DEPARTMENT OF ENERGY

10 CFR Part 430

[EERE–2022–BT–STD–0025]

RIN 1904–AF36

Energy Conservation Program: Energy Conservation Standards for Portable Electric Spas

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

ACTION: Notification of data availability and request for comment.

SUMMARY: In this notice of data availability (''NODA''), the U.S. Department of Energy (''DOE'') is publishing data and certain preliminary analytical results related to DOE's evaluation of potential energy conservation standards for portable electric spas (''PESs''). DOE requests comments, data, and information regarding the data and analysis.

DATES: Written comments and information will be accepted on or before, January 17, 2023.

ADDRESSES: Interested persons are encouraged to submit comments using the Federal eRulemaking Portal at *www.regulations.gov,* under docket number EERE–2022–BT–STD–0025. Follow the instructions for submitting comments. Alternatively, interested persons may submit comments, identified by docket number EERE–2022–BT–STD–0025, by any of the following methods:

Email: PortableElecSpas2022STD0025@ee.doe.gov. Include the docket number EERE–2022–BT–STD–0025 in the subject line of the message.

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

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

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

To inform interested parties and to facilitate this rulemaking process, DOE has prepared preliminary analytical data, which is available on the rulemaking docket at: *www.regulations.gov/docket/EERE-2022-BT-STD-0025.*

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

The docket web page can be found at *www.regulations.gov/docket/EERE-2022-BT-STD-0025.* The docket web page contains instructions on how to access all documents, including public comments in the docket. See section IV.A of this document for information on how to submit comments through *www.regulations.gov.*

FOR FURTHER INFORMATION CONTACT:

Mr. Jeremy Dommu, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Office, EE–2J, 1000 Independence Avenue SW, Washington, DC 20585–0121. Telephone: (202) 586–9870. Email *ApplianceStandardsQuestions@ee.doe.gov.*

Ms. Kristin Koernig, U.S. Department of Energy, Office of the General Counsel, GC–33, 1000 Independence Avenue SW, Washington, DC 20585–0121. Telephone: (202) 586–3593. Email: *Kristin.koernig@hq.doe.gov.*

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

SUPPLEMENTARY INFORMATION:

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V. Approval of the Office of the Secretary

I. Introduction

A. Authority

The Energy Policy and Conservation Act, as amended (''EPCA''),[1] authorizes DOE to regulate the energy efficiency of a number of consumer products and certain industrial equipment. (42 U.S.C. 6291–6317) Title III, Part B [2] of EPCA established the Energy Conservation Program for Consumer Products Other Than Automobiles, which, in addition to identifying particular consumer products and commercial equipment as covered under the statute, permits the Secretary of Energy to classify additional types of consumer products as covered products. (42 U.S.C. 6292(a)(20)) In a notice of final determination of coverage (''NOFD'') published in the **Federal Register** on September 2, 2022 (''September 2022 NOFD''), DOE classified PESs as a covered product pursuant to 42 U.S.C. 6292(b)(1) after determining that classifying PESs as a covered product is necessary or appropriate to carry out the purposes of EPCA and that average annual household energy use for PESs is likely to exceed 100 kilowatt-hours per year. 87 FR 54123.

The relevant purposes of EPCA include:

(1) To conserve energy supplies through energy conservation programs, and, where necessary, the regulation of certain energy uses; and

(2) To provide for improved energy efficiency of motor vehicles, major appliances, and certain other consumer products. (42 U.S.C. 6201(4) and (5))

First, DOE determined that the coverage of PESs is both necessary and appropriate to carry out the purposes of EPCA on the basis of market data, the existence of technology options for improving energy efficiency of PESs, and supporting argument of commenters in response to the notice of proposed determination of coverage. 87 FR 54123, 54125–54126.

DOE then determined that estimated household energy use was likely to exceed 100 kWh/year based on market data and certification data reported to the California Energy Commission's (''CEC'') Modernized Appliance Efficiency Database System (''MAEDbS'').[3] In the September 2022 NOFD, DOE had estimated average energy consumption of 1,699 kWh per year per household, which matched estimates submitted by commenters in response to the notice of proposed determination of coverage. *Id.* at 87 FR 54126–54127.

Having determined that classifying PESs as a covered product was necessary or appropriate to carry out the purposes of EPCA and that average annual household energy use for PESs was likely to exceed 100 kilowatt-hours per year, DOE classified PESs as a covered product. *Id.* at 87 FR 54127.

Additionally, in the September 2022 NOFD, DOE established a definition of the term ''portable electric spa,'' which was ''a factory-built electric spa or hot tub, supplied with equipment for heating and circulating water at the time of sale or sold separately for subsequent attachment.'' *Id.* at 87 FR 54125; *see also* 10 CFR 430.2.

As PESs are now a covered product, EPCA allows DOE to prescribe an energy conservation standard for any type (or class) of covered products of a type specified in 42 U.S.C. 6292(a)(20) if the requirements of 42 U.S.C. 6295(o) and (p) are met and the Secretary determines that—

(A) the average per household energy use within the United States by products of such type (or class) exceeded 150 kilowatt-hours (or its Btu equivalent) for any 12-month period ending before such determination;

(B) the aggregate household energy use within the United States by products of such type (or class) exceeded 4,200,000,000 kilowatt-hours (or its Btu equivalent) for any such 12-month period;

(C) substantial improvement in the energy efficiency of products of such type (or class) is technologically feasible; and

(D) the application of a labeling rule under 42 U.S.C. 6294 to such type (or class) is not likely to be sufficient to induce manufacturers to produce, and consumers and other persons to purchase, covered products of such type (or class) which achieve the maximum energy efficiency which is technologically feasible and economically justified. (42 U.S.C. 6295(l)(1))

EPCA further provides that, not later than 6 years after the issuance of any final rule establishing or amending a standard, DOE must publish either a notification of determination that standards for the product do not need to be amended, or a notice of proposed rulemaking (''NOPR'') including new proposed energy conservation standards (proceeding to a final rule, as appropriate). (42 U.S.C. 6295(m)(1)) Not later than three years after issuance of a final determination not to amend standards, DOE must publish either a notice of determination that standards for the product do not need to be amended, or a NOPR including new proposed energy conservation standards (proceeding to a final rule, as appropriate). (42 U.S.C. 6295(m)(3)(B))

Under EPCA, any new or amended energy conservation standard must be designed to achieve the maximum improvement in energy efficiency that DOE determines is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A)) Furthermore, the new or amended standard must result in a significant conservation of energy. (42 U.S.C. 6295(o)(3)(B))

DOE is publishing this NODA to collect data and information to inform its decision to establish energy conservation standards for PESs consistent with its obligations under EPCA.

B. Rulemaking Process

DOE must follow specific statutory criteria for prescribing new or amended standards for covered products, including PESs. As noted, EPCA requires that any new or amended energy conservation standard prescribed by the Secretary of Energy (''Secretary'') be designed to achieve the maximum improvement in energy efficiency (or water efficiency for certain products specified by EPCA) that is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A)) Furthermore, DOE may not adopt any standard that would not result in the significant conservation of energy. (42 U.S.C. 6295(o)(3))

The significance of energy savings offered by a new or amended energy conservation standard cannot be determined without knowledge of the specific circumstances surrounding a given rulemaking.[4] For example, some covered products and equipment have most of their energy consumption occur during periods of peak energy demand. The impacts of these products on the energy infrastructure can be more pronounced than products or equipment with relatively constant demand. In evaluating the significance of energy savings, DOE considers differences in primary energy and full-fuel cycle

[1] All references to EPCA in this document refer to the statute as amended through the Energy Act of 2020, Public Law 116–260 (Dec. 27, 2020), which reflect the last statutory amendments that impact Parts A and A–1 of EPCA.

[2] For editorial reasons, upon codification in the U.S. Code, Part B was redesignated Part A.

[3] CEC Modernized Appliance Efficiency Database System. Available at *cacertappliances.energy.ca.gov.* (last accessed October 26, 2022).

[4] Procedures, Interpretations, and Policies for Consideration in New or Revised Energy Conservation Standards and Test Procedures for Consumer Products and Commercial/Industrial Equipment, 86 FR 70892, 70901 (Dec. 13, 2021).

(''FFC'') effects for different covered products and equipment when determining whether energy savings are significant. Primary energy and FFC effects include the energy consumed in electricity production (depending on load shape), in distribution and transmission, and in extracting, processing, and transporting primary fuels (*i.e.,* coal, natural gas, petroleum fuels), and thus present a more complete picture of the impacts of energy conservation standards. Accordingly, DOE evaluates the significance of energy savings on a case-by-case basis, taking into account the significance of cumulative FFC national energy savings, the cumulative FFC emissions reductions, and the need to confront the global climate crisis, among other factors.

To determine whether a standard is economically justified, EPCA requires that DOE determine whether the benefits of the standard exceed its burdens by considering, to the greatest extent practicable, the following seven factors:

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

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

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

4. Any lessening of the utility or the performance of the products likely to result from the standard;

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

6. The need for national energy and water conservation; and

7. Other factors the Secretary considers relevant.

(42 U.S.C. 6295(o)(2)(B)(i)(I)–(VII))

DOE fulfills these and other applicable requirements by conducting a series of analyses throughout the rulemaking process. Table I.1 shows the individual analyses that are performed to satisfy each of the requirements within EPCA.

TABLE I.1—EPCA REQUIREMENTS AND CORRESPONDING DOE ANALYSIS

EPCA requirement	Corresponding DOE analysis
Significant Energy Savings	• Shipments Analysis. • National Impact Analysis. • Energy Analysis.
Technological Feasibility	• Market and Technology Assessment. • Screening Analysis. • Engineering Analysis.
Economic Justification:	
Economic impact on manufacturers and consumers	• Manufacturer Impact Analysis. • Life-Cycle Cost and Payback Period Analysis. • Life-Cycle Cost Subgroup Analysis. • Shipments Analysis.
Lifetime operating cost savings compared to increased cost for the product.	• Markups for Product Price Analysis. • Energy Analysis. • Life-Cycle Cost and Payback Period Analysis.
Total projected energy savings	• Shipments Analysis. • National Impact Analysis.
Impact on utility or performance	• Screening Analysis. • Engineering Analysis.
Impact of any lessening of competition	• Manufacturer Impact Analysis.
Need for national energy and water conservation	• Shipments Analysis. • National Impact Analysis.
Other factors the Secretary considers relevant	• Employment Impact Analysis. • Utility Impact Analysis. • Emissions Analysis. • Monetization of Emission Reductions Benefits.[5] • Regulatory Impact Analysis.

Further, EPCA establishes a rebuttable presumption that a standard is economically justified if the Secretary finds that the additional cost to the consumer of purchasing a product complying with an energy conservation standard level will be less than three times the value of the energy savings during the first year that the consumer will receive as a result of the standard, as calculated under the applicable test procedure. (42 U.S.C. 6295(o)(2)(B)(iii))

EPCA 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. 6295(o)(1)) Also, the Secretary may not prescribe an amended or new standard if interested persons have established by a preponderance of the evidence that the standard is likely to result in the unavailability in the United States in any covered product type (or class) of performance characteristics (including reliability), features, sizes, capacities, and volumes that are substantially the same as those

[5] On March 16, 2022, the Fifth Circuit Court of Appeals (No. 22–30087) granted the federal government's emergency motion for stay pending appeal of the February 11, 2022, preliminary injunction issued in *Louisiana* v. *Biden,* No. 21–cv–1074–JDC–KK (W.D. La.). As a result of the Fifth Circuit's order, the preliminary injunction is no longer in effect, pending resolution of the federal government's appeal of that injunction or a further court order. Among other things, the preliminary injunction enjoined the defendants in that case from ''adopting, employing, treating as binding, or relying upon'' the interim estimates of the social cost of greenhouse gases—which were issued by the Interagency Working Group on the Social Cost of Greenhouse Gases on February 26, 2021—to monetize the benefits of reducing greenhouse gas emissions. In the absence of further intervening court orders, DOE will revert to its approach prior to the injunction and present monetized benefits where appropriate and permissible by law.

generally available in the United States. (42 U.S.C. 6295(o)(4))

Additionally, EPCA specifies requirements when promulgating an energy conservation standard for a covered product that has two or more subcategories. DOE must specify a different standard level for a type or class of product that has 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 such feature justifies a higher or lower standard. (42 U.S.C. 6295(q)(1)) In determining whether a performance-related feature justifies a different standard for a group of products, DOE must consider such factors as the utility to the consumer of the feature and other factors DOE deems appropriate. (*Id.*) Any rule prescribing such a standard must include an explanation of the basis on which such higher or lower level was established. (42 U.S.C. 6295(q)(2))

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

Before proposing a standard, DOE typically seeks public input on the analytical framework, models, and tools that DOE intends to use to evaluate standards for the product at issue and the results of preliminary analyses DOE performed for the product. See section IV.B of this document for a list of analysis and data on which DOE seeks comment.

DOE is examining whether to establish energy conservation standards for PESs pursuant to its obligations under EPCA. This notification announces the availability of preliminary analytical results and data.

C. Deviation From Appendix A

In accordance with section 3(a) of 10 CFR part 430, subpart C, appendix A (''appendix A''), DOE notes that it is deviating from the provision in appendix A regarding the pre-NOPR stage for an energy conservation standard rulemaking. Section 6(d)(2) of appendix A specifies that the length of the public comment period for a pre-NOPR will vary depending upon the circumstances of the particular rulemaking, but will not be less than 75 calendar days. For this NODA, DOE is providing a 60-day comment period, which DOE deems appropriate given the publication of three antecedent notices relating to PESs, two of which, themselves, offered opportunity for comment related to PESs and all of which would be understood by interested parties as a signal that DOE would be evaluating potential energy conservation standards. Those three antecedent notices were the proposed determination of portable electric spas as a covered consumer product (87 FR 8745 (Feb. 16, 2022)), the final determination of portable electric spas as a covered consumer product (87 FR 54123 (Sept. 2, 2022)), and the proposed rulemaking for the test procedure for portable electric spas (87 FR 63356 (Oct. 18, 2022)), respectively. Further, a 60-day comment period will allow DOE to review comments received in response to this NODA and use them to inform the analysis of the product considered in evaluating potential energy conservation standards.

II. Background

A. Current Process

DOE has not previously conducted an energy conservation standards rulemaking for PESs. As described in section I.A of this NODA, DOE previously determined that PESs met the criteria for classification as a covered product pursuant to EPCA and classified PESs as a covered product. 87 FR 54123.

Following this determination of coverage, DOE published a NOPR proposing a test procedure for PESs in the **Federal Register** on October 18, 2022. 87 FR 63356. In that NOPR, DOE proposed to incorporate by reference an industry test method published by the Pool and Hot Tub Alliance (''PHTA'')[6] in partnership with the International Code Council (''ICC'') and approved by the American National Standards Institute (''ANSI''), ANSI/APSP/ICC–14 2019, ''American National Standard for Portable Electric Spa Energy Efficiency'' (''APSP–14 2019'') with certain exceptions and additions. 87 FR 63356, 63361–63369. The proposed test method produces a measure of the energy consumption of PESs (*i.e.,* the normalized average standby power) that represents the average power consumed by the spa, normalized to a standard temperature difference between the ambient air and the water in the spa, while the cover is on and the product is operating in its default operation mode. *Id.* at 87 FR 63361.

Comments received to date as part of the coverage determination rulemaking have helped DOE identify and resolve issues related to the NODA.

III. Summary of the Analyses Performed by DOE

For the product covered in this NODA, DOE conducted in-depth technical analyses in the following areas: (1) engineering; (2) markups to determine product price; (3) energy use; (4) life cycle cost (''LCC'') and payback period (''PBP''); and (5) national impacts. The preliminary analytical results that present the methodology and results of each of these analyses that are not included in the body of this notice are available at: *www.regulations.gov/docket/EERE-2022-BT-STD-0025.* Specifically, DOE is making available the following data and analysis:

(1) Approved and Archived Portable Electric Spas exported from the CEC's Meads. Data as of August 8, 2022.

(2) DOE's testing results for a simple inflatable portable electric spa. Testing followed methods specified in APSP–14 2019 and attempted to isolate the effects of various test conditions and design options.

(3) Reference table for DOE's proposed efficiency levels for non-inflatable and inflatable portable electric spas, including particular changes in specifications and the estimated effects on energy consumption and costs thereof.

DOE also conducted, and has included in this NODA, several other analyses that either support the major analyses or are preliminary analyses that will be expanded if DOE determines that a NOPR is warranted to propose new energy conservation standards. These analyses include: (1) the market and technology assessment; (2) the screening analysis, which contributes to the engineering analysis; and (3) the shipments analysis, which contributes to the LCC and PBP analysis and the national impact analysis (''NIA''). In addition to these analyses, DOE has begun preliminary work on the

[6] The PHTA is a result of a 2019 merger between the Association of Pool and Spa Professionals (''APSP'') and the National Swimming Pool Foundation (''NSPF''). The reference to APSP has been retained in the ANSI designation of ANSI/APSP/ICC–14 2019.

manufacturer impact analysis and has identified the methods to be used for the consumer subgroup analysis, the emissions analysis, the employment impact analysis, the regulatory impact analysis, and the utility impact analysis. DOE will expand on these analyses in the NOPR should one be issued.

A. Market and Technology Assessment

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

1. Product Description

DOE referred to PES product literature and to its communications with spa manufacturers to inform its understanding of the technology and the different types of products within the industry. Relevant product literature includes APSP–14 2019, the current industry test procedure and energy conservation standards, materials related to state rulemakings, academic papers, and marketing materials.[7] In particular, DOE also made significant use of the following sources: the final staff report for CEC's 2018 Appliance Efficiency Rulemaking for Spas, ''Analysis of Efficiency Standards and Marking for Spas;'' [8] the Codes and Standards Enhancement (''CASE'') Initiative submission from California investor-owned utilities in support of CEC's 2012 rulemaking for spas, ''Analysis of Standards Proposal for Portable Electric Spas;'' [9] a 2018 graduate thesis from California State University, Sacramento, ''Improving Energy Efficiency of Portable Electric Spas by Improving Its Thermal Conductivity Properties;'' [10] and a 2012 graduate thesis from California Polytechnic State University, San Luis Obispo, ''Measurement and Analysis of the Standby Power of Twenty-Seven Portable Electric Spas.'' [11] PES manufacturers were contacted via the PHTA.

APSP–14 2019 defines a spa as ''a product intended for the immersion of persons in temperature-controlled water circulated in a closed system'' and a portable electric spa as ''a factory-built electric spa or hot tub, supplied with equipment for heating and circulating water at the time of sale or sold separately for subsequent attachment.'' DOE adopted this definition of ''portable electric spa'' without modification in the September 2022 NOFD. 87 FR 54123, 54125.

Integral heating and circulation equipment are features that distinguish PESs from similar products in inflatable or above-ground pools and therapy bathtubs or permanent residential spas, respectively. Beyond these characteristic features, PESs often also include chemical systems for water sanitation as well as features such as additional lighting, audio systems, and internet connectivity for more precise and accessible spa monitoring.

DOE requests comment on the previous description of the target technology and the scope of this product, including whether any modifications or additions are necessary to characterize this product.

2. Potential Product Classes

DOE must specify a different standard level for a type or class of product that has the same function or intended use if DOE determines that products within such group: consume a different kind of energy from that consumed by other covered products within such type (or class); or have a capacity or other performance-related feature which other products within such type (or class) do not have and such feature justifies a higher or lower standard. (42 U.S.C. 6295(q)(1)) In determining whether a performance-related feature justifies a different standard for a group of products, DOE must consider such factors as the utility to the consumer of the feature and other factors DOE deems appropriate. (*Id.*) Any rule prescribing such a standard must include an explanation of the basis on which such higher or lower level was established. (42 U.S.C. 6295(q)(2))

DOE observed several distinguishable categories of products in the PES market that provide consumers with unique utility that could necessitate a different standard level for energy consumption.

a. Inflatable Spas

Inflatable spas are characterized by collapsible and storable bodies. They are usually made of a flexible polyvinyl chloride (''PVC'') plastic tub, which is filled with air during use and which connects to a control unit external to the tub but still integral to the product as distributed in commerce. Inflatable spas are often used seasonally and, during seasons when inflatable spas are not in use, they are often deflated and put in storage. Correspondence with inflatable spa manufacturers indicated that inflatable spas provide unique utility as a result of their low price relative to other portable electric spas and their ability to be collapsed and moved more easily than other spas. Inflatable spas often have maximum water temperatures settings greater than 100 °F, and the PVC construction that allows them to be less expensive and collapsible also decrease their ability to retain heat. This characteristic generally makes the power demand of inflatable spas higher than that of other portable electric spas. As a result, DOE tentatively concludes that inflatable spas are not able to be subject to the same energy consumption limits as other spas.

b. Exercise Spas

Exercise spas are characterized by their large size and ability to generate a water flow strong enough to allow for physical activity such as swimming in place. Exercise spas are usually composed of a rectangular rigid synthetic plastic cabinet topped with a rigid vacuum-formed acrylic shell. The cavity between the cabinet and acrylic shell houses components such as pumps and heaters and also allows for dense insulating materials to help the spa retain heat. Exercise spas provide unique utility in their capacity to facilitate physical activity inside the spa for a person as large as the 99th Percentile Man as specified in ANSI/APSP/ICC–16.[12] Exercise spas may have maximum water temperatures settings above or below 100 °F. According to manufacturers, consumers tend to set the water temperature of exercise spas to less than 100 °F when using exercise

[7] APSP–14 2019 is available at: *webstore.ansi.org/standards/apsp/ansiapspicc142019.*

[8] California Energy Commission. ''Final Staff Report—Analysis of Efficiency Standards and Marking for Spas.'' February 2, 2018.

[9] Codes and Standards Enhancement (CASE) Initiative. ''Analysis of Standards Proposal for Portable Electric Spas.'' May 15, 2014.

[10] Ramos, Nestor. ''Improving Energy Efficiency of Portable Electric Spas by Improving Its Thermal Conductivity Properties.'' Spring, 2018.

[11] Hamill, Andrew. ''Measurement and Analysis of the Standby Power of Twenty-Seven Portable Electric Spas.'' September, 2012.

[12] ANSI/APSP/ICC–16 is available at *https://webstore.ansi.org/standards/apsp/ansiapspicc162017PA2021.*

spas for physical activity. And exercise spas' capacity to house dense insulation makes them able to retain heat and reduce energy consumption more than inflatable spas.

c. Standard Spas

Standard spas are neither collapsible nor designed for use in recreational physical activities. Like exercise spas, they are typically composed of rigid plastic cabinets affixed to an acrylic shell. However, they may also be constructed of other rigid materials. DOE is aware of some standard spas whose exteriors are made entirely of rotationally molded plastic. Standard spas are not designed to generate a water flow strong enough to allow for swimming in place and are usually not large enough to allow for a person to swim in place. Standard spas offer unique utility in comparison to inflatable spas in that they typically have more and higher performance jet pumps, as well as the capacity for more additional features such as lights, water features, or stereo systems. Standard spas usually have maximum water temperature settings of above 100 °F. Like exercise spas, the rigid and relatively large space between the perimeter of the spa and the spa shell allows for dense insulation, which makes standard spas able to reduce energy consumption more than inflatable spas.

d. Combination Spas

Combination spas are single contiguous spas consisting of distinct exercise spa and standard spa sections, each of which has an independent control for the setting of water temperature. Combination spas provide unique utility in their capacity to provide distinct reservoirs intended for physical activity and also therapy and leisure. Like standard and exercise spas, combination spas are able to house dense insulation, increasing their ability to retain heat and to lower their energy consumption.

DOE's descriptions of these potential product classes were largely informed by the current industry standard, APSP–14 2019. In this NODA, standard spas, exercise spas, and combination spas are sometimes collectively referred to as ''non-inflatable'' spas or ''hard-sided'' spas. And in this NODA, inflatable spas are often treated separately because their construction is associated with limited technology options and higher energy consumption. Exercise spas, standard spas, and combination spas, however, are often treated similarly as non-inflatable spas.

DOE requests comment on whether the distinction between categories of PESs, as described in section III.A.2 of this NODA, is significant enough to warrant the establishment of different product classes for each type.

3. Manufactures and Industry Structure

The PES market is largely split between inflatable spas, standard spas, and exercise and combination spas, with each type catering to different consumer segments that do not significantly overlap. Similarly, there is no significant overlap between the manufacturers of inflatable spas and non-inflatable spas, although one manufacturer will often make all of the standard, exercise, and combination spas. The inflatable spa market is concentrated in a small number of manufacturers characterized by large production volumes, vertical integration, and manufacturing plants located outside of the United States. The market for non-inflatable spas, however, is more fragmented among manufacturers who purchase most spa components and whose manufacturing plants are located in North America. Manufacturers of both inflatable and non-inflatable spas often produce models under multiple brands. In particular, manufacturers of non-inflatable spas may also offer different brands, and even product lines within a brand, at multiple price points. Features that tend to correlate to the price point of a spa include the number and strength of therapy jets, the quality of cabinet materials, and the presence of additional features, such as lighting or stereo systems.

DOE requests comment on the above description of the PES manufacturers and the PES industry structure and whether any other details are necessary for characterizing the industry or for determining whether energy conservation standards for PESs might be justified.

4. Other Regulatory Programs

As part of its analysis, DOE surveyed existing regulatory programs concerning the energy consumption of PESs. These regulatory programs include both programs that enforce mandatory limits in their respective jurisdictions and voluntary programs. The first such mandatory program was CEC's mandatory Title 20 regulations concerning PESs, which were adopted in 2004. Over the next decade, four other states adopted mandatory standards, in some cases following CEC's regulations and, in other cases, creating their own, such as Arizona's Title 44 adopted in 2009. In 2014, PHTA created the first iteration of a voluntary industry standard in APSP–14 2014, which measures and sets limits for the energy required to maintain the set temperature and circulate water while the spa is not in use, known as ''standby power.''

The most recent development in test procedures and energy conservation standards for PESs was the publication of APSP–14 2019 in 2019. This revised version of the APSP–14 (*i.e.,* APSP–14 2019) was created in collaboration with CEC and was promptly adopted as California's new standard. The 2019 version revised some test methods and lowered the maximum allowable standby power for exercise and combination spas from those in APSP–14 2014. APSP–14 2019 also included standby power limits for inflatable spas for the first time. As of July 2022, nine states have adopted APSP–14 2019, three states have adopted the previous version APSP–14 2014, and Arizona and Connecticut follow Arizona's 2009 Title 44 provisions and California's 2006 Title 20 provisions, respectively.

DOE is also aware of standards in the European Union and Canada. The European Union standard, CSN EN 17125, covers a wider range of products and concerns safety requirements and test methods for energy consumption.[13] CSN EN 17125 specifies labeling requirements for energy consumption but does not specify a maximum limit for the energy consumption of PESs. A Canadian national standard, *Energy Performance of Hot Tubs and Spas,* reaffirmed in 2021, (''CSA C374:11''), provides both a test method and energy performance requirements for PESs.[14] CSA C374:11 cites CEC's Title 20, and its test procedure and energy conservation standards are similar to those in APSP–14 2019.

DOE requests information on any voluntary or mandatory test procedure and energy conservation standards for PESs that are not mentioned in section III.A.4 of this NODA.

5. Technology Options for Improving Efficiency

DOE reviewed product literature and conducted manufacturer interviews to survey the technologies that could lower the normalized average standby power of a PES and are currently available for use in the portable electric spa market. To identify the most relevant technology

[13] CSN EN 17125 is available at: *https://www.en-standard.eu/csn-en-17125-domestic-spas-whirlpool-spas-hot-tubs-safety-requirements-and-test-methods/.*

[14] CSA C374:11 (R2021) is available at: *https://www.csagroup.org/store/product/2703317/.*

options, DOE researched the components of PESs that consume energy and the design characteristics that affect energy consumption. DOE's research and data submitted by manufacturers suggest that the most substantial energy uses of a portable electric spa in standby mode are the energy use associated with maintaining the water temperature and circulating the water. As a result, DOE's analysis considered technology options that focus on these two systems. Because their designs are quite different, inflatable spas and non-inflatable spas have different instances of applicable technology options, although the engineering motivations behind the types of technology options are similar. DOE's research did not identify reasons that technology options would differ between standard spas, exercise, and combination spas. Accordingly, the same technology options are considered for each spa variety.

DOE seeks comment generally on the descriptions of relevant energy-saving technology options as described in section III.A.5 of this document, including whether any options require revised or additional details to characterize each option's effects on a PES's energy consumption.

a. Insulation

To minimize heat losses, PESs require insulating materials between the hot spa water and cool ambient air. This NODA uses the unmodified term ''insulation'' to refer to the insulation in the walls and floor of the spa, as opposed to any insulating materials in the cover. In non-inflatable spas, this material is often a polyurethane spray foam, which is applied to the bottom of the spa shell. Foam can also be applied in sheets inside the perimeter of the spa cabinet. Foam insulation can be any selected thickness, with the maximum amount of foam known as ''full-foam'' insulation, which entirely fills the space between the spa shell and the cabinet. Even in full-foam applications, however, foam or other insulating materials cannot totally encapsulate a spa's pumps or heating element. The most typical foam used has a density of 0.5 pounds per cubic foot. Both thicker and denser insulation increase, up to a point, the total R-value of the insulation, which then reduces the energy consumption of spas. However, the marginal effectiveness of thicker or denser insulation in the walls and floor, as measured in R-value, decreases progressively. Although in practice foam may be added in arbitrary increments, the efficiency analysis in section III.C.1 considers two specific levels of additional insulation. The first corresponds to R–6 added in the spa's wall sections to prevent heat loss from the water outward to the ambient air and to R–3.5 added in the floor section to prevent heat loss from the water downward to the ground. The second corresponds to R–6 added in the wall sections. The efficiency analysis also considers a design option in which two inches of 0.5 pound per cubic foot of foam is replaced with 2 pound per cubic foot of foam.

Inflatable spas are typically only insulated by air pockets, their PVC material, and flexible foam integrated into their covers and, especially, into attachable ''jackets.'' To maintain its collapsible and storable characteristics, however, many other methods of adding foam or other insulating materials to non-inflatable spas are not applicable. In response to mandatory energy consumption limits in some jurisdictions, some inflatable spa manufacturers developed a ''jacket,'' which has foam integrated into it and surrounds the inflated spa. During correspondence with DOE, inflatable manufacturers reported that such a jacket or a similar design is necessary for reducing the energy consumption below maximum levels as specified by the most recent industry and CEC standards.

DOE seeks comment regarding use of additional or improved insulation as a technology option for PESs and, in particular, what would limit adding further insulation to a PES.

b. Cover

Heat loss, which drives PES energy consumption, can also occur through the top face of a spa, in addition to through the walls and floor. Covers prevent this heat loss by acting as an insulator against conductive heat transfer and also as a convection and vapor barrier to maintain high humidity levels above the water surface, thus preventing evaporative cooling. In non-inflatable spas, spa covers are typically made of rigid polystyrene foam panels wrapped in moisture barriers and protective vinyl sheaths. Most covers on non-inflatable spas have a central hinge, which allows consumers to remove and otherwise handle them more easily. The hinge is typically created by joining two pieces of rigid foam with a patch of vinyl. To allow for easy folding, there is typically a space of one to two inches between the two sections. This design is known as a ''dual-hinged'' design because either half may be lifted first. Like insulation in the body of non-inflatable spas, the main method for increasing the thermal resistance of a cover is to increase its thickness or density. Also, like insulation in the body of an inflatable spa, the marginal effectiveness of additional cover thickness or density decreases as the thickness or density increase. Product literature and online retail data suggest that the ranges of cover thicknesses and densities available are two inches to six inches and one pound per cubic foot to two pounds per cubic foot, respectively.

Inflatable spa covers consist of thin flexible foam material that is about one-half inch thick and surrounded by a flexible PVC tarp. In lieu of additional foam that would reduce the cover's ability to collapse or to be stored, some inflatable spa manufacturers distribute spas with inflatable inserts, which end users may place in a pouch on the bottom of the cover. These inserts reduce the heat loss through the top face of the spa by adding additional insulating pockets of air between the water and ambient air and by improving the seal of the cover.

DOE seeks comment regarding use of improved covers as a technology option for PESs and, in particular, what would limit further energy performance increases of PES covers.

c. Sealing

A particularly important aspect of the performance of a spa cover is that it largely depends on the extent to which the cover is able to create an airtight seal between the area above the spa's water and the area surrounding the spa. Inadequate seals allow air to exchange between each area, resulting in heat losses through evaporation and convection. Areas through which air typically escapes are around the edge of the cover, where the cover meets the flange created by the top of the spa shell, and the central double-hinging area of the cover, if the cover does have a hinge. A common method of addressing the seal around the edge of the cover is by ensuring both the spa flange and the bottom of the cover are as flat as possible. To address air leaks through a hinge in the cover, manufacturers might insert a separate piece of foam to fill the gap between each half of the cover created by the hinge. This ''hinge seal'' is also composed of rigid foam sheathed in a protective material, such as vinyl, and is connected to the stretch of material connecting each section of the spa cover. The hinge seal is not connected to each section, however, allowing for easy folding. Manufacturers might also opt for a ''single-hinged'' folding design, in which there is no space gap between vertical edges of each spa cover sections. Instead, the edges of each section of the cover are angled, with one overlapping the other. This design eliminates the gap between sections. With this design, only the section of the cover resting on top of the other at the hinge can be lifted first. Covers can typically be buckled into position, but manufacturers and product literature suggest that, when fastened, these buckles do not to a large extent affect the seal but are mostly intended for safety. Correspondence with manufacturers has also suggested that the cover cannot be perfectly sealed. Because pressure will build as a result of thermal expansion and contraction of interior air and water, as well as from the potential addition of air through jets, some amount of air will be forced to escape through even very fortified spa covers.

Manufacturers have indicated to DOE that similar sealing strategies addressing air from leaking out of the spa cabinet could also reduce a spa's normalized average standby power. However, DOE did not identify evidence of air leakage through spa regions other than the cover. Accordingly, no technology options or technologies were analyzed that explicitly address the sealing of other areas than the cover of the spa.

DOE seeks comment regarding use of improved sealing as a technology option for PESs, regarding whether air leakage is significant at PES locations other than the cover, and regarding what would limit further sealing improvements energy performance increases of PES covers.

d. Radiant Barrier

The insulation and sealing methods described previously reduce conductive and convective heat losses, respectively. Energy can also leave the spa through radiative heat transfer. This type of heat transfer can be reduced by the application of a radiant barrier that reflects radiation back toward the center of the spa. Commonly available radiant barriers are composite ''thermal blankets'' made of a thin insulating material, such as bubble wrap, with reflective foil on both of its sides. DOE is aware of several manufacturers who use such a material or similar ones as a method of reducing their spas' heat losses. Correspondence with manufacturers and DOE's own research indicates that radiant barriers require an air gap between them and the radiating heat source to be effective. Like insulation, the marginal effectiveness of radiant barriers decreases as the spa reduces its heat losses via other methods.

DOE seeks comment on the description of radiant barriers and data on the relative effects of radiant barriers when paired with different amounts of insulation and different thicknesses of adjacent air gaps.

e. Insulated Ground Cover

To reduce heat conducted from the bottom of a spa to the ground, it is possible to install spas on top of a layer of insulating material. While non-inflatable spas are not typically distributed with such layers, an example of this application is in the current industry test procedure, APSP–14 2019, which allows for spas to be placed on top of two inches of polyisocyanurate sheathed with at least half an inch of plywood during testing. Inflatable spas, however, are often distributed with thin foam mats meant to be placed underneath the spas. These mats are typically to protect them from debris which might puncture the spas' PVC material. DOE has also observed similar, thicker ground covers available for purchase, which are marketed on the basis of their insulating capacities in addition to protective capacities. These thicker ground covers reduce the conductive heat transfer through the bottom of the spa to the ground. Based on their expected effectiveness and availability on the market, DOE considered insulated ground covers as a viable technology option for inflatable PESs.

For this NODA, DOE did not explicitly model the addition of an insulated ground cover as a technology option for non-inflatable PESs because it remains unclear how DOE's proposed test procedure for PESs may affect manufacturers' installation instructions (*e.g.,* to use an insulated ground cover) and consequently typical PES installation configurations. Additionally, existing performance data for PESs does not typically disclose presence of an insulated ground cover. Due to this uncertainty and the fact that such an addition into DOE's model would change the effects of other design options, DOE employed the more conservative approach of not modeling insulated ground covers as a technology option for non-inflatable PESs in this NODA. However, DOE may do so in the future as indicated by comment or data. In contrast to the approach taken for non-inflatable PESs, DOE did include insulated ground covers as a technology option for inflatable spas because of the abundance of currently available products marketed as insulating ground covers for that spa type.

DOE requests comment regarding whether insulated ground covers warrant inclusion in the set of technology options for non-inflatable PESs, including whether non-inflatable PESs are typically installed on top of insulated ground covers and whether that installation would be likely to change in view of the proposed DOE test procedure (*see* 87 FR 63356).

f. Dedicated Circulation Pump

Most non-inflatable spas use two-speed jet pumps for powering therapy jets and for water circulation. These jet pumps operate at high speed when powering therapy jets and low speed when used only for circulation purposes. The overall efficiency of a pump depends on several factors, including the hydraulic efficiency of the impeller and casing, the geometry of the plumbing system, and the electrical efficiency of the pump's motor. However, it is possible to simplify the comparison of the efficiencies of two differently sized pumps operating at the same motor speed. In general, when a pump operates at a motor speed significantly lower than its maximum motor speed on a given plumbing system, it will be less efficient than a smaller pump operating at its maximum motor speed on that same plumbing system. Consequently, a pump configuration more efficient than a single two-speed pump is two single-speed pumps, including a higher horsepower pump sized for operating therapy jets and a lower horsepower pump sized for filtration purposes. DOE is aware that pump inefficiencies may manifest as waste heat, which, if absorbed by the spa water, would reduce the load on the heating element and ultimately may mitigate the effects of a relatively inefficient pump and pump motor. The extent to which this waste heat is captured is still being investigated. Although in practice two-speed pumps and dedicated circulation pumps vary in power consumption, and the amount of waste heat will depend on how a given pump motor dissipates heat and on a spa's insulation, the efficiency analysis in section III.C.1 considers just two estimated values for water circulation: one associated with using the low-speed setting of a two-speed pump, and one associated with using a one-speed dedicated circulation pump. DOE did not evaluate dedicated circulation pumps as a technology option for inflatable spas because inflatable spas typically use a one-speed dedicated circulation pump and a separate air blower for massage jets.

DOE seeks comment and data on the degree to which two-speed pump inefficiencies manifest as waste heat and to which that waste heat is absorbed by the spa's water.

g. Heat Pump

DOE is aware of the existence of heat pumps marketed for use with PESs. Heat pumps would require less power as a heat source than the electric resistance heaters typically used in the PES industry. DOE is aware of at least one manufacturer of heat pump models marketed for use with spas explicitly.[15] However, heat pumps designed for use with portable electric spas appear otherwise absent in the market. DOE is unaware of portable electric spas that are equipped with heat pumps by their manufacturers.

For the one spa-compatible heat pumps supplier that DOE identified, models list coefficients of performance[16] that range from 3.16 to 6.2, though at lower output temperatures than those typical of PESs. In general, heat pump performance declines as a function of increase of the thermal gradient across which they operate. However, DOE did not obtain data to extrapolate those values to higher temperatures. In general, heat pump performance declines as a function of increase of the thermal gradient across which they operate. Additionally, DOE did not obtain data regarding how heat pumps would affect installation cost if non-integral units required separate mounting, plumbing, and electrical connection.

Accordingly, for this NODA, heat pumps were not included in the set of design options modeled in the engineering analysis due to lack of sufficient data and limited availability. If warranted, DOE may model the addition of a heat pump as a technology option in future analysis.

DOE requests comment regarding whether heat pumps would be likely to reduce energy consumption in PESs and, if so, quantified estimates of the effects of heat pump integration on both energy consumption and manufacturer production cost.

DOE requests comment regarding the availability of heat pumps compatible with PESs.

[15] Arctic Heat Pumps. Arctic Titanium Heat Pump for Swimming Pools and Spas—015ZA/B. Available at *www.arcticheatpumps.com/arctic-titanium-heat-pump-for-swimming-pools-and-spas-heats-chills-11-700-btu-dc-inverter.html.* (last accessed August 5, 2022) The 2022–08–05 material from this website is available in docket 2022–BT–STD–0025 at *www.regulations.gov.*

[16] Coefficient of performance (''COP'') is a figure characterizing the relative performance of heat pumps. It represents the ratio of heat transferred to the input energy required to transfer it. A higher COP indicates less energy consumed to per unit of heat delivered.

B. Screening Analysis

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

Technological feasibility. Technologies that are not incorporated in commercial products or in working prototypes will not be considered further.

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

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

Adverse impacts on health or safety. If it is determined that a technology would have significant adverse impacts on health or safety, that technology will not be considered further.

Unique-pathway proprietary technologies. If a design option utilizes proprietary technology that represents a unique pathway to achieving a given efficiency level, that technology will not be considered further due to the potential for monopolistic concerns.

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

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

In the case of PESs, DOE has tentatively determined that no technology options identified in section III.A.5 met the criteria for screening. Accordingly, all technology options identified in section III.A.5 were considered during the engineering analysis, with the exception of heat pumps and insulated ground covers (for non-inflatable spas only), which are not explicitly analyzed as design options for reasons discussed in section III.A.5 of this NODA.

C. Engineering Analysis

The purpose of the engineering analysis is to establish the relationship between the efficiency and cost of PESs. There are two elements to consider in the engineering analysis: the selection of efficiency levels to analyze (*i.e.,* the ''efficiency analysis'') and the determination of PESs cost at each efficiency level (*i.e.,* the ''cost analysis''). In determining the performance of higher-efficiency PESs, DOE considered technologies and design option combinations not eliminated by the screening analysis. For each product class of PES, DOE estimated the manufacturer production cost (''MPC'') for the baseline as well as higher efficiency levels. The output of the engineering analysis is a set of cost-efficiency ''curves'' that are used in downstream analyses (*i.e.,* the LCC and PBP analyses and the NIA).

DOE converts the MPC to the manufacturer selling price (''MSP'') by applying a manufacturer markup. The MSP is the price the manufacturer charges its first customer, when selling into the PES distribution channels. The manufacturer markup accounts for manufacturer non-production costs and profit margin. DOE developed the manufacturer markup by examining publicly available financial information for manufacturers of the covered product.

1. Efficiency Analysis

DOE selected efficiency levels to analyze by identifying baseline units for non-inflatable and inflatable spas, evaluating the effects of efficiency design options on those units, and extrapolating the results to spas of other sizes. The baseline unit is intended to be representative of the most consumptive spas available in the market. For non-inflatable spas, DOE identified ''Spa J'' from the 2012 study ''Measurement and Analysis of the Standby Power of Twenty-Seven Portable Electric Spas'' as the baseline unit.[17] For inflatable spas, DOE acquired a sample unit and measured its performance without the additional features that make it compliant with CEC energy conservation standards (and, by extension, with APSP–14 2019). The results of those tests were considered to be representative of the most consumptive inflatable spas on the market.

DOE seeks comment on its selection of the baseline unit, including whether any other units on the market would

[17] Hamill, Andrew. ''Measurement and Analysis of the Standby Power of Twenty-Seven Portable Electric Spas.'' September, 2012.

better represent the most consumptive spas available for purchase.

The non-inflatable spa baseline unit was identified on the basis of its fill volume and normalized average standby power. However, no information was available regarding its features and, in particular, its insulation characteristics. To predict the effects of technologies and design option combinations on the non-inflatable baseline unit, it was necessary to estimate insulation levels of the model's spa cabinet. To do this estimate, a simplified model of the energy consumption of PESs was created, which accepts spa specifications, including fill volume, linear dimensions, and insulation type, and predicts the normalized average standby losses of a spa. Predictions were made for a subset of spas in MAEDbS on which DOE collected additional data through brochures and other marketing materials, and predictions were then compared to values reported in MAEDbS. By establishing a relationship between the amount of insulation and normalized average standby power, it was possible to estimate the amount of insulation in the non-inflatable baseline unit, Spa J. Additionally, Spa J was reported to be tested with a cover better than other covers observed to be available on the market. Using the energy consumption model, the normalized average standby power was approximated for Spa J if it had been fitted with a cover of a lower R-value. The energy consumption model is described in more detail below.

DOE's research and correspondence with manufacturers indicate that the drivers of PESs' energy consumption in standby mode are: (1) heat losses, and (2) the energy demands of filtration. In addition to the energy consumption of the filtration system, there are small power demands, such as that of a spa's controls unit, that are also modeled as constant with size. In DOE's analysis, the energy consumption of the filtration system and other wattage inputs, which are constant with size and do not contribute to water heating, are collectively referred to as ''non-heat losses.'' In the energy consumption model, these non-heat losses were modeled as constant with size and were discretized into two potential values for non-inflatable spas—a larger value for spas that use the low-speed setting of high-hp pumps for filtration, and a smaller value for spas that use a better-sized dedicated circulation pump for filtration purposes. Only one value for non-heat losses was estimated for inflatable spas, which typically already use dedicated circulation pumps for filtration and separate air blowers for massage jets. The estimated values for non-heat losses are summarized in the table below. The ''High HP 2-Speed Pump'' column represents the non-heat losses associated with a high horsepower two-speed pump for non-inflatable spas and the single speed pump typical for inflatable spas, while the ''Dedicated Circulation Pump'' column represents non-heat losses associated with dedicated circulation pump upgrades.

TABLE III.1—ESTIMATED NON-HEAT LOSSES OF PESS

Spa type	Non-heat losses	
	High HP 2-speed pump	Dedicated circulation pump
Standard Spa	40 Watts	20 Watts.
Exercise Spa	40 Watts	20 Watts.
Combination Spa	40 Watts	20 Watts.
Inflatable Spa	n/a	27.25 Watts.

DOE requests comment on the range of filtration system power demands in PESs as described in Table III.1. DOE also requests comment on any correlation between power demand and whether a spa uses a high horsepower two-speed pump or a lower horsepower dedicated circulation pump.

To calculate a spa's heat loss in standby mode, DOE assumed that a spa's normalized average standby power loss is approximately equal to the instantaneous heat loss of a spa held at thermal equilibrium, with spa water temperature and ambient air temperature held at the values respectively specified by DOE's proposed test procedure. It is noteworthy that doing so ignores temperature fluctuations characteristic of PESs' heating cycles.

DOE accounted for heat losses due to one-dimensional conductive heat transfer through the walls, floor, and cover of the spa, as well as heat losses due to convection at the outer wall and due to radiation. Spas were modelled as thermal circuits consisting of walls, floor, and cover in parallel with each other. The total thermal resistance of the walls and floor of the spa depends in part on their respective thicknesses and, consequently, the shape of the spa shell. Therefore, a simplified shell configuration consisting of basic upright seats on every side (*i.e.,* no lounge seats) was considered. As a result of this assumption, walls were divided into lower-insulation top wall and higher-insulation bottom wall sections, and the floor was divided into lower-insulation center and higher-insulation perimeter sections. In particular, the following simplifications were made regarding the distance from the spa shell to the spa cabinet:

TABLE III.2—MEASUREMENTS OF SIMPLIFIED MODEL OF NON-INFLATABLE SPA SHELL

Section of spa	Description	Maximum insulation thickness
Top of Wall	The horizontal distance from the spa cabinet to the seat backs.	6 inches.
Bottom of Wall	The horizontal distance from the spa cabinet to the wall of the foot well.	18 inches.
Center of floor	The vertical distance from the base of the spa to the bottom of the foot well.	3 inches.
Perimeter of floor.	The vertical distance from the base of the spa to the bottom of the seat.	15 inches.

In addition to conductive heat transfer, heat losses due to radiation and convection were estimated. Losses due to radiation were approximated using the average percent difference between the average standby losses of spa models units with and without reflective layers in their insulation. DOE identified those unit pairs and their differences in standby energy consumption using MAEDbS. DOE also conducted independent testing on one inflatable spa and one non-inflatable spa, measuring the energy consumption before and after each was retrofitted with a reflective radiant barrier. To estimate the effects of air convection on the outside surfaces of the spa, DOE selected a convective heat transfer coefficient characteristic of airflow at the rate specified in DOE's proposed test procedure and applied it in series with the spa walls, floor, and cover. Although air leaks are known to affect the heat losses of a spa, DOE did not obtain data sufficient to characterize the magnitude of their effect. Accordingly, DOE's energy model does not estimate the effect of air leaks explicitly. Instead, losses due to air leaks are treated as included in the losses through bridge sections, as described as follows.

DOE requests comment on its assumption of a standard shell shape as described in Table III.2, especially whether it is representative and whether DOE should consider certain shapes that result in maximum or minimum amounts of insulation.

DOE requests data and comment on the effectiveness of radiant barriers in reducing the normalized average standby power of PESs and on what factors make radiant barriers more or less effective.

DOE requests data and comment on the extent to which spas lose heat through air convection out of unsealed regions of the spa and on the factors that affect heat losses due to sealing.

DOE requests comment on the best way to quantify varying degrees of cover seal, including perimeter seal against the spa flange and hinge seal through the center of the cover.

The PES energy consumption model system described previously overlooks several complicating factors. Specifically, the typical spa's cabinet holds plumbing, heating equipment, and other components that not only displace insulation, but also bring hot water closer to the outside of the spa and even generate their own waste heat, which escapes the spa or enters the water at unknown proportions. At the same time, the foam itself is subject to voids and other variations. Rather than attempting to find an analytical solution that considers factors such as the number of jets and amount of piping, the physical size of internal components, or the distance of each from the outside of the spa, DOE used a simplified model that considers the heat loss through these ''thermal bridges'' as the amount of heat loss that could not be predicted by the one-dimensional model described above. DOE used this assumption to reformulate the thermal circuit of a spa as consisting of one-part thermal bridge section and one-part insulated section, which is subdivided into walls, floor, and cover, as described previously. Bridge sections were modeled as smaller but responsible for a disproportionate amount of heat flux. Specifically, the proportion of areas were estimated to be 90 percent insulated area to 10 percent bridge area. As a result, it was possible to calculate an average R-value for bridge sections in a spa. Using the average R-value for bridge sections and the modeled area ratios of insulated area to bridge area, the energy consumption model calculated total energy use with a median 0.9 percent error and an average of −4.38 percent error.

DOE requests comment on the method of analyzing thermal bridges as a single section of low R-value on the spa. Additionally, DOE requests information about techniques and models which are used in industry to predict spa performance.

DOE requests comment and data on the discrepancy between heat loss through the wall where the components are housed and through other walls.

DOE requests comment on any strategies for considering the effects of hot water traveling through plumbing on a spa's heat loss.

The R-value of a typical spa's bridge section was important to infer insulation thickness of Spa J, the chosen baseline unit for non-inflatable spas. Although Spa J's ''equivalent insulation thickness'' was calculated using the measured heat loss rate, this value cannot be used to represent the spa's insulation thickness because it does not consider bridge sections of relatively low thermal resistance. Consequently, it would underestimate the amount of insulation in Spa J and overestimate both the space available for additional insulation and ultimately the amount by which it would be possible to lower heat losses. Using the average R-value for bridge sections, DOE found what may be a more representative insulation equivalent resistance, which is then able to be decomposed into individual walls, cover, and floor equivalent resistances.

With estimated insulation characteristics for its baseline non-inflatable spa, it was possible to calculate the expected effects of additional insulation on the baseline spa's normalized average standby power consumption. DOE used these calculations to evaluate additional insulation in the walls of the spa, the floor, and the cover. These calculations, along with data from DOE's testing a non-inflatable spa and from the 2012 Hamill study, were used to establish proposed efficiency levels for non-inflatable spas. DOE selected efficiency levels in the order of increasing dollar to implement per expected watt savings using costs described below in the cost analysis.

DOE was also able to conduct its own testing on an inflatable spa baseline unit. Because DOE's energy consumption model relies to a large extent on R-values, and as DOE found less data on the R-value of inflatable spa materials, the effects of most inflatable design options were related to test data rather than calculations. For design options utilizing additional insulation and for which DOE did not have test data, a model similar to the one described previously was used. And efficiency levels for inflatable spas were chosen in the order of increasing dollar to implement per expected watt savings, similar to non-inflatable spas.

After the normalized standby power consumption was calculated for the baseline non-inflatable and inflatable spas, the standby power of spas with other volumes was extrapolated using a scaling relationship. DOE used the relationship defined in APSP–14 2019 standards levels, which vary energy consumption proportionally to the volume of the spa raised to the two-thirds power. Several manufacturers recounted during correspondence with DOE that a constant term was added to the scaling relationship to account for energy demands unrelated to size during the most recent revision of APSP–14 2019. Consequently, DOE chose to again break total standby power losses into heat losses and non-heat losses, and to scale only heat losses proportionally to volume raised to the two-thirds power, while holding non-heat losses constant at different fill volumes.

DOE requests comment describing its appropriation of the scaling relationship defined in APSP–14 2019 and whether there are any other traits with which DOE might vary energy consumption.

The efficiency analysis above was informed by data acquired by testing to the current industry standard test procedure, APSP–14 2019. However, DOE has proposed a test procedure for PESs, which made it necessary to convert initial results into those which might be expected if spas were to be tested under that proposed test procedure. In particular, this conversion accounted for a higher temperature gradient between spa water and ambient air temperatures during testing, and for the removal of the foam and plywood foundation allowed by APSP–14 2019.[18] To account for the change in temperature gradient, original values were multiplied by a re-normalization factor of 1.243, the ratio of the proposed temperature difference of 46 °F to the industry standard of 37 °F. DOE removed R–13 of insulation from the floor section of the spa in its model to account for the loss of two inches of polyisocyanurate foam underneath the spa. While the converted values will be used for downstream analyses, DOE is also releasing the values before conversion so that manufacturers may consider them in the context of existing data.

DOE requests comment on whether there are other factors DOE should consider in converting normalized average standby power values to reflect the proposed test procedure.

2. Cost Analysis

DOE gathered data through manufacturer interviews, sample unit teardowns, and publicly available retail data to estimate the costs of both whole baseline units and of incremental design options. When necessary, profit margins for inflatables and non-inflatable spa manufacturers, as well as certain distributors, were estimated to convert MPC to MSP to final sale price.

DOE requests comment and data on typical markups from MPC to MSP and from MSP to final sale price.

Once the costs of baseline units and individual design options were estimated, DOE investigated a scaling function that could relate the price of a spa to its fill volume. As a first approximation, DOE estimated that the cost of a spa would be directly proportional to its fill-volume to the two-thirds power. DOE analyzed a small sample of retail data and found that, for units otherwise equal in qualities and features, such a relationship appears to slightly overestimate the cost of smaller spas and underestimate the cost of larger spas.

DOE requests comment and data characterizing the relationship between MPC and the size of a PES and whether there are better methods for approximating the effects of size changes on MPC than the one described previously.

DOE requests comment and data characterizing to what degree sales margins vary with spa size.

3. Engineering Results

The initial results of the efficiency analysis contained the estimated energy consumption of PESs at each efficiency level, as would be measured according to the current industry test procedure, APSP–14. These initial results are not used in the energy use analysis or other downstream analyses because they do not reflect DOE's proposed test procedure. However, as manufacturers are most likely to have data as measured with the current industry standard test procedure, the initial results of the efficiency analysis are summarized in the tables which follow. In the sets of efficiency levels for both non-inflatable and inflatable spas, Efficiency Level 1 is equivalent to the maximum consumption limit set by APSP–14 2019.

TABLE III.3—ENERGY CONSUMPTION FOR NON-INFLATABLE SPAS USING INDUSTRY TP

Efficiency level	Energy consumption using industry TP (watts)	Energy consumption of a 334-gal unit (watts)
0 (Baseline)	40 + 6.88 * $Vol^{2/3}$	371
1	40 + 3.75 * $Vol^{2/3}$	220
2	40 + 2.92 * $Vol^{2/3}$	180
3	40 + 2.74 * $Vol^{2/3}$	172
4	40 + 2.74 * $Vol^{2/3}$	152
5	40 + 2.63 * $Vol^{2/3}$	146
6	40 + 2.38 * $Vol^{2/3}$	135
7	40 + 1.88 * $Vol^{2/3}$	111
8 (Max-Tech)	40 + 1.80 * $Vol^{2/3}$	107

TABLE III.4—ENERGY CONSUMPTION FOR INFLATABLE SPAS USING INDUSTRY TP

Efficiency level	Energy consumption using industry TP (watts)	Estimated energy consumption of a 200-gal unit (watts)
0 (Baseline)	9.20 * $Vol^{2/3}$	315
1	7.00 * $Vol^{2/3}$	239
2	4.78 * $Vol^{2/3}$	164
3(Max-Tech)	4.73 * $Vol^{2/3}$	162

DOE requests comment on the efficiency levels described in tables Table III.3 and Table III.4, including whether any do not align with expected effects design options associated with them, as described in Table III.7 and Table III.8.

As discussed previously in this document, on October 18, 2022, DOE proposed a test procedure for measuring the energy consumption of PESs. 87 FR 63356. DOE's proposed test procedure aligns with the current industry test procedure in many regards, including in its use of normalized average standby power as a metric for the energy consumption of PESs. However, DOE's proposed test procedure includes changes to the specified ambient air temperature and to the amount of insulation allowed under the spa during

[18] Appendix A of APSP–14 states the following: The floor may be insulated with 2in. (51mm) thick R–13 polyisocyanurate with radiant barrier on both sides.

testing. These changes can be expected to increase the measured normalized average standby power of all PESs. Section III.C.1 discusses DOE's method of converting standby power values measured under the industry test procedure to the values expected if the standby power values for the same spas were measured under DOE's proposed test procedure. The converted and final results are summarized in the tables below. These values are used in the analyses described in later sections of this document.

The tables below also summarize the expected percent change in energy consumption on each efficiency level as a result of DOE's proposed test procedure. The increased temperature gradient is not expected to affect any efficiency levels differently. However, the effect of removing additional insulation from underneath the spa will depend on the amount of foam present in the base section of the spa and on the presence of other design options. As a result, the percent change is not constant across efficiency levels. The change in normalized average standby power at a given efficiency level due to DOE's proposed test procedure is expected to remain constant for spas of all volumes at that efficiency level.

TABLE III.5—ENERGY CONSUMPTION FOR NON-INFLATABLE SPA USING PROPOSED TP

Efficiency level	Energy consumption using proposed TP (watts)	Energy consumption of a 334-gal unit (watts)	% Increase from industry TP (%)
0	40 + 9.55 * $Vol^{2/3}$	500	35
1	40 + 5.37 * $Vol^{2/3}$	299	36
2	40 + 4.34 * $Vol^{2/3}$	249	38
3	40 + 4.12 * $Vol^{2/3}$	238	38
4	40 + 4.02 * $Vol^{2/3}$	213	40
5	40 + 3.88 * $Vol^{2/3}$	207	42
6	40 + 3.04 * $Vol^{2/3}$	167	24
7	40 + 2.73 * $Vol^{2/3}$	152	37
8	40 + 2.63 * $Vol^{2/3}$	147	37

TABLE III.6—ENERGY CONSUMPTION FOR INFLATABLE SPA USING PROPOSED TP

Efficiency level	Energy consumption using proposed TP (watts)	Energy consumption of a 200-gal unit (watts)	% Increase from industry TP (%)
0	14.39 * $Vol^{2/3}$	492	56
1	12.03 * $Vol^{2/3}$	411	72
2	7.50 * $Vol^{2/3}$	257	57
3	7.44 * $Vol^{2/3}$	254	57

DOE requests comment on the expected effects of DOE's proposed test procedure, as described in Table III.5 and Table III.6, including on whether its effects on normalized average standby power would be greater than or less than DOE's estimates.

Efficiency levels for PESs were established by estimating the effects of adding each design option to a representative unit at the previous efficiency level. The design option, which presented the lowest cost in dollars per watt expected to be saved, was selected as characteristic of the next efficiency level. Although potential standards at different efficiency levels will not prescribe specific design options, this approach resulted in the possibility of characterizing each efficiency level by the addition of a specific design option. DOE's estimates of the cost to manufacture each design option, as well as the baseline spa, are described in section III.C.2 of this NODA. The characteristic design options and their estimated costs on 334-gallon non-inflatable spas and a 200-gallon inflatable spa are summarized in the tables III.7 and III.8.

TABLE III.7—CHARACTERISTIC DESIGN OPTIONS FOR NON-INFLATABLE EFFICIENCY LEVELS

Efficiency level	Characteristic design option added from previous EL	Total MPC for 334-gal unit	Marginal MPC for 334-gal unit
0	The baseline spa, Spa J, was estimated to have R–10 worth of insulation in the walls and floor and an R–14 cover.	$3,120	$0
1	Additional R–6 in the wall sections and R–3.5 in the floor section	3,186	66
2	Additional R–6 in the wall sections	3,252	66
3	Additional inch of cover thickness (equivalent to an additional R–4)	3,280	28
4	Switch from two-speed pump to dedicated jet and circulation pumps	3,405	125
5	Additional inch of cover thickness (equivalent to an additional R–4)	3,433	28
6	Replace two inches of 0.5lb foam with 2lb foam insulation	3,607	174
7	Add radiant barrier around perimeter of spa	3,697	90
8	Increase cover density from 1lb foam to 2lb foam	3,767	70

TABLE III.8—CHARACTERISTIC DESIGN OPTIONS FOR INFLATABLE SPA EFFICIENCY LEVELS

Efficiency level	Characteristic design option added from previous EL	Total MPC on 200-gal unit	Marginal MPC on 200-gal unit
0	None	$122	$0
1	Flexible foam jacket and inflatable cover insert	165	43
2	Additional reflective blanket around spa	297	132
3	½ inch thick foam ground cover	329	32

DOE requests comment and data regarding the design options and associated estimated costs described in tables Table III.7 and Table III.8 of this NODA.

Section III.C.2 also discusses the conversion of MPC to MSP using manufacturer markups, and the scaling relationship used to extrapolate from the price of the baseline unit to units of other sizes. In particular, the price of a spa was modeled as growing proportionally to the fill volume to the two thirds power. The manufacturer markups used and the ultimate MSP scaling relationships are described in Tables III.9 and III.10.

TABLE III.9—MANUFACTURER MARKUPS BY MANUFACTURER TYPE

Manufacturer types	Estimated manufacturer markup
Inflatable Spa Manufacturer	1.17
Non-Inflatable Spa Manufacturer	1.43

TABLE III.10—PORTABLE ELECTRIC SPA MSP BY VOLUME

Efficiency level	MSP for non-inflatable spas ($)	MSP for inflatable spas ($)
0	92.69 * *Vol* $^{2/3}$	4.07 * *Vol* $^{2/3}$
1	94.64 * *Vol* $^{2/3}$	5.50 * *Vol* $^{2/3}$
2	98.54 * *Vol* $^{2/3}$	9.92 * *Vol* $^{2/3}$
3	103.27 * *Vol* $^{2/3}$	10.98 * *Vol* $^{2/3}$
4	111.72 * *Vol* $^{2/3}$	n/a
5	120.99 * *Vol* $^{2/3}$	n/a
6	136.22 * *Vol* $^{2/3}$	n/a
7	154.10 * *Vol* $^{2/3}$	n/a
8	174.05 * *Vol* $^{2/3}$	n/a

Those estimates describe a relationship between the marginal cost and the marginal efficiency of a PES as the PES is made progressively more efficient. The relationship is the basis of analyses described in sections D, E, F, G, and H of this NODA.

D. Markups Analysis

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

1. Distribution Channels

For this NODA, DOE has identified separate distribution channels into groups for hard-sided (standard, exercise, and combination) and inflatable spas. DOE based the market shares on confidential manufacturer interviews conducted under non-disclosure agreements. For PESs, the main parties in the distribution chains are shown in Table III.11.

TABLE III.11—DISTRIBUTION CHANNELS

Index	Distribution channel agents	Market share (%)	
		Hard-sided spas	Inflatable spas
1	Manufacturer → Wholesaler → Spa Product Contractor → Consumer	5	
2	Manufacturer → Spa Product Retailer → Consumer	60	
3	Manufacturer → Big Box Retailer → Consumer	20	50
4	Manufacturer → Big Box Internet Retailer → Consumer	10	50
5	Manufacturer → Consumer (direct sale)	5	

2. Markups

Baseline markups are applied to the price of products with baseline efficiency, while incremental markups are applied to the difference in price between baseline and higher-efficiency models (the incremental cost increase). The incremental markup is typically less than the baseline markup and is designed to maintain similar per-unit operating profit before and after new or amended standards.[19]

For this NODA, DOE did not develop PES-specific baseline and incremental markups for each actor in the distribution chain. Instead, based on supply chain similarities, DOE used the markups analysis developed for its Pool Heater energy conservation standard as a proxy.[20] If DOE decides to pursue minimum efficiency standards for PESs, DOE will examine the PES supply chain in detail.

DOE applied the following baseline and incremental markups for each step of the distribution channels listed in Table III.11, which are shown in Table III.12.

TABLE III.12—AGENT SPECIFIC MARKUPS

Agent	Baseline markup	Incremental markup
Wholesaler	1.41	1.15
Spa Product Retailer	1.76	1.22
Big Box Retailer	1.31	1.07
Big Box Internet Retailer	1.31	1.07
Consumer (direct sale)	1.70	1.22
Spa Product Contractor	1.40	1.21

DOE requests information on the existence of any distribution channels other than the distribution channels listed in Table III.11 of this document. Further, DOE requests comment on whether the same distribution channels are applicable to installations of new and replacement PESs.

DOE requests information on the fraction of shipments that are distributed through the channels shown in Table III.11 of this document.

3. Sales Taxes

The sales tax represents state and local sales taxes that are applied to the consumer product price. The sales tax is a multiplicative factor that increases the consumer product price.

DOE derived state and local taxes from data provided by the Sales Tax Clearinghouse.[21] DOE derived population-weighted average tax values for each Census Region, as shown in Table III.13.[22]

TABLE III.13—AVERAGE SALES TAX RATES BY CENSUS REGION

Census region	Description	Sales tax rate (%)
1	Northeast	6.90
2	Midwest	7.10
3	South	7.36
4	West	7.53
Population-weighted average		7.28

4. Summary of Markups

Table III.14 summarizes the markups at each stage in the distribution channel and provides the average sales tax to arrive at overall markups for the potential product classes considered in this analysis.

TABLE III.14—SUMMARY OF MARKUPS

Equipment class	Baseline markup	Incremental markups
Standard	1.75	1.27
Exercise	1.75	1.27
Combination	1.75	1.27
Inflatable	1.41	1.15

E. Energy Use Analysis

The purpose of the energy use analysis is to determine the annual energy consumption of PESs during stand-by operation at different efficiencies in representative U.S. single-family homes and to assess the energy savings potential of increased PES efficiency. The energy use analysis estimated the range of energy use of PESs in the field (*i.e.,* as they are actually used by consumers). The energy use analysis provided the basis for other analyses DOE performed,

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

[20] Please see chapter 6 of the Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Consumer Pool Heaters. DOE. 2022. Available at *https://www.regulations.gov/document/EERE-2021-BT-STD-0020-0005.*

[21] Sales Tax Clearinghouse Inc. State Sales Tax Rates Along with Combined Average City and County Rates. July 2021. Available at *https://thestc.com/STrates.stm* (Last accessed July 1, 2021.)

[22] *See: https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf.*

particularly assessments of the energy savings and the savings in consumer operating costs that could result from adoption of new standards.

The energy use analysis uses the energy use models developed in the engineering analysis. The engineering analysis calculated the rate of heat loss from the spa as a function of the difference between the spa operating temperature and the ambient temperature. For this analysis, DOE developed distributions of binned hourly ambient temperature data using the dry-bulb temperature from the Typical Meteorological Year 3 (''TMY3'') [23] weather data as a function of climate zone, as described in section III.E.3 of this document. The annual energy use (''AEU'') in kilowatt hours per year (kWh/yr) for each climate zone, *z,* for all spas, other than combination spas, is expressed as:

$$AEU_z = \sum_j w_{z,j}\left(\left(Sys_{non-heat} + Sys_{heat} \times Vol^{\frac{2}{3}}\right) \times \frac{T_{op} - T_{amb\,j}}{T_{opTP} - T_{ambTP}}\right) \times npy_z$$

For combination spas, where there are two independently heated pools of water:

$$AEU_z = \sum_j w_{z,j}\left(\left[Sys_{non-heat} + \left(Sys_{heat} \times Vol^{\frac{2}{3}}\right) \times \frac{T_{op} - T_{amb\,j}}{T_{opTP} - T_{ambTP}}\right]_{StandardSpa} + \left[\left(Sys_{heat} \times Vol^{\frac{2}{3}}\right) \times \frac{T_{op} - T_{amb\,j}}{T_{opTP} - T_{ambTP}}\right]_{ExerciseSpa}\right) \times npy_z$$

Where:

AEU_z = the annual energy use, in kWh, of the spa installed in climate zone *z;* if there are any hours where T_{amb} exceeds T_{op}, AEU is set equal to zero,

j = a bin index representing the ambient temperature at which the spa is operating,

$w_{z,j}$ = the probability of the monthly ambient temperature for climate zone *z,*

$Sys_{non\text{-}heat}$ = the energy use of non-heat producing systems, *i.e.,* water pumps, controls, etc., which does not scale with spa water volume,

z = climate zone,

Sys_{heat} = a coefficient representing heating system energy use, which scales with spa water volume,

Vol = the spa's water volume,

T_{op} = the spa's operating temperature (87 for exercise spas, and the exercise portion of combination spas, 102 for all other products) (°F),

T_{opTP} = the spa's operating temperature as defined in the test procedure (102 °F),

$T_{amb\,j}$ = the ambient temperature (°F),

T_{ambTP} = the national average ambient temperature, as defined in the test procedure (56 °F), and

npy_z = number of months of operation per year for PESs installed in climate zone *z.*

DOE seeks comment on its energy use model. Specifically, DOE seeks comment on the energy use model for combination spas, where the $Sys_{non\text{-}heat}$ variable is normalized with volume of water portioned to the standard spa pool.

1. Consumer Sample

DOE conducts its analysis in support of a potential new minimum energy conservation standard at the national level. This means that DOE must distribute consumers of PES products throughout the nation to capture variability of key inputs of PES operation. Specifically, for the annual energy use estimate, DOE had concern regarding distributing the population of PES installations across different regions to capture variability in outdoor (ambient) temperatures, which impact PES stand-by energy consumption. This distribution of installations is referred to as the ''Consumer Sample.''

For this NODA, DOE used the statistical household data available in the Energy Information Administration. Residential Energy Consumption Survey: 2015 (''RECS'').[24] [25] DOE used the data from RECS of households with a hot tub (*RECBATH=1, FUELTUB=5, and TYPEHUQ=[2, 3]*) to define the national spatial sample of PES installations over analysis regions defined by the intersection of census regions *r* and climate zones *z.* The climate zones are those defined in the RECS microdata. The percent distribution of consumers over census region/climate zone is provided in Table III.15.

[23] The TMY data sets hold hourly values of solar radiation and meteorological elements for a 1-year period. Their intended use is for computer simulations of solar energy conversion systems and building systems to facilitate performance comparisons of different system types, configurations, and locations in the United States and its territories. Because the values represent typical rather than extreme conditions, they are not suited for designing systems to meet the worst-case conditions occurring at a location.

[24] U.S. Department of Energy—Energy Information Administration. Residential Energy Consumption Survey: 2015 RECS Survey Data. 2015. Available at *https://www.eia.gov/consumption/residential/data/2015/.* (Last accessed August 5, 2021.)

[25] At the time of drafting, the Residential Energy Consumption Survey has released a new version based on 2020 inputs as a preliminary analysis. If DOE elects to pursue new minimum efficiency standards for PESs, DOE will update the consumer sample to the 2020 version of RECS.

TABLE III.15—REGION AND CLIMATE ZONE PROBABILITIES OF HOT TUB INSTALLATIONS

Census region (*r*)	Climate zone (*z*)					
	Cold/very cold	Hot-dry/ mixed-dry	Hot-humid	Marine	Mixed-humid	Total
1	18.0	0.0	0.0	0.0	2.1	20.1
2	16.5	0.0	0.0	0.0	6.4	22.9
3	1.1	0.0	9.8	0.0	14.5	25.4
4	8.8	9.0	0.7	13.1	0.0	31.6
Total	44.5	9.0	10.5	13.1	22.9	100.0

2. Typical Annual Operating Hours (*npy*)

A key input to the energy use analysis is the number of annual operating hours of the product. Available data indicated that PESs operate in stand-by mode for the majority of hours that they are on. During the process of updating PES standards for California in 2018, CEC reported a duty cycle between 5,040 hours per year for inflatable spas (which are intended for seasonal use) and 8,760 hours per year for standard, exercise, and combination spas.[26] DOE notes that these estimates may be typical for California, but are not represented in the existing data in RECS.

The RECS data include a field (*MONTUB*) quantifying the number of months per year that the hot tub is considered in use. For this analysis, DOE considered the term ''in use'' to mean plugged-in and running. RECS does not specify which months the spa is in use, only the quantity of months. Therefore, for this NODA, DOE interpreted these data as that the spas in RECS will be operating during the warmest months of the year, as shown in Table III.16. For inflatable PES, DOE made the modeling assumption that they would be in operation up to a maximum of warmest 6 months of the year.

TABLE III.16—MAPPING OF RECS MONTHS OF OPERATION TO CALENDAR MONTHS

	Months of operation (*npy*)											
	1	2	3	4	5	6	7	8	9	10	11	12
Jan												1
Feb											1	1
Mar									1	1	1	1
Apr							1	1	1	1	1	1
May					1	1	1	1	1	1	1	1
Jun			1	1	1	1	1	1	1	1	1	1
Jul	1	1	1	1	1	1	1	1	1	1	1	1
Aug		1	1	1	1	1	1	1	1	1	1	1
Sep				1	1	1	1	1	1	1	1	1
Oct						1	1	1	1	1	1	1
Nov								1	1	1	1	1
Dec										1	1	1
Hours/year	744	1,488	2,208	2,928	3,672	4,416	5,136	5,856	6,600	7,344	8,016	8,760

DOE used RECS data to estimate the probability that a spa would be in use *npy* months per year as a function of climate zone. Given the sparsity of RECS data and to estimate the probabilities, DOE first binned the recorded value of *MONTUB* into 4 bins: 1 to 3 months per year, 4 to 6 months per year, 7 to 9 months per year, and 10 to 12 months per year. Then DOE calculated the percent of RECS households falling in each bin for each climate zone. Finally, DOE used the modelling assumption that the 3 values in each bin are equally probable. The resulting distribution of the expected number of months per year (*npy*) are shown in Table III.17. Once the number of months of operation is known, the hours of operation are calculated as if the spa is in operation over the full month.

TABLE III.17—ASSIGNMENT OF CLIMATE ZONE (*z*) BY MONTHS OF OPERATION (*npy*) FOR HARD-SIDED SPAS

Months per year (*npy*)	Cold/very cold	Hot-dry/ mixed-dry	Hot-humid	Marine	Mixed-humid
1	0.07	0.06	0.09	0.06	0.04
2	0.07	0.06	0.09	0.06	0.04
3	0.07	0.06	0.09	0.06	0.04
4	0.07	0.06	0.09	0.06	0.04
5	0.06	0.06	0.05	0.05	0.06
6	0.06	0.06	0.05	0.05	0.06
7	0.06	0.06	0.05	0.05	0.06
8	0.06	0.06	0.05	0.05	0.06
9	0.12	0.13	0.11	0.14	0.15

[26] Final Staff Report, Analysis of Efficiency Standards and Marking for Spas, 2018 Appliance Efficiency Rulemaking for Spas Docket Number 18–AAER–02 TN 222413. See: pg. 35, Available at *https://efiling.energy.ca.gov/GetDocument.aspx?tn=222413&DocumentContentId=31256.*

TABLE III.17—ASSIGNMENT OF CLIMATE ZONE (*z*) BY MONTHS OF OPERATION (*npy*) FOR HARD-SIDED SPAS—Continued

Months per year (*npy*)	Cold/very cold	Hot-dry/ mixed-dry	Hot-humid	Marine	Mixed-humid
10	0.12	0.13	0.11	0.14	0.15
11	0.12	0.13	0.11	0.14	0.15
12	0.12	0.13	0.11	0.14	0.15

TABLE III.18—ASSIGNMENT OF CLIMATE ZONE (*z*) BY MONTHS OF OPERATION (*npy*) FOR INFLATABLE SPAS

Months per year (*npy*)	Cold/very cold	Hot-dry/ mixed-dry	Hot-humid	Marine	Mixed-humid
1	0.17	0.16	0.19	0.17	0.13
2	0.17	0.16	0.19	0.17	0.13
3	0.17	0.16	0.19	0.17	0.13
4	0.17	0.16	0.19	0.17	0.13
5	0.16	0.18	0.12	0.15	0.23
6	0.16	0.18	0.12	0.15	0.23

DOE requests comment on its approach to estimating annual operating hours. Additionally, DOE requests comment on its modeling assumption that PES would be operated during the warmest months of the year.

3. Ambient Temperature (T_{amb})

For the purposes of the NODA, DOE has made the modeling assumption that all PESs are installed outdoors and their energy use will be a function of the ambient temperature of the PESs' location. Losses to the external environment depend both on how many months per year the spa operates, and the distribution of ambient temperatures for those months in the given climate zone. To establish representative hourly temperatures for each of the PESs' installations as a function of climate zone (z), DOE calculated the probability distribution of temperatures, binned into 5 °F segments, denoted *j,* based on TMY3 data. For this NODA, DOE averaged over one TMY3 weather station for each state within a climate zone to determine a single hourly temperature series for each zone, *z.* For each value of *npy,* DOE binned the temperature time series for the appropriate months to create a distribution. The distribution was normalized by the total number of hours for that selection of months. The result is a distribution *w(z,j,npy),* which defines the percent of hours allocated to each bin j for climate zone *z,* with *npy* months of operation.[27]

An example of the probability distribution of ambient temperatures for PESs operating for 1 and 7 months a year installed in census region 2 (Midwest), which covers climate zones: cold/very cold and mixed-humid, are shown in Table III.19.

TABLE III.19—EXAMPLE AMBIENT TEMPERATURE PROBABILITIES FOR CENSUS REGION 2 (MIDWEST), WHERE PESS ARE OPERATED FOR 1 AND 7 MONTHS PER YEAR

Months of operation *npy*	Temperature bin °F (*j*)	Probability (*w*)	
		Cold/very cold (*z*)	Mixed-humid (*z*)
1	62.5	0.095	
1	67.5	0.223	0.067
1	72.5	0.219	0.266
1	77.5	0.249	0.215
1	82.5	0.172	0.196
1	87.5	0.042	0.179
1	92.5		0.077
Total		1.000	1.00
7	32.5	0.003	
7	37.5	0.033	0.001
7	42.5	0.052	0.022
7	47.5	0.084	0.049
7	52.5	0.102	0.071
7	57.5	0.117	0.123
7	62.5	0.155	0.135
7	67.5	0.165	0.156
7	72.5	0.134	0.168
7	77.5	0.102	0.116
7	82.5	0.046	0.099
7	87.5	0.008	0.048
7	92.5		0.012

[27] For the treatment of TMY3 data and mapping weather stations to regions, climate zones and states please see Appendix 7C or the Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Consumer Furnaces. U.S. Department of Energy. 2022. Available at *https://www.regulations.gov/document/EERE-2014-BT-STD-0031-0320.*

TABLE III.19—EXAMPLE AMBIENT TEMPERATURE PROBABILITIES FOR CENSUS REGION 2 (MIDWEST), WHERE PESS ARE OPERATED FOR 1 AND 7 MONTHS PER YEAR—Continued

Months of operation *npy*	Temperature bin °F (*j*)	Probability (*w*)	
		Cold/very cold (*z*)	Mixed-humid (*z*)
Total		1.000	1.00

Representative values of the distribution are provided in Table III.19 for one month of operation and for seven months of operation per year. In general, the smaller the *npy,* the more usage is concentrated in warmer months.

DOE requests comment on its approach to determining regional ambient temperatures.

4. Operating Water Temperature (T_{op})

An input to the energy use analysis is the typical stand-by mode operating temperature of the spa. DOE understands that the typical operating temperature for any given spa would be determined by the personal preference of the consumer. Further, DOE understands that all potential product classes of PESs can be operated over a range of temperatures, with a recommended safe operating maximum temperature of 104 °F.[28] DOE recognizes that this maximum temperature would not apply to exercise spas not capable of maintaining a minimum water temperature of 100 °F. DOE was unable to find a credible source to create a lower bound, minimum stand-by operating temperature. In a guidance document to dutyholders of spas, the Health and Safety Executive determined a typical operating range of 30–40 °C (86–104 °F).[29]

For any future potential energy conservation standards for PESs, DOE tentatively concludes that the typical stand-by mode operating temperatures aligns with the minimum operating temperatures stated in APSP–14 2019, and that these temperatures are representative of the average. These values are shown in Table III.20.

TABLE III.20—TYPICAL OPERATING WATER TEMPERATURE (°F) BY SPA POTENTIAL PRODUCT CLASS DEFINED IN APSP–14 2019

Temp. °F	Product class	Requirement	Reference
102 ±2	exercise spas or the exercise portion of a combination spa.	capable of maintaining a minimum water temperature of 100 °F.	5.6.1.1
87 ±2	exercise spas or the exercise portion of a combination spa.	is not capable of maintaining a minimum water temperature of 100 °F.	5.6.1.2
102 ±2	standard spas, the standard spa portion of a combination spa, or inflatable spas.		5.6.1.3

For spas capable of maintaining a minimum water temperature of 100 °F, DOE assumed for modelling a single point temperature of 102 °F. For spas not capable of maintaining a minimum water temperature of 100 °F, DOE assumed for modelling a single point temperature of 87 °F. DOE split the fraction of exercise, and the exercise portion of combination spas, where 30 percent of installations would operate at 87 °F and the remaining 70 percent of installations would operate at 102 °F. DOE made the modeling assumption that the spa would be maintained at this temperature for the operating hours that the spa is in stand-by mode. However, in the field, DOE expects that spas will be operated over a range of temperatures to meet the comfort of the consumer.

DOE requests data or comment on the typical operating temperature for exercise spas *not* capable of maintaining a minimum temperature of 100 °F. And DOE requests data or comment on the distribution of typical operating temperature for exercise spas *not* capable of maintaining a minimum temperature of 100 °F.

DOE requests data or comment on the distribution of typical operating temperature for spas capable of maintaining a minimum temperature of 100 °F. And DOE requests data or comment on the distribution of typical operating temperature for exercise spas capable of maintaining a minimum temperature of 100 °F.

5. Annual Energy Use Results

TABLE III.21—AVERAGE ANNUAL ENERGY USE BY POTENTIAL PRODUCT CLASS (KWH/YEAR)

Efficiency level	Spa type			
	Combination	Exercise	Inflatable	Standard
0	8,978	6,869	988	2,570
1	5,118	3,937	816	1,542
2	4,182	3,219	511	1,283
3	3,978	3,063	507	1,228
4	3,783	2,902	N/A	1,101
5	3,654	2,803	N/A	1,066
6	2,894	2,223	N/A	860

[28] U.S. Consumer Product Safety Commission, CPSC Warns of Hot Tub Temperatures, December 31, 1979. Available at *www.cpsc.gov/Newsroom/News-Releases/1980/CPSC-Warns-Of-Hot-Tub-Temperatures* (Last accessed: January 14, 2022.)

[29] The Control of Legionella and Other Infectious Agents in Spa-Pool Systems, Health and Safety Executive, 2017. Available at *www.hse.gov.uk/pubns/priced/hsg282.pdf.*

TABLE III.21—AVERAGE ANNUAL ENERGY USE BY POTENTIAL PRODUCT CLASS (KWH/YEAR)—Continued

Efficiency level	Spa type			
	Combination	Exercise	Inflatable	Standard
7	2,605	2,002	N/A	781
8	2,512	1,931	N/A	756

F. Life-Cycle Cost and Payback Period Analyses

DOE conducted LCC and PBP analyses to evaluate the economic impacts on individual consumers defined in the consumer sample (see section III.E.1) of potential energy conservation standards for PESs. The effect of potential energy conservation standards on individual consumers usually involves a reduction in operating cost and an increase in purchase cost. In this NODA, DOE used the following two metrics to measure consumer impacts:

- The LCC is the total consumer expense of an appliance or product over the life of that product, consisting of total installed cost (manufacturer selling price, distribution chain markups, sales tax, and installation costs) plus operating costs (expenses for energy use, maintenance, and repair). To compute the operating costs, DOE discounts future operating costs to the time of purchase and sums them over the lifetime of the product.
- The PBP is the estimated amount of time (in years) it takes consumers to recover the increased purchase cost (including installation) of a more-efficient product through lower operating costs. DOE calculates the PBP by dividing the change in purchase cost at higher efficiency levels by the change in annual operating cost for the year that amended or new standards are assumed to take effect.

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

For each considered efficiency level in each potential product class, DOE calculated the LCC and PBP for a nationally representative set of housing units. As stated previously, DOE developed household samples from the 2015 RECS. For each sample household, DOE determined the energy consumption for the PESs and the appropriate electricity price. By developing a representative sample of households, the analysis captured the variability in energy consumption and energy prices associated with the use of PESs.

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

The computer model DOE uses to calculate the LCC and PBP relies on a Monte Carlo simulation to incorporate uncertainty and variability into the analysis. The Monte Carlo simulations randomly sample input values from the probability distributions and PES's user samples. For this NODA the Monte Carlo approach was implemented in a computer simulation. The model calculated the LCC and PBP for products at each efficiency level for 10,000 housing units per simulation run. The analytical results include a distribution of 10,000 data points showing the range of LCC savings for a given efficiency level relative to the no-new-standards case efficiency distribution. In performing an iteration of the Monte Carlo simulation for a given consumer, product efficiency is chosen based on its probability. If the chosen product efficiency is greater than or equal to the efficiency of the standard level under consideration, the LCC and PBP calculation reveals that a consumer is not impacted by the standard level. By accounting for consumers who already purchase more-efficient products, DOE avoids overstating the potential benefits from increasing product efficiency.

DOE calculated the LCC and PBP for all consumers of PESs as if each were to purchase a new product in the expected year of required compliance with new standards. Any new standards would apply to PESs manufactured 5 years after the date on which any new standard is published. (42 U.S.C. 6295(l)(2)) For purposes of its analysis, DOE used 2029 as the first year of compliance with any new standards for PESs.

Table III.22 summarizes the approach and data DOE used to derive inputs to the LCC and PBP calculations. The subsections that follow provide further discussion on the approach and data.

TABLE III.22—SUMMARY OF INPUTS AND METHODS FOR THE LCC AND PBP ANALYSIS *

Inputs	Source/method
Product Cost	Derived by multiplying MPCs by manufacturer and retailer markups and sales tax, as appropriate.
Installation Costs	Assumed no change with efficiency level and not considered in the NODA.
Annual Energy Use	The total annual energy use multiplied by the hours per year. Average number of hours based on RECS 2015. Variability: Based on the Census region, and Climate Zone.
Energy Prices	Electricity: Determined as per LBNL–2001169.[30]
Energy Price Trends	Based on *AEO2022* price projections.
Repair and Maintenance Costs	Assumed not to change with efficiency level.
Product Lifetime	Average: 10.5 years for hard-sided spas, 3.0 for inflatable spas.

[30] Coughlin, K., Beraki, B. *Residential Electricity Prices A Review of Data Sources and Estimation Methods.* Energy Analysis and Environmental Impacts Division Lawrence Berkeley National Laboratory Energy Efficiency Standards Group. 2018. Available at *https://eta-publications.lbl.gov/sites/default/files/lbnl-2001169.pdf.*

TABLE III.22—SUMMARY OF INPUTS AND METHODS FOR THE LCC AND PBP ANALYSIS *—Continued

Inputs	Source/method
Discount Rates	Approach involves identifying all possible debt or asset classes that might be used to purchase the considered appliances or might be affected indirectly. Primary data source was the Federal Reserve Board's Survey of Consumer Finances.
Compliance Date	2029.

1. Inputs to the Life-Cycle Cost Model

The LCC is the total consumer expense during the life of an appliance, including purchase expense and operating costs (including energy expenditures). DOE discounts future operating costs to the time of purchase and sums them over the lifetime of the product. DOE defines LCC by the following equation:

$$LCC = TIC + \sum_{t=1}^{N} \frac{OC_t}{(1+r)^t}$$

Where:

LCC = life-cycle cost in dollars,
TIC = total installed cost in dollars,
Σ = sum over product lifetime, from year *1* to year *N,*
N = lifetime of appliance in years,
OC_t = operating cost in dollars in year t,
r = discount rate, and
t = year for which operating cost is being determined.

DOE expresses dollar values in 2021$ for the LCC.

a. Inputs to Total Installed Cost

Product Costs

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

Future Product Costs

Examination of historical price data for certain appliances and equipment that have had energy conservation standards indicates that the assumption of constant real prices and costs may overestimate long-term trends in appliance and equipment prices in many cases. Economic literature and historical data suggest that the real costs of these products may, in fact, trend downward over time according to ''learning'' or ''experience'' curves. Desroches *et al.* (2013) summarizes the data and literature currently available that is relevant to price projections for selected appliances and equipment.[31] The extensive literature on the ''learning'' or ''experience'' curve phenomenon is typically based on observations in the manufacturing sector.[32] In the experience curve method, the real cost of production is related to the cumulative production or ''experience'' with a manufactured product. This experience is usually measured in terms of cumulative production. Thus, as experience (production) accumulates, the cost of producing the next unit decreases.

If DOE proceeds with new efficiency standards for PESs, DOE may derive the learning rate parameter for all PESs from the historical Producer Price Index (''PPI'') data for ''326191—Plastics Plumbing Fixture Manufacturing'' for the time period between 1993 and 2021 from the Bureau of Labor Statistics (''BLS'').[33 34] If DOE determines that new efficiency standards for PESs are warranted, DOE will inflation-adjust the price indices calculation by dividing the PPI series by the implicit Gross Domestic Product price deflator for the same years.

DOE requests comment on its proposed methodology to project future equipment prices.

DOE requests information or data related to the past trends in production costs of PESs. Additionally, DOE requests data or information related to the cost of PES production over time.

Installation Costs

As noted, inputs to the calculation of total install cost include the installation costs. Installation cost includes labor, overhead, and any miscellaneous materials and parts needed to install the product. As part of its Title 20 regulatory activities for PESs, CEC examined potentially available technologies that can be employed to improve the efficiency of PESs. CEC's report includes several technology options but states that improved insulation (in terms of improved insulation coverage, type, and quantity) within the tub walls and of the tub cover offer the greatest opportunity for improved efficiency. The report also mentions further attainable efficiency improvements through, but not limited to, improved spa cover design and improved pump and motor system design within in the spa itself.[35] DOE tentatively finds that none of these technologies would impact the quantity of labor, overhead, or materials needed to install a PES if DOE were to adopt new energy efficiency standards. Based on these findings, DOE tentatively concludes that installation costs should not be included in any future life-cycle cost analysis.

DOE requests comment on its decision to exclude installation costs from any future efficiency standard calculation.

DOE requests data and details on the installation costs of PESs, and whether those costs vary by product type or any other factor affecting their efficiency.

b. Inputs to Operating Costs

Annual Energy Consumption

For each sampled household, DOE determined the energy consumption for a PES at different efficiency levels using the approach described previously in section III.E of this document.

Electricity Prices

Using data from EEI Typical Bills and Average Rates reports, DOE derived annual electricity prices in 2021 for all the census regions in *RECS*.[36 37] DOE calculated electricity prices using the

[31] Desroches, Louis-Benoit, et al., ''Incorporating Experience Curves in Appliance Standards Analysis'', Energy Policy 52 (2013): 402–416.

[32] In addition to Desroches (2013), see Weiss, M., Junginger, H.M., Patel, M.K., Blok, K., (2010a). A Review of Experience Curve Analyses for Energy Demand Technologies. Technological Forecasting & Social Change. 77:411–428.

[33] This U.S. industry consists of establishments primarily engaged in manufacturing plastics or fiberglass plumbing fixtures. Examples of products made by these establishments are plastics or fiberglass bathtubs, *hot tubs,* portable toilets, and shower stalls. See *www.naics.com/naics-code-description/?code=326191*

[34] Product series ID: NDU3261913261911, see more information at *www.bls.gov/ppi.*

[35] Final Staff Report, Analysis of Efficiency Standards and Marking for Spas, 2018 Appliance Efficiency Rulemaking for Spas Docket Number 18–AAER–02 TN 222413. Available at *efiling.energy.ca.gov/GetDocument.aspx?tn=222413&DocumentContentId=31256.*

[36] Edison Electric Institute, Typical Bills and Average Rates Report, Winter 2021, 2021.

[37] Edison Electric Institute, Typical Bills and Average Rates Report, Summer 2021, 2021.

methodology described in Coughlin and Beraki (2018), where for each purchase sampled, DOE assigned the average and marginal electricity price for the census region in which the PES is located.[38] Because marginal electricity price captures more accurately the incremental costs or savings associated with a change in energy use relative to the consumer's bill in the reference case, it may provide a better representation of incremental change in consumer costs than average electricity prices. Therefore, DOE used average electricity prices to characterize the baseline energy level and marginal electricity prices to characterize the incremental change in energy costs associated with the other energy levels considered. The regional average and marginal electricity prices are shown in Table III.23.

TABLE III.23—REGIONAL AVERAGE AND MARGINAL ELECTRICITY PRICES

[$/kWh, 2021$]

Census region	Geographic area	Average $/kWh	Marginal $/kWh
1	Northeast	0.1834	0.1687
2	Midwest	0.1380	0.1240
3	South	0.1164	0.0994
4	West	0.1959	0.2145

Future Electricity Price Trends

To arrive at prices in future years, DOE will multiply the 2021 electricity prices by the forecast of annual average price changes for each census division from the most recent Energy Information Administration's Annual Energy Outlook (''AEO'').[39] To estimate price trends after 2050, DOE maintained prices constant at 2050 levels.

DOE requests comment on its use of AEO to project electricity prices into the future.

Maintenance and Repair Costs

As noted, inputs to the calculation of operating expenses include repair and maintenance costs, among other factors. For this NODA, DOE made the modeling assumption that maintenance costs would not change with increased product stand-by efficiency. DOE understands that PES maintenance broadly falls into two categories: (1) maintaining water quality, and (2) the care and upkeep of the PES itself. DOE does not foresee a difference in costs to consumers in maintaining water quality under a new potential efficiency standard to stand-by power. Further, DOE understands the maintenance to the PES itself to be cleaning activities (*i.e.,* cleaning of the filters, spa interior, spa exterior, and cover).[40] Based on these understandings, DOE does not consider that these cleaning activities would cost the consumer more under a new potential energy conservation standard.

However, DOE notes that the costs to repair more efficient PES mechanical systems and insulation may be greater in the case of a potential new energy conservation standard.

DOE requests feedback and specific data on whether maintenance costs differ in comparison to the baseline maintenance costs for any of the specific efficiency improving technology options applicable to PESs.

DOE requests comment on the typical repairs to PESs and how they may differ in the case of a potential new energy conservation standard.

2. Product Lifetime

The product lifetime is the age at which a product is retired from service. Rather than use a single average value for the lifetime of PESs, DOE developed lifetime distributions to characterize the age, in years, when hard- and inflatable PESs will be retired from service. To model PES lifetimes, DOE assumed that the probability function for the annual survival of PESs would take the form of a Weibull distribution. A Weibull distribution is a probability distribution commonly used to measure failure rates.[41 42]

a. Hard-Sided Spas

DOE examined historical hard-sided spa installation data from PK Data, Inc. (''PK Data'') for the years from 2015 through 2020 and fit a Weibull distribution to these data with minimum and maximum lifetimes of 1 year and 30 years, respectively. This Weibull distribution yielded an average lifetime of 9.3 years.

b. Inflatable Spas

DOE did not have equivalent data from which to estimate lifetimes for inflatable spas. As a result, DOE used the average lifetime on the design life from the CEC CASE report on PESs.[43] To estimate the lifetime of inflatable spas, DOE fit a Weibull function based on the modeling assumptions of an average and maximum lifetimes of 3.0 and 5.0 years, respectively.

[38] Coughlin, K., Beraki, B. Residential Electricity Prices A Review of Data Sources and Estimation Methods. Energy Analysis and Environmental Impacts Division Lawrence Berkeley National Laboratory Energy Efficiency Standards Group. 2018. Available at *https://eta-publications.lbl.gov/sites/default/files/lbnl-2001169.pdf.*

[39] *See www.eia.gov/outlooks/aeo.*

[40] *See https://staging-na01-jacuzzi.demandware.net/on/demandware.static/-/Library-Sites-jacuzzi-shared-content/default/v44de813235d8b46eb8c84da693ec1bed8e8ec186/pdf-documents/Jacuzzi_Swim_Spa_Collection_Owners_Manual_English.pdf.*

[41] For reference on the Weibull distribution, see sections 1.3.6.6.8 and 8.4.1.3 of the NIST/SEMATECH e-Handbook of Statistical Methods. Available at *www.itl.nist.gov/div898/handbook/.*

[42] For an example methodology of how DOE approaches its survival calculation, see section 8.3.4 of chapter 8 of the Technical Support Document: Energy Efficiency Program For Consumer Products and Commercial and Industrial Equipment: Consumer Furnaces. DOE. 2022. Available at *https://www.regulations.gov/document/EERE-2014-BT-STD-0031-0320.*

[43] California Energy Commission. ''Final Staff Report—Analysis of Efficiency Standards and Marking for Spas.'' February 2, 2018.

TABLE III.24—LIFETIME PARAMETERS

	Value			Weibull parameters	
	Minimum (*years*)	Average (*years*)	Maximum (*years*)	Alpha (scale)	Beta (shape)
Hard-Sided Spas	1	9.3	30	9.91	1.85
Inflatable Spas	1	3.0	5	3.20	7.00

DOE requests comment on its lifetime analysis.

3. Rebound Effect

DOE considered the possibility that some consumers may use a higher-efficiency PES more than a baseline one, thereby negating some or all the energy savings from the more-efficient product. Such a change in consumer behavior when operating costs decline is known as a (direct) rebound effect. Because the heating and pumping systems operation in ''stand-by mode'' also function when the PES is operated in ''active mode,'' an increase in PES usage due to a rebound effect would not impact any potential energy savings in a new standards case. For this reason, DOE tentatively finds that the rebound effect should not apply to PES stand-by power.

DOE requests comment on its reasoning to not apply a rebound effect to PES stand-by power energy use.

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

To accurately estimate the share of consumers that would be affected by a potential energy conservation standard at a particular efficiency level, DOE's LCC analysis considers the projected distribution (market shares) of product efficiencies under the no-new-standards case (*i.e.,* the case without amended or new energy conservation standards).

To establish the fraction of PES purchases that exceed baseline equipment in terms of energy efficiency in the absence of potential new standards, DOE examined information provided by PHTA and U.S. Census data.

The information provided by the PHTA shows the adoption of state level minimum efficiency requirements for PESs. These state level programs are related to different editions of APSP–14 2019, and this variation in state-level adoption creates a fractured regulatory environment where different states have different minimum energy efficiency requirements.

For this NODA, DOE has made the simplified modeling assumption that all spas sold in states with an existing standard would adhere to APSP–14 2019 and will be considered above the baseline in 2029. Further, DOE notes that the RECS 2015 data does not have state-level information from which to derive the relative spa owning probability for each state, and, for the purposes of estimating the efficiency distribution in the no-new standards case, DOE used state populations published in the 2021 Census.[44] DOE acknowledges that this modeling assumption may overrepresent the state of national efficiency adoption to the detriment of national energy savings as states with less stringent standards are modeled with greater minimum efficiency levels. However, this potential overrepresentation may be balanced by those consumers in non-regulated states purchasing more efficient products. These populations are shown in Table III.25 and are held constant over time.

Using the projected distribution of efficiencies for PESs, DOE randomly assigned a product efficiency to each household drawn from the consumer sample. If a consumer is assigned a product efficiency that is greater than or equal to the efficiency under consideration, the consumer would not be affected by a standard at that efficiency level.

TABLE III.25—PESS MINIMUM EFFICIENCY STANDARDS BY STATE

State	Standard	Population
Arizona	AZ Title 44	7,276,316
California	APSP 14–2019	39,237,836
Connecticut	CA Title 20 (2006)	3,605,597
District of Columbia	APSP 14–2019	670,050
Massachusetts	APSP 14–2019	6,984,723
New Jersey	APSP 14–2019	9,267,130
Oregon	APSP 14–2019	4,246,155
Pennsylvania	APSP 14–2019	12,964,056
Rhode Island	APSP 14–2019	1,095,610
Colorado	APSP 14–2014	5,812,069
Maryland	APSP 14–2019	6,165,129
Nevada	APSP 14–2019	3,143,991
Vermont	APSP 14–2014	645,570
Washington	APSP 14–2014	7,738,692
Total Population Covered by Standards		108,852,924
U.S. Population		331,893,745
Fraction above Baseline		32.8%
Fraction at Baseline		67.2%

[44] Annual Estimates of the Resident Population for the United States, Regions, States, District of Columbia, and Puerto Rico: April 1, 2020 to July 1, 2021 (NST–EST2021–POP). U.S. Census Bureau, Population Division. December 2021.

TABLE III.26—DISTRIBUTION OF EFFICIENCIES IN THE NO-NEW STANDARDS CASE (%)

Type	Efficiency level								
	0	1	2	3	4	5	6	7	8
All Spas	67.2	32.8	0	0	0	0	0	0	0

5. Discount Rates

In the calculation of LCC, DOE applies discount rates appropriate to households to estimate the present value of future operating cost savings in the year of compliance. DOE estimated a distribution of discount rates for PESs based on the opportunity cost of consumer funds.

DOE applies weighted average discount rates calculated from consumer debt and asset data, rather than marginal or implicit discount rates.[45] The LCC analysis estimates net present value over the lifetime of the product. As a result, the appropriate discount rate will reflect the general opportunity cost of household funds, taking this time scale into account. Given the long-time horizon modeled in the LCC analysis, the application of a marginal interest rate associated with an initial source of funds is inaccurate. Regardless of the method of purchase, consumers are expected to continue to rebalance their debt and asset holdings over the LCC analysis period, based on the restrictions consumers face in their debt payment requirements and the relative size of the interest rates available on debts and assets. DOE estimates the aggregate impact of this rebalancing using the historical distribution of debts and assets.

To establish residential discount rates for the LCC analysis, DOE identified all relevant household debt or asset classes to approximate a consumer's opportunity cost of funds related to appliance energy cost savings. Then DOE estimated the average percentage shares of the various types of debt and equity by household income group using data from the Federal Reserve Board's Survey of Consumer Finances (''SCF'') for 1995, 1998, 2001, 2004, 2007, 2010, 2013, 2016, and 2019.[46] Using the SCF and other sources, DOE developed a distribution of rates for each type of debt and asset by income group to represent the rates that may apply in the year in which new energy conservation standards would take effect. DOE assigned each sample household a specific discount rate drawn from one of the distributions. The average rate across all types of household debt and equity and income groups were then mapped to RECS income bins for the fraction of homes with portable electric spas.[47]

TABLE III.27—MAPPING OF SCF INCOME GROUPS TO RECS 2015 INCOME BIN

RECS income bins	1	2	3	4	5	6
1	100.0%					
2	2.9%	86.6%	10.6%			
3			100.0%			
4			15.4%	84.6%		
5				100.0%		
6				13.4%	86.6%	
7					88.4%	11.6%
8						100.0

TABLE III.28—AVERAGE REAL EFFECTIVE DISCOUNT RATES

SCF income group	Discount rate (%)
1	4.76
2	4.99
3	4.54
4	3.84
5	3.47
6	3.23
Overall Average	*4.29*

Source: Board of Governors of the Federal Reserve System, Survey of Consumer Finances (1995–2019).

[45] The implicit discount rate is inferred from a consumer purchase decision between two otherwise identical goods with different first cost and operating cost. It is the interest rate that equates the increment of first cost to the difference in net present value of lifetime operating cost, incorporating the influence of several factors: transaction costs; risk premiums and response to uncertainty; time preferences; and interest rates at which a consumer is able to borrow or lend. The implicit discount rate is not appropriate for the LCC analysis because it reflects a range of factors that influence consumer purchase decisions, rather than the opportunity cost of the funds that are used in purchases.

[46] Note that two older versions of the SCF are also available (1989 and 1992); these surveys are not used in this analysis because they do not provide all of the necessary types of data (*e.g.,* credit card interest rates, etc.). DOE has tentatively determined that the time span covered by the eight surveys included is sufficiently representative of recent debt and equity shares and interest rates.

[47] A detailed discussion of DOE discount rate methodology for residential consumers can be found in the Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Consumer Furnaces. DOE, 2022, in chapters 8, and appendix 8H. Available at *https://www.regulations.gov/document/EERE-2014-BT-STD-0031-0320.*

6. Payback Period Analysis

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

$$PBP = \frac{\Delta IC}{\Delta OC}$$

Where:

PBP = payback period in years,

ΔIC = difference in the total installed cost between the more efficient product (efficiency levels 1, 2, 3, etc.) and the baseline product, and

ΔOC = difference in first-year annual operating costs between the more efficient product and the baseline product.

The data inputs to PBP are the total installed cost of the product to the consumer for each efficiency level and the annual (first year) operating costs for each efficiency level. As for the LCC, the inputs to the total installed cost are the product price and installation cost. The inputs to the operating costs are the annual energy and annual maintenance costs. The PBP uses the same inputs as does the LCC analysis, except that electricity price trends are not required. Because the PBP is a simple payback, the required electricity cost is only for the year in which a potential new energy conservation standard would take effect—in this case, 2029.

7. Consumer Results

TABLE III.29—STANDARD SPAS: AVERAGE LCC AND PBP RESULTS

Efficiency level	Average costs (2021$)				Simple payback period (years)	Average lifetime (years)
	Installed cost	First year's operating cost	Lifetime operating cost	LCC		
0	8,507	352	2,648	11,644		8.8
1	8,594	246	1,849	10,937	0.8	8.8
2	8,852	207	1,555	10,918	2.4	8.8
3	9,165	198	1,491	11,188	4.5	8.8
4	9,725	179	1,345	11,638	7.8	8.8
5	10,338	174	1,305	12,251	11.9	8.8
6	11,347	142	1,068	13,088	16.5	8.8
7	12,530	130	978	14,258	23.9	8.8
8	13,851	126	949	15,636	34.6	8.8

TABLE III.30—STANDARD SPAS: AVERAGE LCC SAVINGS RELATIVE TO THE NO-NEW-STANDARDS CASE EFFICIENCY DISTRIBUTION

Efficiency level	% Consumers with net cost	Average savings—impacted consumers (2021$)
1	6.4	1,056
2	35.2	726
3	51.2	456
4	65.9	6
5	77.0	−607
6	84.6	−1,444
7	91.4	−2,614
8	96.1	−3,992

TABLE III.31—EXERCISE SPAS: AVERAGE LCC AND PBP RESULTS

Efficiency level	Average costs (2021$)				Simple payback period (years)	Average lifetime (years)
	Installed cost	First year's operating cost	Lifetime operating cost	LCC		
0	26,791	930	6,937	35,077		8.8
1	27,063	631	4,715	33,144	0.9	8.8
2	27,876	521	3,892	33,187	2.7	8.8
3	28,862	497	3,715	34,060	5.1	8.8
4	30,624	472	3,530	35,751	9.4	8.8
5	32,556	457	3,417	37,696	14.6	8.8
6	35,731	368	2,756	40,415	20.2	8.8
7	39,459	335	2,504	44,132	29.7	8.8
8	43,618	324	2,423	48,479	44.0	8.8

TABLE III.32—EXERCISE SPAS: AVERAGE LCC SAVINGS RELATIVE TO THE NO-NEW-STANDARDS CASE EFFICIENCY DISTRIBUTION

Efficiency level	% Consumers with net cost	Average savings—impacted consumers (2021$)
1	7.9	2,889
2	39.5	1,889
3	55.8	1,017
4	72.1	−674
5	82.1	−2,619
6	88.5	−5,338
7	94.2	−9,055
8	97.5	−13,403

TABLE III.33—COMBINATION SPAS: AVERAGE LCC AND PBP RESULTS

Efficiency level	Average costs (2021$)				Simple payback period (years)	Average lifetime (years)
	Installed cost	First year's operating cost	Lifetime operating cost	LCC		
0	34,175	1,218	9,093	44,965		8.8
1	34,523	823	6,143	42,387	0.9	8.8
2	35,560	678	5,064	42,412	2.7	8.8
3	36,818	647	4,831	43,519	4.9	8.8
4	39,065	617	4,609	45,690	9.1	8.8
5	41,531	597	4,460	48,167	14.1	8.8
6	45,581	481	3,592	51,611	19.5	8.8
7	50,336	437	3,262	56,345	28.6	8.8
8	55,642	422	3,155	61,888	42.2	8.8

TABLE III.34—COMBINATION SPAS: AVERAGE LCC SAVINGS RELATIVE TO THE NO-NEW-STANDARDS CASE EFFICIENCY DISTRIBUTION

Efficiency level	% Consumers with net cost	Average savings—impacted consumers (2021$)
1	7.5	3,835
2	38.4	2,553
3	54.2	1,446
4	70.6	−724
5	81.0	−3,201
6	88.2	−6,646
7	94.1	−11,379
8	97.4	−16,923

TABLE III.35—INFLATABLE SPAS: AVERAGE LCC AND PBP RESULTS

Efficiency level	Average costs (2021$)				Simple payback period (years)	Average lifetime (years)
	Installed cost	First year's operating cost	Lifetime operating cost	LCC		
0	244	147	424	780		3.0
1	287	130	375	778	2.8	3.0
2	549	83	238	924	5.5	3.0
3	858	82	237	1,256	13.0	3.0

TABLE III.36—INFLATABLE SPAS: AVERAGE LCC SAVINGS RELATIVE TO THE NO-NEW-STANDARDS CASE EFFICIENCY DISTRIBUTION: COMBINATION SPAS

Efficiency level	% Consumers with net cost	Average savings—impacted consumers (2021$)
1	38.7	3
2	84.6	−143
3	99.6	−475

G. Shipments Analysis

DOE uses projections of annual product shipments to calculate the national impacts of potential amended or new energy conservation standards on energy use, NPV, and future manufacturer cash flows.[48] The shipments model takes an accounting approach in tracking market shares of each potential product class and the vintage of units in the stock. Stock accounting uses product shipments as inputs to estimate the age distribution of in-service product stocks for all years. The age distribution of in-service product stocks is a key input to calculations of both the NES and NPV because operating costs for any year depend on the age distribution of the stock.

1. Approach to Shipments and Stock Models

DOE developed a national stock model to estimate annual shipments of products under potential energy efficiency standards. The model considers market segments as distinct inputs to projected shipments. DOE considered new home installations and replacements in existing households as the primary market segments for PESs.

DOE's shipments model takes a stock accounting approach, tracking the vintage of units in the existing stock and expected housing stock trends. The stock accounting uses product shipments, a retirement function, and initial in-service product stock as inputs to develop an estimate of the age distribution of in-service product stock for all years. The age distribution of in-service product stock is a key input to calculations of both the NES and NPV because the operating costs for any year depend on the age distribution of the stock. The dependence of operating cost on the product age distribution occurs under a standards-case scenario that produces increasing efficiency over time, whereby older, less efficient units may have higher operating costs, while younger, more-efficient units have lower operating costs.

2. Initial Stock Estimates

a. Hard-Sided Spas Stock

DOE used industry data from PK Data to estimate the initial stock for hard-sided spas.[49] The PK Data were compiled from manufacturer data and other sources, including dealers, retailers, and consumers, and provide an estimated installation base for these spas. However, these data did not specify the fraction of installations that are standard, exercise, or combination spas. For this NODA, DOE has made the modeling assumptions that the fraction of the market for standard, exercise, and combination spas will follow the model count in MAEDbS.[50] The stock breakdown based on the data received by DOE from PK Data and the weights from MAEDbS are shown in Table III.37.

TABLE III.37—PK DATA AND DOE STOCK ESTIMATES OF HARD-SIDED SPAS

[Units, 2020]

	All spas PK data	Standard	Exercise	Combination
Fraction (%)	100	85	12	3
Units (2020)	5,454,117	4,635,999	654,494	163,624

DOE requests comment on its stock ratios for hard-sided spas. Additionally, DOE seeks input on the market shares of standard, exercise, and combination spas.

b. Inflatable Spas Stock

Inflatable spas (inflatable spas) are a relatively new product to the spa industry. As such, DOE was unable to find comprehensive, publicly available information to indicate either their shipments or existing stock. The CEC's ''2018 Appliance Efficiency Rulemaking for Spas, Final Staff Report'' projected California's stock of inflatable spas in 2020 to be 20,101 units. When this value is scaled by population, it produces a national stock estimate of 170,025 units, or approximately 3 percent of the stock of hard-sided Spas. For this NODA, DOE has made the modeling assumption that stock of inflatable spas in 2020 was 170,025 units.

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

[49] P.K. Data Inc. 2022 Hot Tube Market Data: Custom Compilation for Lawrence Berkeley National Laboratory (through 2021). 2022. Alpharetta, GA. (Last accessed April 12, 2022.) Available at *https://www.pkdata.com/reports-store.html#/.*

[50] California Energy Commission's Modernized Appliance Efficiency Database System. Available at *https://cacertappliances.energy.ca.gov/Login.aspx.*

TABLE III.38—ESTIMATED TOTAL PES STOCKS, AND MARKET WEIGHT, 2020 (UNITS)

Potential product class	Potential product class weight, *M*	Units
Standard	82.5	4,635,999
Exercise	11.7	654,494
Combination	2.9	163,624
Inflatable	2.9	170,025

DOE seeks comment on its 2020 stock estimates for all spa types.

3. Product Saturations

PES stocks are distributed nationally according to the number of single-family houses by census region, *r*, and climate zone, *z*, derived from RECS. These regional distributions are considered static over the analysis period. PES saturations are expressed as:

$$Stock_i = \frac{Stock_i}{Stock_t} \times Stock_t,$$

$$S_i = \frac{Stock_i}{H_i}$$

Where:

$Stock_t$ = the total PES stock in 2022, *i.e.,* 5,624,142 units,
i = an index indicating the location (r, z) of the spa,
S = the saturation (count) of spas per single-family household, and
H = total single-family households.

4. Determining Annual Spa Shipments

a. Initial Shipments

Initial shipments for each potential product class of PESs are derived from the stock estimates in section III.G.2, as:

$$Ship_s = \frac{(SH) \times M}{L_{avg}}$$

Where:

$Ship_s$ = total PES shipments for each product class,
M = PES market weight (see Table III.38), and
L_{avg} = the average potential product class's lifetime.

b. New Spa Shipments

To estimate shipments of new purchases, DOE used projections of total housing stock from *AEO2022* coupled with the estimated PES saturation. In other words, to project the shipments for new purchases for any given year, DOE multiplied the regional stock housing projections by the estimated saturation of PES. New shipments in each year are determined as:

$Ship_n(y) = N(y)S(y)$

Where:

$Ship_n$ = new shipments,
y = year of analysis, and
N = new housing starts.

c. Spa Replacements

Over time, some units will be retired and removed from stock, thereby triggering the shipment of a replacement unit. Depending on the vintage, a certain percentage of each type of unit will fail and need to be replaced. To determine when a unit fails, DOE used a Weibull survival function based on a product lifetime distribution with an average lifetime of 9.3 years and 3.5 years for hard-sided, and inflatable spas, respectively. For a more complete discussion of lifetimes, refer to section III.F.2. Shipments for replacements are defined as:

$$Ship_r(y) = \sum_{y-L_{max}}^{y-1} p_r Ship_s$$

Where:

$Ship_r$ = shipments for replacement,
L_{max} = product maximum lifetime, and
p_r = a product's retirement probability.

d. Demolitions

Demolitions refer to the destruction of in-service spas that are not replaced with new equipment. For this NODA, DOE defined the demolition rate as follows. For each location (*r, z*), and analysis year, *y.*

$E = T - N$

$$\sigma = \frac{E(y-1) - E(y) + N(y)}{E(y) + N(y)}$$

Where:

σ = the demolition rate, and
E = existing single-family house count, derived from RECS.

e. Product Lifetimes

The methodology used to determine the distribution of PESs' lifetimes is discussed in section III.F.2.

f. Future Portable Electric Spa Shipments

To project future shipments, DOE typically uses new housing starts projections from AEO as market drivers for products sold to the residential sector. For this NODA, DOE used the Single-Family Households trend from *AEO2022* to drive future spa shipments.[51]

DOE requests comment on its proposed use of future residential construction to project future shipments of PESs.

g. Calculating Shipments and Stock

DOE calculates the total in-service stock of products by integrating historical shipments data starting from a specified year. The start year depends on the historical data available for each product, which for this NODA is based on data from PK Data in 2020. As units are added to the in-service stock, some older units retire and exit the stock. In this NODA, for each year in the analysis period from 2029 through 2058, DOE calculated the shipments and stock as:

$Stock(y) = Stock(y-1)(1-\sigma) + Ship_n(y),$ and

$Ship_s(y) = Ship_n(y) + Ship_r(y) + \sigma Stock(y-1).$

As the last unit shipped during the analysis period will survive beyond 2056, their presence was be accounted for as:

$Stock(y) = Stock(y-1) - Ship_r(y),$

5. Impacts of Increased Product Costs on Shipments

Because DOE's projections of shipments and national impacts from potential energy conservation standards consider a 30-year period, DOE needed to consider how price elasticity evolves in the years after a new standard takes effect in this NODA. Price elasticity is a factor that reflects the percent change in quantity purchased of a product

[51] U.S. Department of Energy—Energy Information Administration. Annual Energy Outlook 2022. 2022. Washington, DC. (Last accessed July 10, 2022.) See: Table 4. Residential Sector Key Indicators and Consumption—Case: Reference case Available at *https://www.eia.gov/outlooks/aeo/data/browser/#/?id=4-AEO2022&cases=ref2022&sourcekey=0.*

given a 1 percent change in price. DOE conducted a literature review and an analysis of appliance price and efficiency data to estimate the effects on product shipments from increases in product purchase price and product energy efficiency.

Existing studies of appliance markets suggest that the demand for durable goods, such as appliances, is price-inelastic. Other information in the literature suggests that appliances are a normal good, such that rising incomes increase the demand for appliances, and that consumer behavior reflects relatively high implicit discount rates when comparing appliance prices and appliance operating costs.

DOE considered the price elasticity developed above to be a short-term value but was unable to identify sources specific to PESs that would be sufficient to model differences in short- and long-term price elasticities. Therefore, to estimate how the price elasticity changes through time, DOE relied on a study pertaining to automobiles.[52] This study shows that the price elasticity of demand for automobiles changes in the years following a change in purchase price, a trend also observed in appliances and other durables.[53] [54] As time passes from the change in purchase price, the price elasticity becomes more inelastic until it reaches a terminal value around the tenth year after the price change. Table III.39 shows the relative change over time in the price elasticity of demand for automobiles. As shown in the table, DOE developed a time series of price elasticity for residential appliances based on the relative change over time in the price elasticity of demand for automobiles. For years not shown in the table, DOE performed a linear interpolation to obtain the price elasticity.[55]

TABLE III.39—CHANGE IN RELATIVE PRICE ELASTICITY FOLLOWING A CHANGE IN PURCHASE PRICE

	Years following price change					
	1	2	3	5	10	20
Change in elasticity relative to first year	1.00	0.78	0.63	0.46	0.35	0.33
Price elasticity	−0.45	−0.35	−0.28	−0.21	−0.16	−0.15

6. Results for 30-years of Shipment (2029–2058)

TABLE III.40—PES SHIPMENTS FOR SELECT YEARS IN THE ABSENCE OF POTENTIAL NEW STANDARDS (EL 0), (UNITS)

Year	Spa type			
	Standard	Exercise	Combination	Inflatable
2029	558,863	78,898	19,725	50,809
2030	562,920	79,471	19,868	51,194
2035	580,511	81,954	20,489	53,077
2040	598,725	84,526	21,131	54,708
2045	615,313	86,868	21,717	56,357
2050	631,547	89,160	22,290	57,934
2055	648,129	91,501	22,875	59,488
2058	657,934	92,885	23,221	60,416

TABLE III.41—PES AFFECTED STOCK FOR SELECT YEARS IN THE ABSENCE OF POTENTIAL NEW STANDARDS (EL 0), (UNITS)

Year	Spa type			
	Standard	Exercise	Combination	Inflatable
2027	558,863	78,898	19,725	50,809
2030	1,113,813	157,244	39,311	101,988
2035	3,474,943	490,580	122,645	184,055
2040	4,828,630	681,689	170,422	190,031
2045	5,420,218	765,207	191,302	195,793
2050	5,684,921	802,577	200,644	201,380
2055	5,858,365	827,063	206,766	206,848
2060	4,697,420	663,165	165,791	90,521
2065	2,075,344	292,990	73,247	0
2070	660,865	93,299	23,325	0
2075	150,756	21,283	5,321	0
2080	24,229	3,421	855	0

[52] Saul H. Hymans, Gardner Ackley, and F. Thomas Juster. Consumer durable spending: Explanation and prediction. Brookings Papers on Economic Activity, 1970(2):173–206, 1970. (Last accessed August 28, 2021.) Available at *https://www.jstor.org/stable/2534239*.

[53] Philip Parker and Ramya Neelamegham. Price elasticity dynamics over the product life cycle: A study of consumer durables. Marketing Letters, 8(2):205–216, April 1997. (Last accessed August 28, 2021.) Available at *https://link.springer.com/article/10.1023%2FA%3A1007962520455*.

[54] DOE relies on Hymens *et al.* (1970) for efficiency scaling factors because it provides the greatest detail out of all the available studies on price elasticity over time.

[55] For an example methodology of how DOE approaches its product price elasticity calculation, please see section 9.4 of chapter 9 of the Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Room Air Conditioners. DOE. 2022. Available at *https://www.regulations.gov/document/EERE-2014-BT-STD-0059-0030*.

TABLE III.41—PES AFFECTED STOCK FOR SELECT YEARS IN THE ABSENCE OF POTENTIAL NEW STANDARDS (EL 0), (UNITS)—Continued

Year	Spa type			
	Standard	Exercise	Combination	Inflatable
2085	2,259	319	80	0
2090	0	0	0	0

H. National Impact Analysis

The NIA assesses the NES and the NPV from a national perspective of total consumer costs and savings that would be expected to result from new or amended standards at specific efficiency levels.[56] (''Consumer'' in this context refers to consumers of the product being regulated.) DOE calculates the NES and NPV for the potential standard levels considered based on projections of annual product shipments, along with the annual energy consumption and total installed cost data from the energy use and LCC analyses. For the present analysis, DOE projected the energy savings, operating cost savings, product costs, and NPV of consumer benefits over the lifetime of PESs sold from 2029 through 2058.

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

Table III.42 summarizes the inputs and methods DOE used for the NIA analysis for the NODA. Discussion of these inputs and methods follows the table.

TABLE III.42—SUMMARY OF INPUTS AND METHODS FOR THE NATIONAL IMPACT ANALYSIS

Inputs	Method
Shipments	Annual shipments from shipments model.
Modeled Compliance Date of Standard	2029.
Efficiency Trends	No-new-standards case. Standards cases.
Annual Energy Consumption per Unit	Annual average values are a function of energy use at each EL.
Total Installed Cost per Unit	Annual average values are a function of cost at each EL.
Annual Energy Cost per Unit	Annual weighted-average values as a function of the annual energy consumption per unit and energy prices.
Repair and Maintenance Cost per Unit	Annual values do not change with efficiency level.
Energy Prices	*AEO2022* projections (to 2050), constant 2050 prices thereafter.
Energy Site-to-Primary and FFC Conversion	A time-series conversion factor based on *AEO2022.*
Discount Rate	3 percent and 7 percent.
Present Year	2022.

1. Products Efficiency Trends

A key component of the NIA is the trend in energy efficiency projected for the no-new-standards case and each of the standards cases. Section III.F.4 of this document describes how DOE developed an energy efficiency distribution for the no-new-standards case (which yields a shipment-weighted average efficiency) for each of the considered potential product classes for the year of anticipated compliance with an amended or new standard.

For the standards cases, DOE used a ''roll-up'' scenario to establish the shipment-weighted efficiency for the year that standards are assumed to become effective (2029). In this scenario, the market shares of products in the no-new-standards case that do not meet the standard under consideration would ''roll up'' to meet the new standard level, and the market share of products above the standard would remain unchanged.

For this NODA, DOE's modeling assumed that the distribution of product efficiencies will remain constant over time.

DOE requests comment on its modeling assumption that PES efficiency will remaining constant over time in the absence of potential new standards.

2. National Energy Savings

The NES analysis involves a comparison of national energy consumption of the considered products between each potential standards case (EL) and the case with no new or amended energy conservation standards. DOE calculated the national energy consumption by multiplying the number of units (stock) of each product (by vintage or age) by the unit energy consumption (also by vintage). DOE calculated annual NES based on the difference in national energy consumption for the no-new-standards case and for each higher efficiency standard case. DOE estimated energy consumption and savings based on site energy and converted the electricity consumption and savings to primary energy (*i.e.,* the energy consumed by power plants to generate site electricity) using annual conversion factors derived from *AEO2022*. Cumulative energy

[56] The NIA accounts for impacts in the 50 states and Washington D.C.

savings are the sum of the NES for each year over the timeframe of the analysis.

The following equation shows that DOE calculated annual NES as the difference between two projections: a no-new-standards case (without new standards) and a standards case. Positive values of NES represent energy savings (that is, they show that national annual energy consumption (''AEC'') under a standards case is less than in the no-new-standards).

$$NES_y = AEC_{Base} - AEC_{STD}$$

Where:

NES = annual national energy savings (quads),
AEC = annual national energy consumption each year in quadrillion Btus (quads) summed over vintages of the product stock, and
y = year in the forecast.

Cumulative energy savings are the sum of annual NES from products shipped between the years 2029 through 2058.

DOE calculated the national annual site energy consumption by multiplying the number or stock of the product (by vintage) by its unit annual energy consumption (AEC; also, by vintage). National annual energy consumption is calculated using the following equation.

$$AEC_y = \Sigma\ STOCK_V \times UEC_V$$

Where:

AEC = annual national energy consumption each year in quadrillion Btus (quads), summed over vintages of the product stock, $STOCK_V$,
$STOCK_V$ = stock of product (millions of units) of vintage *V* that survive in the year for which DOE calculated annual energy consumption,
UEC_V = annual energy consumption of PESs in kilowatt-hours (kWh),
V = year in which the product was purchased as a new unit, and
y = year in the forecast.

The stock of a product depends on annual shipments and the lifetime of the product. DOE projected product shipments under the no-new-standards case and standards cases. To avoid including savings attributable to shipments displaced (units not purchased) because of standards, DOE used the projected standards-case shipments and, in turn, the standards-case stock, to calculate the national AEC for the no-new-standards.

a. Site-to-Power-Plant Energy Conversion Factors

In determining annual NES, DOE initially considered the AEC at a residence (for electricity, the energy, expressed in kWh, consumed by a household). DOE then calculated primary (source) energy use from site energy consumption by applying a conversion factor to account for losses associated with the generation, transmission, and distribution of electricity. The site-to-source conversion factor is a multiplicative factor used to convert site energy consumption into primary, or source, energy consumption, expressed in quadrillion Btus (quads).

DOE used annual site-to-power-plant conversion factors based on the version of the national energy modeling system (''NEMS'') [57] that corresponds to *AEO2022* [58] The factors are marginal values, which represent the response of the national power system to incremental changes in consumption. For electricity, the conversion factors change over time in response to projected changes in generation sources (the types of power plants projected to provide electricity). There is not a specific end-use for PES in NEMS. As such, DOE applied the refrigeration end-use as a proxy, as the load profile of the equipment would be similar—equipment that when plugged-in and running does not respond to the cyclical dynamics of the electricity grid.

b. Full-Fuel Cycle Multipliers

In 2011, DOE announced its intention to use FFC measures of energy use and greenhouse gas and other emissions in the NIA and emissions analyses included in future energy conservation standards rulemakings 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. 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 which DOE explained its determination that EIA's 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). NEMS is a public domain, multi-sector, partial equilibrium model of the U.S. energy sector [59] that EIA uses to prepare its AEO. The FFC factors incorporate losses in production, and delivery in the case of natural gas, (including fugitive emissions) and additional energy used to produce and deliver the various fuels used by power plants. The approach used for deriving FFC measures of energy use and emissions can be found in other DOE analysis.[60]

3. Net Present Value Analysis

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

The NPV is the value in the present of a time-series of costs and savings. The NPV is described by the equation:

$$NPV = PVS - PVC$$

Where:

PVS = present value of operating cost savings, and
PVC = present value of increased total installed costs (including purchase price and installation costs).

DOE determined the PVS and PVC according to the following expressions.

$$PVS = \Sigma\ OCS_y \times DF_y$$
$$PVC = \Sigma\ TIC^y \times DF^y$$

Where:

OCS = total annual savings in operating costs each year summed over vintages of the product stock, $STOCK_V$,
DF = discount factor in each year,
TIC = total annual increases in installed cost each year summed over vintages of the product stock, $STOCK_V$ and
y = year in the forecast.

DOE calculated the total annual consumer savings in operating costs by multiplying the number or stock of the product (by vintage) by its per-unit operating cost savings (also by vintage). DOE calculated the total annual increases in consumer product price by multiplying the number or shipments of the product (by vintage) by its per-unit

[57] For more information on NEMS, refer to the U.S. Department of Energy, Energy Information Administration documentation. A useful summary is *National Energy Modeling System: An Overview 2000,* DOE/EIA–0581(2000), March 2000. EIA approves use of the name NEMS to describe only an official version of the model with no modification to code or data. Energy Information Administration. Annual Energy Outlook 2022 with Projections to 2050. 2022. Washington, DC (Last accessed July 20, 2022.) Available at *https://www.eia.gov/outlooks/aeo/.*

[58] *See www.eia.gov/outlooks/aeo.*

[59] For more information on NEMS, refer to *The National Energy Modeling System: An Overview 2009,* DOE/EIA–0581(2009), October 2009. Available at *www.eia.gov/analysis/pdfpages/0581(2009)index.php* (last accessed September 2022).

[60] An example methodology of deriving FFC measures can be found in the Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Commercial Water Heating Equipment, 2022, appendix 10D. Available at *https://www.regulations.gov/document/EERE-2021-BT-STD-0027-0001.*

increase in consumer cost (also by vintage). Total annual operating cost savings and total annual product price increases are calculated by the following equations.

$$OCS_y = \Sigma\ STOCK_y \times UOCS_v$$
$$TIC_y = \Sigma\ SHIP_y \times UTIC_y$$

Where:

OCS_y = operating cost savings per unit in year y,
$STOCK_V$ = stock of products of vintage V that survive in the year for which DOE calculated annual energy consumption,
$UOCS_V$ = annual operating cost savings per unit of vintage V,
V = year in which the product was purchased as a new unit,
TIC_y = total increase in installed product cost in year y,
$SHIP_y$ = shipments of the product in year y, and
$UTIC_y$ = annual per-unit increase in installed product cost in year y.

The operating cost savings are energy cost savings, which are calculated using the estimated energy savings in each year and the projected price of the appropriate form of energy. To estimate energy prices in future years, DOE multiplied the average regional energy prices by the projection of annual national-average residential energy price changes in the Reference Case from *AEO2022*, which has an end year of 2050. To estimate price trends after 2050, DOE maintained electricity prices constant at 2050 levels.

In calculating the NPV, DOE multiplies the net savings in future years by a discount factor to determine their present value. For this NODA, DOE estimated the NPV of consumer benefits using both a 3-percent and a 7-percent real discount rate. DOE used these discount rates in accordance with guidance provided by the Office of Management and Budget (''OMB'') to Federal agencies on the development of regulatory analysis.[61] The discount rates for the determination of NPV are in contrast to the discount rates used in the LCC analysis, which are designed to reflect a consumer's perspective. The 7-percent real value is an estimate of the average before-tax rate of return to private capital in the U.S. economy. The 3-percent real value represents the ''social rate of time preference,'' which is the rate at which society discounts future consumption flows to their present value.

The operating cost savings are energy cost savings, which are calculated using the estimated energy savings in each year, and the projected price of the appropriate form of energy. To estimate energy prices in future years, DOE multiplied the average regional energy prices by the projection of annual national-average residential energy price changes in the Reference Case from *AEO2022*, which has an end year of 2050.

4. Candidate Standards Levels

In general, DOE typically evaluates potential new or amended standards for products and equipment by grouping individual efficiency levels for each class into candidate standard levels (''CSLs''). Use of CSLs allows DOE to identify and consider manufacturer cost interactions between the product classes and market cross elasticity from consumer purchasing decisions that may change when different standard levels are set, to the extent that there are such interactions.

In the analysis conducted for this NODA, DOE analyzed the benefits and burdens of up to eight CSLs for PESs. DOE developed CSLs that combine efficiency levels for each analyzed product class. These CSLs were developed by directly mapping specific efficiency levels for each of the PES product classes analyzed by DOE. For this NODA, CSL 1 represents PES efficiency at APSP–14 2019. And the remaining CSLs represent the increase in efficiency determined by each efficiency level in the engineering analysis. DOE notes that for inflatable spas DOE did not examine efficiency levels greater than EL 3, and mapped EL 3 to the CSLs greater than 3.

Table III.43 presents the CSLs and the corresponding efficiency levels that DOE has identified for potential new energy conservation standards for PESs.

TABLE III.43—CANDIDATE STANDARD LEVELS FOR PESS

Candidate standard level	Spa type			
	Combination	Exercise	Inflatable	Standard
1	EL 1	EL 1	EL 1	EL 1
2	EL 2	EL 2	EL 2	EL 2
3	EL 3	EL 3	EL 3	EL 3
4	EL 4	EL 4	EL 3	EL 4
5	EL 5	EL 5	EL 3	EL 5
6	EL 6	EL 6	EL 3	EL 6
7	EL 7	EL 7	EL 3	EL 7
8	EL 8	EL 8	EL 3	EL 8

5. Results for 30-years of Shipments (2029–2058)

TABLE III.44—CUMULATIVE FULL-FUEL CYCLE NATIONAL ENERGY SAVINGS (QUADS)

Candidate standard level	Spa type			
	Combination	Exercise	Inflatable	Standard
1	0.11	0.35	0.01	0.86
2	0.14	0.43	0.02	1.09
3	0.15	0.46	0.03	1.14
4	0.16	0.48	0.03	1.26
5	0.16	0.50	0.03	1.31

[61] United States Office of Management and Budget. *Circular A–4: Regulatory Analysis.* September 17, 2003. Section E. Available at *https://www.whitehouse.gov/wp-content/uploads/legacy_drupal_files/omb/circulars/A4/a-4.pdf* (last accessed Aug 8, 2022).

TABLE III.44—CUMULATIVE FULL-FUEL CYCLE NATIONAL ENERGY SAVINGS (QUADS)—Continued

Candidate standard level	Spa type			
	Combination	Exercise	Inflatable	Standard
6	0.19	0.57	0.03	1.48
7	0.20	0.60	0.03	1.56
8	0.20	0.61	0.03	1.59

TABLE III.45—CUMULATIVE CONSUMER NET PRESENT (BILLION, 2021$)

Candidate standard level	Spa type			
	Combination	Exercise	Inflatable	Standard
3% Discount Rate				
1	0.078	0.235	0.007	0.598
2	0.074	0.221	0.015	0.592
3	0.047	0.134	0.006	0.407
4	−0.007	−0.033	0.006	0.089
5	−0.068	−0.226	0.006	−0.333
6	−0.158	−0.507	0.006	−0.941
7	−0.277	−0.883	0.006	−1.769
8	−0.416	−1.318	0.006	−2.739
7% Discount Rate				
1	0.037	0.112	0.003	0.285
2	0.034	0.102	0.007	0.275
3	0.020	0.056	0.001	0.177
4	−0.008	−0.031	0.001	0.009
5	−0.040	−0.131	0.001	−0.211
6	−0.087	−0.279	0.001	−0.532
7	−0.149	−0.474	0.001	−0.962
8	−0.221	−0.700	0.001	−1.465

IV. Publication Participation

A. Submission of Comments

DOE will accept comments, data, and information regarding this NODA no later than the date provided in the **DATES** section at the beginning of this NODA. 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 website will waive any CBI claims for the information submitted. For information on submitting CBI, see the Confidential Business Information section.

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

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

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

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

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

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

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

B. Issues on Which DOE Seeks Comment

Although DOE welcomes comments on any aspect of this NODA, DOE is particularly interested in receiving comments and views of interested parties concerning the following issues:

Issue 1: DOE requests comment on the previously description of the target technology and the scope of this product, including whether any modifications or additions are necessary to characterize this product.

Issue 2: DOE requests comment on whether the distinction between categories of PESs, as described in section III.A.2 of this NODA, is significant enough to warrant the establishment of different product classes for each type.

Issue 3: DOE requests comment on the above description of the PES manufacturers and the PES industry structure and whether any other details are necessary for characterizing the industry or for determining whether energy conservation standards for PESs might be justified.

Issue 4: DOE requests information on any voluntary or mandatory test procedure and energy conservation standards for PESs that are not mentioned in section III.A.4 of this NODA.

Issue 5: DOE seeks comment generally on the descriptions of relevant energy-saving technology options as described in section III.A.5 of this document, including whether any options require revised or additional details to characterize each option's effects on a PES's energy consumption.

Issue 6: DOE seeks comment regarding use of additional or improved insulation as a technology option for PESs, and in particular what would limit adding further insulation to a PES.

Issue 7: DOE seeks comment regarding use of improved covers as a technology option for PESs, and in particular what would limit further energy performance increases of PES covers.

Issue 8: DOE seeks comment regarding use of improved sealing as a technology option for PESs, regarding whether air leakage is significant at PES locations other than the cover, and regarding what would limit further sealing improvements energy performance increases of PES covers.

Issue 9: DOE seeks comment on the description of radiant barriers and data on the relative effects of radiant barriers when paired with different amounts of insulation and different thicknesses of adjacent air gaps.

Issue 10: DOE requests comment regarding whether insulated ground covers warrant inclusion in the set of technology options for non-inflatable PESs.

Issue 11: DOE seeks comment and data on the degree to which two-speed pump inefficiencies manifest as waste heat and to which that waste heat is absorbed by the portable electric spa's water.

Issue 12: DOE requests comment regarding whether heat pumps would be likely to reduce energy consumption in PESs and, if so, quantified estimates of the effects of heat pump integration on both energy consumption and manufacturer production cost.

Issue 13: DOE requests comment regarding the availability of heat pumps compatible with PESs.

Issue 14: DOE seeks comment on its selection of baseline units, including whether any other units on the market would better represent the most consumptive spas available for purchase.

Issue 15: DOE requests comment on the range of filtration system power demands in PESs as described in Table III.1. DOE also requests comment on any correlation between power demand and whether a spa uses a high horsepower two-speed pump or a lower horsepower dedicated circulation pump.

Issue 16: DOE requests comment on its assumption of a standard shell shape as described in Table III.2, especially whether it is representative and whether DOE should consider certain shapes that result in maximum or minimum amounts of insulation.

Issue 17: DOE requests data and comment on the effectiveness of radiant barriers in reducing the normalized average standby power of PES and on what factors make radiant barriers more or less effective.

Issue 18: DOE requests data and comment on the extent to which spas lose heat through air convection out of unsealed regions of the spa and on the factors that affect heat losses due to sealing.

Issue 19: DOE requests comment on the best way to quantify varying degrees of cover seal, including perimeter seal against the spa flange and hinge seal through the center of the cover.

Issue 20: DOE requests comment on the method of analyzing thermal bridges as a single section of low R-value on the spa. Additionally, DOE requests information about techniques and models which are used in industry to predict spa performance.

Issue 21: DOE requests comment and data on the discrepancy between heat loss through the wall where the components are housed and through other walls.

Issue 22: DOE requests comment on any strategies for considering the effects of hot water traveling through plumbing on a spa's heat loss.

Issue 23: DOE requests comment describing its appropriation of the scaling relationship defined in APSP–14 2019 and whether there are any other traits with which DOE might vary energy consumption.

Issue 24: DOE requests comment on whether there are other factors DOE should consider in converting normalized average standby power values to reflect the proposed test procedure.

Issue 25: DOE requests comment and data on typical markups from MPC to MSP and from MSP to final sale price.

Issue 26: DOE requests comment and data characterizing the relationship between MPC and the size of a PES and whether there are better methods for approximating the effects of size changes on MPC than the one described previously.

Issue 27: DOE requests comment and data characterizing to what degree sales margins vary with spa size.

Issue 28: DOE requests comment on the efficiency levels described in tables Table III.3 and Table III.4, including whether any do not align with expected effects design options associated with them, as described below in Table III.7 and Table III.8.

Issue 29: DOE requests comment on the expected effects of DOE's proposed test procedure, as described in Table III.5 and Table III.6, including on whether its effects on normalized average standby power would be greater than or less than DOE's estimates.

Issue 30: DOE requests comment and data regarding the design options and associated estimated costs described in tables Table III.7 and Table III.8 of this NODA.

Issue 31: DOE requests information on the existence of any distribution channels other than the distribution channels listed in Table III.11 of this document. Further, DOE requests comment on whether the same distribution channels are applicable to installations of new and replacement PES.

Issue 32: DOE requests information on the fraction of shipments that are distributed through the channels shown in Table III.11 of this document.

Issue 33: DOE seeks comment on its energy use model. Specifically, DOE seeks comment on the energy use model for combination spas, where the Sysnon-heat variable is normalized with volume of water portioned to the standard spa pool.

Issue 34: DOE requests comment on its approach to estimating annual operating hours. Additionally, DOE requests comments on its modeling assumption that PES would be operated during the warmest months of the year.

Issue 35: DOE requests comment on its approach to determining regional ambient temperatures.

Issue 36: DOE requests data or comment on the typical operating temperature for exercise spas not capable of maintaining a minimum temperature of 100 °F. And DOE requests data or comment on the distribution of typical operating temperature for exercise spas not capable of maintaining a minimum temperature of 100 °F.

Issue 37: DOE requests data or comment on the distribution of typical operating temperature for spas capable of maintaining a minimum temperature of 100 °F. And DOE requests data or comment on the distribution of typical operating temperature for exercise spas capable of maintaining a minimum temperature of 100 °F.

Issue 38: DOE requests comment on its proposed methodology to project future equipment prices.

Issue 39: DOE request information or data related to the past trends in production costs of PESs. Additionally, DOE request data or information related to the cost of PES production over time.

Issue 40: DOE requests comment on its decision to exclude installation costs from any future efficiency standard calculation.

Issue 41: DOE requests data and details on the installation costs of PESs, and whether those costs vary by product type or any other factor affecting their efficiency.

Issue 42: DOE requests comment on its use of AEO to project electricity prices into the future.

Issue 43: DOE requests feedback and specific data on whether maintenance costs differ in comparison to the baseline maintenance costs for any of the specific efficiency improving technology options applicable to PESs.

Issue 44: DOE requests comment on the typical repairs to PESs and how they may differ in the case of a potential new energy conservation standard.

Issue 45: DOE requests comment on its lifetime analysis.

Issue 46: DOE requests comment on its reasoning and assumption to not apply a rebound effect to PES stand-by power energy use.

Issue 47: DOE requests comment on its stock ratios for hard-sided spas. Additionally, DOE seeks input on the market shares of standard, exercise, and combination spas.

Issue 48: DOE seeks comment on its assumed 2020 stock estimates for all spa types.

Issue 49: DOE requests comment on its proposed use of future residential construction to project future shipments of PESs.

Issue 50: DOE requests comment on its modeling assumption that PES efficiency will remaining constant over time in the absence of potential new standards.

Issue 51: Additionally, DOE welcomes comments on other issues relevant to the conduct of this rulemaking that may not specifically be identified in this document.

V. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of this notification of data availability and request for comment.

Signing Authority

This document of the Department of Energy was signed on October 31, 2022, by Francisco Alejandro Moreno, Acting Assistant Secretary for Energy Efficiency and Renewable Energy, pursuant to delegated authority from the Secretary of Energy. That document with the original signature and date is maintained by DOE. For administrative purposes only, and in compliance with requirements of the Office of the Federal Register, the undersigned DOE Federal Register Liaison Officer has been authorized to sign and submit the document in electronic format for publication, as an official document of the Department of Energy. This administrative process in no way alters the legal effect of this document upon publication in the **Federal Register**.

Signed in Washington, DC, on November 2, 2022.

Treena V. Garrett,

Federal Register Liaison Officer, U.S. Department of Energy.

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