[6450-01-P]

DEPARTMENT OF ENERGY

10 CFR Parts 429 and 430

[Docket Number EERE–2014–BT–STD–0021]

RIN 1904-AD24

Energy Conservation Program: Energy Conservation Standards for Residential Dishwashers

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

ACTION: Final rule.

SUMMARY: The Energy Policy and Conservation Act of 1975 (EPCA or the Act), as amended, prescribes energy conservation standards for various consumer products and certain commercial and industrial equipment, including residential dishwashers. EPCA also requires the U.S. Department of Energy (DOE) to periodically determine whether more-stringent, amended standards would be technologically feasible and economically justified, and would save a significant amount of energy. In this final rule, DOE has determined that more stringent residential dishwasher standards would not be economically justified, and, thus, does not amend its energy conservation standards for residential dishwashers. DOE also eliminates an obsolete dishwasher test procedure that

is no longer used to demonstrate compliance with the existing energy conservation standards.

DATES: This rule is effective **[INSERT DATE 30 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER]**. The incorporation by reference of the standards listed in this rule was approved by the Director of the Federal Register on December 17, 2012.

ADDRESSES: This rulemaking can be identified by docket number EERE-2014–BT–STD–0021 and/or regulatory information number (RIN) 1904-AD24.

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

The docket web page can be found at: https://www.regulations.gov/docket?D=EERE-2014-BT-STD-0021. The docket webpage contains simple instructions on how to access all documents, including public comments, in the docket.

For further information on how to review the docket, contact the Appliance and Equipment Standards Program staff at (202) 586-6636 or by email: ApplianceStandardsQuestions@ee.doe.gov.

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SUPPLEMENTARY INFORMATION:

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I. Synopsis of the Final Rule

Title III, Part B[1] of EPCA, Public Law 94-163 (42 U.S.C. 6291–6309, as codified) established the Energy Conservation Program for Consumer Products Other Than Automobiles.[2] This program covers most major household appliances, including the residential dishwashers that are the subject of this document. (42 U.S.C. 6292(a)(6)) EPCA, as amended, prescribed energy conservation standards for residential dishwashers and directed DOE to conduct additional rulemakings to determine whether to amend those standards. (42 U.S.C. 6295(g)(1) and (10)(A) and (B)) DOE is issuing this final rule pursuant to 42 U.S.C. 6295(m), which states that DOE must periodically review its already established energy conservation standards for a covered product not later than 6 years after issuance of any final rule establishing or amending such standards. As a result of such review, DOE must either publish a notice of proposed rulemaking to amend the standards or publish a notice of determination indicating that the existing standards do not need to be amended. (42 U.S.C. 6295(m)(1)(A) and (B))

[1] For editorial reasons, upon codification in the U.S. Code, Part B was redesignated Part A.
[2] All references to EPCA in this document refer to the statute as amended through the Energy Efficiency Improvement Act of 2015, Public Law 114-11 (Apr. 30, 2015).

Based on the evidence summarized in section V.C of this document, the Secretary has determined that amended standards for residential dishwashers are not economically justified. Specifically, the Secretary has determined that the benefits of energy savings, positive net present value of consumer benefits, and emission reductions of more-stringent standards are outweighed by the economic burden on over half of dishwasher consumers. Furthermore, the impacts on manufacturers, including the conversion costs and profit margin impacts, could result in a large reduction in industry net present value. Therefore, DOE has determined not to amend the energy conservation standards for residential dishwashers.

DOE is eliminating an obsolete dishwasher test procedure in appendix C that is no longer used to demonstrate compliance with existing energy conservation standards. DOE is making corresponding amendments to 10 CFR 429 and 430.23 to remove references to the eliminated appendix C. DOE is also amending the introductory note to the current test procedure at title 10 of the CFR part 430, subpart B, appendix C1 (appendix C1) to clarify that it shall be used to determine compliance with energy conservation standards and to make any representations related to energy and/or water consumption.

II. Introduction

A. Authority

Pursuant to EPCA, DOE's energy conservation program for covered products consists essentially of four parts: (1) testing, (2) labeling, (3) the establishment of Federal energy conservation standards, and (4) certification and enforcement procedures. The Federal Trade Commission (FTC) is primarily responsible for labeling, and DOE implements the remainder of the program. Manufacturers of covered products must use the prescribed DOE test procedure as the basis for certifying to DOE that their products comply with the applicable energy conservation standards adopted under EPCA and when making representations to the public regarding the energy use or efficiency of those products. (42 U.S.C. 6293(c) and 6295(s)) Similarly, DOE must use these test procedures to determine whether the products comply with standards adopted pursuant to EPCA. (42 U.S.C. 6295(s)) The DOE test procedures for residential dishwashers are included in appendix C1.

DOE must follow specific statutory criteria for prescribing new or amended standards for covered products, including residential dishwashers. Any new or amended standard for a covered product must be designed to achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A) and (3)(B)) Furthermore, DOE may not adopt any standard that would not result in the significant conservation of energy. (42 U.S.C. 6295(o)(3)) In deciding whether a proposed standard is economically justified, DOE must determine whether the benefits of the standard exceed its burdens. (42 U.S.C. 6295(o)(2)(B)(i))

DOE must make this determination after receiving comments on the proposed standard, and by considering, to the greatest extent practicable, the following seven statutory factors:

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

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

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

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

(7) Other factors the Secretary of Energy (Secretary) considers relevant.

(42 U.S.C. 6295(o)(2)(B)(i)(I)–(VII))

Further, EPCA, as codified, establishes a rebuttable presumption that a standard is economically justified if the Secretary finds that the additional cost to the consumer of purchasing a product complying with an energy conservation standard level will be less

than three times the value of the energy 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, as codified, also contains what is known as an "anti-backsliding" provision, which prevents the Secretary from prescribing any amended standard that either increases the maximum allowable energy use or decreases the minimum required energy efficiency of a covered product. (42 U.S.C. 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 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))

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

EPCA also requires that, in any final rule for new or amended energy conservation standards promulgated after July 1, 2010, DOE is required to address standby mode and off mode energy use. (42 U.S.C. 6295(gg)(3)) Specifically, when DOE adopts a standard for a covered product after that date, it must, if justified by the criteria for adoption of standards under EPCA (42 U.S.C. 6295(o)), incorporate standby mode and off mode energy use into a single standard, or, if that is not feasible, adopt a separate standard for such energy use for that product. (42 U.S.C. 6295(gg)(3)(A)–(B)) DOE's current test procedures in appendix C1 for residential dishwashers address standby mode and off mode energy use.

B. Background

1. Current Standards

In a direct final rule published on May 30, 2012 (2012 Direct Final Rule), DOE prescribed the current energy conservation standards for residential dishwashers manufactured on or after May 30, 2013. 77 FR 31918. These standards are set forth in DOE's regulations at 10 CFR 430.32(f)(3) and are repeated in Table II.1.

Table II.1 Federal Energy Conservation Standards for Residential Dishwashers

Product Class	**Annual Energy Use** (kWh/year)	**Per-Cycle Water Consumption** (gal/cycle)
Standard	307	5.0
Compact	222	3.5

2. History of Standards Rulemaking for Residential Dishwashers

EPCA required that residential dishwashers be equipped with an option to dry without heat. EPCA further required that DOE conduct two cycles of rulemakings to determine if amended standards are justified. (42 U.S.C. 6295(g)(1) and (4))

On May 14, 1991, DOE issued a final rule establishing performance standards for residential dishwashers to complete the first required rulemaking cycle. 56 FR 22250. Compliance with the new standards, codified at 10 CFR 430.32(f), was required on May 14, 1994.

DOE then conducted a second standards rulemaking for residential dishwashers. DOE issued an advance notice of proposed rulemaking (ANOPR) on November 14,

1994, to consider amending the energy conservation standards for residential clothes washers, dishwashers, and clothes dryers. 59 FR 56423. Subsequently, DOE published a Notice of Availability of the "Rulemaking Framework for Commercial Clothes Washers and Residential Dishwashers, Dehumidifiers, and Cooking Products." 71 FR 15059 (Mar. 27, 2006). On November 15, 2007, DOE published a second ANOPR addressing energy conservation standards for these products. 72 FR 64432.

EPCA was subsequently amended to establish maximum energy and water use levels for residential dishwashers manufactured on or after January 1, 2010. (42 U.S.C. 6295(g)(10)(A)) DOE codified the statutory standards for these products in a final rule published March 23, 2009. 74 FR 12058. EPCA also required DOE to conduct a rulemaking, by no later than January 1, 2015, to determine if the standards for residential dishwashers should be amended, and if so, to publish amended standards. (42 U.S.C. 6295(g)(10)(B))

The current energy conservation standards for residential dishwashers were submitted to DOE by groups representing manufacturers, energy and environmental advocates, and consumer groups on September 25, 2010. This collective set of comments, titled "Agreement on Minimum Federal Efficiency Standards, Smart Appliances, Federal Incentives and Related Matters for Specified Appliances" (the "Joint Petition"[3]), recommended specific energy conservation standards for residential dishwashers that, in the commenters' view, would satisfy the EPCA requirements. (42

[3] DOE Docket No. EERE–2011–BT–STD–0060, Comment 1.

U.S.C. 6295(o)) DOE conducted its rulemaking analyses on multiple residential dishwasher efficiency levels, including those suggested in the Joint Petition. In the 2012 Direct Final Rule, DOE established energy conservation standards for residential dishwashers manufactured on or after May 30, 2013, consistent with the levels suggested in the Joint Petition and in satisfaction of the requirement set forth in 42 U.S.C. 6295(g)(10)(B). 77 FR 31918 (May 30, 2012).

DOE is conducting the current energy conservation standards rulemaking pursuant to 42 U.S.C. 6295(m), which requires that within 6 years of issuing any final rule establishing or amending a standard, DOE shall publish either a notice of determination that amended standards are not needed or a notice of proposed rulemaking (NOPR) including new proposed standards. DOE published a NOPR proposing amended standards on December 19, 2014 (2014 NOPR), in which it considered additional information not available at the time of the 2012 Direct Final Rule. 79 FR 76141. In conjunction with the 2014 NOPR, DOE posted on its website the associated technical support document (TSD). The TSD included the results of DOE's analyses, including: (1) the market and technology assessment, (2) screening analysis, (3) engineering analysis, (4) energy and water use determination, (5) markups analysis to determine product price, (6) life-cycle cost (LCC) and payback period (PBP) analyses, (7) shipments analysis, (8) national energy savings (NES) and national impact analysis (NIA), and (9) manufacturer impact analysis (MIA). On February 5, 2015, DOE held a public meeting to receive comments from interested parties on the proposals in the 2014 NOPR.

DOE received a number of comments from interested parties in response to the 2014 NOPR. DOE considered these comments, as well as comments from the public meeting, in preparing this final rule. The commenters are summarized in Table II.2. Relevant comments and DOE's responses are provided in the appropriate sections of this final rule.

Table II.2 Interested Parties Providing Comments on the 2014 NOPR for Residential Dishwashers

Name	Acronym	Commenter Type*
Appliance Standards Awareness Project, Natural Resources Defense Council, Alliance to Save Energy, American Council for an Energy-Efficient Economy, Consumers Union, Northwest Energy Efficiency Alliance, and Northwest Power and Conservation Council	The Joint Commenters	EA
Association of Home Appliance Manufacturers	AHAM	TA
BSH Home Appliances Corporation	BSH	M
Edison Electric Institute	EEI	U
Energy Solutions	Energy Solutions	RO
GE Appliances and Lighting	GE	M
Mercatus Center at George Mason University	Mercatus Center	RO
Natural Resources Defense Council	NRDC	EA
Pacific Gas and Electric Company, Southern California Gas Company, San Diego Gas and Electric, and Southern California Edison (the California Investor-Owned Utilities)	CA IOUs	U
People's Republic of China	China	GA
Samsung Electronics America, Inc.	Samsung	M
U.S. Chamber of Commerce, American Chemistry Council, American Forest & Paper Association, American Fuel & Petrochemical Manufacturers, American Petroleum Institute, Brick Industry Association, Council of Industrial Boiler Owners, National Association of Manufacturers, National Mining Association, National Oilseed Processors Association	The Associations	TA
Whirlpool Corporation	Whirlpool	M

* EA: Efficiency Advocate; GA: Government Agency; M: Manufacturer; RO: Research Organization; TA: Trade Association; U: Utility.

III. General Discussion

DOE developed this final rule after considering comments, data, and information from interested parties that represent a variety of interests. The following discussion addresses some of the issues raised by these commenters. Comments on the methodology for DOE's analysis are presented in the relevant sections in section IV of this final rule.

A. Product Classes and Scope of Coverage

Existing energy conservation standards divide residential dishwashers into two product classes based on capacity (i.e., the number of place settings and serving pieces that can be loaded in the product as specified in American National Standards Institute (ANSI)/Association of Home Appliance Manufacturers (AHAM) Standard DW-1-2010, Household Electric Dishwashers (ANSI/AHAM Standard DW-1-2010)):

- Standard (capacity equal to or greater than eight place settings plus six serving pieces); and
- Compact (capacity less than eight place settings plus six serving pieces).

In the 2014 NOPR, DOE proposed to maintain the existing standard and compact product classes for residential dishwashers because it determined that compact residential dishwashers provide unique utility by means of their countertop or drawer configurations. 79 FR 76142, 76149 (Dec. 19, 2014).

Mercatus Center disagreed with the separation of residential dishwashers into product classes on the basis of capacity, stating that such classification was overly broad. (Mercatus Center, No. 11 at p. 5)[4] China noted that the standards proposed in the 2014 NOPR are fixed values for the standard product class, and that these values may be too strict for larger residential dishwashers within the standard product class. China suggested a specific standard for these products. (China, No. 25 at p. 3) DOE has not identified any performance-related feature affecting consumer utility that would justify differing residential dishwasher standards within each of the proposed product classes under 42 U.S.C. 6295(q), and maintains that the unique utility of countertop and drawer configurations warrants differentiation of residential dishwashers into standard and compact product classes by capacities. The two product classes each cover a range of capacities. However, although the existing definition of the standard product class specifies a minimum capacity, it does not specify an upper limit on capacity. DOE reviewed the certified energy and water consumption levels for the highest-capacity dishwashers currently available on the market in the United States (i.e., those with capacities of 16 place settings), and observed multiple models from different manufacturers that are ENERGY STAR-qualified. Therefore, DOE concludes that no alternate product class structure is required to adequately consider revised energy conservation standards for higher-capacity products, and DOE is not amending the product classes for residential dishwashers in this final rule.

[4] A notation in the form "Mercatus Center, No. 11 at p. 5" identifies a written comment: (1) made by the Mercatus Center at George Mason University; (2) recorded in document number 11 that is filed in the docket of this energy conservation standards rulemaking (Docket No. EERE–2014– BT–STD-0021) and available for review at www.regulations.gov; and (3) which appears on page 5 of document number 11.

B. Test Procedure

EPCA sets forth generally applicable criteria and procedures for DOE's adoption and amendment of test procedures. (42 U.S.C. 6293) Manufacturers of covered products must use these test procedures to certify to DOE that their product complies with energy conservation standards and to quantify the efficiency of their product. DOE's current energy conservation standards for residential dishwashers are expressed in terms of estimated annual energy use (EAEU), in kWh/year, and water consumption, in gal/cycle (see 10 CFR 430.32(f)(3)). The current version of the test procedure at 10 CFR 430.23(c) includes provisions for determining these values as well as estimated annual operating cost (EAOC), based upon testing procedures contained in appendix C1.

In the 2014 NOPR, DOE proposed to delete an obsolete version of the residential dishwasher test procedure codified at 10 CFR part 430, subpart B, appendix C, and re-designate appendix C1 as appendix C. DOE did not receive any objections to the proposed elimination of the obsolete version of the test procedure, and is removing the obsolete test procedure. However, to avoid potential confusion from renaming the current test procedure, DOE is not redesignating appendix C1 as appendix C; DOE is maintaining its designation as appendix C1. Additionally, DOE is revising the text in both 10 CFR 429.19 and 10 CFR 430.23 to account for the removal of the obsolete test procedure, and revising the introductory note in appendix C1 to clarify that it is the applicable test procedure.

DOE received a number of comments which raised concerns about the repeatability and reproducibility of results obtained from appendix C1, and on whether the test procedure is representative of actual consumer use. DOE will address these concerns in a separate test procedure rulemaking and will seek information on these issues in a request for information.

C. Technological Feasibility

1. General

In each energy conservation standards rulemaking, DOE conducts a screening analysis based on information gathered on all current technology options and prototype designs that could improve the efficiency of the products or equipment that are the subject of the rulemaking. As the first step in such an analysis, DOE develops a list of technology options for consideration in consultation with manufacturers, design engineers, and other interested parties. DOE then determines which of those means for improving efficiency are technologically feasible. DOE considers technologies incorporated in commercially available products or in working prototypes to be technologically feasible. 10 CFR part 430, subpart C, appendix A, section 4(a)(4)(i).

After DOE has determined that particular technology options are technologically feasible, it further evaluates each technology option in light of the following additional screening criteria: (1) practicability to manufacture, install, and service; (2) adverse impacts on product utility or availability; and (3) adverse impacts on health or safety. 10 CFR part 430, subpart C, appendix A, section 4(a)(4)(ii)–(iv). Additionally, it is DOE

policy not to include in its analysis any proprietary technology that is a unique pathway to achieving a certain efficiency level. Section IV.B of this final rule discusses the results of the screening analysis for residential dishwashers, particularly the designs DOE considered, those it screened out, and those that are the basis for the standards considered in this rulemaking. For further details on the screening analysis for this rulemaking, see chapter 4 of the final rule TSD.

2. Maximum Technologically Feasible Levels

When DOE considers amended standards for a type or class of covered product, it must determine the maximum improvement in energy efficiency or maximum reduction in energy use that is technologically feasible for such product. (42 U.S.C. 6295(p)(1)) Accordingly, in the engineering analysis, DOE determined the maximum technologically feasible ("max-tech") improvements in energy efficiency for residential dishwashers, using the design parameters for the most efficient products available on the market or in working prototypes. The max-tech levels that DOE determined for this rulemaking are described in section IV.C of this final rule and in chapter 5 of the final rule TSD.

D. Energy Savings

1. Determination of Savings

For each trial standard level (TSL), DOE projected energy savings from application of the TSL to residential dishwashers purchased in the 30-year period that

begins in the year of compliance with any amended standards (2019–2048).[5] The savings are measured over the entire lifetime of residential dishwashers purchased in the 30-year analysis period. DOE quantified the energy savings attributable to each TSL as the difference in energy consumption between each standards case and the no-new-standards case. The no-new-standards case represents a projection of energy consumption that reflects how the market for a product would likely evolve in the absence of amended energy conservation standards.

DOE used its NIA spreadsheet model to estimate energy savings from potential amended standards for residential dishwashers. The NIA spreadsheet model (described in section IV.H of this final rule) calculates energy savings in site energy, which is the energy directly consumed by products at the locations where they are used. For electricity, DOE reports national energy savings in terms of primary energy savings, which is the savings in the energy that is used to generate and transmit the site electricity. For natural gas, the primary energy savings are considered to be equal to the site energy savings. DOE also calculates NES in terms of full-fuel-cycle (FFC) energy savings. The FFC metric includes the energy consumed in extracting, processing, and transporting primary fuels (i.e., coal, natural gas, petroleum fuels), and thus presents a more complete picture of the impacts of energy conservation standards.[6] DOE's approach is based on the calculation of an FFC multiplier for each of the energy types used by covered

[5] Each TSL is comprised of specific efficiency levels for each product class. The TSLs considered for this final rule are described in section IV.A of this final rule. DOE conducted a sensitivity analysis that considers impacts for products shipped in a 9-year period.

[6] The FFC metric is discussed in DOE's statement of policy and notice of policy amendment. 76 FR 51282 (Aug. 18, 2011), as amended at 77 FR 49701 (Aug. 17, 2012).

products or equipment. For more information on FFC energy savings, see section IV.H.2 of this final rule.

2. Significance of Savings

To adopt any new or amended standards for a covered product, DOE must determine that such action would result in "significant" energy savings. (42 U.S.C. 6295(o)(3)(B)) Although the term "significant" is not defined in the Act, the U.S. Court of Appeals for the District of Columbia Circuit, in Natural Resources Defense Council v. Herrington, 768 F.2d 1355, 1373 (D.C. Cir. 1985), indicated that Congress intended "significant" energy savings in the context of EPCA to be savings that are not "genuinely trivial." The energy savings for all of the TSLs considered in this rulemaking are nontrivial, and, therefore, DOE considers them "significant" within the meaning of section 325 of EPCA.

E. Economic Justification

1. Specific Criteria

As noted above, EPCA provides seven factors to be evaluated in determining whether a potential energy conservation standard is economically justified. (42 U.S.C. 6295(o)(2)(B)(i)(I)–(VII)) The following sections discuss how DOE has addressed each of those seven factors in this rulemaking.

a. Economic Impact on Manufacturers and Consumers

In determining the impacts of potential amended standards on manufacturers, DOE conducts a MIA, as discussed in section IV.J of this final rule. DOE first uses an annual cash-flow approach to determine the quantitative impacts. This step includes both a short-term assessment—based on the cost and capital requirements during the period between when a regulation is issued and when entities must comply with the regulation—and a long-term assessment over a 30-year period. The industry-wide impacts analyzed include: (1) industry net present value (INPV), which values the industry on the basis of expected future cash flows; (2) cash flows by year; (3) changes in revenue and income; and (4) other measures of impact, as appropriate. Second, DOE analyzes and reports the impacts on different types of manufacturers, including impacts on small manufacturers. Third, DOE considers the impact of standards on domestic manufacturer employment and manufacturing capacity, as well as the potential for standards to result in plant closures and loss of capital investment. Finally, DOE takes into account cumulative impacts of various DOE regulations and other regulatory requirements on manufacturers.

For individual consumers, measures of economic impact include the changes in LCC and PBP associated with new or amended standards. These measures are discussed further in the following section. For consumers in the aggregate, DOE also calculates the national net present value (NPV) of the economic impacts applicable to a particular rulemaking. DOE also evaluates the LCC impacts of potential standards on identifiable subgroups of consumers that may be affected disproportionately by a national standard.

b. Savings in Operating Costs Compared to Increase in Price

EPCA requires DOE to consider the savings in operating costs throughout the estimated average life of the covered product in the type (or class) compared to any increase in the price of, or in the initial charges for, or maintenance expenses of, the covered product that are likely to result from a standard. (42 U.S.C. 6295(o)(2)(B)(i)(II)) DOE conducts this comparison in its LCC and PBP analysis.

The LCC is the sum of the purchase price of a product (including its installation) and the operating expense (including energy, maintenance, and repair expenditures) discounted over the lifetime of the product. The LCC analysis requires a variety of inputs, such as product prices, product energy consumption, energy prices, maintenance and repair costs, product lifetime, and discount rates appropriate for consumers. To account for uncertainty and variability in specific inputs, such as product lifetime and discount rate, DOE uses a distribution of values, with probabilities attached to each value.

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 due to a more-stringent standard by the change in annual operating cost for the year that standards are assumed to take effect.

For its LCC and PBP analysis, DOE assumes that consumers will purchase the covered products in the first year of compliance with amended standards. The LCC

savings for the considered efficiency levels are calculated relative to the case that reflects projected market trends in the absence of amended standards. DOE's LCC and PBP analysis is discussed in further detail in section IV.F of this final rule.

c. Energy Savings

Although significant conservation of energy is a separate statutory requirement for amending an energy conservation standard, EPCA requires DOE, in determining the economic justification of a standard, to consider the total projected energy savings that are expected to result directly from the standard. (42 U.S.C. 6295(o)(2)(B)(i)(III)) As discussed in section III.D of this final rule, DOE uses the NIA spreadsheet models to project national energy savings.

d. Lessening of Utility or Performance of Products

In establishing product classes and in evaluating design options and the impact of potential standard levels, DOE evaluates potential standards that would not lessen the utility or performance of the considered products. (42 U.S.C. 6295(o)(2)(B)(i)(IV)) As described in the engineering analysis (see section IV.C of this final rule), DOE considered efficiency levels based on the range of products currently available on the market, and analyzed design options based on those observed in such products. Because DOE is not amending the existing standards for residential dishwashers, this rulemaking will not reduce the utility or performance of the products under consideration.

e. Impact of Any Lessening of Competition

EPCA directs DOE to consider the impact of any lessening of competition, as determined in writing by the Attorney General, that is likely to result from a standard. (42 U.S.C. 6295(o)(2)(B)(i)(V)) It also directs the Attorney General to determine the impact, if any, of any lessening of competition likely to result from a standard and to transmit such determination to the Secretary within 60 days of the publication of a proposed rule, together with an analysis of the nature and extent of the impact. (42 U.S.C. 6295(o)(2)(B)(ii)) Because DOE is not amending energy conservation standards for residential dishwashers, no consulatation with the Department of Justice pursuant to 42 U.S.C. 6295(o)(2)(B)(ii) is necessary.

f. Need for National Energy Conservation

DOE also considers the need for national energy conservation in determining whether a new or amended standard is economically justified. (42 U.S.C. 6295(o)(2)(B)(i)(VI)) The energy savings from any amended standards are likely to provide improvements to the security and reliability of the nation's energy system. Reductions in the demand for electricity also may result in reduced costs for maintaining the reliability of the Nation's electricity system. DOE conducts a utility impact analysis to estimate how standards may affect the Nation's needed power generation capacity, as discussed in section IV.M of this final rule.

Amended standards also are likely to result in environmental benefits in the form of reduced emissions of air pollutants and greenhouse gases associated with energy

production and use. DOE conducts an emissions analysis to estimate how potential standards may affect these emissions, as discussed in section IV.K of this final rule; the emissions impacts are reported in section IV.K of this final rule. DOE also estimates the economic value of emissions reductions resulting from the considered TSLs, as discussed in section IV.L of this final rule.

g. Other Factors

In determining whether an energy conservation standard is economically justified, DOE may consider any other factors that the Secretary deems to be relevant. (42 U.S.C. 6295(o)(2)(B)(i)(VII)) To the extent interested parties submit any relevant information regarding economic justification that does not fit into the other categories described above, DOE could consider such information under "other factors." No other factors were deemed to be relevant for this final rule.

2. Rebuttable Presumption

As set forth in 42 U.S.C. 6295(o)(2)(B)(iii), EPCA creates a rebuttable presumption that an energy conservation standard is economically justified if the additional cost to the consumer of a product that meets the standard is less than three times the value of the first year's energy savings resulting from the standard, as calculated under the applicable DOE test procedure. DOE's LCC and PBP analyses generate values used to calculate the effect potential amended energy conservation standards would have on the PBP for consumers. These analyses include, but are not limited to, the 3-year PBP contemplated under the rebuttable-presumption test. In

addition, DOE routinely conducts an economic analysis that considers the full range of impacts to consumers, manufacturers, the Nation, and the environment, as required under 42 U.S.C. 6295(o)(2)(B)(i). The results of this analysis serve as the basis for DOE's evaluation of the economic justification for a potential standard level (thereby supporting or rebutting the results of any preliminary determination of economic justification). The rebuttable presumption payback calculation is discussed in section IV.F of this final rule.

F. Other Issues

DOE received a number of general comments regarding the analysis process and standards in general, and specific comments related to DOE's process guidance at 10 CFR part 430, Subpart C, Appendix A. Samsung commented in support of more stringent standards for residential dishwashers, which it stated would encourage innovation and would provide large benefits to U.S. consumers by way of significant energy and water savings. (Samsung, No. 19 at p. 2) The CA IOUs and Joint Commenters also supported the proposed standards. (CA IOUs, No. 23 at p. 1; Joint Commenters No. 22 at p. 1)

EEI stated that in this rulemaking, DOE elected to depart from the Process Improvement Rule by eliminating the Framework stage and the Preliminary Analysis. EEI stated that the effect of this change is to provide interested parties with only one opportunity to impact the outcome of the proposed rule, which conflicts with the Process Improvement Rule provisions. (EEI, No. 20 at p. 3)

More specifically, commenters noted that DOE guidance at 10 CFR part 430, subpart C, appendix A states that DOE will publish an ANOPR prior to issuance of a proposed standards rule. In EISA 2007, Congress eliminated the requirement for DOE to publish an ANOPR for rulemakings to establish or amend an energy conservation standards. In many cases, DOE publishes a framework document and preliminary analysis prior to publishing a proposed standards. For this rulemaking, however, DOE relied primarily on data and analysis from the recent 2012 Direct Final Rule rather than a preliminary analysis in developing the 2014 NOPR. Commenters also expressed concerns regarding three specific objectives outlined in 10 CFR part 430, subpart C, appendix A, section 1: (a), (d), and (f). Objective (a) is to provide for early input from stakeholders in the rulemaking process. In addition to the opportunities for public input on the 2012 rulemaking, DOE engaged stakeholders in a public meeting after publishing the 2014 NOPR, and conducted extensive manufacturer interviews following the 2014 NOPR. Objective (d) is to eliminate problematic design options early in the process. In the 2014 NOPR, DOE evaluated all technology options against the criteria outlined in the screening analysis (see section IV.B of this final rule), and then discussed conclusions regarding design options in subsequent manufacturer interviews. Objective (f) is to conduct thorough analysis of impacts. In the 2014 NOPR, DOE conducted all relevant impact analyses and requested any relevant information from stakeholders. DOE received feedback in response to these analyses, and as discussed in section IV of this final rule, has incorporated stakeholder feedback into the analyses for this final rule. In developing the analysis for this final rule, DOE's process, which included extensive

stakeholder input, was consistent with the objectives outlined in 10 CFR part 430, subpart C, appendix A, section 1.

Mercatus Center commented in response to the 2014 NOPR that the treatment of market barriers is inconsistent with evidence that consumers are informed about efficiency issues and that this information allows them to make economically efficient choices of residential dishwashers. (Mercatus Center, No. 11 at pp. 3–5)

This comment appears to be referring to section VI.A of the 2014 NOPR, in which DOE, responding to requirements of Executive Order 12866, "Regulatory Planning and Review," briefly describes the problems that the proposed standards address. One of the problems mentioned is a lack of consumer information and/or information processing capability about energy efficiency opportunities in the residential dishwasher market. However, it is difficult to determine the significance of this problem. The commenter presents data showing the popularity of ENERGY STAR-certified residential dishwashers as evidence that consumers are informed about efficiency issues. DOE is aware that there is a segment of the consumer market that responds to the information implicit in the ENERGY STAR certification. This was confirmed in a recent paper from the National Bureau of Economic Research that examined how consumers respond to ENERGY STAR certification in the U.S. refrigerator market,[7] but the study also found that "a non-negligible fraction of consumers also appears to neither value the

[7] Houde, Sebastien. 2014. How Consumers Respond to Environmental Certification and the Value of Energy Information. National Bureau of Economic Research Working Paper No. 20019. http://www.nber.org/papers/w20019.

certification nor consider electricity costs in their purchase decisions." While the reasons for this are not entirely clear, difficulties in processing information in purchase decision-making may be a factor.

Mercatus Center stated that the proposed rule may yield economic inefficiencies as it treats dissimilar consumers as similar. It stated that manufacturers respond to the heterogeneity of consumers by offering a wide variety of products, and forcing all residential dishwashers to include energy-saving technology can generate an excess of costs over benefits (e.g., for buyers who only use their dishwashers a few times a month). (Mercatus Center, No. 11 at p. 9)

DOE acknowledges that for some consumers the cost of purchasing a residential dishwasher that meets the proposed standards exceeds the operating cost savings from a more efficient dishwasher. In issuing this final rule, DOE considered this burden in the context of the full range of benefits and burdens associated with different standard levels and determined not to issue amended standards for residential dishwashers.

IV. Methodology and Revisions to the Analyses Employed in the 2014 Proposed Rule

This section addresses the analyses DOE has performed for this rulemaking with regard to residential dishwashers. Separate subsections address each component of DOE's analyses.

DOE used several analytical tools to estimate the impact of the potential standards levels considered in this document. The first tool is a spreadsheet that calculates the LCC savings and PBP of potential amended or new energy conservation standards. The NIA uses a second spreadsheet set that provides shipments projections and calculates NES and NPV of total consumer costs and savings expected to result from potential energy conservation standards. DOE uses the third spreadsheet tool, the Government Regulatory Impact Model (GRIM), to assess manufacturer impacts of potential standards. These three spreadsheet tools are available on the DOE website for this rulemaking: http://www1.eere.energy.gov/buildings/appliance_standards/rulemaking.aspx?ruleid=106. Additionally, DOE used output from the latest version of the Energy Information Administration's (EIA's) Annual Energy Outlook (AEO) for the emissions and utility impact analyses.

A. Market and Technology Assessment

DOE develops information in the market and technology assessment that provides an overall picture of the market for the products concerned, including the purpose of the products, the industry structure, manufacturers, market characteristics, and technologies used in the products. This activity includes both quantitative and qualitative assessments, based primarily on publicly-available information. The subjects addressed in the market and technology assessment for this rulemaking 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

residential dishwashers. See chapter 3 of the final rule TSD for further discussion of the market and technology assessment.

In the 2014 NOPR market analysis and technology assessment, DOE identified 16 technology options that would be expected to improve the efficiency of residential dishwashers, as measured by the DOE test procedure, shown in Table IV.1. 79 FR 76142, 76151 (Dec. 19, 2014).

Table IV.1 2014 NOPR Technology Options

1. Condensation drying
2. Control strategies
3. Fan/jet drying
4. Flow-through heating
5. Improved fill control
6. Improved food filter
7. Improved motor efficiency
8. Improved spray-arm geometry
9. Increased insulation
10. Low-standby-loss electronic controls
11. Microprocessor controls and fuzzy logic, including adaptive or soil-sensing controls
12. Modified sump geometry, with and without dual pumps
13. Reduced inlet-water temperature
14. Supercritical carbon dioxide washing
15. Ultrasonic washing
16. Variable washing pressures and flow rates

In the 2014 NOPR, DOE requested feedback from manufacturers on its NOPR analyses. After publishing the 2014 NOPR, DOE also conducted manufacturer interviews to discuss the possible design pathways to improve dishwasher efficiencies. From these conversations and additional research, DOE identified desiccant drying as an additional technology option for improving dishwasher efficiency. Along with desiccant

drying, all of the technology options identified in the 2014 NOPR were considered in this final rule analysis.

B. Screening Analysis

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

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

2) 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.

3) Impacts on product utility or product availability. If it is determined that a technology would have significant adverse impact on the utility of the product to 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, it will not be considered further.

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

10 CFR part 430, subpart C, appendix A, 4(a)(4) and 5(b)

In sum, if DOE determines that a technology, or a combination of technologies, fails to meet one or more of the above four criteria, it will be excluded from further consideration in the engineering analysis. The reasons for eliminating any technology are discussed below.

The subsequent sections include comments from interested parties pertinent to the screening criteria, DOE's evaluation of each technology option against the screening analysis criteria, and whether DOE determined that a technology option should be excluded ("screened out") based on the screening criteria.

1. Screened-Out Technologies

In the 2014 NOPR screening analysis, DOE removed three technology options from further consideration: reduced inlet-water temperature, supercritical carbon dioxide washing, and ultrasonic washing. 79 FR 76142, 76152 (Dec. 19, 2014).

In response to the 2014 NOPR, AHAM commented that DOE did not seek updated information from manufacturers on technology options, resulting in analyzing

technology options that should have been removed in the screening analysis. (AHAM, No. 21 at p. 6)

DOE received no additional comments, either in response to the 2014 NOPR or in additional manufacturer interviews, regarding technology options identified in the 2014 NOPR that would not meet the screening criteria. However, DOE is screening out an additional design option for the final rule analysis, described below.

Desiccant drying

Desiccant drying relies on a material, such as zeolite, to adsorb moisture to aid in the drying process and reduce drying energy consumption. Certain European dishwashers currently incorporate this technology option; however, DOE is unaware of any dishwashers available in the United States that use desiccant drying. DOE has screened out desiccant drying from further consideration because it would not be practicable to manufacture on the scale necessary for the residential dishwasher market.

2. Remaining Technologies

Through a review of each technology, DOE concludes that all of the other identified technologies listed in section IV.A of this final rule met all four screening criteria to be examined further as design options in DOE's final rule analysis. In summary, DOE retained the following technology options as shown in Table IV.2:

Table IV.2 Remaining Final Rule Technology Options

1. Condensation drying
2. Control strategies
3. Fan/jet drying
4. Flow-through heating
5. Improved fill control
6. Improved food filter
7. Improved motor efficiency
8. Improved spray-arm geometry
9. Increased insulation
10. Low-standby-loss electronic controls
11. Microprocessor controls and fuzzy logic, including adaptive or soil-sensing controls
12. Modified sump geometry, with and without dual pumps
13. Variable washing pressures and flow rates

DOE determined that these technology options are technologically feasible because they are being used or have previously been used in commercially-available products or working prototypes. DOE also finds that all of the remaining technology options meet the other screening criteria (i.e., practicable to manufacture, install, and service and do not result in adverse impacts on consumer utility, product availability, health, or safety). For additional details, see chapter 4 of the final rule TSD.

C. Engineering Analysis

In the engineering analysis, DOE establishes the relationship between the manufacturer production cost (MPC) and improved residential dishwasher efficiency. This relationship serves as the basis for cost-benefit calculations for individual consumers, manufacturers, and the Nation. DOE typically structures the engineering analysis using one of three approaches: (1) design option, (2) efficiency level, or (3) reverse engineering (or cost assessment). The design-option approach involves adding the estimated cost and associated efficiency of various efficiency-improving design

changes to the baseline product to model different levels of efficiency. The efficiency-level approach uses estimates of costs and efficiencies of products available on the market at distinct efficiency levels to develop the cost-efficiency relationship. The reverse-engineering approach involves testing products for efficiency and determining cost from a detailed bill of materials (BOM) derived from reverse engineering representative products. The efficiency ranges from that of the least-efficient residential dishwasher sold today (i.e., the baseline) to the maximum technologically feasible efficiency level. At each efficiency level examined, DOE determines the MPC; this relationship is referred to as a cost-efficiency curve. In the 2014 NOPR, DOE used a hybrid approach of the three methods to develop the relationship between MPC and residential dishwasher efficiency because it is difficult to assign a specific energy or water savings to a particular design option. 79 FR 76142, 76152 (Dec. 19, 2014).

1. Efficiency Levels

In the 2014 NOPR, DOE analyzed the efficiency levels shown in Table IV.3 and Table IV.4. 79 FR 76142, 76153–76154 (Dec. 19, 2014).

Table IV.3 2014 NOPR Efficiency Levels – Standard Product Class

Efficiency Level	**Annual Energy Use** (kWh/year)	**Per-Cycle Water Consumption** (gal/cycle)
0 – Baseline	307	5.00
1	295	4.25
2	280	3.50
3	234	3.10
4 – Max-Tech	180	2.22

Table IV.4 2014 NOPR Efficiency Levels – Compact Product Class

Efficiency Level	Annual Energy Use (kWh/year)	Per-Cycle Water Consumption (gal/cycle)
0 – Baseline	222	3.50
1	203	3.10
2 – Max-Tech	141	2.00

China suggested that DOE use international units of measure, rather than gallons, for the convenience of World Trade Organization (WTO) member states. (China, No. 25 at p. 3) DOE proposes to maintain water consumption specifications for each efficiency level in gallons per cycle to maintain consistency with current product ratings and consumer familiarity. The conversion from gallons to an international unit, such as liters, is a simple calculation and would not represent a significant burden to WTO member states.

a. Data Sources

DOE used information in its Compliance Certification Database[8] as one data source for developing the efficiency levels in the 2014 NOPR. 79 FR 76142, 76153–76154 (Dec. 19, 2014). As described in chapter 5 of the NOPR TSD, DOE also relied on test data gathered using the ENERGY STAR Test Method for Determining Residential Dishwasher Cleaning Performance (ENERGY STAR Cleaning Performance Test Method) to determine Efficiency Level 3 for standard residential dishwashers.

[8] DOE's Compliance Certification Database is accessible at http://www.regulations.doe.gov/certification-data/.

AHAM observed that the NOPR analysis incorporated data accessed from DOE's Compliance Certification Database as of May 22, 2014, which included some outdated models that had since been removed from the market. (AHAM, No. 21 at p. 6) Energy Solutions asked DOE to review data more recent than May 2014 to see where newer models are rated. (Energy Solutions, Public Meeting Transcript, No. 10 at p. 39)[9]

In developing its rulemaking proposals, DOE strives to use the most recent data available at the time it conducts its analyses. DOE therefore has updated the efficiency levels analyzed in this final rule to reflect current product availability, specifically for the max-tech efficiency level for both product classes. DOE notes that the certification for the model at the max-tech level for the standard product class in the 2014 NOPR analysis has since been withdrawn. At the time of the final rule analysis, DOE found that the maximum available efficiency of products listed in the Compliance Certification Database and available on the market with a typical dishwasher configuration (i.e., built-in and typical product width) for the standard product class was a product with rated annual energy use of 225 kWh/year and water consumption of 2.4 gal/cycle. In addition, the maximum available efficiency of residential dishwashers listed in the compact product class was 130 kWh/year and 1.7 gal/cycle. For residential dishwashers, DOE considers the maximum available efficiency as the max-tech efficiency because DOE has

[9] A notation in the form "Energy Solutions, Public Meeting Transcript, No. 10 at p. 39" identifies an oral comment that DOE received during the February 5, 2015, residential dishwasher energy conservation standards NOPR public meeting. Oral comments were recorded in the public meeting transcript and are available in the residential dishwasher energy conservation standards rulemaking docket (Docket No. EERE-2014-BT-STD-0021). This particular notation refers to a comment: (1) made by Energy Solutions during the public meeting; (2) recorded in document number 10, which is the public meeting transcript that is filed in the docket of this energy conservation standards rulemaking; and (3) which appears on page 39 of document number 10.

observed all design options that it has identified for improving dishwasher efficiency in units currently on the market. DOE also observed that fewer residential dishwashers in the standard product class are available on the market at the energy and water consumption values for Efficiency Level 3 as defined in the 2014 NOPR than existed at the time the 2014 NOPR was issued. Accordingly, DOE has revised the energy and water consumption values that define Efficiency Level 3 for the standard product class, as described in greater detail in section IV.C.1 of this final rule.

The CA IOUs were concerned that in the 2014 NOPR, DOE presented data from testing conducted in support of the 2012 Direct Final Rule. They commented that tested models should be ones that are representative of models meeting the current standard and reasonably representative of the market. (CA IOUs, No. 23 at p. 2) AHAM noted that DOE conducted testing and teardowns on a limited sample of models, some of which were outdated or had been removed from the market. (AHAM, No. 21 at p. 6)

All test data presented in the 2014 NOPR TSD were from testing conducted either in support of developing the ENERGY STAR Cleaning Performance Test Method or specifically for the 2014 NOPR analysis, and were included in the analyses for the 2014 NOPR and this final rule analysis only if the unit under test met the current dishwasher energy conservation standards. DOE did not conduct additional testing for the final rule analysis, but, as described earlier in this section, it has revised the efficiency levels used in the analysis to better reflect the current residential dishwasher market. Additionally, in manufacturer interviews conducted after publishing the 2014 NOPR, DOE confirmed that

the design options incorporated in its test units are representative of the design options included in products currently on the market and of the design options manufacturers would likely use to achieve higher efficiencies. Accordingly, DOE determined that its test data are representative of the current dishwasher market.

b. Consumer Utility

As described in chapter 5 of the NOPR TSD, DOE identified Efficiency Level 3 for the standard product class in the 2014 NOPR as the most efficient level that would maintain product cleaning performance. DOE based this determination on cleaning performance data from the ENERGY STAR Cleaning Performance Test Method, which showed that cleaning performance begins to drop off at energy consumptions and water consumptions below Efficiency Level 3. DOE received multiple comments from interested parties on this issue.

The Joint Commenters emphasized that dishwasher performance should be maintained with new standard levels for consumers to achieve actual energy and water savings, because otherwise consumers may select cycles other than the normal cycle. The Joint Commenters urged DOE to evaluate any additional information beyond cleaning performance, including drying performance and cycle time, provided by manufacturers to ensure that performance can be maintained. (Joint Commenters, No. 22 at p. 2)

AHAM objected to the use of the ENERGY STAR Cleaning Performance Test Method to evaluate performance at the proposed efficiency levels due to AHAM's evaluation of the repeatability and reproducibility of that test procedure. (AHAM, Public Meeting Transcript, No. 10 at p. 20; AHAM, No. 21 at p. 13) According to AHAM, its round robin testing conducted during the development of the ENERGY STAR Cleaning Performance Test Method demonstrated that the test procedure has a maximum standard deviation of 6.76 when using AHAM scoring, albeit on models that did not meet the efficiency levels proposed in the 2014 NOPR. AHAM also stated that it believes that the standard deviation will likely increase as the stringency of the standard levels increases. Furthermore, AHAM and GE commented that DOE's proposed standard level could just as likely negatively impact performance as be neutral, specifically noting that Efficiency Level 3 performance may overlap with Efficiency Level 4 performance. (AHAM, No. 21 at pp. 9–10; GE, No. 26 at pp. 3–4) BSH noted its internal testing found that the ENERGY STAR Cleaning Performance Test Method is repeatable within a single laboratory, but that variability is introduced with tests at different test facilities. (BSH, Public Meeting Transcript, No. 10 at pp. 47–48)

AHAM and GE also commented that DOE did not address dishwasher attributes other than cleaning (e.g., cycle time, drying performance, and noise levels) which potentially impact dishwasher performance and utility. (AHAM, No. 21 at pp. 6–7; GE, No. 26 at pp. 2–3) AHAM expressed concern that DOE had made incorrect assumptions about the mass consumer appeal of the few products on the market (or once on the market) that meet Efficiency Level 3, and commented that energy and water savings for

products currently available are more likely to come at the expense of performance and features than in the past. AHAM noted the small number of models available that meet the proposed levels as compared to its estimates of approximately 667 standard models and 54 compact models on the market at the time of its comment. (AHAM, No. 21 at pp. 6–7, 10)

AHAM stated that water heating is the biggest contributor to dishwasher energy use regardless of the manufacturer, and that manufacturers may be forced to reduce water heating in an effort to comply with the proposed standards, putting performance at risk. (AHAM, No. 21 at p. 8) GE commented that DOE's data from the 2014 NOPR show that performance may begin to degrade at the ENERGY STAR levels in effect at the time of the 2014 NOPR analysis (295 kWh/year and 4.25 gal/cycle). (GE, No. 26 at p. 10)

AHAM and BSH commented that if a portion of a dishwasher cycle changes to save energy, some other aspect must also change to compensate, for example, increasing cycle times. (AHAM, No. 21 at pp. 7–8; BSH, Public Meeting Transcript, No. 10 at pp. 53–55) AHAM stated that data it collected from manufacturers comprising over 90 percent of the market show that as energy use decreases, cycle time (including drying time) increases. According to AHAM, these data indicate that the shipment-weighted average cycle time increases by 12 percent for products meeting Efficiency Level 2 compared to products at the baseline. AHAM further stated that the shipment-weighted average cycle time increases by 37 percent for products meeting Efficiency Level 3 compared to products at the baseline (based on the few models meeting Efficiency Level

3 in the AHAM data set). AHAM commented that this increase in cycle time is likely to be unacceptable to consumers. Finally, AHAM noted that DOE had not shown why it determined that cycle times would be acceptable at Efficiency Level 3 but not at Efficiency Level 4. (AHAM, No. 21 at pp. 7–8) GE stated that standards at Efficiency Level 3 would drive cycle time to greater than 3 hours. According to GE, a survey of 11,000 dishwasher owners showed that cycle time is one of the four major sources of dissatisfaction with these products, the others being odor, rinsing performance, and drying performance. (GE, No. 26 at pp. 3–4)

AHAM stated that in addition to using all or most of the technology options identified in the 2014 NOPR, manufacturers will be required to apply significant innovation at increased cost to meet the proposed standards. AHAM commented that to offset that cost, manufacturers will be forced to make trade-offs, potentially causing loss of product utility. (AHAM, No. 21 at pp. 10–11)

GE believes there would be a compression of the market if standards were adopted at Efficiency Level 3, forcing manufacturers to add cost to increase efficiency rather than increase consumer utility. GE stated as an example that a manufacturer may not be able to invest in sound performance or enhanced rack designs in value-priced models, resulting in reduced consumer utility at lower price points. (GE, No. 26 at p. 4)

Because of the extensive response from interested parties on potential utility concerns at the standard levels proposed in the 2014 NOPR for the standard product

class, and at the request of multiple interested parties, DOE conducted additional manufacturer interviews after the 2014 NOPR to further assess the potential utility impacts at varying dishwasher efficiencies.

Information gathered during the manufacturer interviews suggests that some aspect of dishwasher performance would be compromised in order to maintain cleaning performance at the Efficiency Level 3 considered in the 2014 NOPR. As mentioned in the comments from interested parties, manufacturers generally identified drying performance and cycle times as the parameters most likely to be affected at that efficiency level.

During manufacturer interviews, DOE also requested information on how much the energy or water consumption would need to increase from the previous Efficiency Level 3 to maintain acceptable performance. Manufacturers generally indicated that by using all available design options to improve efficiency, they would likely be able to maintain performance with a maximum energy consumption between 250 and 260 kWh/year. With the additional energy consumption, manufacturers suggested that dishwasher cycles would be able to maintain sufficiently high wash and rinse temperatures to result in good cleaning and drying performance. Based on this feedback, DOE adjusted the energy consumption for Efficiency Level 3 in this final rule analysis to 255 kWh/year.[10]

[10] As discussed later in this section, manufacturers provided different views on consumer utility impacts at this efficiency level. AHAM and a group of its members provided public feedback indicating performance

Manufacturers also indicated during interviews that the maximum energy consumption limit proposed in the 2014 NOPR was the primary concern at Efficiency Level 3 rather than the water consumption. They stated that they would likely be able to maintain performance with the same water consumption proposed in the 2014 NOPR if it is combined with a higher energy use value. From this feedback, DOE maintained water consumption at 3.1 gal/cycle for Efficiency Level 3.

One major concern noted in the comments from interested parties was the lack of products available at the proposed standards at Efficiency Level 3. In addition to the manufacturer feedback during interviews, DOE notes that its Compliance Certification Database includes 97 models that would meet the revised Efficiency Level 3 out of a total of 789 standard dishwashers.[11] Additionally, 137 certified models meet the energy consumption at revised Efficiency Level 3 and 305 models meet the water consumption at revised Efficiency Level 3. For products that would currently meet only one of the two metrics for Efficiency Level 3, the rated value for the other metric is, on average, 261 kWh/year for models not meeting the energy consumption and 3.3 gal/cycle for products not meeting the water consumption. This suggests that these products would likely be able to meet Efficiency Level 3 with only minor changes.

concerns at this level, which differed from the information provided to DOE in confidential manufacturer interviews.

[11] Based on products listed as of August 10, 2016.

Following the manufacturer interviews, AHAM and a group of its members gathered additional data regarding cleaning performance and presented the information to DOE in a meeting on July 8, 2015.[12] The AHAM materials focused on two sets of manufacturer testing: one set consisting of a modified DOE sensor heavy soil load tested in dishwashers reprogrammed to match three energy and water use levels (307 kWh/year and 4.1 gal/cycle, 255 kWh/year and 3.1 gal/cycle, and 234 kWh/year and 3.1 gal/cycle); and one set consisting of two dishwashers that were each loaded with ten place settings soiled with a modified ANSI/AHAM Standard DW-1-2010 soil load, with each dishwasher programmed to match two energy and water use levels (307 kWh/year and 5.0 gal/cycle and 234 kWh/year and 3.1 gal/cycle). AHAM presented results from these tests by exhibiting certain load items as they came out of a test unit at the end of the cycle. AHAM also presented compiled consumer feedback on the test load results in which the consumers generally indicated that the test load items from the units set to 307 kWh/year were adequately cleaned (although some had concerns with performance), while the items coming from the units set to 255 kWh/year or 234 kWh/year would be unacceptable for use. Based on these data, AHAM commented that any standards at these lower energy consumption and water consumption levels would result in worse performance than products currently on the market achieve. Accordingly, AHAM stated that amended dishwasher standards should not be more stringent than the upcoming ENERGY STAR level (270 kWh/year and 3.5 gal/cycle). (AHAM, No. 27 at pp. 1–13)

[12] A summary of the meeting and the materials presented at this meeting are available at http://www.energy.gov/sites/prod/files/2015/08/f25/AHAM%20Comments_Ex%20Parte%20Memo_July%208%2C%202015_Dishwasher%20Standards_FINAL%20%2800039961%29.pdf.

DOE appreciates the additional information on cleaning performance gathered by AHAM and its members. DOE acknowledges that the data may demonstrate utility impacts at Efficiency Level 3 under the test methods utilized by AHAM. In the paragraphs that follow, however, DOE discusses its concerns with AHAM's test methods:

First, DOE notes that the soil loads used for both sets of testing, and in particular the tests conducted with ten soiled place settings, were heavier than the soils typical of 95 percent of consumer loads. The heaviest soil load in appendix C1 requires only 4 soiled place settings, and represents the 5 percent of consumer cycles run with the heaviest soil loads. The majority of consumer use corresponds to the light soil load in appendix C1 (62 percent of cycles), which requires only one soiled place setting with half the soil amount specified in ANSI/AHAM Standard DW-1-2010.

Second, both sets of AHAM tests included additional soils that are more difficult to remove than those specified in appendix C1. For the first set of tests, animal and vegetable fats were applied, and these were the soils that appeared upon visual inspection to remain after the test cycles. For the second set of tests, a significant amount of adhered soil was added to a serving bowl, and cooked-on milk was added to one glass. The soil loads used in appendix C1 and ANSI/AHAM Standard DW-1-2010 were developed to be representative of typical consumer use, so these substitutions resulted in a soiled load that was more difficult to clean than the typical load.

Third, the controls on the four test units were adjusted to obtain certain energy and water responses for each test cycle rather than allowing a soil sensor to determine the appropriate energy and water consumption for the encountered soil load. As described in chapter 5 of the final rule TSD, DOE expects that manufacturers would incorporate soil sensors, among other design options, to achieve Efficiency Level 3. In appendix C1, the light and medium soil loads represent 95 percent of overall dishwasher use. Accordingly, the cycle responses to these soil loads effectively determine the overall energy and water use for a unit, allowing a dishwasher to meet Efficiency Level 3 even if it were to use a relatively high level of energy and water under heavy soil conditions. DOE expects that a load with ten soiled place settings would always trigger a heavier cycle response in a soil-sensing dishwasher that is designed specifically to meet Efficiency Level 3. As a result, DOE concludes that forcing dishwashers to consume less energy and water under the heaviest soil loading conditions than they would likely be designed for would not reflect how actual units in the field would operate for consumers.

In summary, DOE concludes that the results of AHAM's testing do not demonstrate conclusively that residential dishwashers would have unacceptable cleaning performance at the proposed Efficiency Level 3. DOE expects that typical consumer use conditions would be less severe than those used in AHAM's testing, and that actual units in the field would adjust their cycle responses to heavier-than-typical soil loads to obtain better cleaning performance. Further, the information gathered during confidential manufacturer interviews and the 97 certified models that would meet Efficiency Level 3 indicate that performance could be maintained at that efficiency level.

c. Final Rule Efficiency Levels

Based on the information gathered in manufacturer interviews and the Certification Compliance Database, DOE revised the energy consumption associated with Efficiency Level 3 for standard residential dishwashers to 255 kWh/year in this final rule analysis. As described in section IV.C.1.a. of this final rule, DOE also revised the max-tech Efficiency Level 4 for both standard and compact residential dishwashers.

DOE did not receive any comments in response to the Efficiency Level 2 analyzed for standard residential dishwashers in the 2014 NOPR; however, DOE revised the energy consumption at Efficiency Level 2 to 270 kWh/year for this final rule. The energy use and water consumption corresponding to Efficiency Level 2 in the 2014 NOPR were originally selected for analysis in the 2012 Direct Final Rule based on the ENERGY STAR Draft 2 Version 5.0 Dishwashers Specification, released on February 3, 2011.[13] Although these values represent a technologically feasible efficiency level, DOE updated Efficiency Level 2 for this final rule analysis based on the ENERGY STAR Version 6.0 Dishwashers Specification, which became effective on January 29, 2016. This updated specification establishes maximum values of annual energy consumption and per-cycle water consumption of 270 kWh/year and 3.5 gal/cycle, respectively. For

[13] The draft specification document is available at https://www.energystar.gov/products/specs/sites/products/files/ES_Draft_2_V5.0_Dishwashers_Specification.pdf. DOE notes that this level was removed from the Final V5.0 Dishwashers Specification, and subsequent specification versions 5.1 and 5.2.

consistency with the current ENERGY STAR specification, DOE analyzed Efficiency Level 2 at 270 kWh/year and 3.5 gal/cycle for this final rule.

In summary, Table IV.5 and Table IV.6 present the efficiency levels DOE considered in this final rule analysis.

Table IV.5 Final Rule Efficiency Levels – Standard Product Class

Efficiency Level	**Annual Energy Use** (kWh/year)	**Per-Cycle Water Consumption** (gal/cycle)
0 – Baseline	307	5.00
1	295	4.25
2	270	3.50
3	255	3.10
4 – Max-Tech	225	2.4

Table IV.6 Final Rule Efficiency Levels – Compact Product Class

Efficiency Level	**Annual Energy Use** (kWh/year)	**Per-Cycle Water Consumption** (gal/cycle)
0 – Baseline	222	3.50
1	203	3.10
2 – Max-Tech	130	1.70

2. Manufacturer Production Cost Estimates

In the 2014 NOPR, DOE developed MPC estimates for products at each efficiency level. To do this, DOE conducted product teardowns and referred to the 2012 Direct Final Rule to determine which design options manufacturers would likely incorporate at each efficiency level. DOE entered information from the teardowns and expected design options into its cost model to determine associated MPC estimates for

products incorporating the expected design options at each efficiency level, as described in chapter 5 of the NOPR TSD. Table IV.7 and Table IV.8 present the cost-efficiency relationships developed for the 2014 NOPR. 79 FR 76142, 76155–76156 (Dec. 19, 2014).

Table IV.7 2014 NOPR Cost-Efficiency Relationship for Standard Residential Dishwashers

Efficiency Level	Annual Energy Use (kWh/year)	Per-Cycle Water Consumption (gal/cycle)	Incremental Manufacturer Production Cost (2013$)
0 – Baseline	307	5.00	$ -
1	295	4.25	$ 9.52
2	280	3.50	$ 36.53
3	234	3.10	$ 74.72
4 – Max-Tech	180	2.22	$ 74.72

Table IV.8 2014 NOPR Cost-Efficiency Relationship for Compact Residential Dishwashers

Efficiency Level	Annual Energy Use (kWh/year)	Per-Cycle Water Consumption (gal/cycle)	Incremental Manufacturer Production Cost (2013$)
0 – Baseline	222	3.50	$ -
1	203	3.10	$ 8.01
2 – Max-Tech	141	2.00	$ 21.50

AHAM commented that it is not clear how DOE chose the representative products for the baseline and higher efficiency levels, and that DOE did not use current information obtained directly from the manufacturers in its analysis, leading to an overstated baseline cost (by $45 to $60) and understated costs for the higher efficiency levels. Specifically, AHAM commented that the overall MPC estimate for Efficiency Level 1 was reasonable, but the incremental cost to reach that efficiency level was too low due to the overestimated baseline cost. According to AHAM, the incremental cost

between Efficiency Level 1 and Efficiency Level 2 is relatively small, but the change to Efficiency Level 3 would require significant redesign and cost ($55 to $70 beyond Efficiency Level 2). AHAM stated that it was not able to comment on costs required to reach Efficiency Level 4 due to lack of data for that efficiency level. (AHAM, No. 21 at pp. 3, 6, A-4–A-5) GE supported AHAM's claims that DOE overstated the cost of the baseline unit and understated the costs of reaching the higher efficiency levels (including understating the cost of moving from baseline to Efficiency Level 1). GE also stated that Efficiency Level 3 would require innovative technology and new platform designs, but the NOPR analysis did not account for this invention risk, investment cost, nor the potential loss of product utility. (GE, No. 26 at p. 2)

AHAM stated that it collected data from manufacturers representing over 90 percent of shipments in 2014 in order to evaluate the design options associated with each efficiency level in the 2014 NOPR. According to AHAM, its data show that 92 percent of models that do not reach Efficiency Level 3 already use hydraulic system optimization and temperature sensors, so manufacturers would not be able to use those options to meet more stringent levels. In addition, AHAM stated that its data show that 70 percent of models in its data set already employ the control strategies DOE described for meeting Efficiency Level 4. AHAM commented that all of the incremental changes DOE concluded manufacturers could use to improve dishwasher designs from Efficiency Level 2 to Efficiency Level 3 are already in use in products that do not meet Efficiency Level 3. AHAM suggested that DOE review design options with manufacturers to understand how they would reach each efficiency level and to update the standards analysis. (AHAM,

No. 21 at p. 11) GE commented that many of the technology options identified in the 2014 NOPR are not included in products to improve energy efficiency, which has the effect of overstating the cost of the baseline unit. In addition, GE stated that DOE's analysis did not adequately capture either the technology path or the costs to move from Efficiency Level 2 to Efficiency Level 3 because the design options identified for Efficiency Level 3 are either already utilized in products at lower efficiency levels, or would not be considered as an approach to meet Efficiency Level 3. (GE, No. 26 at p. 2)

After publishing the 2014 NOPR, DOE reviewed its MPC estimates for standard residential dishwashers in its interviews with manufacturers. Topics of discussion included the design options that would be used to reach each efficiency level for standard products as well as the costs associated with those design options. DOE also reviewed its cost estimates for other components not directly related to energy and water performance to improve its estimates of the total MPCs for products at each efficiency level.

At the baseline efficiency level, DOE revised its MPC estimate downwards, as recommended in comments from interested parties and supported by the information gained through manufacturer discussions. In the 2014 NOPR, DOE had incorporated representative cost estimates for non-efficiency components such as racks and detergent dispensers. For this final rule analysis, DOE estimated that manufacturers would use the lowest cost option available. DOE also revised its cost estimates for certain components at the baseline efficiency level based on manufacturer feedback. With these revisions, the updated final rule baseline MPC is approximately $55 lower than the 2014 NOPR

estimate. DOE notes that the non-efficiency related component costs that decreased from the 2014 NOPR to this final rule at the baseline level would also decrease at the higher efficiency levels for this final rule because the engineering analysis only considers improvements related to efficiency. As a result, the overall MPCs at each analyzed efficiency level decreased compared to the 2014 NOPR.

For the higher efficiency levels, DOE received manufacturer feedback that it had identified all of the design options manufacturers would use to improve efficiencies. Manufacturers also generally agreed with the design options DOE assumed for Efficiency Level 1 and Efficiency Level 2. However, with the change to the energy consumption at Efficiency Level 2 as described in section IV.C.1.c of this final rule, DOE determined that manufacturers would incorporate a water diverter assembly at Efficiency Level 2. For this final rule analysis, DOE also revised the design options associated with Efficiency Level 3 and Efficiency Level 4. The key changes were shifting condensation drying and an in-sump heater from Efficiency Level 3 to Efficiency Level 4. DOE also determined that incorporating condensation drying at Efficiency Level 4 would require the use of a stainless steel tub. Furthermore, in addition to revising the Efficiency Level 3 and Efficiency Level 4 design options, DOE updated its cost estimates for specific design options at each efficiency level based on manufacturer feedback. This included updating costs for components such as pumps, controls, sensors, and portions of the water system. DOE then adjusted the MPC estimates to reflect 2015 dollars.

There were no substantive changes for the compact dishwasher cost-efficiency relationship other than updating the costs to 2015 dollars. Although the max-tech efficiency level for the compact product class changed compared to the 2014 NOPR analysis, DOE observed that the product offered at the updated max-tech efficiency level appears to have the same design as the previous model, and therefore, DOE expects the MPC to remain unchanged.

Table IV.9 and Table IV.10 provide the updated MPC estimates used for this final rule analysis. Further details of the engineering analysis are provided in chapter 5 of the final rule TSD.

Table IV.9 Final Rule Cost-Efficiency Relationship for Standard Residential Dishwashers

Efficiency Level	Annual Energy Use (kWh/year)	Per-Cycle Water Consumption (gal/cycle)	Incremental Manufacturer Production Cost (2015$)
0 – Baseline	307	5.00	$ -
1	295	4.25	$ 14.76
2	270	3.50	$ 42.20
3	255	3.10	$ 57.61
4 – Max-Tech	225	2.40	$ 92.20

Table IV.10 Final Rule Cost-Efficiency Relationship for Compact Residential Dishwashers

Efficiency Level	Annual Energy Use (kWh/year)	Per-Cycle Water Consumption (gal/cycle)	Incremental Manufacturer Production Cost (2015$)
0 – Baseline	222	3.50	$ -
1	203	3.10	$ 8.50
2 – Max-Tech	130	1.70	$ 28.11

D. Markups Analysis

The markups analysis develops appropriate markups (e.g., manufacturer markups, retailer markups, distributor markups, contractor markups) in the distribution chain and sales taxes to convert the manufacturer selling price (MSP) estimates derived based on the MPCs determined in the engineering analysis to consumer prices, which are then used in the LCC and PBP analysis and in the MIA. At each step in the distribution channel, companies mark up the price of the product to cover business costs and profit margin. For residential dishwashers, the main parties in the distribution chain are manufacturers, retailers, and consumers. The manufacturer markup converts MPC to MSP. DOE developed an average manufacturer markup by examining the annual Securities and Exchange Commission (SEC) 10-K reports filed by publicly-traded manufacturers primarily engaged in appliance manufacturing and whose combined product range includes residential dishwashers.

For retailers, DOE developed separate markups for baseline products (baseline markups) and for the incremental cost of more-efficient products (incremental markups). Incremental markups are coefficients that account for the change in the MSP of higher-efficiency models and the change in the retailer sales price. DOE relied on economic data from the U.S. Census Bureau to estimate average baseline and incremental markups.

AHAM criticized DOE's reliance on the concept of incremental markups, stating that its theory has been disproved and it is in contradiction to empirical evidence. (AHAM, No. 21 at p. 15) In an attachment to AHAM's comment, Shorey Consulting,

Inc. (Shorey Consulting) stated that (1) DOE requires a strong form of economic theory, since it is saying that something will happen solely because theory says it should; and (2) an a priori resort to economic theory without clear empirical support is highly problematic. Shorey Consulting interviewed a sample of local/regional and national appliance retailers and reported that, with very few exceptions, they were skeptical that percentage margins will be lower in a post-standards situation. Shorey Consulting concluded that DOE needs to abandon the incremental margin approach and revert to the average margin approach that corresponds to actual industry practice. (AHAM, No. 21 at pp. A-10–A-11)

DOE disagrees that the theory behind the concept of incremental markups has been disproved. The concept is based on the theory that an increase in profitability, which is implied by keeping a fixed markup percentage when the product price goes up, is not likely to be viable over time in a business that is reasonably competitive. DOE agrees that empirical data on markup practices would be desirable, but such information is closely held and difficult to obtain.

Regarding the Shorey Consulting interviews with appliance retailers, although the retailers said that they maintain the same percentage margin after amended standards for refrigerators took effect, it is not clear to what extent the wholesale prices of refrigerators actually increased. There is some empirical evidence indicating that prices may not

always increase following a new standard[14,15,16]. If this happened to be the case following the new refrigerator standard, then there is no reason to suppose that percentage margins changed either.

DOE's analysis necessarily considers a simplified version of the world of appliance retailing; namely, a situation in which other than appliance product offerings, nothing changes in response to amended standards. DOE's analysis assumes that product cost will increase while the other costs remain constant (i.e., no change in labor, material, or operating costs), and asks whether retailers will be able to keep the same markup percentage over time. DOE recognizes that retailers are likely to seek to maintain the same markup percentage on appliances if the price they pay goes up as a result of appliance standards, but DOE contends that over time downward adjustments are likely to occur due to competitive pressures. Some retailers may find that they can gain sales by reducing the markup and maintaining the same per-unit gross profit as they had before the new standard took effect. Additionally, DOE contends that retail pricing is more complicated than a simple percentage margin or markup. Retailers undertake periodic sales and they reduce the prices of older models as new models come out to replace them.[17, 18, 19] Even if retailers maintain the same percent markup when appliance

[14] Spurlock, C. A. 2013. "Appliance Efficiency Standards and Price Discrimination." Lawrence Berkeley National Laboratory Report LBNL-6283E.
[15] Houde, S. and C. A. Spurlock. 2015. "Do Energy Efficiency Standards Improve Quality? Evidence from a Revealed Preference Approach." Lawrence Berkeley National Laboratory Report LBNL-182701.
[16] Taylor, M., C. A. Spurlock, and H.-C. Yang. 2015. "Confronting Regulatory Cost and Quality Expectations: An Exploration of Technical Change in Minimum Efficiency Performance Standards." Resources for the Future (RFF) 15-50.
[17] Bagwell, K. and Riordan, M.H., 1991. "High and declining prices signal product quality." The American Economic Review, pp. 224-239.

wholesale prices increase as the result of a standard, retailers may respond to competitive pressures and revert to pre-standard average per-unit profits by holding more frequent sales, discounting products under promotion to a greater extent, or discounting older products more quickly. These factors would counteract the higher percentage markup on average, resulting in much the same effect as a lower percentage markup in terms of the prices consumers actually face on average.

DOE acknowledges that its approach to estimating retailer markup practices after amended standards take effect is an approximation of real-world practices that are both complex and varying with business conditions. However, DOE continues to maintain that its assumption that standards do not facilitate a sustainable increase in profitability is reasonable.

Chapter 6 of the final rule TSD provides details on DOE's development of markups for residential dishwashers.

E. Energy and Water Use Analysis

The purpose of the energy and water use analysis is to determine the annual energy and water consumption of residential dishwashers at different efficiencies in representative U.S. single-family homes, multi-family, and manufactured housing

[18] Betts, E. and Peter, J.M., 1995. "The strategy of the retail 'sale': typology, review and synthesis." International Review of Retail, Distribution and Consumer Research, 5(3), pp. 303-331

[19] Elmaghraby, W. and Keskinocak, P., 2003. "Dynamic pricing in the presence of inventory considerations: Research overview, current practices, and future directions." Management Science, 49(10), pp. 1287-1309.

residences, and to assess the energy and water savings potential of increased residential dishwasher efficiency. The analysis estimates the range of energy and water use of residential dishwashers in the field (i.e., as they are actually used by consumers). The energy and water use analysis provides the basis for other analyses DOE performed, particularly assessments of the energy and water savings and the savings in consumer operating costs that could result from adoption of amended or new standards.

DOE determined a range of annual energy use and per-cycle water consumption of residential dishwashers by multiplying the per-cycle energy use and per-cycle water use of each considered design by the number of cycles per year in a representative sample of U.S. households.

DOE analyzed per-cycle energy consumption based on two components: (1) water-heating energy, and (2) machine electrical energy use which consists of primarily of energy for motor operation and for drying. The largest component of residential dishwasher energy consumption is water-heating energy use, which is the energy required to heat the inlet water to the temperature for dishwashing. The machine energy consists of the motor energy (for water pumping and food disposal), and drying energy consists of heat to dry cleaned dishes.

DOE estimated the per-cycle water-heating energy consumption based on DOE's residential dishwasher test procedure (which refers to this quantity as "water energy consumption"). DOE estimated this energy consumption for residential dishwashers that

operate with a nominal inlet hot water temperature of 120 ºF, the most common situation in U.S. homes. For a residential dishwasher using electrically heated water, the water-heating energy consumption, expressed in kWh per cycle, is equal to the water consumption per cycle times a nominal water heater temperature rise of 70 ºF times the specific heat of water (0.0024 kWh per gallon per ºF).[20] For a residential dishwasher using gas-heated or oil-heated water, the calculation is the same, but also incorporates a nominal water heater recovery efficiency of 0.80 for gas-fired water heating and 0.78 for oil-fired water heating.[21]

DOE estimated the per-cycle energy use by subtracting the annual energy use associated with standby power from the total annual energy use and dividing the result by the national average number of residential dishwasher cycles per year. DOE used the following data from the engineering analysis for each considered efficiency level: the total annual residential dishwasher energy use and the standby power use.

DOE determined the standby annual energy consumption by multiplying the energy use in standby mode per hour by the hours the residential dishwasher is in standby mode. Standby mode hours are the difference between the number of hours in a year and

[20] The water heater temperature rise of 70 ºF assumes an average water heater inlet temperature of 50 ºF, as specified as the national average in the dishwasher test procedure.
[21] The recovery efficiency indicates how efficient a water heater is at heating water. The DOE test procedure for dishwashers specifies a recovery efficiency of 0.80 for gas-fired water heating and 0.78 for oil-fired water heating, which is representative of gas and oil water heaters currently in the housing stock.

the active hours. Active hours are equal to the number of residential dishwasher cycles per year multiplied by cycle time, estimated to be 1 hour.[22]

GE noted that DOE indicated that the average dishwasher cycle time is one hour, but AHAM data collected from companies representing over 90 percent of the market indicates that shipment-weighted average cycle time is 1.76 hours. (GE, No. 26 at pp. 2–3) DOE notes that the 1-hour estimate is used in calculating the number of standby and off mode hours to determine the overall energy consumption in those modes. Using 1.76 hours has less than a 2-percent change on the number of hours associated with standby mode or off mode, which already represents a small portion of overall energy consumption. So, DOE expects any change to the energy use associated with the assumed cycle time to be negligible. DOE will consider whether revisions to the cycle time are appropriate when it next revises its test procedure for dishwashers.

DOE estimated the per-cycle water use for each efficiency level in its engineering analysis, as described in chapter 5 of the final rule TSD.

For the NOPR, to estimate the average number of dishwasher cycles per year in a representative sample of U.S. households, DOE relied on a review of survey data it used to develop the 2003 residential dishwasher test procedure amendments. Survey data on consumers' dishwasher usage habits were collected from a number of sources including

[22] The 1-hour cycle time is an estimate of the typical cycle time for a dishwasher. Actual cycle times vary based on wash selection, load, and model of dishwasher.

the EIA's 1997 Residential Energy Consumption Survey (RECS),[23] several residential dishwasher manufacturers, detergent manufacturers, energy and consumer interest groups, independent researchers, and government agencies. These data yielded an average usage of 215 cycles per year.

AHAM commented that DOE used outdated assumptions on the number of annual dishwasher cycles, including disregard for recent RECS data used extensively by DOE in its analyses in favor of the 1997 RECS data. (AHAM, No. 21 at p. 15) In an attachment to AHAM's comment, Shorey Consulting stated that DOE should either use the average number of cycles per year from the 2009 RECS, or substitute the 2009 RECS data for the 1997 data in the Arthur D. Little (ADL) study. (AHAM, No. 21 at p. A-6)

For the final rule, DOE used an average value based on the 2009 RECS data rather than the 1997 RECS average originally used in the review of survey data in the ADL study.[24] These survey data from the ADL study provided a comprehensive data set of point estimates which the RECS data alone do not provide, and are therefore more reflective of dishwasher use nation-wide.

Of the more than 12,000 households in the 2009 RECS, almost 7,400 have residential dishwashers. For each household using a residential dishwasher, RECS

[23] RECS is a national sample survey of housing units that collects statistical information on the consumption of and expenditures for energy in housing units along with data on energy-related characteristics of the housing units and occupants. For information on RECS, see www.eia.doe.gov/emeu/recs/.

[24] Arthur D. Little Inc. Review of Survey Data to Support Revisions to DOE's Dishwasher Test Procedure https://www.regulations.gov/document?D=EERE-2014-BT-STD-0021-0001

provides data on the number of residential dishwasher cycles in the following bins: (1) less than once per week, (2) once per week, (3) 2–3 times per week, (4) 4–6 times per week, and (5) at least once per day. DOE converted the above information to annual values. DOE amended its characterization of the RECS usage bins to eliminate the gaps in the number of annual cycles that had existed in the NOPR analysis.[25] The variability of each bin was accounted for by using triangular distributions for the least and most usage bins and uniform distributions for the three middle bins. This revision changed the weighted average annual cycles from the 171 value used for the NOPR to 204 cycles per year. DOE used the 204 cycles derived from the 2009 RECS (rather than the 245 cycles, the value derived from the 1997 RECS), and followed the method used to derive the average usage of 215 cycles per year for the DOE test procedure. The substitution of the 2009 RECS average changed the average cyles per year from 215 to 207, which DOE used for the final rule. The revisions made for the final rule are described in chapter 7 of the final rule TSD.

To develop the variability of dishwasher use, DOE used the revised bin ranges from the 2009 RECS. DOE randomly assigned a specific numerical value from within the appropriate bin to each household in the residential dishwasher sample. Following the method used for the NOPR, DOE then scaled the assigned usage to the revised average from the survey data (207 cycles/year).

[25] For the lowest bin, usage ranges from 1 to 51 cycles per year; for the bin "once per week," usage ranges from 51 to 103 cycles per year; for the bin "2-3 times per week," usage ranges from 104 to 207 cycles per year; for the bin "4-6 times per week," usage ranges from 208 to 364 cycles per year; and for the highest bin, usage ranges from 365 to 730 cycles per year.

Table IV.11 and Table IV.12 show the estimated average annual energy and water use for each efficiency level analyzed for standard and compact residential dishwashers.

Table IV.11 Standard Residential Dishwashers: Average Annual Energy and Water Use by Efficiency Level

Efficiency Level	Annual Energy Use				Annual Water Use
	Water Heating*	Machine + Drying	Standby†	Total	
	kWh/year	kWh/year	kWh/year	kWh/year	gal/year
Baseline	177.0	130.0	0.0	307	1,075.0
1	150.4	140.3	4.3	295	913.8
2	123.9	141.8	4.3	270	752.5
3	109.7	141.0	4.3	255	666.5
4	85.0	135.8	4.3	225	516.0

* Shown for the case of electrically heated water.

† Standby annual energy use based on a dishwasher cycle length of one hour.
Standby hours = 8760 hours – (215 cycles x 1 hour) = 8545 hours. The 215 cycles is used in the test procedure.

Table IV.12 Compact Residential Dishwashers: Average Annual Energy and Water Use by Efficiency Level

Efficiency Level	Annual Energy Use				Annual Water Use
	Water Heating*	Machine + Drying	Standby†	Total	
	kWh/year	kWh/year	kWh/year	kWh/year	gal/year
Baseline	123.9	78.4	19.7	222	752.5
1	109.7	78.7	14.5	203	666.5
2	60.2	65.5	4.3	130	365.5

* Shown for the case of electrically heated water.

† Standby annual energy use based on a dishwasher cycle length of 1 hour.
Standby hours = 8760 hours – (215 cycles x 1 hour) = 8545 hours.

Chapter 7 of the final rule TSD provides details on DOE's energy and water use analysis for residential dishwashers.

F. Life-Cycle Cost and Payback Period Analysis

DOE conducted LCC and PBP analyses to evaluate the economic impacts on individual consumers of potential energy conservation standards for residential dishwashers. The effect of new or amended energy conservation standards on individual consumers usually involves a reduction in operating cost and an increase in purchase price. 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 and water 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 simple 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 simple 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

dishwashers in the absence of new or amended energy conservation standards. In contrast, the simple PBP for a given efficiency level is measured relative to the baseline product.

For each considered efficiency level in each product class, DOE calculated the LCC and PBP for a nationally representative set of housing units. As stated previously, DOE developed household samples from the 2009 RECS. For each sample household, DOE determined the energy and water consumption for residential dishwashers and the appropriate energy price. By developing a representative sample of households, the analysis captured the variability in energy and water consumption and energy and water prices associated with the use of residential dishwashers.

Inputs to the calculation of total installed cost include the cost of the product—which includes MPCs, manufacturer markups, retailer markups, and sales taxes—and installation costs. Inputs to the calculation of operating expenses include annual energy and water consumption, energy and water 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, which incorporates Crystal Ball™ (a commercially-available software program), 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 residential dishwasher user samples. The model calculated the LCC and PBP for products at each efficiency level for 10,000 housing units per simulation run.

DOE calculated the LCC and PBP for all consumers as if each were to purchase a new product in the expected year of compliance with amended standards. For purposes of its analysis, DOE estimated that any amended standards would apply to residential dishwashers manufactured 3 years after the date on which the amended standard is published. (42 U.S.C. 6295(g)(10)(B)) DOE estimated publication of a final rule in 2016. Therefore, for purposes of its analysis, DOE used 2019 as the first year of compliance.

Table IV.13 summarizes the approach and data DOE used to derive inputs to the LCC and PBP calculations. The subsections that follow provide further discussion. Details of the spreadsheet model, and of all the inputs to the LCC and PBP analyses, are contained in chapter 8 of the final rule TSD and its appendices.

Table IV.13 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. Used historical data to derive a price scaling index to project product costs.
Installation Costs	Baseline installation cost determined with data from RS Means. Assumed no change with efficiency level.
Annual Energy Use	Per cycle energy use multiplied by the total cycles per year. Average number of cycles based on ADL field data and substituting the 2009 RECS average cycles for the 1997 RECS average cycles in the final rule analysis. Variability: Based on the 2009 RECS normalized to the average number of cycles.
Energy Prices	Electricity: Average and marginal prices based on Edison Electric Institute (EEI) 2014. Gas: Based on EIA's Natural Gas Navigator for 2014. Liquified petroleum gas (LPG): Based on EIA's State Energy Consumption, Price and Expenditures Estimates for 2014. Variability: Regional energy prices determined for 27 regions.
Energy Price Trends	Based on AEO 2016 price projections.
Water Prices	Based on Raftelis Financial Consultants and the American Water Works Association's 2014 Water and Wastewater Rate Survey Variability: By census region
Water Price Trends	Based on Bureau of Labor Statistics (BLS) 2016 water price index.
Repair and Maintenance Costs	Assumed no change with efficiency level.
Product Lifetime	Estimated using survey results from RECS (1990, 1993, 1997, 2001, 2005, 2009) and the U.S. Census American Housing Survey (2005, 2007, 2009, 2011, 2013), along with historic data on appliance shipments. Variability: Characterized using Weibull probability distributions.
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	2019.

* References for the data sources mentioned in this table are provided in the sections following the table or in chapter 8 of the final rule TSD.

1. Product Cost

To calculate consumer product costs, DOE multiplied the MPCs developed in the engineering analysis by the markups described above (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.

Economic literature and historical data suggest that the real costs of many products may trend downward over time according to "learning" or "experience" curves. An experience curve analysis focuses on entire industries (often operating globally) and aggregates over many causal factors that may not be well characterized. Experience curve analysis implicitly includes factors such as efficiencies in labor, capital investment, automation, materials prices, distribution, and economies of scale at an industry-wide level.[26]

For the default price trend, DOE estimated an experience rate for residential dishwashers based on an analysis of long-term historical data. Producer Price Index (PPI) data specific to residential dishwashers were not available. Instead, DOE used PPI data for miscellaneous household appliances (1988 to 2014) from the Bureau of Labor Statistics (BLS). An inflation-adjusted price index was calculated using the implicit price deflators for gross domestic product (GDP) for the same years. This series was then regressed on the cumulative quantity of residential dishwashers produced, based on a corresponding series for total shipments of residential dishwashers.

[26] Taylor, M. and Fujita, K.S. Accounting for Technological Change in Regulatory Impact Analyses: The Learning Curve Technique. LBNL-6195E. Lawrence Berkeley National Laboratory, Berkeley, CA. April 2013. http://escholarship.org/uc/item/3c8709p4#page-1

To calculate an experience rate, a least-squares power-law fit was performed on the residential dishwasher price index versus cumulative shipments (including imports). DOE then derived a price factor index, with the price in 2014 equal to 1, to project prices in the year of compliance for amended energy conservation standards in the LCC and PBP analysis, and for the NIA, for each subsequent year through 2048. The index value in each year is a function of the experience rate and the cumulative production through that year. To derive the latter, DOE used projected shipments from the base-case projections made for the NIA (see section IV.G of this final rule). The average annual rate of price decline in the default case is 1.25 percent.

2. Installation Cost

Installation cost includes labor, overhead, and any miscellaneous materials and parts needed to install the product. DOE used data from RS Means to estimate the baseline installation cost for residential dishwashers. DOE found no evidence that installation costs would be impacted with increased efficiency levels.

3. Annual Energy and Water Consumption

For each sampled household, DOE determined the energy consumption for residential dishwashers at different efficiency levels using the approach described above in section IV.E of this final rule.

4. Energy Prices

For electricity, DOE used marginal and average prices which vary by season, region, and baseline electricity consumption level. DOE estimated these prices using data published with the Edison Electric Institute (EEI), Typical Bill and Average Rates reports for summer and winter 2014. For the residential sector each report provides, for most of the major investor-owned utilities (IOUs) in the country, the total bill assuming household consumption levels of 500, 750, and 1,000 kWh for the billing period. See Chapter 8 of the final rule TSD for more information on the methodology.

To value energy savings from reduced hot water use by the dishwasher, DOE calculated average residential natural gas prices for each of the 27 geographic regions using data from EIA's "Natural Gas Navigator."[27] DOE calculated average residential liquified petroleum gas (LPG) prices for each of the 27 geographic regions using data from EIA's "State Energy Consumption, Price, and Expenditures Estimates (SEDS)."[28] DOE calculated average annual regional residential prices by: (1) estimating an average residential price for each State; and (2) weighting each State by the number of residential consumers. The final rule analysis used the data for 2014.

To estimate energy prices in future years, DOE multiplied the average regional energy prices by a projection of annual change in national-average residential energy price consistent with the projections found on page E-8 in the AEO 2016, which has an

[27] Available at: http://www.eia.gov/oil_gas/natural_gas/data_publications/natural_gas_monthly/ngm.html.
[28] Available at: http://www.eia.gov/state/seds/seds-data-fuel.cfm?sid=US

end year of 2040.[29] To estimate price trends after 2040, DOE used the average annual rate of change in prices from 2030 to 2040.

5. Water and Wastewater Prices

DOE obtained data on water and wastewater prices for 2014 from the Water and Wastewater Rate Survey conducted by Raftelis Financial Consultants[30] and the water utility association, American Water Works Association (AWWA). The survey, which analyzes each industry separately, covers approximately 318 water utilities and 231 wastewater utilities. The survey includes, for each utility, the cost to consumers of purchasing a given volume of water or treating a given volume of wastewater. The data provide a division of the total consumer cost into fixed and volumetric charges. DOE's calculations use only the volumetric charge to calculate water and wastewater prices, because only this charge is affected by a change in water use. Average water and wastewater prices were estimated for each of four census regions. Each RECS household was assigned a water and wastewater price depending on its census region location.

DOE included well water prices for well water users using information from the National Groundwater Association. Given the similarity in operating costs between septice systems and public sewer systems and the lack of national data on septic system costs, DOE used the wastewater price calculated for consumers on public sewer systems

[29] EIA. Annual Energy Outlook 2016 with Projections to 2040. Washington, DC. Available at www.eia.gov/forecasts/aeo/. The standards finalized in this rulemaking will take effect before the requirements of the Clean Power Plan (CPP) as modeled in the AEO 2016 reference case, putting downward pressure on electricity prices relative to the projections in this AEO 2016 CPP case. Consequently, DOE used the more conservative price projections found in the AEO 2016 No-CPP case.
[30] AWWA and Raftelis. 2014 Water and Wastewater Rate Survey. (Available at: < http://www.awwa.org/store/productdetail.aspx?productid=47549801.)

for users of septic systems. Chapter 8 of the final rule TSD provides details on DOE's energy and water price development.

To estimate the future trend for water and wastewater prices, DOE used data on the historic trend in the national water price index (U.S. city average) from 1986 through 2014. DOE used the historic inflation-adjusted water price trend to project water and wastewater prices for residential dishwashers.

AHAM commented that DOE should use water and wastewater prices specific to well water and septic users. (AHAM, No. 21 at p. 16) As mentioned above, DOE included well water prices for well water users. DOE uses the wastewater price calculated for consumers on public sewer systems for users of septic systems. DOE notes that well water and septic users account for a very small fraction of dishwasher consumers.

6. Maintenance and Repair Costs

Repair costs are associated with repairing or replacing dishwasher components that have failed in an appliance; maintenance costs are associated with maintaining the operation of the product. Typically, small incremental increases in product efficiency produce no, or only minor, changes in repair and maintenance costs compared to baseline efficiency products.

For the 2014 NOPR, DOE requested information as to whether maintenance and repair costs are a function of efficiency level and product class. DOE did not assume that more efficient residential dishwashers would have greater repair or maintenance costs.

7. Product Lifetime

Because the lifetime of appliances varies depending on utilization and other factors, DOE develops a distribution of lifetimes from which specific values are assigned to the appliances in the household sample. DOE conducted an analysis of residential dishwasher lifetimes in the field based on a combination of shipments data, RECS data on the reported age of the residential dishwashers, and dishwasher stock data reported in the U.S. Census Bureau's American Housing Survey. [31] As described in chapter 8 of the NOPR TSD, the analysis yielded an estimate of mean age for residential dishwashers of approximately 15 years. It also yielded a survival function that DOE incorporated as a probability distribution in its LCC analysis.

AHAM stated that the lifetime of dishwashers should be shorter. It cited two references, an AHAM study conducted in 2011 and a report from 2010. [32] (AHAM, No. 21 at p. 16)

DOE did not receive data from the AHAM study nor is the AHAM 2011 study publically available. DOE reviewed the 2010 report, which analyzed data from a Natural

[31] http://www.census.gov/programs-surveys/ahs.html
[32] Welch, Cory and Brad Rogers. 2010. Estimating the Remaining Useful Lifetime of Residential Appliances. American Council on Energy Efficient Economy Summer Study on Energy Efficiency in Buildings. http://aceee.org/files/proceedings/2010/data/papers/1977.pdf

Resources Canada survey,[33] and fit these data to a Weibull function. The authors of the 2010 report found a shape factor similar to DOE's, but their calculation produced a shorter average lifetime (12.6 years vs. 15.4 years estimated by DOE for the 2014 NOPR). The Canadian survey, which took place in 2003, asked the age of the previous dishwasher when replaced. Such replacements presumably would have taken place during the previous 10–15 years, meaning that the dishwashers were produced even before that. The lifetime of products of that vintage is not relevant to the lifetime of dishwashers produced in the near future. Both the technology and consumer utilization patterns have changed. The evidence suggests that the number of cycles per year was higher in the past, which would lead to a shorter lifetime. Moreover, the accuracy of Natural Resources Canada's survey of dishwasher age is highly uncertain because it was performed only once and did not show the variability of dishwasher vintage over time. In contrast, DOE's method of estimating lifetime uses both historical and more recent data that show how the age of the dishwasher stock has changed over time rather than taking a snap shot of a single year.

8. Discount Rates

In the calculation of LCC, DOE applies discount rates appropriate to households to estimate the present value of future operating costs. DOE estimated a distribution of residential discount rates for residential dishwashers based on consumer financing costs

[33] Natural Resources Canada, Office of Energy Efficiency. 2003. "Survey of Household Energy Use (SHEU), Detailed Statistical Report." http://oee.nrcan.gc.ca/publications/statistics/sheu03/pdf/sheu03.pdf

and opportunity cost of funds related to appliance energy cost savings and maintenance costs.

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. It estimated the average percentage shares of the various types of debt and equity by household income group using data from the Federal Reserve Board's Survey of Consumer Finances[34] (SCF) for 1995, 1998, 2001, 2004, 2007, 2010, and 2013. Using the SCF and other sources, DOE developed a distribution of rates for each type of debt and asset by income group to represent the rates that may apply in the year in which amended standards would take effect. DOE assigned each sample household a specific discount rate drawn from one of the distributions. The average rate across all types of household debt and equity and income groups, weighted by the shares of each type, is 4.34 percent. See chapter 8 in the final rule TSD for further details on the development of consumer discount rates.

AHAM suggested that DOE should use marginal rather than average consumer cost of capital for its discount rate. It pointed to DOE's assumption that, in the long term, consumers are likely to draw from or add to their collection of debt and asset holdings approximately in proportion to their current holdings when future expenditures are required or future savings accumulate, and stated that DOE does not analyze whether consumers' actual long-term marginal cost of funds approximates their current mix of

[34] The Federal Reserve Board, Survey of Consumer Finances 1989, 1992, 1995, 1998, 2001, 2004, 2007, 2010, 2013. http://www.federalreserve.gov/pubs/oss/oss2/scfindex.html

funds. It stated that in looking at the percentage share of consumer balance sheets made up of different types of assets and debts, DOE does not consider whether consumers could add to any of these asset or liability classes and/or what it would mean in the savings/consumption trade-off to do so. It stated that the percentages obscure the absolute magnitude of the amounts available to consumers and the relative ability to generate additional funds from the various sources. It stated that forms of consumer debt such as credit card, other installment loan, or other residential loan should be considered as the only marginal source of funds. It stated that the weighted average real cost of credit card, other installment loan, other residential loan, and other line of credit, which would be 10–12 percent depending on income group, would provide a more accurate estimate of the marginal cost of capital to consumers. (AHAM, No. 21 at pp. A-11–12)

DOE notes that several stakeholders have suggested the use of a marginal discount rate in the LCC analysis, defined as the interest rate applicable to the specific method of financing an appliance purchase. Generally, this is assumed to be the interest rate on credit card purchases. For the reasons explained in the following paragraph, DOE does not use a marginal discount rate in the LCC analysis.

The LCC analysis estimates the net present value of the financial impacts of a given standard level over the lifetime of the product (i.e., 30 years) assuming the standard-compliant product has already been installed. The appropriate discount rate in this context is the consumer's opportunity cost of increased spending today on a more efficient product with a return in the form of reduced operating costs in the future. The

opportunity cost of an investment is the return a consumer could make on that upfront incremental cost by applying it to another investment option. For example, a consumer could pay for an appliance with cash, thereby forgoing potential earnings arising from interest or forgoing the opportunity to pay off existing debt. Alternatively, a consumer could take on debt by using credit to either pay for the purchase of the more efficient appliance, or could put that credit towards an alternative investment option. If a consumer pays for the incremental up-front cost of a more efficient appliance using such debt, they will face the interest rate relevant for that purchase for however long the principal remains in that line of credit. However, the consumer will receive a stream of future benefits in the form of energy expenditure savings that they could either put towards paying off that or other debts, or towards assets, depending on the restrictions they face in their debt payment requirements and the relative size of the interest rates on their debts and assets.

Consumers, however, do not tend to shift all of their funds to assets with the highest interest rate, nor away from debt types with the highest interest rate. Examination of many years of data from the SCF[35] suggests that, at the time of each survey, the vast majority of households held multiple types of debt and/or assets. This tendency is observed across numerous cross-sections of the population, such as income groups, geographic locations, and age of household head. This is because consumers hold a

[35] Board of Governors of the Federal Reserve System (1995, 1998, 2001, 2004, 2007, 2010, 2013). "Survey of Consumer Finances." Retrieved August, 2015, from http://www.federalreserve.gov/pubs/oss/oss2/scfindex.html.

portfolio of debts and assets for a reason. Different credit and asset options reflect differing levels of risk, availability, or other factors.

When assessing the net present value of an investment in energy efficiency, the marginal interest rate alone (assuming it were the interest rate on the credit card used to make the purchase, for example) would only be the relevant discount rate if either: (1) the consumer were restricted from rebalancing debt and asset holdings (by redistributing debt and assets based on the relative interest rates available) over the entire time period modeled in the LCC analysis; or (2) the risk associated with an investment in energy efficiency was at a level commensurate with that reflected by credit card interest rates (i.e., that the risk premium required for an investment in energy efficiency was very high). Below each of these points is addressed in turn:

1) In reference to (1), above, the following provides quantitative justification for the assertion that even if an appliance is purchased with a credit card, few people are likely to keep that purchase on their credit card, thereby paying 20 percent interest on the purchase throughout the product lifetime, while only paying off that purchase with the operating cost savings realized from the more efficient product. The U.S. Bureau of Economic Analysis (BEA) tracks "non-mortgage interest paid by households".[36] Non-mortgage interest paid by households peaked in the recession, reflecting the fact that it was harder for people to pay down credit cards during that time, then returned to more or

[36] U.S. Bureau of Economic Analysis. (2015). "Table 7.11. Interest Paid and Received by Sector and Legal Form of Organization." Retrieved June, 2016, from http://www.bea.gov/iTable/iTable.cfm?ReqID=9#reqid=9&step=3&isuri=1&903=288.

less flat pre-recession levels thereafter. The fact that interest payments have this flat trend over a long-term time horizon, even while people are using credit cards to make purchases more and more frequently,[37] implies that credit card debt itself is not increasing on average, and therefore people must be paying off those credit card purchases and rebalancing their portfolio of debt and assets over time.

In addition, a Federal Reserve report addressing consumer credit card use and payment behavior summarizes a 1999–2000 survey, revealing, that among bank-type credit card users,[38] a substantial share of consumers (about two-thirds) regularly pay any and all outstanding credit card balance in full, and a vast majority of the remaining one-third pay more than the minimum payment due.[39] Of those that only pay the minimum payment due, most do not continue incurring additional debt on that credit card.

2) With respect to a reasonable risk premium applicable to an investment in energy efficiency, DOE notes that there is some uncertainty surrounding returns to an energy efficiency investment (e.g., fluctuations in energy prices). While there is limited data available on the risk associated with specific types of energy efficiency investments,

[37] New, C. (2012). "Cash Dying As Credit Card Payments Predicted To Grow In Volume." Retrieved June, 2016, from http://www.huffingtonpost.com/2012/06/07/credit-card-payments-growth_n_1575417.html.

[38] Bank-type credit cards (i.e., cards issued by a bank rather than a retail store, gas company, and other such issuers) represent the majority of credit cards in use. Data from the 1990s, presented earlier in this Federal Reserve report, suggest that consumers are approximately twice as likely to carry a balance on a bank-type credit card as compared to on credit cards from other issuers.

[39] Durkin, T. A. (2000). "Credit Cards: Use and Consumer Attitudes, 1970–2000." Federal Reserve Bulletin September 2000: 623-634.

Mills et al. (2006)[40] present results from an analysis demonstrating that the risk associated with the returns from investing in an ENERGY STAR Building are in line with that of long-term government bonds (i.e., quite low). There is no reason to assume that the risk premium required for an investment in energy efficiency should be particularly high, and certainly not high enough to justify a required rate of return at a level commensurate with a credit card interest rate.

DOE concludes that the best proxy for the appropriate discount rate to assess the value of an investment in a higher efficiency product in the context of the LCC analysis is the weighted average interest rate from the portfolio of debts and assets held by that household. This value best reflects the opportunity cost of the upfront investment in efficiency to that individual household, and assumes that the household will be able to rebalance their portfolio of debt and asset holdings over the long-term timeframe of the LCC analysis.

9. Efficiency Distribution in the No-New-Standards Case

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

[40] Mills, E., Kromer, S., Weiss, G. and Mathew, P.A., 2006. "From volatility to value: analysing and managing financial and performance risk in energy savings projects." Energy Policy, 34(2), pp. 188-199.

DOE first considered the historical shipments-weighted base-case efficiency trend that was developed for the previous rulemaking for residential dishwashers based on data submitted by AHAM. Based on these historical data, DOE projected a future decline in annual energy use of new dishwashers using an exponential function. This projection was not performed for compact dishwashers, because too few data were available. DOE then conducted an efficiency distribution anslysis for dishwashers based on DOE's Compliance Certification Database for residential dishwashers. The estimated market shares for the no-new-standards case for residential dishwashers are shown in Table IV.14. See chapter 8 of the final rule TSD for further information on the derivation of the efficiency distributions.

Table IV.14 Residential Dishwasher Base-Case Efficiency Distribution by Product Class in 2019

Efficiency Level	Standard		Compact	
	Annual Energy Use (kWh/year)	% of shipments	Annual Energy Use (kWh/year)	% of shipments
Baseline	307	6.5	222	37.0
1	295	31.2	203	51.9
2	270	51.6	130	11.1
3	255	10.2	--	--
4	225	0.4	--	--

10. 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. PBPs are expressed in years. PBPs that exceed the life of the product mean that the increased total installed cost is not recovered in reduced operating expenses.

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

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

G. Shipments Analysis

DOE uses projections of annual product shipments to calculate the national impacts of potential amended energy conservation standards on energy use, NPV, and future manufacturer cash flows.[41] The shipments model takes an accounting approach, tracking market shares of each product class and the vintage of units in the stock. Stock

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

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.

New housing projections and residential dishwasher saturation data comprised the two primary inputs for DOE's estimates of new construction shipments. "New housing" includes newly-constructed single-family and multi-family units (referred to as "new housing completions") and mobile home placements. For new housing completions and mobile home placements, DOE used AEO 2016 for 2012–2040, and froze new housing starts at the level in 2040.

DOE calibrated the shipments model against historical residential dishwasher shipments. In general, DOE estimated replacements using a product retirement function developed from product lifetime. DOE based the retirement function on a probability distribution for the product lifetime that was developed in the LCC analysis. The shipments model assumes that no units are retired below a minimum product lifetime and that all units are retired before exceeding a maximum product lifetime.

For the final rule, DOE applied price and efficiency elasticity parameters to estimate the effect of new standards on residential dishwasher shipments. DOE estimated the price and efficiency elasticity parameters from a regression analysis that incorporated shipments, purchase price, and efficiency data specific to several residential appliances,

including clothes washers, dishwashers, freezers, refrigerators, and room air conditioners, during 1989–2009. Based on evidence that the price elasticity of demand is significantly different over the short run and long run for other consumer goods (i.e., automobiles), A review of the literature shows evidence from numerous markets for durable goods including automobiles, electronics, and refrigerators, suggests long run price elasticity of demand is smaller in magnitude than short run price elasticity of deman; thus a declining trend over time is applied to the estimate of price elasticity for appliances following a price increase subsequent to a standard, therefore, DOE assumed that these elasticities decline over time.[42, 43, 44] DOE estimated shipments in each standards case using the price and efficiency elasticity along with the change in the product price and operating costs between a standards case and the no-new-standards case. See chapter 9 of the final rule TSD for further information.

H. National Impact Analysis

The NIA assesses the NES and the national 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.[45] DOE calculates the NES and NPV based on projections of annual product shipments, along with the annual energy consumption and

[42] Gowrisankaran, Gautam and Marc Rysman. Dynamics of consumer demand for new durable goods. NBER Working Paper 14737, National Bureau of Economic Research, February 2009. http://www.nber.org/papers/w14737.
[43] Hymans, Saul H., Gardner Ackley, and F. Thomas Juster. Consumer durable spending: Explanation and prediction. Brookings Papers on Economic Activity, 1970(2):173–206, 1970. http://www.jstor.org/stable/2534239.
[44] Parker, Philip and Ramya Neelamegham. Price elasticity dynamics over the product life cycle: A study of consumer durables. Marketing Letters, 8(2):205–216, April 1997. http://link.springer.com/article/10.1023%2FA%3A1007962520455.
[45] The NIA accounts for impacts in the 50 States and the U.S. territories.

total installed cost data from the energy use and LCC analyses.[46] For the present analysis, DOE projected the energy savings, operating cost savings, product costs, and NPV of consumer benefits over the lifetime of residential dishwashers sold from 2019 through 2048.

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

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

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

Table IV.15 summarizes the inputs and methods DOE used for the NIA analysis for the final rule. Discussion of these inputs and methods follows the table. See chapter 10 of the final rule TSD for further details.

Table IV.15 Summary of Inputs and Methods for the National Impact Analysis

Inputs	**Method**
Shipments	Annual shipments from shipments model.
Compliance Date of Standard	2019.
Efficiency Trends	No-new-standards case: Efficiency distributions are projected based on historical efficiency data. Standards cases: Use a "roll-up" and shift scenario.
Annual Energy/Water Consumption per Unit	Annual weighted-average values are a function of energy/water use at each TSL.
Total Installed Cost per Unit	Annual weighted-average values are a function of cost at each TSL. Incorporates projection of future product prices based on historical data.
Annual Energy/Water Cost per Unit	Annual weighted-average values as a function of the annual energy/water consumption per unit and energy/water prices.
Repair and Maintenance Cost per Unit	Annual values do not change with efficiency level.
Energy Prices Trend	AEO 2016 projections (to 2040) and extrapolation through 2048.
Water Prices Trend	Linear extrapolation of inflation-adjusted historical national water price index.
Energy Site-to-Primary Conversion	A time-series conversion factor based on AEO 2016.
Discount Rate	Three and seven percent.
Present Year	2016.

1. Product Efficiency Trends

A key component of the NIA is the trend in energy efficiency projected for the no-new-standards case and each of the standards cases. Section IV.F.9 of this final rule describes how DOE developed an energy efficiency distribution for the no-new-standards

case (which yields a shipment-weighted average efficiency) for each of the considered product classes for the first year of the projection period. To project the trend in efficiency for residential dishwashers in the no-new-standards case, DOE assumed that in the base case, shipment-weighted annual energy use will decrease from 278 kWh/year in 2019 to 275 kWh/year in 2048 for standard dishwashers. The approach is further described in chapter 10 of the final rule TSD.

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 (2019). 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 standard dishwasher efficiency after 2019, DOE assumed an efficiency shift scenario in which efficiency increases until reaching a value of 275 kWh/year and then remaining at that level for the remainder of the analysis period. DOE assumed that projected efficiencies for the compact dishwasher product class would remain frozen at the 2019 efficiency level until the end of the analysis period.

2. National Energy and Water Savings

The national energy and water savings analysis involves a comparison of national energy and water consumption of the considered products in each potential standards case (TSL) with consumption in the case with no new or amended energy conservation

standards. DOE calculated the national energy and water consumption by multiplying the number of units (stock) of each product (by vintage or age) by the unit energy and water 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 AEO 2016. Cumulative energy savings are the sum of the NES for each year over the timeframe of the analysis.

In 2011, in response to the recommendations of a committee on "Point-of-Use and Full-Fuel-Cycle Measurement Approaches to Energy Efficiency Standards" appointed by the National Academy of Sciences, DOE announced its intention to use FFC measures of energy use and greenhouse gas and other emissions in the NIA and emissions analyses included in future energy conservation standards rulemakings. 76 FR 51281 (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 National Energy Modeling System (NEMS) is the most appropriate tool for its FFC analysis and its intention to use NEMS for that purpose. 77 FR 49701 (Aug. 17, 2012). NEMS is a public domain, multi-sector, partial equilibrium model of the U.S. energy sector[47] that EIA uses to prepare its AEO. The approach used

[47] For more information on NEMS, refer to The National Energy Modeling System: An Overview, DOE/EIA–0581 (2009) (Oct. 2009) (Available at: http://www.eia.gov/forecasts/aeo/nems/overview/appendix.html).

for deriving FFC measures of energy use and emissions is described in appendix 10B of the final rule TSD.

3. Net Present Value Analysis

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

As discussed in section IV.F.1 of this final rule, DOE developed residential dishwasher price trends based on historical PPI data. DOE applied the same trends to project prices for each product class at each considered efficiency level. By 2048, which is the end date of the projection period, the average residential dishwasher price is projected to drop 45 percent relative to 2015. DOE's projection of product prices is described in appendix 10C of the final rule TSD.

To evaluate the effect of uncertainty regarding the price trend estimates, DOE investigated the impact of different product price projections on the consumer NPV for the considered TSLs for residential dishwashers. In addition to the default price trend,

DOE considered two product price sensitivity cases: (1) a high price decline case based on an exponential fit approach using PPI data for 1991 to 2014; (2) a low price decline case based on an experience rate derived using PPI and shipments data for 2001 to 2014. The derivation of these price trends and the results of these sensitivity cases are described in appendix 10C of the final rule TSD.

The operating cost savings are equal to the energy and water cost savings, which are calculated using the estimated energy and water savings in each year and the projected price of the appropriate form of energy and the projected price of water. 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 consistent with the projections found on page E-8 in AEO 2016,[48] which has an end year of 2040. To estimate price trends after 2040, DOE used the average annual rate of change in prices from 2020 to 2040. Water prices and price trends were estimated based on the sources discussed in section IV.F.5. As part of the NIA, DOE also analyzed scenarios that used inputs from the AEO 2016 cases that have higher and lower energy price trends and the NIA results based on these cases are presented in appendix 10D of the final rule TSD.

In calculating the NPV, DOE multiplies the net savings in future years by a discount factor to determine their present value. For this final rule, DOE estimated the NPV of consumer benefits using both a 3-percent and a 7-percent real discount rate.

[48] The standards finalized in this rulemaking will take effect before the requirements of the Clean Power Plan (CPP) as modeled in the AEO 2016 reference case, putting downward pressure on electricity prices relative to the projections in this AEO 2016 CPP case. Consequently, DOE used the more conservative price projections found in the AEO 2016 No-CPP case.

DOE uses these discount rates in accordance with guidance provided by the Office of Management and Budget (OMB) to Federal agencies on the development of regulatory analysis.[49] 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 Associations commented that the Department's own calculations in the "adverse" case scenario showed that there is a potential for a net loss under the Proposed Rule and would not satisfy the economic feasibility test required by governing law. (The Associations, No. 17 at p. 4) DOE assumes that the term "economic feasibility" used by the Associations refers to the two measures by which a potential standard level is evaluated: economic justification and technological feasibility. DOE further assumes that with the term "adverse case scenario," the Associations are referring to the LCC results that show the impacts of the LCC analysis: the amount of LCC savings and the percentage of the population that experiences a net cost. DOE evaluates the economic justification of each TSL using efficiency levels with positive LCC savings as the basis for the evaluation. Efficiency levels with negative LCC savings are not analyzed in the NIA and are not considered in the development of potential standards.

[49] OMB. Circular A-4: Regulatory Analysis," (Sept. 17, 2003), section E (Available at: www.whitehouse.gov/omb/memoranda/m03-21.html).

I. Consumer Subgroup Analysis

In analyzing the potential impact of new or amended standards on consumers, DOE evaluates the impact on identifiable subgroups of consumers that may be disproportionately affected by a new or amended national standard. DOE evaluates impacts on particular subgroups of consumers by analyzing the LCC impacts and PBP for those particular consumers from alternative standard levels. For this final rule, DOE analyzed the impacts of the considered standard levels on low-income households. Chapter 11 in the final rule TSD describes the consumer subgroup analysis.

J. Manufacturer Impact Analysis

1. Overview

DOE performed an MIA to estimate the financial impacts of amended energy conservation standards on manufacturers of residential dishwashers and to estimate the potential impacts of such standards on employment and manufacturing capacity. The MIA has both quantitative and qualitative aspects and includes analyses of projected industry cash flows, the INPV, investments in research and development (R&D) and manufacturing capital, and domestic manufacturing employment. Additionally, the MIA seeks to determine how amended energy conservation standards might affect manufacturing employment, capacity, and competition, as well as how standards contribute to the overall regulatory burden on manufacturers. Finally, the MIA serves to identify any disproportionate impacts on manufacturer subgroups, including small business manufacturers.

The quantitative part of the MIA primarily relies on the GRIM, an industry cash flow model with inputs specific to this rulemaking. The key GRIM inputs include data on the industry cost structure, unit production costs, product shipments, manufacturer markups, and investments in R&D and manufacturing capital required to produce compliant products. The key GRIM outputs are the INPV, which is the sum of industry annual cash flows over the analysis period, discounted using the industry-weighted average cost of capital, and the impact to domestic manufacturing employment. The model uses standard accounting principles to estimate the impacts of more-stringent energy conservation standards on a given industry by comparing changes in INPV and domestic manufacturing employment between a no-new-standards case and the various standards cases (TSLs). To capture the uncertainty relating to manufacturer pricing strategies following amended standards, the GRIM estimates a range of possible impacts under different markup scenarios.

The qualitative part of the MIA addresses manufacturer characteristics and market trends. Specifically, the MIA considers such factors as a potential standard's impact on manufacturing capacity, competition within the industry, the cumulative impact of other DOE and non-DOE regulations, and impacts on manufacturer subgroups. The complete MIA is outlined in chapter 12 of the final rule TSD.

DOE conducted the MIA for this rulemaking in three phases. In Phase 1 of the MIA, DOE prepared a profile of the residential dishwasher manufacturing industry based on the market and technology assessment, interviews conducted in support of the 2012

Direct Final Rule, and publicly-available information. This included an analysis of residential dishwasher manufacturers that DOE used to derive preliminary financial inputs for the GRIM (e.g., revenues; materials, labor, overhead, and depreciation expenses; selling, general, and administrative expenses (SG&A); and R&D expenses). DOE also used public sources of information to further calibrate its initial characterization of the residential dishwasher manufacturing industry, including company filings of form 10-K from the SEC[50], corporate annual reports, the U.S. Census Bureau's Economic Census, and reports from Hoovers.[51] Based on its analysis, DOE used the same industry average financial parameters developed in support of the 2012 Direct Final Rule and the 2014 NOPR.

In Phase 2 of the MIA, DOE prepared a framework industry cash-flow analysis to quantify the potential impacts of amended energy conservation standards. The GRIM uses several factors to determine a series of annual cash flows starting with the announcement of the standard and extending over a 30-year period following the compliance date of the standard. These factors include annual expected revenues, costs of sales, SG&A and R&D expenses, taxes, and capital expenditures. In general, energy conservation standards can affect manufacturer cash flow in three distinct ways: (1) creating a need for increased investment, (2) raising production costs per unit, and (3) altering revenue due to higher per-unit prices and changes in sales volumes. In performing this analysis, DOE used the financial parameters from the 2012 residential dishwasher energy conservation standards rulemaking, estimates of conversion costs

[50] Available online at www.sec.gov.
[51] Available online at http://www.hoovers.com.

from both the engineering analysis developed for this final rule and manufacturer feedback received in response to the 2014 NOPR, the cost-efficiency curves from the engineering analysis, and the shipment assumptions from the NIA.

In Phase 3 of the MIA, DOE evaluated subgroups of manufacturers that may be disproportionately impacted by amended standards or that may not be accurately represented by the average cost assumptions used to develop the industry cash flow analysis. Such manufacturer subgroups include small business manufacturers, if any, and may also include low-volume manufacturers (LVMs), niche players, and/or manufacturers exhibiting a cost structure that largely differs from the industry average. DOE identified one subgroup for a separate impact analysis: small business manufacturers. The small business subgroup is discussed in section VI.B, "Review under the Regulatory Flexibility Act" and in chapter 12 of the final rule TSD.

2. Government Regulatory Impact Model and Key Inputs

DOE uses the GRIM to quantify the changes in cash flow due to amended standards that result in a higher or lower industry value. The GRIM uses a standard, annual discounted cash-flow analysis that incorporates manufacturer costs, markups, shipments, and industry financial information as inputs. The GRIM models changes in costs, distribution of shipments, investments, and manufacturer margins that could result from an amended energy conservation standard. The GRIM spreadsheet uses the inputs to arrive at a series of annual cash flows, beginning in 2016 (the base year of the analysis), and continuing to 2048. DOE calculated INPVs by summing the stream of

annual discounted cash flows during this period. For manufacturers of residential dishwashers, DOE used a real discount rate of 8.5 percent, derived from industry financials.

The GRIM calculates cash flows using standard accounting principles and compares changes in INPV between the no-new-standards case and each standards case. The difference in INPV between the no-new-standards case and a standards case represents the financial impact of the amended energy conservation standard on manufacturers. As discussed previously, DOE developed critical GRIM inputs using a number of sources, including publicly available data, results of the engineering analysis, and information received from industry stakeholders in response to the 2014 NOPR. The GRIM results are presented in section V.B.2 of this final rule. Additional details about the GRIM, the discount rate, and other financial parameters can be found in chapter 12 of the final rule TSD.

a. Manufacturer Production Costs

Manufacturing more efficient equipment is typically more expensive than manufacturing baseline equipment due to the use of more complex components, which are typically more costly than baseline components. The changes in the MPCs of residential dishwashers can affect the revenues, gross margins, and cash flow of the industry. DOE estimated the MPCs for standard and compact product classes at the baseline and higher efficiency levels, as described in section IV.C of this final rule. The cost model also disaggregated the MPCs into the cost of materials, labor, overhead, and

depreciation. DOE used these MPCs and cost breakdowns for each efficiency level analyzed in the GRIM.

b. Shipments Projections

The GRIM estimates manufacturer revenues based on total unit shipment projections and the distribution of those shipments by efficiency level and product class. Changes in sales volumes and the efficiency mix over time can significantly affect manufacturer finances. For this analysis, the GRIM uses the NIA's annual shipment projections derived from the shipments analysis from 2016 (the base year) to 2048 (the end year of the analysis period). See chapter 9 of the final rule TSD for additional details.

c. Product and Capital Conversion Costs

Amended energy conservation standards could cause manufacturers to incur conversion costs to bring their production facilities and product designs into compliance. DOE evaluated the level of conversion-related expenditures that would be needed to comply with each considered efficiency level in each product class. For the MIA, DOE classified these conversion costs into two major groups: (1) product conversion costs and (2) capital conversion costs. Product conversion costs are investments in research, development, testing, marketing, and other non-capitalized costs necessary to make product designs comply with amended energy conservation standards. Capital conversion costs are investments in property, plant, and equipment necessary to adapt or

change existing production facilities such that new compliant product designs can be fabricated and assembled.

DOE developed two model scenarios to estimate the capital conversion costs required to meet amended energy conservation standards at each TSL. One scenario is based on the capital conversion costs developed for the analysis supporting the 2012 Direct Final Rule, scaled to reflect the new efficiency levels for each product class considered in this final rule. In a data submission to DOE following the publication of the 2014 NOPR, AHAM supported the use of capital conversion cost estimates based on those developed for the 2012 Direct Final Rule for some of the efficiency levels for standard dishwashers considered in this final rule (AHAM, No. 28 at pp. 1–2).[52] Additionally, DOE developed a separate capital conversion cost scenario using the engineering cost model developed for this final rule. For this estimate, DOE identified the design pathways considered in the engineering analysis, estimated the cost of the changes in production equipment to implement each design option, and aggregated these costs to reflect the industry-wide investment using market information about the number of platform and product families currently on the market from each manufacturer.

[52] In its data submittal, AHAM did not support the use of capital conversion costs based on the 2012 Direct Final Rule for standard dishwashers associated with an efficiency level of 180 kWh/year and 2.22 gallons/cycle (i.e., the 2014 NOPR max-tech efficiency level). For this final rule, 180 kWh/year has been eliminated as an analyzed efficiency level, and has been replaced by 225 kWh/year. Additionally, in the 2014 NOPR, Effciency Level 2 corresponded to an energy use of 280 kWh/year. AHAM's data submittal supported the use of capital conversion costs based on the 2012 Direct Final Rule for this level. For this final rule, Efficiency Level 2 is 270 kWh/year. DOE interpolated conversion costs for this level using those based on 2012 Direct Final Rule for NOPR Efficiency Level 2 (280 kWh/year) and Efficiency Level 3 (255 kWh/year).

DOE based product conversion costs related to amended energy conservation standards for dishwashers on the analysis conducted for the 2012 Direct Final Rule, scaled to reflect the new efficiency levels for each product class considered in this final rule. These product coversion costs were used in combination with both above-mentioned capital conversion costs scenarios to estimate total industry conversion costs under each scenario.

In general, DOE assumes all conversion-related investments occur between the year of publication of the final rule and the year by which manufacturers must comply with the new standard. The conversion cost figures used in the GRIM can be found in section V.B.2 of this final rule. For additional information on the estimated capital and product conversion costs, see chapter 12 of the final rule TSD.

d. Markup Scenarios

MSPs include direct manufacturing production costs (i.e., labor, materials, and overhead as estimated in DOE's MPCs) and all non-production costs (i.e., SG&A, R&D, and interest), along with profit. To calculate the MSPs in the GRIM, DOE applied non-production cost markups to the MPCs estimated in the engineering analysis for each product class and efficiency level. Modifying these markups in the standards case yields different sets of impacts on manufacturers. For the MIA, DOE modeled two standards-case markup scenarios to represent uncertainty regarding the potential impacts on prices and profitability for manufacturers following the implementation of amended energy

conservation standards: (1) a preservation of gross margin percentage markup scenario; and (2) a preservation of per-unit operating profit markup scenario. These scenarios lead to different markup values that, when applied to the MPCs, result in varying revenue and cash flow impacts.

Under the preservation of gross margin percentage scenario, DOE applied a single uniform "gross margin percentage" markup across all efficiency levels, which assumes that manufacturers would be able to maintain the same amount of profit as a percentage of revenues at all efficiency levels within a product class. DOE used the baseline manufacturer markup, 1.24, developed for the 2012 Direct Final Rule, and also used in the 2014 NOPR, for all products when modeling the no-new-standards in the GRIM. This scenario represents the upper bound of industry profitability as manufacturers are able to fully pass on additional production costs due to standards to their customers under this scenario.

Under the preservation of per-unit operating profit markup scenario, DOE modeled a situation in which manufacturers are not able to increase per-unit operating profit in proportion to increases in manufacturer production costs. This scenario represents the lower bound of profitability and a more substantial impact on the residential dishwasher industry as manufacturers accept a lower margin in an attempt to offer price competitive products while maintaining the same level of earnings before interest and tax (EBIT) they saw prior to amended standards.

A comparison of industry financial impacts under the two markup scenarios is presented in section V.B.2.a of this final rule.

3. Discussion of Comments

AHAM, residential dishwasher manufacturers, and other interested parties provided several comments on the potential impact of amended energy conservation standards on manufacturers.

At the 2014 NOPR public meeting, multiple stakeholders expressed concern over the lack of manufacturer input and DOE's use of outdated information for the NOPR analysis. (AHAM, Public Meeting Transcript, No. 10 at pp. 22–23, 98; NRDC, Public Meeting Transcript, No. 10 at p. 85; BSH, Public Meeting Transcript, No. 10 at pp. 95–96; Whirlpool, Public Meeting Transcript, No. 10 at pp. 103–104)

DOE recognizes the importance of interviews with manufacturers, as interviews provide critical data for the analysis of the impacts of potential energy conservation standards. Following the 2014 NOPR public meeting, site visits were conducted with six residential dishwasher manufacturers. Feedback received during these interviews and through public comments has been integrated into the analysis for this final rule.

Regarding DOE's treatment of the cumulative effect of regulatory burdens on residential dishwasher manufacturers, AHAM commented that there has been an increase in DOE's energy efficiency regulatory actions in recent years. According to AHAM,

although DOE does attempt to quantify regulatory burden in its analysis, it does not adequately consider the resources and time required to both support DOE with test data and to comply with standards. (AHAM, No. 21 at p. 17)

DOE analyzes cumulative regulatory burdens as part of the MIA. The results of the cumulative regulatory burden analysis on residential dishwasher manufacturers are located in section V.B.2 of this final rule and chapter 12 of the final rule TSD. Additionally, DOE integrates recertification costs associated with industry (third-party) standards compliance that result from amended DOE standards in estimates of industry product conversion costs. Information on product conversion costs can be found in section IV.J.2 of this final rule and chapter 12 of the final rule TSD.

AHAM commented that, in the case of this residential dishwasher rulemaking, the implementation is intended to be at the minimum time between rulemakings allowed by law. AHAM stated that it is clear from interviews with manufacturers that the cycle time is too short for a full recovery of investments, and that DOE should reconsider the structure of the GRIM to account for future rulemakings and their effects on industry value. (AHAM, No. 21 at p. 17)

In this final rule, DOE is not adopting amended energy conservation standards for residential dishwashers. DOE will conduct a future energy conservation standards rulemaking for residential dishwashers pursuant to 42 U.S.C. 6295(m)(3)(B), which requires that within 3 years of issuing any final determination that existing standards do

not need to be amended, DOE shall publish either a notice of determination that amended standards are not needed or a NOPR including new proposed standards. Because it is not known at this time whether DOE will determine in a future rulemaking cycle that it is technologically feasible and economically justified to amend residential dishwashers standards (and if so, to what levels), DOE does not account for future potential amended standards in the GRIM.

Related to the impacts of amended energy conservation standards on industry profitability, AHAM commented that manufacturers will likely need to divert resources ordinarily used for product innovation to standards compliance. Due to minimal consumer payback, AHAM stated that the investments put towards standards compliance will not drive additional purchases, whereas innovation in other areas may have. (AHAM, No. 21 at p. 17)

The effects of investments such as R&D and capital expenditures on manufacturer cash flows due to potential amended residential dishwasher standards are discussed further in section V.B.2.a of this final rule.

AHAM and GE provided comments related to the magnitude of industry conversion costs that would be required for manufacturers of standard residential dishwashers to meet an efficiency level of 234 kWh/year (Efficiency Level 3 in the 2014 NOPR analysis). According to AHAM, a conservative estimate for industry conversion costs to reach 234 kWh/year for standard residential dishwashers is $500 million rather

than the $250 million estimated by DOE. (AHAM, No. 21 at p. 15) GE agreed with this estimate and further stated that, at an efficiency level of 234 kWh/year, manufacturers wishing to preserve platforms that are priced at less than $500 would be forced to trade off consumer utility, which would increase the share of the market for other higher price point dishwashers, creating a negative consumer payback. (GE, No. 26 at p. 5)

Following the 2014 NOPR comment period, AHAM submitted additional data related to industry conversion costs. In its submittal, AHAM stated that the 2014 NOPR estimates for industry conversion costs based on the 2012 Direct Final Rule are approximately correct for Efficiency Level 1 (295 kWh/year) and Efficiency Level 2 (280 kWh/year).[53] According to AHAM, however, the cost previously projected for the efficiency level corresponding to 234 kWh/year for standard residential diswashers is appropriate for an alternate efficiency level of 255 kWh/year and 3.1 gallons per cycle, and the estimate for the NOPR efficiency level corresponding to 180 kWh/year is approximately correct for an efficiency level corresponding to 234 kWh/year. AHAM further commented that manufacturers do not believe 180 kWh/year and 2.22 gallons per cycle is practical and that they have no estimates on the costs to achieve it. (AHAM, No. 28 at pp. 1–2)

DOE appreciates the additional feedback provided by AHAM and residential dishwasher manufacturers relating to the magnitude of conversion costs that will be required to reach different standard levels. Based on this and other feedback relating to

[53] In the 2014 NOPR, Effciency Level 2 corresponded to an energy use of 280 kwh/year. For this final rule, Efficiency Level 2 is 270 kwh/year.

the efficiency levels analyzed in the 2014 NOPR, DOE has reevaluated its standards-case efficiency levels. Industry's feedback on conversion costs has been incorporated into DOE's new estimates of industry conversion costs for this final rule analysis. Section IV.J.2.c and section V.B.2 of this final rule provide information about DOE's estimates of industry conversion costs resulting from potential amended standards for residential dishwashers. Additional information is included in chapter 12 of the final rule TSD.

4. Manufacturer Interviews

As noted in section IV.J.3 of this final rule, DOE relies on manufacturer interviews to provide critical data for the analyzing the impacts of potential amended energy conservation standards. Following the 2014 NOPR public meeting, discussions were held with six residential dishwasher manufacturers. The key issues discussed during these interviews were: (1) consumer utility concerns at the standard levels proposed in the 2014 NOPR, and (2) the engineering cost estimates that fed into the 2014 NOPR analysis. These key issues were also raised in public comments from interested parties in response to the 2014 NOPR. Section IV.C.1.b and section IV.C.2 of this final rule provide additional discussion describing these key issues and how DOE has addressed them in this final rule analysis.

K. Emissions Analysis

The emissions analysis consists of two components. The first component estimates the effect of potential energy conservation standards on power sector and site (where applicable) combustion emissions of carbon dioxide (CO_2), nitrogen oxides

(NO_X), sulfur dioxide (SO_2), and mercury (Hg). The second component estimates the impacts of potential standards on emissions of two additional greenhouse gases, methane (CH_4) and nitrous oxide (N_2O), as well as the reductions to emissions of all species due to "upstream" activities in the fuel production chain. These upstream activities comprise extraction, processing, and transporting fuels to the site of combustion. The associated emissions are referred to as upstream emissions.

The analysis of power sector emissions uses marginal emissions factors derived from data in AEO 2016, as described in section IV.M of this final rule. Details of the methodology are described in the appendices to chapters 13 and 15 of the final rule TSD.

Combustion emissions of CH_4 and N_2O are estimated using emissions intensity factors published by the Environmental Protection Agency (EPA)—Greenhouse Gas (GHG) Emissions Factors Hub.[54] The FFC upstream emissions are estimated based on the methodology described in chapter 15 of the final rule TSD. The upstream emissions include both emissions from fuel combustion during extraction, processing, and transportation of fuel, and "fugitive" emissions (direct leakage to the atmosphere) of CH_4 and CO_2.

[54] Available at: www2.epa.gov/climateleadership/center-corporate-climate-leadership-ghg-emission-factors-hub.

The emissions intensity factors are expressed in terms of physical units per MWh or MMBtu of site energy savings. Total emissions reductions are estimated using the energy savings calculated in the national impact analysis.

For CH_4 and N_2O, DOE calculated emissions reduction in tons and also in terms of units of carbon dioxide equivalent (CO_2eq). Gases are converted to CO_2eq by multiplying each ton of gas by the gas' global warming potential (GWP) over a 100-year time horizon. Based on the Fifth Assessment Report of the Intergovernmental Panel on Climate Change,[55] DOE used GWP values of 28 for CH_4 and 265 for N_2O.

Because the on-site operation of gas-fired and oil-fired water heaters that provide hot water to residential dishwashers requires combustion of fossil fuels and results in emissions of CO_2, NO_X, and SO_2 at the sites where these appliances are used, DOE also accounted for the reduction in these site emissions and the associated upstream emissions due to potential standards. Site emissions of the above gases were estimated using emissions intensity factors from an EPA publication.[56]

The AEO incorporates the projected impacts of existing air quality regulations on emissions. AEO 2016 generally represents current legislation and environmental

[55] Intergovernmental Panel on Climate Change. Anthropogenic and Natural Radiative Forcing. In Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Chapter 8. 2013. Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex, and P.M. Midgley, Editors. Cambridge University Press: Cambridge, United Kingdom and New York, NY, USA.

[56] EPA. External Combustion Sources. In Compilation of Air Pollutant Emission Factors. AP-42. Fifth Edition. Volume I: Stationary Point and Area Sources. Chapter 1. Available at https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emission-factors.

regulations, including recent government actions, for which implementing regulations were available as of the end of February 2016. DOE's estimation of impacts accounts for the presence of the emissions control programs discussed in the following paragraphs.

SO_2 emissions from affected electric generating units (EGUs) are subject to nationwide and regional emissions cap-and-trade programs. Title IV of the Clean Air Act sets an annual emissions cap on SO_2 for affected EGUs in the 48 contiguous States and the District of Columbia (D.C.). (42 U.S.C. 7651 et seq.) SO_2 emissions from 28 eastern States and D.C. were also limited under the Clean Air Interstate Rule (CAIR). 70 FR 25162 (May 12, 2005). CAIR created an allowance-based trading program that operates along with the Title IV program. In 2008, CAIR was remanded to EPA by the U.S. Court of Appeals for the District of Columbia Circuit, but it remained in effect.[57] In 2011, EPA issued a replacement for CAIR, the Cross-State Air Pollution Rule (CSAPR). 76 FR 48208 (Aug. 8, 2011). On August 21, 2012, the D.C. Circuit issued a decision to vacate CSAPR,[58] and the court ordered EPA to continue administering CAIR. On April 29, 2014, the U.S. Supreme Court reversed the judgment of the D.C. Circuit and remanded the case for further proceedings consistent with the Supreme Court's opinion.[59] On October 23, 2014, the D.C. Circuit lifted the stay of CSAPR.[60] Pursuant to this action,

[57] See North Carolina v. EPA, 531 F.3d 896 (D.C. Cir. 2008), modified on rehearing, 550 F.3d 1176 (D.C. Cir. 2008).
[58] See EME Homer City Generation, LP v. EPA, 696 F.3d 7, 38 (D.C. Cir. 2012).
[59] See EPA v. EME Homer City Generation, L.P. 134 S.Ct. 1584, 1610 (U.S. 2014). The Supreme Court held in part that EPA's methodology for quantifying emissions that must be eliminated in certain States due to their impacts in other downwind States was based on a permissible, workable, and equitable interpretation of the Clean Air Act provision that provides statutory authority for CSAPR.
[60] See EME Homer City Generation, L.P. v. EPA, Order (D.C. Cir. filed October 23, 2014) (No. 11-1302).

CSAPR went into effect (and CAIR ceased to be in effect) as of January 1, 2015.[61] AEO 2016 incorporates implementation of CSAPR.

The attainment of emissions caps is typically flexible among EGUs and is enforced through the use of emissions allowances and tradable permits. Under existing EPA regulations, any excess SO_2 emissions allowances resulting from the lower electricity demand caused by the adoption of an efficiency standard could be used to permit offsetting increases in SO_2 emissions by any regulated EGU. In past rulemakings, DOE recognized that there was uncertainty about the effects of efficiency standards on SO_2 emissions covered by the existing cap-and-trade system, but it concluded that negligible reductions in power sector SO_2 emissions would occur as a result of standards.

Beginning in 2016, however, SO_2 emissions will fall as a result of the Mercury and Air Toxics Standards (MATS) for power plants. 77 FR 9304 (Feb. 16, 2012). In the MATS final rule, EPA established a standard for hydrogen chloride as a surrogate for acid gas hazardous air pollutants (HAP), and also established a standard for SO_2 (a non-HAP acid gas) as an alternative equivalent surrogate standard for acid gas HAP. The same controls are used to reduce HAP and non-HAP acid gas; thus, SO_2 emissions will be reduced as a result of the control technologies installed on coal-fired power plants to comply with the MATS requirements for acid gas. AEO 2016 assumes that, in order to continue operating, coal plants must have either flue gas desulfurization or dry sorbent

[61] On July 28, 2015, the D.C. Circuit issued its opinion regarding the remaining issues raised with respect to CSAPR that were remanded by the Supreme Court. The D.C. Circuit largely upheld CSAPR but remanded to EPA without vacatur certain States' emission budgets for reconsideration. EME Homer City Generation, LP v. EPA, 795 F.3d 118 (D.C. Cir. 2015).

injection systems installed by 2016. Both technologies, which are used to reduce acid gas emissions, also reduce SO_2 emissions. Under the MATS, emissions will be far below the cap established by CSAPR, so it is unlikely that excess SO_2 emissions allowances resulting from the lower electricity demand would be needed or used to permit offsetting increases in SO_2 emissions by any regulated EGU. [62] Therefore, DOE believes that energy conservation standards that decrease electricity generation will generally reduce SO_2 emissions in 2016 and beyond.

CSAPR established a cap on NO_x emissions in 28 eastern States and the District of Columbia.[63] Energy conservation standards are expected to have little effect on NO_X emissions in those States covered by CSAPR because excess NO_X emissions allowances resulting from the lower electricity demand could be used to permit offsetting increases in NO_X emissions from other facilities. However, standards would be expected to reduce NO_X emissions in the States not affected by the caps, so DOE estimated NO_X emissions reductions from the standards considered in this final rule for these States.

[62] DOE notes that on June 29, 2015, the U.S. Supreme Court ruled that the EPA erred when the agency concluded that cost did not need to be considered in the finding that regulation of hazardous air pollutants from coal- and oil-fired electric utility steam generating units (EGUs) is appropriate and necessary under section 112 of the Clean Air Act (CAA). Michigan v. EPA, 135 S. Ct. 2699 (2015). The Supreme Court did not vacate the MATS rule, and DOE has tentatively determined that the Court's decision on the MATS rule does not change the assumptions regarding the impact of energy conservation standards on SO_2 emissions. Further, the Court's decision does not change the impact of the energy conservation standards on mercury emissions. The EPA, in response to the U.S. Supreme Court's direction, has now considered cost in evaluating whether it is appropriate and necessary to regulate coal- and oil-fired EGUs under the CAA. EPA concluded in its final supplemental finding that a consideration of cost does not alter the EPA's previous determination that regulation of hazardous air pollutants, including mercury, from coal- and oil-fired EGUs, is appropriate and necessary. 79 Fed. Reg. 24420 (April 25, 2016). The MATS rule remains in effect, but litigation is pending in the D.C. Circuit Court of Appeals over EPA's final supplemental finding MATS rule.

[63] CSAPR also applies to NO_X and it supersedes the regulation of NO_X under CAIR.

The MATS limit mercury emissions from power plants, but they do not include emissions caps and, as such, DOE's energy conservation standards would likely reduce Hg emissions. DOE estimated mercury emissions reduction using emissions factors based on AEO 2016, which incorporates the MATS.

L. Monetizing Carbon Dioxide and Other Emissions Impacts

As part of the development of this final rule, DOE considered the estimated monetary benefits from the reduced emissions of CO_2 and NO_X that are expected to result from each of the TSLs considered. To make this calculation analogous to the calculation of the NPV of consumer benefit, DOE considered the reduced emissions expected to result over the lifetime of products shipped in the projection period for each TSL. This section summarizes the basis for the monetary values used for CO_2 and NO_X emissions and presents the values considered in this analysis.

1. Social Cost of Carbon

The social cost of carbon (SCC) is an estimate of the monetized damages associated with an incremental increase in carbon emissions in a given year. It is intended to include (but is not limited to) climate-change-related changes in net agricultural productivity, human health, property damages from increased flood risk, and the value of ecosystem services. Estimates of the SCC are provided in dollars per metric ton of CO_2. A domestic SCC value is meant to reflect the value of damages in the United

States resulting from a unit change in CO_2 emissions, while a global SCC value is meant to reflect the value of damages worldwide.

Under section 1(b) of Executive Order 12866, "Regulatory Planning and Review," 58 FR 51735 (Oct. 4, 1993), agencies must, to the extent permitted by law, "assess both the costs and the benefits of the intended regulation and, recognizing that some costs and benefits are difficult to quantify, propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs." The purpose of the SCC estimates presented here is to allow agencies to incorporate the monetized social benefits of reducing CO_2 emissions into cost-benefit analyses of regulatory actions. The estimates are presented with an acknowledgement of the many uncertainties involved and with a clear understanding that they should be updated over time to reflect increasing knowledge of the science and economics of climate impacts.

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

a. Monetizing Carbon Dioxide Emissions

When attempting to assess the incremental economic impacts of CO_2 emissions, the analyst faces a number of challenges. A report from the National Research Council[64] points out that any assessment will suffer from uncertainty, speculation, and lack of information about: (1) future emissions of GHGs, (2) the effects of past and future emissions on the climate system, (3) the impact of changes in climate on the physical and biological environment, and (4) the translation of these environmental impacts into economic damages. As a result, any effort to quantify and monetize the harms associated with climate change will raise questions of science, economics, and ethics and should be viewed as provisional.

Despite the limits of both quantification and monetization, SCC estimates can be useful in estimating the social benefits of reducing CO_2 emissions. The agency can estimate the benefits from reduced (or costs from increased) emissions in any future year by multiplying the change in emissions in that year by the SCC values appropriate for that year. The NPV of the benefits can then be calculated by multiplying each of these future benefits by an appropriate discount factor and summing across all affected years.

It is important to emphasize that the interagency process is committed to updating these estimates as the science and economic understanding of climate change and its impacts on society improves over time. In the meantime, the interagency group will

[64] National Research Council. Hidden Costs of Energy: Unpriced Consequences of Energy Production and Use. 2009. National Academies Press: Washington, DC.

continue to explore the issues raised by this analysis and consider public comments as part of the ongoing interagency process.

b. Development of Social Cost of Carbon Values

In 2009, an interagency process was initiated to offer a preliminary assessment of how best to quantify the benefits from reducing carbon dioxide emissions. To ensure consistency in how benefits are evaluated across Federal agencies, the Administration sought to develop a transparent and defensible method, specifically designed for the rulemaking process, to quantify avoided climate change damages from reduced CO_2 emissions. The interagency group did not undertake any original analysis. Instead, it combined SCC estimates from the existing literature to use as interim values until a more comprehensive analysis could be conducted. The outcome of the preliminary assessment by the interagency group was a set of five interim values: global SCC estimates for 2007 (in 2006$) of $55, $33, $19, $10, and $5 per metric ton of CO_2. These interim values represented the first sustained interagency effort within the U.S. government to develop an SCC for use in regulatory analysis. The results of this preliminary effort were presented in several proposed and final rules.

c. Current Approach and Key Assumptions

After the release of the interim values, the interagency group reconvened on a regular basis to generate improved SCC estimates. Specially, the group considered public comments and further explored the technical literature in relevant fields. The interagency group relied on three integrated assessment models commonly used to

estimate the SCC: the FUND, DICE, and PAGE models. These models are frequently cited in the peer-reviewed literature and were used in the last assessment of the Intergovernmental Panel on Climate Change (IPCC). Each model was given equal weight in the SCC values that were developed.

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

In 2010, the interagency group selected four sets of SCC values for use in regulatory analyses. Three sets of values are based on the average SCC from the three integrated assessment models, at discount rates of 2.5, 3, and 5 percent. The fourth set, which represents the 95th percentile SCC estimate across all three models at a 3-percent discount rate, was included to represent higher-than-expected impacts from climate change further out in the tails of the SCC distribution. The values grow in real terms over

time. Additionally, the interagency group determined that a range of values from 7 percent to 23 percent should be used to adjust the global SCC to calculate domestic effects,[65] although preference is given to consideration of the global benefits of reducing CO_2 emissions. Table IV.16 presents the values in the 2010 interagency group report,[66] which is reproduced in appendix 14A of the final rule TSD.

Table IV.16 Annual SCC Values from 2010 Interagency Report, 2010–2050 (2007$ per Metric Ton CO_2)

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

The SCC values used for this document were generated using the most recent versions of the three integrated assessment models that have been published in the peer-reviewed literature, as described in the 2013 update from the interagency working group (revised July 2015).[67] Table IV.17 shows the updated sets of SCC estimates from the latest interagency update in 5-year increments from 2010 through 2050. The full set of

[65] It is recognized that this calculation for domestic values is approximate, provisional, and highly speculative. There is no a priori reason why domestic benefits should be a constant fraction of net global damages over time.

[66] United States Government–Interagency Working Group on Social Cost of Carbon. Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866. February 2010. https://www.whitehouse.gov/sites/default/files/omb/inforeg/for-agencies/Social-Cost-of-Carbon-for-RIA.pdf.

[67] United States Government–Interagency Working Group on Social Cost of Carbon. Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866. May 2013. Revised July 2015. https://www.whitehouse.gov/sites/default/files/omb/inforeg/scc-tsd-final-july-2015.pdf.

annual SCC estimates from 2010 through 2050 is reported in appendix 14B of the final rule TSD. The central value that emerges is the average SCC across models at the 3-percent discount rate. However, for purposes of capturing the uncertainties involved in regulatory impact analysis, the interagency group emphasizes the importance of including all four sets of SCC values.

Table IV.17 Annual SCC Values from 2013 Interagency Update (Revised July 2015), 2010–2050 (2007$ per Metric Ton CO_2)

Year	Discount Rate			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
2010	10	31	50	86
2015	11	36	56	105
2020	12	42	62	123
2025	14	46	68	138
2030	16	50	73	152
2035	18	55	78	168
2040	21	60	84	183
2045	23	64	89	197
2050	26	69	95	212

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

review and reconsider those estimates to reflect increasing knowledge of the science and economics of climate impacts, as well as improvements in modeling.[68]

In summary, in considering the potential global benefits resulting from reduced CO_2 emissions, DOE used the values from the 2013 interagency report (revised July 2015) adjusted to 2015$ using the implicit price deflator for GDP from the Bureau of Economic Analysis. For each of the four sets of SCC cases specified, the values for emissions in 2015 were $12.4, $40.6, $63.2, and $118 per metric ton avoided (values expressed in 2015$). DOE derived values after 2050 based on the trend in 2010–2050 in each of the four cases in the interagency update.

DOE multiplied the CO_2 emissions reduction estimated for each year by the SCC value for that year in each of the four cases. To calculate a present value of the stream of monetary values, DOE discounted the values in each of the four cases using the specific discount rate that had been used to obtain the SCC values in each case.

Mercatus Center and The Associations criticized DOE's use and application of SCC estimates. Mercatus Center stated that the SCC estimates are experimental and tentative, and not necessarily a valid guide for policy decisions; and the NOPR calculations overstate the net benefits for Americans by counting worldwide benefits.

[68] In November 2013, OMB announced a new opportunity for public comment on the interagency technical support document underlying the revised SCC estimates. 78 FR 70586. In July 2015 OMB published a detailed summary and formal response to the many comments that were received: this is available at https://www.whitehouse.gov/blog/2015/07/02/estimating-benefits-carbon-dioxide-emissions-reductions. It also stated its intention to seek independent expert advice on opportunities to improve the estimates, including many of the approaches suggested by commenters.

Mercatus Center added that in many of the NOPR calculations, the SCC estimates are the difference between positive and negative benefit-cost figures. The Associations objected to DOE's continued use of the SCC in the cost-benefit analysis and stated that the SCC calculation should not be used in any rulemaking until it undergoes a more rigorous notice, review, and comment process. (Mercatus Center, No. 11 at p. 8–9, The Associations, No. 17 at p. 3)

In conducting the interagency process that developed the SCC values, technical experts from numerous agencies met on a regular basis to consider public comments, explore the technical literature in relevant fields, and discuss key model inputs and assumptions. Key uncertainties and model differences transparently and consistently inform the range of SCC estimates. However, the three integrated assessment models used to estimate the SCC are frequently cited in the peer-reviewed literature and were used in the last assessment of the IPCC. In addition, new versions of the models that were used to estimate revised SCC values in this final rule were published in peer-reviewed literature (see appendix 14B of the final rule TSD for discussion). Although uncertainties remain, the revised estimates used in this final rule are based on the best available scientific information on the impacts of climate change. The current estimates of the SCC have been developed over many years, using the best science available, and with input from the public.

DOE's analysis estimates both global and domestic benefits of CO_2 emissions reductions. Following the recommendation of the interagency working group, the 2014

NOPR and this final rule focus on a global measure of SCC. As discussed in appendix 14A of the final rule TSD, the climate change problem is highly unusual in at least two respects. First, it involves a global externality: emissions of most GHGs contribute to damages around the world even when they are emitted in the United States. Consequently, to address the global nature of the problem, the SCC must incorporate the full (global) damages caused by GHG emissions. Second, climate change presents a problem that the United States alone cannot solve. Even if the United States were to reduce its GHG emissions to zero, that step would be far from enough to avoid substantial climate change. Other countries would also need to take action to reduce emissions if significant changes in the global climate are to be avoided. Emphasizing the need for a global solution to a global problem, the United States has been actively involved in seeking international agreements to reduce emissions and in encouraging other nations, including emerging major economies, to take significant steps to reduce emissions. When these considerations are taken as a whole, the interagency group concluded that a global measure of the benefits from reducing U.S. emissions is preferable. DOE's approach is consistent with the requirement to weigh the need for national energy conservation, as one of the main reasons for national energy conservation is to contribute to efforts to mitigate the effects of global climate change.

With respect to the comment that the SCC benefits are the difference between positive and negative benefit-cost figures, all of the TSLs considered in this rule have a positive NPV of consumer benefits (i.e., without considering the value of emissions reduction).

2. Social Cost of Other Air Pollutants

As noted previously, DOE has estimated how the considered energy conservation standards would reduce site NO_X emissions nationwide and decrease power sector NO_X emissions in those 22 States not affected by the CSAPR.

DOE estimated the monetized value of NO_X emissions reductions electricity generation using benefit per ton estimates from the Regulatory Impact Analysis for the Clean Power Plan Final Rule, published in August 2015 by EPA's Office of Air Quality Planning and Standards.[69] The report includes high and low values for NO_X (as $PM_{2.5}$) for 2020, 2025, and 2030 using discount rates of 3 percent and 7 percent; these values are presented in appendix 14C of the final rule TSD. DOE primarily relied on the low estimates to be conservative.[70] DOE developed values specific to the end-use category for residential dishwashers using a method described in appendix 14C of the final rule TSD. For this analysis DOE used linear interpolation to define values for the years between 2020 and 2025 and between 2025 and 2030; for years beyond 2030 the value is held constant.

[69] Available at www.epa.gov/cleanpowerplan/clean-power-plan-final-rule-regulatory-impact-analysis. See Tables 4A-3, 4A-4, and 4A-5 in the report. The U.S. Supreme Court has stayed the rule implementing the Clean Power Plan until the current litigation against it concludes. Chamber of Commerce, et al. v. EPA, et al., Order in Pending Case, 577 U.S. (2016). However, the benefit-per-ton estimates established in the Regulatory Impact Analysis for the Clean Power Plan are based on scientific studies that remain valid irrespective of the legal status of the Clean Power Plan.

[70] For the monetized NO_X benefits associated with $PM_{2.5}$, the related benefits are primarily based on an estimate of premature mortality derived from the ACS study (Krewski et al. 2009), which is the lower of the two EPA central tendencies. Using the lower value is more conservative when making the policy decision concerning whether a particular standard level is economically justified. If the benefit-per-ton estimates were based on the Six Cities study (Lepuele et al. 2012), the values would be nearly two-and-a-half times larger. (See chapter 14 of the final rule TSD for citations for the studies mentioned above.)

DOE estimated the monetized value of NO_X emissions reductions from gas-fired water heaters using benefit per ton estimates from the EPA's "Technical Support Document Estimating the Benefit per Ton of Reducing $PM_{2.5}$ Precursors from 17 Sectors."[71] Although none of the sectors refers specifically to residential and commercial buildings, DOE believes that the sector called "Area sources" would be a reasonable proxy for residential and commercial buildings. "Area sources" represents all emission sources for which states do not have exact (point) locations in their emissions inventories. Since exact locations would tend to be associated with larger sources, "area sources" would be fairly representative of small dispersed sources like homes and businesses. The EPA Technical Support Document provides high and low estimates for 2016, 2020, 2025, and 2030 at 3- and 7-percent discount rates. As with the benefit per ton estimates for NO_X emissions reductions from electricity generation, DOE primarily relied on the low estimates to be conservative.

DOE multiplied the emissions reduction (in tons) in each year by the associated $/ton values, and then discounted each series using discount rates of 3 percent and 7 percent as appropriate.

DOE is evaluating appropriate monetization of reduction in other emissions in energy conservation standards rulemakings. DOE has not included monetization of those emissions in the current analysis.

[71] www.epa.gov/sites/production/files/2014-10/documents/sourceapportionmentbpttsd.pdf

M. Utility Impact Analysis

The utility impact analysis estimates several effects on the electric power generation industry that would result from the adoption of new or amended energy conservation standards. The utility impact analysis estimates the changes in installed electrical capacity and generation that would result for each TSL. The analysis is based on published output from the NEMS associated with AEO 2016. NEMS produces the AEO Reference case, as well as a number of side cases that estimate the economy-wide impacts of changes to energy supply and demand. For the current analysis, impacts are quantified by comparing the levels of electricity sector generation, installed capacity, fuel consumption and emissions consistent with the projection described on page E-8 of AEO 2016 and various side cases. Details of the methodology are provided in the appendices to chapters 13 and 15 of the final rule TSD.

The output of this analysis is a set of time-dependent coefficients that capture the change in electricity generation, primary fuel consumption, installed capacity and power sector emissions due to a unit reduction in demand for a given end use. These coefficients are multiplied by the stream of electricity savings calculated in the NIA to provide estimates of selected utility impacts of new or amended energy conservation standards.

N. Employment Impact Analysis

DOE considers employment impacts in the domestic economy as one factor in selecting a standard. Employment impacts from new or amended energy conservation standards include both direct and indirect impacts. Direct employment impacts are any changes in the number of employees of manufacturers of the products subject to standards, their suppliers, and related service firms. The MIA addresses those impacts. Indirect employment impacts are changes in national employment that occur due to the shift in expenditures and capital investment caused by the purchase and operation of more-efficient appliances. Indirect employment impacts from standards consist of the net jobs created or eliminated in the national economy, other than in the manufacturing sector being regulated, caused by: (1) reduced spending by consumers on energy, (2) reduced spending on new energy supply by the utility industry, (3) increased consumer spending on the products to which the new standards apply and other goods and services, and (4) the effects of those three factors throughout the economy.

One method for assessing the possible effects on the demand for labor of such shifts in economic activity is to compare sector employment statistics developed by the Labor Department's BLS. BLS regularly publishes its estimates of the number of jobs per million dollars of economic activity in different sectors of the economy, as well as the jobs created elsewhere in the economy by this same economic activity. Data from BLS indicate that expenditures in the utility sector generally create fewer jobs (both directly

and indirectly) than expenditures in other sectors of the economy.[72] There are many reasons for these differences, including wage differences and the fact that the utility sector is more capital-intensive and less labor-intensive than other sectors. Energy conservation standards have the effect of reducing consumer utility bills. Because reduced consumer expenditures for energy likely lead to increased expenditures in other sectors of the economy, the general effect of efficiency standards is to shift economic activity from a less labor-intensive sector (i.e., the utility sector) to more labor-intensive sectors (e.g., the retail and service sectors). Thus, the BLS data suggest that net national employment may increase due to shifts in economic activity resulting from energy conservation standards.

DOE estimated indirect national employment impacts for the standard levels considered in this final rule using an input/output model of the U.S. economy called Impact of Sector Energy Technologies version 4 (ImSET).[73] ImSET is a special-purpose version of the "U.S. Benchmark National Input-Output" (I-O) model, which was designed to estimate the national employment and income effects of energy-saving technologies. The ImSET software includes a computer-based I-O model having structural coefficients that characterize economic flows among 187 sectors most relevant to industrial, commercial, and residential building energy use.

[72] See U.S. Department of Commerce–Bureau of Economic Analysis. Regional Multipliers: A User Handbook for the Regional Input-Output Modeling System (RIMS II). 1997. U.S. Government Printing Office: Washington, DC. Available at http://www.bea.gov/scb/pdf/regional/perinc/meth/rims2.pdf.
[73] Livingston, O. V., S. R. Bender, M. J. Scott, and R. W. Schultz. ImSET 4.0: Impact of Sector Energy Technologies Model Description and User's Guide. 2015. Pacific Northwest National Laboratory: Richland, WA. PNNL-24563.

DOE notes that ImSET is not a general equilibrium forecasting model, and understands the uncertainties involved in projecting employment impacts, especially changes in the later years of the analysis. Because ImSET does not incorporate price changes, the employment effects predicted by ImSET may over-estimate actual job impacts over the long run for this rule. Therefore, DOE used ImSET only to generate results for near-term timeframes, where these uncertainties are reduced. For more details on the employment impact analysis, see chapter 16 of the final rule TSD.

V. Analytical Results and Conclusions

The following section addresses the results from DOE's analyses with respect to the considered energy conservation standards for residential dishwashers. It addresses the TSLs examined by DOE and the projected impacts of each of these levels if adopted as energy conservation standards for residential dishwashers. Additional details regarding DOE's analyses are contained in the final rule TSD supporting this final rule.

A. Trial Standard Levels

DOE analyzed the benefits and burdens of two TSLs for residential dishwashers.[74] These TSLs were developed by combining specific efficiency levels that have positive

[74] Three TSLs were analyzed during the 2014 NOPR phase for the three of four efficiency levels that had positive LCC savings. Efficiency levels with negative LCC savings are not analyzed in the NIA and are not represented in a TSL. Because only one efficiency level for standard-size residential dishwashers (EL 3) had positive LCC savings for the final rule and both efficiency levels for compact residential dishwashers (EL 1 and EL 2) have positive LCC savings, DOE analyzed two TSLs for the final rule, as presented in Table V.1. Each efficiency level for compact residential dishwashers was combined with the one efficiency level for standard residential dishwashers to form two TSLs.

LCC savings for each of the product classes analyzed by DOE.[75] DOE presents the results for the TSLs in this document, while the results for all efficiency levels that DOE analyzed are in the final rule TSD.

Table V.1 presents the TSLs and the corresponding efficiency levels that DOE has identified for potential amended energy conservation standards for residential dishwashers. TSL 1 represents the only efficiency level for standard-size residential dishwashers with positive LCC savings and the lowest efficiency level above the baseline for compact residential dishwashers. TSL 2 represents the maximum technologically feasible ("max-tech") energy efficiency for the compact product class and repeats the efficiency level for the standard-size product class.

Table V.1 Trial Standard Levels for Residential Dishwashers

TSL	Standard			Compact		
	EL	Annual Energy Use (kWh)	Water Use per Cycle (gal)	EL	Annual Energy Use (kWh)	Water Use per Cycle (gal)
1	3	255	3.10	1	203	3.10
2	3	255	3.10	2	130	1.70

[75] For standard-size residential dishwashers, Efficiency Levels 1, 2, and 4 all had negative average LCC savings, so DOE did not consider them when forming the TSLs. ELs 1, 2, and 4 shifted to negative LCCs due to a number of factors including (1) updates to the engineering analysis (discussed above and in the final rule TSD chapter 5); (2) adjusting to 2015$ from 2014$; (3) an updated base-case efficiency distribution from 2014 to 2016; and (4) using the updated AEO 2016 from AEO 2013.

B. Economic Justification and Energy Savings

1. Economic Impacts on Individual Consumers

DOE analyzed the economic impacts on residential dishwasher consumers by looking at the effects that potential amended standards at each TSL would have on the LCC and PBP. DOE also examined the impacts of potential standards on selected consumer subgroups. These analyses are discussed below.

a. Life-Cycle Cost and Payback Period

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

Table V.2 through Table V.5 show the LCC and PBP results for the TSLs considered for each product class. In the first of each pair of tables, the simple payback is measured relative to the baseline product. In the second table, the impacts are measured relative to the efficiency distribution in the no-new-standards case in the compliance year (see section IV.F of this document). Because some consumers purchase products with higher efficiency in the no-new-standards case, the average savings are less than the difference between the average LCC of the baseline products and the average LCC at each TSL. The savings refer only to consumers who are affected by a standard at

a given TSL. Those who already purchase a product with efficiency at or above a given TSL are not affected. Consumers for whom the LCC increases at a given TSL experience a net cost.

Table V.2 Average LCC and PBP Results for Standard Residential Dishwashers

TSL	EL	Average Costs 2015$				Simple Payback* Years	Average Lifetime years
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	0	411	41	481	893	--	15
--	1	432	40	465	896	16.1	15
--	2	470	37	428	898	13.5	15
1,2	3	491	35	405	897	12.9	15
--	4	539	31	361	900	12.9	15

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product.
*The Simple Payback represents the number of years to recover incremental installed costs for the households experiencing a net benefit.

Table V.3 Average LCC Savings Relative to the No-New-Standards Case for Standard Residential Dishwashers

TSL	EL	Life-Cycle Cost Savings	
		Average LCC Savings*	Percent of Consumers that Experience Net Cost
		2015$	%
--	1	(1.94)	4
--	2	(1.07)	25
1,2	3	0.28	58
--	4	(3.14)	67

* The savings represent the average LCC for affected consumers.
Parentheses indicate negative (-) values.

Table V.4 Average LCC and PBP Results for Compact Residential Dishwashers

TSL	EL	Average Costs 2015$				Simple Payback* years	Average Lifetime years
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	0	445	30	352	798		15
1	1	457	28	323	781	4.8	15
2	2	485	19	213	698	3.3	15

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

*The Simple Payback represents the number of years to recover incremental installed costs for the households experiencing a net benefit.

Table V.5 Average LCC Savings Relative to the No-New-Standards Case for Compact Residential Dishwashers

TSL	EL	Life-Cycle Cost Savings	
		Average LCC Savings*	Percent of Consumers that Experience Net Cost
		2015$	%
1	1	17	8
2	2	90	12

*The savings represent the average LCC for affected consumers

b. Consumer Subgroup Analysis

In the consumer subgroup analysis, DOE estimated the impact of the considered TSLs on low-income households. Table V.6 and Table V.7 compare the average LCC savings and PBP at each efficiency level for the consumer subgroup, along with the average LCC savings for the entire consumer sample. The average LCC savings and PBP for low-income households at the considered efficiency levels are not substantially different from the average for all households. Chapter 11 of the final rule TSD presents the complete LCC and PBP results for the subgroup.

Table V.6 Standard Residential Dishwashers: Comparison of LCC Savings and PBP for Consumer Subgroups and All Households

	Average Life-Cycle Cost Savings (2015$)		Simple Payback Period (years)	
TSL	**Low-income households**	**All Households**	**Low-income households**	**All Households**
1,2	(0.70)	0.28	12.9	12.9

Parentheses indicate negative (-) values.

Table V.7 Compact Residential Dishwashers: Comparison of LCC Savings and PBP for Consumer Subgroups and All Households

	Average Life-Cycle Cost Savings (2015$)		Simple Payback Period (years)	
TSL	**Low-income households**	**All Households**	**Low-income households**	**All Households**
1	16	17	4.9	4.8
2	84	90	3.4	3.3

c. Rebuttable Presumption Payback

As discussed in section IV.F.10 of this final rule, EPCA establishes a rebuttable presumption that an energy conservation standard is economically justified if the increased purchase cost for a product that meets the standard is less than three times the value of the first-year energy savings resulting from the standard. In calculating a rebuttable presumption payback period for each of the considered TSLs, DOE used discrete values, and, as required by EPCA, based the energy use calculation on the DOE test procedure for residential dishwashers. In contrast, the PBPs presented in section IV.F.10 of this final rule were calculated using distributions that reflect the range of energy use in the field.

Table V.8 presents the rebuttable-presumption payback periods for the considered TSLs for residential dishwashers. While DOE examined the rebuttable-presumption criterion, it considered whether the standard levels considered for this rule are

economically justified through a more detailed analysis of the economic impacts of those levels, pursuant to 42 U.S.C. 6295(o)(2)(B)(i), that considers the full range of impacts to the consumer, manufacturer, Nation, and environment. The results of that analysis serve as the basis for DOE to evaluate the economic justification for a potential standard level, thereby supporting or rebutting the results of any preliminary determination of economic justification.

Table V.8 Residential Dishwashers: Rebuttable PBPs

Product Class	Trial Standard Level	
	1	2
Standard (years)	7.5	7.5
Compact (years)	3.7	2.5

2. Economic Impacts on Manufacturers

DOE performed an MIA to estimate the impact of amended energy conservation standards on manufacturers of residential dishwashers. The next section describes the expected impacts on manufacturers at each considered TSL. Chapter 12 of the final rule TSD explains the analysis in further detail.

a. Industry Cash Flow Analysis Results

In this section, DOE provides GRIM results from the analysis, which examines changes in the industry that would result from a standard. The following tables illustrate the estimated financial impacts (represented by changes in INPV) of potential amended energy conservation standards on manufacturers of residential dishwashers, as well as the

conversion costs that DOE estimates manufacturers of residential dishwashers would incur at each TSL.

DOE modeled two scenarios using different markup assumptions and two scenarios using different conversion cost assumptions for a total of four different scenarios. Each scenario results in a unique set of cash flows and corresponding industry value at each TSL. These assumptions correspond to the bounds of a range of market responses that DOE anticipates could occur in the standards case. The tables below depict the financial impacts on manufacturers (represented by changes in INPV) and the conversion costs DOE estimates manufacturers would incur at each TSL. Table V.9 and Table V.10 correspond to the scenarios using scaled estimates of the capital conversion costs from the 2012 Direct Final Rule with the preservation of gross margin markups and the preservation of per-unit operating profit markups respectively. Table V.11 and Table V.12 correspond to the scenarios using estimates of the capital conversion from the current engineering cost model, again with the preservation of gross margin markups and the preservation of per-unit operating profit markups respectively. For a given conversion cost scenario, results corresponding to the preservation of gross margin markups scenario reflect the lower (less severe) bound of impacts whereas the results corresponding to the preservation of per-unit operating profit markups scenario reflect the upper (more severe) bound of impacts.

The INPV results refer to the difference in industry value between the no-new-standards case and the standards case, which DOE calculated by summing the discounted

industry cash flows from the base year (2016) through the end of the analysis period (2048). The discussion also notes the difference in cash flow between the no-new-standards case and the standards case in the year before the compliance date of potential amended energy conservation standards. This figure provides an estimate of the required conversion costs relative to the cash flow generated by the industry in the no-new-standards case.

Table V.9 Manufacturer Impact Analysis for Residential Dishwashers – Scaled Capital Conversion Costs from the 2012 Direct Final Rule with the Preservation of Gross Margin Markups Scenario

	Units	Base Case	Trial Standard Level	
			1	2
INPV	(2015$ millions)	527.7	381.3	379.0
Change in INPV	(2015$ millions)	-	-146.3	-148.7
	(%)	-	-27.7%	-28.2%
Product Conversion Costs	(2015$ millions)	-	93.7	94.8
Capital Conversion Costs	(2015$ millions)	-	141.1	143.2
Total Conversion Costs	(2015$ millions)	-	234.8	238.0

Table V.10 Manufacturer Impact Analysis for Residential Dishwashers – Scaled Capital Conversion Costs from the 2012 Direct Final Rule with the Preservation of Per-Unit Operating Profit Markups Scenario

	Units	Base Case	Trial Standard Level	
			1	2
INPV	(2015$ millions)	527.7	327.0	324.4
Change in INPV	(2015$ millions)	-	-200.7	-203.3
	(%)	-	-38.0%	-38.5%
Product Conversion Costs	(2015$ millions)	-	93.7	94.8
Capital Conversion Costs	(2015$ millions)	-	141.1	143.2
Total Conversion Costs	(2015$ millions)	-	234.8	238.0

Table V.11 Manufacturer Impact Analysis for Residential Dishwashers – Capital Conversion Costs from the 2016 Engineering Cost Model with the Preservation of Gross Margin Markups Scenario

	Units	Base Case	Trial Standard Level	
			1	2
INPV	(2015$ millions)	527.7	464.7	459.3
Change in INPV	(2015$ millions)	-	-63.0	-68.3
	(%)	-	-11.9%	-13.0%
Product Conversion Costs	(2015$ millions)	-	93.7	94.8
Capital Conversion Costs	(2015$ millions)	-	69.1	74.6
Total Conversion Costs	(2015$ millions)	-	162.8	169.4

Table V.12 Manufacturer Impact Analysis for Residential Dishwashers – Capital Conversion Costs from the 2016 Engineering Cost Model with the Preservation of Per-Unit Operating Profit Markups Scenario

	Units	Base Case	Trial Standard Level	
			1	2
INPV	(2015$ millions)	527.7	408.2	402.5
Change in INPV	(2015$ millions)	-	-119.5	-125.2
	(%)	-	-22.6%	-23.7%
Product Conversion Costs	(2015$ millions)	-	93.7	94.8
Capital Conversion Costs	(2015$ millions)	-	69.1	74.6
Total Conversion Costs	(2015$ millions)	-	162.8	169.4

Because standard residential dishwashers represent over 99 percent of shipments in the year leading up to potential amended standards, changes to this product class contribute the majority of impacts to INPV across all TSLs analyzed in this rulemaking.

At TSL 1, DOE estimates impacts on INPV to range from -$200.7 million to -$63.0 million, or a change in INPV of -38.0 percent to -11.9 percent. At this level, industry free cash flow is estimated to decrease by as much as 231.9 percent to -$51.9 million, compared to the no-new-standards case value of $39.4 million in the year leading up to the amended energy conservation standards.

At TSL 1, although overall INPV impacts are indicative of impacts on INPV for the standard residential dishwasher industry, DOE estimates impacts on compact residential dishwasher INPV to range from -$8.5 million to -$6.1 million, or a change in INPV of -207.6 percent to -150.4 percent.

At TSL 1, for standard residential dishwashers, DOE expects manufacturers would optimize the hydraulic system, and incorporate electronic controls, multiple spray arms, separate drain and circulation pumps, tub insulation, a soil sensor, improved filters, a temperature sensor, a flow meter, a water diverter assembly, and variable-speed motors. The component changes required to enable these improvements contribute to an MPC of $205.92 for standard residential dishwashers. At TSL 1, for compact residential dishwashers, DOE expects manufacturers would reduce sump volumes, and incorporate improved controls, tub insulation, and a permanent magnet motor. The component changes required to enable these improvements contribute to an MPC of $176.83 for compact residential dishwashers.

Approximately 11 percent of standard residential dishwasher shipments and 63 percent of compact residential dishwasher shipments currently meet the standards specified at TSL 1 (255 kWh/year and 3.1 gal/cycle for the standard product class, and 203 kWh/year and 3.1 gal/cycle for the compact product class). Because some standard residential dishwashers do not currently employ these energy and water saving measures, the product and capital conversion costs for standard residential dishwashers are estimated to total $224.9 million based on the scaled conversion costs taken from the 2012 Direct Final Rule, or $155.5 million based on the engineering cost model, as the production lines responsible for producing over 89 percent of standard product shipments would need retooling and upgrades. For manufacturers of compact residential dishwashers, these investments total $9.8 million based on the scaled conversion costs

taken from the 2012 Direct Final Rule, or $7.3 million based on the engineering cost model. Accordingly, the conversion costs required to design and produce compliant standard residential dishwashers contribute to the majority of impacts on INPV at TSL 1.

At TSL 2, DOE estimates impacts on INPV to range from -$203.3 million to -$68.3 million, or a change in INPV of -38.5 percent to -13.0 percent. At this level, industry free cash flow is estimated to decrease by as much as 235.1 percent to -$53.2 million, compared to the no-new-standards case value of $39.4 million in the year leading up to the amended energy conservation standards.

At TSL 2, although overall INPV impacts are indicative of impacts on INPV for the standard residential dishwasher industry, DOE estimates impacts on compact residential dishwasher INPV to range from -$12.1 million to -$11.4 million, or a change in INPV of -297.0 percent to -280.0 percent. Because these impacts are attributed to manufacturers of compact residential dishwashers in the countertop configuration, DOE expects that manufacturers would exit the market for these products at TSL 2.

For standard residential dishwashers, TSL 2 corresponds to the same efficiency level (EL 3) as that corresponding to TSL 1. Therefore, at TSL 2, DOE expects manufacturers would incorporate the same design option changes as described for TSL 1. The component changes required to enable these improvements contribute to an MPC of $205.92 for standard residential dishwashers. At TSL 2, for compact residential dishwashers, in addition to the design changes required for baseline units to reach TSL 1,

DOE expects manufacturers would optimize the hydraulic system, integrate improved filters, and incorporate the internal water heater into the base of the tub. The component changes required to enable these improvements contribute to an MPC of $196.44 for compact residential dishwashers at TSL 2.

For standard residential dishwashers, approximately 11 percent of shipments currently meet the standards specified at TSL 2 (255 kWh/year and 3.1 gal/cycle). Similarly, 11 percent of compact residential dishwasher shipments currently meet the standards specified at TSL 2 (130 kWh/year and 1.7 gal/cycle). Because some standard residential dishwashers do not currently employ these energy and water saving measures, the product and capital conversion costs for standard residential dishwashers are estimated to total $224.9 million based on the scaled conversion costs taken from the 2012 Direct Final Rule, or $155.5 million based on the engineering cost model, as the production lines responsible for producing over 89 percent of standard product shipments would need retooling and upgrades. For manufacturers of compact residential dishwashers, these investments total $13.0 million based on the scaled conversion costs taken from the 2012 Direct Final Rule, or $13.9 million based on the engineering cost model. Accordingly, the conversion costs required to design and produce compliant standard residential dishwashers contribute to the majority of impacts on INPV at TSL 2.

b. Direct Impacts on Employment

To quantitatively assess the impacts of energy conservation standards on direct employment, DOE used the GRIM to estimate the domestic labor expenditures and

number of production and non-production employees in the no-new-standards case and at each TSL. DOE used statistical data from the U.S. Census Bureau's 2014 Annual Survey of Manufactures (ASM), results of the engineering analysis, and manufacturer feedback to calculate industry-wide labor expenditures and direct domestic employment levels.

Labor expenditures related to product manufacturing depend on the labor intensity of the product, the sales volume, and an assumption that wages remain fixed in real terms over time. The total labor expenditures in each year are calculated by multiplying the MPCs by the labor percentage of MPCs. The total labor expenditures in the GRIM were then converted to domestic production employment levels. To do this, DOE relied on the Production Workers Annual Wages, Production Workers Annual Hours, Total Fringe Benefits, Annual Payroll, Production Workers Average for Year, and Number of Employees from the ASM to convert total labor expenditure to total production employees.

The total production employees is then multiplied by the U.S. labor percentage to convert total production employment to total domestic production employment. The U.S. labor percentage represents the industry fraction of domestic manufacturing production capacity for the covered product. This value is derived from manufacturer feedback, product database analysis, and publicly available information. DOE estimates that 80 percent of the standard residential dishwashers are produced domestically and that there are currently no compact residential dishwashers produced domestically.

The domestic production employees estimate covers production line workers, including line supervisors, who are directly involved in fabricating and assembling products within the original equipment manufacturer (OEM) facility. Workers performing services that are closely associated with production operations, such as materials handling tasks using forklifts, are also included as production labor. DOE's estimates only account for production workers who manufacture the specific equipment covered by this rulemaking.

Non-production workers account for the remainder of the direct employment figure. The non-production employees covers domestic workers who are not directly involved in the production process, such as sales, engineering, human resources, management, etc. Using the amount of domestic production workers calculated above, non-production domestic employees are extrapolated by multiplying the ratio of non-production workers in the industry compared to production employees. DOE assumes that this employee distribution ratio remains constant between the no-new-standards case and standards cases.

Using the GRIM, DOE estimates in the absence of new energy conservation standards there would be 3,829 domestic workers in the residential dishwasher industry in 2019. Table V.13 shows the range of the impacts of amended energy conservation standards on U.S. manufacturing employment in the residential dishwasher industry. The discussion below provides a qualitative evaluation of the range of potential impacts presented in the table.

Table V.13 Total Number of Domestic Residential Dishwasher Production Workers in 2019

	No-New-Standards Case	Trial Standard Level	
		1	2
Domestic Production Workers in 2019	3,116	800 to 3,241	800 to 3,241
Domestic Non-Production Workers in 2019	713	741	741
Total Direct Domestic Employment in 2019	3,829	1,541 to 3,982	1,541 to 3,982

The direct employment impacts shown in Table IV.13 represent the potential domestic employment changes that could result from amended energy conservation standards for residential dishwashers. The upper bound estimate corresponds to the increase in the number of domestic workers that would result from amended energy conservation standards if manufacturers continue to produce the same scope of covered equipment within the United States after compliance takes effect. The lower bound of the range represents the estimated maximum decrease in the total number of U.S. domestic workers if production of non-compliant product platforms is moved to lower labor-cost countries.

Because TSL 1 and TSL 2 both correspond to Efficiency Level 3 for standard residential dishwashers, the employment impacts displayed in Table V.13 are the same at TSL 1 and TSL 2. Both show a 4 percent increase in domestic production and non-production employment relative to the no-new-standards case, provided manufacturers do not relocate production facilities outside of the United States. However, some of the design options analyzed will require manufacturers to completely redesign product

platforms. Because of the large upfront capital and product development costs associated with platform redesigns, and the fact that few existing units meet the standards at TSL 1 and TSL 2, some manufacturers may consider relocating some of their domestic production of residential dishwashers to lower-labor-cost countries for standards at those TSLs. This scenario is reflected by the lower bound of results in Table V.13. For both TSLs, the lower bound of results correspond to a 74 percent decrease in domestic production employment production, and assumes manufacturers of residential dishwashers decide to shift production of their non-compliant platforms abroad (or source from abroad, maintaining the same number platform offerings).

Additionally, in response to the 2014 NOPR, AHAM commented that DOE underestimated the retail price increase and the subsequent decline in industry shipments resulting from amended energy conservation standards. (AHAM, No. 21 at pp. 14–15) A greater decrease in total shipments than what is modeled in this final rule could also result in a decrease in domestic production employment, as manufacturers react to lower demand by reducing their manufacturing workforce.

Additional detail on the analysis of direct employment can be found in chapter 12 of the final rule TSD. Additionally, the employment impacts discussed in this section are independent of the employment impacts from the broader U.S. economy, which are documented in chapter 16 of the final rule TSD.

c. Impacts on Manufacturing Capacity

Approximately 11 percent of shipments of residential dishwashers already comply with the energy conservation standard levels analyzed in this rulemaking. Not every manufacturer that ships standard residential dishwashers offers products that meet these standards. Because manufacturers would need to make substantial platform changes by the 2019 compliance date, many would have to run parallel production between the announcement of the final rule and the compliance date. This requirement may impact manufacturing capacity during this interim period.

d. Impacts on Sub-Groups of Manufacturers

Using average cost assumptions to develop an industry cash-flow estimate may not be adequate for assessing differential impacts among manufacturer subgroups. Small manufacturers, niche equipment manufacturers, and manufacturers exhibiting a cost structure substantially different from the industry average could be affected disproportionately. DOE examined the potential for disproportionate impacts on small business manufacturers, as discussed in section VI.B of this final rule. DOE did not identify any other manufacturer subgroups for this rulemaking.

e. Cumulative Regulatory Burden

One aspect of assessing manufacturer burden involves looking at the cumulative impact of multiple DOE standards and the regulatory actions of other Federal agencies and States that affect the manufacturers of a covered product or equipment. While any one regulation may not impose a significant burden on manufacturers, the combined

effects of several existing or impending regulations may have serious consequences for some manufacturers, groups of manufacturers, or an entire industry. Multiple regulations affecting the same manufacturer can strain profits and lead companies to abandon product lines or markets with lower expected future returns than competing products. For these reasons, DOE conducts an analysis of cumulative regulatory burden as part of its rulemakings pertaining to appliance efficiency.

For the cumulative regulatory burden, DOE considers the impacts of other Federal regulations affecting manufacturers of residential dishwashers that will take effect approximately 3 years before or after the 2019 compliance date of this rulemaking. Most of the major regulations identified by DOE that meet this criterion are other energy conservation standards for products and equipment also made by manufacturers of residential dishwashers.

Table V.14 lists the other energy conservation standards affecting dishwasher manufacturers. For each rule, the table lists the rule's standard compliance year, the total number of manufacturers operating in that given industry, the number of dishwasher manufacturers affected by the rule, and the approximate year that compliance with standards will be required. The table also contains expected industry conversion costs for the given rule, as well as industry conversion costs as a percentage of conversion period industry revenues.

Table V.14 Other Energy Conservation Standards Rulemakings Affecting the Residential Dishwasher Industry

Regulation	Number of Manufacturers*	Manufacturers from Final Rule**	Approximate Standards Year	Industry Conversion Costs (Millions $)	Industry Conversion Cost / Revenue†
Residential Microwave Ovens 78 FR 36316 (June 17, 2013)	14	9	2016	$43.1 million (2010$)	0.6%
Commercial Refrigeration Equipment 79 FR 17725 (March 28, 2014)	54	1	2017	$184.0 million (2012$)	2.0%
PTAC 80 FR 43162 (July 21, 2015)	12	2	2017	N/A††	N/A††
Automatic Commercial Ice Makers 80 FR 4645 (Jan. 28, 2015)	16	4	2018	$25.1 million (2013$)	2.5%
Residential Clothes Washers 77 FR 32308 (May 31, 2012)	13	10	2018	$418.5 million (2010$)	2.3%
Commercial Clothes Washers 79 FR 74492 (Dec. 15, 2014)	6	3	2018	$10.2 million (2013$)	2.2%
Dehumidifiers 81 FR 38338 (June 13, 2016)	30	4	2019	$52.5 million (2014$)	4.5%
Kitchen Ranges and Ovens 81 FR 60784 (Sep. 2, 2016)	21	11	2019	$119.2 million (2015$)	0.8%
Portable ACs 81 FR 38398 (June 13, 2016)	10	3	2021	$302.8 million (2014$)	8.6%

*This column presents the total number of manufacturers identified in the energy conservation standard rule contributing to cumulative regulatory burden.

**This column presents the number of OEMs producing dishwashers that are also listed as manufacturers in the listed energy conservation standard contributing to cumulative regulatory burden.

†This column presents conversion costs as a percentage of cumulative revenue for the industry during the conversion period. The conversion period is the timeframe over which manufacturers must make conversion costs investments and lasts from the announcement year of the final rule to the standards year of the final rule. This period typically ranges from 3 to 5 years, depending on the energy conservation standard.

††As detailed in the energy conservation standards final rule for packaged terminal air conditioners (PTACs) and packaged terminal heat pumps (PTHPs), DOE established amended energy efficiency standards for PTAC equipment at the minimum efficiency level specified in the ANSI/American Society of Heating, Refrigerating and Air-Conditioning Engineers/Illuminating Engineering Society Standard 90.1-2013 for PTAC equipment. Accordingly, there were no conversion costs associated with amended energy conservation standards for PTACs.

During the comment period following the NOPR public meeting, manufacturers provided comments relating to the substantial effects of multiple overlapping DOE energy conservation standards on manufacturers of residential dishwashers. DOE summarized and addressed these comments in section IV.J.3 of this final rule. For more details, see chapter 12 of the final rule TSD.

DOE will continue to evaluate its approach to assessing cumulative regulatory burden for use in future rulemakings to ensure that it is effectively capturing the overlapping impacts of its regulations. In particular, DOE will assess whether looking at rules where any portion of the compliance period potentially overlaps with the compliance period for the subject rulemaking would yield a more accurate reflection of cumulative regulatory burden.

3. National Impact Analysis

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

a. Significance of Energy Savings

To estimate the energy savings attributable to potential amended standards for residential dishwashers, DOE compared the energy consumption under the no-new-standards case to the anticipated energy consumption under each TSL. The savings are measured over the entire lifetime of products purchased in the 30-year period that begins

in the year of anticipated compliance with amended standards (2019–2048). Table V.15 presents DOE's projections of the national energy and water savings for each TSL considered for residential dishwashers. The savings were calculated using the approach described in section IV.H.2 of this final rule.

Table V.15 Cumulative National Energy and Water Savings for Residential Dishwashers; 30 Years of Shipments (2019–2048)

	Trial Standard Level	
	1	2
Primary energy (quads)	0.46	0.47
FFC energy (quads)	0.49	0.50
Water (trillion gallons)	0.42	0.43

OMB Circular A-4[76] requires agencies to present analytical results, including separate schedules of the monetized benefits and costs that show the type and timing of benefits and costs. Circular A-4 also directs agencies to consider the variability of key elements underlying the estimates of benefits and costs. For this rulemaking, DOE undertook a sensitivity analysis using 9 years, rather than 30 years, of product shipments. The choice of a 9-year period is a proxy for the timeline in EPCA for the review of certain energy conservation standards and potential revision of and compliance with such revised standards.[77] The review timeframe established in EPCA is generally not

[76] OMB. Circular A-4: Regulatory Analysis. September 17, 2003. www.whitehouse.gov/omb/circulars_a004_a-4/.

[77] Section 325(m) of EPCA requires DOE to review its standards at least once every 6 years, and requires, for certain products, a 3-year period after any new standard is promulgated before compliance is required, except that in no case may any new standards be required within 6 years of the compliance date of the previous standards. While adding a 6-year review to the 3-year compliance period adds up to 9 years, DOE notes that it may undertake reviews at any time within the 6-year period and that the 3-year compliance date may yield to the 6-year backstop. A 9-year analysis period may not be appropriate given the variability that occurs in the timing of standards reviews and the fact that for some products, the compliance period is 5 years rather than 3 years.

synchronized with the product lifetime, product manufacturing cycles, or other factors specific to residential dishwashers. Thus, such results are presented for informational purposes only and are not indicative of any change in DOE's analytical methodology. The NES sensitivity analysis results based on a 9-year analytical period are presented in Table V.16. The impacts are counted over the lifetime of residential dishwashers purchased in 2019–2027.

Table V.16 Cumulative National Energy and Water Savings for Residential Dishwashers; 9 Years of Shipments (2019–2027)

	Trial Standard Level	
	1	2
Primary energy (quads)	0.13	0.13
FFC energy (quads)	0.13	0.14
Water (trillion gallons)	0.11	0.11

b. Net Present Value of Consumer Costs and Benefits

DOE estimated the cumulative NPV of the total costs and savings for consumers that would result from the TSLs considered for residential dishwashers. In accordance with OMB's guidelines on regulatory analysis,[78] DOE calculated NPV using both a 7-percent and a 3-percent real discount rate. Table V.17 shows the consumer NPV results with impacts counted over the lifetime of products purchased in 2019–2048.

[78] OMB. Circular A-4: Regulatory Analysis. September 17, 2003. www.whitehouse.gov/omb/circulars_a004_a-4/.

Table V.17 Cumulative Net Present Value of Consumer Benefits for Residential Dishwashers; 30 Years of Shipments (2019–2048)

Discount rate	Trial Standard Level	
	1	2
	Billion 2015$	
3 percent	2.08	2.21
7 percent	0.33	0.37

The NPV results based on the aforementioned 9-year analytical period are presented in Table V.18. The impacts are counted over the lifetime of products purchased in 2019–2027. As mentioned previously, such results are presented for informational purposes only and are not indicative of any change in DOE's analytical methodology or decision criteria.

Table V.18 Cumulative Net Present Value of Consumer Benefits for Residential Dishwashers; 9 Years of Shipments (2019–2027)

Discount rate	Trial Standard Level	
	1	2
	Billion 2015$	
3 percent	0.49	0.53
7 percent	0.03	0.05

The results in Table V.17 reflect the use of a default trend to estimate the change in price for residential dishwashers over the analysis period (see section IV.H.3 of this document). DOE also conducted a sensitivity analysis that considered one scenario with a lower rate of price decline than the reference case and one scenario with a higher rate of price decline than the reference case. The results of these alternative cases are presented in appendix 10C of the final rule TSD. In the high-price-decline case, the NPV of consumer benefits is higher than in the default case. In the low-price-decline case, the NPV of consumer benefits is lower than in the default case.

c. Indirect Impacts on Employment

DOE expects that amended energy conservation standards for residential dishwashers would reduce energy expenditures for consumers of those products, with the resulting net savings being redirected to other forms of economic activity. These expected shifts in spending and economic activity could affect the demand for labor. As described in section IV.F of this document, DOE used an input/output model of the U.S. economy to estimate indirect employment impacts of the TSLs that DOE considered. DOE understands that there are uncertainties involved in projecting employment impacts, especially changes in the later years of the analysis. Therefore, DOE generated results for near-term timeframes (2019–2024), where these uncertainties are reduced.

The results suggest that the proposed standards are likely to have a negligible impact on the net demand for labor in the economy. The net change in jobs is so small that it would be imperceptible in national labor statistics and might be offset by other, unanticipated effects on employment. Chapter 16 of the final rule TSD presents detailed results regarding anticipated indirect employment impacts.

4. Impact on Utility or Performance of Products

Impacts to consumer utility of the standard levels analyzed in this rulemaking are discussed in section IV.C.1.b of this final rule. Because DOE is not amending standards in this final rule, DOE is not reducing the utility or performance of residential dishwashers.

5. Impact of Any Lessening of Competition

DOE considered any lessening of competition that would be likely to result from amended standards, but has determined not to finalize amended standards in this rulemaking. In addition, as discussed in section III.E.1.e of this final rule, because DOE is not amending standards in this final rule, review by the Department of Justice to assess the impact of any lessening of competition is not required.

6. Need of the Nation to Conserve Energy

Enhanced energy efficiency, where economically justified, improves the Nation's energy security, strengthens the economy, and reduces the environmental impacts (costs) of energy production. Reduced electricity demand due to energy conservation standards is also likely to reduce the cost of maintaining the reliability of the electricity system, particularly during peak-load periods. As a measure of this reduced demand, chapter 15 in the final rule TSD presents the estimated reduction in generating capacity, relative to the no-new-standards case, for the TSLs that DOE considered in this rulemaking.

Energy conservation from potential energy conservation standards for residential dishwashers is expected to yield environmental benefits in the form of reduced emissions of air pollutants and GHGs. Table V.19 provides DOE's estimate of cumulative emissions reductions expected to result from the TSLs considered in this rulemaking. The table includes both power sector and site emissions and upstream emissions. The emissions were calculated using the multipliers discussed in section IV.K of this final

rule. DOE reports annual emissions reductions for each TSL in chapter 13 of the final rule TSD.

Table V.19 Cumulative Emissions Reduction for Residential Dishwashers Shipped in 2019–2048

	Trial Standard Level	
	1	2
Power Sector and Site Emissions		
CO_2 (million metric tons)	24.2	25.0
SO_2 (thousand tons)	10.5	10.9
NO_X (thousand tons)	45.3	46.2
Hg (tons)	0.03	0.04
CH_4 (thousand tons)	1.6	1.7
N_2O (thousand tons)	0.2	0.2
Upstream Emissions		
CO_2 (million metric tons)	2.2	2.2
SO_2 (thousand tons)	0.1	0.1
NO_X (thousand tons)	32.4	33.2
Hg (tons)	0.00	0.00
CH_4 (thousand tons)	205.8	210.9
N_2O (thousand tons)	0.0	0.0
Total FFC Emissions		
CO_2 (million metric tons)	26.4	27.2
SO_2 (thousand tons)	10.6	11.0
NO_X (thousand tons)	77.7	79.4
Hg (tons)	0.03	0.04
CH_4 (thousand tons)	207.5	212.6
N_2O (thousand tons)	0.2	0.3

* CO_2eq is the quantity of CO_2 that would have the same GWP.

As part of the analysis for this final rule, DOE estimated monetary benefits likely to result from the reduced emissions of CO_2 that DOE estimated for each of the

considered TSLs for residential dishwashers. As discussed in section IV.L of this document, for CO_2, DOE used the most recent values for the SCC developed by an interagency process. The four sets of SCC values for CO_2 emissions reductions correspond to the average values from a distribution that uses a 5-percent discount rate, the average values from a distribution that uses a 3-percent discount rate, the average values from a distribution that uses a 2.5-percent discount rate, and the 95th-percentile values from a distribution that uses a 3-percent discount rate. For emissions in 2015, the SCC values (expressed in 2015$) are represented by $12.4/t, $40.6/t, $63.2/t, and $118/t, respectively. The values for later years are higher due to increasing damages (public health, economic and environmental) as the projected magnitude of climate change increases.

Table V.20 presents the global value of CO_2 emissions reductions at each TSL. For each of the four cases, DOE calculated a present value of the stream of annual values using the same discount rate as was used in the studies upon which the dollar-per-ton values are based. DOE calculated domestic values as a range from 7 percent to 23 percent of the global values; these results are presented in chapter 14 of the final rule TSD.

Table V.20 Estimates of Global Present Value of CO_2 Emissions Reduction for Residential Dishwashers Shipped in 2019–2048

TSL	SCC Case*			
	5% discount rate, average	3% discount rate, average	2.5% discount rate, average	3% discount rate, 95th percentile
	Million 2015$			
1	183	841	1,337	2,562
2	188	866	1,377	2,639

* For each of the four cases, the corresponding SCC value for emissions in 2015 is $12.4, $40.6, $63.2, and $118 per metric ton (2015$). The values are for CO_2 only (i.e., not CO_{2eq} of other GHGs).

DOE is well aware that scientific and economic knowledge about the contribution of CO_2 and other GHG emissions to changes in the future global climate and the potential resulting damages to the world economy continues to evolve rapidly. Thus, any value placed on reduced CO_2 emissions in this rulemaking is subject to change. DOE, together with other Federal agencies, will continue to review various methodologies for estimating the monetary value of reductions in CO_2 and other GHG emissions. This ongoing review will consider the comments on this subject that are part of the public record for this and other rulemakings, as well as other methodological assumptions and issues. However, consistent with DOE's legal obligations, and taking into account the uncertainty involved with this particular issue, DOE has included in this final rule the most recent values and analyses resulting from the interagency review process.

DOE also estimated the cumulative monetary value of the economic benefits associated with NO_X emissions reductions anticipated to result from the considered TSLs for residential dishwashers. The dollar-per-ton values that DOE used are discussed in section IV.L of this document. Table V.21 presents the cumulative present values for

NO_X emissions reductions for each TSL calculated using 7-percent and 3-percent discount rates. This table presents values that use the low dollar-per-ton values, which reflect DOE's primary estimate. Results that reflect the range of NO_X dollar-per-ton values are presented in Table V.22.

Table V.21 Estimates of Present Value of NO_X Emissions Reduction for Residential Dishwashers Shipped in 2019–2048

TSL	3% discount rate	7% discount rate
	Million 2015$	
1	249	100
2	254	102

7. Other Factors

The Secretary of Energy, in determining whether a standard is economically justified, may consider any other factors that the Secretary deems to be relevant. (42 U.S.C. 6295(o)(2)(B)(i)(VII)) No other factors were considered in this analysis.

8. Summary of National Economic Impacts

The NPV of the monetized benefits associated with emissions reductions can be viewed as a complement to the NPV of the consumer savings calculated for each TSL considered in this rulemaking. Table IV.21 presents the NPV values that result from adding the estimates of the potential economic benefits resulting from reduced CO_2 and NO_X emissions in each of four valuation scenarios to the NPV of consumer savings calculated for each TSL considered in this rulemaking, at both a 7-percent and 3-percent discount rate. The CO_2 values used in the columns of each table correspond to the 2015

values in the four sets of SCC values discussed above. The dollar-per-ton values that DOE used for NO_X emissions are presented in appendix 14C of the final rule TSD.

Table V.22 Net Present Value of Consumer Savings Combined with Present Value of Monetized Benefits from CO_2 and NO_X Emissions Reductions

TSL	Consumer NPV at 3% Discount Rate Added with:			
	SCC Case $12.4/t and 3% Low NO_X Values	SCC Case $40.6/t and 3% Low NO_X Values	SCC Case $63.2/t and 3% Low NO_X Values	SCC Case $118/t and 3% Low NO_X Values
	Billion 2015$			
1	2.5	3.2	3.7	4.9
2	2.6	3.3	3.8	5.1
TSL	Consumer NPV at 7% Discount Rate Added with:			
	SCC Case $12.4/t and 7% Low NO_X Values	SCC Case $40.6/t and 7% Low NO_X Values	SCC Case $63.2/t and 7% Low NO_X Values	SCC Case $118/t and 7% Low NO_X Values
	Billion 2015$			
1	0.6	1.3	1.8	3.0
2	0.7	1.3	1.9	3.1

Note: The SCC case values represent the global SCC in 2015, in 2015$ per metric ton (t), for each case.

The national operating cost savings are domestic U.S. monetary savings that occur as a result of purchasing the covered residential dishwashers. The national operating cost savings is measured for the lifetime of products shipped in 2019–2048. The CO_2 reduction is a benefit that accrues globally due to decreased domestic energy consumption that is expected to result from this rule. Because CO_2 emissions have a very long residence time in the atmosphere, the SCC values in future years reflect future climate-related impacts that continue beyond 2100 through 2300.

C. Conclusion

When considering new or amended energy conservation standards, the standards that DOE adopts for any type (or class) of covered product must be designed to achieve the maximum improvement in energy efficiency that the Secretary determines is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A)) In determining whether a standard is economically justified, the Secretary must determine whether the benefits of the standard exceed its burdens by, to the greatest extent practicable, considering the seven statutory factors discussed previously. (42 U.S.C. 6295(o)(2)(B)(i)) The new or amended standard must also result in significant conservation of energy. (42 U.S.C. 6295(o)(3)(B))

For this final rule, DOE considered the impacts of potential amended standards for residential dishwashers at each TSL, beginning with the maximum technologically feasible level, to determine whether that level was economically justified. To aid the reader as DOE discusses the benefits and/or burdens of each TSL, tables in this section present a summary of the results of DOE's quantitative analysis for each TSL. In addition to the quantitative results presented in the tables, DOE also considers other burdens and benefits that affect economic justification. These include the impacts on identifiable subgroups of consumers who may be disproportionately affected by a national standard and impacts on employment.

DOE also notes that the economics literature provides a wide-ranging discussion of how consumers trade off upfront costs and energy savings in the absence of government intervention. Much of this literature attempts to explain why consumers appear to undervalue energy efficiency improvements. There is evidence that consumers undervalue future energy savings as a result of: (1) a lack of information; (2) a lack of sufficient salience of the long-term or aggregate benefits; (3) a lack of sufficient savings to warrant delaying or altering purchases; (4) excessive focus on the short term, in the form of inconsistent weighting of future energy cost savings relative to available returns on other investments; (5) computational or other difficulties associated with the evaluation of relevant tradeoffs; and (6) a divergence in incentives (for example, between renters and owners, or builders and purchasers). Having less than perfect foresight and a high degree of uncertainty about the future, consumers may trade off these types of investments at a higher than expected rate between current consumption and uncertain future energy cost savings.

In DOE's current regulatory analysis, potential changes in the benefits and costs of a regulation due to changes in consumer purchase decisions are included in two ways. First, if consumers forego the purchase of a product in the standards case, this decreases sales for product manufacturers, and the impact on manufacturers attributed to lost revenue is included in the MIA. Second, DOE accounts for energy savings attributable only to products actually used by consumers in the standards case; if a standard decreases the number of products purchased by consumers, this decreases the potential energy savings from an energy conservation standard. DOE provides estimates of shipments and

changes in the volume of product purchases in chapter 9 of the final rule TSD. However, DOE's current analysis does not explicitly control for heterogeneity in consumer preferences, preferences across subcategories of products or specific features, or consumer price sensitivity variation according to household income.[79]

While DOE is not prepared at present to provide a fuller quantifiable framework for estimating the benefits and costs of changes in consumer purchase decisions due to an energy conservation standard, DOE is committed to developing a framework that can support empirical quantitative tools for improved assessment of the consumer welfare impacts of appliance standards. DOE has posted a paper that discusses the issue of consumer welfare impacts of appliance energy conservation standards, and potential enhancements to the methodology by which these impacts are defined and estimated in the regulatory process.[80] DOE welcomes comments on how to more fully assess the potential impact of energy conservation standards on consumer choice and how to quantify this impact in its regulatory analysis in future rulemakings.

[79] P.C. Reiss and M.W. White. Household Electricity Demand, Revisited. Review of Economic Studies. 2005. 72(3): pp. 853–883. doi: 10.1111/0034-6527.00354.
[80] Sanstad, A. H. Notes on the Economics of Household Energy Consumption and Technology Choice. 2010. Lawrence Berkeley National Laboratory. https://www1.eere.energy.gov/buildings/appliance_standards/pdfs/consumer_ee_theory.pdf.

Table V.23 and Table V.24 summarize the quantitative impacts estimated for each TSL for residential dishwashers. The national impacts are measured over the lifetime of residential dishwashers purchased in the 30-year period that begins in the anticipated year of compliance with potential amended standards (2019–2048). The energy savings, emissions reductions, and value of emissions reductions refer to full-fuel-cycle results. The efficiency levels contained in each TSL are described in section V.A of this final rule.

Table V.23 Summary of Analytical Results for Residential Dishwasher TSLs: National Impacts

Category	TSL 1	TSL 2
Cumulative FFC National Energy Savings (quads)		
	0.49	0.50
NPV of Consumer Costs and Benefits (2015$ billion)		
3% discount rate	2.08	2.21
7% discount rate	0.33	0.37
Cumulative FFC Emissions Reduction (Total FFC Emission)		
CO_2 (million metric tons)	26.4	27.2
SO_2 (thousand tons)	10.6	11.0
NO_X (thousand tons)	77.7	79.4
Hg (tons)	0.03	0.04
CH_4 (thousand tons)	207.5	212.6
N_2O (thousand tons)	0.2	0.3
Value of Emissions Reduction (Total FFC Emissions)		
CO_2 (2015$ million)*	183 to 2,562	188 to 2,639
NO_X – 3% discount rate (2015$ million)	249.0 to 561.3	253.8 to 572.1
NO_X – 7% discount rate (2015$ million)	99.9 to 226.1	101.8 to 230.5

* Range of the economic value of CO_2 reductions is based on estimates of the global benefit of reduced CO_2 emissions.

Table V.24 Summary of Analytical Results for Residential Dishwasher TSLs: Manufacturer and Consumer Impacts

Category	TSL 1	TSL 2
Manufacturer Impacts		
Industry NPV (2015$ million) (No-new-standards case, INPV = 527.7)	327.0 to 464.7	324.4 to 459.3
Industry NPV (% change)	(38.0) to (11.9)	(38.5) to (13.0)
Consumer Average LCC Savings (2015$)		
Standard Dishwasher	0.28	0.28
Compact Dishwasher	17	90
Shipment-Weighted Average*	0.41	1.00
Consumer Simple PBP (years)		
Standard Dishwasher	12.9	12.9
Compact Dishwasher	4.8	3.3
Shipment-Weighted Average*	12.8	12.7
% of Consumers that Experience Net Cost		
Standard Dishwasher	58	58
Compact Dishwasher	8	12
Shipment-Weighted Average*	57.6	57.6

Parentheses indicate negative (-) values.
* Weighted by shares of each product class in total projected shipments in 2019

DOE first considered TSL 2, which represents Efficiency Level 3 for product class 1 and max-tech for product class 2. TSL 2 would save 0.50 quads of energy, an amount DOE considers significant. Under TSL 2, the NPV of consumer benefit would be $0.37 billion using a discount rate of 7 percent, and $2.21 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 2 are 27.2 Mt of CO_2, 11.0 thousand tons of SO_2, 79.4 thousand tons of NO_X, 0.04 tons of Hg, 212.6 thousand tons of CH_4, and 0.26 thousand tons of N_2O. The estimated monetary value of the CO_2 emissions reduction at TSL 2 ranges from $188 million to $2,639 million.

At TSL 2, the average LCC impact is a savings of $0.28 for standard residential dishwashers and $90 for compact residential dishwashers. The simple payback period is 12.9 years for standard residential dishwashers and 3.3 years for compact residential dishwashers. The fraction of consumers experiencing a net LCC cost is 58 percent for standard residential dishwashers and 12 percent for compact residential dishwashers.

At TSL 2, the projected change in INPV ranges from a decrease of $203.3 million to a decrease of $68.3 million, which correspond to decreases of 38.5 percent and 13.0 percent, respectively. Products that meet the efficiency standards specified by this TSL are projected to represent 11 percent of shipments in the year leading up to amended standards. As such, manufacturers would have to redesign nearly all products by the expected 2019 compliance date to meet demand. Redesigning nearly all units to meet the current max-tech efficiency levels would require considerable capital and product conversion expenditures. At TSL 2, the capital conversion costs total as much as $143.2 million, 1.7 times the industry annual capital expenditure in the year leading up to amended standards. DOE estimates that complete platform redesigns would cost the industry $94.8 million in product conversion costs. These conversion costs largely relate to the extensive research programs required to develop new products that meet the efficiency standards set forth by TSL 2. These costs are equivalent to 2.5 times the industry annual budget for R&D. As such, the conversion costs associated with the changes in products and manufacturing facilities required at TSL 2 could require significant use of manufacturers' financial reserves (manufacturer capital pools), impacting other areas of business that compete for these resources and significantly

reducing INPV. In addition, manufacturers could face a substantial impact on profitability at TSL 2. Because manufacturers are more likely to reduce their margins to maintain a price-competitive product at higher TSLs, DOE expects that TSL 2 would yield impacts closer to the high end of the range of INPV impacts. If the high end of the range of impacts is reached, as DOE expects, TSL 2 could result in a net loss to manufacturers of 38.5 percent of INPV. DOE also notes that the significant impacts on the INPV of compact residential dishwasher manufacturers, as discussed in section V.B.2.a of this final rule, would likely result in the elimination of countertop products from the market.

Additionally, at TSL 2, there is uncertainty regarding whether products would be able to maintain consumer utility. The current test method for measuring cleaning performance, the ENERGY STAR Cleaning Performance Test Method, may have variable results. DOE also received conflicting feedback over whether consumer utility would be negatively impacted at TSL 2. For these reasons, DOE cannot be certain that TSL 2 would not negatively impact consumer utility.

The Secretary concludes that at TSL 2 for residential dishwashers, the benefits of energy savings, positive NPV of consumer benefits, emission reductions, and the estimated monetary value of the emissions reductions would be outweighed by the economic burden on some consumers, the potential for negative consumer utility impacts, and the impacts on manufacturers, including the conversion costs and profit margin

impacts that could result in a large reduction in INPV. Consequently, the Secretary has concluded that TSL 2 is not economically justified.

DOE then considered TSL 1, which represents Efficiency Level 3 for product class 1 and Efficiency Level 1 for product class 2. TSL 1 would save an estimated 0.49 quads of energy, an amount DOE considers significant. Under TSL 1, the NPV of consumer benefit would be $0.33 billion using a discount rate of 7 percent, and $2.08 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 1 are 26.4 Mt of CO_2, 10.6 thousand tons of SO_2, 77.7 thousand tons of NO_X, 0.03 tons of Hg, 207.5 thousand tons of CH_4, and 0.25 thousand tons of N_2O. The estimated monetary value of the CO_2 emissions reduction at TSL 1 ranges from $183 million to $2,562 million.

At TSL 1, the average LCC impact is a savings of $0.28 for standard residential dishwashers and $17 for compact residential dishwashers. The simple payback period is 12.9 years for standard residential dishwashers and 4.8 years for compact residential dishwashers. The fraction of consumers experiencing a net LCC cost is 58 percent for standard residential dishwashers and 8 percent for compact residential dishwashers.

At TSL 1, the projected change in INPV ranges from a decrease of $200.7 million to a decrease of $63.0 million, which represent decreases of 38.0 percent and 11.9 percent, respectively. Products that meet the efficiency standards specified by this TSL

are projected to represent approximately 11 percent of shipments in the year leading up to amended standards. As such, manufacturers would have to overhaul a significant fraction of products by the 2019 compliance date to meet demand. At TSL 1, the estimated capital conversion costs total as much as $141.1 million, which is 1.7 times the industry annual capital expenditure in the year leading up to amended standards. DOE estimates that the redesigns necessary to meet these standards would cost the industry $93.7 million in product conversion costs. These conversion costs largely relate to the research programs required to develop products that meet the efficiency standards set forth by TSL 1, and are 2.5 times the industry annual budget for R&D in the year leading up to amended standards. As such, the conversion costs associated with the changes in products and manufacturing facilities required at TSL 1 would still require significant use of manufacturers' financial reserves (manufacturer capital pools), impacting other areas of business that compete for these resources and significantly reducing INPV. Because manufacturers are more likely to reduce their margins to maintain a price-competitive product at higher TSLs, DOE expects that TSL 1 would yield impacts closer to the high end of the range of INPV impacts as indicated by the preservation of operating profit markup scenario. If the high end of the range of impacts is reached, as DOE expects, TSL 1 could result in a net loss of 38.0 percent in INPV to manufacturers of residential dishwashers.

Additionally, at TSL 1, there is uncertainty regarding whether products would be able to maintain consumer utility for the same reasons as discussed for TSL 2. The current test method for measuring cleaning performance, the ENERGY STAR Cleaning

Performance Test Method, may have variable results. DOE also received conflicting feedback over whether consumer utility would be negatively impacted at TSL 1. For these reasons, DOE cannot be certain that TSL 1 would not negatively impact consumer utility.

The Secretary concludes that at TSL 1 for residential dishwashers, the benefits of energy savings, positive NPV of consumer benefits, emission reductions, and the estimated monetary value of the emissions reductions would be outweighed by the economic burden on many consumers, the potential for negative consumer utility impacts, and the impacts on manufacturers, including the conversion costs and profit margin impacts that could result in a large reduction in INPV. Consequently, the Secretary has concluded that TSL 1 is not economically justified.

Therefore, based on the above considerations, DOE concludes that amended energy conservation standards for residential dishwashers would not be economically justified at any level above the current standard level because benefits of more stringent standards would not outweigh the burdens. Therefore, DOE has determined not to amend the residential dishwasher energy conservation standards.

VI. Procedural Issues and Regulatory Review

A. Review Under Executive Orders 12866 and 13563

This rule has been determined to be not significant for purposes of Executive Order (E.O.) 12866, "Regulatatory Planning and Review." 58 FR 51735 (Oct. 4, 1993).

As a result, the Office of Management and Budget did not review this rule.

B. Review Under the Regulatory Flexibility Act

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

For manufacturers of residential dishwashers, the SBA has set a size threshold, which defines those entities classified as "small businesses" for the purposes of the statute. Manufacturers of residential dishwashers have a primary NAICS code of 335228, "Other Major Household Appliance Manufacturing." The SBA sets a threshold of 1,000 employees or less for an entity to be considered as a small business for this NAICS code.

To estimate the number of small businesses which could be impacted by the amended energy conservation standards, DOE conducted a market survey using all

available public information to identify potential small manufacturers. To identify small business manufacturers, DOE surveyed the May 2012 direct final rule for residential dishwasher energy conservation standards, the AHAM membership directory,[81] DOE's Compliance Certification Database,[82] and individual company websites. DOE screened out companies that did not themselves manufacture products covered by this rulemaking, did not meet the definition of a "small business," or are foreign owned and operated.

Approximately half of the total domestic market for residential dishwashers is manufactured in the United States by one corporation. Together, this manufacturer and three other manufacturers do not meet the definition of a small business manufacturer and comprise at least 90 percent of the residential dishwasher market. The small portion of the remaining residential dishwasher market is supplied by a combination of approximately 10 OEMs. All of these companies are either foreign-owned and operated, or exceed the SBA's employment threshold for consideration as a small business under the appropriate NAICS code. Therefore, DOE did not identify any domestic small business manufacturers of residential dishwashers.

DOE reviewed this final rule pursuant to the Regulatory Flexibility Act and the procedures and policies discussed above. DOE finds that amended energy conservation standards for residential dishwashers would not be economically justified. Therefore, the rule does not establish amended energy conservation standards for residential dishwashers. On the basis of the foregoing, DOE certifies that the rule will not have a

[81] https://www.aham.org/AHAM/AuxCurrentMembers
[82] https://www.regulations.doe.gov/certification-data/

significant economic impact on a substantial number of small entities. Accordingly, DOE has not prepared a FRFA for this final rule.

C. Review Under the Paperwork Reduction Act

Manufacturers of residential dishwashers must certify to DOE that their products comply with any applicable energy conservation standards. In certifying compliance, manufacturers must test their products according to the DOE test procedures, including any amendments adopted for those test procedures. DOE has established regulations for the certification and recordkeeping requirements for all covered consumer products and commercial equipment, including residential dishwashers. 76 FR 12422 (Mar. 7, 2011); 80 FR 5099 (Jan. 30, 2015). The collection-of-information requirement for the certification and recordkeeping is subject to review and approval by OMB under the Paperwork Reduction Act (PRA). This requirement has been approved by OMB under OMB control number 1910-1400. Public reporting burden for the certification is estimated to average 30 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

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

This rule, which finds that amended energy conservation standards for residential dishwashers would not be economically justified, imposes no new information or record keeping requirements. Accordingly, the Office of Management and Budget (OMB) clearance is not required under the Paperwork Reduction Act. (44 U.S.C. 3501 et seq.)

D. Review Under the National Environmental Policy Act of 1969

In this final rule, DOE determines that amended energy conservation standards for residential dishwashers would not be economically justified at any level above the current standard level because benefits of more stringent standards would not outweigh the burdens. DOE has determined that review under the National Environmental Policy Act of 1969 (NEPA), Public Law 91-190, codified at 42 U.S.C. 4321 et seq. is not required at this time because amended standards are not being adopted. NEPA review can only be initiated "as soon as environmental impacts can be meaningfully evaluated." Because this rule concludes that amended standards are not warranted, and does not establish such amended standards, DOE has determined that there are no environmental impacts to be evaluated at this time. Accordingly, neither an environmental assessment nor an environmental impact statement is required.

E. Review Under Executive Order 13132

Executive Order 13132, "Federalism," 64 FR 43255 (Aug. 10, 1999), imposes certain requirements on Federal agencies formulating and implementing policies or regulations that preempt State law or that have Federalism implications. The Executive Order requires agencies to examine the constitutional and statutory authority supporting

any action that would limit the policymaking discretion of the States and to carefully assess the necessity for such actions. The Executive Order also requires agencies to have an accountable process to ensure meaningful and timely input by State and local officials in the development of regulatory policies that have Federalism implications. On March 14, 2000, DOE published a statement of policy describing the intergovernmental consultation process it will follow in the development of such regulations. 65 FR 13735. As this final rule does not amended the standards for residential dishwashers, there is no impact on the policymaking discretion of the States. Therefore, no action is required by Executive Order 13132.

F. Review Under Executive Order 12988

With respect to the review of existing regulations and the promulgation of new regulations, section 3(a) of Executive Order 12988, "Civil Justice Reform," imposes on Federal agencies the general duty to adhere to the following requirements: (1) eliminate drafting errors and ambiguity, (2) write regulations to minimize litigation, (3) provide a clear legal standard for affected conduct rather than a general standard, and (4) promote simplification and burden reduction. 61 FR 4729 (Feb. 7, 1996). Regarding the review required by section 3(a), section 3(b) of Executive Order 12988 specifically requires that Executive agencies make every reasonable effort to ensure that the regulation (1) clearly specifies the preemptive effect, if any, (2) clearly specifies any effect on existing Federal law or regulation, (3) provides a clear legal standard for affected conduct while promoting simplification and burden reduction, (4) specifies the retroactive effect, if any, (5) adequately defines key terms, and (6) addresses other important issues affecting

clarity and general draftsmanship under any guidelines issued by the Attorney General. Section 3(c) of Executive Order 12988 requires Executive agencies to review regulations in light of applicable standards in section 3(a) and section 3(b) to determine whether they are met or it is unreasonable to meet one or more of them. DOE has completed the required review and determined that, to the extent permitted by law, this final rule meets the relevant standards of Executive Order 12988.

G. Review Under the Unfunded Mandates Reform Act of 1995

Title II of the Unfunded Mandates Reform Act of 1995 (UMRA) requires each Federal agency to assess the effects of Federal regulatory actions on State, local, and Tribal governments and the private sector. Public Law 104-4, sec. 201 (codified at 2 U.S.C. 1531). For a regulatory action likely to result in a rule that may cause the expenditure by State, local, and Tribal governments, in the aggregate, or by the private sector of $100 million or more in any one year (adjusted annually for inflation), section 202 of UMRA requires a Federal agency to publish a written statement that estimates the resulting costs, benefits, and other effects on the national economy. (2 U.S.C. 1532(a), (b)) The UMRA also requires a Federal agency to develop an effective process to permit timely input by elected officers of State, local, and Tribal governments on a "significant intergovernmental mandate," and requires an agency plan for giving notice and opportunity for timely input to potentially affected small governments before establishing any requirements that might significantly or uniquely affect them. On March 18, 1997, DOE published a statement of policy on its process for intergovernmental consultation under UMRA. 62 FR 12820. DOE's policy statement is also available at

http://energy.gov/sites/prod/files/gcprod/documents/umra_97.pdf. This final rule does not contain a Federal intergovernmental mandate, nor is it expected to require expenditures of $100 million or more in any one year by the private sector. As a result, the analytical requirements of UMRA do not apply.

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

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

I. Review Under Executive Order 12630

Pursuant to Executive Order 12630, "Governmental Actions and Interference with Constitutionally Protected Property Rights," 53 FR 8859 (March 15, 1988), DOE has determined that this final rule would not result in any takings that might require compensation under the Fifth Amendment to the U.S. Constitution.

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

Section 515 of the Treasury and General Government Appropriations Act, 2001 (44 U.S.C. 3516, note) provides for Federal agencies to review most disseminations of information to the public under information quality guidelines established by each agency

pursuant to general guidelines issued by OMB. OMB's guidelines were published at 67 FR 8452 (Feb. 22, 2002), and DOE's guidelines were published at 67 FR 62446 (Oct. 7, 2002). DOE has reviewed this final rule under the OMB and DOE guidelines and has concluded that it is consistent with applicable policies in those guidelines.

K. Review Under Executive Order 13211

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

Because this final rule does not amend standards for residential dishwashers, it is not a significant energy action, nor has it been designated as such by the Administrator at OIRA. Accordingly, DOE has not prepared a Statement of Energy Effects.

L. Review Under the Information Quality Bulletin for Peer Review

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

In response to OMB's Bulletin, DOE conducted formal in-progress peer reviews of the energy conservation standards development process and analyses and has prepared a Peer Review Report pertaining to the energy conservation standards rulemaking analyses. Generation of this report involved a rigorous, formal, and documented evaluation using objective criteria and qualified and independent reviewers to make a judgment as to the technical/scientific/business merit, the actual or anticipated results, and the productivity and management effectiveness of programs and/or projects. The "Energy Conservation Standards Rulemaking Peer Review Report" dated February 2007 has been disseminated and is available at the following website: www.energy.gov/eere/buildings/peer-review.

M. Congressional Notification

As required by 5 U.S.C. 801, DOE will report to Congress on the promultagion of this rule prior to its effective date. The report will state that it has been determined that the rule is a not a "major rule" as defined by 5 U.S.C. 804(2).

VII. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of this final rule.

List of Subjects

10 CFR Part 429

Confidential business information, Energy conservation, Household appliances, Imports, Incorporation by reference, Reporting and recordkeeping requirements.

10 CFR Part 430

Administrative practice and procedure, Confidential business information, Energy conservation, Household appliances, Imports, Incorporation by reference, Intergovernmental relations, Reporting and recordkeeping requirements, and Small businesses.

Issued in Washington, DC, on November 22, 2016.

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David J. Friedman
Acting Assistant Secretary
Energy Efficiency and Renewable Energy

For the reasons set forth in the preamble, DOE amends parts 429 and 430 of chapter II of title 10 of the Code of Federal Regulations, as set forth below:

PART 429 – CERTIFICATION, COMPLIANCE, AND ENFORCEMENT FOR CONSUMER PRODUCTS AND COMMERCIAL AND INDUSTRIAL EQUIPMENT

1. The authority citation for part 429 continues to read as follows:

Authority: 42 U.S.C. 6291–6317; 28 U.S.C. 2461 note.

§429.4 [Amended]

2. Section 429.4 is amended by removing paragraph (b)(1) and redesignating paragraphs (b)(2) and (3) as (b)(1) and (2), respectively.

3. Section 429.19 is amended by revising paragraph (b)(3) to read as follows:

§ 429.19 Dishwashers.

* * * * *

(b) * * *

(3) Pursuant to §429.12(b)(13), a certification report shall include the following additional product-specific information the capacity in number of place settings as specified in ANSI/AHAM DW-1-2010 (incorporated by reference, see §429.4), presence of a soil sensor (if yes, the number of cycles required to reach calibration), the water inlet temperature used for testing in degrees Fahrenheit (°F), the cycle selected for energy

testing and whether that cycle is soil-sensing, the options selected for the energy test, and presence of a built-in water softening system (if yes, the energy use in kilowatt-hours and the water use in gallons required for each regeneration of the water softening system, the number of regeneration cycles per year, and data and calculations used to derive these values).

PART 430 - ENERGY CONSERVATION PROGRAM FOR CONSUMER PRODUCTS

4. The authority citation for part 430 continues to read as follows:

Authority: 42 U.S.C. 6291–6309; 28 U.S.C. 2461 note.

§ 430.3 [Amended]

5. Section 430.3 is amended by removing paragraph (i)(2) and redesignating paragraphs (i)(3) through (9) as (i)(2) through (8), respectively.

6. Section 430.23 is amended by revising paragraph (c) to read as follows:

§430.23 Test procedures for the measurement of energy and water consumption.

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(c) Dishwashers. (1) The Estimated Annual Operating Cost (EAOC) for dishwashers must be rounded to the nearest dollar per year and is defined as follows:

(i) When cold water (50 °F) is used,

(A) For dishwashers having a truncated normal cycle as defined in section 1.22 of appendix C1 to this subpart, EAOC = $(D_e \times E_{TLP}) + (D_e \times N \times (M + M_{WS} + E_F - (E_D/2)))$.

(B) For dishwashers not having a truncated normal cycle, EAOC = $(D_e \times E_{TLP}) + (D_e \times N \times (M + M_{WS} + E_F))$.

Where,

D_e = the representative average unit cost of electrical energy, in dollars per kilowatt-hour, as provided by the Secretary,

E_{TLP} = the annual combined low-power mode energy consumption in kilowatt-hours per year and determined according to section 5.7 of appendix C1 to this subpart,

N = the representative average dishwasher use of 215 cycles per year,

M = the machine energy consumption per cycle for the normal cycle, as defined in section 1.12 of appendix C1 to this subpart, in kilowatt-hours and determined according to section 5.1.1 of appendix C1 to this subpart for non-soil-sensing dishwashers and section 5.1.2 of appendix C1 to this subpart for soil-sensing dishwashers,

M_{WS} = the machine energy consumption per cycle for water softener regeneration, in kilowatt-hours and determined according to section 5.1.3 of appendix C1 to this subpart,

E_F = the fan-only mode energy consumption per cycle, in kilowatt-hours and determined according to section 5.2 of appendix C1 to this subpart, and

E_D = the drying energy consumption, in kilowatt-hours and defined as energy consumed using the power-dry feature after the termination of the last rinse option of the normal cycle; determined according to section 5.3 of appendix C1 to this subpart,

(ii) When electrically-heated water (120 °F or 140 °F) is used,

(A) For dishwashers having a truncated normal cycle as defined in section 1.22 of appendix C1 to this subpart, $EAOC = (D_e \times E_{TLP}) + (D_e \times N \times (M + M_{WS} + E_F - (E_D/2))) + (D_e \times N \times (W + W_{WS}))$.

(B) For dishwashers not having a truncated normal cycle, $EAOC = (D_e \times E_{TLP}) + (D_e \times N \times (M + M_{WS} + E_F)) + (D_e \times N \times (W + W_{WS}))$.

Where,

D_e, E_{TLP}, N, M, M_{WS}, E_F, and E_D, are defined in paragraph (c)(1)(i) of this section,

W = the water energy consumption per cycle for the normal cycle, as defined in section 1.12 of appendix C1 to this subpart, in kilowatt-hours and determined according to section 5.5.1.1 of appendix C1 to this subpart for dishwashers that operate with a nominal 140 °F inlet water temperature and section 5.5.2.1 of appendix C1 to this subpart for dishwashers that operate with a nominal inlet water temperature of 120 °F, and

W_{WS} = the water softener regeneration water energy consumption per cycle in kilowatt-hours and determined according to section 5.5.1.2 of appendix C1 to this subpart for dishwashers that operate with a nominal 140 °F inlet water temperature and section 5.5.2.2 of appendix C1 to this subpart for dishwashers that operate with a nominal inlet water temperature of 120 °F.

(iii) When gas-heated or oil-heated water is used,

(A) For dishwashers having a truncated normal cycle as defined in section 1.22 of appendix C1 to this subpart, $EAOC_g = (D_e \times E_{TLP}) + (D_e \times N \times (M + M_{WS} + E_F - (E_D/2))) + (D_g \times N \times (W_g + W_{WSg}))$.

(B) For dishwashers not having a truncated normal cycle, $EAOC_g = (D_e \times E_{TLP}) + (D_e \times N \times (M + M_{WS} + E_F)) + (D_g \times N \times (W_g + W_{WSg}))$.

Where,

D_e, E_{TLP}, N, M, M_{WS}, E_F, and E_D are defined in paragraph (c)(1)(i) of this section,

D_g = the representative average unit cost of gas or oil, as appropriate, in dollars per Btu, as provided by the Secretary,

W_g = the water energy consumption per cycle for the normal cycle, as defined in section 1.12 of appendix C1 to this subpart, in Btus and determined according to section 5.6.1.1 of appendix C1 to this subpart for dishwashers that operate with a nominal 140 °F inlet water temperature and section 5.6.2.1 of appendix C1 to this subpart for dishwashers that operate with a nominal inlet water temperature of 120 °F, and

W_{WSg} = the water softener regeneration energy consumption per cycle in Btu per cycle and determined according to section 5.6.1.2 of appendix C1 to this subpart for dishwashers that operate with a nominal 140 °F inlet water temperature and section 5.6.2.2 of appendix C1 to this subpart for dishwashers that operate with a nominal inlet water temperature of 120 °F.

(2) The estimated annual energy use, EAEU, expressed in kilowatt-hours per year must be rounded to the nearest kilowatt-hour per year and is defined as follows:

(i) For dishwashers having a truncated normal cycle as defined in section 1.22 of appendix C1 to this subpart:

$EAEU = (M + M_{WS} + E_F – (E_D/2) + W + W_{WS}) \times N + (E_{TLP})$

Where,

M, M_{WS}, E_D, N, E_F, and E_{TLP} are defined in paragraph (c)(1)(i) of this section, and W and W_{WS} are defined in paragraph (c)(1)(ii) of this section.

(ii) For dishwashers not having a truncated normal cycle:

$$EAEU = (M + M_{WS} + E_F + W + W_{WS}) \times N + E_{TLP}$$

Where,

M, M_{WS}, N, E_F, and E_{TLP} are defined in paragraph (c)(1)(i) of this section, and W and W_{WS} are defined in paragraph (c)(1)(ii) of this section.

(3) The sum of the water consumption, V, and the water consumption during water softener regeneration, V_{WS}, expressed in gallons per cycle and defined in section 5.4 of appendix C1 to this subpart, must be rounded to one decimal place.

(4) Other useful measures of energy consumption for dishwashers are those which the Secretary determines are likely to assist consumers in making purchasing decisions and which are derived from the application of appendix C1 to this subpart.

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Appendix C to Subpart B of Part 430—[Removed]

7. Appendix C to subpart B of part 430 is removed.

8. Appendix C1 is amended by revising the introductory note to read as follows:

Appendix C1 to Subpart B of Part 430—Uniform Test Method for Measuring the Energy Consumption of Dishwashers

Note: Manufacturers must test all dishwashers using the provisions of Appendix C1 to certify compliance with energy conservation standards and to make any other representations related to energy and/or water consumption.

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§430.32 [Amended]

9. Section 430.32 is amended by:

a. Removing paragraph (f)(1) introductory text;

b. Removing and reserving paragraph (f)(2); and

c. Redesignating paragraph (f)(3) as (f)(1).

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