2038.

Table V.8 Cumulative National Energy Savings for Oil and Weatherized Gas Furnaces; 9 Years of Shipments (2030–2038)

Product Class	**Efficiency Level**		
	1	**2**	**3**
	FFC Energy Savings (*quads*)		
Non-Weatherized Oil Furnace	0.002	0.01	0.02
Mobile Home Non-Weatherized Oil Furnace	0.0002	0.0004	0.001
Weatherized Gas Furnace	0.20		

2. Net Present Value of Consumer Costs and Benefits

DOE estimated the cumulative NPV of the total costs and savings for consumers that would result from the ELs considered for oil and weatherized gas furnaces. In accordance with OMB's guidelines on regulatory analysis,[65] DOE calculated NPV using both a 7-percent and a 3-percent real discount rate. Table V.9 shows the consumer NPV results with impacts counted over the lifetime of products purchased in 2030–2059.

[65] U.S. Office of Management and Budget, *Circular A-4: Regulatory Analysis* (Sept. 17, 2003) (Available at: *obamawhitehouse.archives.gov/omb/circulars_a004_a-4/*) (Last accessed June 1, 2023).

Table V.9 Cumulative Net Present Value of Consumer Benefits for Oil and Weatherized Gas Furnaces; 30 Years of Shipments (2030–2059)

Discount Rate	Product Class	Efficiency Level (EL)		
		1	2	3
		billion 2022$		
3%	Non-Weatherized Oil Furnace	0.06	0.20	0.20
	Mobile Home Non-Weatherized Oil Furnace	0.01	0.01	0.01
	Weatherized Gas Furnace	1.88		
7%	Non-Weatherized Oil Furnace	0.02	0.08	0.03
	Mobile Home Non-Weatherized Oil Furnace	0.002	0.003	0.005
	Weatherized Gas Furnace	0.45		

The NPV results based on the aforementioned nine-year analytical period are presented in Table V.10. The impacts are counted over the lifetime of oil and weatherized gas furnaces purchased in 2030–2038. As mentioned previously, such results are presented for informational purposes only and are not indicative of any change in DOE's analytical methodology or decision criteria.

Table V.10 Cumulative Net Present Value of Consumer Benefits for Oil and Weatherized Gas Furnaces; 9 Years of Shipments (2030–2038)

Discount Rate	Product Class	Efficiency Level (EL)		
		1	2	3
		billion 2022$		
3%	Non-Weatherized Oil Furnace	0.03	0.11	0.12
	Mobile Home Non-Weatherized Oil Furnace	0.003	0.01	0.01
	Weatherized Gas Furnace	0.67		
7%	Non-Weatherized Oil Furnace	0.02	0.05	0.02
	Mobile Home Non-Weatherized Oil Furnace	0.002	0.003	0.004
	Weatherized Gas Furnace	0.22		

C. Proposed Determination

After carefully considering the comments on the November 2022 Preliminary Analysis and the available data and information, DOE has tentatively determined that the energy conservation standards for oil, electric, and weatherized gas furnaces do not need to be amended, for the reasons explained in the paragraphs immediately following. DOE will consider all comments received on this proposed determination prior to issuing the next document in this rulemaking proceeding.

As required by EPCA, this NOPD analyzes whether amended standards for oil, electric, and weatherized gas furnaces would result in significant conservation of energy, be technologically feasible, and be cost-effective. (42 U.S.C. 6295(m)(1)(A) and 42 U.S.C. 6295(n)(2)) DOE's initial findings under the enumerated statutory criteria and the additional analysis are discussed in the paragraphs that follows. Because an analysis of potential cost-effectiveness and energy savings first requires an evaluation of the relevant technology, DOE first discusses the technological feasibility of amended standards. DOE then addresses the cost-effectiveness and energy savings associated with potential amended standards for the subject furnaces.

1. Technological Feasibility

EPCA mandates that DOE consider whether amended energy conservation standards for oil, electric, and weatherized gas furnaces would be technologically feasible. (42 U.S.C. 6295(m)(1)(A) and 42 U.S.C. 6295(n)(2)(B)) DOE has tentatively determined that there are technology options that would improve the efficiency of oil and weatherized gas furnaces. These technology options are being used in commercially available oil and weatherized gas furnaces and, therefore, are technologically feasible. (See section IV.A.3 of this document for further information.) Hence, DOE has tentatively determined that amended energy conservation standards for oil and weatherized gas furnaces are technologically feasible. However, as discussed in section IV.A.1.a of this document, DOE is not aware of any technology options that would improve the efficiency of electric furnaces. Therefore, DOE has tentatively determined that amended energy conservation standards for electric furnaces are not technologically feasible.

2. Cost-Effectiveness

EPCA requires DOE to consider whether energy conservation standards for oil and weatherized gas furnaces would be cost-effective through an evaluation of the savings in operating costs throughout the estimated average life of the covered product compared to any increase in the price of, or in the initial charges for, or maintenance expenses of, the covered products which are likely to result from the imposition of an amended standard. (42 U.S.C. 6295(m)(1)(A), 42 U.S.C. 6295(n)(2)(C), and 42 U.S.C. 6295(o)(2)(B)(i)(II)) DOE conducted an LCC analysis to estimate the net costs/benefits to users from increased efficiency in the considered oil and weatherized gas furnace product classes. As shown in Table V.1 through Table V.6, for all product classes, all of the considered efficiency levels result in positive LCC savings, with the percentage of consumers experiencing net cost ranging from 0.5 percent at EL 1 to 37 percent at max-tech for NWOF, approximately 1 percent at all ELs for MHOF, and 40 percent at the only considered efficiency level for WGF.

DOE then aggregated the results from the LCC analysis to estimate the NPV of the total costs and benefits experienced by the Nation. (See results in Table V.9 and Table V.10) As noted, the inputs for determining the NPV are: (1) total annual installed cost; (2) total annual operating costs (energy costs and repair and maintenance costs), and (3) a discount factor to calculate the present value of costs and savings.

3. Significant Conservation of Energy

EPCA also mandates that DOE consider whether amended energy conservation standards for oil and weatherized gas furnaces would result in significant conservation of energy. (42 U.S.C. 6295(m)(1)(A) and 42 U.S.C. 6295(n)(2)(A))

To estimate the energy savings attributable to potential amended standards for oil and weatherized gas furnaces, DOE compared their energy consumption under the no-new-standards case to their anticipated energy consumption under each potential standard level. The savings are measured over the entire lifetime of products purchased in the 30-year period that begins in the year of anticipated compliance with amended standards (2030–2059).

As shown in Table V.7, DOE estimates that amended standards would results in FFC energy savings of 0.004 quads at EL 1 to 0.05 quads at max-tech level for non-weatherized oil furnaces, 0.0004 quads at EL 1 to 0.001 quads at max-tech level for mobile home non-weatherized oil furnaces, and 0.66 quads at EL 1 (max-tech level) for weatherized gas furnaces, over a 30-year analysis period (2030–2059).

4. Further Considerations

Oil Furnaces

DOE estimates that the shipments of NWOFs and MHOFs have declined by more than 70 percent over the past 20 years and only accounted for less than one percent of the overall consumer furnace market in the past 10 years. DOE considered this declining trend and the small market share for oil furnaces in the furnace shipments model and projected that the shipments of NWOFs and MHOFs will continue to decline over the analysis period (*i.e.*, 2030-2059). DOE also considered that the shipments of NWOFs and MHOFs could decline faster than current projections, which may lead to further reductions in energy savings from potential amended standards.

As the oil furnace market contracted, the industry has seen consolidation. DOE estimates there were 11 OEMs of NWOF selling into the U.S. market at the time of the June 2011 DFR that set current standard levels for oil furnaces. Since then, manufacturers have merged, been acquired, and left the market. Currently there are seven OEMs of NWOF selling into the U.S. market.

DOE estimated the NWOF market to be approximately 36,000 units per year and the MHOF market to be approximately 2,000 units per year in 2023. These products together are less than one percent of the overall U.S. residential furnace market, which is approximately 4.2 million shipments per year in 2023. The size of the market could make cost recovery challenging for manufacturers. With the small market size and continued trend of diminishing sales, the timeframe for recouping investments may be longer than acceptable for manufacturers. Given the small role of oil furnaces in the overall furnace market and the low sales relative to the consumer boiler and consumer water heater markets, manufacturers may de-prioritize updates for these product classes. The existing oil-fired furnace market currently has a diversity of competitors; however, the loss of a few manufacturers could lead to shifts in market competition.

Weatherized Gas Furnaces

DOE estimates that the shipments of WGFs have been approximately 0.35 million per year for the past 10 years and accounted for approximately 7 percent of the overall consumer furnace market over the past 20 years. DOE considered the small market share for WGFs in the furnace shipments model and projected that the shipments of WGFs will be approximately flat and account for less than 8 percent of the overall consumer furnace market over the analysis period (*i.e.*, 2030-2059). DOE also considered that the shipments of WGFs could be less than current projections, which may lead to reductions in energy savings from potential amended standards.

WGFs have the largest potential energy savings of the product classes in this rulemaking. However, DOE recognizes challenges for the industry at the max-tech level, which requires condensing furnace designs. DOE identified eight OEMs of weatherized gas furnaces. Only one OEM offers models that can meet the max-tech level. Models that meet the max-tech level account for 1 percent of all WGF listings.

All other OEMs would need to invest in new WGF designs to meet a condensing efficiency level. DOE expects that developing a new condensing model lines would require significant investment. If manufacturers plan to continue offering the same diversity of models, they would need to redesign nearly 1,500 basic models, or 99 percent of what is available on the market today. Designing condensing models would require the incorporation of a secondary heat exchanger and condensate management system. Manufacturers would likely need to reconfigure their existing heat exchanger to optimize airflow over the secondary heat exchanger, which could require investments in product redesign and retooling for hard-tooled portions of the heat exchanger. Manufacturers may also have to choose between adding the secondary heat exchanger within the physical limitations of the existing chassis dimension or adopting a new chassis size, which has the potential to be capital intensive. The added production of the secondary heat exchanger could necessitate additional floor space and increased assembly and fabrication times.

DOE observed that the range of heating capacities offered at EL 1 do not cover the same range of capacities as non-condensing models. Condensing WGF models range from 60 to 96 kBtu/h, whereas non-condensing WGF models span capacities from 40 to 150 kBtu/h. DOE is concerned that amended standards for WGFs may limit capacity availability for consumers.

5. Summary

As discussed previously, a determination that amended standards are not needed must be based on consideration of whether amended standards will result in significant conservation of energy, are technologically feasible, and are cost-effective. (42 U.S.C. 6295(m)(1)(A) and 42 U.S.C. 6295(n)(2)) Additionally, DOE can only propose an amended standard if it is, among other things, economically justified. (42 U.S.C. 6295(m)(1)(B); 42 U.S.C. 6295(o)(2)(A))

As explained elsewhere in this document , DOE has tentatively determined that amended energy conservation standards for electric furnaces are not technologically feasible. Oil-fired furnaces and WGFs have relatively small markets and shipments of these products are expected to flatten or decline; manufacturers facing increased standards for these product categories may opt to focus on products with larger market shares, resulting in certain products or capacities becoming unavailable for consumers as well as further consolidation of the market. Consequently, DOE has tentatively determined that it is unable to conclude that amended standards for oil-fired furnaces and WGFs would be economically justified. For these reasons, as well as those discussed throughout this notice, DOE is unable to conclude that amended standards for furnaces at any of the efficiency levels analyzed would meet the applicable statutory criteria. Therefore, DOE has tentatively determined that energy conservation standards for oil, electric, and weatherized gas furnaces do not need to be amended at this time.

DOE requests comments on its proposed determination that the existing energy conservation standards for oil, electric, and weatherized gas furnaces do not need to be amended. DOE will consider all comments received on this proposed determination before issuing the next document in this proceeding.

VI. Procedural Issues and Regulatory Review

A. Review Under Executive Orders 12866, 13563, and 14094

Executive Order ("E.O.") 12866, "Regulatory Planning and Review," 58 FR 51735 (Oct. 4, 1993), as supplemented and reaffirmed by E.O. 13563, "Improving Regulation and Regulatory Review," 76 FR 3821 (Jan. 21, 2011) and amended by E.O. 14094, "Modernizing Regulatory Review," 88 FR 21879 (April 11, 2023), requires agencies, to the extent permitted by law, to: (1) propose or adopt a regulation only upon a reasoned determination that its benefits justify its costs (recognizing that some benefits and costs are difficult to quantify); (2) tailor regulations to impose the least burden on society, consistent with obtaining regulatory objectives, taking into account, among other things, and to the extent practicable, the costs of cumulative regulations; (3) select, in choosing among alternative regulatory approaches, those approaches that maximize net benefits (including potential economic, environmental, public health and safety, and other advantages; distributive impacts; and equity); (4) to the extent feasible, specify performance objectives, rather than specifying the behavior or manner of compliance that regulated entities must adopt; and (5) identify and assess available alternatives to direct regulation, including providing economic incentives to encourage the desired behavior, such as user fees or marketable permits, or providing information upon which choices can be made by the public. DOE emphasizes as well that E.O. 13563 requires agencies to use the best available techniques to quantify anticipated present and future benefits and costs as accurately as possible. In its guidance, the Office of Information and Regulatory Affairs ("OIRA") in the Office of Management and Budget ("OMB") has emphasized that such techniques may include identifying changing future compliance costs that might result from technological innovation or anticipated behavioral changes. For the reasons stated in this preamble, this proposed regulatory action is consistent with these principles.

Section 6(a) of E.O. 12866 also requires agencies to submit “significant regulatory actions” to OIRA for review. OIRA has determined that this proposed regulatory action does not constitute a “significant regulatory action” within the scope of section 3(f)(1) of E.O. 12866, as amended by E.O. 14094. Accordingly, this action was not submitted to OIRA for review under E.O. 12866.

B. Review Under the Regulatory Flexibility Act

The Regulatory Flexibility Act (5 U.S.C. 601 *et seq.*) requires preparation of an initial regulatory flexibility analysis (“IRFA”) and a final regulatory flexibility analysis (“FRFA”) for any rule that by law must be proposed for public comment, unless the agency certifies that the rule, if promulgated, will not have a significant economic impact on a substantial number of small entities. As required by E.O. 13272, “Proper Consideration of Small Entities in Agency Rulemaking,” 67 FR 53461 (August 16, 2002), DOE published procedures and policies in the *Federal Register* on February 19, 2003, to ensure that the potential impacts of its rules on small entities are properly considered during the rulemaking process. 68 FR 7990. DOE has made its procedures and policies available on the Office of the General Counsel’s website (*energy.gov/gc/office-general-counsel*).

DOE reviewed this proposed determination under the provisions of the Regulatory Flexibility Act and the policies and procedures published on February 19,

2003. Because DOE is proposing not to amend standards for oil, electric, and weatherized gas furnaces, if adopted, the determination would not amend any energy conservation standards. On the basis of the foregoing, DOE certifies that the proposed determination, if adopted, would not have a significant economic impact on a substantial number of small entities. Accordingly, DOE has not prepared an IRFA for this proposed determination. DOE will transmit this certification and supporting statement of factual basis to the Chief Counsel for Advocacy of the Small Business Administration for review under 5 U.S.C. 605(b).

C. Review Under the Paperwork Reduction Act of 1995

This proposed determination, which proposes to determine that amended energy conservation standards for oil, electric, and weatherized gas furnaces are unneeded under the applicable statutory criteria, would impose no new informational or recordkeeping requirements. Accordingly, OMB clearance is not required under the Paperwork Reduction Act. (44 U.S.C. 3501 *et seq*.)

D. Review Under the National Environmental Policy Act of 1969

DOE is analyzing this proposed action in accordance with the National Environmental Policy Act of 1969 ("NEPA") and DOE's NEPA implementing regulations (10 CFR part 1021). DOE's regulations include a categorical exclusion for actions which are interpretations or rulings with respect to existing regulations. 10 CFR part 1021, subpart D, appendix A4. DOE anticipates that this action qualifies for categorical exclusion A4 because it is an interpretation or ruling in regard to an existing regulation and otherwise meets the requirements for application of a categorical exclusion. *See* 10 CFR 1021.410. DOE will complete its NEPA review before issuing the final action.

E. Review Under Executive Order 13132

E.O. 13132, "Federalism," 64 FR 43255 (August 10, 1999), imposes certain requirements on Federal agencies formulating and implementing policies or regulations that preempt State law or that have Federalism implications. The Executive order requires agencies to examine the constitutional and statutory authority supporting any action that would limit the policymaking discretion of the States and to carefully assess the necessity for such actions. The Executive order also requires agencies to have an accountable process to ensure meaningful and timely input by State and local officials in the development of regulatory policies that have federalism implications. On March 14, 2000, DOE published a statement of policy describing the intergovernmental consultation process it will follow in the development of such regulations. 65 FR 13735. DOE has examined this proposed determination and has tentatively determined that it would not have a substantial direct effect on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government. EPCA governs and prescribes Federal preemption of State regulations as to energy conservation for the products that are the subject of this proposed determination. States can petition DOE for exemption from such preemption to the extent, and based on criteria, set forth in EPCA. (42 U.S.C. 6297) Therefore, no further action is required by E.O. 13132.

F. Review Under Executive Order 12988

With respect to the review of existing regulations and the promulgation of new regulations, section 3(a) of E.O. 12988, "Civil Justice Reform," 61 FR 4729 (Feb. 7, 1996), imposes on Federal agencies the general duty to adhere to the following requirements: (1) eliminate drafting errors and ambiguity; (2) write regulations to minimize litigation; (3) provide a clear legal standard for affected conduct rather than a general standard, and (4) promote simplification and burden reduction. Regarding the review required by section 3(a), section 3(b) of E.O. 12988 specifically requires that Executive agencies make every reasonable effort to ensure that the regulation: (1) clearly specifies the preemptive effect, if any; (2) clearly specifies any effect on existing Federal law or regulation; (3) provides a clear legal standard for affected conduct while promoting simplification and burden reduction; (4) specifies the retroactive effect, if any; (5) adequately defines key terms, and (6) addresses other important issues affecting clarity and general draftsmanship under any guidelines issued by the Attorney General. Section 3(c) of Executive Order 12988 requires Executive agencies to review regulations in light of applicable standards in section 3(a) and section 3(b) to determine whether they are met or it is unreasonable to meet one or more of them. DOE has completed the required review and determined that, to the extent permitted by law, this proposed determination meets the relevant standards of E.O. 12988.

G. Review Under the Unfunded Mandates Reform Act of 1995

Title II of the Unfunded Mandates Reform Act of 1995 ("UMRA") requires each Federal agency to assess the effects of Federal regulatory actions on State, local, and Tribal governments and the private sector. Pub. L. 104-4, sec. 201 (codified at 2 U.S.C.

1531). For a proposed regulatory action likely to result in a rule that may cause the expenditure by State, local, and Tribal governments, in the aggregate, or by the private sector of $100 million or more in any one year (adjusted annually for inflation), section 202 of UMRA requires a Federal agency to publish a written statement that estimates the resulting costs, benefits, and other effects on the national economy. (2 U.S.C. 1532(a), (b)) The UMRA also requires a Federal agency to develop an effective process to permit timely input by elected officers of State, local, and Tribal governments on a proposed "significant intergovernmental mandate," and requires an agency plan for giving notice and opportunity for timely input to potentially affected small governments before establishing any requirements that might significantly or uniquely affect them. On March 18, 1997, DOE published a statement of policy on its process for intergovernmental consultation under UMRA. 62 FR 12820. DOE's policy statement is also available at *energy.gov/sites/prod/files/gcprod/documents/umra_97.pdf*.

DOE examined this proposed determination according to UMRA and its statement of policy and determined that the proposed determination does not contain a Federal intergovernmental mandate, nor is it expected to require expenditures of $100 million or more in any one year by State, local, and Tribal governments, in the aggregate, or by the private sector. As a result, the analytical requirements of UMRA do not apply.

H. Review Under the Treasury and General Government Appropriations Act, 1999

Section 654 of the Treasury and General Government Appropriations Act, 1999 (Pub. L. 105-277) requires Federal agencies to issue a Family Policymaking Assessment for any rule that may affect family well-being. This proposed determination would not have any impact on the autonomy or integrity of the family as an institution. Accordingly, DOE has concluded that it is not necessary to prepare a Family Policymaking Assessment.

I. Review Under Executive Order 12630

Pursuant to E.O. 12630, "Governmental Actions and Interference with Constitutionally Protected Property Rights," 53 FR 8859 (March 18, 1988), DOE has determined that this proposed determination would not result in any takings that might require compensation under the Fifth Amendment to the U.S. Constitution.

J. Review Under the Treasury and General Government Appropriations Act, 2001

Section 515 of the Treasury and General Government Appropriations Act, 2001 (44 U.S.C. 3516 note) provides for Federal agencies to review most disseminations of information to the public under information quality guidelines established by each agency pursuant to general guidelines issued by OMB. OMB's guidelines were published at 67 FR 8452 (Feb. 22, 2002), and DOE's guidelines were published at 67 FR 62446 (Oct. 7, 2002). Pursuant to OMB Memorandum M-19-15, "Improving Implementation of the Information Quality Act" (April 24, 2019), DOE published updated guidelines which are available at: *www.energy.gov/sites/prod/files/2019/12/f70/DOE%20Final%20Updated%20IQA%20Guidelines%20Dec%202019.pdf*. DOE has reviewed this NOPD under the OMB and DOE guidelines and has concluded that it is consistent with applicable policies in those guidelines.

K. Review Under Executive Order 13211

E.O. 13211, "Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use," 66 FR 28355 (May 22, 2001), requires Federal agencies to prepare and submit to the Office of Information and Regulatory Affairs ("OIRA") at OMB, a Statement of Energy Effects for any proposed significant energy action. A "significant energy action" is defined as any action by an agency that promulgates or is expected to lead to promulgation of a final rule, and that: (1) is a significant regulatory action under Executive Order 12866, or any successor Executive Order; and (2) is likely to have a significant adverse effect on the supply, distribution, or use of energy, or (3) is designated by the Administrator of OIRA as a significant energy action. For any proposed significant energy action, the agency must give a detailed statement of any adverse effects on energy supply, distribution, or use should the proposal be implemented, and of reasonable alternatives to the action and their expected benefits on energy supply, distribution, and use.

This proposed determination, which does not propose to amend energy conservation standards for oil, electric, and weatherized gas furnaces, is not a significant regulatory action under Executive Order 12866. Moreover, it would not have a significant adverse effect on the supply, distribution, or use of energy, nor has it been designated as such by the Administrator at OIRA. Therefore, it is not a significant energy action, and accordingly, DOE has not prepared a Statement of Energy Effects.

L. Review Under the Information Quality Bulletin for Peer Review

On December 16, 2004, OMB, in consultation with the Office of Science and Technology Policy ("OSTP"), issued its Final Information Quality Bulletin for Peer Review ("the Bulletin"). 70 FR 2664 (Jan. 14, 2005). The Bulletin establishes that certain scientific information shall be peer reviewed by qualified specialists before it is disseminated by the Federal Government, including influential scientific information related to agency regulatory actions. The purpose of the bulletin is to enhance the quality and credibility of the Government's scientific information. Under the Bulletin, the energy conservation standards rulemaking analyses are "influential scientific information," which the Bulletin defines as "scientific information the agency reasonably can determine will have, or does have, a clear and substantial impact on important public policies or private sector decisions." *Id.* at 70 FR 2667.

In response to OMB's Bulletin, DOE conducted formal peer reviews of the energy conservation standards development process and the analyses that are typically used and has prepared a Peer Review report pertaining to the energy conservation standards rulemaking analyses.[66] Generation of this report involved a rigorous, formal, and documented evaluation using objective criteria and qualified and independent reviewers to make a judgment as to the technical/scientific/business merit, the actual or anticipated results, and the productivity and management effectiveness of programs and/or projects. Because available data, models, and technological understanding have

[66] "Energy Conservation Standards Rulemaking Peer Review Report" (2007) (Available at: *energy.gov/eere/buildings/downloads/energy-conservation-standards-rulemaking-peer-review-report-0*) (Last accessed June 26, 2023).

changed since 2007, DOE has engaged with the National Academy of Sciences ("NAS") to review DOE's analytical methodologies and ascertain whether modifications are needed to improve DOE's analyses. DOE is in the process of evaluating the resulting December 2021 report.[67]

VII. Public Participation

A. Participation in the Public Meeting Webinar

DOE will hold a public meeting webinar upon receiving a request by the deadline identified in the **DATES** section at the beginning of this proposed determination. Interested persons may submit their request for the public meeting webinar to the Appliance and Equipment Standards Program at *OEWGFurnaces2021STD0031@ee.doe.gov*. If a public meeting webinar is requested, DOE will release webinar registration information, participant instructions, and information about the capabilities available to webinar participants on DOE's website at: *www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=59*. Participants are responsible for ensuring their systems are compatible with the webinar software.

B. Submission of Comments

DOE will accept comments, data, and information regarding this proposed determination no later than the date provided in the **DATES** section at the beginning of

[67] The December 2021 NAS report is available at *www.nationalacademies.org/our-work/review-of-methods-for-setting-building-and-equipment-performance-standards* (Last accessed June 26, 2023).

this proposed determination. Interested parties may submit comments, data, and other information using any of the methods described in the **ADDRESSES** section at the beginning of this document.

Submitting comments via www.regulations.gov. The *www.regulations.gov* webpage will require you to provide your name and contact information. Your contact information will be viewable to DOE Building Technologies staff only. Your contact information will not be publicly viewable except for your first and last names, organization name (if any), and submitter representative name (if any). If your comment is not processed properly because of technical difficulties, DOE will use this information to contact you. If DOE cannot read your comment due to technical difficulties and cannot contact you for clarification, DOE may not be able to consider your comment.

However, your contact information will be publicly viewable if you include it in the comment itself or in any documents attached to your comment. Any information that you do not want to be publicly viewable should not be included in your comment, nor in any document attached to your comment. Otherwise, persons viewing comments will see only first and last names, organization names, correspondence containing comments, and any documents submitted with the comments.

Do not submit to *www.regulations.gov* information for which disclosure is restricted by statute, such as trade secrets and commercial or financial information (hereinafter referred to as Confidential Business Information ("CBI")). Comments submitted through *www.regulations.gov* cannot be claimed as CBI. Comments received through the website will waive any CBI claims for the information submitted. For information on submitting CBI, *see* the Confidential Business Information section.

DOE processes submissions made through *www.regulations.gov* before posting. Normally, comments will be posted within a few days of being submitted. However, if large volumes of comments are being processed simultaneously, your comment may not be viewable for up to several weeks. Please keep the comment tracking number that *www.regulations.gov* provides after you have successfully uploaded your comment.

Submitting comments via email, hand delivery/courier, or postal mail. Comments and documents submitted via email, hand delivery/courier, or postal mail also will be posted to *www.regulations.gov*. If you do not want your personal contact information to be publicly viewable, do not include it in your comment or any accompanying documents. Instead, provide your contact information in a cover letter. Include your first and last names, email address, telephone number, and optional mailing address. With this instruction followed, the cover letter will not be publicly viewable as long as it does not include any comments.

Include contact information each time you submit comments, data, documents, and other information to DOE. If you submit via postal mail or hand delivery/courier, please provide all items on a CD, if feasible, in which case it is not necessary to submit printed copies. No telefacsimiles (faxes) will be accepted.

Comments, data, and other information submitted to DOE electronically should be provided in PDF (preferred), Microsoft Word or Excel, WordPerfect, or text (ASCII) file format. Provide documents that are not secured, that are written in English, and that are free of any defects or viruses. Documents should not contain special characters or any form of encryption, and, if possible, they should carry the electronic signature of the author.

Campaign form letters. Please submit campaign form letters by the originating organization in batches of between 50 to 500 form letters per PDF or as one form letter with a list of supporters' names compiled into one or more PDFs. This reduces comment processing and posting time.

Confidential Business Information. Pursuant to 10 CFR 1004.11, any person submitting information that he or she believes to be confidential and exempt by law from public disclosure should submit via email two well-marked copies: one copy of the document marked "confidential" including all the information believed to be confidential, and one copy of the document marked "non-confidential" with the information believed to be confidential deleted. DOE will make its own determination about the confidential status of the information and treat it according to its determination.

It is DOE's policy that all comments may be included in the public docket, without change and as received, including any personal information provided in the comments (except information deemed to be exempt from public disclosure).

C. Issues on Which DOE Seeks Comment

Although DOE has not identified any specific issues on which it seeks comment, DOE welcomes comments on any aspect of this proposed determination.

VIII. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of this notification of proposed determination and request for comment.

Signing Authority

This document of the Department of Energy was signed on November 17, 2023, by Jeffrey Marootian, Principal Deputy Assistant Secretary for Energy Efficiency and Renewable Energy, pursuant to delegated authority from the Secretary of Energy. That document with the original signature and date is maintained by DOE. For administrative purposes only, and in compliance with requirements of the Office of the Federal Register, the undersigned DOE Federal Register Liaison Officer has been authorized to sign and submit the document in electronic format for publication, as an official document of the Department of Energy. This administrative process in no way alters the legal effect of this document upon publication in the *Federal Register*.

Signed in Washington, D.C., on November 17, 2023.

X Jeffrey M. Maroottian

Digitally signed by Jeffrey M. Marootian
Date: 2023.11.17 12:04:40 -05'00'

Jeffrey Marootian
Principal Deputy Assistant Secretary
for Energy Efficiency and Renewable Energy
U.S. Department of Energy