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10 CFR Part 431

Energy Conservation Program for Certain Industrial Equipment: Energy Conservation Standards and Test Procedures for Commercial Heating, Air-Conditioning, and Water-Heating Equipment; Proposed Rule

## DEPARTMENT OF ENERGY

## 10 CFR Part 431

[Docket No. EERE-2014-BT-STD-0015]

RIN 1904-AD23

**Energy Conservation Program for Certain Industrial Equipment: Energy Conservation Standards and Test Procedures for Commercial Heating, Air-Conditioning, and Water-Heating Equipment**

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

**ACTION:** Notice of proposed rulemaking (NPR) and announcement of public meeting.

**SUMMARY:** The Energy Policy and Conservation Act of 1975 (EPCA), as amended, prescribes energy conservation standards for various consumer products and certain commercial and industrial equipment, including several classes of commercial heating, air-conditioning, and water-heating equipment. EPCA also requires that each time the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 90.1 is amended with respect to the standard levels or design requirements applicable to that equipment, the U.S. Department of Energy (DOE) must adopt amended uniform national standards for this equipment equivalent to those in ASHRAE Standard 90.1, unless DOE determines that there is clear and convincing evidence showing that more-stringent, amended standards would be technologically feasible and economically justified, and would save a significant additional amount of energy. ASHRAE most recently amended Standard 90.1 on October 9, 2013. Based upon its analysis of the energy savings potential of amended energy conservation standards and the lack of clear and convincing evidence to support more-stringent standards, DOE is proposing to adopt the amended standards in ASHRAE Standard 90.1 for: Small three-phase commercial air-cooled air conditioners (single package only) and heat pumps (single package and split system) less than 65,000 Btu/h; water-source heat pumps; and commercial oil-fired storage water heaters. DOE is also making a proposed determination that the standards for small three-phase commercial air-cooled air conditioners (split system) do not need to be amended. Finally, DOE is proposing updates to the current Federal test procedures to incorporate

by reference the most current version of the American National Standards Institute (ANSI) Z21.47, *Gas-fired central furnaces*, specified in ASHRAE Standard 90.1 applicable to commercial warm-air furnaces, and to the most current version of ASHRAE 103, *Method of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers*. This document also announces a public meeting to receive comment on these proposed standards and associated analyses and results, as well as the proposed test procedure provisions.

**DATES: Meeting:** DOE will hold a public meeting on Friday, February 6, 2015 from 1:00 p.m. to 4:00 p.m., in Washington, DC. The meeting will also be broadcast as a webinar. See section X, "Public Participation," for webinar registration information, participant instructions, and information about the capabilities available to webinar participants.

**Comments:** DOE will accept comments, data, and information regarding this notice of proposed rulemaking (NPR) before and after the public meeting, but no later than March 24, 2015. See section X, "Public Participation," for details.

**ADDRESSES:** The public meeting will be held at the U.S. Department of Energy, Forrestal Building, Room 8E-089, 1000 Independence Avenue SW., Washington, DC 20585. To attend, please notify Ms. Brenda Edwards at (202) 586-2945. Please note that foreign nationals visiting DOE Headquarters are subject to advance security screening procedures. Any foreign national wishing to participate in the meeting should advise DOE as soon as possible by contacting Ms. Edwards at the phone number above to initiate the necessary procedures. Please also note that any person wishing to bring a laptop or tablet into the Forrestal Building will be required to obtain a property pass. Visitors should avoid bringing laptops, or allow an extra 45 minutes. Persons may also attend the public meeting via webinar. For more information, refer to section X, "Public Participation," near the end of this document.

Due to the REAL ID Act implemented by the Department of Homeland Security (DHS), there have been recent changes regarding identification (ID) requirements for individuals wishing to enter Federal buildings from specific States and U.S. territories. As a result, driver's licenses from the following States or territory will not be accepted for building entry, and instead, one of the alternate forms of ID listed below will be required.

DHS has determined that regular driver's licenses (and ID cards) from the following jurisdictions are not acceptable for entry into DOE facilities: Alaska, American Samoa, Arizona, Louisiana, Maine, Massachusetts, Minnesota, New York, Oklahoma, and Washington.

Acceptable alternate forms of Photo-ID include: U.S. Passport or Passport Card; an Enhanced Driver's License or Enhanced ID-Card issued by the States of Minnesota, New York or Washington (Enhanced licenses issued by these States are clearly marked Enhanced or Enhanced Driver's License); a military ID or other Federal government-issued Photo-ID card.

**Instructions:** Any comments submitted must identify the NPR on Energy Conservation Standards and Test Procedures for ASHRAE Standard 90.1 Equipment, and provide docket number EERE-2014-BT-STD-0015 and/or regulatory information number (RIN) 1904-AD23. Comments may be submitted using any of the following methods:

1. **Federal eRulemaking Portal:** [www.regulations.gov](http://www.regulations.gov). Follow the instructions for submitting comments.

2. **E-Mail:** [ComHeatingACWH Equip2014STD0015@ee.doe.gov](mailto:ComHeatingACWH Equip2014STD0015@ee.doe.gov). Include the docket number and/or RIN in the subject line of the message. Submit electronic comments in WordPerfect, Microsoft Word, PDF, or ASCII file format, and avoid the use of special characters or any form of encryption.

3. **Postal Mail:** Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Office, Mailstop EE-5B, 1000 Independence Avenue SW., Washington, DC 20585-0121. If possible, please submit all items on a compact disc (CD), in which case it is not necessary to include printed copies.

4. **Hand Delivery/Courier:** Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Office, 950 L'Enfant Plaza SW., Suite 600, Washington, DC 20024. Telephone: (202) 586-2945. If possible, please submit all items on a CD, in which case it is not necessary to include printed copies.

Written comments regarding the burden-hour estimates or other aspects of the collection-of-information requirements contained in this proposed rule may be submitted to Office of Energy Efficiency and Renewable Energy through the methods listed above and by email to [Chad\\_S\\_Whiteman@omb.eop.gov](mailto:Chad_S_Whiteman@omb.eop.gov).

No telefacsimilies (faxes) will be accepted. For detailed instructions on submitting comments and additional

information on the rulemaking process, see section X 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](http://www.regulations.gov). All documents in the docket are listed in the [www.regulations.gov](http://www.regulations.gov) index. However, some documents listed in the index may not be publicly available, such as those containing information that is exempt from public disclosure.

A link to the docket Web page can be found at: [www.regulations.gov/#!docketDetail;D=EERE-2014-BT-STD-0015](http://www.regulations.gov/#!docketDetail;D=EERE-2014-BT-STD-0015). This Web page contains a link to the docket for this document on the [www.regulations.gov](http://www.regulations.gov) site. The [www.regulations.gov](http://www.regulations.gov) Web page contains simple instructions on how to access all documents, including public comments, in the docket. See section X, "Public Participation," for further information on how to submit comments through [www.regulations.gov](http://www.regulations.gov).

For further information on how to submit a comment, review other public comments and the docket, or participate in the public meeting, contact Ms. Brenda Edwards at (202) 586-2945 or by email: [Brenda.Edwards@ee.doe.gov](mailto:Brenda.Edwards@ee.doe.gov).

**FOR FURTHER INFORMATION CONTACT:** Ms. Ashley Armstrong, 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: (202) 586-6590. Email: [Ashley.Armstrong@ee.doe.gov](mailto:Ashley.Armstrong@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) 586-9507. Email: [Eric.Stas@hq.doe.gov](mailto:Eric.Stas@hq.doe.gov).

For information on how to submit or review public comments, contact Ms. Brenda Edwards at (202) 586-2945 or by email: [Brenda.Edwards@ee.doe.gov](mailto:Brenda.Edwards@ee.doe.gov).

**SUPPLEMENTARY INFORMATION:** DOE proposes to incorporate by reference the following industry standards into 10 CFR 431.76:

- ANSI Z21.47-2012, "Gas-Fired Central Furnaces," ANSI approved on March 27, 2012.

Copies of ANSI Z21.47-2012 can be obtained from ANSI, American National Standards Institute, 25 W. 43rd Street, 4th Floor, New York, NY 10036. (212) 642-4900, or by going to <http://www.ansi.org>.

- ASHRAE Standard 103-2007, sections 7.2.2.4, 7.8, 9.2, and 11.3.7,

"Method of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers," ANSI approved on March 25, 2008.

Copies of ASHRAE Standard 103-2007 can be obtained from ASHRAE, American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc., 1791 Tullie Circle NE., Atlanta, Georgia 30329. (404) 636-8400, or by going to <http://www.ashrae.org>.

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## I. Summary of the Proposed Rule

Title III, Part C<sup>1</sup> of the Energy Policy and Conservation Act of 1975 (“EPCA” or “the Act”), Public Law 94–163, (42 U.S.C. 6311–6317, as codified), added by Public Law 95–619, Title IV, section 441(a), established the Energy Conservation Program for Certain Industrial Equipment, which sets forth a variety of provisions designed to improve energy efficiency. These encompass several types of commercial heating, air-conditioning, and water-heating equipment, including those that are the subject of this rulemaking. (42 U.S.C. 6311(1)(B) and (K)) EPCA, as amended, also requires the U. S. Department of Energy (DOE) to consider amending the existing Federal energy conservation standard for certain types of listed commercial and industrial equipment (generally, commercial water heaters, commercial packaged boilers, commercial air-conditioning and

heating equipment, and packaged terminal air conditioners and heat pumps) each time the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 90.1, *Energy Standard for Buildings Except Low-Rise Residential Buildings*, is amended with respect to such equipment. (42 U.S.C.

6313(a)(6)(A)) For each type of equipment, EPCA directs that if ASHRAE Standard 90.1 is amended, DOE must adopt amended energy conservation standards at the new efficiency level in ASHRAE Standard 90.1, unless clear and convincing evidence supports a determination that adoption of a more-stringent efficiency level as a national standard would produce significant additional energy savings and be technologically feasible and economically justified. (42 U.S.C. 6313(a)(6)(A)(ii)) If DOE decides to adopt as a national standard the efficiency levels specified in the amended ASHRAE Standard 90.1, DOE must establish such standard not later than 18 months after publication of the amended industry standard. (42 U.S.C. 6313(a)(6)(A)(ii)(I)) If DOE determines that a more-stringent standard is appropriate under the statutory criteria, DOE must establish such more-stringent standard not later than 30 months after publication of the revised ASHRAE Standard 90.1. (42 U.S.C. 6313(a)(6)(B)) ASHRAE officially released ASHRAE Standard 90.1–2013 on October 9, 2013, thereby triggering DOE’s previously referenced obligations pursuant to EPCA to determine for those types of equipment with efficiency level or design requirement changes beyond the current Federal standard, whether: (1) The amended industry standard should be adopted; or (2) clear and convincing evidence exists to justify more-stringent standard levels.

Accordingly, this NOPR sets forth DOE’s determination of scope for consideration of amended energy conservation standards with respect to certain heating, ventilating, air-conditioning, and water-heating equipment addressed in ASHRAE Standard 90.1–2013. Such inquiry is necessary to ascertain whether the revised ASHRAE efficiency levels have become more stringent, thereby ensuring that any new amended national standard would not result in prohibited “backsliding.” For those equipment classes for which ASHRAE set more-stringent efficiency levels<sup>2</sup>

<sup>2</sup> ASHRAE Standard 90.1–2013 did not change any of the design requirements for the commercial (HVAC) and water-heating equipment covered by EPCA.

(i.e., small three-phase air-cooled air conditioners (single package only) and heat pumps (single package and split system) less than 65,000 Btu/h; water-source heat pumps; commercial oil-fired storage water heaters; single package vertical units; and packaged terminal air conditioners), DOE analyzed the energy savings potential of amended national energy conservation standards (at both the new ASHRAE Standard 90.1 efficiency levels and more-stringent efficiency levels). For small three-phase air-cooled air conditioners and heat pumps less than 65,000 Btu/h and water-source heat pumps, DOE analyzed the economic savings potential of amended national energy conservation standards at more-stringent efficiency levels, in addition to the energy savings potential. For commercial oil-fired storage water heaters, DOE determined that the potential for energy savings from adopting more-stringent levels than the ASHRAE Standard 90.1 levels was not significant, and, thus, DOE is proposing to adopt the ASHRAE Standard 90.1 levels without further analysis (see section IV.B for further details). For single package vertical units and packaged terminal air conditioners, DOE is performing economic analyses and responding to relevant comments from the NODA in separate rulemakings that were previously ongoing,<sup>3</sup> and consequently, the analysis for this equipment and further discussion or proposal of standard levels will not be discussed in this NOPR.

DOE has tentatively concluded that for three classes of small three-phase air-cooled air conditioners and heat pumps less than 65,000 Btu/h, three classes of water-source heat pumps, and one class of commercial oil-fired storage water heaters: (1) The revised efficiency levels in ASHRAE 90.1–2013<sup>4</sup> are more stringent than current national standards; and (2) their adoption as Federal energy conservation standards would result in energy savings where models exist below the revised efficiency levels. DOE has also tentatively concluded that there is not clear and convincing evidence that would justify adoption of more-stringent efficiency levels for this equipment.

<sup>3</sup> See Packaged Terminal Air Conditioners and Heat Pumps Standards Rulemaking Web page: [www1.eere.energy.gov/buildings/appliance\\_standards/rulemaking.aspx?ruleid/64](http://www1.eere.energy.gov/buildings/appliance_standards/rulemaking.aspx?ruleid/64) and Single Package Vertical Air Conditioners and Heat Pumps Standards Rulemaking Web page: [www1.eere.energy.gov/buildings/appliance\\_standards/rulemaking.aspx?ruleid=107](http://www1.eere.energy.gov/buildings/appliance_standards/rulemaking.aspx?ruleid=107).

<sup>4</sup> To obtain a copy of ASHRAE Standard 90.1–2013, visit <https://www.ashrae.org/resources-publications/bookstore/standard-90-1>.

<sup>1</sup> For editorial reasons, upon codification in the U.S. Code, Part C was redesignated Part A–1.

It is noted that DOE's regulations currently have a single equipment class for small, three-phase commercial air-cooled air conditioners less than 65,000 Btu/h, which covers both split-system and single-package models. Although ASHRAE Standard 90.1–2013 did not amend standard levels for the split-system models within that equipment class, it did so for the single-package models. Given this split, DOE is proposing to once again separate these two types of equipment into separate equipment classes. In the NOPR, DOE is proposing to evaluate amended standards for split-system models under the six-year-lookback provision at 42 U.S.C. 6313(a)(6)(C). Following this evaluation, DOE has tentatively

concluded that there is not clear and convincing evidence that would justify adoption of more-stringent efficiency levels for small three-phase split-system air-cooled air conditioners less than 65,000 Btu/h, where the efficiency level in ASHRAE 90.1–2013 is the same as the current Federal energy conservation standards.

Thus, in accordance with the criteria discussed elsewhere in this document, DOE is proposing amended energy conservation standards for three classes of small three-phase air-cooled air conditioners and heat pumps less than 65,000 Btu/h, three classes of water-source heat pumps, and one class of commercial oil-fired storage water heaters by adopting the efficiency levels

specified by ASHRAE Standard 90.1–2013, as shown in Table I.1. The proposed standards, if adopted, would apply to all equipment listed in Table I.1 and manufactured in, or imported into, the United States on or after the date two years after the effective date specified in ASHRAE Standard 90.1–2013 (*i.e.*, by January 1, 2017 for small air-cooled air conditioners and heat pumps and by October 9, 2015 for water-source heat pumps and oil-fired storage water heaters). (42 U.S.C. 6313(a)(6)(D)(i)) DOE is making a determination that standards for split-system air-cooled air conditioners less than 65,000 Btu/h do not need to be amended.

TABLE I.1—PROPOSED ENERGY CONSERVATION STANDARDS FOR SPECIFIC TYPES OF COMMERCIAL EQUIPMENT

Equipment class	Efficiency level	Anticipated compliance date
Three-Phase Air-Cooled Single-Package Air Conditioners <65,000 Btu/h	14.0 SEER	January 1, 2017.
Three-Phase Air-Cooled Single-Package Heat Pumps <65,000 Btu/h	14.0 SEER, 8.0 HSPF	January 1, 2017.
Three-Phase Air-Cooled Split-System Heat Pumps <65,000 Btu/h	14.0 SEER, 8.2 HSPF	January 1, 2017.
Oil-Fired Storage Water Heaters >105,000 Btu/h and <4,000 Btu/h/gal	80% E <sub>f</sub>	October 9, 2015.
Water-Source (Water-to-Air, Water-Loop) Heat Pumps <17,000 Btu/h	12.2 EER, 4.3 COP	October 9, 2015.
Water-Source (Water-to-Air, Water-Loop) Heat Pumps ≥17,000 and <65,000 Btu/h	13.0 EER, 4.3 COP	October 9, 2015.
Water-Source (Water-to-Air, Water-Loop) Heat Pumps ≥65,000 and <135,000 Btu/h	13.0 EER, 4.3 COP	October 9, 2015.

In addition, when the generally accepted industry test procedures referenced in ASHRAE Standard 90.1 are updated, EPCA requires DOE to amend the DOE test procedures for the relevant type(s) of ASHRAE equipment (which manufacturers are required to use in order to certify compliance with energy conservation standards mandated under EPCA) to be consistent with the amended industry test procedure. (42 U.S.C. 6314(a)(4)(B)) DOE typically incorporates such industry test standards by reference, unless it determines they would not meet the requirements of 42 U.S.C. 6314(a)(2) and (3). Specifically, the amendments in this NOPR would update the citations and incorporations by reference in DOE's regulations to the most recent version of American National Standards Institute (ANSI) Z21.47, *Standard for Gas-Fired Central Furnaces* (*i.e.*, ANSI Z21.47–2012). However, as a substantive matter, DOE notes that the most recent version does not contain any updates to the sections currently referenced by the DOE test procedure, so no additional burden would be expected to result from this test procedure update.

Additionally, EISA 2007 amended EPCA to require that at least once every 7 years, DOE must conduct an evaluation of the test procedures for all covered equipment and either amend test procedures (if the Secretary determines that amended test procedures would more accurately or fully comply with the requirements of 42 U.S.C. 6314(a)(2)–(3)) or publish notice in the **Federal Register** of any determination not to amend a test procedure. (42 U.S.C. 6314(a)(1)(A)) Under this requirement, DOE has reviewed the test procedure for commercial warm-air furnaces and is proposing to update the citations and incorporations by reference to the most recent version of ASHRAE 103, *Method of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boiler* (*i.e.*, ASHRAE 103–2007). Thus, the final rule resulting from this rulemaking will satisfy the requirement to review the test procedures for commercial warm-air furnaces within seven years. DOE notes that the most recent version of ASHRAE 103 does not contain any updates to the sections currently referenced by the DOE test procedure, so no additional

burden would be expected to result from this test procedure update.

**II. Introduction**

The following section briefly discusses the statutory authority underlying this proposal, as well as some of the relevant historical background related to the establishment of standards for small three-phase air-cooled air conditioners and heat pumps less than 65,000 Btu/h, water-source heat pumps, and commercial oil-fired storage water heaters.

*A. Authority*

Title III, Part C<sup>5</sup> of the Energy Policy and Conservation Act of 1975 (EPCA or the Act), Public Law 94–163 (42 U.S.C. 6311–6317, as codified), added by Public Law 95–619, Title IV, section 441(a), established the Energy Conservation Program for Certain Industrial Equipment, which includes the commercial heating, air-conditioning, and water-heating equipment that is the subject of this

<sup>5</sup> For editorial reasons, upon codification in the U.S. Code, Part C was redesignated Part A–1.

rulemaking.<sup>6</sup> In general, this program addresses the energy efficiency of certain types of commercial and industrial equipment. Relevant provisions of the Act specifically include definitions (42 U.S.C. 6311), energy conservation standards (42 U.S.C. 6313), test procedures (42 U.S.C. 6314), labelling provisions (42 U.S.C. 6315), and the authority to require information and reports from manufacturers (42 U.S.C. 6316).

EPCA contains mandatory energy conservation standards for commercial heating, air-conditioning, and water-heating equipment. (42 U.S.C. 6313(a)) Specifically, the statute sets standards for small, large, and very large commercial package air-conditioning and heating equipment, packaged terminal air conditioners (PTACs), packaged terminal heat pumps (PTHPs), warm-air furnaces, packaged boilers, storage water heaters, instantaneous water heaters, and unfired hot water storage tanks. *Id.* In doing so, EPCA established Federal energy conservation standards that generally correspond to the levels in ASHRAE Standard 90.1, as in effect on October 24, 1992 (*i.e.*, ASHRAE Standard 90.1–1989), for each type of covered equipment listed in 42 U.S.C. 6313(a). The Energy Independence and Security Act of 2007 (EISA 2007) amended EPCA by adding definitions and setting minimum energy conservation standards for single-package vertical air conditioners (SPVACs) and single-package vertical heat pumps (SPVHPs). (42 U.S.C. 6313(a)(10)(A)) The efficiency standards for SPVACs and SPVHPs established by EISA 2007 correspond to the levels contained in ASHRAE Standard 90.1–2004, which originated as addendum “d” to ASHRAE Standard 90.1–2001.

In acknowledgement of technological changes that yield energy efficiency benefits, the U.S. Congress further directed DOE through EPCA to consider amending the existing Federal energy conservation standard for each type of equipment listed, each time ASHRAE Standard 90.1 is amended with respect to such equipment. (42 U.S.C. 6313(a)(6)(A)) For each type of equipment, EPCA directs that if ASHRAE Standard 90.1 is amended,<sup>7</sup>

DOE must publish in the **Federal Register** an analysis of the energy savings potential of amended energy efficiency standards within 180 days of the amendment of ASHRAE Standard 90.1. (42 U.S.C. 6313(a)(6)(A)(i)) EPCA further directs that DOE must adopt amended standards at the new efficiency level in ASHRAE Standard 90.1, unless clear and convincing evidence supports a determination that adoption of a more-stringent level would produce significant additional energy savings and be technologically feasible and economically justified. (42 U.S.C. 6313(a)(6)(A)(ii)) If DOE decides to adopt as a national standard the efficiency levels specified in the amended ASHRAE Standard 90.1, DOE must establish such standard not later than 18 months after publication of the amended industry standard. (42 U.S.C. 6313(a)(6)(A)(ii)(I)) However, if DOE determines that a more-stringent standard is justified under 42 U.S.C. 6313(a)(6)(A)(ii)(II), then it must establish such more-stringent standard not later than 30 months after publication of the amended ASHRAE Standard 90.1. (42 U.S.C. 6313(a)(6)(B)) In addition, DOE notes that pursuant to the EISA 2007 amendments to EPCA, under 42 U.S.C. 6313(a)(6)(C), the agency must periodically review its already-established energy conservation standards for ASHRAE equipment. In December 2012, this provision was further amended by the American

adopt uniform national standards based on ASHRAE action is for ASHRAE to change a standard for any of the equipment listed in EPCA section 342(a)(6)(A)(i) (42 U.S.C. 6313(a)(6)(A)(i)) by increasing the energy efficiency level for that equipment type. *Id.* at 10042. In other words, if the revised ASHRAE Standard 90.1 leaves the standard level unchanged or lowers the standard, as compared to the level specified by the national standard adopted pursuant to EPCA, DOE does not have the authority to conduct a rulemaking to consider a higher standard for that equipment pursuant to 42 U.S.C. 6313(a)(6)(A). DOE subsequently reiterated this position in a final rule published in the **Federal Register** on July 22, 2009 (74 FR 36312, 36313) and again on May 16, 2012 (77 FR 28928, 28937). However, in the AEMTCA amendments to EPCA in 2012, Congress modified several provisions related to ASHRAE Standard 90.1 equipment. In relevant part, DOE is now triggered to act whenever ASHRAE Standard 90.1’s “standard levels or design requirements under that standard” are amended. (42 U.S.C. 6313(a)(6)(A)(i)) Furthermore, DOE is now required to conduct an evaluation of each class of covered equipment in ASHRAE Standard 90.1 “every 6 years.” (42 U.S.C. 6313(a)(6)(C)(i)) For any covered equipment for which more than 6 years has elapsed since issuance of the most recent final rule establishing or amending a standard for such equipment, DOE must publish either the required notice of determination that standards do not need to be amended or a NOPR with proposed standards by December 31, 2013. (42 U.S.C. 6313(a)(6)(C)(vi)) DOE has incorporated these new statutory mandates into its rulemaking process for covered ASHRAE 90.1 equipment.

Energy Manufacturing Technical Corrections Act (AEMTCA) to clarify that DOE’s periodic review of ASHRAE equipment must occur “[e]very six years.” (42 U.S.C. 6313(a)(6)(C)(i))

AEMTCA also modified EPCA to specify that any amendment to the design requirements with respect to the ASHRAE equipment would trigger DOE review of the potential energy savings under U.S.C. 6313(a)(6)(A)(i). Additionally, AEMTCA amended EPCA to require that if DOE proposes an amended standard for ASHRAE equipment at levels more stringent than those in ASHRAE Standard 90.1, DOE, in deciding whether a standard is economically justified, must determine, after receiving comments on the proposed standard, whether the benefits of the standard exceed its burdens by considering, to the maximum extent practicable, the following seven 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 product in the type (or class) compared to any increase in the price, initial charges, or maintenance expenses of the products likely to result from the standard;

(3) The total projected amount of energy savings likely to result directly from the standard;

(4) Any lessening of the utility or the performance of the 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 conservation; and

(7) Other factors the Secretary considers relevant.

(42 U.S.C. 6313(a)(6)(B)(ii))

EPCA also requires that if a test procedure referenced in ASHRAE Standard 90.1 is updated, DOE must update its test procedure to be consistent with the amended test procedure in ASHRAE Standard 90.1, unless DOE determines that the amended test procedure is not reasonably designed to produce test results that reflect the energy efficiency, energy use, or estimated operating costs of the ASHRAE equipment during a representative average use cycle. In addition, DOE must determine that the amended test procedure is not unduly burdensome to conduct. (42 U.S.C. 6314(a)(2) and(4))

Additionally, EISA 2007 amended EPCA to require that at least once every 7 years, DOE must conduct an

<sup>6</sup> All references to EPCA in this document refer to the statute as amended through the American Energy Manufacturing Technical Corrections Act (AEMTCA), Public Law 112–210 (Dec. 18, 2012).

<sup>7</sup> Although EPCA does not explicitly define the term “amended” in the context of ASHRAE Standard 90.1, DOE provided its interpretation of what would constitute an “amended standard” in a final rule published in the **Federal Register** on March 7, 2007 (hereafter referred to as the “March 2007 final rule”). 72 FR 10038. In that rule, DOE stated that the statutory trigger requiring DOE to

evaluation of the test procedures for all covered equipment and either amend test procedures (if the Secretary determines that amended test procedures would more accurately or fully comply with the requirements of 42 U.S.C. 6314(a)(2)–(3)) or publish notice in the **Federal Register** of any determination not to amend a test procedure. (42 U.S.C. 6314(a)(1)(A)) The final rule resulting from this rulemaking will satisfy the requirement to review the test procedures for commercial warm-air furnaces within seven years.

On October 9, 2013 ASHRAE officially released and made public ASHRAE Standard 90.1–2013. This action triggered DOE’s obligations under 42 U.S.C. 6313(a)(6), as outlined previously.

EPCA, as codified, also contains what is known as an “anti-backsliding” provision, which prevents the Secretary from prescribing any amended standard that either increases the maximum allowable energy use or decreases the minimum required energy efficiency of a covered product. (42 U.S.C. 6313(a)(6)(B)(iii)(I)) Also, the Secretary may not prescribe an amended or new standard if interested persons have established by a preponderance of the evidence that such standard would likely result in the unavailability in the United States of any covered product type (or class) of performance characteristics (including reliability), features, sizes, capacities, and volumes that are substantially the same as those generally available in the United States at the time of the Secretary’s finding. (42 U.S.C. 6313(a)(6)(B)(iii)(II)(aa))

Further, EPCA, as codified, 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 energy (and, as applicable, water) savings during the first year that the consumer will receive as a result of the standard, as calculated under the applicable test procedure.

Additionally, when a type or class of covered equipment such as ASHRAE equipment, has two or more subcategories, DOE often specifies more than one standard level. DOE generally will adopt a different standard level than that which applies generally to such type or class of products for any group of covered products that have the same function or intended use if DOE determines that products within such group: (A) Consume a different kind of energy from that consumed by other covered products within such type (or class); or (B) have a capacity or other performance-related feature which other products within such type (or class) do not have and which justifies a higher or lower standard. In determining whether a performance-related feature justifies a different standard for a group of products, DOE generally considers such factors as the utility to the consumer of the feature and other factors DOE deems appropriate. In a rule prescribing such a standard, DOE includes an explanation of the basis on which such higher or lower level was established. DOE plans to follow a similar process in the context of this rulemaking.

**B. Background**

**1. ASHRAE Standard 90.1–2013**

As noted previously, ASHRAE released a new version of ASHRAE

Standard 90.1 on October 9, 2013. The ASHRAE standard addresses efficiency levels for many types of commercial heating, ventilating, air-conditioning (HVAC), and water-heating equipment covered by EPCA. ASHRAE Standard 90.1–2013 revised its efficiency levels for certain commercial equipment, but for the remaining equipment, ASHRAE left in place the preexisting levels (*i.e.*, the efficiency levels in ASHRAE Standard 90.1–2010). ASHRAE Standard 90.1–2013 did not change any of the design requirements for the commercial HVAC and water-heating equipment covered by EPCA.

Table II.1 presents the equipment classes (and corresponding efficiency levels) for which efficiency levels in ASHRAE Standard 90.1–2013 (for metrics included in Federal energy conservation standards) differed from those in the previous version of ASHRAE Standard 90.1 (*i.e.*, ASHRAE Standard 90.1–2010). Table II.1 also presents the existing Federal energy conservation standards and the corresponding standard levels in both ASHRAE Standard 90.1–2010 and ASHRAE Standard 90.1–2013 for those equipment classes. Section IV of this document assesses each of these equipment types to determine whether the amendments in ASHRAE Standard 90.1–2013 constitute increased energy efficiency levels, as would necessitate further analysis of the potential energy savings from amended Federal energy conservation standards; the conclusions of this assessment are presented in the final column of Table II.1.

**TABLE II.1—FEDERAL ENERGY CONSERVATION STANDARDS AND ENERGY EFFICIENCY LEVELS IN ASHRAE STANDARD 90.1–2013 FOR SPECIFIC TYPES OF COMMERCIAL EQUIPMENT \***

ASHRAE equipment class **	Energy efficiency levels in ASHRAE Standard 90.1–2010	Energy efficiency levels in ASHRAE Standard 90.1–2013	Federal energy conservation standards	Energy-savings potential analysis required?
<b>Commercial Package Air-Conditioning and Heating Equipment—Air-Cooled</b>				
Air-Cooled Air Conditioner, 3-Phase, Single-Package, <65,000 Btu/h.	13.0 SEER .....	14.0 SEER (as of 1/1/2015).	13.0 SEER .....	Yes—See section IV.A.1.
Air-Cooled Heat Pump, 3-Phase, Single-Package, <65,000 Btu/h.	13.0 SEER, 7.7 HSPF	14.0 SEER, 8.0 HSPF (as of 1/1/2015).	13.0 SEER, 7.7 HSPF	Yes—See section IV.A.1.
Air-Cooled Heat Pump, 3-Phase, Split System, <65,000 Btu/h.	13.0 SEER, 7.7 HSPF	14.0 SEER, 8.2 HSPF (as of 1/1/2015).	13.0 SEER, 7.7 HSPF	Yes—See section IV.A.1.
<b>Commercial Package Air-Conditioning and Heating Equipment—Water-Source</b>				
Water-Source Heat Pump, <17,000 Btu/h .....	11.2 EER, 4.2 COP ...	12.2 EER, 4.3 COP <sub>H</sub> ***.	11.2 EER, 4.2 COP ...	Yes—See section IV.A.2.
Water-Source Heat Pump, ≥17,000 and <65,000 Btu/h.	12.0 EER, 4.2 COP ...	13.0 EER, 4.3 COP <sub>H</sub> ***.	12.0 EER, 4.2 COP ...	Yes—See section IV.A.2.
Water-Source Heat Pump, ≥65,000 and <135,000 Btu/h.	12.0 EER, 4.2 COP ...	13.0 EER, 4.3 COP <sub>H</sub> ***.	12.0 EER, 4.2 COP ...	Yes—See section IV.A.2.

TABLE II.1—FEDERAL ENERGY CONSERVATION STANDARDS AND ENERGY EFFICIENCY LEVELS IN ASHRAE STANDARD 90.1–2013 FOR SPECIFIC TYPES OF COMMERCIAL EQUIPMENT\*—Continued

ASHRAE equipment class**	Energy efficiency levels in ASHRAE Standard 90.1–2010	Energy efficiency levels in ASHRAE Standard 90.1–2013	Federal energy conservation standards	Energy-savings potential analysis required?
<b>Commercial Package Air-Conditioning and Heating Equipment—PTACs</b>				
Package Terminal Air Conditioner, <7,000 Btu/h, Standard Size (New Construction) †.	EER = 11.7 as of 10/8/12).	EER = 11.9 (as of 1/1/2015).	EER = 11.7 .....	Yes—See section IV.A.3.
Package Terminal Air Conditioner, ≥7,000 and ≤15,000 Btu/h, Standard Size (New Construction) †.	EER = 13.8—(0.300 × Cap ††) (as of 10/8/12).	EER = 14.0—(0.300 × Cap ††) (as of 1/1/2015).	EER = 13.8—(0.300 × Cap ††).	Yes—See section IV.A.3.
Package Terminal Air Conditioner, >15,000 Btu/h, Standard Size (New Construction) †.	EER = 9.3 (as of 10/8/12).	EER = 9.5 (as of 1/1/2015).	EER = 9.3 .....	Yes—See section IV.A.3.
<b>Commercial Package Air-Conditioning and Heating Equipment—SDHV and TTW</b>				
Through-the-Wall (TTW), Air-Cooled Heat Pumps, ≤30,000 Btu/h.	13.0 SEER, 7.4 HSPF	12.0 SEER, 7.4 HSPF	13.0 SEER, 7.7 HSPF	No—See section IV.A.4.
Small-Duct, High-Velocity, Air-Cooled (SDHV) Air Conditioners, <65,000 Btu/h.	10.0 SEER .....	11.0 SEER .....	13.0 SEER .....	No—See section IV.A.4.
Small-Duct, High-Velocity, Air-Cooled Heat Pumps, <65,000 Btu/h.	10.0 SEER, HSPF not listed †††.	11.0 SEER, 6.8 HSPF	13.0 SEER, 7.7 HSPF	No—See section IV.A.4.
<b>Commercial Package Air-Conditioning and Heating Equipment—SPVACs and SPVHPs</b>				
Single Package Vertical Air Conditioners, <65,000 Btu/h.	9.0 EER .....	10.0 EER .....	9.0 EER .....	Yes—See section IV.A.5.
Single Package Vertical Air Conditioners, ≥65,000 and <135,000 Btu/h.	8.9 EER .....	10.0 EER .....	8.9 EER .....	Yes—See section IV.A.5.
Single Package Vertical Air Conditioners, ≥135,000 and <240,000 Btu/h.	8.6 EER .....	10.0 EER .....	8.6 EER .....	Yes—See section IV.A.5.
Single Package Vertical Heat Pumps, <65,000 Btu/h.	9.0 EER, 3.0 COP .....	10.0 EER, 3.0 COP <sub>H</sub> ***.	9.0 EER, 3.0 COP .....	Yes—See section IV.A.5.
Single Package Vertical Heat Pumps, ≥65,000 and <135,000 Btu/h.	8.9 EER, 3.0 COP .....	10.0 EER, 3.0 COP <sub>H</sub> ***.	8.9 EER, 3.0 COP .....	Yes—See section IV.A.5.
Single Package Vertical Heat Pumps, ≥135,000 and <240,000 Btu/h.	8.6 EER, 2.9 COP .....	10.0 EER, 3.0 COP <sub>H</sub> ***.	8.6 EER, 2.9 COP .....	Yes—See section IV.A.5.
Single Package Vertical Air Conditioners Nonweatherized Space Constrained, ≤30,000 Btu/h.	N/A .....	9.2 EER .....	N/A † .....	No—See section IV.A.5.
Single Package Vertical Air Conditioners Nonweatherized Space Constrained, >30,000 and ≤36,000 Btu/h.	N/A .....	9.0 EER .....	N/A † .....	No—See section IV.A.5.
Single Package Vertical Heat Pumps Nonweatherized Space Constrained, ≤30,000 Btu/h.	N/A .....	9.2 EER, 3.0 COP <sub>H</sub> ...	N/A † .....	No—See section IV.A.5.
Single Package Vertical Heat Pumps Nonweatherized Space Constrained, >30,000 and ≤36,000 Btu/h.	N/A .....	9.0 EER, 3.0 COP <sub>H</sub> ...	N/A † .....	No—See section IV.A.5.
<b>Commercial Water Heaters</b>				
Electric Storage Water Heaters, >12 kW, ≥20 gal.	20 + 35 V <sup>1/2</sup> SL ††, Btu/h.	0.3 + 27/V <sub>m</sub> ††† %/h ...	0.3 + 27/V <sub>m</sub> ††† %/h ...	No—See Section IV.B.
Gas Storage Water Heaters, >75,000 Btu/h, <4,000 Btu/h/gal.	80% E <sub>i</sub> ; Q/800 + 110 V <sup>1/2</sup> SL †, Btu/h.	80% E <sub>i</sub> ; Q/799 + 16.6 V <sup>1/2</sup> SL †, Btu/h ††.	80% E <sub>i</sub> ; Q/800 + 110 V <sub>r</sub> <sup>1/2</sup> Btu/hr.	No—See Section IV.B.
Oil Storage Water Heaters, >105,000 Btu/h, <4,000 Btu/h/gal.	78% E <sub>i</sub> ; Q/800 + 110 V <sup>1/2</sup> SL †, Btu/h.	80% E <sub>i</sub> ; Q/799 + 16.6 V <sup>1/2</sup> SL †, Btu/h ††.	78% E <sub>i</sub> ; Q/800 + 110 V <sub>r</sub> <sup>1/2</sup> Btu/hr.	Yes—See Section IV.B.
Gas Instantaneous Water Heaters, ≥200,000 Btu/h, ≥4,000 Btu/h/gal, ≥10 gal.	80% E <sub>i</sub> ; Q/800 + 110 V <sup>1/2</sup> SL †, Btu/h.	80% E <sub>i</sub> ; Q/799 + 16.6 V <sup>1/2</sup> SL †, Btu/h ††.	80% E <sub>i</sub> ; Q/800 + 110 V <sub>r</sub> <sup>1/2</sup> Btu/hr.	No—See Section IV.B.
Oil Instantaneous Water Heaters, >210,000 Btu/h, ≥4,000 Btu/h/gal, ≥10 gal.	78% E <sub>i</sub> ; Q/800 + 110 V <sup>1/2</sup> SL †, Btu/h.	78% E <sub>i</sub> ; Q/799 + 16.6 V <sup>1/2</sup> SL †, Btu/h ††.	78% E <sub>i</sub> ; Q/800 + 110 V <sub>r</sub> <sup>1/2</sup> Btu/hr.	No—See Section IV.B.

\* “E<sub>i</sub>” means thermal efficiency; “EER” means energy efficiency ratio; “SEER” means seasonal energy efficiency ratio; “HSPF” means heating seasonal performance factor; “COP” and “COP<sub>H</sub>” mean coefficient of performance; and “Btu/h” or “Btu/hr” means British thermal units per hour.

\*\* ASHRAE Standard 90.1–2013 equipment classes may differ from the equipment classes defined in DOE’s regulations, but no loss of coverage will occur (i.e., all previously covered DOE equipment classes remain covered equipment).

\*\*\* While ASHRAE Standard 90.1–2013 added a subscript <sub>H</sub> to COP for all heat pumps, its definition for “coefficient of performance (COP), heat pump—heating” has not changed. As a result, DOE believes the subscript to be a clarifying change of nomenclature (to differentiate from the COP metric used for refrigeration) only, rather than a change to the metric itself.

† “Standard size” refers to PTAC equipment with wall sleeve dimensions ≥16 inches high or ≥42 inches wide. For DOE’s purposes, this equipment class applies to standard-size equipment regardless of application (e.g., new construction or replacement).

†† “Cap” means cooling capacity in kBtu/h at 95°F outdoor dry-bulb temperature.

††† This may have been an editorial error in ASHRAE 90.1–2010.



\* While ASHRAE Standard 90.1–2013 added this equipment class, DOE believes that equipment falling into these classes is already covered by Federal standards, most commonly in the residential space-constrained central air conditioning equipment class with minimum standards of 12.0 SEER for air conditioners and heat pumps and 7.4 HSPF for heat pumps. See section II.A.5.1 of this NODA for further detail.

\*\* “V” means rated volume in gallons; “SL” means standby loss.

\*\*\* “V<sub>m</sub>” means measured volume in tank.

◇ “Q” means the nameplate input rate in Btu/hr; “V” means rated volume in gallons; “SL” means standby loss. DOE’s descriptor, “Vr,” also means rated volume in gallons and differs only in nomenclature.

◇◇ As explained in section IV.B, DOE believes that all changes to standby loss levels for these equipment classes were editorial errors because they are identical to SI (International System of Units; metric system) formulas rather than I–P (Inch–Pound; English system) formulas.

DOE notes that ASHRAE 90.1–2013 also increased integrated energy efficiency ratio (IEER) levels for additional equipment not listed in Table II.1, including small, large, and very large air-cooled and water-cooled air conditioners and heat pumps. However, because current Federal energy conservation standards for this equipment do not use IEER as a rating metric, DOE is not triggered to review this equipment. In September 2014, DOE published a notice of proposed rulemaking (NOPR) for commercial air-cooled equipment. 79 FR 58948 (Sept. 30, 2014). In the NOPR, DOE proposed amended standards for small, large, and very large air-cooled commercial air conditioners and heat pumps based on IEER as the energy efficiency descriptor. Should DOE finalize new standards using IEER as the metric, future increases in IEER levels in ASHRAE Standard 90.1 as compared to the Federal energy conservation standards would trigger DOE to review its efficiency levels for that equipment.

## 2. Notice of Data Availability

On April 11, 2014, DOE published a notice of data availability (April 2014 NODA) in the **Federal Register** and requested public comment as a preliminary step required pursuant to EPCA when DOE considers amended energy conservation standards for certain types of commercial equipment covered by ASHRAE Standard 90.1. 79 FR 20114. Specifically, the April 2014 NODA presented for public comment DOE’s analysis of the potential energy savings estimates related to amended national energy conservation standards for the types of commercial equipment for which DOE was triggered by ASHRAE action, based on: (1) The modified efficiency levels contained within ASHRAE Standard 90.1–2013; and (2) more-stringent efficiency levels. *Id.* at 20134–36. DOE has described these analyses and preliminary conclusions and sought input from interested parties, including the submission of data and other relevant information. *Id.*

In addition, DOE presented a discussion in the April 2014 NODA of the changes found in ASHRAE Standard 90.1–2013. *Id.* at 20119–25. The April 2014 NODA includes a description of

DOE’s evaluation of each ASHRAE equipment type in order for DOE to determine whether the amendments in ASHRAE Standard 90.1–2013 have increased efficiency levels or changed design requirements. As an initial matter, DOE sought to determine which requirements for covered equipment in ASHRAE Standard 90.1, if any: (1) Have been revised solely to reflect the level of the current Federal energy conservation standard (where ASHRAE is merely “catching up” to the current national standard); (2) have been revised but with a reduction in stringency; or (3) have had any other revisions made that do not change the standard’s stringency, in which case, DOE is not triggered to act under 42 U.S.C. 6313(a)(6) for that particular equipment type. For those types of equipment in ASHRAE Standard 90.1 for which ASHRAE actually increased efficiency levels above the current Federal standard, DOE subjected that equipment to the potential energy savings analysis discussed previously and presented the results in the April 2014 NODA for public comment. 79 FR 20114, 20134–36 (April 11, 2014). Lastly, DOE presented an initial assessment of the test procedure changes included in ASHRAE Standard 90.1–2013. *Id.* at 20124–25.

As a result of the preliminary determination of scope set forth in the April 2014 NODA, DOE found that there were equipment types for which ASHRAE increased the efficiency levels (thereby triggering further analysis) including: (1) Three classes of small three-phase air-cooled air conditioners and heat pumps less than 65,000 Btu/h; (2) three classes of small water-source heat pumps; (3) six classes of single package vertical units; (4) three classes of packaged terminal air conditioners; and (5) commercial oil-fired storage water heaters. 79 FR 20114, 20119–23 (April 11, 2014). DOE presented its methodology, data, and results for the preliminary energy savings analysis developed for these equipment classes in the April 2014 NODA for public comment. 79 FR 20114, 20125–38 (April 11, 2014).

## III. General Discussion of Comments Regarding the ASHRAE Process and DOE’s Interpretation of EPCA’s Requirements With Respect to ASHRAE Equipment

In response to its request for comment on the April 2014 NODA, DOE received 11 comments from manufacturers, trade associations, utilities, and energy efficiency advocates. Commenters included: First Co.; Lennox International Inc.; National Comfort Products (NCP); Earthjustice; Goodman Global, Inc.; California Investor-Owned Utilities (CA IOUs); GE Appliances; a group including Appliance Standards Awareness Project (ASAP), the American Council for an Energy-Efficient Economy (ACEEE), the Natural Resources Defense Council (NRDC), and the Northwest Energy Efficiency Alliance (jointly referred to as the Advocates); Daikin Applied; Edison Electric Institute (EEI); and the Air-conditioning, Heating, and Refrigeration Institute (AHRI). As discussed previously, these comments are available in the docket for this rulemaking and may be reviewed as described in the **ADDRESSES** section. The following section summarizes the issues raised in these comments, along with DOE’s responses.

DOE received numerous comments regarding whether it should, in general, adopt levels contained in ASHRAE standard 90.1–2013 as the Federal energy conservation standard, rather than more-stringent levels. Several commenters stated that DOE should follow ASHRAE’s lead (*e.g.*, Daikin Applied, No. 0022 at p. 1; Goodman Global, Inc., No. 0018 at p. 4; Lennox International Inc., No. 0015 at p. 1–2). AHRI stated that the ASHRAE revisions represent consensus standards that were subject to rigorous public review and were evaluated for cost-effectiveness. (AHRI, No. 24 at p. 1) Because the current Federal values are lower than ASHRAE 90.1–2013 values, EEI argued that less-efficient equipment could continue to enter the market until the effective date of any DOE standards, which would be four years after DOE completes the rulemaking for levels higher than ASHRAE. (EEI, No. 23 at p. 2) EEI added that adopting ASHRAE would reduce the amount of DOE

resources needed for updating these standards. (*Id.*)

On the other hand, the Advocates and CA IOUs commented that significant, non-trivial energy savings would be achievable by adopting higher efficiency levels than those in ASHRAE 90.1–2013 for the equipment classes analyzed in the NODA, at least when considered in aggregate. (Advocates, No. 21 at p. 1; CA IOUs, No. 19 at pp. 2–3) The commenters provided justifications for adopting higher efficiency levels for specific equipment classes; these details are discussed in the relevant sections of this NOPR.

In response to the submitted comments, DOE notes that it makes decisions about whether to adopt levels in ASHRAE 90.1–2013 or higher efficiency levels based on application of the statutory criteria to potential standard levels for individual equipment types (per its mandate under EPCA), rather than upon some general assessment of perceived benefits of a shorter process by adopting the ASHRAE levels or any other reason. Specifically, EPCA directs that if ASHRAE Standard 90.1 is amended, DOE must adopt amended energy conservation standards at the new efficiency level in ASHRAE Standard 90.1, unless clear and convincing evidence supports a determination that adoption of a more-stringent level as a national standard would produce significant additional energy savings and be technologically feasible and economically justified. (42 U.S.C. 6313(a)(6)(A)(ii)) In order to determine if more-stringent efficiency levels would meet EPCA's criteria, DOE must review the efficiency levels in ASHRAE Standard 90.1–2013 and more-stringent efficiency levels for their energy savings and economic potentials irrespective of whether the efficiency levels were part of a consensus standards process. The specific rationale for DOE's decisions for each equipment type can be found in the relevant sections of this document.

AHRI also lodged several complaints regarding the analyses described in the April 2014 NODA. AHRI stated that DOE's analysis ignored the energy savings from changes ASHRAE implemented even before Standard 90.1–2013 was published. For example, AHRI argued that ASHRAE's water-source heat pump level was developed in 2011, adopted in 2012, and took effect immediately. (AHRI, No. 24 at p. 2) Thus, the products have been providing energy savings for at least 2 years. (*Id.*) AHRI further asserted that DOE's analysis ignores the savings that occur from implementation of the

ASHRAE standard in 2015 or 2017, rather than developing its own revised standard that would take effect in 2020. According to AHRI, DOE's rulemaking process will lose 3 to 5 years of energy savings, and DOE's analysis must consider the energy savings associated with earlier implementation of the ASHRAE 90.1–2013. (*Id.*) Finally, AHRI stated that the April 2014 NODA did not address technological feasibility and economic justification, unlike ASHRAE 90.1. (*Id.*)

In response, DOE only takes into account energy savings that result from adoption of a Federal standard, not from adoption of an industry standard such as ASHRAE Standard 90.1. However, DOE did take the savings gap into account in the April 2014 NODA by using an analysis period of 30 years beginning with 2015 or 2017 for the ASHRAE level, and a shorter analysis period beginning in 2020 but with the same end date for efficiency levels higher than ASHRAE. As part of any rulemaking triggered by ASHRAE, DOE follows EPCA's mandate by only addressing energy savings in the NODA and analyzing technological feasibility and economic justification in the NOPR where the potential for energy savings appears to be significant. DOE further notes that it can only take credit for savings from mandatory Federal standards and, therefore, cannot take credit for early adoption of ASHRAE Standard 90.1 levels prior to the compliance date of the corresponding DOE standard when evaluating any decision to amend DOE standards. DOE commends ASHRAE's action to amend Standard 90.1, as well as any early adoption of these levels by manufacturers to improve commercial equipment efficiency and to reduce national energy use. DOE strives to consider such early adoption in its analysis to the extent that further energy savings associated with DOE's adoption of either the ASHRAE 90.1 standard level or a more-stringent standard level would be negated or reduced. In other words, DOE seeks to determine any shifts in the baseline prior to adoption of amended DOE standards, thereby allowing for a more accurate assessment of energy savings. See section V.F.3 for more information regarding efficiency distributions of equipment shipments that allow proper consideration of the energy savings generated specifically by DOE's potential actions.

#### **IV. General Discussion of the Changes in ASHRAE Standard 90.1–2013 and Determination of Scope for Further Rulemaking Activity**

As discussed previously, before beginning an analysis of the potential economic impacts and energy savings that would result from adopting the efficiency levels specified by ASHRAE Standard 90.1–2013 or more-stringent efficiency levels, DOE first sought to determine whether or not the ASHRAE Standard 90.1–2013 efficiency levels actually represented an increase in efficiency above the current Federal standard levels. This section discusses each equipment class for which the ASHRAE Standard 90.1–2013 efficiency level differs from the current Federal standard level, along with DOE's preliminary conclusion as to the action DOE is taking with respect to that equipment. (Once again, DOE notes that ASHRAE Standard 90.1–2013 did not change any of the design requirements for the commercial HVAC and water-heating equipment covered by EPCA, so DOE is not conducting further analysis in the sections below on that basis.)

##### *A. Commercial Package Air Conditioning and Heating Equipment*

EPCA, as amended, defines "commercial package air conditioning and heating equipment" as air-cooled, evaporatively-cooled, water-cooled, or water-source (not including ground water-source) electrically operated, unitary central air conditioners and central air conditioning heat pumps for commercial use. (42 U.S.C. 6311(8)(A); 10 CFR 431.92) EPCA also defines "small," "large," and "very large" commercial package air conditioning and heating equipment based on the equipment's rated cooling capacity. (42 6311(8)(B)–(D); 10 CFR 431.92) "Small commercial package air conditioning and heating equipment" means equipment rated less than 135,000 Btu per hour (cooling capacity). (42 U.S.C. 6311(8)(B); 10 CFR 431.92) "Large commercial package air conditioning and heating equipment" means equipment rated at or above 135,000 Btu per hour and less than 240,000 Btu per hour (cooling capacity). (42 U.S.C. 6311(8)(C); 10 CFR 431.92) "Very large commercial package air conditioning and heating equipment" means equipment rated at or above 240,000 Btu per hour and less than 760,000 Btu per hour (cooling capacity). (42 U.S.C. 6311(8)(D); 10 CFR 431.92)

##### **1. Air-Cooled Equipment**

The current Federal energy conservation standards for the three

classes of air-cooled commercial package air conditioners and heat pumps for which ASHRAE Standard 90.1–2013 amended efficiency levels are shown in Table II.1 and can be found in DOE's regulations at 10 CFR 431.97. The Federal energy conservation standards for air-cooled air conditioners and heat pumps are differentiated based on the unit's cooling capacity (*i.e.*, small, large, or very large). For small equipment, there is an additional disaggregation into: (1) Equipment less than 65,000 Btu/h and (2) equipment greater than or equal to 65,000 Btu/h and less than 135,000 Btu/h. In setting initial standards for three-phase equipment less than 65,000 Btu/h, Congress used the same metric for this commercial equipment as for residential single-phase equipment (*i.e.*, seasonal energy efficiency ratio (SEER)), which is reflected in DOE's current regulations. Unlike the current Federal energy conservation standards, ASHRAE Standard 90.1 also differentiates the equipment that is less than 65,000 Btu/h into split system and single package subcategories. Historically, ASHRAE has set equivalent efficiency levels for this equipment; however, effective January 1, 2015, ASHRAE Standard 90.1–2013 increases the efficiency level for single package air conditioners but not split system air conditioners. The increased efficiency level for single package air conditioners surpasses the current Federal energy conservation standard level for the overall equipment class, while the efficiency level for split system air conditioners meets and does not exceed the Federal energy conservation standard for the overall equipment class. ASHRAE Standard 90.1–2013 also increases the efficiency levels, effective January 1, 2015, for both single package and split system air-cooled heat pumps, for SEER and heating seasonal performance factor (HSPF), to efficiency levels that surpass the current Federal energy conservation standard levels. ASHRAE Standard 90.1–2013 increases the HSPF level for split systems above that for single package heat pumps.

Because ASHRAE increased the standard for only single package air conditioners, and increased the HSPF level to a more stringent level for split system heat pumps than for single package heat pumps, in the April 2014 NODA, DOE proposed to consider separate equipment classes for single package and split system equipment in the overall equipment classes of small commercial package air conditioners and heat pumps (air-cooled, three-phase) less than 65,000 Btu/h, as existed

prior to codification of EISA 2007, and requested comment on this issue.

In response, AHRI, Goodman Global, and Lennox International agreed that DOE should re-create separate classes for split system and single package equipment with input ratings less than 65,000 Btu/h. (AHRI, No. 24 at p. 2; Goodman Global, Inc., No. 18 at p. 2; Lennox International Inc., No. 15 at p. 5) The CA IOUs instead preferred having only two equipment classes, one for air conditioners, and one for heat pumps, with identical levels across single package and split system equipment. (CA IOUs, No. 19 at p. 4) In order to facilitate following the statutory requirements of the ASHRAE trigger, in this NOPR, DOE continues to propose the re-creation of separate equipment classes.

With regard to split system three-phase air conditioners, Earthjustice stated that standards must be reviewed, if not under the ASHRAE trigger, then under the six-year look back, as the clock will expire next year. (Earthjustice, No. 17 at pp. 1–2) Specifically, Earthjustice opined that ASHRAE has amended the Standard 90.1 levels for air-cooled, three-phase air-conditioners less than 65,000 Btu/h by increasing the required SEER levels for single package air conditioners and all heat pump units. The fact that ASHRAE did not also increase the Standard 90.1-required SEER level for split system air conditioners in this equipment class does not insulate split system units from DOE's obligation to consider amended standards. The "more stringent" standard that EPCA obliges DOE to consider for this equipment class may be one that, for example, applies a SEER 14 level (or a higher SEER level) to all air-cooled 3-phase air-conditioners less than 65,000 Btu/h (see 42 U.S.C. 6313(a)(6)(A)(i)(II)). (Earthjustice, No. 17 at p. 1) In addition, more than six years have elapsed since EISA 2007 amended the standards for the split system air conditioners at issue, and even if the 6-year clock began to run only when DOE incorporated the EISA 2007 levels into the Code of Federal Regulations, the time limit for DOE's review will expire next year.<sup>8</sup>

<sup>8</sup> DOE notes that pursuant to the EISA 2007 amendments to EPCA, under 42 U.S.C. 6313(a)(6)(C), the agency must periodically review its already established energy conservation standards for ASHRAE equipment. In December 2012, this provision was further amended by the American Energy Manufacturing Technical Corrections Act (AEMTCA) to clarify that DOE's periodic review of ASHRAE equipment must occur "[e]very six years." (42 U.S.C. 6313(a)(6)(C)(i)) The final rule incorporating the EISA 2007 prescribed levels into the CFR was published on March 23, 2009. 74 FR 12058.

(Earthjustice, No. 17 at pp. 1–2) The CA IOUs also requested that DOE update efficiency levels for split-system air conditioners even though ASHRAE did not update them. (CA IOUs, No. 19 at p. 4)

In response, DOE initially notes that EPCA's trigger regarding ASHRAE equipment is tied to the equipment that ASHRAE acts to amend. (42 U.S.C. 6313(a)(6)(A)) In this case, DOE was triggered for 3-phase air-cooled single-package air conditioners less than 65,000 Btu/h, but not the split-system variant, even though both types of units were included in a more comprehensive DOE equipment class. As noted previously, DOE is acting to prevent confusion by proposing to re-create separate product classes for the two types of systems. However, DOE has decided to now consider amended standards for 3-phase air-cooled split-system air conditioners less than 65,000 Btu/h under its 6-year look back authority. (42 U.S.C. 6313(a)(6)(C)(i)) It is worth noting that DOE did not consider ASHRAE's single-package air conditioner level of 14 SEER as the default adoption value for split-system air conditioners. Instead, DOE is treating those as a separate equipment class and has reviewed the adoption of 14 SEER for split-system air conditioners as a level more stringent than ASHRAE that must result in significant additional conservation of energy and be technologically feasible and economically justified.

In the April 2014 NODA, DOE conducted an analysis of the potential energy savings due to amended standards for single-package air conditioners and single-package and split-system heat pumps (air-cooled, three-phase, less than 65,000 Btu/h). At that time, DOE did not conduct an analysis of the potential energy savings for split-system air conditioners, but it added it to the analysis performed for this NOPR.

In response to the April 2014 NODA, Goodman Global supported the ASHRAE levels for small air-cooled air conditioners and heat pumps so that single-phase and three-phase products would have the same minimum efficiencies, which is a reduced burden. (Goodman Global, Inc., No. 17 at p. 4) Goodman Global added that it does not believe higher values than ASHRAE Standard 90.1–2013 could be justified from a simple payback perspective. (*Id.*) In contrast, the Advocates and the CA IOUs supported higher efficiency levels for three-phase equipment. The CA IOUs argued that the higher annual operating hours in nonresidential applications would support a higher

efficiency standard. (CA IOUs, No. 19 at p. 4) The Advocates stated that three-phase commercial units use a three-phase compressor, which is generally more efficient than a single-phase compressor, which suggests that a three-phase central air conditioner or heat pump has the potential to be more efficient than a comparable single-phase unit does. (Advocates, No. 21 at p. 1) Furthermore, the Advocates commented that efficiency levels were found on the market that were much higher than the ASHRAE Standard 90.1–2013 level of SEER 14 and that energy savings as high as 0.2 quads may be possible. (Advocates, No. 21 at p. 3) The CA IOUs stated that more than one-fifth of the models of three-phase air-cooled single-package units for sale in California could meet a 16 SEER standard, which would result in energy savings five times greater than the 0.02 quad savings from simply adopting the ASHRAE level. (CA IOUs, No. 0019 at p. 2) The CA IOUs added that most manufacturers currently have products that meet 15 SEER, and given that a compliance date for more-stringent levels would be 2020, the manufacturers that do not would have 6 years to redesign. (*Id.*)

Upon reviewing the results of the potential energy savings analysis in the April 2014 NODA, DOE agrees with the Advocates and the CA IOUs that additional significant energy savings are possible and has conducted additional economic analysis on this equipment. However, after analysis, DOE has tentatively determined that efficiency levels higher than those in ASHRAE Standard 90.1–2013 are not economically justified for any of the four equipment classes and is proposing in this NOPR to adopt the energy efficiency levels contained in ASHRAE Standard 90.1–2013 for small air-cooled commercial package air conditioning and heating equipment less than 65,000 Btu/h (see section VIII.D.1). For split system air conditioners, DOE is not updating standards, as the ASHRAE levels are equal to the current Federal minimum.

For small commercial three-phase equipment less than 65,000 Btu/h, the CA IOUs stated that DOE should consider including the energy efficiency ratio (EER) metric, along with SEER, to align more closely with industry standards. (CA IOUs, No. 0019 at p. 3–4) The commenter noted that original equipment manufacturers would use both metrics when rating a unit. The CA IOUs also commented that the SEER metric is based on residential use patterns and, by itself, may not be

appropriate to characterize energy use in nonresidential buildings. According to the commenter, full-load EER better approximates performance during peak loading conditions. (*Id.*)

In response, DOE does not have authority to adopt multiple metrics for a single equipment class. Pursuant to 42 U.S.C. 6313(a)(6), the Secretary has authority to amend the energy conservation standards for specified equipment, but under 42 U.S.C. 6311(18), the statute's definition of the term "energy conservation standard" is limited to: (A) A performance standard that prescribes a minimum level of energy efficiency or a maximum quantity of energy use for a product; or (B) a design requirement for a product. The language of EPCA authorizes DOE to establish a single performance standard or a single design standard, but not multiple performance standards.

## 2. Water-Source Equipment

The current Federal energy conservation standards for the three classes of commercial water-source heat pumps for which ASHRAE Standard 90.1–2013 amended efficiency levels are shown in Table II.1 and can be found in DOE's regulations at 10 CFR 431.97. The Federal energy conservation standards for water-source equipment are differentiated based on the model's cooling capacity. ASHRAE Standard 90.1–2013 increased the energy efficiency levels for all three equipment classes to efficiency levels that surpass the current Federal energy conservation standard levels. Therefore, DOE conducted an analysis of the potential energy savings due to amended standards for this equipment in the April 2014 NODA.

In response to the April 2014 NODA, the Advocates requested that DOE conduct further analysis to consider higher efficiency levels than those in ASHRAE Standard 90.1–2013 efficiency levels for water-source heat pumps, because efficiency levels as high as 21 EER are available on the market and higher efficiency levels could achieve additional national energy savings of as much as 1 quad. (The Advocates, No. 21 at p. 1) Upon reviewing the results of the potential energy savings analysis in the April 2014 NODA, DOE agrees with the Advocates that additional energy savings are possible and has conducted further analysis on this equipment. However, after the analysis, DOE has tentatively determined that there is not clear and convincing evidence that efficiency levels higher than those in ASHRAE 90.1–2013 are economically justified for any of the three water-

source heat pump classes and is proposing in this NOPR to adopt the energy efficiency levels contained in ASHRAE Standard 90.1–2013 for water-source heat pumps (see section VIII.D.2).

ASHRAE Standard 90.1–2013 also changed the name of this equipment class from "water source" to "water to air, water-loop" and changed the heating-mode descriptor for this equipment from COP to COP<sub>H</sub>. In the April 2014 NODA, DOE suggested that these were editorial changes only and that this new nomenclature refers to the same water-source heat pump equipment covered by Federal energy conservation standards, but with the metric nomenclature serving to clarify the difference between COP for refrigeration and COP for heat pumps. DOE requested comment on this issue. 79 FR 20114, 20120, 20137 (April 11, 2014). In response, AHRI agreed that the nomenclature changes were editorial. (AHRI, No. 24 at p. 3)

In the April 2014 NODA, DOE noted that EPCA does not define "water-source heat pump" other than to exclude ground-water-source units from the definition of "commercial package air conditioning and heating equipment" at 42 U.S.C. 6311(8)(A). 79 FR 20114, 20120 (April 11, 2014). However, DOE noted that there are several related types of water-source and ground-water-source heat pumps, as shown in Table IV.1. ASHRAE Standard 90.1–2013 included new nomenclature for all such types of heat pumps. DOE further noted that the vast majority of water-source (water-to-air, water-loop) heat pump models are also rated for performance in ground-loop or ground-water heat pump applications. It is DOE's understanding that design differences of the models used in the different applications are minimal, including potential use of material with better corrosion resistance in the water coil (for open-loop systems only) and/or added insulation for ground-water or ground-loop systems. Efficiency ratings are different across these three application types primarily because of the different test conditions. (Ground and ground-water-source systems are tested with cooler entering water.) Because of the similarity in models across applications, DOE believes that increased efficiency standards for water-loop applications may affect heat pumps for ground-source and ground-water applications, although they are excluded from coverage. *Id.*

TABLE IV.1—NOMENCLATURE FOR TYPES OF WATER-LOOP, GROUND-LOOP, AND GROUND-WATER-SOURCE HEAT PUMPS

ASHRAE standard 90.1–2010	ASHRAE standard 90.1–2013	Test procedure
Water-source (86° entering water) .....	Water-to-air, water-loop .....	ISO Standard 13256–1.
Ground-water-source (59° entering water) .....	Water-to-air, ground-water.	
Ground-water source (77° entering water) .....	Brine-to-air, ground-loop.	ISO Standard 13256–2.
Water-source water-to-water (86° entering water) .....	Water-to-water, water-loop .....	
Water-source water-to-water (59° entering water) .....	Water-to-water, ground-water.	
Ground-water-source brine-to-water (77° entering water) .....	Brine-to-water, ground-loop.	

In the April 2014 NODA, DOE considered adding a definition for “water-source heat pump” to the Code of Federal Regulations (CFR) that would include both single-phase and three-phase units of all capacities (up to 760,000 Btu/h) and would be applicable to water-to-air heat pumps. Specifically, DOE considered adapting the definition from that in the ASHRAE handbook:<sup>9</sup> “A water-source heat pump is a [single-phase or three-phase] reverse-cycle heat pump that uses [a circulating water loop] as the heat source for heating and as the heat sink for cooling. The main components are a compressor, refrigerant-to-water heat exchanger, refrigerant-to-air heat exchanger, refrigerant expansion devices, and refrigerant reversing valve.” DOE requested comment on this definition. 79 FR 20114, 20120 (April 11, 2014).

Regarding the proposed definition, Goodman Global agreed that it is beneficial to all stakeholders to define as clearly as possible the products being regulated. (Goodman Global, Inc., No. 17 at p. 2) On the other hand, AHRI stated that a definition for “water-source heat pump” was outside the scope of activity of this document, because ASHRAE Standard 90.1 does not contain any definition of a water-source heat pump. (AHRI, No. 24 at p. 3) AHRI also argued that the lack of definition has not hampered implementation of Federal minimum efficiency for such equipment and that DOE has not established any significant need or provided any compelling reasons that require the addition of this definition. (*Id.*) DOE agrees with Goodman Global and does not agree with AHRI, tentatively concluding that the nomenclature changes in ASHRAE Standard 90.1 that moved away from the term “water-source” necessitate inclusion of a definition for clarity.

AHRI and Daikin Applied expressed concern with the definition covering capacities up to 760,000 Btu/h, noting

that neither ASHRAE Standard 90.1 nor DOE have standards for models above 135,000 Btu/h. (AHRI, No. 24 at p. 3; Daikin Applied, No. 22 at p. 1) Daikin Applied further commented that the size of the market above 135,000 Btu/h is approximately 2–3 percent of the total, that the AHRI certification program stops at 166,000 Btu/h, and that practically speaking, the largest models on the market are 250,000 Btu/h. (*Id.*) Daikin Applied argued that there would be test burdens associated with accommodating the larger sizes in test labs. (*Id.*) In response, DOE notes that regardless of any current size limits on water-source heat pump standards, it does not change the fact that Congress set forth the scope of coverage in the statutory definitions for “commercial package air conditioning and heating equipment” and “very large commercial package air conditioning and heating equipment,” which is limited to equipment with a cooling capacity below 760,000 Btu per hour. (42 U.S.C. 6311(8)(A) and (D)) However, setting in place a definition of “water-source heat pump” that clearly delineates what that equipment entails, as well as the limits on DOE’s regulatory authority, would not in and of itself generate any standards compliance responsibilities or test burden. If the market changed and larger-size units became the norm, such standards might be appropriate, with ASHRAE presumably setting levels for such equipment. However, providing increased clarity through an appropriate definition is not directly tied to any such future developments.

Accordingly, DOE proposes to adopt the following definition, adapted from the ASHRAE Handbook and the definition proposed in the April 2014 NODA, and specifically referencing the new nomenclature included in ASHRAE 90.1–2013: “*Water-source heat pump* means a single-phase or three-phase reverse-cycle heat pump of all capacities (up to 760,000 Btu/h) that uses a circulating water loop as the heat source for heating and as the heat sink for cooling. The main components are a compressor, refrigerant-to-water heat exchanger, refrigerant-to-air heat exchanger, refrigerant expansion

devices, refrigerant reversing valve, and indoor fan. Such equipment includes, but is not limited to, water-to-air water-loop heat pumps.” DOE requests additional comment on this proposed definition. This is identified as Issue 1 under “Issues on Which DOE Seeks Comment” in section X.E of this NOPR.

Furthermore, DOE is proposing to revise the nomenclature for its water-source heat pump equipment classes to match the revised nomenclature in ASHRAE 90.1–2013: water-to-air, water-loop. Specifically, DOE proposes to revise Table 1 to 10 CFR 431.96 and Tables 1 and 2 to 10 CFR 431.97 to refer to “water-source (water-to-air, water-loop)” heat pumps rather than simply “water-source” heat pumps. Throughout this document, any reference to water-source heat pump equipment classes should be considered as referring to water-to-air, water-loop heat pumps.

In preparing this rulemaking, DOE noticed that the 2013 CFR<sup>10</sup> and the current e-CFR<sup>11</sup> contained errors in Table 1 and Table 2 to 10 CFR 431.96 and Table 2 to 10 CFR 431.97 for small water-source heat pumps (*i.e.*, less than 135,000 Btu/h), as well as in Table 1 to 10 CFR 431.97 for small, large, and very large water-source heat pumps. DOE has determined that these errors were incorporated through the previous ASHRAE-trigger final rule. 77 FR 28928 (May 16, 2012). By this rulemaking, DOE seeks to clarify the relevant tables by removing the inadvertently amended language.

### 3. Packaged Terminal Air Conditioners and Heat Pumps

EPCA defines a “packaged terminal air conditioner” as “a wall sleeve and a separate unencased combination of heating and cooling assemblies specified by the builder and intended for mounting through the wall. It includes a prime source of refrigeration, separable outdoor louvers, forced ventilation, and heating availability by

<sup>9</sup> 2012 ASHRAE Handbook, Heating, Ventilating, and Air-Conditioning Systems and Equipment. ASHRAE, Chapter 9 (Available at: <https://www.ashrae.org/resources-publications/description-of-the-2012-ashrae-handbook-hvac-systems-and-equipment>).

<sup>10</sup> See <http://www.gpo.gov/fdsys/pkg/CFR-2013-title10-vol3/pdf/CFR-2013-title10-vol3-part431-subpartF.pdf>.

<sup>11</sup> See <http://www.ecfr.gov/cgi-bin/retrieveECFR?gp=&SID=1f6aa69c8e81d1ccc6e9158c94d81e91&r=PART@n=pt10.3.431#sp10.3.431.f>.

builder's choice of hot water, steam, or electricity." (42 U.S.C. 6311(10)(A)) EPCA defines a "packaged terminal heat pump" as "a packaged terminal air conditioner that utilizes reverse cycle refrigeration as its prime heat source and should have supplementary heat source available to builders with the choice of hot water, steam, or electric resistant heat." (42 U.S.C. 6311(10)(B)) DOE codified these definitions at 10 CFR 431.92 in a direct final rule published in the **Federal Register** on October 21, 2004. 69 FR 61962, 61970.

The current Federal energy conservation standards for the three classes of PTACs for which ASHRAE Standard 90.1–2013 amended efficiency levels are shown in Table II.1 and are found in DOE's regulations at 10 CFR 431.97. The Federal energy conservation standards for PTACs are differentiated based on the cooling capacity and physical dimensions (standard versus nonstandard size). ASHRAE Standard 90.1–2013 increased the energy efficiency levels for all three standard-size PTAC equipment classes to efficiency levels that meet those for PTHPs and surpass the current Federal energy conservation standard levels for PTACs. Therefore, DOE conducted an analysis of the potential energy savings due to amended standards for standard-size PTACs in the April 2014 NODA. 79 FR 20114, 20120–21 (April 11, 2014).

Prior to the ASHRAE trigger, in February 2013, DOE published a notice of public meeting and availability of the Framework Document regarding energy conservation standards for packaged terminal air conditioners and heat pumps standards. 78 FR 12252 (Feb. 22, 2013). This Framework Document was published as a first step toward meeting the six-year look back requirement specified in EISA 2007. (42 U.S.C. 6313(a)(6)(C)(i)) As part of the six-year look back, in September 2014, DOE issued a NOPR for PTAC and PTHP equipment that included equipment classes for which ASHRAE Standard 90.1–2013 increased efficiency levels (*i.e.*, standard-size PTACs), as well as those for which it did not. 79 FR 55537 (Sept. 16, 2014). Consequently, PTACs will not be discussed in the remainder of this document; comments received on the April 2014 NODA related to PTACs were discussed in the PTAC NOPR.

#### 4. Small-Duct, High-Velocity, and Through-The-Wall Equipment

EPCA does not separate three-phase small-duct high-velocity (SDHV) or through-the-wall (TTW) heat pumps from other types of small commercial package air-conditioning and heating equipment in its definitions. (42 U.S.C.

6311(8)) Therefore, EPCA's definition of "small commercial package air conditioning and heating equipment" would include three-phase SDHV and TTW heat pumps. In contrast, single-phase SDHV and space-constrained equipment (including TTW), which are not the subject of this document, have separate product classes under DOE's residential central air conditioner and heat pump standards (see 10 CFR 430.32(c)).

ASHRAE Standard 90.1–2013 appeared to change some of the efficiency levels for three-phase SDHV and TTW equipment. Specifically, ASHRAE Standard 90.1–2010 had increased the cooling efficiency requirements for TTW heat pumps to 13.0 SEER in comparison to the efficiency levels of 12.0 SEER in ASHRAE Standard 90.1–2007. However, in March 2011, ASHRAE issued Proposed Addendum h for public review that would correct the minimum SEER for this equipment to 12.0 SEER, and this addendum was approved and incorporated into ASHRAE Standard 90.1–2013. Therefore, this change in ASHRAE Standard 90.1–2013 was correcting an editorial error in ASHRAE Standard 90.1–2010.

For SDHV air conditioners and heat pumps, ASHRAE Standard 90.1–2013 increases the cooling efficiency requirement from 10.0 SEER to 11.0 SEER. It also includes a heating efficiency requirement for SDHV heat pumps of 6.8 HSPF, which was present in ASHRAE 90.1–2007 but not ASHRAE 90.1–2010 (which DOE also thought to be an editorial error). These changes were made through Addendum bj to ASHRAE 90.1–2010, which noted that the previously adopted Addendum j to ASHRAE Standard 90.1–2010 had deleted the SDHV equipment class entirely because all SDHV models sold were single-phase residential products, but that Addendum bj was re-establishing the equipment class because manufacturers had expressed an intention to introduce three-phase equipment to the market. In addition, Addendum bj noted that it contained minimum efficiency levels identical to those established by DOE for single-phase residential SDHV products.

The DOE standards for both commercial (three-phase) TTW and SDHV air conditioners, which are 13.0 SEER, and for heat pumps, which are 13.0 SEER and 7.7 HSPF, were established for the overall equipment category of small commercial package air-conditioning and heating equipment by EISA 2007, which amended EPCA. (42 U.S.C. 6313(a)(7)(D)) Because the ASHRAE Standard 90.1–2013 efficiency

levels for three-phase TTW and SDHV equipment are less than the applicable Federal standards, DOE has tentatively concluded that it is not required to take action on this equipment at this time (see 42 U.S.C. 6313(a)(6)(A)(i) and (B)(iii)(I)). DOE did not receive comment on this issue and reaffirms this position.

#### 5. Single-Package Vertical Air Conditioners and Single-Package Vertical Heat Pumps

EPCA, as amended, defines "single package vertical air conditioner" as air-cooled commercial package air conditioning and heating equipment that:

(1) Is factory-assembled as a single package that:

(i) Has major components that are arranged vertically;

(ii) is an encased combination of cooling and optional heating components; and

(iii) is intended for exterior mounting on, adjacent interior to, or through an outside wall;

(2) is powered by a single- or 3-phase current;

(3) may contain one or more separate indoor grilles, outdoor louvers, various ventilation options, indoor free air discharges, ductwork, wall plenum, or sleeves; and

(4) has heating components that may include electrical resistance, steam, hot water, or gas, but may not include reverse cycle refrigeration as a heating means.

(42 U.S.C. 6311(22) ; 10 CFR 431.92) EPCA, as amended, defines "single package vertical heat pump" as a single-package vertical air conditioner that

(1) uses reverse cycle refrigeration as its primary heat source; and

(2) may include secondary supplemental heating by means of electrical resistance, steam, hot water, or gas.

(42 U.S.C. 6311(23); 10 CFR 431.92)

The current Federal energy conservation standards for the six classes of single-package vertical units (SPVUs) for which ASHRAE Standard 90.1–2013 amended efficiency levels are shown in Table II.1 and can be found in DOE's regulations at 10 CFR 431.97. The equipment classes for SPVACs and SPVHPs, as well as their attendant Federal energy conservation standards, are differentiated based on cooling capacity. ASHRAE Standard 90.1–2013 increased the energy efficiency levels for all six equipment classes to efficiency levels that surpass the current Federal energy conservation standard levels. Therefore, DOE conducted an analysis of the potential energy savings

due to amended standards for this equipment in the April 2014 NODA. 79 FR 20114, 20121 (April 11, 2014).

In response to the April 2014 NODA, Lennox urged DOE to adopt the ASHRAE Standard 90.1–2013 efficiency levels for SPVUs. (Lennox International Inc., No. 0015 at p. 2) On the other hand, the Advocates encouraged DOE to initiate a rulemaking for SPVUs to consider higher efficiency levels than those in ASHRAE Standard 90.1–2013 because of potential national energy savings up to 0.48 quads. (Advocates, No. 21 at p. 3) DOE notes that prior to the release of ASHRAE Standard 90.1–2013, DOE had already been conducting a rulemaking on SPVUs as a result of a one-time review requirement added by EISA 2007. See 76 FR 25622, 25633 (May 5, 2011). DOE will continue to conduct its SPVU analysis as part of a separate rulemaking that will also meet the requirements of the ASHRAE trigger, and accordingly, DOE has not included any further analysis or results regarding SPVUs in this NOPR. In the April 11, 2014 NODA, DOE also discussed its consideration of a space-constrained SPVU equipment class (79 FR 20114, 20121–23); DOE's consideration of that issue will also occur in the separate SPVU rulemaking.

#### B. Commercial Water Heaters

EPCA defines “storage water heater” as a water heater that heats and stores water within the appliance at a thermostatically controlled temperature for delivery on demand. This term does not include units with an input rating of 4,000 Btu/h or more per gallon of stored water. (42 U.S.C. 6311(12)(A)) DOE further clarified this definition in its regulations by adding that it is industrial equipment. 10 CFR 431.102. EPCA defines “instantaneous water heater” as a water heater that has an input rating of at least 4,000 Btu/h per gallon of stored water. (42 U.S.C. 6311(12)(B)) DOE further clarified this definition in its regulations by adding that it is industrial equipment, including products meeting this description that are designed to heat water to temperatures of 180°F or higher. 10 CFR 431.102.

The current Federal energy conservation standards for the five classes of storage and instantaneous water heaters for which ASHRAE Standard 90.1–2013 amended efficiency levels are shown in Table II.1 and set forth in DOE's regulations at 10 CFR 431.110. The equipment classes for commercial storage and instantaneous water heaters, and attendant Federal energy conservation standards, are differentiated based on fuel type and

size category. ASHRAE Standard 90.1–2013 appeared to change the standby loss levels for four equipment classes (gas-fired storage water heaters, oil-fired storage water heaters, gas-fired instantaneous water heaters, and oil-fired instantaneous water heaters) to efficiency levels that surpass the current Federal energy conservation standard levels. However, as discussed in the April 11, 2014 NODA, upon review of the changes, DOE believes that all changes to standby loss levels for these equipment classes were editorial errors because they are identical to SI (International System of Units; metric system) formulas rather than I–P (Inch-Pound; English system) formulas. 79 FR 20114, 20123. Therefore, DOE did not conduct an analysis of the potential energy savings for this equipment. DOE received no comment on this issue.

As discussed in the April 11, 2014 NODA, ASHRAE Standard 90.1–2013 also changed the standby loss level for electric storage water heaters, in this case in a purposeful manner to align with the current Federal energy conservation standard level. *Id.* Because these levels meet and do not exceed the current Federal standards, DOE did not conduct an analysis of the potential energy savings for this equipment class.

ASHRAE Standard 90.1–2013 also increased the thermal efficiency levels for oil-fired storage water heaters to efficiency levels that surpass the current Federal energy conservation standards. Therefore, DOE conducted an analysis of the potential energy savings due to amended thermal efficiency standards for oil-fired storage water heaters in the April 2014 NODA. *Id.*

DOE did not receive any comments from stakeholders specific to the efficiency level DOE should adopt for oil-fired storage water heaters. Based on the results of the April 2014 NODA, DOE has determined that there are minimal energy savings available from this equipment and has not conducted further analyses on these products. Therefore, DOE is proposing in this NOPR to adopt the energy efficiency levels contained in ASHRAE Standard 90.1–2013 for commercial oil-fired storage water heaters (see section VIII.D.3).

In response to the April 2014 NODA, DOE received comment from the Advocates that the standards for all commercial water heaters, not just oil-fired storage water heaters, are due for a six-year look back. (Advocates, No. 21 at p. 3) Although DOE acknowledges its statutory obligation to review the standards for commercial water heaters, in order to best allocate available resources, DOE is limiting the scope of

this current rulemaking to ASHRAE-triggered equipment. However, in October 2014, the agency issued a request for information (RFI) regarding commercial water heaters to initiate a separate six-year look back rulemaking for all categories of commercial water heating equipment. 79 FR 62899 (Oct. 21, 2014).

#### C. Test Procedures

EPCA requires the Secretary to amend the DOE test procedures for covered ASHRAE equipment to the latest version of those generally accepted industry testing procedures or the rating procedures developed or recognized by AHRI or by ASHRAE, as referenced by ASHRAE/IES Standard 90.1, unless the Secretary determines by rule published in the **Federal Register** and supported by clear and convincing evidence that the latest version of the industry test procedure does not meet the requirements for test procedures described in paragraphs (2) and (3) of 42 U.S.C. 6314(a).<sup>12</sup> (42 U.S.C. 6314(a)(4)(B)) ASHRAE Standard 90.1–2013 updated several of its test procedures for ASHRAE equipment. Specifically, ASHRAE Standard 90.1–2013 updated to the most recent editions of test procedures for small commercial package air conditioners and heating equipment (AHRI 210/240–2008 with Addendum 1 and 2, *Performance Rating of Unitary Air-Conditioning & Air-Source Heat Pump Equipment*), large and very large commercial package air conditioners and heating equipment (AHRI 340/360–2007 with Addenda 1 and 2, *Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment*), variable refrigerant flow equipment (AHRI 1230–2010 with Addendum 1, *Performance Rating of Variable Refrigerant Flow (VRF) Multi-Split Air-Conditioning and Heat Pump Equipment*), commercial warm-air furnaces (ANSI (American National Standards Institute) Z21.47–2012, *Standard for Gas-Fired Central*

<sup>12</sup> (2) Test procedures prescribed in accordance with this section shall be reasonably designed to produce test results which reflect energy efficiency, energy use, and estimated operating costs of a type of industrial equipment (or class thereof) during a representative average use cycle (as determined by the Secretary), and shall not be unduly burdensome to conduct. (3) If the test procedure is a procedure for determining estimated annual operating costs, such procedure shall provide that such costs shall be calculated from measurements of energy use in a representative average-use cycle (as determined by the Secretary), and from representative average unit costs of the energy needed to operate such equipment during such cycle. The Secretary shall provide information to manufacturers of covered equipment respecting representative average unit costs of energy.



*Furnaces*), and commercial water heaters (ANSI Z21.10.3–2011, *Gas Water Heaters*, Volume III, *Storage Water Heaters with Input Ratings Above 75,000 Btu Per Hour, Circulating and Instantaneous*).

In the April 2014 NODA, DOE preliminarily reviewed each of the test procedures that were updated in ASHRAE Standard 90.1–2013 and discussed the changes to those industry test procedures. 79 FR 20114, 20123–25 (April 11, 2014). DOE found that for AHRI 210/240, AHRI 340/360, AHRI 1230, and ANSI Z1.10.3, DOE had already incorporated by reference the most recent version<sup>13</sup> and did not need to take action. DOE received no comment on this issue. For ANSI Z21.47, DOE determined that the changes to the 2012 version do not impact those provisions of that industry test procedure that are used under the DOE test procedure for gas-fired warm air furnaces, and, therefore, such changes do not affect the energy efficiency ratings for gas-fired furnaces. Consequently, DOE determined that no further action was required at the time. *Id.* at 20124–25. In response to the April 2014 NODA, AHRI, Goodman Global, and Lennox International agreed with DOE's substantive assessment of ANSI Z21.47–2012. (AHRI, No. 24 at p. 5; Goodman Global, Inc., No. 18 at p. 2; Lennox International, Inc., No. 15 at p. 6) However, in keeping with EPCA's mandate to incorporate the latest version of the applicable industry test procedure pursuant to 42 U.S.C. 6314(a)(4)(B), DOE is proposing to incorporate by reference ANSI Z21.47–2012. Once again, DOE anticipates no substantive change or increase in test burden to be associated with this test procedure amendment for warm air furnaces.

DOE is also required to review the test procedures for covered ASHRAE equipment at least once every seven years. (42 U.S.C. 6314(a)(1)(A)) In addition to the updates to the referenced standards discussed previously, DOE is proposing to update the citations and incorporations by reference in DOE's regulations for commercial warm-air furnaces to the most recent version of ASHRAE 103, *Method of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boiler* (*i.e.*, ASHRAE 103–2007). The applicable sections of this standard include measurement of condensate and calculation of additional heat gain and heat losses for condensing furnaces. DOE notes that the most recent version

does not contain any updates to the sections currently referenced by the DOE test procedure, so no additional burden would be expected to result from this test procedure update.

DOE is aware that some commercial furnaces are designed for make-up air heating (*i.e.*, heating 100 percent outdoor air). DOE defines “commercial warm air furnace” at 10 CFR 431.72 as self-contained oil-fired or gas-fired furnaces designed to supply heated air through ducts to spaces that require it, with a capacity (rated maximum input) at or above 225,000 Btu/h. Further, DOE's definitions specify that this equipment includes combination warm air furnace/electric air conditioning units but does not include unit heaters and duct furnaces. Given the characteristics of this category of commercial furnaces, DOE tentatively concludes that gas-fired and oil-fired commercial furnaces that are designed for make-up air heating and that have input ratings at or above 225,000 Btu/h meet the definition of “commercial warm air furnace” because they are self-contained units that supply heated air through ducts. Consequently, DOE is clarifying that commercial warm air furnaces that are designed for make-up air heating are subject to DOE's regulatory requirements, including being tested according to the test procedure specified in 10 CFR 431.76.

DOE is seeking comments on any relevant issues that would affect the test procedure for commercial warm air furnaces. Interested parties are welcome to comment on any aspect of the DOE commercial warm air furnaces test procedure as part of this comprehensive 7-year-review. This is identified as issue 2 in section X.E, “Issues on Which DOE Seeks Comment.”

#### **V. Methodology for Small Commercial Air-Cooled Air Conditioners and Heat Pumps Less Than 65,000 Btu/h**

This section addresses the analyses DOE has performed for this rulemaking with respect to small commercial air-cooled air conditioners and heat pumps less than 65,000 Btu/h. A separate subsection addresses each analysis. In overview, DOE used a spreadsheet to calculate the life-cycle cost (LCC) and payback periods (PBPs) of potential energy conservation standards. DOE used another spreadsheet to provide shipments projections and then calculate national energy savings and net present value impacts of potential amended energy conservation standards.

#### *A. Market Assessment*

To begin its review of the ASHRAE Standard 90.1–2013 efficiency levels, DOE developed information that provides an overall picture of the market for the equipment concerned, including the purpose of the equipment, the industry structure, and market characteristics. This activity included both quantitative and qualitative assessments based primarily on publicly-available information. The subjects addressed in the market assessment for this rulemaking include equipment classes, manufacturers, quantities, and types of equipment sold and offered for sale. The key findings of DOE's market assessment are summarized in the following sections. For additional detail, see chapter 2 of the NOPR technical support document (TSD).

##### 1. Equipment Classes

As discussed previously, the Federal energy conservation standards for air-cooled air conditioners and heat pumps are differentiated based on the cooling capacity (*i.e.*, small, large, or very large). For small equipment, there is an additional disaggregation into: (1) Equipment less than 65,000 Btu/h and (2) equipment greater than or equal to 65,000 Btu/h and less than 135,000 Btu/h. ASHRAE Standard 90.1–2013 also differentiates the equipment that is less than 65,000 Btu/h into split system and single package subcategories. In the past, DOE has followed the same disaggregation. However, when EISA 2007 increased the efficiency levels to identical levels across single package and split system equipment, effective in 2008, DOE combined the equipment classes in the CFR, resulting in only two equipment classes, one for air conditioners and one for heat pumps. 74 FR 12058, 12074 (March 23, 2009). Because ASHRAE has increased the standard for only single package air conditioners, and has increased the HSPF level to a more stringent level for split system heat pumps than for single package heat pumps, and DOE is obligated to adopt, at a minimum, the increased level in ASHRAE 90.1–2013 for that equipment class, DOE proposes to re-create separate equipment classes for single package and split system equipment in the overall equipment classes of small commercial package air conditioners and heat pumps (three-phase air-cooled) less than 65,000 Btu/h, as shown in Table V.1.

<sup>13</sup> This final rule for commercial heating, air-conditioning, and water-heating equipment was



TABLE V.1—PROPOSED EQUIPMENT CLASSES FOR SMALL COMMERCIAL PACKAGED AIR-CONDITIONING AND HEATING EQUIPMENT &lt;65,000 Btu/h

Product	Cooling capacity Btu/h)	Sub-category
Small Commercial Packaged Air Conditioning and Heating Equipment (Air-Cooled, 3-Phase, Split System) .....	<65,000	AC HP
Small Commercial Packaged Air Conditioning and Heating Equipment (Air-Cooled, 3-Phase, Single Package)	<65,000	AC HP

## 2. Review of Current Market

In order to obtain the information needed for the market assessment for this rulemaking, DOE consulted a variety of sources, including manufacturer literature, manufacturer Web sites, and the AHRI certified directory.<sup>14</sup> The information DOE gathered serves as resource material throughout the rulemaking. The sections below provide an overview of the market assessment, and chapter 2 of the NOPR TSD provides additional detail on the market assessment, including citations to relevant sources.

### a. Trade Association Information

DOE researched various trade groups representing manufacturers, distributors, and installers of the various types of equipment being analyzed in this rulemaking. AHRI is one of the largest trade associations for manufacturers of space-heating, cooling, and water-heating equipment, representing more than 90 percent of the residential and commercial air-conditioning, space-heating, water-heating, and commercial refrigeration equipment manufactured in the United States.<sup>15</sup> AHRI also develops and publishes test procedure standards for measuring and certifying the performance of residential and commercial HVAC equipment and coordinates with the International Organization for Standardization (ISO) to help harmonize U.S. standards with international standards, if feasible. AHRI also maintains the AHRI Directory of Certified Product Performance, which is a database that lists all the products and equipment that have been certified by AHRI, thereby providing equipment ratings for all manufacturers who elect to participate in the program. DOE

<sup>14</sup> AHRI Directory of Certified Product Performance (2013) (Available at: [www.ahridirectory.org](http://www.ahridirectory.org)) (Last accessed November 11, 2013).

<sup>15</sup> Air-Conditioning, Heating, and Refrigeration Institute Web site, *About Us* (2013) (Available at: [www.ari.org/site/318/About-Us](http://www.ari.org/site/318/About-Us)) (Last accessed December 18, 2014).

utilized this database in developing base-case efficiency distributions.

The Heating, Air-conditioning and Refrigeration Distributors International (HARDI) is a trade association that represents over 450 wholesale heating, ventilating, air-conditioning, and refrigeration (HVACR) companies, plus over 300 manufacturing associates and nearly 140 manufacturing representatives. HARDI estimates that 80 percent of the revenue of HVACR systems goes through its members.<sup>16</sup> DOE did not utilize HARDI data for this rule.

The Air Conditioning Contractors of America (ACCA) is another trade association whose members include over 4,000 contractors and 60,000 professionals in the indoor environment and energy service community. According to their Web site, ACCA provides contractors with technical, legal, and market resources, helping to promote good practices and to keep buildings safe, clean, and affordable.<sup>17</sup> DOE did not use ACCA data for this rule.

### b. Manufacturer Information

DOE reviewed data for air-cooled commercial air conditioners and heat pumps currently on the market by examining the AHRI Directory of Certified Product Performance. DOE identified 23 parent companies (comprising 61 manufacturers) of small three-phase air-cooled air conditioners and heat pumps, which are listed in chapter 2 of the NOPR TSD. Of these manufacturers, five were identified as small businesses based upon number of employees and the employee thresholds set by the Small Business Administration. More details on this analysis can be found below in section IX.B.

<sup>16</sup> Heating, Air-conditioning & Refrigeration Distributors International Web site, *About HARDI* (2014) (Available at: [www.hardinet.org/about-hardi-0](http://www.hardinet.org/about-hardi-0)) (Last accessed February 10, 2014).

<sup>17</sup> Air Conditioning Contractors of America Web site, *About ACCA* (2014) (Available at: [www.acca.org/acca](http://www.acca.org/acca)) (Last accessed February 10, 2014).

### c. Market Data

DOE reviewed the AHRI database to characterize the efficiency and performance of small commercial air-cooled air conditioners and heat pumps less than 65,000 Btu/h models currently on the market. The full results of this market characterization are found in chapter 2 of the NOPR TSD. For split-system air conditioners, the average SEER value was 13.9, and 120 models (0.1 percent of the total models) have SEER ratings below the ASHRAE Standard 90.1–2013 level of 13.0 SEER. For single-package air conditioners, the average SEER value was 14.3, and 1,450 models (45 percent of the total models) have SEER ratings below the ASHRAE Standard 90.1–2013 level of 14.0 SEER.

For single-package heat pumps, the average SEER value is 14.0. Of the models identified by DOE, 653 models (54 percent of the total models) have SEER ratings below the ASHRAE Standard 90.1–2013 level of 14.0 SEER. The average HSPF value for this equipment class is 7.9. Of the models identified by DOE, 632 models (52 percent of the total models) have HSPF ratings below the ASHRAE Standard 90.1–2013 levels of 8.0. For split-system heat pumps, the average SEER value for this equipment class is 13.7. Of the models identified by DOE, 30,009 models (64 percent of the total models) have SEER ratings below the ASHRAE Standard 90.1–2013 level of 14.0. The average HSPF for this equipment class is 7.9. Of the models identified by DOE, 36,902 models (79 percent of the total models) have HSPF ratings below the ASHRAE Standard 90.1–2013 level of 8.2. For more information on market performance data, see chapter 2 of the NOPR TSD.

### B. Engineering Analysis

The engineering analysis establishes the relationship between an increase in energy efficiency and the increase in cost (manufacturer selling price (MSP)) of a piece of equipment DOE is evaluating for potential amended energy conservation standards. This relationship serves as the basis for cost-benefit calculations for individual

consumers, manufacturers, and the Nation. The engineering analysis identifies representative baseline equipment, which is the starting point for analyzing possible energy efficiency improvements. For covered ASHRAE equipment, DOE sets the baseline for analysis at the ASHRAE Standard 90.1 efficiency level, because by statute, DOE cannot adopt any level below the revised ASHRAE level. The engineering analysis then identifies higher efficiency levels and the incremental increase in product cost associated with achieving the higher efficiency levels. After identifying the baseline models and cost of achieving increased efficiency, DOE estimates the additional costs to the commercial consumer through an analysis of contractor costs and markups and uses that information in the downstream analyses to examine the costs and benefits associated with increased equipment efficiency.

DOE typically structures its engineering analysis around one of three methodologies: (1) The design-option approach, which calculates the incremental costs of adding specific design options to a baseline model; (2) the efficiency-level approach, which calculates the relative costs of achieving increases in energy efficiency levels without regard to the particular design options used to achieve such increases; and/or (3) the reverse-engineering or cost-assessment approach, which involves a “bottom-up” manufacturing cost assessment based on a detailed bill of materials derived from teardowns of the equipment being analyzed. A supplementary method called a catalog teardown uses published manufacturer catalogs and supplementary component data to estimate the major physical differences between a piece of equipment that has been physically disassembled and another piece of similar equipment for which catalog data are available to determine the cost of the latter equipment. Deciding which methodology to use for the engineering analysis depends on the equipment, the design options under study, and any historical data upon which DOE may draw.

1. Approach

For this analysis, DOE used a combination of the efficiency-level and the cost-assessment approach. DOE used the efficiency-level approach to identify incremental improvements in efficiency for each equipment class and the cost-assessment approach to develop a cost for each efficiency level. The efficiency levels that DOE considered in the engineering analysis were representative of three-phase central air conditioners and heat pumps currently produced by manufacturers at the time the engineering analysis was developed. DOE relied on data reported in the AHRI Directory of Certified Product Performance to select representative efficiency levels.

DOE generated a bill of materials (BOM) for each representative product that it disassembled. DOE did this for multiple manufacturers’ products that span a range of efficiency levels for the equipment classes that are analyzed in this rulemaking. The BOMs describe the manufacture of the equipment in detail, listing all parts and including all manufacturing steps required to make each part and to assemble the unit. DOE also conducted catalog teardowns to supplement the information obtained directly from physical teardowns. Subsequently, DOE developed a cost model that calculates manufacturer production cost (MPC) for each unit, based on the detailed BOM data. Chapter 3 of the NOPR TSD describes DOE’s cost model in greater detail. The calculated costs are plotted as a function of the equipment efficiency levels (based on rated efficiency) to create cost-efficiency curves. DOE notes that the cost at some efficiency levels was interpolated or extrapolated based on the available physical and catalog teardown data.

DOE developed cost-efficiency curves for a representative capacity of three tons, which it decided well represents the range of capacities on the market for commercial three-phase products. Because other capacity levels had similar designs and efficiency levels, cost-efficiency curves were not developed for any other capacities. Instead, DOE was able to utilize the

cost-efficiency curve for the representative capacity and apply it to all three-phase products.

DOE based the cost-efficiency relationship for three-phase central air conditioners and heat pumps on reverse engineering conducted for the June 2011 direct final rule (DFR) for single-phase central air conditioners and heat pumps. 76 FR 37408. DOE researched manufacturer literature and noticed that most model numbers between single-phase products and three-phase equipment are interchangeable, with only a single-digit difference in the model number for the supply voltage. Although three-phase equipment contains three-phase compressors instead of single-phase compressors, DOE did not notice any inconsistency in energy efficiency ratings between single-phase products and three-phase equipment. To supplement the 2011 DFR data (29 physical teardowns and 12 catalog teardowns), DOE completed one physical teardown and seven catalog teardowns of three-phase equipment. This approach allowed DOE to provide an estimate of equipment prices at different efficiencies and spanned a range of technologies currently on the market that are used to achieve the increased efficiency levels.

2. Baseline Equipment

DOE selected baseline efficiency levels as reference points for each equipment class, against which it measured changes resulting from potential amended energy conservation standards. DOE defined the baseline efficiency levels as reference points to compare the technology, energy savings, and cost of equipment with higher energy efficiency levels. Typically, units at the baseline efficiency level just meet Federal energy conservation standards and provide basic consumer utility. However, EPCA requires that DOE must adopt either the ASHRAE Standard 90.1–2013 levels or more-stringent levels. Therefore, because the ASHRAE Standard 90.1–2013 levels were the lowest levels that DOE could adopt, DOE used those levels as the reference points against which more-stringent levels were evaluated.

	Split-system AC	Single-pack-age AC	Split-system HP	Single-pack-age HP
<b>SEER</b>				
Baseline—Federal Standard .....	13.0	13.0	13.0	13.0
Baseline—ASHRAE Standard .....	13.0	14.0	14.0	14.0
<b>HSPF</b>				
Baseline—Federal Standard .....			7.7	7.7

	Split-system AC	Single-pack-age AC	Split-system HP	Single-pack-age HP
Baseline—ASHRAE Standard .....			8.2	8.0

Table V.2 shows the current baseline and ASHRAE efficiency levels for each equipment class of small commercial air-cooled air conditioners and heat pumps <65,000 Btu/h.

TABLE V.2—BASELINE EFFICIENCY LEVELS FOR SMALL COMMERCIAL AIR-COOLED AIR CONDITIONERS (AC) AND HEAT PUMPS (HP) <65,000 Btu/h

	Split-system AC	Single-pack-age AC	Split-system HP	Single-pack-age HP
<b>SEER</b>				
Baseline—Federal Standard .....	13.0	13.0	13.0	13.0
Baseline—ASHRAE Standard .....	13.0	14.0	14.0	14.0
<b>HSPF</b>				
Baseline—Federal Standard .....			7.7	7.7
Baseline—ASHRAE Standard .....			8.2	8.0

3. Identification of Increased Efficiency Levels for Analysis

DOE analyzed several efficiency levels and obtained incremental cost data for the four equipment classes under consideration. Table V.3 presents the efficiency levels examined for each equipment class. As part of the engineering analyses, DOE considered up to six efficiency levels beyond the baseline for each equipment class. DOE derived the maximum technologically feasible (“max-tech”) level from the market maximum in the AHRI Certified Directory,<sup>18</sup> as of November 2013. The highest available efficiency level for split-system heat pumps was 16.2,

compared to 18.05 for single-package heat pumps. DOE has tentatively determined that split-system heat pumps are capable of reaching the same efficiency level as single-package units, because the same technologies to increase efficiency can be employed across both equipment classes. As a result, the analyzed “max-tech” level for single-package and split-system heat pumps was 18.05. In the April 2014 commercial heating, air-conditioning, and water-heating equipment NODA, DOE determined the “max-tech” level for single-package air conditioners to be 19.15. 79 FR 20114, 20126 (April 11, 2014). DOE also tentatively determined that split-system air conditioners are

capable of reaching the same efficiency levels as single-package units. For the engineering analysis, DOE rounded the “max-tech” levels to integer values of 18 and 19 for split-system and single-package heat pumps, and split-system and single-package air conditioners, respectively. The impact of this rounding, which results in efficiency levels that are whole-number values of SEER, is minimal.

The efficiency levels for each considered equipment class are presented in Table V.3. For additional details on the efficiency levels selected for analysis, see chapter 3 of the NOPR TSD.

TABLE V.3—EFFICIENCY LEVELS FOR SMALL COMMERCIAL AIR-COOLED AIR CONDITIONERS AND HEAT PUMPS <65,000 Btu/h

Efficiency level	Split-system AC	Single-pack-age AC	Split-system HP		Single-package HP	
	SEER	SEER	SEER	HSPF	SEER	HSPF
Federal Baseline .....	13	13	13	7.7	13	7.7
0—ASHRAE Baseline* .....	14	14	14	8.2	14	8.0
1 .....	15	15	15	8.5	15	8.4
2 .....	16	16	16	8.7	16	8.8
3 .....	17	17	17	9.0	17	8.9
4** .....	18	18	18	9.2	18	9.1
5*** .....	19	19				

\* For consistency across equipment classes, DOE refers to 14 SEER as EL 0, which is only the ASHRAE Baseline for three of the equipment classes, excluding split-system AC.

\*\* Efficiency Level 4 is “Max-Tech” for HP equipment classes.

\*\*\* Efficiency Level 5 is “Max-Tech” for AC equipment classes.

<sup>18</sup> See: <http://www.ahridirectory.org/ahridirectory/pages/home.aspx>.

4. Engineering Analysis Results

The results of the engineering analysis are cost-efficiency curves based on results from the cost models for analyzed units. DOE's calculated MPCs for small commercial air conditioners and heat pumps less than 65,000 Btu/h are shown in Table V.4 through Table V.7, and further details on the calculation of these curves can be found in chapter 3 of the NOPR TSD. DOE used the cost-efficiency curves from the engineering analysis as an input for the life-cycle cost and payback period analyses.

TABLE V.4—MANUFACTURER PRODUCTION COSTS FOR THREE-TON SPLIT-SYSTEM COMMERCIAL AIR-COOLED AIR CONDITIONERS

SEER	MPC [\$]
13 .....	855
14 .....	937
15 .....	1,023
16 .....	1,115
17 .....	1,212
18 .....	1,316
19 .....	1,427

TABLE V.5—MANUFACTURER PRODUCTION COSTS FOR THREE-TON SINGLE-PACKAGE COMMERCIAL AIR-COOLED AIR CONDITIONERS

SEER	MPC [\$]
13 .....	1,003
14 .....	1,122
15 .....	1,241
16 .....	1,361
17 .....	1,480
18 .....	1,599
19 .....	1,719

TABLE V.6—MANUFACTURER PRODUCTION COSTS FOR THREE-TON SPLIT-SYSTEM COMMERCIAL AIR-COOLED HEAT PUMPS

SEER	HSPF	MPC [\$]
13 .....	7.7	1,068
14 .....	8.2	1,154
15 .....	8.5	1,244
16 .....	8.7	1,377
17 .....	9.0	1,486
18 .....	9.2	1,601

TABLE V.7—MANUFACTURER PRODUCTION COSTS FOR THREE-TON SINGLE-PACKAGE COMMERCIAL AIR-COOLED HEAT PUMPS

SEER	HSPF	MPC [\$]
13 .....	7.7	1,239

TABLE V.7—MANUFACTURER PRODUCTION COSTS FOR THREE-TON SINGLE-PACKAGE COMMERCIAL AIR-COOLED HEAT PUMPS—Continued

SEER	HSPF	MPC [\$]
14 .....	8.0	1,372
15 .....	8.4	1,504
16 .....	8.8	1,637
17 .....	8.9	1,769
18 .....	9.1	1,902

a. Manufacturer Markups

DOE applies a non-production cost multiplier (the manufacturer markup) to the full MPC to account for corporate non-production costs and profit. The resulting manufacturer selling price (MSP) is the price at which the manufacturer can recover all production and non-production costs and earn a profit. To meet new or amended energy conservation standards, manufacturers often introduce design changes to their equipment lines that result in increased manufacturer production costs. Depending on the competitive environment for these particular types of equipment, some or all of the increased production costs may be passed from manufacturers to retailers and eventually to commercial consumers in the form of higher purchase prices. As production costs increase, manufacturers typically incur additional overhead. The MSP should be high enough to recover the full cost of the equipment (*i.e.*, full production and non-production costs) and yield a profit. The manufacturer markup has an important bearing on profitability. A high markup under a standards scenario suggests manufacturers can pass along the increased variable costs and some of the capital and product conversion costs (the one-time expenditures) to the consumer. A low markup suggests that manufacturers will not be able to recover as much of the necessary investment in plants and equipment.

For small commercial air-cooled air-conditioners and heat pumps, DOE used a manufacturer markup of 1.3, as developed for the 2011 direct final rule for single-phase central air conditioners and heat pumps. 76 FR 37408 (June 27, 2011). This markup was calculated using U.S. Security and Exchange Commission (SEC) 10-K reports for publicly-owned heating and cooling companies, as well as feedback from manufacturer interviews. See chapter 3 of the NOPR TSD for more details about the methodology DOE used to determine the manufacturing markup.

b. Shipping Costs

Manufacturers of commercial HVAC products typically pay for freight (shipping) to the first step in the distribution chain. 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 non-production costs that comprise the manufacturer markup. DOE calculated the MSP for small commercial air-cooled air-conditioners and heat pumps by multiplying the MPC at each efficiency level (determined from the cost model) by the manufacturer markup and adding shipping costs for equipment at the given efficiency level. More specifically, DOE calculated shipping costs at each efficiency level based on a typical 53-foot straight-frame trailer with a storage volume of 4,240 cubic feet. DOE examined the sizes of small commercial air-cooled air-conditioners and heat pumps and determined the number of units that would fit in each trailer, based on assumptions about the arrangement of units in the trailer. See chapter 3 of the NOPR TSD for more details about the methodology DOE used to determine the shipping costs.

C. Markups Analysis

The markups analysis develops appropriate markups in the distribution chain to convert the estimates of manufacturer selling price derived in the engineering analysis to commercial consumer prices. ("Commercial consumer" refers to purchasers of the equipment being regulated.) DOE calculates overall baseline and incremental markups based on the equipment markups at each step in the distribution chain. The incremental markup relates the change in the manufacturer sales price of higher-efficiency models (the incremental cost increase) to the change in the commercial consumer price.

In the 2014 NOPR for Central Unitary Air Conditioners (CUAC), which includes equipment similar to but larger than that in this NOPR, DOE determined that there are three types of distribution channels to describe how the equipment passes from the manufacturer to the commercial consumer. 79 FR 58948, 58975 (Sept. 30, 2014). In the new construction market, the manufacturer sells the equipment to a wholesaler. The wholesaler sells the equipment to a mechanical contractor, who sells it to a general contractor, who in turn sells the equipment to the commercial consumer or end user as part of the building. In the replacement market, the

manufacturer sells to a wholesaler, who sells to a mechanical contractor, who in turn sells the equipment to the commercial consumer or end user. In the third distribution channel, used in both the new construction and replacement markets, the manufacturer sells the equipment directly to the customer through a national account.

In this NOPR, DOE used two of the three distribution channels described above to determine the markups. Given the small cooling capacities of air conditioners and heat pumps less than 65,000 Btu/h, DOE did not use the national accounts distribution chain in the markups analysis. National accounts are composed of large commercial consumers of HVAC equipment that negotiate equipment prices directly with the manufacturers, such as national retail chains. The end market consumers of three-ton central air conditioners and heat pumps are small offices and small retailers and do not fit the profile of large national chains.

In the 2014 CUAC NOPR, based on information that equipment manufacturers provided, commercial consumers were estimated to purchase 50 percent of the covered equipment through small mechanical contractors, 32.5 percent through large mechanical contractors, and the remaining 17.5 percent through national accounts. 79 FR 58948, 58976 (Sept. 30, 2014). For this NOPR, DOE removed the national accounts distribution channel and recalculated the size of the small and large mechanical contractor distribution channels assuming they make up the entire market. Therefore, the small mechanical distribution chain accounts for 61 percent of equipment purchases (*i.e.*, 50 percent divided by the sum of 50 percent and 32.5 percent), and the large mechanical contractor distribution chain represents 39 percent of purchases.

For this NOPR, DOE used the markups from the 2014 CUAC NOPR, for which DOE utilized updated versions of: (1) The Heating, Air Conditioning & Refrigeration Distributors International 2010 Profit Report to develop wholesaler markups; (2) the Air Conditioning Contractors of America's (ACCA) 2005 Financial Analysis for the HVACR Contracting Industry to develop mechanical contractor markups; and (3) U.S. Census Bureau economic data for the commercial and institutional building construction industry to develop general contractor markups.<sup>19</sup>

<sup>19</sup> U.S. Census Bureau, 2007 Economic Census, Construction Industry Series and Wholesale Trade

Chapter 5 of the NOPR TSD provides further detail on the estimation of markups.

#### D. Energy Use Analysis

The energy use analysis provides estimates of the annual energy consumption of small air-cooled air conditioners and heat pumps with cooling capacities less than 65,000 Btu/h at the considered efficiency levels. DOE uses these values in the LCC and PBP analyses and in the NIA.

The cooling unit energy consumption (UEC) by equipment type and efficiency level came from the national impact analysis associated with the 2011 direct final rule (DFR) for residential central air conditioners and heat pumps. (EERE-2011-BT-STD-0011-0011). Specifically, DOE used the UECs for single-phase equipment installed in commercial buildings. The UECs for split system and single package equipment were similar in the 2011 analysis for lower efficiency levels, but at higher efficiency levels, the only UECs available were for split-system equipment. DOE assumed that the similarities at lower levels could be expected to hold at higher efficiency levels; therefore, DOE is using the UECs for split equipment for all equipment classes in this NOPR, including split system and single package. In the April 11, 2014 NODA, DOE requested comment on the use of UECs from an analysis of single-phase products in commercial applications. 79 FR 20114, 20137. In response, Goodman, Lennox, and AHRI commented that single-phase and three-phase products should not differ substantially in energy consumption. (Goodman Global, Inc., No. 18 at p. 2; Lennox International, Inc., No. 15 at p. 6; AHRI, No. 24 at p. 5) Goodman added that for products less than 65,000 Btu/h, industry practice involves creating a single-phase product and then changing the compressor from single-phase to three-phase while leaving the motors for the condenser fan and evaporator blower at single-phase. (Goodman Global, Inc., No. 18 at p. 2) DOE agrees with the commenters and has maintained this approach.

In order to assess variability in the cooling UEC by region and building type, DOE used a Pacific Northwest National Laboratory report<sup>20</sup> that estimated the annual energy usage of space cooling and heating products using a Full Load Equivalent Operating Hour (FLEOH) approach. DOE

Subject Series (Available at: [www.census.gov/econ/census/data/historical\\_data.html](http://www.census.gov/econ/census/data/historical_data.html)).

<sup>20</sup> See Appendix D of the 2000 Screening Analysis for EPCAT-Covered Commercial HVAC and Water-Heating Equipment. (EERE-2006-STD-0098-0015)

normalized the provided FLEOHs to the UEC data discussed above to vary the average UEC across region and building type. The building types used in this analysis are small retail establishments and small offices.

In the April 11, 2014 NODA, DOE stated that it also considered analyzing heating UECs for heat pumps. 79 FR 20114, 20126. However, in reviewing the 2011 analysis, DOE found that the heating UECs did not scale proportionally with HSPF for commercial installations. *Id.* Therefore, DOE preliminarily determined that it was not possible to quantify energy savings given the available data. DOE requested comment seeking data and information related to the heating energy use of commercial heat pumps. *Id.* at 20137.

In response, AHRI commented that Pacific Northwest National Laboratory (PNNL) analyzes the benefits of increased efficiency requirements in ASHRAE 90.1-2013, and it increased the heating seasonal performance factor (HSPF) for 3-phase heat pumps less than 65,000 Btu/h. Therefore, PNNL may have information on the energy savings related to ASHRAE's standard. (AHRI, No. 24 at p. 6) Goodman suggests it is logical for there to be a reasonable relationship between the HSPF rating and UEC. (Goodman Global, Inc., No. 18 at p. 2) On the other hand, Lennox pointed out that HSPF is an efficiency metric designed to reflect the performance of a heat pump operating against a residential load profile in which the building balance point is at 65°F. Most commercial buildings have enough internal heat gain that their heating balance points can be at 30°F or below.<sup>21</sup> Therefore, the heat pump will not have a heating demand until the ambient temperature reaches this balance point. Much of the performance contribution for heat pumps to reach a high HSPF comes from its performance in the temperature range where it will never operate in a commercial building. For this reason, there will be little energy savings from increasing HSPF for commercial air-cooled equipment. (Lennox International Inc., No. 15 at p. 8)

DOE notes that ASHRAE increased the HSPF and SEER levels for this equipment to levels that matched DOE's residential requirements, for

<sup>21</sup> In other words, the quantity of people, lighting, and equipment in the commercial building produce so much heat (*i.e.*, internal heat gain) that heating is not required until the temperature is quite low, as mentioned in this case to be 30 °F. In contrast, residential buildings tend to have lower internal heat gain, so heating is required at a higher temperature.

consistency in the market rather than necessarily to achieve energy savings. In light of Goodman and Lennox's comments, DOE has further reviewed the results of the simulations for the 2011 DFR and determined that the heating loads for these small commercial applications are extremely low (less than 500 kwh/year). As a result, DOE has not included any energy savings due to the increase in HSPF for this equipment.

#### *E. Life-Cycle Cost and Payback Period Analysis*

The purpose of the LCC and PBP analysis is to analyze the effects of potential amended energy conservation standards on commercial consumers of small commercial air-cooled air conditioners and heat pumps less than 65,000 btu/h by determining how a potential amended standard affects their operating expenses (usually decreased) and their total installed costs (usually increased).

The LCC is the total consumer expense over the life of the equipment, consisting of equipment and installation costs plus operating costs (*i.e.*, expenses for energy use, maintenance, and repair). DOE discounts future operating costs to the time of purchase using commercial consumer discount rates. The PBP is the estimated amount of time (in years) it takes commercial consumers to recover the increased total installed cost (including equipment and installation costs) of a more-efficient type of equipment through lower operating costs. DOE calculates the PBP by dividing the change in total installed cost (normally higher) due to a standard by the change in annual operating cost (normally lower) that results from the potential standard. However, unlike the LCC, DOE only considers the first year's operating expenses in the PBP calculation. Because the PBP does not account for changes in operating expenses over time or the time value of money, it is also referred to as a simple PBP.

For any given efficiency level, DOE measures the PBP and the change in LCC relative to an estimate of the base-case efficiency level. For split-system air conditioners, for which ASHRAE did not increase efficiency levels, the base-case estimate reflects the market in the absence of amended energy conservation standards, including the market for equipment that exceeds the current energy conservation standards. For single-package air conditioners, split-system heat pumps, and single-package heat pumps, the base-case estimate reflects the market in the case where the ASHRAE 90.1–2013 level

becomes the Federal minimum, and the LCC calculates the LCC savings likely to result from higher efficiency levels compared with the ASHRAE base-case.

DOE conducted an LCC and PBP analysis for small commercial air-cooled air conditioners and heat pumps less than 65,000 btu/h using a computer spreadsheet model. When combined with Crystal Ball (a commercially-available software program), the LCC and PBP model generates a Monte Carlo simulation to perform the analyses by incorporating uncertainty and variability considerations in certain of the key parameters as discussed below. Inputs to the LCC and PBP analysis are categorized as: (1) Inputs for establishing the total installed cost and (2) inputs for calculating the operating expense. The following sections contain brief discussions of comments on the inputs and key assumptions of DOE's LCC and PBP analysis and explain how DOE took these comments into consideration. They are also described in detail in chapter 6 of the NOPR TSD.

#### 1. Equipment Costs

In the LCC and PBP analysis, the equipment costs faced by purchasers of small air-cooled air conditioning and heat pump equipment are derived from the MSPs estimated in the engineering analysis, the overall markups estimated in the markups analysis, and sales tax.

To develop an equipment price trend for the NOPR, DOE derived an inflation-adjusted index of the producer price index (PPI) for "unitary air-conditioners, except air source heat pumps" from 1978 to 2013, which is the PPI series most relevant to small air-cooled air-conditioning equipment. The PPI index for heat pumps covered too short a time period to provide a useful picture of pricing trends, so the air-conditioner time series was used for both air conditioners and heat pumps. DOE expects this to be a reasonably accurate assessment for heat pumps because heat pumps are produced by the same manufacturers as air-conditioners and contain most of the same components. Although the overall PPI index shows a long-term declining trend, data for the last decade have shown a flat-to-slightly-rising trend. Given the uncertainty as to which of the trends will prevail in coming years, DOE chose to apply a constant price trend (at 2013 levels) for the NOPR. See chapter 6 of the NOPR TSD for more information on the price trends.

#### 2. Installation Costs

DOE derived national average installation costs for small air-cooled air conditioning and heat pump equipment

from data provided in RS Means 2013.<sup>22</sup> RS Means provides estimates for installation costs for the subject equipment by equipment capacity, as well as cost indices that reflect the variation in installation costs for 656 cities in the United States. The RS Means data identify several cities in all 50 States and the District of Columbia. DOE incorporated location-based cost indices into the analysis to capture variation in installation costs, depending on the location of the consumer.

Based on these data, DOE tentatively concluded that data for 3-ton rooftop air conditioners would be sufficiently representative of the installation costs for air conditioners less than 65,000 btu/h. For heat pumps, DOE used the installation costs for 3-ton air-source heat pumps.

DOE also varied installation cost as a function of equipment weight. Because weight tends to increase with equipment efficiency, installation cost increased with equipment efficiency. The weight of the equipment in each class and efficiency level was determined through the engineering analysis.

#### 3. Unit Energy Consumption

The calculation of annual per-unit energy consumption by each class of the subject small air-cooled air conditioning and heating equipment at each considered efficiency level is based on the energy use analysis as described above in section V.D and in chapter 4 of the NOPR TSD.

#### 4. Electricity Prices and Electricity Price Trends

DOE used average and marginal electricity prices by Census Division based on tariffs from a representative sample of electric utilities. This approach calculates energy expenses based on actual commercial building average and marginal electricity prices that customers are paying.<sup>23</sup> The Commercial Buildings Energy Consumption Survey (CBECS) 1992 and CBECS 1995 surveys provide monthly electricity consumption and demand for a large sample of buildings. DOE used these values to help develop usage patterns associated with various building types. Using these monthly values in conjunction with the tariff data, DOE calculated monthly electricity

<sup>22</sup> RS Means Mechanical Cost Data 2013. *Reed Construction Data, LLC (2012)*.

<sup>23</sup> Coughlin, K., C. Bolduc, R. Van Buskirk, G. Rosenquist and J.E. McMahon, "Tariff-based Analysis of Commercial Building Electricity Prices" (2008) Lawrence Berkeley National Laboratory: Berkeley, CA. Report No. LBNL-55551.

bills for each building. The average price of electricity is defined as the total electricity bill divided by total electricity consumption. From this average price, the marginal price for electricity consumption was determined by applying a 5-percent decrement to the average CBECS consumption data and recalculating the electricity bill. Using building location and the prices derived from the above method, an average and marginal price were determined for each region of the U.S.

The average electricity price multiplied by the baseline electricity consumption for each equipment class defines the baseline LCC. For each efficiency level, the operating cost savings are calculated by multiplying the electricity consumption savings (relative to the baseline) by the marginal consumption price.

For this NOPR, the tariff-based prices were updated to 2013 using the commercial electricity price index published in the *AEO*. An examination of data published by the Edison Electric Institute<sup>24</sup> indicates that the rate of increase of marginal and average prices is not significantly different, so the same factor was used for both pricing estimates. DOE projected future electricity prices using trends in average commercial electricity price from *AEO 2014*.

For further discussion of electricity prices, see chapter 6 of the NOPR TSD.

#### 5. Maintenance Costs

Maintenance costs are costs to the commercial consumer of ensuring continued operation of the equipment (e.g., checking and maintaining refrigerant charge levels and cleaning heat-exchanger coils). DOE derived annualized maintenance costs for small commercial air-cooled air conditioners and heat pumps from RS Means data.<sup>25</sup> These data provided estimates of person-hours, labor rates, and materials required to maintain commercial air-conditioning and heating equipment. The estimated annualized maintenance cost is \$298 for air conditioners rated between 36,000 Btu/h and 288,000 Btu/h and \$329 for heat pumps rated between 36,000 Btu/h and 288,000 Btu/h; this capacity range includes the equipment that is the subject of this NOPR. DOE assumed that the maintenance costs do not vary with efficiency level.

<sup>24</sup> Edison Electric Institute, *EI Typical Bills and Average Rates Report* (bi-annual, 2007–2012).

<sup>25</sup> RS Means *Facilities Maintenance & Repair Cost Data 2013*. Reed Construction Data, LLC. (2012).

#### 6. Repair Costs

Repair costs are costs to the commercial consumer associated with repairing or replacing components that have failed. DOE utilized RS Means<sup>26</sup> to find the repair costs for small commercial air-cooled air conditioners and heat pumps. For air conditioners, DOE used the repair costs for a 3-ton, single-zone rooftop unit. For heat pumps, DOE took the repair costs for 1.5-ton, 5-ton, and 10-ton air-to-air heat pumps and linearly scaled the repair costs to derive a 3-ton repair cost. DOE assumed that the repair would be a one-time event in year 10 of the equipment life. DOE then annualized the present value of the cost over the average equipment life of 19 or 16 years (for air conditioners and heat pumps, respectively) to obtain an annualized equivalent repair cost. This value ranges from \$141 to \$154 at the baseline level, depending on equipment class. The materials portion of the repair cost was scaled with the percentage increase in manufacturers' production cost by efficiency level. The labor cost was held constant across efficiency levels. This annualized repair cost was then added to the maintenance cost to create an annual "maintenance and repair cost" for the lifetime of the equipment. For further discussion of how DOE derived and implemented repair costs, see chapter 6 of the NOPR TSD.

#### 7. Equipment Lifetime

Equipment lifetime is the age at which the subject small air-cooled air conditioners and heat pumps less than 65,000 Btu/h are retired from service. DOE based equipment lifetime on a retirement function in the form of a Weibull probability distribution. DOE used the inputs from the 2011 DFR technical support document for central air conditioners and heat pumps, which represented a mean lifetime of 19.01 years for air conditioners and 16.24 years for heat pumps, and used the same values for units in both residential and commercial applications. (EERE–2011–BT–STD–0011–0012) Given the similarity of such equipment types, DOE believes the lifetime for single-phase equipment may be a reasonable approximation of the lifetime for similar three-phase equipment.

#### 8. Discount Rate

The discount rate is the rate at which future expenditures are discounted to estimate their present value. The cost of capital commonly is used to estimate the present value of cash flows to be derived from a typical company project

<sup>26</sup> *Id.*

or investment. Most companies use both debt and equity capital to fund investments, so the cost of capital is the weighted-average cost to the firm of equity and debt financing. DOE uses the capital asset pricing model (CAPM) to calculate the equity capital component, and financial data sources to calculate the cost of debt financing.

DOE derived the discount rates by estimating the weighted-average cost of capital (WACC) of companies that purchase air-cooled air-conditioning equipment. More details regarding DOE's estimates of commercial consumer discount rates are provided in chapter 6 of the NOPR TSD.

#### 9. Base-Case Market Efficiency Distribution

For the LCC analysis, DOE analyzes the considered efficiency levels relative to a base case (*i.e.*, the case without amended energy efficiency standards, in this case the current Federal standards for split-system air conditioners, and the default scenario in which DOE is required to adopt the efficiency levels in ASHRAE 90.1–2013 for the three equipment classes triggered by ASHRAE). This analysis requires an estimate of the distribution of equipment efficiencies in the base case (*i.e.*, what consumers would have purchased in the compliance year in the absence of amended standards for split-system air conditioners, or amended standards more stringent than those in ASHRAE 90.1–2013 for the three triggered equipment classes). DOE refers to this distribution of equipment energy efficiencies as the base-case efficiency distribution. For more information on the development of the base-case distribution, see section V.F.3 and chapter 6 of the NOPR TSD.

#### 10. Compliance Date

DOE calculated the LCC and PBP for all commercial consumers as if each were to purchase new equipment in the year that compliance with amended standards is required. Generally, covered equipment to which a new or amended energy conservation standard applies must comply with the standard if such equipment is manufactured or imported on or after a specified date. In this NOPR, DOE is evaluating whether more-stringent efficiency levels than those in ASHRAE Standard 90.1–2013 would be technologically feasible, economically justified, and result in a significant additional amount of energy savings. If DOE were to propose a rule prescribing energy conservation standards at the efficiency levels contained in ASHRAE Standard 90.1–2013 for the three triggered equipment

classes, EPCA states that compliance with any such standards shall be required on or after a date which is two or three years (depending on equipment size) after the compliance date of the applicable minimum energy efficiency requirement in the amended ASHRAE/IES standard. (42 U.S.C. 6313(a)(6)(D)) Given the equipment size at issue here, DOE has applied the two-year implementation period to determine the compliance date of any energy conservation standard equal to the efficiency levels specified by ASHRAE Standard 90.1–2013 proposed by this rulemaking. Thus, if DOE decides to adopt the efficiency levels in ASHRAE Standard 90.1–2013, the compliance date of the rulemaking would be dependent upon the date specified in ASHRAE Standard 90.1–2013 or its publication date, if none is specified. In this case, the rule would apply to small commercial air-cooled air conditioners and heat pumps less than 65,000 Btu/h manufactured on or after January 1, 2017, which is two years after the date specified in ASHRAE Standard 90.1–2013.

If DOE were to propose a rule prescribing energy conservation standards more stringent than the efficiency levels contained in ASHRAE Standard 90.1–2013, EPCA states that compliance with any such standards is required for products manufactured on or after a date which is four years after the date the final rule is published in the **Federal Register**. (42 U.S.C. 6313(a)(6)(D)) DOE has applied this 4-year implementation period to determine the compliance date for any energy conservation standard more stringent than the efficiency levels specified by ASHRAE Standard 90.1–2013 that might be prescribed at the final rule stage for the three equipment classes triggered by ASHRAE. Thus, for equipment for which DOE might adopt a level more stringent than the ASHRAE efficiency levels, the rule would apply to products manufactured on or after a date four years from the date of publication of the final rule, which the statute requires to be completed by April 9, 2016 (thereby resulting in a compliance date no later than April 9, 2020).<sup>27</sup>

For split system air-cooled air conditioners, which DOE evaluated

under the 6 year look back, DOE applied a different compliance date. Specifically, EPCA states that amended standards prescribed under this subsection shall apply to products manufactured after a date that is the later of: (I) the date that is 3 years after publication of the final rule establishing a new standard; or (II) the date that is 6 years after the effective date of the current standard for a covered product. (42 U.S.C. 6313(a)(6)(C)(iv)) Because DOE must publish a final rule by April 9, 2016, in the case that it adopts standards higher than those in ASHRAE Standard 90.1 for the other three equipment classes, DOE projected that the date under clause (I) would be April 2019, which is later than the date under clause (II). For purposes of its analysis, DOE used 2019 as the first year of compliance with amended standards.

Economic justification is not required for DOE to adopt the efficiency levels in ASHRAE 90.1–2013, as DOE is statutorily required to, at a minimum, adopt those levels. Therefore, DOE did not perform an LCC analysis on the ASHRAE Standard 90.1–2013 levels, and for purposes of the LCC analysis, DOE used 2020 as the first year of compliance with amended standards.

#### 11. Payback Period Inputs

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

Similar to the LCC, the inputs to the PBP calculation are the total installed cost of the equipment to the commercial consumer for each efficiency level and the average annual operating expenditures for each efficiency level for each building type and Census Division, weighted by the probability of shipment to each market. The PBP calculation uses the same inputs as the LCC analysis, except that discount rates are not needed. Because the simple PBP does not take into account changes in operating expenses over time or the time value of money, DOE considered only the first year's operating expenses to calculate the PBP, unlike the LCC, which is calculated over the lifetime of the equipment. Chapter 6 of the NOPR TSD provides additional detail about the PBP.

#### F. National Impact Analysis—National Energy Savings and Net Present Value Analysis

The national impact analysis (NIA) evaluates the effects of a considered energy conservation standard from a national perspective rather than from the consumer perspective represented by the LCC. This analysis assesses the net present value (NPV) (future amounts discounted to the present) and the national energy savings (NES) of total commercial consumer costs and savings, which are expected to result from amended standards at specific efficiency levels. For each efficiency level analyzed, DOE calculated the NPV and NES for adopting more-stringent standards than the efficiency levels specified in ASHRAE Standard 90.1–2013.

The NES refers to cumulative energy savings from 2017 through 2046 for the three equipment classes triggered by ASHRAE; however when evaluating more-stringent standards, energy savings do not begin accruing until the later compliance date of 2020. DOE calculated new energy savings in each year relative to a base case, defined as DOE adoption of the efficiency levels specified by ASHRAE Standard 90.1–2013. DOE also calculated energy savings from adopting efficiency levels specified by ASHRAE Standard 90.1–2013 compared to the EPCA base case (*i.e.*, the current Federal standards).

For split-system air conditioners, the NES refers to cumulative energy savings from 2019 through 2048 for all standards cases. DOE calculated new energy savings in each year relative to a base case, defined as the current Federal standards, which are equivalent to the efficiency levels specified by ASHRAE Standard 90.1–2013.

The NPV refers to cumulative monetary savings. DOE calculated net monetary savings in each year relative to the base case (ASHRAE Standard 90.1–2013) as the difference between total operating cost savings and increases in total installed cost. Cumulative savings are the sum of the annual NPV over the specified period. DOE accounted for operating cost savings until past 2100, when the equipment installed in the 30th year after the compliance date of the amended standards should be retired.

#### 1. Approach

The NES and NPV are a function of the total number of units in use and their efficiencies. Both the NES and NPV depend on annual shipments and equipment lifetime. Both calculations start by using the shipments estimate

<sup>27</sup> Since ASHRAE published ASHRAE Standard 90.1–2013 on October 9, 2013, EPCA requires that DOE publish a final rule adopting more-stringent standards than those in ASHRAE Standard 90.1–2013, if warranted, within 30 months of ASHRAE action (*i.e.*, by April 2016). Thus, four years from April 2016 would be April 2020, which would be the anticipated compliance date for DOE adoption of more-stringent standards.



and the quantity of units in service derived from the shipments model.

With regard to estimating the NES, because more-efficient air conditioners and heat pumps are expected to gradually replace less-efficient ones, the energy per unit of capacity used by the air conditioners and heat pumps in service gradually decreases in the standards case relative to the base case. DOE calculated the NES by subtracting energy use under a standards-case scenario from energy use in a base-case scenario.

Unit energy savings for each equipment class are taken from the LCC spreadsheet for each efficiency level and weighted based on market efficiency distributions. To estimate the total energy savings for each efficiency level, DOE first calculated the national site energy consumption (*i.e.*, the energy directly consumed by the units of equipment in operation) for each class of air conditioner and heat pumps for each year of the analysis period. The NES and NPV analysis periods begin with the earliest expected compliance date of amended Federal energy conservation standards (*i.e.*, 2017 for the equipment classes triggered by ASHRAE, assuming DOE adoption of the baseline ASHRAE Standard 90.1–2013 efficiency levels, and 2019 for split-system air conditioners, 3 years after DOE would likely issue a final rule requiring standards more stringent than ASHRAE). For the analysis of DOE's potential adoption of more-stringent efficiency levels for the equipment classes triggered by ASHRAE, the earliest compliance date would be 2020, four years after DOE would likely issue a final rule requiring such standards. Second, DOE determined the annual site energy savings, consisting of the difference in site energy consumption between the base case and the standards case for each class of small commercial air conditioner and heat pump less than 65,000 Btu/h. Third, DOE converted the annual site energy savings into the annual primary and FFC energy savings using annual conversion factors derived from the *AEO 2014* version of the Energy Information Administration's (EIA) National Energy Modeling System (NEMS). Finally, DOE summed the annual primary and FFC energy savings from 2017 to 2046 (or 2019 to 2048) to calculate the total NES for that period. DOE performed these calculations for each efficiency level considered for small commercial air conditioners and heat pumps in this rulemaking.

DOE considered whether a rebound effect is applicable in its NES analysis. A rebound effect occurs when an increase in equipment efficiency leads

to an increased demand for its service. The NEMS model assumes a certain elasticity factor to account for an increased demand for service due to the increase in cooling (or heating) efficiency.<sup>28</sup> EIA refers to this as an efficiency rebound. For the small commercial air conditioning and heating equipment market, there are two ways that a rebound effect could occur: (1) Increased use of the air conditioning equipment within the commercial buildings in which they are installed; and (2) additional instances of air conditioning of building spaces that were not being cooled before.

DOE does not expect either of these instances to occur because the annual energy use for this equipment is very low; therefore, the energy cost savings from more-efficient equipment would likely not be high enough to induce a commercial consumer to increase the use of the equipment, either in a previously-cooled space or another previously-uncooled space. Therefore, DOE did not assume a rebound effect in the present NOPR analysis. DOE seeks input from interested parties on whether there will be a rebound effect for improvements in the efficiency of small commercial air conditioners and heat pumps. If interested parties believe a rebound effect would occur, DOE is interested in receiving data quantifying the effects, as well as input regarding how should DOE quantify this in its analysis. This is identified as Issue 3 under "Issues on Which DOE Seeks Comment" in section X.E of this NOPR.

To estimate NPV, DOE calculated the net impact as the difference between net operating cost savings (including electricity cost savings and increased repair costs) and increases in total installed costs (including customer prices). DOE calculated the NPV of each considered standard level over the life of the equipment using the following three steps. First, DOE determined the difference between the equipment costs under the standard-level case and the base case in order to obtain the net equipment cost increase resulting from the higher standard level. As noted in section V.E.1, DOE used a constant price assumption as the default price forecast. Second, DOE determined the difference between the base-case operating costs and the standard-level operating costs in order to obtain the net operating cost savings from each higher efficiency level. Third, DOE determined the difference between the net operating cost savings and the net equipment cost

increase in order to obtain the net savings (or expense) for each year. DOE then discounted the annual net savings (or expenses) to 2014 for air conditioners and heat pumps bought on or after 2017 (or 2019) and summed the discounted values to provide the NPV of an efficiency level. An NPV greater than zero shows net savings (*i.e.*, the efficiency level would reduce commercial consumer expenditures relative to the base case in present value terms). An NPV that is less than zero indicates that the efficiency level would result in a net increase in commercial consumer expenditures in present value terms.

To make the analysis more transparent to all interested parties, DOE used a commercially-available spreadsheet tool to calculate the energy savings and the national economic costs and savings from potential amended standards. Interested parties can review DOE's analyses by changing various input quantities within the spreadsheet.

Unlike the LCC analysis, the NES spreadsheet does not use distributions for inputs or outputs, but relies on national average first costs and energy costs developed from the LCC spreadsheet. DOE used the NES spreadsheet to perform calculations of energy savings and NPV using the annual energy consumption and total installed cost data from the LCC analysis. DOE projected the energy savings, energy cost savings, equipment costs, and NPV of benefits for equipment sold in each small commercial air-cooled air conditioner and heat pump class from 2017 through 2046 (or 2019 through 2048). For the three equipment classes triggered by ASHRAE, for efficiency levels more stringent than those in ASHRAE 90.1–2013, energy savings and costs do not begin accruing until 2020, the estimated first year of compliance. The projections provided annual and cumulative values for all four output parameters described previously.

## 2. Shipments Analysis

Equipment shipments are an important element in the estimate of the future impact of a potential energy conservation standard. DOE developed shipment projections for small commercial air-cooled air conditioners and heat pumps less than 65,000 Btu/h and, in turn, calculated equipment stock over the course of the analysis period by assuming a Weibull distribution with an average 19-year equipment life for air conditioners and a 16-year life for heat pumps. (See section V.E.7 for more information on lifetime.) DOE used the shipments projection and the equipment

<sup>28</sup> An overview of the NEMS model and documentation is found at <http://www.eia.doe.gov/oiaf/aeo/overview/index.html>.

stock to determine the NES. The shipments portion of the spreadsheet model projects small commercial air-cooled air conditioner and heat pump shipments through 2046.

In the April 11, 2014 NODA, DOE relied on 1999 shipment estimates along with trends from the U.S. Census to estimate shipments for this equipment. 79 FR 20114, 20130. Table V.8 shows the 1999 shipments estimates from the 2000 Screening Analysis for EPACT-Covered Commercial HVAC and Water-Heating Equipment (EERE-2006-STD-0098-0015). While the U.S. Census provides shipments data for air-cooled equipment less than 65,000 Btu/h, it does not disaggregate the shipments into single-phase and three-phase. Therefore, DOE used the Census data from 1999 to 2010<sup>29</sup> as a trend from which to extrapolate DOE’s 1999 estimated shipments data (which is divided by equipment class) for three-phase equipment for the time period from 2000 to 2010. DOE then used the estimated shipments from 1999 to 2010 to establish a trend from which to project shipments beyond 2010. For heat pumps, DOE used a linear trend, which is slightly decreasing for single-package units and increasing for split systems. However, for single-package air conditioners, the trend was precipitously declining. As a result, for single-package air conditioners for the years after 2010, DOE used the average value from 1999 to 2010.

TABLE V.8—DOE ESTIMATED SHIPMENTS OF SMALL THREE-PHASE COMMERCIAL AIR CONDITIONERS AND HEAT PUMPS <65,000 Btu/h

Equipment class	1999
Three-Phase Air-Cooled Split-System Air Conditioners <65,000 Btu/h .....	91,598
Three-Phase Air-Cooled Single-Package Air Conditioners <65,000 Btu/h .....	213,728
Three-Phase Air-Cooled Split-System Heat Pumps <65,000 Btu/h .....	11,903
Three-Phase Air-Cooled Single-Package Heat Pumps <65,000 Btu/h .....	27,773

<sup>29</sup> U.S. Census Bureau, Current Industrial Reports for Refrigeration, Air Conditioning, and Warm Air Heating Equipment, MA333M. Note that the current industrial reports were discontinued in 2010, so more recent data are not available. (Available at: [http://www.census.gov/manufacturing/cir/historical\\_data/ma333m/index.html](http://www.census.gov/manufacturing/cir/historical_data/ma333m/index.html)).

DOE received several comments on the NODA in response to these shipments estimates. Goodman found it illogical for DOE to base the initial value of shipments on data that was estimated a decade and a half ago. (Goodman Global, Inc., No. 18 at p. 3) The initial values, Goodman stated, should come from aggregated data provided by an industry trade association such as AHRI. (*Id.*) Goodman, AHRI, and Lennox also argued that by averaging shipments over 1999 to 2010, DOE did not account for the recent decline in shipments and, therefore, was overstating market volumes and potential energy savings. (AHRI, No. 24 at p. 8; Goodman, No. 18 at p. 3; Lennox International, No. 15 at p. 7) AHRI also asserted that the analysis did not support either the assumption that current shipments of packaged three-phase heat pumps less than 65,000 Btu/h are at 1999 levels and will decrease only slowly during the next 35 years or the assumption that current shipments of three-phase split-system heat pumps less than 65,000 Btu/h are nearly double those of 1999 and will more than double again in the next 35 years. (AHRI, No. 24 at p. 8).

In response to these comments, DOE reviewed its shipments analysis. AHRI did not provide any more recent data, so DOE continued to rely on the 1999 estimates for the initial value. However, DOE did revise its shipment projections for the years beyond 2010. Because the Census data end in 2010, DOE cannot use that data to determine whether shipments continue to decline past 2010. Therefore, DOE reviewed AHRI’s monthly shipments data for the broader category of central air conditioners and heat pumps to determine more recent trends.<sup>30</sup> DOE found that the average annual growth rate from 2005 to 2010 was – 12 percent for air conditioners and – 4 percent for heat pumps. However, the average annual growth rate from 2010 to 2014 was 7 percent for air conditioners and 8 percent for heat pumps. These data indicate that the decline in shipments through 2010 has stopped and has in fact begun to

<sup>30</sup> AHRI, *HVACR & Water Heating Industry Statistical Profile* (2012) (Available at: <http://www.ari.org/site/883/Resources/Statistics/AHRI-Industry-Statistical-Profile>). See also AHRI Monthly Shipments: <http://www.ari.org/site/498/Resources/Statistics/Monthly-Shipments>; especially December 2013 release: [http://www.ari.org/App\\_Content/ahri/files/Statistics/Monthly%20Shipments/2013/December2013.pdf](http://www.ari.org/App_Content/ahri/files/Statistics/Monthly%20Shipments/2013/December2013.pdf); May 2014 release: [http://www.ari.org/App\\_Content/ahri/files/Statistics/Monthly%20Shipments/2014/May2014.pdf](http://www.ari.org/App_Content/ahri/files/Statistics/Monthly%20Shipments/2014/May2014.pdf).

reverse. Therefore, DOE used the AHRI-reported growth rates from 2010 to 2011 (10 percent for air conditioners and 1 percent for heat pumps) to scale its projected 2010 shipments to 2011, at which time it could begin projecting shipments using *Annual Energy Outlook (AEO) 2014* forecasts (2011 through 2040) for commercial floor space. DOE assumed that shipments of small commercial air-cooled air conditioners and heat pumps would be related to the growth of commercial floor space. DOE used this projection, with an average annual growth rate of 1 percent, to project shipments for each of the four equipment classes through 2040. For years beyond 2040, DOE also applied an average annual growth rate of 1 percent.

Table V.9 shows the projected shipments for the different equipment classes of small commercial air-cooled air conditioners and heat pumps less than 65,000 Btu/h for selected years from 2017 to 2046, as well as the cumulative shipments. As equipment purchase price and repair costs increase with efficiency, DOE recognizes that higher first costs and repair costs can result in a drop in shipments. However, DOE had no basis for estimating the elasticity of shipments for small commercial air-cooled air conditioners and heat pumps less than 65,000 Btu/h as a function of first costs, repair costs, or operating costs. In addition, because air-cooled air conditioners are likely the lowest-cost option for air conditioning small office and retail applications, DOE has tentatively concluded that it is unlikely that shipments would change as a result of higher first costs and repair costs. Therefore, DOE presumed that the shipments projection would not change with higher standard levels. DOE seeks input on this assumption. This is identified as Issue 4 under “Issues on Which DOE Seeks Comment” in section X.E of this NOPR. Chapter 7 of the NOPR TSD provides additional details on the shipments forecasts.

TABLE V.9—SHIPMENTS PROJECTION FOR SMALL COMMERCIAL AIR-COOLED AIR CONDITIONERS AND HEAT PUMPS <65,000 Btu/h

Equipment	Units shipped by year and equipment class							Cumulative shipments (2017–2046) *
	2017	2020	2025	2030	2035	2040	2046	
Three-Phase Air-Cooled Split-System Air Conditioners <65,000 Btu/h .....	80,210	83,175	87,651	91,610	96,170	101,593	107,802	2,806,115
Three-Phase Air-Cooled Single-Package Air Conditioners <65,000 Btu/h .....	122,271	126,790	133,613	139,649	146,600	154,867	164,332	4,277,584
Three-Phase Air-Cooled Split-System Heat Pumps <65,000 Btu/h ...	19,634	20,360	21,455	22,424	23,541	24,868	26,388	686,883
Three-Phase Air-Cooled Single-Package Heat Pumps <65,000 Btu/h .....	25,157	26,086	27,490	28,732	30,162	31,863	33,810	880,091
Total .....	247,272	256,411	270,210	282,415	296,473	313,191	332,333	8,650,673

\* Note that the analysis period for split-system air conditioners is 2019–2048, but for comparison purposes, the same time period for cumulative shipments is shown for each equipment class.

3. Base-Case and Standards-Case Forecasted Distribution of Efficiencies

In the April 11, 2014 NODA, DOE presented base-case efficiency distributions based on model availability in the AHRI certified directory. 79 FR 20114, 20132. DOE bundled the efficiency levels into “efficiency ranges” and determined the percentage of models within each range. DOE applied the percentages of models within each efficiency range to the total unit shipments for a given equipment class to estimate the distribution of shipments within the base case. In response, AHRI commented that DOE’s use of a market-weighted unit energy consumption (UEC) based on the distribution of efficiencies of available models was flawed. (AHRI, No. 24 at p. 7) AHRI stated that the majority of shipments involve models at or near the minimum efficiency standard level, with volume of shipments decreasing as efficiency increases. Although there may be no information on the exact percentages, AHRI considered this to be the general pattern. (*Id.*) Goodman

Global also disagreed that roughly half or more of commercial HVAC products less than 65,000 Btu/h shipped today are above the minimum efficiency level; Goodman estimated roughly three-quarters of such models are at base efficiency today. (Goodman Global, Inc. No 18 at p. 3) Neither AHRI nor Goodman provided any data to support their positions or to allow DOE to better estimate the base-case efficiency distribution. Therefore, DOE has retained the initial distribution used in the NODA.

For this NOPR, DOE has estimated a base-case efficiency trend of an increase of approximately 1 SEER every 35 years, based on the EER trend from 2012 to 2035 found in the Commercial Unitary Air Conditioner Advance Notice of Proposed Rulemaking (ANOPR).<sup>31</sup> DOE used this same trend in the standards-case scenarios. DOE requests comment on the estimated efficiency trend. This is identified as Issue 5 under “Issues on Which DOE Seeks Comment” in section X.E of this NOPR.

As in the April 11, 2014 NODA, for each efficiency level analyzed, DOE

used a “roll-up” scenario to establish the market shares by efficiency level for the year that compliance would be required with amended standards (*i.e.*, 2017 for adoption of efficiency levels in ASHRAE Standard 90.1–2013 or 2020 if DOE adopts more-stringent efficiency levels than those in ASHRAE Standard 90.1–2013). 79 FR 20114, 20132. DOE collected information that suggests the efficiencies of equipment in the base case that did not meet the standard level under consideration would roll up to meet the standard level. This information also suggests that equipment efficiencies in the base case that were above the standard level under consideration would not be affected. In response to the April 2014 NODA, AHRI and Goodman agreed that the roll-up scenario was a reasonable assumption. (AHRI, No. 24 at p. 8; Goodman Global, Inc., No. 18 at p. 3) Table V.10 presents the estimated base-case efficiency market shares for each small commercial air-cooled air conditioner and heat pump equipment class.

TABLE V.10—BASE-CASE EFFICIENCY MARKET SHARES FOR SMALL COMMERCIAL AIR-COOLED AIR CONDITIONERS AND HEAT PUMPS <65,000 Btu/h

Three-phase air-cooled split-system air conditioners <65,000 Btu/h (2019)		Three-phase air-cooled single-package air conditioners <65,000 Btu/h (2020)		Three-phase air-cooled split-system heat pumps <65,000 Btu/h (2020)		Three-phase air-cooled single-package heat pumps <65,000 Btu/h (2020)	
SEER	Market share (%)	SEER	Market share (%)	SEER	Market share (%)	SEER	Market share (%)
13 .....	26	13	0	13	0	13	0
14 .....	50	14	52	14	80	14	69

<sup>31</sup> See DOE’s technical support document underlying DOE’s July 29, 2004 ANOPR. 69 FR

45460 (Available at: <http://www.regulations.gov/#/documentDetail;D=EERE-2006-STD-0103-0078>).

DOE assumed that the EER trend would reasonably represent a SEER trend.

TABLE V.10—BASE-CASE EFFICIENCY MARKET SHARES FOR SMALL COMMERCIAL AIR-COOLED AIR CONDITIONERS AND HEAT PUMPS <65,000 Btu/h—Continued

Three-phase air-cooled split-system air conditioners <65,000 Btu/h (2019)		Three-phase air-cooled single-package air conditioners <65,000 Btu/h (2020)		Three-phase air-cooled split-system heat pumps <65,000 Btu/h (2020)		Three-phase air-cooled single-package heat pumps <65,000 Btu/h (2020)	
SEER	Market share (%)	SEER	Market share (%)	SEER	Market share (%)	SEER	Market share (%)
15 .....	22	15	30	15	19	15	21
16 .....	2	16	7	16	1	16	9
17 .....	0	17	4	17	0	17	1
18 .....	0	18	7	18	0	18	1
19 .....	0	19	0	.....	.....	.....	.....

Note: The 0% market share at 13.0 SEER for three equipment classes is accounting for the default adoption of ASHRAE Standard 90.1–2013 levels in 2017.

4. National Energy Savings and Net Present Value

The stock of small commercial air-cooled air conditioner and heat pump equipment less than 65,000 Btu/h is the total number of units in each equipment class purchased or shipped from previous years that have survived until a given point. The NES spreadsheet,<sup>32</sup> through use of the shipments model, keeps track of the total number of units shipped each year. For purposes of the NES and NPV analyses, DOE assumes that shipments of air conditioner and heat pump units survive for an average of 19 years and 16 years, respectively, following a Weibull distribution, at the end of which time they are removed from service.

The national annual energy consumption is the product of the annual unit energy consumption and the number of units of each vintage in the stock, summed over all vintages. This approach accounts for differences in unit energy consumption from year to year. In determining national annual energy consumption, DOE estimated energy consumption and savings based on site energy and converted the electricity consumption and savings to

primary energy using annual conversion factors derived from the *AEO 2014* version of NEMS. Cumulative energy savings are the sum of the NES for each year over the timeframe of the analysis.

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 national impact analyses and emissions analyses included in future energy conservation standards rulemakings. 76 FR 51281 (Aug. 18, 2011). After evaluating the approaches discussed in the August 18, 2011 notice, DOE published a statement of amended policy in the **Federal Register** in which DOE explained its determination that NEMS is the most appropriate tool for its FFC analysis and its intention to use NEMS for that purpose. 77 FR 49701 (Aug. 17, 2012). The approach used for this NOPR is described in Appendix 8–A of the NOPR TSD.

In accordance with the OMB’s guidelines on regulatory analysis, DOE calculated NPV using both a 7-percent

and a 3-percent real discount rate. The 7-percent rate is an estimate of the average before-tax rate of return on private capital in the U.S. economy. DOE used this discount rate to approximate the opportunity cost of capital in the private sector, because recent OMB analysis has found the average rate of return on capital to be near this rate. DOE used the 3-percent rate to capture the potential effects of standards on private consumption (e.g., through higher prices for products and reduced purchases of energy). This rate represents the rate at which society discounts future consumption flows to their present value. This rate can be approximated by the real rate of return on long-term government debt (i.e., yield on United States Treasury notes minus annual rate of change in the Consumer Price Index), which has averaged about 3 percent on a pre-tax basis for the past 30 years.

Table V.11 summarizes the inputs to the NES spreadsheet model along with a brief description of the data sources. The results of DOE’s NES and NPV analysis are summarized in section VIII.B.1.b and described in detail in chapter 8 of the NOPR TSD.

TABLE V.11—SUMMARY OF SMALL COMMERCIAL AIR-COOLED AIR CONDITIONER AND HEAT PUMPS <65,000 Btu/h NES AND NPV MODEL INPUTS

Inputs	Description
Shipments .....	Annual shipments based on U.S. Census, AHRI monthly shipment reports, and <i>AEO2014</i> forecasts of commercial floor space. (See chapter 7 of the NOPR TSD.)
Compliance Date of Standard .....	2020 for adoption of a more-stringent efficiency level than those specified by ASHRAE Standard 90.1–2013 for the three equipment classes triggered by ASHRAE. 2017 for adoption of the efficiency levels specified by ASHRAE Standard 90.1–2013. 2019 for split-system air conditioners.
Base-Case Efficiencies .....	Distribution of base-case shipments by efficiency level, with efficiency trend of an increase of 1 EER every 35 years.

<sup>32</sup> The NES spreadsheet can be found in the docket for the ASHRAE rulemaking at:

[www.regulations.gov/#!docketDetail;D=EERE-2014-BT-STD-0015](http://www.regulations.gov/#!docketDetail;D=EERE-2014-BT-STD-0015).

TABLE V.11—SUMMARY OF SMALL COMMERCIAL AIR-COOLED AIR CONDITIONER AND HEAT PUMPS <65,000 Btu/h NES AND NPV MODEL INPUTS—Continued

Inputs	Description
Standards-Case Efficiencies .....	Distribution of shipments by efficiency level for each standards case. In compliance year, units below the standard level “roll-up” to meet the standard. Efficiency trend of an increase of 1 EER every 35 years.
Annual Energy Use per Unit .....	Annual national weighted-average values are a function of efficiency level. (See chapter 4 of the NOPR TSD.)
Total Installed Cost per Unit .....	Annual weighted-average values are a function of efficiency level. (See chapter 5 of the NOPR TSD.)
Annualized Maintenance and Repair Costs per Unit .....	Annual weighted-average values are a function of efficiency level. (See chapter 5 of the NOPR TSD.)
Escalation of Fuel Prices .....	AEO2014 forecasts (to 2040) and extrapolation for beyond 2040. (See chapter 8 of the NOPR TSD.)
Site to Primary and FFC Conversion .....	Based on AEO2014 forecasts (to 2040) and extrapolation for beyond 2040. (See chapter 8 of the NOPR TSD.)
Discount Rate .....	3 percent and 7 percent real.
Present Year .....	Future costs are discounted to 2014.

**VI. Methodology for Water-Source Heat Pumps**

This section addresses the analyses DOE has performed for this rulemaking with respect to water-source heat pumps. A separate subsection addresses each analysis. In overview, DOE used a spreadsheet to calculate the LCC and PBP of potential energy conservation standards. DOE used another spreadsheet to provide shipments projections and then calculate national energy savings and net present value impacts of potential amended energy conservation standards.

*A. Market Assessment*

To begin its review of the ASHRAE Standard 90.1–2013 efficiency levels, DOE developed information that provides an overall picture of the market for the equipment concerned, including the purpose of the equipment, the industry structure, and market characteristics. This activity included both quantitative and qualitative assessments based primarily on publicly-available information. The subjects addressed in the market assessment for this rulemaking include equipment classes, manufacturers, quantities, and types of equipment sold and offered for sale. The key findings of DOE’s market assessment are summarized subsequently. For additional detail, see chapter 2 of the NOPR TSD.

**1. Equipment Classes**

EPCA and ASHRAE Standard 90.1–2013 both divide water-source heat pumps into three categories based on the following cooling capacity ranges: (1) <17,000 Btu/h; (2) ≥17,000 and <65,000 Btu/h; and (3) ≥65,000 and <135,000 Btu/h. As noted previously, ASHRAE 90.1–2013 revised the

nomenclature for these equipment classes to refer to “water-to-air, water-loop.” In this document, DOE is proposing to revise the nomenclature for these equipment classes (but not the broader category) to match that used by ASHRAE.

**2. Review of Current Market**

In order to obtain the information needed for the market assessment for this rulemaking, DOE consulted a variety of sources, including manufacturer literature, manufacturer Web sites, and the AHRI certified directory.<sup>33</sup> The information DOE gathered serves as resource material throughout the rulemaking. The sections that follow provide an overview of the market assessment, and chapter 2 of the NOPR TSD provides additional detail on the market assessment, including citations to relevant sources.

**a. Trade Association Information**

DOE identified the same trade groups relevant to water-source heat pumps as to those listed in section V.A.2.a for small air-cooled air conditioners and heat pumps, namely AHRI, HARDI, and ACCA. DOE used data available from AHRI in its analysis, as described in the next section.

**b. Manufacturer Information**

DOE reviewed data for water-source (water-to-air, water-loop) heat pumps currently on the market by examining the AHRI Directory of Certified Product Performance. DOE identified 18 parent companies (comprising 21 manufacturers) of water-source (water-to-air, water-loop) heat pumps, which are listed in chapter 2 of the NOPR TSD.

<sup>33</sup> AHRI Directory of Certified Product Performance (2013) (Available at: [www.ahridirectory.org](http://www.ahridirectory.org)) (Last accessed November 11, 2013).

Of these manufacturers, seven were identified as small businesses based upon number of employees and the employee thresholds set by the Small Business Administration. More details on this analysis can be found below in section IX.B.

**c. Market Data**

DOE reviewed the AHRI database to characterize the efficiency and performance of water-source (water-to-air, water-loop) heat pump models currently on the market. The full results of this market characterization are found in chapter 2 of the NOPR TSD. For water-source heat pumps less than 17,000 Btu/h, the average EER was 13.8, and the average coefficient of performance (COP) was 4.7. Of the models identified by DOE, 34 (six percent of the total models) have EERs rated below the ASHRAE Standard 90.1–2013 levels, and 30 (five percent of the total models) have COPs rated below the ASHRAE Standard 90.1–2013 levels. For water-source heat pumps greater than or equal to 17,000 Btu/h and less than 65,000 Btu/h, the average EER was 15.2, and the average COP was 4.9. Of the models identified by DOE, 72 (two percent of the total models) have EERs rated below the ASHRAE Standard 90.1–2013 levels, and 133 (four percent of the total models) have COPs rated below the ASHRAE Standard 90.1–2013 levels. For water-source heat pumps greater than or equal to 65,000 Btu/h and less than 135,000 Btu/h, the average EER was 14.7, and the average COP was 4.8. Of the models identified by DOE, five (one percent of the total models) have EERs rated below the ASHRAE Standard 90.1–2013 levels, and two (0.5 percent of the total models) have COPs rated below the ASHRAE Standard 90.1–2013 levels.

### B. Engineering Analysis

The engineering analysis establishes the relationship between an increase in energy efficiency and the increase in cost (manufacturer selling price (MSP)) of a piece of equipment DOE is evaluating for potential amended energy conservation standards. This relationship serves as the basis for cost-benefit calculations for individual consumers, manufacturers, and the Nation. The engineering analysis identifies representative baseline equipment, which is the starting point for analyzing possible energy efficiency improvements. For covered ASHRAE equipment, DOE sets the baseline for analysis at the ASHRAE Standard 90.1 efficiency level, because by statute, DOE cannot adopt any level below the revised ASHRAE level. The engineering analysis then identifies higher efficiency levels and the incremental increase in product cost associated with achieving the higher efficiency levels. After identifying the baseline models and cost of achieving increased efficiency, DOE estimates the additional costs to the commercial consumer through an analysis of contractor costs and markups, and uses that information in the downstream analyses to examine the costs and benefits associated with increased equipment efficiency.

DOE typically structures its engineering analysis around one of three methodologies: (1) The design-option approach, which calculates the incremental costs of adding specific design options to a baseline model; (2) the efficiency-level approach, which calculates the relative costs of achieving increases in energy efficiency levels without regard to the particular design options used to achieve such increases; and/or (3) the reverse-engineering or cost-assessment approach, which involves a “bottom-up” manufacturing cost assessment based on a detailed bill of materials derived from teardowns of the equipment being analyzed. A supplementary method called a catalog teardown uses published manufacturer catalogs and supplementary component data to estimate the major physical differences between a piece of equipment that has been physically disassembled and another piece of similar equipment for which catalog data are available to determine the cost

of the latter equipment. Deciding which methodology to use for the engineering analysis depends on the equipment, the design options under study, and any historical data upon which DOE may draw.

#### 1. Approach

For this analysis, DOE used a combination of the efficiency-level approach and the cost-assessment approach. DOE used the efficiency-level approach to identify incremental improvements in efficiency for each equipment class and the cost-assessment approach to develop a cost for each efficiency level. The efficiency levels that DOE considered in the engineering analysis were representative of commercial water-source heat pumps currently produced by manufacturers at the time the engineering analysis was developed. DOE relied on data reported in the AHRI Directory of Certified Product Performance to select representative efficiency levels. This directory reported EER, COP, heating and cooling capacities, and other data for all three application types (water-loop, ground-water, ground-loop) for all AHRI-certified units. After identifying representative efficiency levels, DOE used a catalog teardown or “virtual teardown” approach to estimate equipment costs at each level. DOE obtained general descriptions of key water-source heat pump components in product literature and used data collected for dozens of HVAC products to characterize the components’ design details. This approach was used instead of the physical teardown approach due to time constraints.

Although there are benefits to using a catalog teardown approach, DOE notes that there are drawbacks as well. Most significantly, there are differences between water-source heat pumps and the commercial heating and cooling equipment that were physically torn down. DOE was only able to account for these differences based upon data supplied from manufacturer catalogs or component data. Therefore, there may be additional minor details or parts of the units that were not accounted for. However, DOE has tentatively concluded that this approach provides a reasonable approximation of the cost increases associated with efficiency

increases by including all major parts and components. In the end, the approach allowed DOE to provide estimates of equipment prices for the range of efficiencies currently available on the market.

After selecting efficiency levels for each capacity class, as described in the sections that follow, DOE selected products for the catalog teardown analysis that corresponded to the representative efficiencies and cooling capacities. The engineering analysis included data for over 60 water-source heat pumps. DOE calculated the MPC for products spanning the full range of efficiencies from the baseline to the max-tech level for each analyzed equipment class. In some cases, catalog data providing sufficient information for cost analysis were not available at each efficiency level under consideration. Hence, DOE calculated the costs for some of the efficiency levels based on the cost/efficiency trends observed for other efficiency levels for which such catalog data were available. The engineering analysis is described in more detail in chapter 3 of the NOPR TSD.

#### 2. Baseline Equipment

DOE selected baseline efficiency levels as reference points for each equipment class, against which it measured changes resulting from potential amended energy conservation standards. DOE defined the baseline efficiency levels as reference points to compare the technology, energy savings, and cost of equipment with higher energy efficiency levels. Typically, units at the baseline efficiency level just meet Federal energy conservation standards and provide basic consumer utility. However, EPCA requires that DOE must adopt either the ASHRAE Standard 90.1–2013 levels or more-stringent levels. Therefore, because the ASHRAE Standard 90.1–2013 levels were the lowest levels that DOE could adopt, DOE used those levels as the reference points against which more-stringent levels were evaluated. Table VI.1 shows the current baseline and ASHRAE efficiency levels for each water-source heat pump equipment class. In Table VI.2 below, the ASHRAE levels are designated “0” and more-stringent levels are designated 1, 2, and so on.

TABLE VI.1—BASELINE EFFICIENCY LEVELS FOR WATER-SOURCE HEAT PUMPS

	Water-source (water-to-air, water-loop) heat pumps <17,000 Btu/h	Water-source (water-to-air, water-loop) heat pumps ≥17,000 and <65,000 Btu/h	Water-source (water-to-air, water-loop) heat pumps ≥65,000 and <135,000 Btu/h
<b>Efficiency level (EER)</b>			
Baseline—Federal Standard .....	11.2	12.0	12.0
Baseline—ASHRAE Standard .....	12.2	13.0	13.0

3. Identification of Increased Efficiency Levels for Analysis

DOE developed and considered potential increased energy efficiency levels for each equipment class. These more-stringent efficiency levels are representative of efficiency levels along

the technology paths that manufacturers of residential heating products commonly use to maintain cost-effective designs while increasing energy efficiency. DOE developed more-stringent energy efficiency levels for each of the equipment classes, based on a review of AHRI’s Directory of Certified

Product Performance, manufacturer catalogs, and other publicly-available literature. The efficiency levels selected for analysis for each water-source heat pump equipment class are shown in Table VI.2. Chapter 3 of the NOPR TSD shows additional details on the efficiency levels selected for analysis.

TABLE VI.2—EFFICIENCY LEVELS FOR ANALYSIS OF WATER-SOURCE HEAT PUMPS

	Water-source (water-to-air, water-loop) heat pumps <17,000 Btu/h	Water-source (water-to-air, water-loop) heat pumps ≥17,000 and <65,000 Btu/h	Water-source (water-to-air, water-loop) heat pumps ≥65,000 and <135,000 Btu/h
<b>Efficiency Level (EER, Btu/W-h)</b>			
Baseline—Federal Standard .....	11.2	12.0	12.0
Baseline—ASHRAE Level (0) .....	12.2	13.0	13.0
Efficiency Level 1 .....	13.0	14.6	14.0
Efficiency Level 2 .....	14.0	16.6	15.0
Efficiency Level 3 .....	15.7	18.0	16.0
Efficiency Level 4* .....	16.5	19.2	17.2
Efficiency Level 5** .....	18.1	21.6	.....

\* Efficiency Level 4 is “Max-Tech” for the largest equipment classes.  
 \*\* Efficiency Level 5 is “Max-Tech” for the two smaller equipment classes.

4. Engineering Analysis Results

The results of the engineering analysis are cost-efficiency curves based on results from the cost models for

analyzed units. DOE’s calculated MPCs for the three analyzed classes of water-source heat pumps are shown in Table VI.3. DOE used the cost-efficiency curves from the engineering analysis as

an input for the life-cycle cost and PBP analysis. Further details regarding MPCs for water-source heat pumps may be found in chapter 3 of the NOPR TSD.

TABLE VI.3—MANUFACTURER PRODUCTION COSTS FOR WATER-SOURCE HEAT PUMPS

	Water-source (water-to-air, water-loop) heat pumps <17,000 Btu/h		Water-source (water-to-air, water-loop) heat pumps ≥17,000 and <65,000 Btu/h		Water-source (water-to-air, water-loop) heat pumps ≥65,000 and <135,000 Btu/h	
	EER	MPC (\$)	EER	MPC (\$)	EER	MPC (\$)
ASHRAE—Level 0 .....	12.2	860	13.0	1,346	13.0	3,274
Efficiency Level 1 .....	13.0	904	14.6	1,463	14.0	3,660
Efficiency Level 2 .....	14.0	960	16.6	1,609	15.0	4,045
Efficiency Level 3 .....	15.7	1,053	18.0	1,711	16.0	4,431
Efficiency Level 4 .....	16.5	1,097	19.2	1,798	17.2	4,893
Efficiency Level 5 .....	18.1	1,185	21.6	1,974	.....	.....

#### a. Manufacturer Markups

As discussed in detail in section V.B.4.a, DOE applies a non-production cost multiplier (the manufacturer markup) to the full MPC to account for corporate non-production costs and profit. The resulting manufacturer selling price (MSP) is the price at which the manufacturer can recover all production and nonproduction costs and earn a profit. Because water-source heat pumps and commercial air-cooled equipment are sold by similar heating and cooling product manufacturers, DOE used the same manufacturer markup of 1.3 that was developed for small commercial air-cooled air-conditioners and heat pumps, as described in chapter 3 of the NOPR TSD.

#### b. Shipping Costs

Manufacturers of commercial HVAC equipment typically pay for freight (shipping) to the first step in the distribution chain. 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 non-production costs that comprise the manufacturer markup. DOE calculated the MSP for water-source heat pumps by multiplying the MPC at each efficiency level (determined from the cost model) by the manufacturer markup and adding shipping costs. Shipping costs for water-source heat pumps were calculated similarly to those for small commercial air-cooled air-conditioners and heat pumps described in section V.B.4.b. See chapter 3 of the NOPR TSD for more details about DOE's shipping cost assumptions and the shipping costs per unit for each water-source heat pump product class.

#### c. Markups Analysis

The markups analysis develops appropriate markups in the distribution chain to convert the estimates of manufacturer selling price derived in the engineering analysis to commercial consumer prices. ("Commercial consumer" refers to purchasers of the equipment being regulated.) DOE calculates overall baseline and incremental markups based on the equipment markups at each step in the distribution chain. The incremental markup relates the change in the manufacturer sales price of higher-efficiency models (the incremental cost increase) to the change in the commercial consumer price.

For water-source heat pumps, DOE used the same markups that were developed for small commercial air-

cooled air-conditioners and heat pumps, as discussed in section V.C. DOE understands that the equipment move through the same distribution channels and that, therefore, using the same markups is reasonable. In addition, DOE's development of markups within those channels is at the broader equipment category level, in this case heating, ventilation, and air-conditioning equipment. As with small commercial air-cooled equipment, DOE did not use national accounts in its markups analysis for water-source heat pumps, because DOE does not believe that the commercial consumers of water-source heat pump equipment less than 135,000 Btu/h would typically be national retail chains that negotiate directly with manufacturers. DOE seeks comment on whether the use of national accounts would be appropriate in this analysis. This is identified as Issue 6 under "Issues on Which DOE Seeks Comment" in section X.E of this NOPR.

Chapter 6 of the NOPR TSD provides further detail on the estimation of markups.

#### D. Energy Use Analysis

The energy use analysis provides estimates of the annual energy consumption of water-source heat pumps at the considered efficiency levels. DOE uses these values in the LCC and PBP analyses and in the NIA.

The cooling unit energy consumption (UEC) by equipment type and efficiency level used in the April 11, 2014 NODA came from Appendix D of the 2000 Screening Analysis for EPACT-Covered Commercial HVAC and Water-Heating Equipment. (EERE-2006-STD-0098-0015) 79 FR 20114, 20126-27. Where identical efficiency levels were available, DOE used the UEC directly from the screening analysis. For additional efficiency levels, DOE scaled the UECs based on the ratio of EER, as was done in the original analysis. In response to the NODA, AHRI commented that DOE should use up-to-date data to estimate the cooling UEC of water-source heat pumps, because significant improvements have been made in envelope construction in the 14 years since the screening analysis was performed. (AHRI, No. 24 at p. 6) In reviewing this comment, DOE found that the NEMS commercial demand module accounts for improvements in building shell characteristics and changes in internal load by adjusting the cooling energy use with a factor that is a function of region and building activity. Consequently, for this NOPR, DOE used these factors to adjust the cooling energy use from the 2000 Screening Analysis.

In the April 11, 2014 NODA, DOE did not analyze heating UECs for water-source heat pumps because of lack of data availability. 79 FR 20114, 20126. DOE requested input and data related to this topic but did not receive any. For this NOPR, to characterize the heating-side performance, DOE analyzed CBECS 2003 data to develop a national-average annual energy use per square foot for buildings that use heat pumps. DOE assumed that the average COP of the commercial unitary heat pump (CUHP) was 2.9.<sup>34</sup> DOE converted the energy use per square foot value to annual energy use per ton using a ton-per-square-foot relationship derived from the energy use analysis in the 2014 CUAC NOPR. (EERE-2013-BT-STD-0007-0027) This analysis relates to equipment larger than some of the equipment that is the subject of this current NOPR and is directly applicable only to air-source heat pumps rather than water-source heat pumps. However, for this NOPR, DOE assumed that this estimate was sufficiently representative of the heating energy use for all three classes of water-source heat pumps. DOE seeks comment on this issue. This is identified as Issue 7 under "Issues on Which DOE Seeks Comment" in section X.E of this NOPR.

Because equipment energy use is a function of efficiency, DOE assumed that the annual heating energy consumption of a unit scales proportionally with its heating COP efficiency level. Finally, to determine the COPs of units with given EERs, DOE correlated COP to EER based on the AHRI Certified Equipment Database.<sup>35</sup> Thus, for any given cooling efficiency of a water-source heat pump, DOE was able to use this method to establish the corresponding heating efficiency, and, in turn, the associated annual heating energy consumption.

In order to create variability in the cooling and heating UECs by region and building type, DOE used a Pacific Northwest National Laboratory report<sup>36</sup> that estimated the annual energy usage of space cooling and heating products using a Full Load Equivalent Operating Hour (FLEOH) approach. DOE normalized the provided FLEOHs to the UECs taken from the 2011 DFR for central air conditioners and heat pumps to vary the average UEC across region

<sup>34</sup> A heating efficiency of 2.9 COP corresponds to the existing minimum heating efficiency standard for commercial unitary heat pumps, a value which DOE believes is representative of the heat pump stock characterized by CBECS.

<sup>35</sup> See: <http://www.ahridirectory.org/ahridirectory/pages/homeM.aspx>.

<sup>36</sup> See Appendix D of the 2000 Screening Analysis for EPACT-Covered Commercial HVAC and Water-Heating Equipment. (EERE-2006-STD-0098-0015)



and building type. In this analysis, DOE used the following building types: Office, education, lodging, multi-family apartments, and healthcare. DOE seeks comment on whether these building types are appropriate or whether there are other building types that should be considered for the water-source heat pump analysis. This is identified as Issue 8 under “Issues on Which DOE Seeks Comment” in section X.E of this NOPR.

#### *E. Life-Cycle Cost and Payback Period Analysis*

The purpose of the LCC and PBP analysis is to analyze the effects of potential amended energy conservation standards on commercial consumers of water-source heat pumps by determining how a potential amended standard affects their operating expenses (usually decreased) and their total installed costs (usually increased).

The LCC is the total consumer expense over the life of the equipment, consisting of equipment and installation costs plus operating costs (*i.e.*, expenses for energy use, maintenance, and repair). DOE discounts future operating costs to the time of purchase using commercial consumer discount rates. The PBP is the estimated amount of time (in years) it takes commercial consumers to recover the increased total installed cost (including equipment and installation costs) of a more-efficient type of equipment through lower operating costs. DOE calculates the PBP by dividing the change in total installed cost (normally higher) due to a standard by the change in annual operating cost (normally lower) that results from the potential standard. However, unlike the LCC, DOE only considers the first year’s operating expenses in the PBP calculation. Because the PBP does not account for changes in operating expense over time or the time value of money, it is also referred to as a simple PBP.

For any given efficiency level, DOE measures the PBP and the change in LCC relative to an estimate of the base-case efficiency level. For water-source heat pumps, the base-case estimate reflects the market in the case where the ASHRAE level becomes the Federal minimum, and the LCC calculates the LCC savings likely to result from higher efficiency levels compared with the ASHRAE base case.

DOE conducted an LCC and PBP analysis for water-source heat pumps using a computer spreadsheet model. When combined with Crystal Ball (a commercially-available software program), the LCC and PBP model generates a Monte Carlo simulation to

perform the analyses by incorporating uncertainty and variability considerations in certain of the key parameters as discussed below. Inputs to the LCC and PBP analysis are categorized as: (1) Inputs for establishing the total installed cost and (2) inputs for calculating the operating expense. The following sections contain brief discussions of comments on the inputs and key assumptions of DOE’s LCC and PBP analysis and explain how DOE took these comments into consideration. They are also described in detail in chapter 6 of the NOPR TSD.

#### 1. Equipment Costs

In the LCC and PBP analysis, the equipment costs faced by purchasers of water-source heat pumps are derived from the MSPs estimated in the engineering analysis, the overall markups estimated in the markups analysis, and sales tax.

To develop an equipment price trend for the NOPR, DOE derived an inflation-adjusted index of the PPI for “all other miscellaneous refrigeration and air-conditioning equipment” from 1990–2013, which is the PPI series most relevant to water-source heat pumps. Although the inflation-adjusted index shows a declining trend from 1990 to 2004, data since 2008 have shown a flat-to-slightly rising trend. Given the uncertainty as to which of the trends will prevail in coming years, DOE chose to apply a constant price trend (at 2013 levels) for each efficiency level in each equipment class for the NOPR. See chapter 6 of the NOPR TSD for more information on the price trends.

#### 2. Installation Costs

DOE derived installation costs for water-source heat pump equipment from current RS Means data (2013).<sup>37</sup> RS Means provides estimates for installation costs for the subject equipment by equipment capacity, as well as cost indices that reflect the variation in installation costs for 656 cities in the United States. The RS Means data identify several cities in all 50 States and the District of Columbia. DOE incorporated location-based cost indices into the analysis to capture variation in installation costs, depending on the location of the consumer.

Based on these data, DOE tentatively concluded that data for 1-ton, 3-ton, and 7.5-ton water-source heat pumps would be sufficiently representative of the installation costs for of water-source heat pumps with capacities of less than

17,000 btu/h, greater than or equal to 17,000 and less than 65,000 btu/h, and greater than or equal to 65,000 and less than 135,000 btu/h, respectively.

DOE also varied installation cost as a function of equipment weight. Because weight tends to increase with equipment efficiency, installation cost increased with equipment efficiency. The weight of the equipment in each class and efficiency level was determined through the engineering analysis.

#### 3. Unit Energy Consumption

The calculation of annual per-unit energy consumption by each class of the subject water-source heat pumps at each considered efficiency level based on the energy use analysis is described above in section VI.D and in chapter 4 of the NOPR TSD.

#### 4. Electricity Prices and Electricity Price Trends

DOE used the same average and marginal electricity prices and electricity price trends as discussed in the methodology for small commercial air-cooled air conditioners and heat pumps (see section V.E.4). These data were developed for the broader commercial air-conditioning category and, thus, are also relevant to water-source heat pumps.

#### 5. Maintenance Costs

Maintenance costs are costs to the commercial consumer of ensuring continued operation of the equipment (*e.g.*, checking and maintaining refrigerant charge levels and cleaning heat-exchanger coils). Because RS Means does not provide maintenance costs for water-source heat pumps, DOE used annualized maintenance costs for air-source heat pumps, the closest related equipment category, derived from RS Means data.<sup>38</sup> DOE does not expect the maintenance costs for water-source heat pumps to differ significantly from those for air-source heat pumps. These data provided estimates of person-hours, labor rates, and materials required to maintain commercial air-source heat pumps. The estimated annualized maintenance cost is \$329 for a heat pump rated up to 60,000 Btu/h and \$398 for a heat pump rated greater than 60,000 Btu/h. DOE applied the former cost to water-source heat pumps less than 17,000 Btu/h and heat pumps greater than or equal to 17,000 and less than 65,000 Btu/h. DOE applied the latter cost to water-source heat pumps greater than or equal to 65,000 Btu/h

<sup>37</sup> RS Means Mechanical Cost Data 2013. *Reed Construction Data, LLC. (2012).*

<sup>38</sup> RS Means Facilities Maintenance & Repair Cost Data 2013. *Reed Construction Data, LLC. (2012).*

and less than 135,000 Btu/h. DOE requests comment on how maintenance costs for water-source heat pumps might be expected to differ from that for air-source heat pumps. This is identified as Issue 9 under “Issues on Which DOE Seeks Comment” in section X.E of this NOPR.

#### 6. Repair Costs

Repair costs are costs to the commercial consumer associated with repairing or replacing components that have failed. As with maintenance costs, RS Means does not provide repair costs for water-source heat pumps. Therefore, DOE assumed the repair costs for water-source heat pumps would be similar to air-source units and utilized RS Means<sup>39</sup> to find the repair costs for air-source heat pumps. DOE does not expect the repair costs for water-source heat pumps to differ significantly from those for air-source heat pumps. DOE took the repair costs for 1.5-ton, 5-ton, and 10-ton air to air heat pumps and linearly scaled the repair costs to derive repair costs for 1-ton, 3-ton, and 7.5-ton equipment. DOE assumed that the repair would be a one-time event in year 10 of the equipment life. DOE then annualized the present value of the cost over the average equipment life (see next section) to obtain an annualized equivalent repair cost. This value ranged from \$92 to \$237 for the ASHRAE baseline, depending on equipment class. The materials portion of the repair cost was scaled with the percentage increase in manufacturers’ production cost by efficiency level. The labor cost was held constant across efficiency levels. This annualized repair cost was then added to the maintenance cost to create an annual “maintenance and repair cost” for the lifetime of the equipment. For further discussion of how DOE derived and implemented repair costs, see chapter 8 of the NOPR TSD. DOE requests comment on how repair costs for water-source heat pumps might be expected to differ from that for air-source heat pumps. This is identified as Issue 10 under “Issues on Which DOE Seeks Comment” in section X.E of this NOPR.

#### 7. Equipment Lifetime

Equipment lifetime is the age at which the subject water-source heat pump are retired from service. In the April 11, 2014 NODA, DOE used a mean lifetime of 19 years from the 2000 screening analysis for EPACK-Covered Commercial HVAC and Water-Heating Equipment (EERE-2006-STD-0098-0015). 79 FR 20114, 20133. For this

NOPR, DOE based equipment lifetime on a retirement function in the form of a Weibull probability distribution. Because a function specific to water-source heat pumps was not available, DOE used that for air-cooled air conditioners presented in the 2011 DFR (EERE-2011-BT-STD-0011-0012), as it is for similar equipment and represented the desired mean lifetime of 19 years. DOE requests data and information that would help it develop a retirement function specific to water-source heat pumps. This is identified as Issue 11 under “Issues on Which DOE Seeks Comment” in section X.E of this NOPR.

#### 8. Discount Rate

The discount rate is the rate at which future expenditures are discounted to estimate their present value. The cost of capital commonly is 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 the cost of capital is the weighted-average cost of capital (WACC) to the firm of equity and debt financing. DOE uses the capital asset pricing model (CAPM) to calculate the equity capital component, and financial data sources to calculate the cost of debt financing.

DOE derived the discount rates by estimating the cost of capital of companies that purchase water-source heat pump equipment. More details regarding DOE’s estimates of commercial consumer discount rates are provided in chapter 6 of the NOPR TSD.

#### 9. Base-Case Market Efficiency Distribution

For the LCC analysis, DOE analyzes the considered efficiency levels relative to a base case (*i.e.*, the case without amended energy efficiency standards, in this case the default scenario in which DOE is statutorily required to adopt the efficiency levels in ASHRAE 90.1–2013). This analysis requires an estimate of the distribution of equipment efficiencies in the base case (*i.e.*, what consumers would have purchased in the compliance year in the absence of amended standards more stringent than those in ASHRAE 90.1–2013). DOE refers to this distribution of equipment energy efficiencies as the base-case efficiency distribution. For more information on the development of the base-case distribution, see section VI.F.3 and chapter 6 of the NOPR TSD.

#### 10. Compliance Date

DOE calculated the LCC and PBP for all commercial consumers as if each

were to purchase new equipment in the year that compliance with amended standards is required. Generally, covered equipment to which a new or amended energy conservation standard applies must comply with the standard if such equipment is manufactured or imported on or after a specified date. In this NOPR, DOE is evaluating whether more-stringent efficiency levels than those in ASHRAE Standard 90.1–2013 would be technologically feasible, economically justified, and result in a significant additional amount of energy savings. If DOE were to propose a rule prescribing energy conservation standards at the efficiency levels contained in ASHRAE Standard 90.1–2013, EPCA states that compliance with any such standards shall be required on or after a date which is two or three years (depending on equipment size) after the compliance date of the applicable minimum energy efficiency requirement in the amended ASHRAE/IES standard. (42 U.S.C. 6313(a)(6)(D)) Given the equipment size at issue here, DOE has applied the two-year implementation period to determine the compliance date of any energy conservation standard equal to the efficiency levels specified by ASHRAE Standard 90.1–2013 proposed by this rulemaking. Thus, if DOE decides to adopt the efficiency levels in ASHRAE Standard 90.1–2013, the compliance date of the rulemaking would be dependent upon the date specified in ASHRAE Standard 90.1–2013 or its publication date, if none is specified. In this case, the rule would apply to water-source heat pumps manufactured on or after October 9, 2015, which is two years after the publication date of ASHRAE Standard 90.1–2013.

If DOE were to propose a rule prescribing energy conservation standards more stringent than the efficiency levels contained in ASHRAE Standard 90.1–2013, EPCA states that compliance with any such standards is required for equipment manufactured on or after a date which is four years after the date the final rule is published in the **Federal Register**. (42 U.S.C. 6313(a)(6)(D)) DOE has applied this 4-year implementation period to determine the compliance date for any energy conservation standard more stringent than the efficiency levels specified by ASHRAE Standard 90.1–2013 that might be prescribed at the final rule stage. Thus, for equipment for which DOE might adopt a level more stringent than the ASHRAE efficiency levels, the rule would apply to such equipment manufactured on or after a date four years from the date of

<sup>39</sup> *Id.*

publication of the final rule, which the statute requires to be completed by April 9, 2016 (thereby resulting in a compliance date no later than April 9, 2020).<sup>40</sup>

Economic justification is not required for DOE to adopt the efficiency levels in ASHRAE 90.1–2013, as DOE is statutorily required to, at a minimum, adopt those levels. Therefore, DOE did not perform an LCC analysis on the ASHRAE Standard 90.1–2013 levels, and, for purposes of the LCC analysis, DOE used 2020 as the first year of compliance with amended standards.

#### 11. Payback Period Inputs

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

Similar to the LCC, the inputs to the PBP calculation are the total installed cost of the equipment to the commercial consumer for each efficiency level and the average annual operating expenditures for each efficiency level for each building type and Census Division, weighted by the probability of shipment to each market. The PBP calculation uses the same inputs as the LCC analysis, except that discount rates are not needed. Because the simple PBP does not take into account changes in operating expenses over time or the time value of money, DOE considered only the first year's operating expenses to calculate the PBP, unlike the LCC, which is calculated over the lifetime of the equipment. Chapter 6 of the NOPR TSD provides additional detail about the PBP.

#### F. National Impact Analysis—National Energy Savings and Net Present Value Analysis

The NIA evaluates the effects of a considered energy conservation standard from a national perspective rather than from the consumer perspective represented by the LCC. This analysis assesses the NPV (future amounts discounted to the present) and the NES of total commercial consumer

costs and savings, which are expected to result from amended standards at specific efficiency levels. For each efficiency level analyzed, DOE calculated the NPV and NES for adopting more-stringent standards than the efficiency levels specified in ASHRAE Standard 90.1–2013.

The NES refers to cumulative energy savings from 2016 through 2045;<sup>41</sup> however, when evaluating more-stringent standards, energy savings do not begin accruing until the later compliance date of 2020. DOE calculated new energy savings in each year relative to a base case, defined as DOE adoption of the efficiency levels specified by ASHRAE Standard 90.1–2013. DOE also calculated energy savings from adopting efficiency levels specified by ASHRAE Standard 90.1–2013 compared to the EPCA base case (*i.e.*, the current Federal standards).

The NPV refers to cumulative monetary savings. DOE calculated net monetary savings in each year relative to the base case (ASHRAE Standard 90.1–2013) as the difference between total operating cost savings and increases in total installed cost. Cumulative savings are the sum of the annual NPV over the specified period. DOE accounted for operating cost savings until past 2100, when the equipment installed in the thirtieth year after the compliance date of the amended standards should be retired.

#### 1. Approach

The NES and NPV are a function of the total number of units and their efficiencies. Both the NES and NPV depend on annual shipments and equipment lifetime. Both calculations start by using the shipments estimate and the quantity of units in service derived from the shipments model. DOE used the same approach to determine NES and NPV for water-source heat pumps which was used for small commercial air-cooled air-conditioning and heating equipment, as described in section V.F.1. In this case, the analysis period runs from 2016 through 2045.

DOE considered whether a rebound effect is applicable in its NES analysis, a concept explained in detail in section V.F.1. DOE does not expect commercial consumers with water-source heat pump equipment to increase their use of the equipment, either in a previously cooled space or another previously uncooled space. Water-source heat

pumps are part of engineered water-loop systems designed for specific applications. It is highly unlikely that the operation or installation of these systems would be changed simply as a result of energy cost savings. Therefore, DOE did not assume a rebound effect in the present NOPR analysis. DOE seeks input from interested parties on whether there will be a rebound effect for improvements in the efficiency of water-source heat pumps. If interested parties believe a rebound effect would occur, DOE is interested in receiving data quantifying the effects, as well as input regarding how DOE should quantify this in its analysis. This is identified as Issue 3 under “Issues on Which DOE Seeks Comment” in section X.E of this NOPR.

#### 2. Shipments Analysis

Equipment shipments are an important element in the estimate of the future impact of a potential energy conservation standard. DOE developed shipment projections for water-source heat pumps and, in turn, calculated equipment stock over the course of the analysis period by assuming a Weibull distribution with an average 19-year equipment life. (See section V.E.7 for more information on equipment lifetime.) DOE used the shipments projection and the equipment stock to determine the NES. The shipments portion of the spreadsheet model projects water-source heat pump shipments through 2045.

In the April 11, 2014 NODA, DOE based its shipments analysis for water-source heat pumps on data from the U.S. Census. 79 FR 20114, 20130. The U.S. Census published historical (1980, 1983–1994, 1997–2006, and 2008–2010) water-source heat pump shipment data.<sup>42</sup> Table VI.4 exhibits the shipment data provided for a selection of years. DOE analyzed data from the years 1990–2010 to establish a trend from which to project shipments beyond 2010. DOE used a linear trend. Because the Census data do not distinguish between equipment capacities, DOE used the shipments data by equipment class provided by AHRI in 1999, and published in the 2000 Screening Analysis for EPACT-Covered Commercial HVAC and Water-Heating Equipment (EERE–2006–STD–0098–0015), to distribute the total water-source heat pump shipments to individual equipment classes. Table

<sup>40</sup> Since ASHRAE published ASHRAE Standard 90.1–2013 on October 9, 2013, EPCA requires that DOE publish a final rule adopting more-stringent standards than those in ASHRAE Standard 90.1–2013, if warranted, within 30 months of ASHRAE action (*i.e.*, by April 2016). Thus, four years from April 2016 would be April 2020, which would be the anticipated compliance date for DOE adoption of more-stringent standards.

<sup>41</sup> Although the expected compliance date for adoption of the efficiency levels in ASHRAE Standard 90.1–2013 is October 9, 2015, DOE began its analysis period in 2016 to avoid ascribing savings to the three-quarters of 2015 prior to the compliance date.

<sup>42</sup> U.S. Census Bureau, Current Industrial Reports for Refrigeration, Air Conditioning, and Warm Air Heating Equipment, MA333M. Note that the current industrial reports were discontinued in 2010, so more recent data are not available (Available at: [http://www.census.gov/manufacturing/cir/historical\\_data/ma333m/index.html](http://www.census.gov/manufacturing/cir/historical_data/ma333m/index.html)).

VI.5 exhibits the shipment data provided for 1999. DOE assumed that this distribution of shipments across the various equipment classes remained constant and has used this same distribution in its projection of future shipments of water-source heat pumps. The complete historical data set and the projected shipments for each equipment class can be found in the ASHRAE NOPR TSD.

TABLE VI.4—TOTAL SHIPMENTS OF WATER-SOURCE HEAT PUMPS  
[Census Product Code: 333415E181]

	1989	1999	2009
Total .....	157,080	120,545	180,101

TABLE VI.5—TOTAL SHIPMENTS OF WATER-SOURCE HEAT PUMPS  
(AHRI)

Equipment class	1999	Percent
WSHP <17000 Btu/h .....	41,000	31
WSHP 17000–65000 Btu/h .....	86,000	65
WSHP 65000–135000 Btu/h .....	5,000	4

In the April 11, 2014 NODA, DOE noted that an EIA report on geothermal heat pump manufacturers<sup>43</sup> shows shipments of water-source units (defined by EIA as those tested to ARI-320) as only 22,009 in 2009 and 7,808 in 2000, which is significantly less than that reported by the Census (product code 333415E181) and by AHRI. 79 FR 20114, 20130. DOE added that both the Census data and the EIA report show consistent shipments of separately-reported ground-source and ground-water-source heat pumps (listed as Census product code 333415G and defined by EIA as those tested to ARI-325/330) at approximately 87,000 shipments in 2009; DOE is not counting

these shipments in its estimates as reported in Table VI.4. DOE believes that water-source heat pumps operate with a water loop using a boiler or chiller as the heat source or sink, and that, therefore, may not be considered “geothermal;” in this case, the EIA report may not include a comprehensive number of water-source heat pump shipments. *Id.*

In the April 11, 2014 NODA, DOE requested comment on the market for water-source heat pumps, especially what magnitude of annual shipments is most accurate and how shipments are expected to change over time. DOE also sought comment on the share of the market for ground-source and ground-

water-source heat pump applications that use models also rated for water-loop application. *Id.* at 20130–31. In response, AHRI reported that it has no data on the market share of various applications and no comment on the current shipments or future trends. (AHRI, No. 24 at p. 7) DOE did not receive any other comment on this issue. Consequently, DOE has retained the shipments analysis used in the April 11, 2014 NODA for water-source heat pumps. Table VI.6 shows the projected shipments for the different equipment classes of water-source heat pumps for selected years from 2016 to 2045, as well as the cumulative shipments.

TABLE VI.6—SHIPMENTS PROJECTION FOR WATER-SOURCE HEAT PUMPS

Equipment	Units Shipped by Year and Equipment Class							Cumulative shipments (2016–2045)
	2016	2020	2025	2030	2035	2040	2045	
WSHP <17000 Btu/h .....	62,934	68,072	74,495	80,918	87,341	93,764	100,187	2,446,810
WSHP 17000–65000 Btu/h .....	132,007	142,785	156,258	169,731	183,203	196,676	210,148	5,132,334
WSHP 65000–135000 Btu/h .....	7,675	8,301	9,085	9,868	10,651	11,435	12,218	7,579,144
Total .....	202,616	219,159	239,838	260,517	281,195	301,874	322,553	7,877,536

As equipment purchase price and repair costs increase with efficiency, DOE recognizes that higher first costs and repair costs can result in a drop in shipments. However, DOE had no basis for estimating the elasticity of shipments for water-source heat pumps as a function of first costs, repair costs, or operating costs. In addition, because water-source heat pumps are often

installed for their higher efficiency as compared to air-cooled equipment, DOE has tentatively concluded that it is unlikely that shipments would change as a result of higher first costs and repair costs. Therefore, DOE presumed that the shipments projection would not change with higher standard levels. DOE seeks input on this assumption. This is identified as Issue 4 under “Issues on

Which DOE Seeks Comment” in section X.E of this NOPR. Chapter 7 of the NOPR TSD provides additional details on the shipments forecasts.

3. Base-Case and Standards-Case Forecasted Distribution of Efficiencies

In the April 11, 2014 NODA, DOE presented base-case efficiency distributions based on model

<sup>43</sup> U.S. Energy Information Administration, Geothermal Heat Pump Manufacturing Activities

2009 (2010) (Available at: [www.eia.gov/renewable/renewables/geothermalrpt09.pdf](http://www.eia.gov/renewable/renewables/geothermalrpt09.pdf)).

availability in the AHRI certified directory. 79 FR 20114, 20132. As noted in section V.F.3, DOE received comments that this was an incorrect assumption; however, no data were provided that would allow DOE to better estimate the base-case efficiency distribution. Therefore, DOE has retained the initial distribution used in the April 2014 NODA.

For this NOPR, DOE has estimated a base-case efficiency trend of an increase of approximately 1 EER every 35 years,

based on the trend from 2012 to 2035 found in the Commercial Unitary Air Conditioner Advance Notice of Proposed Rulemaking (ANOPR).<sup>44</sup> DOE used this same trend in the standards-case scenarios. DOE requests comment on its estimated efficiency trends. This is identified as Issue 5 under “Issues on Which DOE Seeks Comment” in section X.E of this NOPR.

As in the April 11, 2014 NODA, for each efficiency level analyzed, DOE used a “roll-up” scenario to establish

the market shares by efficiency level for the first full year that compliance would be required with amended standards (i.e., 2016 for adoption of efficiency levels in ASHRAE Standard 90.1–2013 or 2020 if DOE adopts more-stringent efficiency levels than those in ASHRAE Standard 90.1–2013). As noted in section V.F.3, stakeholders agreed that this was a reasonable assumption. Table VI.7 presents the estimated base-case efficiency market shares for each water-source heat pump equipment class.

TABLE VI.7—BASE-CASE EFFICIENCY MARKET SHARES IN 2020 FOR WATER-SOURCE HEAT PUMPS

Water-source (water-to-air, water-loop) heat pumps <17,000 Btu/h		Water-source (water-to-air, water-loop) heat pumps ≥17,000 and <65,000 Btu/h		Water-source (water-to-air, water-loop) heat pumps ≥65,000 and <135,000 Btu/h	
EER	Market share %	EER	Market share %	EER	Market share %
11.2	0.0	12.0	0.0	12.0	0.0
12.2	0.7	13.0	7.6	13.0	0.0
13.0	49.7	14.6	55.1	14.0	29.8
14.0	22.0	16.6	25.0	15.0	48.5
15.7	20.5	18.0	8.9	16.0	20.1
16.5	4.9	19.2	2.5	17.0	1.7
18.1	2.3	21.6	1.0		

NOTE: The 0% market share at the first listed EER level is accounting for the default adoption of ASHRAE Standard 90.1–2013 levels in 2016.

4. National Energy Savings and Net Present Value

The stock of water-source heat pump equipment is the total number of units in each equipment class purchased or shipped from previous years that have survived until a given point in time. The NES spreadsheet,<sup>45</sup> through use of the shipments model, keeps track of the total number of units shipped each year. For purposes of the NES and NPV analyses, DOE assumes that shipments of water-source heat pump units survive for an average of 19 years, following a Weibull distribution, at the end of which time they are removed from service.

The national annual energy consumption is the product of the annual unit energy consumption and the number of units of each vintage in

the stock, summed over all vintages. This approach accounts for differences in unit energy consumption from year to year. In determining national annual energy consumption, DOE estimated energy consumption and savings based on site energy and converted the electricity consumption and savings to primary energy using annual conversion factors derived from the AEO 2014 version of NEMS. Cumulative energy savings are the sum of the NES for each year over the timeframe of the analysis.

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 national impact

analyses and emissions analyses included in future energy conservation standards rulemakings. 76 FR 51281 (Aug. 18, 2011). After evaluating the approaches discussed in the August 18, 2011 notice, DOE published a statement of amended policy in the **Federal Register** in which DOE explained its determination that NEMS is the most appropriate tool for its FFC analysis and its intention to use NEMS for that purpose. 77 FR 49701 (Aug. 17, 2012). The approach used for this NOPR is described in Appendix 8–A of the NOPR TSD.

Table VI.8 summarizes the inputs to the NES spreadsheet model along with a brief description of the data sources. The results of DOE’s NES and NPV analysis are summarized in section VIII.B.2.b and described in detail in chapter 7 of the NOPR TSD.

TABLE VI.8—SUMMARY OF WATER-SOURCE HEAT PUMP NES AND NPV MODEL INPUTS

Inputs	Description
Shipments	Annual shipments based on U.S. Census data. (See chapter 7 of the NOPR TSD.) 2020 for adoption of a more-stringent efficiency level than those specified by ASHRAE Standard 90.1–2013. 2016 for adoption of the efficiency levels specified by ASHRAE Standard 90.1–2013.
Compliance Date of Standard	
Base-Case Efficiencies	Distribution of base-case shipments by efficiency level, with efficiency trend of an increase of 1 EER every 35 years.

<sup>44</sup> See DOE’s technical support document underlying DOE’s July 29, 2004 ANOPR. 69 FR 45460 (Available at: [www.regulations.gov/#!documentDetail;D=EERE-2006-STD-70103-0078](http://www.regulations.gov/#!documentDetail;D=EERE-2006-STD-70103-0078)).

<sup>45</sup> The NES spreadsheet can be found in the docket for the ASHRAE rulemaking at: [www.regulations.gov/#!docketDetail;D=EERE-2014-BT-STD-0015](http://www.regulations.gov/#!docketDetail;D=EERE-2014-BT-STD-0015).

TABLE VI.8—SUMMARY OF WATER-SOURCE HEAT PUMP NES AND NPV MODEL INPUTS—Continued

Inputs	Description
Standards-Case Efficiencies .....	Distribution of shipments by efficiency level for each standards case. In compliance year, units below the standard level “roll-up” to meet the standard. Efficiency trend of an increase of 1 EER every 35 years.
Annual Energy Use per Unit .....	Annual national weighted-average values are a function of efficiency level. (See chapter 4 of the NOPR TSD.)
Total Installed Cost per Unit .....	Annual weighted-average values are a function of efficiency level. (See chapter 5 of the NOPR TSD.)
Annualized Maintenance and Repair Costs per Unit .....	Annual weighted-average values are a function of efficiency level. (See chapter 5 of the NOPR TSD.)
Escalation of Fuel Prices .....	<i>AEO2014</i> forecasts (to 2040) and extrapolation for beyond 2040. (See chapter 8 of the NOPR TSD.)
Site to Primary and FFC Conversion .....	Based on <i>AEO2014</i> forecasts (to 2040) and extrapolation for beyond 2040. (See chapter 8 of the NOPR TSD.)
Discount Rate .....	3 percent and 7 percent real.
Present Year .....	Future costs are discounted to 2014.

## VII. Methodology for Emissions Analysis and Monetizing Carbon Dioxide and Other Emissions Impacts

### A. Emissions Analysis

In the emissions analysis, DOE estimates the reduction in power sector emissions of carbon dioxide (CO<sub>2</sub>), nitrogen oxides (NO<sub>x</sub>), sulfur dioxide (SO<sub>2</sub>), and mercury (Hg) from potential amended energy conservation standards for the ASHRAE equipment that is the subject of this document. In addition, DOE estimates emissions impacts in production activities (extracting, processing, and transporting fuels) that provide the energy inputs to power plants. These are referred to as “upstream” emissions. Together, these emissions account for the full-fuel cycle (FFC). In accordance with DOE’s FFC Statement of Policy (76 FR 51281 (Aug. 18, 2011) as amended at 77 FR 49701 (August 17, 2012)), the FFC analysis also includes impacts on emissions of methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O), both of which are recognized as greenhouse gases. The combustion emissions factors and the method DOE used to derive upstream emissions factors are described in chapter 9 of the NOPR TSD. The cumulative emissions reduction estimated for the subject ASHRAE equipment is presented in section VIII.C.

DOE primarily conducted the emissions analysis using emissions factors for CO<sub>2</sub> and most of the other gases derived from data in *AEO 2014*. Combustion emissions of CH<sub>4</sub> and N<sub>2</sub>O were estimated using emissions intensity factors published by the U.S. Environmental Protection Agency (EPA) in its Greenhouse Gas (GHG) Emissions Factors Hub.<sup>46</sup> DOE developed separate emissions factors for power sector

emissions and upstream emissions. The method that DOE used to derive emissions factors is described in chapter 9 of the NOPR TSD.

EIA prepares the *AEO* using NEMS. Each annual version of NEMS incorporates the projected impacts of existing air quality regulations on emissions. *AEO 2014* generally represents current legislation and environmental regulations, including recent government actions, for which implementing regulations were available as of October 31, 2013.

SO<sub>2</sub> emissions from affected electric generating units (EGUs) are subject to nationwide and regional emissions cap-and-trade programs. Title IV of the Clean Air Act sets an annual emissions cap on SO<sub>2</sub> for affected EGUs in the 48 contiguous States and the District of Columbia (DC). (42 U.S.C. 7651 *et seq.*) SO<sub>2</sub> emissions from 28 eastern States and DC were also limited under the Clean Air Interstate Rule (CAIR). 70 FR 25162 (May 12, 2005). CAIR, which created an allowance-based trading program that operates along with the Title IV program, was remanded to the EPA by the U.S. Court of Appeals for the District of Columbia Circuit, but it remained in effect.<sup>47</sup> In 2011, EPA issued a replacement for CAIR, the Cross-State Air Pollution Rule (CSAPR). 76 FR 48208 (Aug. 8, 2011). On August 21, 2012, the D.C. Circuit issued a decision to vacate CSAPR.<sup>48</sup> The court ordered EPA to continue administering CAIR. The emissions factors used for this NOPR, which are based on *AEO*

2014, assume that CAIR remains a binding regulation through 2040.<sup>49</sup>

The attainment of emissions caps is typically flexible among EGUs and is enforced through the use of emissions allowances and tradable permits. Beginning in 2016, however, SO<sub>2</sub> emissions will decline significantly as a result of the Mercury and Air Toxics Standards (MATS) for power plants. 77 FR 9304 (Feb. 16, 2012). In the final MATS rule, EPA established a standard for hydrogen chloride as a surrogate for acid gas hazardous air pollutants (HAP), and also established a standard for SO<sub>2</sub> (a non-HAP acid gas) as an alternative equivalent surrogate standard for acid gas HAP. The same controls are used to reduce HAP and non-HAP acid gas; thus, SO<sub>2</sub> emissions will be reduced as a result of the control technologies installed on coal-fired power plants to comply with the MATS requirements for acid gas. *AEO 2014* assumes that, in order to continue operating, coal plants must have either flue gas desulfurization or dry sorbent injection systems installed by 2016. Both technologies are used to reduce acid gas emissions, and also reduce SO<sub>2</sub> emissions. Under the MATS, emissions

<sup>49</sup> On April 29, 2014, the U.S. Supreme Court reversed the judgment of the D.C. Circuit and remanded the case for further proceedings consistent with the Supreme Court’s opinion. The Supreme Court held in part that EPA’s methodology for quantifying emissions that must be eliminated in certain states due to their impacts in other downwind states was based on a permissible, workable, and equitable interpretation of the Clean Air Act provision that provides statutory authority for CSAPR. See *EPA v. EME Homer City Generation*, No. 12–1182, slip op. at 32 (U.S. April 29, 2014). On October 23, 2014, the D.C. Circuit lifted the stay of CSAPR. Pursuant to this action, CSAPR will go into effect (and the Clean Air Interstate Rule will sunset) as of January 1, 2015. However, because DOE used emissions factors based on *AEO 2014* for this NOPR, the analysis assumes that CAIR, not CSAPR, is the regulation in force. The difference between CAIR and CSAPR is not relevant for the purpose of DOE’s analysis of SO<sub>2</sub> emissions.

<sup>47</sup> See *North Carolina v. EPA*, 550 F.3d 1176 (D.C. Cir. 2008); *North Carolina v. EPA*, 531 F.3d 896 (D.C. Cir. 2008).

<sup>48</sup> See *EME Homer City Generation, LP v. EPA*, 696 F.3d 7, 38 (D.C. Cir. 2012), cert. granted, 81 U.S.L.W. 3567, 81 U.S.L.W. 3696, 81 U.S.L.W. 3702 (U.S. June 24, 2013) (No. 12–1182).

<sup>46</sup> See <http://www.epa.gov/climateleadership/inventory/ghg-emissions.html>.

will be far below the cap established by CAIR, so it is unlikely that excess SO<sub>2</sub> emissions allowances resulting from the lower electricity demand would be needed or used to permit offsetting increases in SO<sub>2</sub> emissions by any regulated EGU. Therefore, DOE believes that energy efficiency standards will reduce SO<sub>2</sub> emissions in 2016 and beyond.

CAIR established a cap on NO<sub>x</sub> emissions in 28 eastern States and the District of Columbia.<sup>50</sup> Energy conservation standards are expected to have little effect on NO<sub>x</sub> emissions in those States covered by CAIR, because excess NO<sub>x</sub> emissions allowances resulting from the lower electricity demand could be used to permit offsetting increases in NO<sub>x</sub> emissions. However, standards would be expected to reduce NO<sub>x</sub> emissions in the States not affected by the caps, so DOE estimated NO<sub>x</sub> emissions reductions from the standards considered in this NOPR for these States.

The MATS limit mercury emissions from power plants, but they do not include emissions caps. DOE estimated mercury emissions using emissions factors based on *AEO 2014*, which incorporates the MATS.

### B. Monetizing Carbon Dioxide and Other Emissions Impacts

As part of the development of this proposed rule, DOE considered the estimated monetary benefits from the reduced emissions of CO<sub>2</sub> and NO<sub>x</sub> that are expected to result from each of the efficiency levels considered. In order to make this calculation analogous to the calculation of the NPV of consumer benefit, DOE considered the reduced emissions expected to result over the lifetime of equipment shipped in the forecast period for each efficiency level. This section summarizes the basis for the monetary values used for each of these emissions and presents the values considered in this NOPR.

For this NOPR, DOE relied on a set of values for the social cost of carbon (SCC) that was developed by a Federal interagency process. The basis for these values is summarized in the next section, and a more detailed description of the methodologies used is provided as an appendix to chapter 14 of the NOPR TSD.

<sup>50</sup> CSAPR also applies to NO<sub>x</sub>, and it would supersede the regulation of NO<sub>x</sub> under CAIR. As stated previously, the current analysis assumes that CAIR, not CSAPR, is the regulation in force. The difference between CAIR and CSAPR with regard to DOE's analysis of NO<sub>x</sub> is slight.

### 1. Social Cost of Carbon

The SCC is an estimate of the monetized damages associated with an incremental increase in carbon emissions in a given year. It is intended to include (but is not limited to) changes in net agricultural productivity, human health, property damages from increased flood risk, and the value of ecosystem services. Estimates of the SCC are provided in dollars per metric ton of CO<sub>2</sub>. A domestic SCC value is meant to reflect the value of damages in the United States resulting from a unit change in CO<sub>2</sub> emissions, while a global SCC value is meant to reflect the value of damages worldwide.

Under section 1(b) of Executive Order 12866, "Regulatory Planning and Review," 58 FR 51735 (Oct. 4, 1993), agencies must, to the extent permitted by law, "assess both the costs and the benefits of the intended regulation and, recognizing that some costs and benefits are difficult to quantify, propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs." The purpose of the SCC estimates presented here is to allow agencies to incorporate the monetized social benefits of reducing CO<sub>2</sub> emissions into cost-benefit analyses of regulatory actions. The estimates are presented with an acknowledgement of the many uncertainties involved and with a clear understanding that they should be updated over time to reflect increasing knowledge of the science and economics of climate impacts.

As part of the interagency process that developed these SCC estimates, technical experts from numerous agencies met on a regular basis to consider public comments, explore the technical literature in relevant fields, and discuss key model inputs and assumptions. The main objective of this process was to develop a range of SCC values using a defensible set of input assumptions grounded in the existing scientific and economic literatures. In this way, key uncertainties and model differences transparently and consistently inform the range of SCC estimates used in the rulemaking process.

### a. Monetizing Carbon Dioxide Emissions

When attempting to assess the incremental economic impacts of CO<sub>2</sub> emissions, the analyst faces a number of challenges. A report from the National Research Council<sup>51</sup> points out that any

<sup>51</sup> National Research Council, *Hidden Costs of Energy: Unpriced Consequences of Energy Production and Use*, National Academies Press: Washington, DC (2009).

assessment will suffer from uncertainty, speculation, and lack of information about: (1) Future emissions of GHGs; (2) the effects of past and future emissions on the climate system; (3) the impact of changes in climate on the physical and biological environment; and (4) the translation of these environmental impacts into economic damages. As a result, any effort to quantify and monetize the harms associated with climate change will raise questions of science, economics, and ethics and should be viewed as provisional.

Despite the limits of both quantification and monetization, SCC estimates can be useful in estimating the social benefits of reducing CO<sub>2</sub> emissions. The agency can estimate the benefits from reduced (or costs from increased) emissions in any future year by multiplying the change in emissions in that year by the SCC values appropriate for that year. The NPV of the benefits can then be calculated by multiplying each of these future benefits by an appropriate discount factor and summing across all affected years.

It is important to emphasize that the interagency process is committed to updating these estimates as the science and economic understanding of climate change and its impacts on society improves over time. In the meantime, the interagency group will continue to explore the issues raised by this analysis and consider public comments as part of the ongoing interagency process.

### b. Development of Social Cost of Carbon Values

In 2009, an interagency process was initiated to offer a preliminary assessment of how best to quantify the benefits from reducing carbon dioxide emissions. To ensure consistency in how benefits are evaluated across Federal agencies, the Administration sought to develop a transparent and defensible method, specifically designed for the rulemaking process, to quantify avoided climate change damages from reduced CO<sub>2</sub> emissions. The interagency group did not undertake any original analysis. Instead, it combined SCC estimates from the existing literature to use as interim values until a more comprehensive analysis could be conducted. The outcome of the preliminary assessment by the interagency group was a set of five interim values: Global SCC estimates for 2007 (in 2006\$) of \$55, \$33, \$19, \$10, and \$5 per metric ton of CO<sub>2</sub>. These interim values represented the first sustained interagency effort within the U.S. government to develop an SCC for use in regulatory analysis. The results of this preliminary effort

were presented in several proposed and final rules.

c. Current Approach and Key Assumptions

After the release of the interim values, the interagency group reconvened on a regular basis to generate improved SCC estimates. Specifically, the group considered public comments and further explored the technical literature in relevant fields. The interagency group relied on three integrated assessment models commonly used to estimate the SCC: the FUND, DICE, and PAGE models. These models are frequently cited in the peer-reviewed literature and were used in the last assessment of the Intergovernmental Panel on Climate Change (IPCC). Each model was given equal weight in the SCC values that were developed.

Each model takes a slightly different approach to model how changes in

emissions result in changes in economic damages. A key objective of the interagency process was to enable a consistent exploration of the three models, while respecting the different approaches to quantifying damages taken by the key modelers in the field. An extensive review of the literature was conducted to select three sets of input parameters for these models: Climate sensitivity, socio-economic and emissions trajectories, and discount rates. A probability distribution for climate sensitivity was specified as an input into all three models. In addition, the interagency group used a range of scenarios for the socio-economic parameters and a range of values for the discount rate. All other model features were left unchanged, relying on the model developers' best estimates and judgments.

In 2010, the interagency group selected four sets of SCC values for use

in regulatory analyses. Three sets of values are based on the average SCC from the three integrated assessment models, at discount rates of 2.5, 3, and 5 percent. The fourth set, which represents the 95th percentile SCC estimate across all three models at a 3-percent discount rate, was included to represent higher-than-expected impacts from climate change further out in the tails of the SCC distribution. The values grow in real terms over time. Additionally, the interagency group determined that a range of values from 7 percent to 23 percent should be used to adjust the global SCC to calculate domestic effects,<sup>52</sup> although preference is given to consideration of the global benefits of reducing CO<sub>2</sub> emissions. Table VII.1 presents the values in the 2010 interagency group report,<sup>53</sup> which is reproduced in appendix 10–A of the NOPR TSD.

TABLE VII.1—ANNUAL SCC VALUES FROM 2010 INTERAGENCY REPORT, 2010–2050  
[2007\$ per metric ton CO<sub>2</sub>]

Year	Discount rate			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
2010	4.7	21.4	35.1	64.9
2015	5.7	23.8	38.4	72.8
2020	6.8	26.3	41.7	80.7
2025	8.2	29.6	45.9	90.4
2030	9.7	32.8	50.0	100.0
2035	11.2	36.0	54.2	109.7
2040	12.7	39.2	58.4	119.3
2045	14.2	42.1	61.7	127.8
2050	15.7	44.9	65.0	136.2

The SCC values used for this document were generated using the most recent versions of the three integrated assessment models that have been published in the peer-reviewed literature.<sup>54</sup>

Table VII.2 shows the updated sets of SCC estimates from the 2013 interagency update in 5-year increments from 2010 to 2050. The full set of annual SCC estimates between 2010 and 2050 is reported in appendix 10–B of the NOPR TSD. The central value that

emerges is the average SCC across models at the 3-percent discount rate. However, for purposes of capturing the uncertainties involved in regulatory impact analysis, the interagency group emphasizes the importance of including all four sets of SCC values.

TABLE VII.2—ANNUAL SCC VALUES FROM 2013 INTERAGENCY REPORT, 2010–2050  
[2007\$ per metric ton CO<sub>2</sub>]

Year	Discount rate			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
2010	11	32	51	89
2015	11	37	57	109

<sup>52</sup> It is recognized that this calculation for domestic values is approximate, provisional, and highly speculative. There is no *a priori* reason why domestic benefits should be a constant fraction of net global damages over time.

<sup>53</sup> *Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866*, Interagency

Working Group on Social Cost of Carbon, United States Government (February 2010) (Available at: [www.whitehouse.gov/sites/default/files/omb/inforeg/for-agencies/Social-Cost-of-Carbon-for-RIA.pdf](http://www.whitehouse.gov/sites/default/files/omb/inforeg/for-agencies/Social-Cost-of-Carbon-for-RIA.pdf)).

<sup>54</sup> *Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive*

*Order 12866*, Interagency Working Group on Social Cost of Carbon, United States Government (May 2013; revised November 2013) (Available at: <http://www.whitehouse.gov/sites/default/files/omb/assets/inforeg/technical-update-social-cost-of-carbon-for-regulator-impact-analysis.pdf>).



TABLE VII.2—ANNUAL SCC VALUES FROM 2013 INTERAGENCY REPORT, 2010–2050—Continued  
[2007\$ per metric ton CO<sub>2</sub>]

Year	Discount rate			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
2020 .....	12	43	64	128
2025 .....	14	47	69	143
2030 .....	16	52	75	159
2035 .....	19	56	80	175
2040 .....	21	61	86	191
2045 .....	24	66	92	206
2050 .....	26	71	97	220

It is important to recognize that a number of key uncertainties remain, and that current SCC estimates should be treated as provisional and revisable because they will evolve with improved scientific and economic understanding. The interagency group also recognizes that the existing models are imperfect and incomplete. The 2009 National Research Council report mentioned previously points out that there is tension between the goal of producing quantified estimates of the economic damages from an incremental ton of carbon and the limits of existing efforts to model these effects. There are a number of analytical challenges that are being addressed by the research community, including research programs housed in many of the Federal agencies participating in the interagency process to estimate the SCC. The interagency group intends to periodically review and reconsider those estimates to reflect increasing knowledge of the science and economics of climate impacts, as well as improvements in modeling.

In summary, in considering the potential global benefits resulting from reduced CO<sub>2</sub> emissions, DOE used the values from the 2013 interagency report adjusted to 2013\$ using the implicit price deflator for gross domestic product (GDP) from the Bureau of Economic Analysis. For each of the four sets of SCC cases specified, the values for emissions in 2015 were \$12.0, \$40.5, \$62.4, and \$119 per metric ton avoided (values expressed in 2013\$). DOE derived values after 2050 using the

relevant growth rates for the 2040–2050 period in the interagency update.

DOE multiplied the CO<sub>2</sub> emissions reduction estimated for each year by the SCC value for that year in each of the four cases. To calculate a present value of the stream of monetary values, DOE discounted the values in each of the four cases using the specific discount rate that had been used to obtain the SCC values in each case.

#### 2. Valuation of Other Emissions Reductions

As noted previously, DOE has taken into account how considered energy conservation standards would reduce site NO<sub>x</sub> emissions nationwide and increase power sector NO<sub>x</sub> emissions in those 22 States not affected by the CAIR. DOE estimated the monetized value of net NO<sub>x</sub> emissions reductions resulting from each of the efficiency levels considered for this NOPR based on estimates found in the relevant scientific literature. Estimates of monetary value for reducing NO<sub>x</sub> from stationary sources range from \$476 to \$4,893 per ton in 2013\$.<sup>55</sup> DOE calculated monetary benefits using a medium value for NO<sub>x</sub> emissions of \$2,684 per short ton (in 2013\$) and real discount rates of 3 percent and 7 percent.

DOE is evaluating appropriate monetization of avoided SO<sub>2</sub> and Hg emissions in energy conservation standards rulemakings. DOE has not included monetization of those emissions in the current analysis.

### VIII. Analytical Results and Conclusions

#### A. Efficiency Levels Analyzed

##### 1. Small Commercial Air-Cooled Air Conditioners and Heat Pumps Less Than 65,000 Btu/h

The methodology for small commercial air-cooled air conditioners and heat pumps less than 65,000 Btu/h was presented in section V of this NOPR. Table VIII.1 presents the market baseline efficiency level and the higher efficiency levels analyzed for each equipment class of small commercial air-cooled air conditioners and heat pumps less than 65,000 Btu/h subject to this proposed rule. The EPCA baseline efficiency levels correspond to the lowest efficiency levels currently available on the market. The efficiency levels above the baseline represent efficiency levels specified by ASHRAE Standard 90.1–2013 and efficiency levels more stringent than those specified in ASHRAE Standard 90.1–2013 where equipment is currently available on the market. Note that for the energy savings and economic analysis, efficiency levels above those specified in ASHRAE Standard 90.1–2013 are compared to ASHRAE Standard 90.1–2013 as the baseline rather than the EPCA baseline (*i.e.*, the current Federal standards). For split-system air conditioners, for which ASHRAE 90.1–2013 did not change the efficiency level, all efficiency levels are compared to the Federal or EPCA baseline.

<sup>55</sup> U.S. Office of Management and Budget, Office of Information and Regulatory Affairs, *2006 Report to Congress on the Costs and Benefits of Federal*

*Regulations and Unfunded Mandates on State, Local, and Tribal Entities* (2006) (Available at:

[www.whitehouse.gov/sites/default/files/omb/assets/omb/inforeg/2006\\_cb/2006\\_cb\\_final\\_report.pdf](http://www.whitehouse.gov/sites/default/files/omb/assets/omb/inforeg/2006_cb/2006_cb_final_report.pdf)).

TABLE VIII.1—EFFICIENCY LEVELS ANALYZED FOR SMALL COMMERCIAL AIR-COOLED AIR CONDITIONERS AND HEAT PUMPS <65,000 Btu/h

	Small three-phase air-cooled split-system air conditioners <65,000 Btu/h	Small three-phase air-cooled single-package air conditioners <65,000 Btu/h	Small three-phase air-cooled split-system heat pumps <65,000 Btu/h	Small three-phase air-cooled single-package heat pumps <65,000 Btu/h
<b>Efficiency Level (SEER/HSPF)</b>				
Baseline—Federal Standard .....	13	13	13/7.7	13/7.7
ASHRAE Level (0) .....	* 14	14	14/8.2	14/8.0
Efficiency Level 1 .....	15	15	15/8.5	15/8.4
Efficiency Level 2 .....	16	16	16/8.7	16/8.8
Efficiency Level 3 .....	17	17	17/9.0	17/8.9
Efficiency Level 4** .....	18	18	18.0/9.2	18.0/9.1
Efficiency Level 5*** .....	19	19	.....	.....

\*For split system air conditioners, the ASHRAE level is 13.0 SEER. DOE analyzed the 14.0 SEER level as a level more stringent than ASHRAE, but designated it as efficiency level 0 for consistency in SEER level across equipment classes.

\*\* Efficiency Level 4 is “Max-Tech” for HP equipment classes.  
 \*\*\* Efficiency Level 5 is “Max-Tech” for AC equipment classes.

2. Water-Source Heat Pumps

Table VIII.2 presents the baseline efficiency level and the more-stringent efficiency levels analyzed for each equipment class of water-source heat

pumps subject to this proposed rule. The baseline efficiency levels correspond to the lowest efficiency levels currently available on the market. The efficiency levels above the baseline

represent efficiency levels specified in ASHRAE Standard 90.1–2013 and more-stringent efficiency levels where equipment is currently available on the market.

TABLE VIII.2—EFFICIENCY LEVELS ANALYZED FOR WATER-SOURCE HEAT PUMPS

	Water-source (water-to-air, water-loop) heat pumps <17,000 Btu/h	Water-source (water-to-air, water-loop) heat pumps ≥17,000 and <65,000 Btu/h	Water-source (water-to-air, water-loop) heat pumps ≥65,000 and <135,000 Btu/h
<b>Efficiency Level (EER/COP)</b>			
Baseline—Federal Standard .....	11.2/4.2	12.0/4.2	12.0/4.2
ASHRAE Level (0) .....	12.2/4.3	13.0/4.3	13.0/4.3
Efficiency Level 1 .....	13.0/4.6	14.6/4.8	14.0/4.7
Efficiency Level 2 .....	14.0/4.8	16.6/5.3	15.0/4.8
Efficiency Level 3 .....	15.7/5.1	18.0/5.6	16.0/5.0
Efficiency Level 4* .....	16.5/5.3	19.2/5.9	17.2/5.1
Efficiency Level 5** .....	18.1/5.6	21.6/6.5	.....

\* Efficiency Level 4 is “Max-Tech” for the largest equipment class.  
 \*\* Efficiency Level 5 is “Max-Tech” for the two smaller equipment classes.

3. Commercial Oil-Fired Storage Water Heaters

The methodology for oil-fired storage water heating equipment was presented in the April 2014 NODA. 79 FR 20114, 20129–33 (April 11, 2014). Table VIII.3

presents the baseline efficiency level and the more-stringent efficiency levels analyzed for the class of oil-fired storage water heaters subject to this proposed rule. The baseline efficiency levels correspond to the lowest efficiency levels currently available on the market.

The efficiency levels above the baseline represent efficiency levels specified in ASHRAE Standard 90.1–2013 and more-stringent efficiency levels where equipment is currently available on the market.

TABLE VIII.3—EFFICIENCY LEVELS ANALYZED FOR COMMERCIAL OIL-FIRED STORAGE WATER-HEATING EQUIPMENT

Efficiency level (E <sub>i</sub> )	Oil-fired storage water-heating equipment (≤105,000 Btu/h and <4,000 Btu/h/gal) (%)
Baseline—Federal Standard .....	78
ASHRAE Level (0) .....	80
Efficiency Level 1 .....	81

TABLE VIII.3—EFFICIENCY LEVELS ANALYZED FOR COMMERCIAL OIL-FIRED STORAGE WATER-HEATING EQUIPMENT—Continued

Efficiency Level 2—“Max-Tech”— .....	Oil-fired storage water-heating equipment (≤105,000 Btu/h and <4,000 Btu/h/gal) (%)
	82

*B. Energy Savings and Economic Justification*

1. Small Commercial Air-Cooled Air Conditioners and Heat Pumps Less Than 65,000 Btu/h

a. Economic Impacts on Commercial Customers

1. Life-Cycle Cost and Payback Period

To evaluate the net economic impact of potential amended energy conservation standards on commercial consumers of small commercial air-cooled air conditioners and heat pumps, DOE conducted LCC and PBP analyses for each efficiency level. In general, higher-efficiency equipment would affect commercial consumers in two ways: (1) Purchase price would increase, and (2) annual operating costs would decrease. Inputs used for calculating the LCC and PBP include total installed costs (*i.e.*, equipment price plus installation costs), and operating costs (*i.e.*, annual energy usage, energy prices, energy price trends, repair costs, and maintenance costs). The LCC calculation also uses equipment lifetime and a discount rate.

The output of the LCC model is a mean LCC savings (or cost<sup>56</sup>) for each equipment class, relative to the baseline small commercial air-cooled air conditioner and heat pump efficiency

level. The LCC analysis also provides information on the percentage of commercial consumers that are negatively affected by an increase in the minimum efficiency standard.

DOE also performed a PBP analysis as part of the LCC analysis. The PBP is the number of years it would take for the commercial consumer to recover the increased costs of higher-efficiency equipment as a result of energy savings based on the operating cost savings. The PBP is an economic benefit-cost measure that uses benefits and costs without discounting. Chapter 6 of the NOPR TSD provides detailed information on the LCC and PBP analyses.

DOE’s LCC and PBP analyses provided five key outputs for each efficiency level above the baseline (*i.e.*, efficiency levels above the current Federal standard for split-system air conditioners or efficiency levels more stringent than those in ASHRAE Standard 90.1–2013 for the three triggered equipment classes), as reported in Table VIII.4 through Table VIII.11 below. These outputs include the proportion of small commercial air-cooled air conditioner and heat pump purchases in which the purchase of such a unit that is compliant with the amended energy conservation standard creates a net LCC increase, no impact,

or a net LCC savings for the commercial consumer. Another output is the average net LCC savings from standard-compliant equipment, as well as the average PBP for the consumer investment in standard-compliant equipment.

Chapter 6 of the NOPR TSD provides detailed information on the LCC and PBP analyses.

Table VIII.4 through Table VIII.11 show the LCC and PBP results for all efficiency levels considered for each class of small commercial air-cooled air conditioner and heat pump in this NOPR. In the first of each pair of tables, the simple payback is measured relative to the baseline equipment (*i.e.*, equipment at the current Federal standards for split-system air conditioners or equipment with the efficiency levels required in ASHRAE Standard 90.1–2013 for the three triggered equipment classes). In the second tables, the LCC savings are measured relative to the base-case efficiency distribution in the compliance year (*i.e.*, the range of equipment expected to be on the market in the absence of amended standards for split-system air conditioners or the default case where DOE adopts the efficiency levels in ASHRAE Standard 90.1–2013 for the three triggered equipment classes).

TABLE VIII.4—AVERAGE LCC AND PBP RESULTS BY EFFICIENCY LEVEL FOR SMALL THREE-PHASE AIR-COOLED SPLIT-SYSTEM AIR CONDITIONERS <65,000 Btu/h

Efficiency level	Average costs 2013\$				Simple pay-back (years)	Average life-time (years)
	Installed cost	First year’s operating cost	Lifetime operating cost	LCC		
Baseline .....	\$3,859	\$765	\$7,424	\$11,282	N/A	19
0 .....	4,106	762	7,389	11,495	68	19
1 .....	4,353	755	7,326	11,680	49	19
2 .....	4,619	749	7,268	11,887	47	19
3 .....	4,873	753	7,302	12,176	80	19
4 .....	5,138	757	7,342	12,480	148	19
5 .....	5,415	762	7,400	12,815	562	19

**Note:** The results for each efficiency level are calculated assuming that all commercial consumers use equipment with that efficiency level. The PBP is measured relative to the baseline equipment.

<sup>56</sup> An LCC cost is shown as a negative savings in the results presented.

TABLE VIII.5—LCC SAVINGS RELATIVE TO THE BASE-CASE EFFICIENCY DISTRIBUTION FOR SMALL THREE-PHASE AIR-COOLED SPLIT-SYSTEM AIR CONDITIONERS <65,000 Btu/h

Efficiency level	Life-cycle cost savings	
	% of Customers that experience	Average savings*
	Net cost	2013\$
0 .....	26	(55)
1 .....	75	(196)
2 .....	97	(398)
3 .....	100	(687)
4 .....	100	(992)
5 .....	100	(1,326)

\* The calculation includes households with zero LCC savings (no impact).

TABLE VIII.6—AVERAGE LCC AND PBP RESULTS BY EFFICIENCY LEVEL FOR SMALL THREE-PHASE AIR-COOLED SINGLE-PACKAGE AIR CONDITIONERS <65,000 Btu/h

Efficiency level	Average costs 2013\$				Simple payback (years)	Average Lifetime (years)
	Installed cost	First year's operating cost	Lifetime operating cost	LCC		
ASHRAE Baseline .....	\$4,731	\$761	\$7,408	\$12,139	N/A	19
1 .....	5,036	747	7,275	12,311	47	19
2 .....	5,343	742	7,224	12,567	50	19
3 .....	5,642	746	7,262	12,904	80	19
4 .....	5,944	750	7,300	13,244	128	19
5 .....	6,308	755	7,350	13,659	261	19

**Note:** The results for each efficiency level are calculated assuming that all commercial consumers use equipment with that efficiency level. The PBP is measured relative to the baseline equipment.

TABLE VIII.7—LCC SAVINGS RELATIVE TO THE BASE-CASE EFFICIENCY DISTRIBUTION FOR SMALL THREE-PHASE AIR-COOLED SINGLE-PACKAGE AIR CONDITIONERS <65,000 Btu/h

Efficiency level	Life-cycle cost savings	
	% of Customers that experience	Average savings*
	Net cost	2013\$
1 .....	49	(89)
2 .....	81	(297)
3 .....	89	(596)
4 .....	93	(913)
5 .....	100	(1,326)

\* The calculation includes households with zero LCC savings (no impact).

TABLE VIII.8—AVERAGE LCC AND PBP RESULTS BY EFFICIENCY LEVEL FOR SMALL THREE-PHASE AIR-COOLED SPLIT-SYSTEM HEAT PUMPS <65,000 Btu/h

Efficiency level	Average costs 2013\$				Simple payback (years)	Average lifetime (years)
	Installed cost	First year's operating cost	Lifetime operating cost	LCC		
ASHRAE Baseline .....	\$4,467	\$784	\$6,969	\$11,436	N/A	16
1 .....	4,725	772	6,857	11,582	35	16
2 .....	5,066	766	6,807	11,873	41	16
3 .....	5,346	766	6,811	12,157	54	16
4 .....	5,636	767	6,819	12,454	70	16

**Note:** The results for each efficiency level are calculated assuming that all commercial consumers use equipment with that efficiency level. The PBP is measured relative to the baseline equipment.

TABLE VIII.9—LCC SAVINGS RELATIVE TO THE BASE-CASE EFFICIENCY DISTRIBUTION FOR SMALL THREE-PHASE AIR-COOLED SPLIT-SYSTEM HEAT PUMPS <65,000 Btu/h

Efficiency level	Life-cycle cost savings	
	% of customers that experience	Average savings *
	Net cost	2013\$
1 .....	75	(117)
2 .....	99	(406)
3 .....	100	(690)
4 .....	100	(988)

\* The calculation includes households with zero LCC savings (no impact).

TABLE VIII.10—AVERAGE LCC AND PBP RESULTS BY EFFICIENCY LEVEL FOR SMALL THREE-PHASE AIR-COOLED SINGLE-PACKAGE HEAT PUMPS <65,000 Btu/h

Efficiency level	Average costs 2013\$				Simple pay-back (years)	Average life-time (years)
	Installed cost	First year's operating cost	Lifetime operating cost	LCC		
ASHRAE Baseline .....	\$5,103	\$786	\$6,982	\$12,085	N/A	16
1 .....	5,444	773	6,869	12,313	50	16
2 .....	5,771	766	6,810	12,581	50	16
3 .....	6,099	767	6,817	12,915	67	16
4 .....	6,484	768	6,823	13,307	87	16

**Note:** The results for each efficiency level are calculated assuming that all commercial consumers use equipment with that efficiency level. The PBP is measured relative to the baseline equipment.

TABLE VIII.11—LCC SAVINGS RELATIVE TO THE BASE-CASE EFFICIENCY DISTRIBUTION FOR SMALL THREE-PHASE AIR-COOLED SINGLE-PACKAGE HEAT PUMPS <65,000 Btu/h

Efficiency level	Life-cycle cost savings	
	% of customers that experience	Average savings *
	Net cost	2013\$
1 .....	68	(\$157)
2 .....	90	(\$399)
3 .....	99	(\$728)
4 .....	99	(\$1,117)

\* The calculation includes households with zero LCC savings (no impact).

b. National Impact Analysis

1. Amount and Significance of Energy Savings

To estimate the lifetime energy savings for equipment shipped through 2046 (or 2048) due to amended energy conservation standards, DOE compared the energy consumption of small commercial air-cooled air conditioners and heat pumps less than 65,000 Btu/h under the ASHRAE Standard 90.1–2013

efficiency levels (or current Federal levels for split-system air conditioners) to energy consumption of the same small commercial air-cooled air conditioners and heat pumps under more-stringent efficiency standards. For the three equipment classes triggered by ASHRAE, DOE also compared the energy consumption of those small commercial air-cooled air conditioners and heat pumps under the ASHRAE Standard 90.1–2013 efficiency levels to

energy consumption of small commercial air-cooled air conditioners and heat pumps under the current EPCA base case (*i.e.*, under current Federal standards). DOE examined up to five efficiency levels higher than those of ASHRAE Standard 90.1–2013. Table VIII.12 through Table VIII.15 show the projected national energy savings at each of the considered standard levels. (See chapter 8 of the NOPR TSD.)

TABLE VIII.12—POTENTIAL ENERGY SAVINGS FOR SMALL THREE-PHASE AIR-COOLED SPLIT-SYSTEM AIR CONDITIONERS <65,000 Btu/h

Efficiency level	Primary energy savings estimate (quads)	FFC energy savings estimate (quads)
Level 0—14 SEER .....	0.02	0.02
Level 1—15 SEER .....	0.08	0.08

TABLE VIII.12—POTENTIAL ENERGY SAVINGS FOR SMALL THREE-PHASE AIR-COOLED SPLIT-SYSTEM AIR CONDITIONERS <65,000 Btu/h—Continued

Efficiency level	Primary energy savings estimate (quads)	FFC energy savings estimate (quads)
Level 2—16 SEER .....	0.13	0.14
Level 3—17 SEER .....	0.16	0.17
Level 4—18 SEER .....	0.18	0.19
Level 5—“Max-Tech”—19 SEER .....	0.19	0.20

TABLE VIII.13—POTENTIAL ENERGY SAVINGS FOR SMALL THREE-PHASE AIR-COOLED SINGLE-PACKAGE AIR CONDITIONERS <65,000 Btu/h

Efficiency level	Primary energy savings estimate* (quads)	FFC energy savings estimate* (quads)
Level 0—ASHRAE—14 SEER .....	0.04	0.04
Level 1—15 SEER .....	0.05	0.06
Level 2—16 SEER .....	0.11	0.12
Level 3—17 SEER .....	0.15	0.15
Level 4—18 SEER .....	0.18	0.18
Level 5—“Max-Tech”—19 SEER .....	0.19	0.20

\* The potential energy savings for efficiency levels more stringent than those specified by ASHRAE Standard 90.1–2013 were calculated relative to the efficiency levels that would result if ASHRAE Standard 90.1–2013 standards were adopted.

TABLE VIII.14—POTENTIAL ENERGY SAVINGS FOR SMALL THREE-PHASE AIR-COOLED SPLIT-SYSTEM HEAT PUMPS <65,000 Btu/h

Efficiency level	Primary energy savings estimate* (quads)	FFC energy savings estimate* (quads)
Level 0—ASHRAE—14 SEER .....	0.01	0.01
Level 1—15 SEER .....	0.01	0.01
Level 2—16 SEER .....	0.02	0.02
Level 3—17 SEER .....	0.03	0.03
Level 4—“Max-Tech”—18 SEER .....	0.03	0.03

\* The potential energy savings for efficiency levels more stringent than those specified by ASHRAE Standard 90.1–2013 were calculated relative to the efficiency levels that would result if ASHRAE Standard 90.1–2013 standards were adopted.

TABLE VIII.15—POTENTIAL ENERGY SAVINGS FOR SMALL THREE-PHASE AIR-COOLED SINGLE-PACKAGE HEAT PUMPS <65,000 Btu/h

Efficiency level	Primary energy savings estimate* (quads)	FFC energy savings estimate* (quads)
Level 0—ASHRAE—14 SEER .....	0.01	0.01
Level 1—15 SEER .....	0.01	0.01
Level 2—16 SEER .....	0.02	0.02
Level 3—17 SEER .....	0.03	0.03
Level 4—“Max-Tech”—18 SEER .....	0.04	0.04

\* The potential energy savings for efficiency levels more stringent than those specified by ASHRAE Standard 90.1–2013 were calculated relative to the efficiency levels that would result if ASHRAE Standard 90.1–2013 standards were adopted.

2. Net Present Value of Customer Costs and Benefits

The NPV analysis is a measure of the cumulative commercial consumer

benefit or cost of standards to the Nation. In accordance with OMB’s guidelines on regulatory analysis (OMB Circular A–4, section E (Sept. 17, 2003)), DOE calculated NPV using both a 7-

percent and a 3-percent real discount rate. Table VIII.16 and Table VIII.17 provide an overview of the NPV results. (See chapter 8 of the NOPR TSD for further detail.)

TABLE VIII.16—SUMMARY OF CUMULATIVE NET PRESENT VALUE FOR SMALL THREE-PHASE AIR-COOLED AIR CONDITIONERS AND HEAT PUMPS <65,000 Btu/h

[Discounted at seven percent]  
[Net present value (billion 2013\$)]

Equipment class	Efficiency level 0	Efficiency level 1	Efficiency level 2	Efficiency level 3	Efficiency level 4	Efficiency level 5
Three-Phase Air-Cooled Split-System Air Conditioners .. <65,000 Btu/h .....	(0.04)	(0.16)	(0.36)	(0.61)	(0.88)	(1.08)
Three-Phase Air-Cooled Single-Package Air Conditioners .. <65,000 Btu/h .....	*N/A	(0.13)	(0.40)	(0.75)	(1.16)	(1.51)
Three-Phase Air-Cooled Split-System Heat Pumps <65,000 Btu/h .....	*N/A	(0.03)	(0.08)	(0.14)	(0.18)	**N/A
Three-Phase Air-Cooled Single-Package Heat Pumps <65,000 Btu/h .....	*N/A	(0.04)	(0.10)	(0.19)	(0.25)	**N/A

**Notes:** Numbers in parentheses indicate negative NPV. The net present value for efficiency levels more stringent than those specified by ASHRAE Standard 90.1–2013 were calculated relative to the efficiency levels that would result if ASHRAE Standard 90.1–2013 standards were adopted.  
\* Economic analysis was not conducted for the ASHRAE levels (EL 0).  
\*\* The max-tech level for this equipment class is EL 4.

TABLE VIII.17—SUMMARY OF CUMULATIVE NET PRESENT VALUE FOR SMALL THREE-PHASE AIR-COOLED AIR CONDITIONERS AND HEAT PUMPS <65,000 Btu/h

[Discounted at three percent]  
[Net present value (billion 2013\$)]

Equipment class	Efficiency level 0	Efficiency level 1	Efficiency level 2	Efficiency level 3	Efficiency level 4	Efficiency level 5
Three-Phase Air-Cooled Split-System Air Conditioners <65,000 Btu/h .....	(0.07)	(0.26)	(0.61)	(1.11)	(1.64)	(2.01)
Three-Phase Air-Cooled Single-Package Air Conditioners <65,000 Btu/h .....	* N/A	(0.20)	(0.71)	(1.41)	(2.21)	(2.84)
Three-Phase Air-Cooled Split-System Heat Pumps <65,000 Btu/h .....	* N/A	(0.05)	(0.14)	(0.25)	(0.32)	** N/A
Three-Phase Air-Cooled Single-Package Heat Pumps <65,000 Btu/h .....	* N/A	(0.07)	(0.18)	(0.34)	(0.46)	** N/A

**Notes:** Numbers in parentheses indicate negative NPV. The net present value for efficiency levels more stringent than those specified by ASHRAE Standard 90.1–2013 were calculated relative to the efficiency levels that would result if ASHRAE Standard 90.1–2013 standards were adopted.  
\* Economic analysis was not conducted for the ASHRAE levels (EL 0).  
\*\* The max-tech level for this equipment class is EL 4.

2. Water-Source Heat Pumps

a. Economic Impacts on Commercial Customers

1. Life-Cycle Cost and Payback Period

Table VIII.18 through Table VIII.23 show the LCC and PBP results for all

efficiency levels considered for each class of water-source heat pump in this NOPR. In the first of each pair of tables, the simple payback is measured relative to the baseline equipment (*i.e.*, equipment with the efficiency level specified in ASHRAE Standard 90.1–2013). In the second tables, the LCC

savings are measured relative to the base-case efficiency distribution in the compliance year (*i.e.*, the range of equipment expected to be on the market in the default case where DOE adopts the efficiency levels in ASHRAE Standard 90.1–2013).

TABLE VIII.18—AVERAGE LCC AND PBP RESULTS BY EFFICIENCY LEVEL FOR WATER-SOURCE HEAT PUMPS (WATER-TO-AIR, WATER-LOOP) <17,000 Btu/h

Efficiency level	Average costs 2013\$				Simple pay-back (years)	Average life-time (years)
	Installed cost	First year's operating cost	Lifetime operating cost	LCC		
ASHRAE Baseline .....	\$3,184	\$645	\$7,581	\$10,765		\$3,184
1 .....	3,320	636	7,469	10,789	15	3,320
2 .....	3,494	628	7,385	10,879	17	3,494
3 .....	3,782	619	7,271	11,054	20	3,782
4 .....	3,917	615	7,229	11,146	21	3,917
5 .....	4,189	609	7,159	11,349	24	4,189

**Note:** The results for each efficiency level are calculated assuming that all commercial consumers use equipment with that efficiency level. The PBP is measured relative to the baseline equipment.

TABLE VIII.19—LCC SAVINGS RELATIVE TO THE BASE-CASE EFFICIENCY DISTRIBUTION FOR WATER-SOURCE (WATER-TO-AIR, WATER-LOOP) HEAT PUMPS <17,000 Btu/h

Efficiency level	Life-cycle cost savings	
	Percent of customers that experience	Average savings *
	Net cost	2013\$
1 .....	0	0
2 .....	46	(46)
3 .....	68	(173)
4 .....	89	(259)

TABLE VIII.19—LCC SAVINGS RELATIVE TO THE BASE-CASE EFFICIENCY DISTRIBUTION FOR WATER-SOURCE (WATER-TO-AIR, WATER-LOOP) HEAT PUMPS <17,000 Btu/h—Continued

Efficiency level	Life-cycle cost savings	
	Percent of customers that experience	Average savings *
	Net cost	2013\$
5 .....	95	(458)

\* The calculation includes households with zero LCC savings (no impact).

TABLE VIII.20—AVERAGE LCC AND PBP RESULTS BY EFFICIENCY LEVEL FOR WATER-SOURCE (WATER-TO-AIR, WATER-LOOP) HEAT PUMPS ≥17,000 Btu/h AND <65,000 Btu/h

Efficiency level	Average costs 2013\$				Simple payback (years)	Average lifetime (years)
	Installed cost	First year's operating cost	Lifetime operating cost	LCC		
ASHRAE Baseline .....	\$4,834	\$1,102	\$12,980	\$17,814	.....	19
1 .....	5,111	1,059	12,473	17,584	6.2	19
2 .....	5,458	1,024	12,057	17,515	7.3	19
3 .....	5,700	1,008	11,868	17,569	8.2	19
4 .....	5,908	999	11,759	17,667	9.1	19
5 .....	6,328	982	11,564	17,892	10.8	19

**Note:** The results for each efficiency level are calculated assuming that all commercial consumers use equipment with that efficiency level. The PBP is measured relative to the baseline equipment.

TABLE VIII.21—LCC SAVINGS RELATIVE TO THE BASE-CASE EFFICIENCY DISTRIBUTION FOR WATER-SOURCE (WATER-TO-AIR, WATER-LOOP) HEAT PUMPS ≥17,000 Btu/h AND < 65,000 Btu/h

Efficiency level	Life-cycle cost savings	
	Percent of customers that experience	Average savings *
	Net cost	2013\$
1 .....	2	19
2 .....	29	62
3 .....	53	14

TABLE VIII.21—LCC SAVINGS RELATIVE TO THE BASE-CASE EFFICIENCY DISTRIBUTION FOR WATER-SOURCE (WATER-TO-AIR, WATER-LOOP) HEAT PUMPS ≥17,000 Btu/h AND < 65,000 Btu/h—Continued

Efficiency level	Life-cycle cost savings	
	Percent of customers that experience	Average savings *
	Net cost	2013\$
4 .....	66	(80)

TABLE VIII.21—LCC SAVINGS RELATIVE TO THE BASE-CASE EFFICIENCY DISTRIBUTION FOR WATER-SOURCE (WATER-TO-AIR, WATER-LOOP) HEAT PUMPS ≥17,000 Btu/h AND < 65,000 Btu/h—Continued

Efficiency level	Life-cycle cost savings	
	Percent of customers that experience	Average savings *
	Net cost	2013\$
5 .....	76	(303)

\* The calculation includes households with zero LCC savings (no impact).

TABLE VIII.22—AVERAGE LCC AND PBP RESULTS BY EFFICIENCY LEVEL FOR WATER-SOURCE (WATER-TO-AIR, WATER-LOOP) HEAT PUMPS ≥65,000 Btu/h AND <135,000 Btu/h

Efficiency level	Average costs 2013\$				Simple payback (years)	Average lifetime (years)
	Installed cost	First year's operating cost	Lifetime operating cost	LCC		
ASHRAE Baseline .....	\$11,886	\$2,170	\$25,586	\$37,471	.....	19
1 .....	12,832	2,095	24,705	37,537	14	19
2 .....	13,780	2,057	24,246	38,026	16	19
3 .....	14,681	2,024	23,865	38,546	17	19



TABLE VIII.22—AVERAGE LCC AND PBP RESULTS BY EFFICIENCY LEVEL FOR WATER-SOURCE (WATER-TO-AIR, WATER-LOOP) HEAT PUMPS ≥65,000 Btu/h AND <135,000 Btu/h—Continued

Efficiency level	Average costs 2013\$				Simple payback (years)	Average lifetime (years)
	Installed cost	First year's operating cost	Lifetime operating cost	LCC		
4 .....	15,817	1,993	23,492	39,309	20	19

**Note:** The results for each efficiency level are calculated assuming that all commercial consumers use equipment with that efficiency level. The PBP is measured relative to the baseline equipment.

TABLE VIII.23—LCC SAVINGS RELATIVE TO THE BASE-CASE EFFICIENCY DISTRIBUTION FOR WATER-SOURCE (WATER-TO-AIR, WATER-LOOP) HEAT PUMPS ≥65,000 Btu/h AND <135,000 Btu/h

Efficiency level	Life-cycle cost savings	
	Percent of customers that experience	Average savings*
	Net cost	2013\$
1 .....	** 0	** 0
2 .....	27	(147)
3 .....	72	(556)
4 .....	93	(1,305)

\*The calculation includes households with zero LCC savings (no impact).

\*\* The base-case efficiency distribution has 0-percent market share at the ASHRAE baseline; therefore, there are no savings for EL1.

b. National Impact Analysis

1. Amount and Significance of Energy Savings

To estimate the lifetime energy savings for equipment shipped through 2045 due to amended energy conservation standards, DOE compared the energy consumption of commercial water-source heat pumps under the ASHRAE Standard 90.1–2013 efficiency levels to energy consumption of the same water-source heat pumps under more-stringent efficiency standards. DOE also compared the energy consumption of those commercial water-source heat pumps under the ASHRAE Standard 90.1–2013 efficiency

levels to energy consumption of commercial water-source heat pumps under the current EPCA base case (i.e., under current Federal standards). DOE examined up to five efficiency levels higher than those of ASHRAE Standard 90.1–2013. Table VIII.24 through Table VIII.26 show the projected national energy savings at each of the considered standard levels. (See chapter 8 of the NOPR TSD.)

TABLE VIII.24—POTENTIAL ENERGY SAVINGS FOR WATER-SOURCE (WATER-TO-AIR, WATER-LOOP) HEAT PUMPS <17,000 Btu/h

Efficiency level	Primary energy savings estimate* (quads)	FFC energy savings estimate* (quads)
Level 0—ASHRAE—12.2 EER**.		
Level 1—13.0 EER .....	0.0002	0.0002
Level 2—14.0 EER .....	0.02	0.02
Level 3—15.7 EER .....	0.06	0.06
Level 4—16.5 EER .....	0.08	0.08
Level 5—“Max-Tech”—18.1 EER .....	0.11	0.11

\* The potential energy savings for efficiency levels more stringent than those specified by ASHRAE Standard 90.1–2013 were calculated relative to the efficiency levels that would result if ASHRAE Standard 90.1–2013 standards were adopted.

\*\* The base-case efficiency distribution has 0-percent market share at the Federal baseline; therefore, there are no savings for the ASHRAE level.

TABLE VIII.25—POTENTIAL ENERGY SAVINGS FOR WATER-SOURCE (WATER-TO-AIR, WATER-LOOP) HEAT PUMPS ≥17,000 AND <65,000 Btu/h

Efficiency level	Primary energy savings estimate* (quads)	FFC energy savings estimate* (quads)
Level 0—ASHRAE—13.0 EER**.		
Level 1—14.6 EER .....	0.02	0.03
Level 2—16.6 EER .....	0.26	0.27
Level 3—18.0 EER .....	0.45	0.47
Level 4—19.2 EER .....	0.60	0.63
Level 5—“Max-Tech”—21.6 EER .....	0.83	0.87

\* The potential energy savings for efficiency levels more stringent than those specified by ASHRAE Standard 90.1–2013 were calculated relative to the efficiency levels that would result if ASHRAE Standard 90.1–2013 standards were adopted.

\*\* The base-case efficiency distribution has 0-percent market share at the Federal baseline; therefore, there are no savings for the ASHRAE level.

TABLE VIII.26—POTENTIAL ENERGY SAVINGS FOR WATER-SOURCE (WATER-TO-AIR, WATER-LOOP) HEAT PUMPS ≥65,000 AND <135,000 Btu/h

Efficiency level	Primary energy savings estimate* (quads)	FFC energy savings estimate* (quads)
Level 0—ASHRAE—13.0 EER**		
Level 1—14.0 EER**		
Level 2—15.0 EER .....	0.01	0.01
Level 3—16.0 EER .....	0.03	0.03
Level 4—“Max-Tech”—17.2 EER .....	0.05	0.05

\* The potential energy savings for efficiency levels more stringent than those specified by ASHRAE Standard 90.1–2013 were calculated relative to the efficiency levels that would result if ASHRAE Standard 90.1–2013 standards were adopted.

\*\* The base-case efficiency distribution has 0-percent market share at the Federal baseline and the ASHRAE baseline; therefore, there are no savings for the ASHRAE level or EL1.

2. Net Present Value of Customer Costs and Benefits (See chapter 8 of the NOPR TSD for further detail.)

Table VIII.27 and Table VIII.28 provide an overview of the NPV results.

TABLE VIII.27—SUMMARY OF CUMULATIVE NET PRESENT VALUE FOR WATER-SOURCE (WATER-TO-AIR, WATER-LOOP) HEAT PUMPS

[Discounted at seven percent]  
[Net present value (billion 2013\$)]

Equipment class	Efficiency level 1	Efficiency level 2	Efficiency level 3	Efficiency level 4	Efficiency level 5
Water-Source (Water-to-Air, Water-Loop) HP <17,000 Btu/h .....	(0.00)	(0.04)	(0.13)	(0.19)	(0.30)
Water-Source (Water-to-Air, Water-Loop) HP ≥17,000 to <65,000 Btu/h .....	0.01	0.01	(0.09)	(0.24)	(0.53)
Water-Source (Water-to-Air, Water-Loop) HP ≥65,000 to 135,000 Btu/h .....	*	(0.01)	(0.05)	(0.10)	** N/A

Notes: Numbers in parentheses indicate negative NPV.

The net present value for efficiency levels more stringent than those specified by ASHRAE Standard 90.1–2013 were calculated relative to the efficiency levels that would result if ASHRAE Standard 90.1–2013 standards were adopted. Economic analysis was not conducted for the ASHRAE levels (EL 0).

\* The base-case efficiency distribution has 0-percent market share at the ASHRAE baseline; therefore, there are no savings for EL1.

\*\* The max-tech level for this equipment class is EL 4.

TABLE VIII.28—SUMMARY OF CUMULATIVE NET PRESENT VALUE FOR WATER-SOURCE (WATER-TO-AIR, WATER-LOOP) HEAT PUMPS

[Discounted at three percent]  
[Net Present Value (Billion 2013\$)]

Equipment class	Efficiency level 1	Efficiency level 2	Efficiency level 3	Efficiency level 4	Efficiency level 5
Water-Source (Water-to-Air, Water-Loop) HP <17,000 Btu/h .....	(0.00)	(0.05)	(0.19)	(0.29)	(0.46)
Water-Source (Water-to-Air, Water-Loop) HP ≥17,000 to <65,000 Btu/h .....	0.03	0.26	0.22	0.05	(0.31)
Water-Source (Water-to-Air, Water-Loop) HP ≥65,000 to 135,000 Btu/h .....	(*)	(0.02)	(0.07)	(0.14)	** N/A

Notes: Numbers in parentheses indicate negative NPV.

The net present value for efficiency levels more stringent than those specified by ASHRAE Standard 90.1–2013 were calculated relative to the efficiency levels that would result if ASHRAE Standard 90.1–2013 standards were adopted. Economic analysis was not conducted for the ASHRAE levels (EL 0).

\* The base-case efficiency distribution has 0-percent market share at the ASHRAE baseline; therefore, there are no savings for EL1.

\*\* The max-tech level for this equipment class is EL 4.

3. Commercial Oil-Fired Storage Water Heaters

DOE estimated the potential primary energy savings in quads (i.e., 10<sup>15</sup> Btu) for each efficiency level considered within each equipment class analyzed. Table VIII.29 shows the potential energy

savings resulting from the analyses conducted as part of the April 2014 NODA. 79 FR 20114, 20136 (April 11, 2014). In response to the NODA, AHRI stated that DOE’s derivation of unit energy consumption for oil-fired storage water heaters based on a proportional relationship to gas-fired storage water

heaters in the Commercial Building Energy Consumption Survey (CBECS) might not be fully correct because of regional variations between the two energy sources. (AHRI, No. 24 at p. 7) After re-examining the energy savings analysis for oil-fired storage water heaters, DOE has tentatively determined

that any resulting imprecision in this estimate would not be enough to make the energy-savings estimates for this class non-trivial, and, therefore, DOE did not adjust its analysis for the NOPR.

As mentioned in section IV.B, DOE did not conduct an economic analysis for this oil-fired storage water heater equipment category because of the minimal energy savings.

65,000 Btu/h, water-source heat pumps, and oil-fired storage water heaters covered in this NOPR could also produce environmental benefits in the form of reduced emissions of air pollutants and greenhouse gases.

**TABLE VIII.29—POTENTIAL ENERGY SAVINGS ESTIMATES FOR COMMERCIAL OIL-FIRED STORAGE WATER HEATERS >105,000 Btu/h AND <4,000 Btu/h/gal**

Efficiency level	Primary energy savings estimate* (Quads)	FFC energy savings estimate* (Quads)
Level 0—ASHRAE—80% E <sub>t</sub> .....	0.002	0.002
Level 1—81% E <sub>t</sub> .....	0.001	0.001
Level 2—“Max-Tech”—82% E <sub>t</sub> .....	0.002	0.002

\* The potential energy savings for efficiency levels more stringent than those specified by ASHRAE Standard 90.1–2013 were calculated relative to the efficiency levels that would result if ASHRAE Standard 90.1–2013 standards were adopted.

*C. Need of the Nation To Conserve Energy*

An improvement in the energy efficiency of the equipment subject to this rule, where economically justified, is likely to improve the security of the nation’s energy system by reducing overall demand for energy, to strengthen the economy, and to reduce the environmental impacts or costs of energy production. Reduced electricity demand may also improve the reliability of the electricity system, particularly during peak-load periods. Reductions in national electric generating capacity estimated for each efficiency level considered in this rulemaking, throughout the same analysis period as the NIA, are reported in chapter 11 of the NOPR TSD.

Energy savings from amended standards for the small air-cooled air conditioners and heat pumps less than

Table VIII.30 and Table VIII.31 provide DOE’s estimate of cumulative emissions reductions projected to result from the efficiency levels analyzed in this rulemaking.<sup>57</sup> The tables include both power sector emissions and upstream emissions. The upstream emissions were calculated using the multipliers discussed in section VII.A. DOE reports annual CO<sub>2</sub>, NO<sub>x</sub>, and Hg emissions reductions for each efficiency level in chapter 9 of the NOPR TSD. As discussed in section VII.A, DOE did not include NO<sub>x</sub> emissions reduction from power plants in States subject to CAIR, because an energy conservation standard would not affect the overall level of NO<sub>x</sub> emissions in those States due to the emissions caps mandated by CAIR.

**TABLE VIII.30—CUMULATIVE EMISSIONS REDUCTION FOR POTENTIAL STANDARDS FOR SMALL THREE-PHASE AIR-COOLED AIR CONDITIONERS AND HEAT PUMPS <65,000 Btu/h**

[2017–2046 for ASHRAE level; 2020–2046 for more-stringent levels; 2019–2048 for split-system air conditioners]

	Efficiency level					
	ASHRAE/0	1	2	3	4	5
<b>Power Sector Emissions</b>						
CO <sub>2</sub> (million metric tons) .....	3.7	8.9	16.8	20.8	24.3	25.9
SO <sub>2</sub> (thousand tons) .....	2.9	6.9	13.0	16.1	18.8	20.1
NO <sub>x</sub> (thousand tons) .....	2.8	6.7	12.6	15.6	18.2	19.4
Hg (tons) .....	0.01	0.02	0.04	0.05	0.06	0.06
N <sub>2</sub> O (thousand tons) .....	0.05	0.13	0.24	0.30	0.35	0.37
CH <sub>4</sub> (thousand tons) .....	0.38	0.90	1.69	2.10	2.45	2.61
<b>Upstream Emissions</b>						
CO <sub>2</sub> (million metric tons) .....	0.22	0.54	1.00	1.24	1.45	1.54
SO <sub>2</sub> (thousand tons) .....	0.04	0.09	0.17	0.22	0.25	0.27
NO <sub>x</sub> (thousand tons) .....	3.2	7.6	14.3	17.7	20.7	22.0
Hg (tons) .....	0.0001	0.0002	0.0004	0.0005	0.0006	0.0006
N <sub>2</sub> O (thousand tons) .....	0.002	0.005	0.009	0.011	0.012	0.013
CH <sub>4</sub> (thousand tons) .....	19	45	83	103	121	128
<b>Total FFC Emissions</b>						
CO <sub>2</sub> (million metric tons) .....	4.0	9.5	17.8	22.1	25.8	27.4
SO <sub>2</sub> (thousand tons) .....	2.9	7.0	13.2	16.4	19.1	20.3
NO <sub>x</sub> (thousand tons) .....	6.0	14.3	26.8	33.4	38.9	41.4
Hg (tons) .....	0.01	0.02	0.04	0.05	0.06	0.06
N <sub>2</sub> O (thousand tons) .....	0.06	0.13	0.25	0.31	0.36	0.39
CH <sub>4</sub> (thousand tons) .....	19	45	85	105	123	131

**Note:** The potential emissions reduction for efficiency levels more stringent than those specified by ASHRAE Standard 90.1–2013 were calculated relative to the efficiency levels that would result if ASHRAE Standard 90.1–2013 standards were adopted.

<sup>57</sup> Because DOE did not conduct additional analysis for oil-fired storage water heaters, estimates

of environmental benefits for amended standards for that equipment type are not shown here.

TABLE VIII.31—CUMULATIVE EMISSIONS REDUCTION FOR POTENTIAL STANDARDS FOR WATER-SOURCE HEAT PUMPS [2016–2045 for ASHRAE level; 2020–2045 for more-stringent levels]

	Efficiency level					
	ASHRAE/0 *	1	2	3	4	5
<b>Power Sector Emissions</b>						
CO <sub>2</sub> (million metric tons) .....		1.4	16.3	30.5	41.6	56.8
SO <sub>2</sub> (thousand tons) .....		1.1	12.9	24.2	32.9	44.9
NO <sub>x</sub> (thousand tons) .....		1.1	12.3	23.1	31.4	42.9
Hg (tons) .....		0.003	0.040	0.075	0.101	0.139
N <sub>2</sub> O (thousand tons) .....		0.02	0.23	0.44	0.60	0.81
CH <sub>4</sub> (thousand tons) .....		0.14	1.63	3.06	4.17	5.69
<b>Upstream Emissions</b>						
CO <sub>2</sub> (million metric tons) .....		0.08	0.97	1.81	2.47	3.37
SO <sub>2</sub> (thousand tons) .....		0.01	0.17	0.32	0.43	0.59
NO <sub>x</sub> (thousand tons) .....		1.2	13.8	25.9	35.2	48.0
Hg (tons) .....		0.00003	0.00037	0.00070	0.00095	0.00130
N <sub>2</sub> O (thousand tons) .....		0.001	0.008	0.016	0.021	0.029
CH <sub>4</sub> (thousand tons) .....		7.0	80.5	150.8	205.2	279.9
<b>Total FFC Emissions</b>						
CO <sub>2</sub> (million metric tons) .....		1.5	17.3	32.4	44.0	60.1
SO <sub>2</sub> (thousand tons) .....		1.1	13.1	24.5	33.3	45.5
NO <sub>x</sub> (thousand tons) .....		2.3	26.1	49.0	66.7	91.0
Hg (tons) .....		0.004	0.040	0.075	0.102	0.140
N <sub>2</sub> O (thousand tons) .....		0.02	0.24	0.45	0.62	0.84
CH <sub>4</sub> (thousand tons) .....		7.2	82.1	153.9	209.4	285.6

**Note:** The potential emissions reduction for efficiency levels more stringent than those specified by ASHRAE Standard 90.1–2013 were calculated relative to the efficiency levels that would result if ASHRAE Standard 90.1–2013 standards were adopted.  
 \* There are no reductions for the ASHRAE level because there is no market share projected at the Federal baseline in the base case.

As part of the analysis for this NOPR, DOE estimated monetary benefits likely to result from the reduced emissions of CO<sub>2</sub> and NO<sub>x</sub> estimated for each of the efficiency levels analyzed for small air-cooled air conditioners and heat pumps less than 65,000 Btu/h, water-source heat pumps, and oil-fired storage water heaters. As discussed in section VII.B.1, for CO<sub>2</sub>, DOE used values for the SCC developed by an interagency process. The interagency group selected four sets of SCC values for use in regulatory analyses. Three sets are based on the average SCC from three integrated

assessment models, at discount rates of 2.5 percent, 3 percent, and 5 percent. The fourth set, which represents the 95th-percentile SCC estimate across all three models at a 3-percent discount rate, is included to represent higher-than-expected impacts from temperature change further out in the tails of the SCC distribution. The four SCC values for CO<sub>2</sub> emissions reductions in 2015, expressed in 2013\$, are \$12.0/ton, \$40.5/ton, \$62.4/ton, and \$119/ton. The values for later years are higher due to increasing emissions-related costs as the

magnitude of projected climate change increases.

Table VIII.32 and Table VIII.33 present the global value of CO<sub>2</sub> emissions reductions at each efficiency level. For each of the four cases, DOE calculated a present value of the stream of annual values using the same discount rate as was used in the studies upon which the dollar-per-ton values are based. DOE calculated domestic values as a range from 7 percent to 23 percent of the global values, and these results are presented in chapter 10 of the NOPR TSD.

TABLE VIII.32—GLOBAL PRESENT VALUE OF CO<sub>2</sub> EMISSIONS REDUCTION FOR POTENTIAL STANDARDS FOR SMALL THREE-PHASE AIR-COOLED AIR CONDITIONERS AND HEAT PUMPS <65,000 Btu/h

Efficiency level	SCC scenario *			
	5% discount rate, average	3% discount rate, average	2.5% discount rate, average	3% discount rate, 95th percentile
<i>million 2013\$</i>				
<b>Power Sector Emissions</b>				
ASHRAE/0 .....	23	110	177	340
1 .....	53	261	420	808
2 .....	103	498	799	1541
3 .....	127	617	990	1910
4 .....	149	721	1156	2231
5 .....	159	768	1232	2378

TABLE VIII.32—GLOBAL PRESENT VALUE OF CO<sub>2</sub> EMISSIONS REDUCTION FOR POTENTIAL STANDARDS FOR SMALL THREE-PHASE AIR-COOLED AIR CONDITIONERS AND HEAT PUMPS <65,000 Btu/h—Continued

Efficiency level	SCC scenario *			
	5% discount rate, average	3% discount rate, average	2.5% discount rate, average	3% discount rate, 95th percentile
<b>Upstream Emissions</b>				
ASHRAE/0 .....	1.3	6.5	10	20
1 .....	3.1	15	25	48
2 .....	6.0	29	47	91
3 .....	7.4	36	59	113
4 .....	8.7	43	68	132
5 .....	9.3	45	73	140
<b>Total FFC Emissions</b>				
ASHRAE/0 .....	24	116	187	360
1 .....	56	277	445	856
2 .....	109	527	846	1632
3 .....	135	654	1049	2023
4 .....	157	763	1224	2362
5 .....	168	814	1305	2518

**Note:** The potential emissions reduction for efficiency levels more stringent than those specified by ASHRAE Standard 90.1–2013 were calculated relative to the efficiency levels that would result if ASHRAE Standard 90.1–2013 standards were adopted.

\*For each of the four cases, the corresponding SCC value for emissions in 2015 is \$12.0, \$40.5, \$62.4 and \$119 per metric ton (2013\$).

TABLE VIII.33—GLOBAL PRESENT VALUE OF CO<sub>2</sub> EMISSIONS REDUCTION FOR POTENTIAL STANDARDS FOR WATER-SOURCE HEAT PUMPS

Efficiency level	SCC scenario *			
	5% discount rate, average	3% discount rate, average	2.5% discount rate, average	3% discount rate, 95th percentile
<i>million 2013\$</i>				
<b>Power Sector Emissions</b>				
ASHRAE/0 ** .....	.....	.....	.....	.....
1 .....	8.7	42	68	131
2 .....	99	482	773	1491
3 .....	186	902	1448	2794
4 .....	253	1228	1972	3804
5 .....	347	1681	2698	5206
<b>Upstream Emissions</b>				
ASHRAE/0 ** .....	.....	.....	.....	.....
1 .....	0.5	2.5	4.0	7.7
2 .....	5.8	28	45	88
3 .....	11	53	85	164
4 .....	15	72	116	224
5 .....	20	99	159	306
<b>Total FFC Emissions</b>				
ASHRAE/0 ** .....	.....	.....	.....	.....
1 .....	9.2	45	72	138
2 .....	105	510	818	1579
3 .....	196	955	1533	2958
4 .....	267	1300	2088	4028
5 .....	367	1780	2856	5512

**Note:** The potential emissions reduction for efficiency levels more stringent than those specified by ASHRAE Standard 90.1–2013 were calculated relative to the efficiency levels that would result if ASHRAE Standard 90.1–2013 standards were adopted.

\*For each of the four cases, the corresponding SCC value for emissions in 2015 is \$12.0, \$40.5, \$62.4 and \$119 per metric ton (2013\$).

\*\* There are no reductions for the ASHRAE level because there is no market share projected at the Federal baseline in the base case.

DOE is well aware that scientific and economic knowledge about the contribution of CO<sub>2</sub> and other GHG emissions to changes in the future global climate and the potential resulting damages to the world economy

continues to evolve rapidly. Thus, any value placed in this rulemaking on reducing CO<sub>2</sub> emissions is subject to change. DOE, together with other Federal agencies, will continue to review various methodologies for estimating the monetary value of reductions in CO<sub>2</sub> and other GHG emissions. This ongoing review will consider the comments on this subject that are part of the public record for this and other rulemakings, as well as other methodological assumptions and issues. However, consistent with DOE's legal obligations, and taking into account the uncertainty involved with this particular issue, DOE has included in this NOPR the most recent values and analyses resulting from the interagency review process.

DOE also estimated a range for the cumulative monetary value of the economic benefits associated with NO<sub>x</sub> emissions reductions anticipated to result from amended standards for the small air-cooled air conditioners and heat pumps less than 65,000 Btu/h, water-source heat pumps, and oil-fired storage water heaters that are the subject of this NOPR. The dollar-per-ton values that DOE used are discussed in section VII.B.2.

Table VIII.34 and Table VIII.35 present the present value of cumulative NO<sub>x</sub> emissions reductions for each efficiency level calculated using the average dollar-per-ton values and 7-percent and 3-percent discount rates.

TABLE VIII.34—PRESENT VALUE OF NO<sub>x</sub> EMISSIONS REDUCTION FOR POTENTIAL STANDARDS FOR SMALL THREE-PHASE AIR-COOLED AIR CONDITIONERS AND HEAT PUMPS <65,000 Btu/h

[2017–2046 for ASHRAE Level; 2020–2046 for More-Stringent Levels; 2019–2048 for Split-System Air Conditioners]

Efficiency level	3% discount rate	7% discount rate
<i>million 2013\$</i>		
<b>Power Sector Emissions</b>		
ASHRAE/0 ....	3.3	1.4
1 .....	7.8	3.2
2 .....	15	6.4
3 .....	19	7.9
4 .....	22	9.2
5 .....	23	9.9
<b>Upstream Emissions</b>		
ASHRAE/0 ....	3.6	1.4
1 .....	8.6	3.3
2 .....	17	6.6
3 .....	21	8.2
4 .....	24	9.5

TABLE VIII.34—PRESENT VALUE OF NO<sub>x</sub> EMISSIONS REDUCTION FOR POTENTIAL STANDARDS FOR SMALL THREE-PHASE AIR-COOLED AIR CONDITIONERS AND HEAT PUMPS <65,000 Btu/h—Continued

[2017–2046 for ASHRAE Level; 2020–2046 for More-Stringent Levels; 2019–2048 for Split-System Air Conditioners]

Efficiency level	3% discount rate	7% discount rate
5 .....	26	10
<b>Total FFC Emissions</b>		
ASHRAE/0 ....	7.0	2.8
1 .....	16	6.5
2 .....	32	13
3 .....	39	16
4 .....	46	19
5 .....	49	20

**Note:** The potential emissions reduction for efficiency levels more stringent than those specified by ASHRAE Standard 90.1–2013 were calculated relative to the efficiency levels that would result if ASHRAE Standard 90.1–2013 standards were adopted.

TABLE VIII.35—PRESENT VALUE OF NO<sub>x</sub> EMISSIONS REDUCTION FOR POTENTIAL STANDARDS FOR WATER-SOURCE HEAT PUMPS

[2016–2045 for ASHRAE Level; 2020–2045 for More-Stringent Levels]

Efficiency level	3% discount rate	7% discount rate
<i>million 2013\$</i>		
<b>Power Sector Emissions</b>		
ASHRAE/0* ...	.....	.....
1 .....	1.3	0.5
2 .....	15	6.0
3 .....	27	11
4 .....	37	15
5 .....	51	21
<b>Upstream Emissions</b>		
ASHRAE/0* ...	.....	.....
1 .....	1.4	0.5
2 .....	16	6.2
3 .....	30	12
4 .....	41	16
5 .....	56	22
<b>Total FFC Emissions</b>		
ASHRAE/0* ..	.....	.....
1 .....	2.7	1.1
2 .....	31	12
3 .....	57	23
4 .....	78	31
5 .....	107	43

**Note:** The potential emissions reduction for efficiency levels more stringent than those specified by ASHRAE Standard 90.1–2013 were calculated relative to the efficiency levels that would result if ASHRAE Standard 90.1–2013 standards were adopted.

\* There are no reductions for the ASHRAE level because there is no market share projected at the Federal baseline in the base case.

D. Proposed Standards

1. Small Commercial Air-Cooled Air Conditioners and Heat Pumps Less Than 65,000 Btu/h

As noted previously, EPCA specifies that, for any commercial and industrial equipment addressed under 42 U.S.C. 6313(a)(6)(A)(i), DOE may prescribe an energy conservation standard more stringent than the level for such equipment in ASHRAE Standard 90.1, as amended, only if “clear and convincing evidence” shows that a more-stringent standard would result in significant additional conservation of energy and is technologically feasible and economically justified. (42 U.S.C. 6313(a)(6)(A)(ii)(II)) This requirement also applies to split-system air conditioners evaluated under the 6-year look back. (42 U.S.C. 6313(a)(6)(C)(i)(II))

In evaluating more-stringent efficiency levels than those specified by ASHRAE Standard 90.1–2013 for small air-cooled air conditioners and heat pumps less than 65,000 Btu/h, DOE reviewed the results in terms of their technological feasibility, significance of energy savings, and economic justification.

DOE has tentatively concluded that all of the SEER and HSPF levels considered by DOE are technologically feasible, as units with equivalent efficiency appeared to be available in the current market at all levels examined.

DOE examined the potential energy savings that would result from the efficiency levels specified in ASHRAE Standard 90.1–2013 and compared these to the potential energy savings that would result from efficiency levels more stringent than those in ASHRAE Standard 90.1–2013. DOE estimates that 0.05 quads of energy would be saved if DOE adopts the efficiency levels set in ASHRAE Standard 90.1–2013 for each small air-cooled air conditioner and heat pump class specified in that standard. If DOE were to adopt efficiency levels more stringent than those specified by ASHRAE Standard 90.1–2013, the potential additional energy savings range from 0.02 quads to 0.45 quads. Associated with proposing more-stringent efficiency levels for the three triggered equipment classes is a three-year delay in implementation compared to the adoption of energy conservation standards at the levels specified in ASHRAE Standard 90.1–2013 (see section V.E.10). This delay in

implementation of amended energy conservation standards would result in a small amount of energy savings being lost in the first years (2017 through 2020) compared to the savings from adopting the levels in ASHRAE Standard 90.1–2013; however, this loss may be compensated for by increased savings in later years. Taken in isolation, the energy savings associated with more-stringent standards might be considered significant enough to warrant adoption of such standards. However, as noted previously, energy savings are not the only factor that DOE must consider.

In considering whether potential standards are economically justified, DOE also examined the LCC savings and national NPV that would result from

adopting efficiency levels more stringent than those set forth in ASHRAE Standard 90.1–2013. The analytical results show negative average LCC savings and negative national NPV at both 7-percent and 3-percent discount rate for all efficiency levels in all four equipment classes. These results indicate that adoption of efficiency levels more stringent than those in ASHRAE Standard 90.1–2013 as Federal energy conservation standards would likely lead to negative economic outcomes for the Nation. Consequently, this criterion for adoption of more-stringent standard levels does not appear to have been met.

As such, DOE does not have “clear and convincing evidence” that any significant additional conservation of

energy that would result from adoption of more-stringent efficiency levels than those specified in ASHRAE Standard 90.1–2013 would be economically justified. Therefore, DOE is proposing to adopt the energy efficiency levels for these products as set forth in ASHRAE Standard 90.1–2013. For split-system air conditioners, for which the efficiency level was not updated in Standard 90.1–2013, DOE is making a determination that standards for the product do not need to be amended for the reasons stated above. Table VIII.36 presents the proposed amended energy conservation standards and compliance dates for small air-cooled air conditioners and heat pumps less than 65,000 Btu/h.

TABLE VIII.36—PROPOSED ENERGY CONSERVATION STANDARDS FOR SMALL THREE-PHASE AIR-COOLED AIR CONDITIONERS AND HEAT PUMPS <65,000 Btu/h

Equipment type	Efficiency level	Compliance date
Three-Phase Air-Cooled Split System Air Conditioners <65,000 Btu/h	13.0 SEER *	June 16, 2008.
Three-Phase Air-Cooled Single Package Air Conditioners <65,000 Btu/h	14.0 SEER	January 1, 2017.
Three-Phase Air-Cooled Split System Heat Pumps <65,000 Btu/h	14.0 SEER 8.2 HSPF	January 1, 2017.
Three-Phase Air-Cooled Single Package Heat Pumps <65,000 Btu/h	14.0 SEER 8.0 HSPF	January 1, 2017.

\*13.0 SEER is the existing Federal minimum energy conservation standard for three-phase air-cooled split system air conditioners <65,000 Btu/h.

2. Water-Source Heat Pumps

In evaluating more-stringent efficiency levels for water-source heat pumps than those specified by ASHRAE Standard 90.1–2013, DOE reviewed the results in terms of their technological feasibility, significance of energy savings, and economic justification.

DOE has tentatively concluded that all of the EER and COP levels considered by DOE are technologically feasible, as units with equivalent efficiency appeared to be available in the current market at all levels examined.

DOE examined the potential energy savings that would result from the efficiency levels specified in ASHRAE Standard 90.1–2013 and compared these to the potential energy savings that would result from efficiency levels more stringent than those in ASHRAE Standard 90.1–2013. DOE does not estimate any energy savings from adopting the levels set in ASHRAE Standard 90.1–2013, as very few models exist on the market below that level, and by 2020, DOE expects those models to be off the market. If DOE were to adopt efficiency levels more stringent than those specified by ASHRAE Standard

90.1–2013, the potential additional energy savings range from 0.03 quads to 1.0 quads. Associated with proposing more-stringent efficiency levels is a four-and-a-half-year delay in implementation compared to the adoption of energy conservation standards at the levels specified in ASHRAE Standard 90.1–2013 (see section VI.E.10). This delay in implementation of amended energy conservation standards would result in a small amount of energy savings being lost in the first years (2016 through 2020) compared to the savings from adopting the levels in ASHRAE Standard 90.1–2013; however, this loss may be compensated for by increased savings in later years. Taken in isolation, the energy savings associated with more-stringent standards might be considered significant enough to warrant adoption of such standards. However, as noted above, energy savings are not the only factor which DOE must consider.

In considering whether potential standards are economically justified, DOE also examined the NPV that would result from adopting efficiency levels more stringent than those set forth in

ASHRAE Standard 90.1–2013. With a 7-percent discount rate, EL 1 results in positive NPV, and ELs 2 through 5 result in negative NPV. With a 3-percent discount rate, ELs 1 and 2 create positive NPV, while ELs 3 through 5 result in negative NPVs. These results indicate that adoption of efficiency levels more stringent than those in ASHRAE Standard 90.1–2013 as Federal energy conservation standards might lead to negative economic outcomes for the Nation, except at EL1, which offers very little energy savings.

Furthermore, although DOE based its analyses on the best available data when examining the potential energy savings and the economic justification of efficiency levels more stringent than those specified in ASHRAE Standard 90.1–2013, DOE believes there are several limitations regarding that data which should be considered before proposing amended energy conservation standards for water-source heat pumps.

First, DOE reexamined the uncertainty in its analysis of water-source heat pumps. As noted in section VI.D, DOE relied on cooling energy use estimates from a 2000 study. While DOE applied a scaling factor to attempt to account for changes in buildings since

2000, this is only a rough estimate. DOE considered running building simulations by applying a water-source heat pump module to reference buildings. However, DOE has been unable to obtain reliable information on the distribution of water-source heat pump applications. Therefore, it is not clear which building types would be most useful to simulate and how DOE would weight the results of the simulations. Furthermore, DOE has no field data with which to corroborate the results of the simulations. The analysis of heating energy use is also very uncertain; DOE relied on estimates for air-source heat pumps, but it is unclear whether water-source heat pumps would have similar heating usage, as they tend to be used in different applications. Any inaccuracy in UEC directly impacts the energy savings estimates and consumer impacts.

Second, in developing its analysis, DOE made refinements to various inputs, such as heating UEC and repair cost. DOE observed that the NPV results were highly sensitive to small changes in these inputs, with NPV for EL 2, for example, changing from positive to negative and back over several iterations. This model sensitivity, combined with high uncertainty in various inputs, makes it difficult for DOE to determine that the results provide clear and convincing evidence that higher standards would be economically justified.

Third, DOE relied on shipments estimates from the U.S. Census. As noted in section VI.F.2, these estimates are considerably higher than those found in an EIA report. Furthermore, DOE disaggregated the shipments into equipment class using data from over a decade ago. Although DOE requested comment in the April 2014 NODA, DOE has not received any information or data regarding the shipments of this equipment. Any inaccuracy in the shipment projection in total or by equipment class contributes to the uncertainty of the energy savings results and, thus, makes it difficult for DOE to determine that any additional energy savings are significant.

Fourth, due to the limited data on the existing distribution of shipments by efficiency level or historical efficiency trends, DOE was not able to assess possible future changes in either the available efficiencies of equipment in the water-source heat pump market or the sales distribution of shipments by efficiency level in the absence of setting more-stringent standards. Instead, DOE applied an efficiency trend from a commercial air conditioner rulemaking published 10 years ago. DOE recognizes that manufacturers may continue to make future improvements in water-source heat pump efficiencies even in the absence of mandated energy conservation standards. In particular, water-source heat pumps tend to be a fairly efficient product, and the distribution of model availability

indicates that many commercial consumers are already purchasing equipment well above the baseline. Consequently, it is likely that the true improvements in efficiency in the absence of a standard may be higher than estimated. This possibility increases the uncertainty of the energy savings estimates. To the extent that manufacturers improve equipment efficiency and commercial consumers choose to purchase improved products in the absence of standards, the energy savings estimates would likely be reduced.

In light of the above, DOE would again restate the statutory test for adopting energy conservation standards more stringent than the levels in ASHRAE Standard 90.1. DOE must have “clear and convincing” evidence in order to propose efficiency levels more stringent than those specified in ASHRAE Standard 90.1–2013, and for the reasons explained in this document, the totality of information does not meet the level necessary to support these more-stringent efficiency levels for water-source heat pumps. Consequently, DOE has tentatively decided to propose the efficiency levels in ASHRAE Standard 90.1–2013 as amended energy conservation standards for all three water-source heat pump equipment classes. Accordingly, Table VIII.37 presents the proposed amended energy conservation standards and compliance dates for water-source heat pumps.

TABLE VIII.37—PROPOSED ENERGY CONSERVATION STANDARDS FOR WATER-SOURCE HEAT PUMPS

Equipment type	Efficiency level	Compliance date
Water-Source (Water-to-Air, Water-Loop) HP <17,000 Btu/h .....	12.2 EER ..... 4.3 COP .....	October 9, 2015.
Water-Source (Water-to-Air, Water-Loop) HP ≥17,000 to <65,000 Btu/h .....	13.0 EER ..... 4.3 COP .....	October 9, 2015.
Water-Source (Water-to-Air, Water-Loop) HP ≥65,000 to 135,000 Btu/h .....	13.0 EER ..... 4.3 COP .....	October 9, 2015.

DOE seeks comments from interested parties on its proposed amended energy conservation standards for water-source heat pumps, as well as the other efficiency levels considered. This is identified as Issue 12 under “Issues on Which DOE Seeks Comment” in section X.E of this NOPR. Although DOE currently believes that it would be appropriate to adopt the efficiency levels in ASHRAE Standard 90.1–2013 for water-source heat pumps, DOE may consider the possibility of setting standards at more-stringent efficiency levels if public comments and additional data supply clear and

convincing evidence in support of such an approach.

3. Commercial Oil-Fired Storage Water Heaters

EPCA specifies that, for any commercial and industrial equipment addressed under 42 U.S.C. 6313(a)(6)(A)(i), DOE may prescribe an energy conservation standard more stringent than the level for such equipment in ASHRAE Standard 90.1, as amended, only if “clear and convincing evidence” shows that a more-stringent standard would result in significant additional conservation of energy and is technologically feasible

and economically justified. (42 U.S.C. 6313(a)(6)(A)(ii)(II))

In evaluating more-stringent efficiency levels for oil-fired storage water-heating equipment than those specified by ASHRAE Standard 90.1–2013, DOE reviewed the results in terms of the significance of their additional energy savings. DOE believes that the energy savings from increasing national energy conservation standards for oil-fired storage water heaters above the levels specified by ASHRAE Standard 90.1–2013 would be minimal. As such, DOE does not have “clear and convincing evidence” that significant additional conservation of energy would



result from adoption of more-stringent standard levels. Therefore, DOE did not examine whether the levels are economically justified, and DOE is

proposing to adopt the energy efficiency levels for this equipment type as set forth in ASHRAE Standard 90.1–2013. Table VIII.38 presents the proposed

energy conservation standard and compliance date for oil-fired storage water heaters.

TABLE VIII.38—PROPOSED ENERGY CONSERVATION STANDARDS FOR OIL-FIRED STORAGE WATER HEATERS

Equipment type	Efficiency level (Et)	Compliance date
Oil-Fired Storage Water Heaters >105,000 Btu/h and <4,000 Btu/h/gal .....	80% .....	October 9, 2015.

**IX. Procedural Issues and Regulatory Review**

*A. Review Under Executive Order 12866 and 13563*

Section 1(b)(1) of Executive Order 12866, “Regulatory Planning and Review,” 58 FR 51735 (Oct. 4, 1993), requires each agency to identify the problem that it intends to address, including, where applicable, the failures of private markets or public institutions that warrant new agency action, as well as to assess the significance of that problem. The problems that the proposed standards set forth in this NOPR address are as follows:

(1) Insufficient information and the high costs of gathering and analyzing relevant information leads some customers to miss opportunities to make cost-effective investments in energy efficiency.

(2) In some cases the benefits of more efficient equipment are not realized due to misaligned incentives between purchasers and users. An example of such a case is when the equipment purchase decision is made by a building contractor or building owner who does not pay the energy costs.

(3) There are external benefits resulting from improved energy efficiency of small air-cooled air conditioners and heat pumps less than 65,000 Btu/h, water-source heat pumps, and oil-fired storage water heaters that are not captured by the users of such equipment. These benefits include externalities related to public health, environmental protection, and national energy security that are not reflected in energy prices, such as reduced emissions of air pollutants and greenhouse gases that impact human health and global warming. DOE attempts to quantify some of the external benefits through use of social cost of carbon values.

In addition, DOE has determined that the proposed regulatory action is not an “economically significant regulatory action” under section 3(f)(1) of Executive Order 12866. Accordingly, DOE has not prepared a regulatory impact analysis (RIA) for this rule, and the Office of Information and Regulatory Affairs (OIRA) in the Office of Management and Budget (OMB) has not reviewed this rule.

DOE has also reviewed this regulation pursuant to Executive Order 13563, issued on January 18, 2011 (76 FR 3281

(Jan. 21, 2011)). Executive Order 13563 is supplemental to and explicitly reaffirms the principles, structures, and definitions governing regulatory review established in Executive Order 12866. To the extent permitted by law, agencies are required by Executive Order 13563 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 Executive Order 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 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 the preamble, DOE believes that this NOPR is consistent with these principles, including the requirement that, to the extent permitted by law, benefits justify costs and that net benefits are maximized.

*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) 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 Executive Order 13272, “Proper Consideration of Small Entities in Agency Rulemaking,” 67 FR 53461 (August 16, 2002), DOE published procedures and policies 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 Web site (<http://energy.gov/gc/office-general-counsel>).

For manufacturers of small air-cooled air conditioners and heat pumps less than 65,000 Btu/h, water-source heat pumps, and oil-fired storage water heaters, the Small Business Administration (SBA) has set a size threshold, which defines those entities classified as “small businesses” for the purposes of the statute. DOE used the SBA’s small business size standards to determine whether any small entities would be subject to the requirements of the rule. 65 FR 30836, 30848 (May 15, 2000), as amended at 65 FR 53533, 53544 (Sept. 5, 2000) and 77 FR 49991, 50000 (August 20, 2012), as codified at 13 CFR part 121. The size standards are listed by North American Industry Classification System (NAICS) code and industry description and are available at [http://www.sba.gov/sites/default/files/Size\\_Standards\\_Table.pdf](http://www.sba.gov/sites/default/files/Size_Standards_Table.pdf). The ASHRAE equipment covered by this rule are classified under NAICS 333318, “Other Commercial and Service Industry Machinery Manufacturing” (oil-fired water heaters) and NAICS 333415, “Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing” (all other equipment

addressed by the document). For an entity to be considered as a small business, the SBA sets a threshold of 1,000 employees or fewer for the first category including commercial water heaters and 750 employees or fewer for the second category.

DOE examined each of the manufacturers it found during its market assessment and used publicly-available information to determine if any manufacturers identified qualify as a small business under the SBA guidelines discussed previously. (For a list of all manufacturers of ASHRAE equipment covered by this rule, see chapter 2 of the NOPR TSD.) DOE's research involved individual company Web sites and marketing research tools (e.g., Hoovers reports<sup>58</sup>) to create a list of companies that manufacture the types of ASHRAE equipment affected by this rule. DOE screened out companies that do not have domestic manufacturing operations for ASHRAE equipment (*i.e.*, manufacturers that produce all of their ASHRAE equipment internationally). DOE also did not consider manufacturers that are subsidiaries of parent companies that exceed the applicable 1000-employee or 750-employee threshold set by the SBA to be small businesses. DOE identified 16 companies that qualify as small manufacturers: 5 central air conditioner manufacturers (of the 23 total identified), 7 water-source heat pump manufacturers (of the 18 total identified), and 7 oil-fired storage water heater manufacturers (of the 10 total identified). Please note that there are 3 small manufacturers that produce equipment in more than one of these categories.

Based on reviews of product listing data in the AHRI Directory for commercial equipment, DOE estimates that small manufacturers account for less than 1 percent of the market for covered three-phase central air conditioner equipment and less than 5 percent of the market for covered water-source heat pump equipment. In the oil-fired storage water heat market, DOE understands that one of the small manufacturers is a significant player in the market. That manufacturer accounts for 34 percent of product listings. DOE believes that the remaining oil-fired storage water heater manufacturers account for less than 5 percent of the market.

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

2003. 68 FR 7990. As part of this rulemaking, DOE examined the potential impacts of amended standard levels on manufacturers, as well as the potential implications of the proposed revisions to the commercial warm air furnace test procedures on compliance burdens.

DOE examined the impact of raising the standards to the proposed levels by examining the distribution of efficiencies of commercially-available models in the AHRI Directory. For water-source heat pumps and oil-fired storage water heaters, DOE found that all manufacturers in the directory, including the small manufacturers, already offer equipment at and above the efficiency levels being proposed. While these small manufacturers would have to discontinue a fraction of their models in order to comply with the standards proposed in this rulemaking, DOE does not believe that there would be a significant burden placed on industry, as the market would shift to the new baseline levels when compliance with the new standards is required.

For small commercial air-cooled air conditioners and heat pumps, DOE found one small manufacturer of single-package units in the directory with no models that could meet the proposed ASHRAE levels.

To estimate the impacts of the proposed standard, DOE researched prior energy conservation standard analyses of the covered equipment, as well as any analyses of comparable single-phase products. The 2011 direct final rule for residential furnaces, central air conditioners, and heat pumps included analysis for a 14 SEER efficiency level for split-system as well as single-package air conditioners and heat pumps. 76 FR 37408 (June 27, 2011). The 2011 analysis indicated that manufacturers would need to include additional heat exchanger surface area and to include modulating components to reach the 14 SEER level from a 13 SEER baseline. The 2011 analyses further concluded that these improvements could be made without significant investments in equipment and production assets. The proposed levels for oil-fired storage water heaters or water-source heat pumps have not been analyzed as a part of any prior energy conservation standard rulemakings.

However, DOE understands that the ASHRAE standards were developed through an industry consensus process, which included consideration of manufacturer input, including the impacts to small manufacturers, when increasing the efficiency of equipment.

Because EPCA requires DOE to adopt the ASHRAE levels or to propose higher standards, DOE is limited in terms of the steps it can take to mitigate impacts to small businesses, but DOE reasons that such mitigation has already occurred since small manufacturers had input into the development of the industry consensus standard that DOE is statutorily required to adopt. DOE requests public comment on the number of small manufacturers producing covered three-phase central air conditioners, water-source heat pumps, and oil-fired storage water-heating equipment. Additionally, DOE requests data on the market shares of small manufactures covered in this rulemaking and the potential impacts of this rule on those manufacturers.

As for the specific changes being proposed for the commercial warm air furnace test procedure, the test procedures (ANSI Z21.47-2012 and ASHRAE 103-2007) that DOE is proposing to incorporate by reference do not include any updates to the methodology in those sections utilized in the DOE test procedure. Thus, DOE has tentatively concluded that this test procedure rulemaking would keep the DOE test procedure current with the latest version of the applicable industry testing standards, but it will not change the methodology used to generate ratings of commercial warm air furnaces. Consequently, the proposed test procedure amendments would not be expected to have a substantive impact on manufacturers, either large or small.

For the reasons stated previously, DOE did not prepare an initial regulatory flexibility analysis for the proposed rule. DOE will transmit its certification and a supporting statement of factual basis to the Chief Counsel for Advocacy of the SBA for review pursuant to 5 U.S.C. 605(b).

#### *C. Review Under the Paperwork Reduction Act of 1995*

Manufacturers of the ASHRAE equipment subject to this NOPR must certify to DOE that their equipment complies with any applicable energy conservation standards. In certifying compliance, manufacturers must test their equipment according to the applicable DOE test procedures for the relevant ASHRAE equipment, including any amendments adopted for those test procedures on the date that compliance is required. DOE has established regulations for the certification and recordkeeping requirements for all covered consumer products and commercial equipment, including the ASHRAE equipment in this NOPR. 76

<sup>58</sup> For more information see: <http://www.hoovers.com/>.

FR 12422 (March 7, 2011). The collection-of-information requirement for the certification and recordkeeping is subject to review and approval by OMB under the Paperwork Reduction Act (PRA). This requirement has been approved by OMB under OMB control number 1910–1400. Public reporting burden for the certification is estimated to average 20 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

Notwithstanding any other provision of the law, no person is required to respond to, nor shall any person be subject to a penalty for failure to comply with, a collection of information subject to the requirements of the PRA, unless that collection of information displays a currently valid OMB Control Number.

#### *D. Review Under the National Environmental Policy Act of 1969*

Pursuant to the National Environmental Policy Act (NEPA) of 1969, DOE has determined that the proposed rule fits within the category of actions included in Categorical Exclusion (CX) B5.1 and otherwise meets the requirements for application of a CX. See 10 CFR part 1021, App. B, B5.1(b); 1021.410(b) and Appendix B, B(1)–(5). The proposed rule fits within the category of actions because it is a rulemaking that establishes energy conservation standards for consumer products or industrial equipment, and for which none of the exceptions identified in CX B5.1(b) apply. Therefore, DOE has made a CX determination for this rulemaking, and DOE does not need to prepare an Environmental Assessment or Environmental Impact Statement for this proposed rule. DOE's CX determination for this proposed rule is available at <http://cxnepa.energy.gov/>.

#### *E. Review Under Executive Order 13132*

Executive Order 13132, "Federalism," imposes certain requirements on Federal agencies formulating and implementing policies or regulations that preempt State law or that have Federalism implications. 64 FR 43255 (August 10, 1999). 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 rule 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 equipment types that are the subject of this proposed rule. 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 Executive Order 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 Executive Order 12988, "Civil Justice Reform," 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; and (3) provide a clear legal standard for affected conduct rather than a general standard; and (4) promote simplification and burden reduction. 61 FR 4729 (Feb. 7, 1996). Regarding the review required by section 3(a), section 3(b) of Executive Order 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 rule meets the relevant standards of Executive Order 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. Public Law 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 <http://energy.gov/gc/office-general-counsel>.

This proposed rule contains neither an intergovernmental mandate nor a mandate that may result in the expenditure by State, local, and Tribal governments, in the aggregate, or by the private sector, of \$100 million or more in any year. Accordingly, no assessment or analysis is required under the UMRA.

#### *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 rule 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 Executive Order 12630, "Governmental Actions and Interference with Constitutionally Protected Property Rights," 53 FR 8859 (March 18, 1988),

DOE has determined that this proposed rule 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). DOE has reviewed this NOPR 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*

Executive Order 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 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 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.

DOE has tentatively concluded that this regulatory action, which sets forth proposed energy conservation standards for certain types of ASHRAE equipment, is not a significant energy action because the proposed standards are not a significant regulatory action under Executive Order 12866 and are not likely to 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. Accordingly, DOE has not prepared a Statement of Energy Effects on the proposed rule.

*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 2667.

In response to OMB's Bulletin, DOE conducted formal in-progress peer reviews of the energy conservation standards development process and analyses and has prepared a Peer Review Report pertaining to the energy conservation standards rulemaking analyses. 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. The "Energy Conservation Standards Rulemaking Peer Review Report" dated February 2007 has been disseminated and is available at the following Web site: <http://energy.gov/eere/buildings/peer-review>.

**X. Public Participation**

*A. Attendance at the Public Meeting*

The time, date, and location of the public meeting are listed in the **DATES** and **ADDRESSES** sections at the beginning of this document. If you plan to attend the public meeting, please notify Ms. Brenda Edwards at (202) 586-2945 or [Brenda.Edwards@ee.doe.gov](mailto:Brenda.Edwards@ee.doe.gov). As explained in the **ADDRESSES** section, foreign nationals visiting DOE Headquarters are subject to advance security screening procedures. Any foreign national wishing to participate in the meeting should advise DOE of this fact as soon as possible by contacting Ms. Brenda Edwards to initiate the necessary procedures.

In addition, you can attend the public meeting via webinar. Webinar registration information, participant instructions, and information about the capabilities available to webinar participants will be published on DOE's Web site at: <https://www1.gotomeeting.com/register/584170792>. Participants are responsible for ensuring their systems are compatible with the webinar software.

*B. Procedure for Submitting Prepared General Statements for Distribution*

Any person who has plans to present a prepared general statement may request that copies of his or her statement be made available at the public meeting. Such persons may submit requests, along with an advance electronic copy of their statement in PDF (preferred), Microsoft Word or Excel, WordPerfect, or text (ASCII) file format, to the appropriate address shown in the **ADDRESSES** section at the beginning of this document. The request and advance copy of statements must be received at least one week before the public meeting and may be emailed, hand-delivered, or sent by mail. DOE prefers to receive requests and advance copies via email. Please include a telephone number to enable DOE staff to make follow-up contact, if needed.

*C. Conduct of the Public Meeting*

DOE will designate a DOE official to preside at the public meeting and may also use a professional facilitator to aid discussion. The meeting will not be a judicial or evidentiary-type public hearing, but DOE will conduct it in accordance with section 336 of EPCA (42 U.S.C. 6306). A court reporter will be present to record the proceedings and prepare a transcript. DOE reserves the right to schedule the order of presentations and to establish the procedures governing the conduct of the public meeting. There shall not be discussion of proprietary information, costs or prices, market share, or other commercial matters regulated by U.S. anti-trust laws. After the public meeting, interested parties may submit further comments on the proceedings, as well as on any aspect of the rulemaking, until the end of the comment period.

The public meeting will be conducted in an informal, conference style. DOE will present summaries of comments received before the public meeting, allow time for prepared general statements by participants, and encourage all interested parties to share their views on issues affecting this rulemaking. Each participant will be allowed to make a general statement (within time limits determined by DOE),

before the discussion of specific topics. DOE will allow, as time permits, other participants to comment briefly on any general statements.

At the end of all prepared statements on a topic, DOE will permit participants to clarify their statements briefly and comment on statements made by others. Participants should be prepared to answer questions by DOE and by other participants concerning these issues. DOE representatives may also ask questions of participants concerning other matters relevant to this rulemaking. The official conducting the public meeting will accept additional comments or questions from those attending, as time permits. The presiding official will announce any further procedural rules or modification of the above procedures that may be needed for the proper conduct of the public meeting.

A transcript of the public meeting will be included in the docket, which can be viewed as described in the *Docket* section at the beginning of this document and will be accessible on the DOE Web site. In addition, any person may buy a copy of the transcript from the transcribing reporter.

#### D. Submission of Comments

DOE will accept comments, data, and information regarding this proposed rule before or after the public meeting, but no later than the date provided in the **DATES** section at the beginning of this proposed rule. 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* Web page 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 Web site will waive any CBI claims for the information submitted. For information on submitting CBI, see the Confidential Business Information section below.

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 mail.* Comments and documents submitted via email, hand delivery, or 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. 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 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, postal mail, or hand delivery/courier 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. Submit these documents via email or on a CD, if feasible. DOE will make its own determination about the confidential status of the information and treat it according to its determination.

Factors of interest to DOE when evaluating requests to treat submitted information as confidential include: (1) A description of the items; (2) whether and why such items are customarily treated as confidential within the industry; (3) whether the information is generally known by or available from other sources; (4) whether the information has previously been made available to others without obligation concerning its confidentiality; (5) an explanation of the competitive injury to the submitting person which would result from public disclosure; (6) when such information might lose its confidential character due to the passage of time; and (7) why disclosure of the information would be contrary to the public interest.

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).

#### E. Issues on Which DOE Seeks Comment

Although DOE welcomes comments on any aspect of this proposal, DOE is particularly interested in receiving comments and views of interested parties concerning the following issues:

1. DOE's proposed definition of "water-source heat pump."
2. Any relevant issues that would affect the test procedures for commercial warm-air furnaces. Interested parties are welcome to comment on any aspect of these test procedures as part of this comprehensive 7-year-review.

3. Is there a rebound effect in small air-cooled three-phase air conditioner and heat pump equipment less than 65,000 Btu/h or water-source heat pump energy use as a result of improvements in the efficiency of such units?

4. Would shipments of small air-cooled three-phase air conditioners and heat pump equipment less than 65,000 Btu/h or water-source heat pump equipment change at more-stringent standard levels?

5. The use of the projected base-case efficiency trend of an increase of 1 SEER or EER every 35 years for small air-cooled three-phase air conditioner and heat pump equipment less than 65,000 Btu/h and water-source heat pump equipment.

6. Should the mark-ups analysis for water-source heat pumps include national accounts?

7. DOE's methodology for developing heating UECs for water-source heat pumps. DOE also seeks relevant data on this issue.

8. The appropriate building types for the water-source heat pump energy use analysis, which currently include office, education, lodging, multi-family, and healthcare.

9. How maintenance costs for water-source heat pumps might be expected to differ from that for air-source heat pumps.

10. How repair costs for water-source heat pumps might be expected to differ from that for air-source heat pumps.

11. What is the appropriate retirement function for water-source heat pumps?

12. The proposed standard levels for water-source heat pumps, as well as the other efficiency levels considered.

## XI. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of this notice of proposed rulemaking.

### List of Subjects in 10 CFR Part 431

Administrative practice and procedure, Confidential business information, Energy conservation, Incorporation by reference, Reporting and recordkeeping requirements.

Issued in Washington, DC, on December 23, 2014.

**Kathleen B. Hogan,**

*Deputy Assistant Secretary for Energy Efficiency, Energy Efficiency and Renewable Energy.*

For the reasons set forth in the preamble, DOE proposes to amend part 431 of Chapter II, Subchapter D, of Title 10 of the Code of Federal Regulations as set forth below:

## PART 431—ENERGY EFFICIENCY PROGRAM FOR CERTAIN COMMERCIAL AND INDUSTRIAL EQUIPMENT

■ 1. The authority citation for part 431 continues to read as follows:

**Authority:** 42 U.S.C. 6291–6317.

■ 2. Section 431.75 is amended by revising paragraphs (b) and (c) to read as follows:

### § 431.75 Materials incorporated by reference.

\* \* \* \* \*

(b) *ANSI*. American National Standards Institute, 25 W. 43rd Street, 4th Floor, New York, NY 10036. (212) 642–4900 or go to <http://www.ansi.org>.

(1) ANSI Z21.47–2012, (“ANSI Z21.47–2012”), “*Gas-Fired Central Furnaces*,” ANSI approved on March 27, 2012, IBR approved for § 431.76.

(2) [Reserved]

(c) *ASHRAE*. American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc., 1791 Tullie Circle, NE., Atlanta, Georgia 30329, (404) 636–8400, or go to: <http://www.ashrae.org>.

(1) ASHRAE Standard 103–2007, sections 7.2.2.4, 7.8, 9.2, and 11.3.7, “Method of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers,” ANSI approved on March 25, 2008, IBR approved for § 431.76.

(2) [Reserved]

\* \* \* \* \*

■ 3. Section 431.76 is revised to read as follows:

### § 431.76 Uniform test method for the measurement of energy efficiency of commercial warm air furnaces.

(a) *Scope*. This section covers the test requirements used to measure the energy efficiency of commercial warm air furnaces with a rated maximum input of 225,000 Btu per hour or more. On and after [DATE 360 DAYS AFTER PUBLICATION OF THE FINAL RULE IN THE **Federal Register**], any representations made with respect to the energy use or efficiency of commercial warm air furnaces must be made in accordance with the results of testing pursuant to this section. At that time, you must use the relevant procedures in ANSI Z21.47–2012 or UL 727–2006 (incorporated by reference, see § 431.75). On and after [DATE 30 DAYS AFTER PUBLICATION OF THE FINAL RULE IN THE **Federal Register**] and prior to [DATE 360 DAYS AFTER PUBLICATION OF THE FINAL RULE IN THE **Federal Register**], manufacturers must test commercial warm air furnaces in accordance with this section or the section as it appeared at 10 CFR part 430, subpart B in the 10 CFR parts 200 to 499 edition revised January 1, 2014. DOE notes that, because testing under this section is required as of [DATE 360 DAYS AFTER PUBLICATION OF THE FINAL RULE IN THE **Federal Register**],

manufacturers may wish to begin using this amended test procedure immediately. Any representations made with respect to the energy use or efficiency of such commercial warm air furnaces must be made in accordance with whichever version is selected.

(b) *Testing*. Where this section prescribes use of ANSI Z21.47–2012 or UL Standard 727–2006 (incorporated by reference, see § 431.75), perform only the procedures pertinent to the measurement of the steady-state efficiency, as specified in paragraph (c) of this section.

(c) *Test set-up*—(1) *Test set-up for gas-fired commercial warm air furnaces*. The test set-up, including flue requirement, instrumentation, test conditions, and measurements for determining thermal efficiency is as specified in sections 1.1 (Scope), 2.1 (General), 2.2 (Basic Test Arrangements), 2.3 (Test Ducts and Plenums), 2.4 (Test Gases), 2.5 (Test Pressures and Burner Adjustments), 2.6 (Static Pressure and Air Flow Adjustments), 2.39 (Thermal Efficiency), and 4.2.1 (Basic Test Arrangements for Direct Vent Central Furnaces) of ANSI Z21.47–2012 (incorporated by reference, see § 431.75). The thermal efficiency test must be conducted only at the normal inlet test pressure, as specified in section 2.5.1 of ANSI Z21.47–2012, and at the maximum hourly Btu input rating specified by the manufacturer for the product being tested.

(2) *Test setup for oil-fired commercial warm air furnaces*. The test setup, including flue requirement, instrumentation, test conditions, and measurement for measuring thermal efficiency is as specified in sections 1 (Scope), 2 (Units of Measurement), 3 (Glossary), 37 (General), 38 and 39 (Test Installation), 40 (Instrumentation, except 40.4 and 40.6.2 through 40.6.7, which are not required for the thermal efficiency test), 41 (Initial Test Conditions), 42 (Combustion Test—Burner and Furnace), 43.2 (Operation Tests), 44 (Limit Control Cutout Test), 45 (Continuity of Operation Test), and 46 (Air Flow, Downflow or Horizontal Furnace Test), of UL 727–2006 (incorporated by reference, see § 431.75). You must conduct a fuel oil analysis for heating value, hydrogen content, carbon content, pounds per gallon, and American Petroleum Institute (API) gravity as specified in section 8.2.2 of HI BTS–2000 (incorporated by reference, see § 431.75). The steady-state combustion conditions, specified in Section 42.1 of UL 727–2006, are attained when variations of not more than 5 °F in the measured flue gas temperature occur for

three consecutive readings taken 15 minutes apart.

(d) *Additional test measurements*—(1) *Measurement of flue CO<sub>2</sub> (carbon dioxide) for oil-fired commercial warm air furnaces.* In addition to the flue temperature measurement specified in section 40.6.8 of UL 727–2006 (incorporated by reference, see § 431.75), you must locate one or two sampling tubes within six inches downstream from the flue temperature probe (as indicated on Figure 40.3 of UL 727–2006). If you use an open end tube, it must project into the flue one-third of the chimney connector diameter. If you use other methods of sampling CO<sub>2</sub>, you must place the sampling tube so as to obtain an average sample. There must be no air leak between the temperature probe and the sampling tube location. You must collect the flue gas sample at the same time the flue gas temperature is recorded. The CO<sub>2</sub> concentration of the flue gas must be as specified by the manufacturer for the product being tested, with a tolerance of ±0.1 percent. You must determine the flue CO<sub>2</sub> using an instrument with a reading error no greater than ±0.1 percent.

(2) *Procedure for the measurement of condensate for a gas-fired condensing commercial warm air furnace.* The test procedure for the measurement of the condensate from the flue gas under steady-state operation must be conducted as specified in sections 7.2.2.4, 7.8, and 9.2 of ASHRAE 103–2007 (incorporated by reference, see § 431.75) under the maximum rated input conditions. You must conduct this condensate measurement for an additional 30 minutes of steady-state operation after completion of the steady-state thermal efficiency test specified in paragraph (c) of this section.

(e) *Calculation of thermal efficiency*—(1) *Gas-fired commercial warm air furnaces.* You must use the calculation

procedure specified in section 2.39, Thermal Efficiency, of ANSI Standard Z21.47–2012 (incorporated by reference, see § 431.75).

(2) *Oil-fired commercial warm air furnaces.* You must calculate the percent flue loss (in percent of heat input rate) by following the procedure specified in sections 11.1.4, 11.1.5, and 11.1.6.2 of the HI BTS–2000 (incorporated by reference, see § 431.75). The thermal efficiency must be calculated as:

$$\text{Thermal Efficiency (percent)} = 100 \text{ percent} - \text{flue loss (in percent)}.$$

(f) *Procedure for the calculation of the additional heat gain and heat loss, and adjustment to the thermal efficiency, for a condensing commercial warm air furnace.* (1) You must calculate the latent heat gain from the condensation of the water vapor in the flue gas, and calculate heat loss due to the flue condensate down the drain, as specified in sections 11.3.7.1 and 11.3.7.2 of ASHRAE Standard 103–2007 (incorporated by reference, see § 431.75), with the exception that in the equation for the heat loss due to hot condensate flowing down the drain in section 11.3.7.2, the assumed indoor temperature of 70 °F and the temperature term T<sub>OA</sub> must be replaced by the measured room temperature as specified in section 2.2.8 of ANSI Z21.47–2012 (incorporated by reference, see § 431.75).

(2) *Adjustment to the thermal efficiency for condensing furnaces.* You must adjust the thermal efficiency as calculated in paragraph (e)(1) of this section by adding the latent gain, expressed in percent, from the condensation of the water vapor in the flue gas, and subtracting the heat loss (due to the flue condensate down the drain), also expressed in percent, both as calculated in paragraph (f)(1) of this

section, to obtain the thermal efficiency of a condensing furnace.

■ 4. Section 431.92 is amended by adding in alphabetical order a definition for “Water-source heat pump” to read as follows:

**§ 431.92 Definitions concerning commercial air conditioners and heat pumps.**

\* \* \* \* \*

*Water-source heat pump* means a single-phase or three-phase reverse-cycle heat pump that uses a circulating water loop as the heat source for heating and as the heat sink for cooling. The main components are a compressor, refrigerant-to-water heat exchanger, refrigerant-to-air heat exchanger, refrigerant expansion devices, refrigerant reversing valve, and indoor fan. Such equipment includes, but is not limited to, water-to-air water-loop heat pumps.

■ 5. Section 431.97 is amended by:

- a. Revising paragraph (b);
- b. Redesignating Tables 4 through 8 as Tables 5 through 9 respectively, in paragraphs (c), (d), (e) and (f); and
- c. Revising paragraph (c).

The revisions read as follows:

**§ 431.97 Energy efficiency standards and their compliance dates.**

\* \* \* \* \*

(b) Each commercial air conditioner or heat pump (not including single package vertical air conditioners and single package vertical heat pumps, packaged terminal air conditioners and packaged terminal heat pumps, computer room air conditioners, and variable refrigerant flow systems) manufactured on or after the compliance date listed in the corresponding table must meet the applicable minimum energy efficiency standard level(s) set forth in Tables 1, 2, 3, and 4 of this section.

TABLE 1 TO § 431.97—MINIMUM COOLING EFFICIENCY STANDARDS FOR AIR-CONDITIONING AND HEATING EQUIPMENT

[Not including single package vertical air conditioners and single package vertical heat pumps, packaged terminal air conditioners and packaged terminal heat pumps, computer room air conditioners, and variable refrigerant flow multi-split air conditioners and heat pumps]

Equipment category	Cooling capacity	Sub-category	Heating type	Efficiency level	Compliance date: equipment manufactured on and after . . .
Small Commercial Packaged Air-Conditioning and Heating Equipment (Air-Cooled, 3-Phase, Split-System).	<65,000 Btu/h .....	AC .....	All .....	SEER = 13 .....	June 16, 2008.
		HP .....	All .....	SEER = 13 .....	June 16, 2008. <sup>1</sup>
Small Commercial Packaged Air-Conditioning and Heating Equipment (Air-Cooled, 3-Phase, Single-Package).	<65,000 Btu/h .....	AC .....	All .....	SEER = 13 .....	June 16, 2008. <sup>1</sup>
		HP .....	All .....	SEER = 13 .....	June 16, 2008. <sup>1</sup>



TABLE 1 TO § 431.97—MINIMUM COOLING EFFICIENCY STANDARDS FOR AIR-CONDITIONING AND HEATING EQUIPMENT—  
Continued

[Not including single package vertical air conditioners and single package vertical heat pumps, packaged terminal air conditioners and packaged terminal heat pumps, computer room air conditioners, and variable refrigerant flow multi-split air conditioners and heat pumps]

Equipment category	Cooling capacity	Sub-category	Heating type	Efficiency level	Compliance date: equipment manufactured on and after . . .
Small Commercial Packaged Air-Conditioning and Heating Equipment (Air-Cooled).	≥65,000 Btu/h and <135,000 Btu/h.	AC .....	No Heating or Electric Resistance Heating.	EER = 11.2 .....	January 1, 2010.
		HP .....	All Other Types of Heating	EER = 11.0 .....	January 1, 2010.
Large Commercial Packaged Air-Conditioning and Heating Equipment (Air-Cooled).	≥135,000 Btu/h and <240,000 Btu/h.	AC .....	No Heating or Electric Resistance Heating.	EER = 10.8 .....	January 1, 2010.
		HP .....	All Other Types of Heating	EER = 11.0 .....	January 1, 2010.
Very Large Commercial Packaged Air-Conditioning and Heating Equipment (Air-Cooled).	≥240,000 Btu/h and <760,000 Btu/h.	AC .....	No Heating or Electric Resistance Heating.	EER = 10.8 .....	January 1, 2010.
		HP .....	All Other Types of Heating	EER = 10.6 .....	January 1, 2010.
Small Commercial Package Air-Conditioning and Heating Equipment (Water-Cooled).	<65,000 Btu/h ..... ≥65,000 Btu/h and <135,000 Btu/h.	AC .....	All .....	EER = 10.4 .....	January 1, 2010.
		AC .....	No Heating or Electric Resistance Heating.	EER = 10.0 .....	January 1, 2010.
Large Commercial Package Air-Conditioning and Heating Equipment (Water-Cooled).	≥135,000 and <240,000 Btu/h.	AC .....	All Other Types of Heating	EER = 9.8 .....	January 1, 2010.
		AC .....	No Heating or Electric Resistance Heating.	EER = 9.5 .....	January 1, 2010.
Very Large Commercial Package Air-Conditioning and Heating Equipment (Water-Cooled).	≥240,000 and <760,000 Btu/h.	AC .....	All Other Types of Heating	EER = 9.3 .....	January 1, 2010.
		AC .....	No Heating or Electric Resistance Heating.	EER = 12.1 .....	October 29, 2003.
Small Commercial Package Air-Conditioning and Heating Equipment (Evaporatively-Cooled).	≥65,000 and <135,000 Btu/h.	AC .....	All .....	EER = 12.1 .....	June 1, 2013.
		AC .....	No Heating or Electric Resistance Heating.	EER = 12.1 .....	June 1, 2013.
Large Commercial Package Air-Conditioning and Heating Equipment (Evaporatively-Cooled).	≥135,000 and <240,000 Btu/h.	AC .....	All Other Types of Heating	EER = 11.9 .....	June 1, 2013.
		AC .....	No Heating or Electric Resistance Heating.	EER = 12.5 .....	June 1, 2014.
Very Large Commercial Package Air-Conditioning and Heating Equipment (Evaporatively-Cooled).	≥240,000 and <760,000 Btu/h.	AC .....	All Other Types of Heating	EER = 12.3 .....	June 1, 2014.
		AC .....	No Heating or Electric Resistance Heating.	EER = 12.4 .....	June 1, 2014.
Small Commercial Packaged Air-Conditioning and Heating Equipment (Water-Source: Water-to-Air, Water-Loop).	<17,000 Btu/h ..... ≥17,000 Btu/h and <65,000 Btu/h.	HP .....	All .....	EER = 12.2 .....	June 1, 2014.
		HP .....	All .....	EER = 12.2 .....	June 1, 2014.
Small Commercial Packaged Air-Conditioning and Heating Equipment (Water-Source: Water-to-Air, Water-Loop).	≥65,000 Btu/h and <135,000 Btu/h.	HP .....	All .....	EER = 12.1 .....	October 29, 2003. <sup>2</sup>
		HP .....	All .....	EER = 12.0 .....	October 29, 2003. <sup>2</sup>
Small Commercial Packaged Air-Conditioning and Heating Equipment (Water-Source: Water-to-Air, Water-Loop).	≥65,000 Btu/h and <135,000 Btu/h.	HP .....	All .....	EER = 12.0 .....	October 29, 2003. <sup>2</sup>
		HP .....	All .....	EER = 12.0 .....	October 29, 2003. <sup>2</sup>

<sup>1</sup> And manufactured before January 1, 2017. See Table 3 of this section for updated efficiency standards.

<sup>2</sup> And manufactured before October 9, 2015. See Table 3 of this section for updated efficiency standards.

TABLE 2 TO § 431.97—MINIMUM HEATING EFFICIENCY STANDARDS FOR AIR-CONDITIONING AND HEATING EQUIPMENT  
[Heat Pumps]

Equipment category	Cooling capacity	Efficiency level	Compliance date: equipment manufactured on and after . . .
Small Commercial Packaged Air-Conditioning and Heating Equipment (Air-Cooled, 3-Phase, Split-System).	<65,000 Btu/h .....	HSPF = 7.7 .....	June 16, 2008. <sup>1</sup>
Small Commercial Packaged Air-Conditioning and Heating Equipment (Air-Cooled, 3-Phase, Single-Package).	<65,000 Btu/h .....	HSPF = 7.7 .....	June 16, 2008. <sup>1</sup>
Small Commercial Packaged Air-Conditioning and Heating Equipment (Air-Cooled).	≥65,000 Btu/h and <135,000 Btu/h.	COP = 3.3 .....	January 1, 2010.



TABLE 2 TO § 431.97—MINIMUM HEATING EFFICIENCY STANDARDS FOR AIR-CONDITIONING AND HEATING EQUIPMENT—  
Continued  
[Heat Pumps]

Equipment category	Cooling capacity	Efficiency level	Compliance date: equipment manufactured on and after . . .
Large Commercial Packaged Air-Conditioning and Heating Equipment (Air-Cooled).	≥135,000 Btu/h and <240,000 Btu/h.	COP = 3.2 .....	January 1, 2010.
Very Large Commercial Packaged Air-Conditioning and Heating Equipment (Air-Cooled).	≥240,000 Btu/h and <760,000 Btu/h.	COP = 3.2 .....	January 1, 2010.
Small Commercial Packaged Air-Conditioning and Heating Equipment (Water-Source: Water-to-Air, Water-Loop).	<135,000 Btu/h .....	COP = 4.2 .....	October 29, 2003. <sup>2</sup>

<sup>1</sup> And manufactured before January 1, 2017. See Table 3 of this section for updated efficiency standards.  
<sup>2</sup> And manufactured before October 9, 2015. See Table 3 of this section for updated efficiency standards.

TABLE 3 TO § 431.97—UPDATES TO THE MINIMUM COOLING EFFICIENCY STANDARDS FOR CERTAIN AIR-CONDITIONING AND HEATING EQUIPMENT

Equipment category	Cooling capacity	Sub-category	Heating type	Efficiency level	Compliance date: equipment manufactured on and after . . .
Small Commercial Packaged Air-Conditioning and Heating Equipment (Air-Cooled, 3-Phase, Split-System).	<65,000 Btu/h .....	AC .....	All .....	SEER = 13.0 .....	June 16, 2008.
Small Commercial Packaged Air-Conditioning and Heating Equipment (Air-Cooled, 3-Phase, Single-Package).	<65,000 Btu/h .....	HP .....	All .....	SEER = 14.0 .....	January 1, 2017.
		AC .....	All .....	SEER = 14.0 .....	January 1, 2017.
Small Commercial Packaged Air-Conditioning and Heating Equipment (Water-Source: Water-to-Air, Water-Loop).	<17,000 Btu/h .....	HP .....	All .....	SEER = 14.0 .....	January 1, 2017.
		HP .....	All .....	EER = 12.2 .....	October 9, 2015.
	≥17,000 Btu/h and <65,000 Btu/h. ≥65,000 Btu/h and <135,000 Btu/h.	HP .....	All .....	EER = 13.0 .....	October 9, 2015.
		HP .....	All .....	EER = 13.0 .....	October 9, 2015.

TABLE 4 TO § 431.97—UPDATES TO THE MINIMUM HEATING EFFICIENCY STANDARDS FOR CERTAIN AIR-CONDITIONING AND HEATING EQUIPMENT  
[Heat pumps]

Equipment category	Cooling capacity	Efficiency level	Compliance date: equipment manufactured on and after . . .
Small Commercial Packaged Air-Conditioning and Heating Equipment (Air-Cooled, 3-Phase, Split-System).	<65,000 Btu/h .....	HSPF = 8.2 .....	January 1, 2017.
Small Commercial Packaged Air-Conditioning and Heating Equipment (Air-Cooled, 3-Phase, Single-Package).	<65,000 Btu/h .....	HSPF = 8.0 .....	January 1, 2017.
Small Commercial Packaged Air-Conditioning and Heating Equipment (Water-Source: Water-to-Air, Water-Loop).	<135,000 Btu/h .....	COP = 4.3 .....	October 9, 2015.

(c) Each packaged terminal air conditioner (PTAC) and packaged terminal heat pump (PTHP) manufactured on or after January 1, 1994, and before October 8, 2012 (for standard size PTACs and PTHPs) and before October 7, 2010 (for non-standard

size PTACs and PTHPs) must meet the applicable minimum energy efficiency standard level(s) set forth in Table 5 of this section. Each PTAC and PTHP manufactured on or after October 8, 2012 (for standard size PTACs and PTHPs) and on or after October 7, 2010

(for non-standard size PTACs and PTHPs) must meet the applicable minimum energy efficiency standard level(s) set forth in Table 6 of this section.  
\* \* \* \* \*

■ 6. Section 431.110 is revised to read as follows:

**§ 431.110 Energy conservation standards and their effective dates.**

Each commercial storage water heater, instantaneous water heater, unfired hot

water storage tank and hot water supply boiler <sup>1</sup> must meet the applicable energy conservation standard level(s) as follows:

Equipment category	Size	Energy conservation standard <sup>a</sup>		
		Maximum standby loss <sup>c</sup> (equipment manufactured on and after October 29, 2003) <sup>b</sup>	Minimum thermal efficiency (equipment manufactured on and after October 29, 2003 and before October 9, 2015) <sup>b</sup>	Minimum thermal efficiency (equipment manufactured on and after October 9, 2015) <sup>b</sup>
Electric storage water heaters .....	All .....	$0.30 + 27/V_m$ (%/hr) .....	N/A .....	N/A.
Gas-fired storage water heaters .....	≤155,000 Btu/hr .....	$Q/800 + 110(V_r)^{1/2}$ (Btu/hr) .....	80% .....	80%.
	>155,000 Btu/hr .....	$Q/800 + 110(V_r)^{1/2}$ (Btu/hr) .....	80% .....	80%.
Oil-fired storage water heaters .....	≤155,000 Btu/hr .....	$Q/800 + 110(V_r)^{1/2}$ (Btu/hr) .....	78% .....	80%.
	>155,000 Btu/hr .....	$Q/800 + 110(V_r)^{1/2}$ (Btu/hr) .....	78% .....	80%.
Gas-fired instantaneous water heaters and hot water supply boilers.	<10 gal .....	N/A .....	80% .....	80%.
	≥10 gal .....	$Q/800 + 110(V_r)^{1/2}$ (Btu/hr) .....	80% .....	80%.
Oil-fired instantaneous water heaters and hot water supply boilers.	<10 gal .....	N/A .....	80% .....	80%.
	≥10 gal .....	$Q/800 + 110(V_r)^{1/2}$ (Btu/hr) .....	78% .....	78%.
<b>Equipment category</b>	<b>Size</b>	<b>Minimum thermal insulation</b>		
Unfired hot water storage tank .....	All .....	R-12.5		

<sup>a</sup>  $V_m$  is the measured storage volume, and  $V_r$  is the rated volume, both in gallons. Q is the nameplate input rate in Btu/hr.

<sup>b</sup> For hot water supply boilers with a capacity of less than 10 gallons: (1) The standards are mandatory for products manufactured on and after October 21, 2005, and (2) products manufactured prior to that date, and on or after October 23, 2003, must meet either the standards listed in this table or the applicable standards in subpart E of this part for a “commercial packaged boiler.”

<sup>c</sup> Water heaters and hot water supply boilers having more than 140 gallons of storage capacity need not meet the standby loss requirement if: (1) The tank surface area is thermally insulated to R-12.5 or more; (2) a standing pilot light is not used; and (3) for gas or oil-fired storage water heaters, they have a fire damper or fan assisted combustion.

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<sup>1</sup> Any packaged boiler that provides service water, that meets the definition of “commercial packaged

boiler” in subpart E of this part, but does not meet the definition of “hot water supply boiler” in this

subpart, must meet the requirements that apply to it under subpart E.