DEPARTMENT OF ENERGY

Office of Energy Efficiency and Renewable Energy

10 CFR Parts 430 and 431

[Docket No. EE–2006–STD–0127]

RIN 1904–AB49

Energy Conservation Program: Energy Conservation Standards for Certain Consumer Products (Dishwashers, Dehumidifiers, Electric and Gas Kitchen Ranges and Ovens, and Microwave Ovens) and for Certain Commercial and Industrial Equipment (Commercial Clothes Washers)

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

ACTION: Advance notice of proposed rulemaking and notice of public meeting.

SUMMARY: The Energy Policy and Conservation Act (EPCA or the Act) authorizes the Department of Energy (DOE) to establish energy conservation standards for various consumer products and commercial and industrial equipment—including residential dishwashers, dehumidifiers, and electric and gas kitchen ranges and ovens and microwave ovens (hereafter referred to as ''cooking products''), as well as commercial clothes washers—if DOE determines that energy conservation standards would be technologically feasible and economically justified, and would result in significant energy savings. DOE is publishing this advance notice of proposed rulemaking (ANOPR) to consider establishing energy conservation standards for these products and to announce a public meeting to receive comments on a variety of issues.

DATES: DOE will hold a public meeting on December 13, 2007, starting at 9 a.m. in Washington, DC. DOE must receive requests to speak at the public meeting no later than 4 p.m., November 29, 2007. DOE must receive a signed original and an electronic copy of statements to be given at the public meeting no later than 4 p.m., December 6, 2007.

DOE will accept comments, data, and information regarding the ANOPR before or after the public meeting, but no later than January 29, 2008. See section IV, ''Public Participation,'' of this ANOPR for details.

ADDRESSES: The public meeting will be held at the Holiday Inn Capital, 550 C Street, SW., DC 20024.

Any comments submitted must identify the ANOPR for Home Appliance Products, and provide the docket number EE–2006–STD–0127 and/or Regulatory Information Number (RIN) 1904–AB49. Comments may be submitted using any of the following methods:

- *Federal eRulemaking Portal: http://www.regulations.gov.* Follow the instructions for submitting comments.
- *E-mail: home_appliance.rulemaking@ee.doe.gov.* Include the docket number EE–2006–STD–0127 and/or RIN 1904–AB49 in the subject line of the message.
- *Mail:* Ms. Brenda Edwards-Jones, U.S. Department of Energy, Building Technologies Program, Mailstop EE–2J, 1000 Independence Avenue, SW., Washington, DC 20585–0121. Please submit one signed paper original.
- *Hand Delivery/Courier:* Ms. Brenda Edwards-Jones, U.S. Department of Energy, Building Technologies Program, Room 1J–018, 1000 Independence Avenue, SW., Washington, DC 20585. Telephone: (202) 586–2945. Please submit one signed paper original.

For detailed instructions on submitting comments and additional information on the rulemaking process, see section IV of this document (Public Participation).

Docket: For access to the docket to read background documents or comments received, visit the U.S. Department of Energy, Forrestal Building, Room 1J–018 (Resource Room of the Building Technologies Program), 1000 Independence Avenue, SW., Washington, DC, (202) 586–2945, between 9 a.m. and 4 p.m., Monday through Friday, except Federal holidays. Please call Ms. Brenda Edwards-Jones at the above telephone number for additional information regarding visiting the Resource Room. Please note: DOE's Freedom of Information Reading Room (Room 1E–190 at the Forrestal Building) no longer houses rulemaking materials.

FOR FURTHER INFORMATION CONTACT:
Stephen Witkowski, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies, EE–2J, 1000 Independence Avenue, SW., Washington, DC 20585–0121, (202) 586–7463. E-mail: *stephen.witkowski@ee.doe.gov.*

Francine Pinto or Eric Stas, U.S. Department of Energy, Office of the General Counsel, Forrestal Building, Mail Station GC–72, 1000 Independence Avenue, SW., Washington, DC, 20585. Telephone: (202) 586–9507. E-mail: *Francine.Pinto@hq.doe.gov* or *Eric.Stas@hq.doe.gov.*

Regarding the public meeting, Brenda Edwards-Jones, U.S. Department of Energy, Building Technologies Program, Room 1J–018, 1000 Independence Avenue, SW., Washington, DC 20585. Telephone: (202) 586–2945. E-mail: *Brenda.Edwards-Jones@ee.doe.gov.*

SUPPLEMENTARY INFORMATION:

I. Introduction

A. Purpose of the Advance Notice of Proposed Rulemaking

The purpose of this ANOPR is to provide interested persons with an opportunity to comment on:

1. The product classes that the Department of Energy (DOE) is planning to analyze in this rulemaking;
2. The analytical framework, models, and tools (*e.g.*, life-cycle cost (LCC) and national energy savings (NES) spreadsheets) DOE is using in performing analyses of the impacts of energy conservation standards for residential dishwashers, dehumidifiers, cooking products, and commercial clothes washers (CCWs) (collectively referred to in this ANOPR as ''the four appliance products'');
3. The analyses performed for the ANOPR, including in particular the results of the engineering analyses, the LCC and payback period (PBP) analyses, and the NES and national impact analyses, which are presented in the *ANOPR Technical Support Document (TSD): Energy Efficiency Standards for Consumer Products and Commercial and Industrial Equipment: Residential Dishwashers, Dehumidifiers, And Cooking Products And Commercial Clothes Washers*,[1] as summarized in this ANOPR (2007 TSD); and
4. The candidate energy conservation standard levels that DOE has developed from these analyses.

B. Overview of the Analyses Performed

The Energy Policy and Conservation Act (42 U.S.C. 6291 *et seq.*) directs DOE to consider establishing or amending energy conservation standards for various consumer products and commercial and industrial equipment, including the four appliance products which are the subject of this ANOPR. For each of these products, DOE conducted in-depth technical analyses for this ANOPR in the following areas: (1) Engineering, (2) energy and water use characterization, (3) markups to determine equipment price, (4) LCC and PBP, (5) shipments, (6) national impacts, and (7) preliminary manufacturer impacts. The ANOPR presents a discussion of the methodologies and assumptions utilized in these analyses. For each type of analysis, Table I.1 identifies the sections in this document that contain the results of the analysis, and summarizes the methodologies, key inputs, and assumptions for the analysis. DOE consulted with interested parties in developing these analyses, and invites further input from stakeholders on these topics. Obtaining that input is the purpose of this ANOPR. Thus, it should be noted that the analytical results presented here are subject to revision following review and input from stakeholders and other interested parties. The final rule will contain the final analytical results.

[1] To be published on the DOE Web site at: *http://www.eere.energy.gov/buildings/appliance_standards/residential/cooking_products.html*

TABLE I.1.—IN-DEPTH TECHNICAL ANALYSES CONDUCTED FOR THE ADVANCE NOTICE OF PROPOSED RULEMAKING

Analysis area	Methodology	Key inputs	Key assumptions	ANOPR section for results
Engineering (TSD Chapter 5):				
Dishwashers Dehumidifiers	Efficiency level approach supplemented with design option analysis.	Component cost data; Performance values.	Analysis can be extended in subsequent analyses to product classes and efficiency levels for which the Association of Home Appliance Manufacturers (AHAM) did not provide data.	Section II.C.3.
Cooking Products	....	....	Historical data from DOE's 1996 analysis on residential cooking products are still representative of current manufacturing costs.	
Commercial Clothes Washers.	....	....	Analysis can be extended to energy and water efficiency levels for which AHAM did not provide data.	
Energy and Water Use Characterization (TSD Chapter 6):				
Dishwashers	Establish per-cycle energy and water use and then multiply by annual cycles.	Per-cycle energy and water use; Average annual usage of 215 cycles based on DOE test procedure; Variability of usage based on Energy Information Administration (EIA)'s Residential Energy Consumption Survey (RECS).	Per-cycle water use is a direct function of per-cycle energy use (based on AHAM data).	Section II.D.1.
Dehumidifiers	Establish daily energy use by dividing product capacity by efficiency and then multiply by annual hourly usage.	Per-cycle energy and water use; Average annual usage of 1095 hours based on AHAM estimates; Variability of usage based on multiple sources.	Average usage of 1095 hours is representative of dehumidifier use.	Section II.D.2.
Cooking Products	Use recent survey data to estimate annual energy use.	Recent survey data from California and Florida—indicates a drop in annual energy use of ~40% for electric and gas ranges and ~15% for microwave ovens relative to DOE test procedure estimates; Variability of usage based on EIA's RECS.	Recent survey data are indicative of current household cooking habits; Historical data from DOE's 1996 analysis on residential cooking products are still representative of component energy use (*e.g.*, self-cleaning, clock, ignition).	Section II.D.3.
Commercial Clothes Washers.	Establish per-cycle energy and water use and then multiply by annual cycles.	Per-cycle energy and water use; Average daily usage of 3.4 cycles for multi-family and 6 cycles for laundromats; Variability of usage based on multiple sources.	Per-cycle energy use data in DOE's 2000 TSD on residential clothes washers is representative of per-cycle drying and per-cycle machine energy for commercial washers.	Section II.D.4.
Markups to Determine Equipment Price (TSD Chapter 7):				
Dishwashers Dehumidifiers Cooking Products Commercial Clothes Washers.	Assess financial data from: (1) U.S. Securities and Exchange Commission (SEC) reports on appliance manufacturers to develop manufacturer markups and (2) the U.S. Census Business Expenditure Survey to develop retailer and commercial distributor markups. Use markups to transform manufacturer costs into consumer prices.	Distribution channels; SEC reports on appliance manufacturers; U.S. Census Business Expenditure Survey; State sales taxes; Shipments to different States.	Markups for baseline and more-efficient equipment are different.	Section II.E.

TABLE I.1.—IN-DEPTH TECHNICAL ANALYSES CONDUCTED FOR THE ADVANCE NOTICE OF PROPOSED RULEMAKING—Continued

Analysis area	Methodology	Key inputs	Key assumptions	ANOPR section for results
LCC and PBP (TSD Chapter 8):				
Dishwashers	Use Monte Carlo simulation in combination with inputs that are characterized with probability distributions to establish a distribution of consumer economic impacts (*i.e.*, LCC savings and PBPs) that identify the percent of.	Manufacturer costs; Markups (including sales taxes); Installation costs; Annual energy (and water) consumption; Energy (and water) prices and future trends; Maintenance and repair costs; Product lifetime; Discount rates.	Only 3% of consumers purchase dishwashers at existing minimum standards (based on AHAM data); Standards do not impact repair and maintenance costs; *AEO2007* basis for energy price forecasts; Average product lifetime is 12.3 years; Average discount rate is 5.6%.	II.G.4
Dehumidifiers	....	....	Approximately 30% of consumers purchase dehumidifiers at existing minimum standards (based on AHAM data); Standards do not impact repair and maintenance costs; *Annual Energy Outlook (AEO) 2007* basis for energy price forecasts; Average product lifetime is 11 years; Average discount rate is 5.6%.	
Cooking Products	....	....	For gas ranges, only 18 percent of consumers purchase equipment with standing pilots; For electric cooking products and microwave ovens, 100 percent of consumer purchase equipment at baseline levels; Average product lifetime is 19 years for electric and gas ranges and 9 years for microwave ovens; Standards do not impact repair and maintenance costs; *AEO2007* basis for energy price forecasts; Average discount rate is 5.6%.	
Commercial Clothes Washers.	....	....	Approximately 80 percent of consumers purchase equipment at existing minimum standards (based on AHAM data); Standards do not impact repair and maintenance costs; *AEO2007* basis for energy price forecasts; Average product lifetime is 7.1 or 11.3 years depending on product application; Discount rate can be estimated by company-weighted average cost of capital.	
Shipments (TSD Chapter 9):				

TABLE I.1.—IN-DEPTH TECHNICAL ANALYSES CONDUCTED FOR THE ADVANCE NOTICE OF PROPOSED RULEMAKING—Continued

Analysis area	Methodology	Key inputs	Key assumptions	ANOPR section for results
Dishwashers Dehumidifiers Cooking Products Commercial Clothes Washers.	Forecast shipments through the use of a product stock accounting model by dividing market into segments—*e.g.*, new construction, replacements, and early replacements, or first-time owners; Use increases in purchase price and savings in operating costs to forecast the impact of standards on shipments.	Historical shipments (for calibration purposes); Historical product saturations; New construction forecasts; Survival functions (based on product lifetimes); Sensitivity to 'relative price,' *i.e.*, sensitivity to the combined effect of purchase price increases, operating cost savings, and household income.	Market segments are: new construction, replacements, and first-time owners (existing households without the product); Sensitivity to 'relative price' is low. Market segments are: replacements and first-time owners; Sensitivity to 'relative price' is low. Market segments are: new construction, replacements, and early replacements; Sensitivity to 'relative price' is low. Market segments are: new construction and replacements; New construction shipments driven by multifamily housing market only; Sensitivity to 'relative price' is low.	II.H.3.
National Impacts (TSD Chapter 10):				
Dishwashers Dehumidifiers Cooking Products Commercial Clothes Washers.	Forecast national annual energy (and water) use, national annual equipment costs, and national annual operating cost savings.	Annual forecasted shipments; Forecasted base case and standards case efficiencies; Per-unit annual energy (and water) consumption, Per-unit total installed costs; Per-unit operating costs; Site-to-source conversion factors for electricity and natural gas; Discount rates; Effective date of standard; and Present year.	Annual shipments from shipments model; Forecasted base case and standards case efficiencies remain frozen at levels in the year 2012; National Energy Modeling System (NEMS) basis for site-to-source conversion factors; Discount rates are 3 percent and 7 percent real based on Office of Management and Budget (OMB) guidelines; Future costs discounted to present year: 2007.	Section II.I.4.

1. Engineering Analysis

The engineering analysis establishes the relationship between the cost and efficiency of a product DOE is evaluating for standards. This relationship serves as the basis for cost and benefit calculations for individual consumers, manufacturers, and the Nation. The engineering analysis identifies representative baseline equipment, which is the starting point for analyzing technologies that provide energy efficiency improvements. Baseline equipment here refers to a model or models having features and technologies typically found in equipment currently offered for sale. The baseline model in each product class represents the characteristics of products in that class, and, for products already subject to energy conservation standards, usually is a model that just meets the current standard. After identifying the baseline models, DOE estimates their manufacturing cost, after which, DOE estimates the incremental manufacturing costs for producing more efficient equipment.

For dishwashers, dehumidifiers, and CCWs, the engineering analysis uses industry-supplied cost-efficiency data, which are based on an efficiency-level approach (which calculates the relative costs of achieving increases in energy efficiency levels), and cost-efficiency curves that DOE derived based on a design-option approach (which calculates the incremental costs of adding specific design options to a baseline model). For kitchen ranges and ovens (including microwave ovens), DOE established cost-efficiency curves using its 1996 *Technical Support Document for Residential Cooking Products,*[2] updated to the present time in the 2007 TSD for this rulemaking, as discussed below. Some stakeholders provided comments to DOE that the design options and associated efficiency increments were still valid for cooking products other than microwave ovens. For microwave ovens, DOE analyzed current efficiency data to validate the efficiency increments specified in the 1996 technical analysis, after which it was determined that no changes to those increments were necessary. To determine manufacturing cost increments, DOE, with the concurrence of manufacturers, used producer price index (PPI) data from the Bureau of Labor Statistics (BLS) to scale costs identified in the 1996 analysis to 2006$. Section II.C on the engineering analysis discusses this cost-efficiency relationship, as well as the product

[2] Available online at DOE's website: *http://www.eere.energy.gov/buildings/appliance_standards/residential/cooking_products_0998_r.html.*

classes analyzed, the representative baseline units, and the methodology to be used to extend the analysis to product classes for which DOE did not receive data

2. Energy and Water Use Characterization

The energy use and water characterization provides estimates of annual energy and water consumption for the four appliance products, which DOE uses in the subsequent LCC and PBP analyses and the national impact analysis (NIA). DOE developed energy consumption estimates for all of the product classes analyzed in the engineering analysis, as the basis for its energy and water use estimates. In the case of dishwashers, DOE used the annual usage (in cycles per year) established in its test procedure to estimate the product's annual energy and water use. For dehumidifiers, DOE relied on industry-supplied estimates of annual usage (in hours per year) to estimate the product's annual energy use. For kitchen ranges and ovens, the 2004 California Residential Appliance Saturation Study (CA RASS) [3] and a year-long monitoring study conducted in 1999 by the Florida Solar Energy Center (FSEC) [4] indicate that household cooking has continued to drop since the mid-1990s; DOE used these surveys as the basis for estimating product annual energy use. For CCWs, DOE used industry-sponsored research to estimate the product's annual energy and water use. For further details on the CCW estimates, see section II.D.4 of this ANOPR.

3. Markups to Determine Equipment Price

DOE derives consumer prices for products based on manufacturer markups, retailer markups (for residential products), distributor markups (for CCWs), and sales taxes. In deriving these markups, DOE has determined: (1) The distribution channels for product sales; (2) the markup associated with each party in the distribution channels, and (3) the existence and magnitude of differences between markups for baseline equipment (''baseline markups'') and for more-efficient equipment (''incremental markups''). DOE calculates both overall baseline and overall incremental markups based on the product markups at each step in the distribution channel. It defines the overall baseline markup as the ratio of consumer price (not including sales tax) and manufacturer cost for baseline equipment; the overall incremental markup relates the change in the manufacturer sales price of higher-efficiency models (the incremental cost increase) to the change in the retailer or distributor sales price. DOE determined manufacturer markups through the use of U.S. Securities and Exchange Commission (SEC) reports on appliance manufacturers, and used U.S. Census Business Expenditure Surveys to develop retailer and commercial distributor markups. DOE collected consumer retail prices for each of the four appliance products to provide a rough validation of its markups for baseline equipment. Baseline equipment is produced in large volumes, is not heavily laden with consumer features, and is typically competitively priced by retailers and distributors; therefore, collected retail prices of baseline equipment are likely to reflect the actual cost of producing and selling minimally-compliant products.

Because DOE's approach for calculating baseline retail prices through the use of manufacturing costs, baseline markups, and sales taxes are intended to capture only the cost of producing minimally-compliant equipment, any collected baseline retail prices serve as a good check on the prices calculated through the markup approach. But because more-efficient equipment often includes non-energy related features, DOE cannot rely solely on collected retail prices for high-efficiency products to validate the prices determined through its markup approach. Current retail prices for high-efficiency equipment likely reflect the added cost of consumer amenities that have no impact on efficiency and, therefore, mask the incremental price associated with features that only affect product efficiency.

4. Life-Cycle Cost and Payback Period Analyses

The LCC and PBP analyses determine the economic impact of potential standards on individual consumers. The LCC is the total consumer expense for a product over the life of the product. The LCC analysis compares the LCCs of products designed to meet possible energy-efficiency standards with the LCCs of the products likely to be installed in the absence of standards. DOE determines LCCs by considering: (1) Total installed cost to the purchaser (which consists of manufacturer costs, sales taxes, distribution chain markups, and installation cost); (2) the operating expenses of the product (determined by energy and water use, energy and water prices, and repair and maintenance costs); (3) product lifetime; and (4) a discount rate that reflects the real consumer cost of capital and puts the LCC in present value terms.

The PBP represents the number of years needed to recover the increase in purchase price (including the incremental installation cost) of more-efficient equipment through savings in the operating cost of the product. It is the change in total installed cost due to increased efficiency divided by the change in annual operating cost from increased efficiency.

5. National Impact Analysis

The NIA estimates both the national energy savings (NES) and the net present value (NPV) of total customer costs and savings expected to result from new standards at specific efficiency levels (referred to as candidate standard levels). In conducting the NIA, DOE calculated NES and NPV for any given candidate standard level for each of the four appliance products as the difference between a base case forecast (without new standards) and the standards case forecast (with standards). DOE determined national annual energy consumption by multiplying the number of units in use (by vintage [5]) by the average unit energy (and water) consumption (also by vintage). Cumulative energy savings are the sum of the annual NES determined over a specified time period, which in the NIA consisted of the range of years for which the forecast was made. The national NPV is the sum over time of the discounted net savings each year, which consists of the difference between total operating cost savings and increases in total installed costs. Critical inputs to this analysis include shipments projections, retirement rates (based on estimated product or equipment lifetimes), and estimates of changes in shipments and retirement rates in response to changes in product or equipment costs due to standards.

[3] California Energy Commission. *California Statewide Residential Appliance Saturation Study,* June 2004. Prepared for the California Energy Commission by KEMA–XENERY, Itron, and RoperASW. Contract No. 400–04–009. *http://www.energy.ca.gov/appliances/rass/index.html.*

[4] Parker, D. S. *Research Highlights from a Large Scale Residential Monitoring Study in a Hot Climate. Proceeding of International Symposium on Highly Efficient Use of Energy and Reduction of its Environmental Impact,* January 2002. Japan Society for the Promotion of Science Research for the Future Program, Osaka, Japan. JPS–RFTF97P01002: pp. 108–116. Also published as FSEC–PF369–02, Florida Solar Energy Center, Cocoa, FL. *http://www.fsec.ucf.edu/en/publications/html/FSEC-PF–369–02/index.htm.*

[5] The term ''vintage'' refers to the age of the unit in years.

C. Authority

Part B of Title III of EPCA established the energy conservation program for consumer products other than automobiles, including dishwashers and electric and gas kitchen ranges and ovens (which include microwave ovens). (This ANOPR refers to electric and gas kitchen ranges and ovens and microwave ovens collectively as ''cooking products.'') Amendments to EPCA in the National Appliance Energy Conservation Act of 1987 (Pub. L. 100–12; NAECA) established energy conservation standards for dishwashers and cooking products, as well as requirements for determining whether these standards should be amended. (See 42 U.S.C. 6295(g) and (h), respectively) Subsequent amendments expanded Title III of EPCA to include additional consumer products and certain commercial and industrial equipment, including dehumidifiers and CCWs. In particular, sections 135(c)(4) and 136(e) of the Energy Policy Act of 2005, Public Law 109–58; (EPACT 2005) amended EPCA to authorize DOE to consider the need to modify the energy conservation standards that the Act, as amended, prescribed for dehumidifiers (42 U.S.C. 6295(cc)) and for CCWs (42 U.S.C. 6313(e)), respectively. This includes authority for DOE to amend the water efficiency standard the Act, as amended, prescribes for commercial clothes washers.

Before DOE prescribes any new or amended standard for any of the four appliance products, however, it must first solicit comments on a proposed standard. Moreover, DOE must design each new or amended standard for these products to achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified, and such a standard must also result in significant conservation of energy. (42 U.S.C. 6295(o)(2)(A) and (o)(3); 42 U.S.C. 6316(a)) To determine whether a proposed standard is economically justified, DOE must, after receiving comments on the proposed standard, determine whether the benefits of the standard exceed its burdens to the greatest extent practicable, weighing the following seven factors:

1. The economic impact of the standard on manufacturers and consumers of 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 which are likely to result from the imposition of the standard;
3. The total projected amount of energy, or as applicable, water, savings likely to result directly from the imposition of the standard;
4. Any lessening of the utility or the performance of the covered products likely to result from the imposition of 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 imposition of 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); 42 U.S.C. 6316(a))

D. Background

1. History of Standards Rulemaking for Residential Dishwashers, Dehumidifiers, and Cooking Products; and Commercial Clothes Washers

For dishwashers, NAECA amended EPCA to establish prescriptive standards, requiring that dishwashers be equipped with an option to dry without heat, and further requiring that DOE conduct two cycles of rulemakings to determine if more stringent standards are justified. (42 U.S.C. 6295 (g)(1) and (4)) On May 14, 1991, DOE issued a final rule establishing the first set of performance standards for dishwashers (56 FR 22250); the new standards became effective on May 14, 1994 (10 CFR 430.32(f)). DOE initiated a second standards rulemaking for dishwashers by issuing an ANOPR on November 14, 1994 (59 FR 56423). However, as a result of the priority-setting process outlined in its *Procedures for Consideration of New or Revised Energy Conservation Standards for Consumer Products* (the ''Process Rule'') (61 FR 36974 (July 15, 1996); 10 CFR part 430, Subpart C, Appendix A), DOE suspended the standards rulemaking for dishwashers.

Section 135(c)(4) of EPACT 2005 added dehumidifiers as products covered under EPCA and established standards for them that will become effective on October 1, 2007. (42 U.S.C. 6295(cc)) DOE has incorporated these standards into its regulations (70 FR 60407, 60414 (October 18, 2005); 10 CFR 430.32(v)). The amendments to EPCA also require that DOE issue a final rule by October 1, 2009, to determine whether these standards should be amended. (42 U.S.C. 6295(cc)) If amended standards are justified, they must become effective by October 1, 2012. (*Id.*) In the event that DOE fails to publish such a final rule, the EPACT 2005 specifies a new set of amended standards with an effective date of October 1, 2012. (*Id.*)

As with dishwashers, NAECA amended EPCA to establish prescriptive standards for cooking products, requiring gas ranges and ovens with an electrical supply cord that are manufactured on or after January 1, 1990 not to be equipped with a constant burning pilot, and requiring DOE to conduct two cycles of rulemakings for ranges and ovens to determine if the standards established should be amended. (42 U.S.C. 6295 (h)(1)–(2)) DOE initially analyzed standards for cooking products as part of an eight-product standards rulemaking. It issued a notice of proposed rulemaking (NOPR) on March 4, 1994, proposing performance standards for gas and electric residential cooking products, including microwave ovens (59 FR 10464). In accordance with the Process Rule, DOE refined its standards analysis for cooking products. For gas cooking products, DOE focused on the economic justification for eliminating constant burning pilots. Partially due to the difficulty of conclusively demonstrating that elimination of constant burning pilots was economically justified for gas cooking products without an electrical supply cord, DOE issued a final rule on September 8, 1998, that covered only electric cooking products, including microwave ovens (63 FR 48038). The final rule found that no standards were justified for electric cooking products. DOE never completed its standards rulemaking for gas cooking products.

Similar to dehumidifiers, EPACT 2005 included amendments to EPCA that added CCWs as covered equipment, and it also established standards for such equipment that is manufactured on or after January 1, 2007. (EPACT 2005, section 136(a) and (e); 42 U.S.C. 6311(1) and 6313(e)) DOE has incorporated these standards into its regulations (70 FR 60407, 60416 (October 18, 2005); 10 CFR 431.156). EPACT 2005 also requires that DOE issue a final rule by January 1, 2010, to determine whether these standards should be amended. (EPACT 2005, section 136(e); 42 U.S.C. 6313(e))

2. Current Rulemaking Process

To initiate the current rulemaking to develop standards for the four appliance products, on March 15, 2006, DOE published on its Web site the *Rulemaking Framework for Commercial Clothes Washers and Residential Dishwashers, Dehumidifiers, and Cooking Products* (the Framework

Document). The Framework Document describes the procedural and analytic approaches DOE anticipates using to evaluate the establishment of energy conservation standards for these products. This document is available at: *http://www.eere.energy.gov/buildings/appliance_standards/pdfs/home_appl_framework_31506.pdf.*

DOE subsequently published a notice announcing the availability of the Framework Document, inviting written public comments to be submitted by May 11, 2006, and announcing a public meeting to discuss the proposed analytical framework for this rulemaking (71 FR 15059 (March 27, 2006)). At the April 27, 2006 public meeting, DOE described the different analyses it would conduct, such as the LCC and PBP analyses, the methods proposed for conducting them, and the relationship among the various analyses. Manufacturers, trade associations, environmental advocates, regulators, and other interested parties attended the meeting. The major issues discussed at the public meeting were: (1) Relevance of the existing DOE test procedure for microwave ovens; (2) baseline unit definitions for the four appliance products; (3) product classes for the four appliance products; (4) consideration of limiting standby power as a design option for all four appliance products; (5) technology options for improving efficiency for all four appliance products; (6) type of approach to employ for the engineering analysis; (7) efficiency levels to consider for all four appliance products; (8) inclusion of a water factor for dishwashers; (9) consideration of cleaning performance in setting dishwasher standards; (10) implications of clothes container volume on CCW efficiency; (11) proposed approaches for specifying typical annual energy and water consumption for all four products; (12) potential data sources for characterizing variability in annual energy and water consumption; (13) typical distribution channels and markups for all four appliance products; (14) data sources for retail prices; (15) type of approach to employ for the LCC and PBP analyses; (16) variability of forecasted energy and water prices; (17) repair, maintenance, and installation cost relationship to product efficiency; (18) product lifetimes; (19) development of consumer discount rates; (20) purchase price impacts on product shipments; (21) forecasted saturation rates of commercial clothes washers; (22) consumer subgroups; (23) water and wastewater utility impacts; and (24) wastewater discharge impacts.

Written comments submitted during the Framework Document comment period elaborated on the issues raised at the meeting and also addressed other major issues, including the following: (1) Transparency of manufacturer cost data development; (2) engineering data availability for dishwashers, kitchen ranges and ovens, and CCWs; and (3) inclusion of embedded energy in supplying water and treating wastewater.

DOE developed two spreadsheet tools for this rulemaking. The first tool calculates LCC and PBPs. There are six LCC spreadsheets, one each for the following products: (1) Dishwashers, (2) dehumidifiers, (3) cooktops, (4) ovens, (5) microwave ovens, and (6) CCWs. Each of the LCC spreadsheets includes product efficiency distributions and has the capability to determine LCC savings and PBPs based on average values. The spreadsheets also can be combined with Crystal Ball (a commercially available software program) to generate a Monte Carlo simulation, which incorporates uncertainty and variability considerations. The second tool (the NIA spreadsheet tool) calculates the impacts of candidate standards at various levels on shipments and calculates the NES and NPV at various candidate standard levels. There are five NIA spreadsheets, one each for the following products and combinations of products: (1) Dishwashers, (2) dehumidifiers, (3) cooktops and ovens, (4) microwave ovens, and (5) CCWs. DOE posted these spreadsheets on its Web site on December 4, 2006, for early stakeholder review and comment.[6]

Comments received since publication of the Framework Document have helped identify issues involved in this rulemaking, and have provided information that has contributed to DOE's proposed resolution of these issues. This ANOPR quotes and summarizes many of these public comments. A parenthetical reference at the end of a quotation or paraphrase provides the location of the item in the public record.

3. Analysis Process

Table I.2 sets forth the analyses DOE has conducted and intends to conduct in its evaluation of standards for CCWs, and residential dishwashers, cooking products, and dehumidifiers. Until recently, DOE performed the manufacturer impact analysis (MIA) in its entirety between the ANOPR and NOPR during energy conservation standards rulemakings. As noted in the table, however, DOE has performed a preliminary MIA for this ANOPR. DOE believes this change will improve the rulemaking process.

TABLE I.2.—THE FOUR APPLIANCE PRODUCTS—ANALYSIS PROCESS

ANOPR	NOPR	Final rule
Market and technology assessment	Revised ANOPR analyses	Revised analyses.
Screening analysis	Life-cycle cost sub-group analysis.	
Engineering analysis	Manufacturer impact analysis.	
Energy use and end-use load characterization	Utility impact analysis.	
Markups for equipment price determination	Net national employment impacts.	
Life-cycle cost and payback period analyses	Environmental assessment.	
Shipments analysis	Regulatory impact analysis.	
National impact analysis.		
Preliminary manufacturer impact analysis.		

The analyses listed in Table I.2 reflect analyses used in the rulemaking, including the development of economic models and analytical tools. In addition, in an effort to support groups of interested parties seeking to develop and present consensus recommendations on standards, DOE posted draft versions of its LCC and NIA spreadsheets on its Web site. If timely new data, models, or tools that enhance the development of standards become

[6] Available online at DOE's Web site: *http://www.eere.energy.gov/buildings/appliance_standards/residential/cooking_products.html*

available, DOE will incorporate them into this rulemaking.

4. Miscellaneous Rulemaking Issues

a. Joint Stakeholder Recommendations

The Edison Electric Institute (EEI) suggested that DOE should use a negotiated rulemaking process for residential dishwashers and cooking equipment, because manufacturers appear to want regulatory certainty for these products. EEI suggested a separate negotiated process for CCWs because these products are designed for a different market. For dehumidifiers, EEI suggested DOE analyze the standards identified in EPACT 2005 that are due to become effective in 2012, and if they are technically feasible, economically justified, and will not reduce competition, consider a negotiated rulemaking so that standards can be issued before the October 1, 2009 deadline mandated by EPACT 2005. (EEI, No. 7 at p. 2) [7]

The Process Rule specifically identifies ''consensus proposals for new or revised standards as an effective mechanism for balancing the economic, energy, and environmental interests affected by standards. Thus, notwithstanding any other policy on selection of proposed standards, a consensus recommendation on an updated efficiency level submitted by a group that represents all interested parties will be proposed by DOE if it is determined to meet the statutory criteria.'' (10 CFR Part 430, Appendix A to Subpart C, section 5(e)(2)). Therefore, DOE encourages the submittal of any consensus proposals or joint stakeholder recommendations pertaining to any or all of the four appliance products. If the supporting analyses provided by the group address all of the statutory criteria and use valid economic assumptions and analytical methods, DOE expects to use these supporting analyses as the basis of a proposed rule.

b. Standby Power for Dishwashers and Cooking Products

Standby power is currently incorporated into the energy factor [8] (EF) for conventional ovens via the measurement of clock power consumption and for gas cooktops via the energy consumption of constant burning pilots, both of which are incorporated into the EF calculation for their respective products. The dishwasher test procedure includes a measurement of standby power, but standby energy use is not incorporated into calculated EF. The issue of whether to include standby power in the energy efficiency metrics for dishwashers and cooking products was addressed in several comments that DOE received. The Alliance to Save Energy, American Council for an Energy-Efficient Economy (ACEEE), Appliance Standards Awareness Project, Natural Resources Defense Council, and Northeast Energy Efficiency Partnerships (hereafter ''Joint Comment'') stated that standby energy use should be included in the analyses for all products, with the appropriate metric for the standards being annual energy consumption rather than energy factor. The Joint Comment stated that EPACT 2005 instructs DOE to consider standby power in its rulemaking for all products, and where significant, to include standby power in some fashion into the appropriate standard. The Joint Comment further stated that standby energy use can be significant for clothes washers, dishwashers, and microwave ovens. (Joint Comment, No. 9 at p. 2)

For dishwashers, Potomac Resources Inc. (Potomac) commented that it would be useful to address standby power directly through design options such as the power supply. (Public Meeting Transcript, No. 5 at p. 61) [9] ACEEE, EEI, and Whirlpool Corporation (Whirlpool) agreed that standby power is important to include in the energy use calculations, but EEI and Whirlpool argued that individual system components should not be regulated, instead stating that standby power should be addressed for the system as a whole. (Public Meeting Transcript, No. 5 at pp. 62, 64, and 66) ACEEE commented that if standby energy use is determined to be significant, then DOE's analysis should include design options, efficiency levels, or increased annual energy consumption to capture efficiency improvement opportunities. (Public Meeting Transcript, No. 5 at p. 64) ACEEE, the Association of Home Appliance Manufacturers (AHAM), and Whirlpool stated that if DOE incorporates standby power into the efficiency standard, it should do this through maximum annual energy usage rather than a prescriptive standby power level. These commenters argued that such an approach would allow manufacturers flexibility in meeting the standard. (Public Meeting Transcript, No. 5 at p. 125; AHAM, No. 14 at p. 8; Whirlpool, No. 10 at p. 8) Whirlpool further commented that if standby power is included in annual energy consumption, DOE should add 8.5 kilowatt-hours (kWh) to the standard, equating to one watt standby power per covered appliance over the course of a year. In addition, Whirlpool argued that standby power should not be driven so low that it impacts the adoption of electronics that can shift start times to off-peak periods. (Whirlpool, No. 10 at p. 8)

In response to the comments, we note that the analysis DOE conducted for dishwashers does not explicitly consider design options to reduce standby energy consumption. DOE conducted the engineering analysis to capture the costs associated with improving EF only. The cost data AHAM provided and the product teardowns did not specifically account for changes in standby power. The LCC analysis, however, does account for standby power in the calculation of annual energy consumption. The LCC assumes a baseline standby power draw of two watts, totaling 17 kWh of annual energy consumption. DOE assumes this same consumption level at all EF values. If technologies to decrease standby power consumption are determined to be a significant source of energy savings and are technologically feasible and economically justified, DOE plans to consider standby power as part of an overall energy efficiency standard focusing on maximum annual energy usage, rather than a separate standby power level, in order to allow manufacturers maximum flexibility in specifying features and design options while still remaining below a certain annual energy consumption level. As one approach, DOE tentatively believes that a reduction in the two-watt baseline standby power level could be reflected in a corresponding reduction in annual energy usage, which could be modeled for the purposes of this analysis as an equivalent change in EF. DOE seeks comment on the specification of annual energy usage as the metric for dishwasher standards.

[7] A notation in the form ''EEI, No. 7, p. 2'' identifies a written comment that DOE has received and has included in the docket of this rulemaking. This particular notation refers to a comment (1) by the Edison Electric Institute, (2) in document number 7 in the docket of this rulemaking, and (3) appearing on page 2 of document number 7.

[8] Energy factor (EF) is a measure of the energy consumption required by the product under the conditions of the DOE test procedure. The units of EF vary depending on the product. For example, the EF for dishwashers is expressed in cycles/kWh, while the EF for dehumidifiers is in liters/kWh.

[9] A notation in the form ''Public Meeting Transcript, No. 5 at p. 61'' identifies an oral comment that DOE received during the April 27, 2006, Framework public meeting and which was recorded in the public meeting transcript in the docket for this rulemaking (Docket No. EE–2006–STD–0127), maintained in the Resource Room of the Building Technologies Program. This particular notation refers to a comment (1) made during the public meeting, (2) recorded in document number 5, which is the public meeting transcript that is filed in the docket of this rulemaking, and (3) which appears on pages 61 of document number 5.

ACEEE commented during the Framework public meeting that the use of standby power needs to be considered for all cooking products. (Public Meeting Transcript, No. 5 at p. 91) AHAM recognized that standby power consumption is essentially already included in the test procedure for ovens and cooktops; however, for microwave ovens, a test procedure revision would be required. (Public Meeting Transcript, No. 5 at p. 92) AHAM also stated that manufacturers (driven by consumer/market desires) want the flexibility to produce microwave ovens with different displays, and, thus, different levels of standby power consumption, in order to provide products with market differentiation. Therefore, AHAM recommended that standby power not be considered as a separate prescriptive requirement, but instead, if regulated, standby power should be incorporated in an annual energy consumption metric (AHAM, No. 17 at p. 4). Contrary to these views, GE Consumer & Industrial (GE) opposed incorporating standby power into efficiency standards because that would result in a determination of higher energy consumption under the regulation for ''intelligent'' appliances. (GE, No. 13 at p. 4)

DOE added low-standby-power electronic controls as design options for both standard and self-cleaning gas ovens, as well as for both standard and self-cleaning electric ovens. However, it did not include these design options when setting overall efficiency levels for these products because DOE does not have efficiency improvement or incremental cost information on them. DOE is seeking data to conduct this analysis and requests stakeholder comment on this issue.

AHAM provided data on microwave standby power for a sample of 21 microwave ovens available in the U.S. market. For the AHAM submission, standby power was tested in accordance with International Electrotechnical Commission (IEC) 62301–2005, *Household electrical appliances—Measurement of standby power*. These data show a wide range of standby power use. Microwave oven standby power consumption is understood to be a function of the digital clock display, with more complex graphical displays drawing more power. AHAM did not provide the type of oven characteristics information which could provide more insight into the factors affecting standby power or the costs associated with reducing the standby energy consumption.

For the NOPR analysis, DOE is considering purchasing, testing, and analyzing microwave ovens to better understand the utility, cost, and cost implications of reducing standby power consumption. Addition of a standby power test to the existing test procedure would be necessary before standby power could be included in an efficiency standard. DOE intends to modify the test procedure accordingly because it believes that standby power represents a significant portion of microwave oven annual energy usage. According to the DOE test procedure, the annual useful cooking energy output of a microwave oven is 79.8 kWh. For a baseline microwave oven with an efficiency of 55.7 percent, annual energy consumption for cooking processes is 143.3 kWh. Each watt of standby power represents an additional 8.76 kWh per year, or 6 percent of the annual cooking energy consumption. AHAM-supplied data demonstrated a wide variation in existing standby power levels, with values ranging between 1.5 and 5.8 watts, such that the likely impact of a standard would be significant. DOE will conduct testing and teardown analysis in support of the test procedure NOPR to incorporate standby power. DOE plans to complete the test procedure change prior to publishing the NOPR for this standard-setting rulemaking.

DOE specifically seeks data and stakeholder feedback on how to conduct an analysis of standby power for microwave ovens. This is identified as Issue 1 under ''Issues on Which DOE Seeks Comment'' in section IV.E of this ANOPR.

5. Test Procedures

A test procedure outlines the method to determine the energy efficiency and annual energy use of products and equipment, and it is used as the basis for representation and determination of compliance with energy conservation standards. Section 7(b) of the Process Rule provides that DOE will propose necessary modifications to the test procedures for a product before issuing an ANOPR concerning energy conservation standards for that product. Section 7(c) of the Process Rule states that DOE will issue a final modified test procedure prior to issuing a proposed rule for energy conservation standards.

DOE has established test procedures for each of the four appliance products subject to today's notice. DOE last revised its test procedures for cooking products in 1997, to make several revisions to more accurately measure the efficiency of these products (62 FR 51976 (Oct. 3, 1997); 10 CFR part 430, Subpart B, Appendix I). Similarly, in 2003, DOE revised its test procedures for dishwashers to more accurately measure their efficiency, as well as their water use (68 FR 51887 (Aug. 29, 2003); 10 CFR part 430, Subpart B, Appendix C). At this time, DOE does not expect to make further changes to the dishwasher test procedure.

EPACT 2005 amended EPCA to require that CCWs be rated according to the same test procedures established for residential clothes washers. (EPACT 2005, section 136(f); 42 U.S.C. 6314(a)(8)) DOE adopted those test procedures for CCWs in its final rule published on October 18, 2005 (70 FR 60407, 60416). EPACT 2005 also amended EPCA to specify that the U.S. Environmental Protection Agency (EPA) test criteria used under the Energy Star Program must serve as the basis for DOE's test procedure for dehumidifiers. (EPACT 2005, section 135(b); 42 U.S.C. 6293(b)(13)) The Energy Star test criteria for dehumidifiers require that American National Standards Institute (ANSI)/AHAM Standard DH–1–2003, *Dehumidifiers*, be used to measure energy use during capacity-rating tests, and that the Canadian Standards Association (CAN/CSA) standard CAN/CSA–C749–1994 (R2005), *Performance of Dehumidifiers*, be used to calculate the energy factor. DOE has adopted these test criteria, along with related definitions and tolerances, as its test procedure for dehumidifiers (71 FR 71340, 71347, 71366, 713667–68 (Dec. 8, 2006); 10 CFR part 430, Subpart B, Appendix X).

DOE received comments pertaining to its test procedures for kitchen ranges and ovens and CCWs. With regard to kitchen ranges and ovens, Wolf Appliance Company, LLC , an affiliate of Sub-Zero Freezer Company, Inc. (Wolf), and Whirlpool suggested that DOE modify its test procedure for residential kitchen ranges and ovens because it is inadequate for measuring the energy use of certain product characteristics and features. Specifically, Wolf stated that the current test procedure does not accurately measure the performance and efficiency of several components (such as larger burner rings, heavier burner grates, and high performance convection systems). (Wolf, No. 6 at p. 1) Whirlpool stated that the current test procedure does not measure energy consumption as a function of oven cavity size, does not address the fundamental differences in commercial-type products [10] versus more traditional residential cooking products, and does not recognize that

[10] Commercial-type cooktops and ovens are characterized by higher burner firing rates, larger dimensions, and heavier components than typical residential cooking products.

gas surface burner efficiency is a function of the burner rate. Whirlpool added that the microwave oven test procedure does not account for the variation in the product's size and wattage, both of which affect microwave oven energy consumption. (Whirlpool, No. 10 at p. 6) With regard to CCWs, Whirlpool noted that commercial laundry practices differ from the more familiar residential practices in several key respects (*e.g.*, the test procedure assumes that a modest eight-pound load will be used, but commercial washers typically are filled with a larger load). (Whirlpool, No. 10 at p. 3)

In response, DOE recognizes that there may be issues with its test procedures for measuring the energy use impacts of the cooking product characteristics noted by Wolf and Whirlpool. However, with the exception of standby power consumption for microwave ovens, DOE does not intend to initiate rulemakings to modify its test procedures for appliances covered by this rulemaking, before finalizing amended energy conservation standards, for the reasons that follow. DOE intends to initiate a test procedure modification for microwave ovens to include standby power consumption because the data received from AHAM indicates that standby power represents a significant portion of annual energy usage and because the data shows a wide spread in current standby power levels. DOE does not plan a test procedure change for conventional ovens because the oven test procedure already measures standby power in the form of clock power and, for standard gas ovens, the pilot light. For cooktops, DOE does not believe that standby power not already captured in the test procedure represents a significant portion of annual energy consumption. Gas cooktops already measure the energy consumption of standing pilots, which for the baseline configuration are assumed to consume 600 kWh annually and which are in addition to the annual cooking energy consumption. In comparison, each watt of standby power consumes 8.76 kWh annually. For electric cooktops, DOE does not have any data on standby power consumption that indicate the potential for significant energy savings. Therefore, a test procedure change to measure standby power for cooktops would not be warranted. With regard to CCWs, although for efficiency rating purposes CCWs use the residential clothes washer test procedure, DOE's methods for characterizing the energy and water use for commercial washers (as described in section II.D.4) accounted for the consumer usage patterns specific to this product.

DOE specifically seeks data and stakeholder feedback on the decision to retain the existing test procedures for appliances covered under this rulemaking other than microwave ovens. This is identified as Issue 6 under ''Issues on Which DOE Seeks Comment'' in section IV.E of this ANOPR.

II. Analyses for the Four Appliance Products

This section addresses the analyses DOE has performed and intends to perform for this rulemaking. For each product covered by this rulemaking (*i.e.*, residential dishwashers, dehumidifiers, and cooking products, and CCWs), DOE will perform a set of separate analyses, including a market and technology assessment, a screening analysis, an engineering analysis, an energy use and water use characterization, LCC and PBP analyses, a shipments analysis, a NIA, and a MIA. A separate sub-section addresses each type of analysis, which contains a general introduction that describes the analysis and a discussion of related comments received from interested parties.

A. Market and Technology Assessment

When DOE begins a standards rulemaking, it develops information that provides an overall picture of the market for the products concerned, including the nature of the product, the industry structure, and market characteristics for the product. This activity consists of both quantitative and qualitative efforts based primarily on publicly available information. The subjects addressed in the market and technology assessment for this rulemaking include product classes, baseline units, technologies for design options, manufacturers, quantities and types of products sold and offered for sale, retail market trends, industry cost structure, and regulatory and non-regulatory programs. This information serves as resource material throughout the rulemaking.

1. Product Classes

In general, when evaluating and establishing energy efficiency standards, DOE divides covered products into classes by: (1) The type of energy used, and (2) capacity or other performance-related features that affect consumer utility and efficiency. Different energy conservation standards may apply to different product classes. The following describes and discusses the product classes DOE plans to use in this rulemaking.

a. Dishwashers

For dishwashers, the size of the unit significantly affects the amount of energy consumed due to the corresponding amount of water heating required. In other words, standard-sized dishwashers with relatively greater water consumption have significantly greater energy use than compact units. Because standard dishwashers offer enhanced consumer utility over compact units (*i.e.*, the ability to wash more dishes), DOE has established the following product classes, which are based on the size of the dishwasher (as specified in ANSI/AHAM Standard DW–1–2005, Dishwashers):

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

AHAM and EEI both commented that the two product classes are appropriate for the analysis. (Public Meeting Transcript, No. 5 at p. 55; AHAM, No. 14 at p. 8; EEI, No. 7 at p. 3) Potomac, however, suggested that the standard product class should be disaggregated to at least several product classes based on place-setting capacity. (Public Meeting Transcript, No. 5 at pp. 61–62). American Rivers, Association of Metropolitan Water Agencies, Austin Water Utility, California Urban Water Conservation Council, East Bay Municipal Utility District, and Seattle Public Utilities (hereafter ''Multiple Water Organizations'') recommended that one or more new product classes be defined in addition to compact and standard sizes, which would allow flexibility for manufacturers to make smaller or larger machines. According to the Multiple Water Organizations, consumers would then be encouraged to wash full dishwasher loads rather than partial or multiple loads. (Multiple Water Organizations, No. 11 at p. 2) DOE notes that current dishwasher models include single- and two-drawer units as well as dishwashers that provide a user-selectable option for upper-or lower-rack-only washing to aid in running optimal load sizes. Therefore, DOE believes the current two product classes offer adequate flexibility in terms of dishwasher loading to maintain consumer utility and wash performance for different load sizes. Thus, additional product classes are not warranted.

b. Dehumidifiers

EPACT 2005 sets energy conservation standards for dehumidifiers based on the capacity of the unit as measured in pints of water extracted per day. (EPACT 2005, section 135(c); 42 U.S.C. 6295(cc)) Specifically, for units manufactured on or after October 1, 2007, EPACT 2005 sets a separate standard for dehumidifiers in each of the following five categories: (1) 25.00 pints/day or less, (2) 25.01–35.00 pints/day, (3) 35.01–54.00 pints/day, (4) 54.01–74.99 pints/day, and (5) 75.00 pints/day or more. (*Id.*) EPACT 2005 also prescribes more stringent energy conservation standards that would go into effect if DOE fails to issue amended standards that apply to products manufactured on or after October 1, 2012. (*Id.*) In prescribing these standards, EPACT 2005 subdivides the 35.01–54.00 pints/day category into two categories: 35.01–45.00 pints/day and 45.01–54.00 pints/day. Therefore, in accordance with EPACT 2005 amendments to EPCA, DOE is using the following product classes for dehumidifiers:

- 25.00 pints/day or less;
- 25.01–35.00 pints/day;
- 35.01–45.00 pints/day;
- 45.01–54.00 pints/day;
- 54.01–74.99 pints/day; and
- 75.00 pints/day or more.

During the Framework public meeting and Framework comment period, stakeholders differed as to appropriate specifications for the product classes for dehumidifiers. EEI asked whether a distinction should be made between fixed and portable dehumidifers. (EEI, No. 7 at p. 3) AHAM opposed EEI's suggestions, expressing a preference for the product classes as identified in EPACT 2005. (Public Meeting Transcript, No. 5 at p. 70; AHAM, No. 14 at p. 9)

While fixed and portable dehumidifiers offer different utility in terms of ease of installation and flexibility in location, DOE is unaware of any dehumidification performance differences. Therefore, DOE has determined that additional product classes are not warranted based on portability, and for the purpose of this rulemaking, DOE intends to maintain the dehumidifier product classes as defined by EPACT 2005 (*i.e.*, a ''self-contained, electrically operated, and mechanically encased assembly''). (EPACT 2005, section 135(a); 42 U.S.C. 6291(34))

DOE also received comments that baseline unit characteristics for dehumidifiers may not be possible to establish since EPACT 2005 will not come into effect until October 1, 2007. DOE performed its engineering analysis across a wide range of unit capacities and efficiencies to capture as complete a picture of the 25–75 pints/day dehumidifier market as possible. In total, DOE has disassembled and analyzed 14 dehumidifiers to date. Furthermore, DOE used market and technology assessment research and consulted with numerous stakeholders to determine basline unit characteristics. (Refer to Chapters 3 and 5 of the TSD for further details.) DOE intends to use EPACT 2005-compliant dehumidifiers as a baseline since manufacturers are already modifying any non-compliant product they have to meet this new minimum energy efficiency level.

c. Cooking Products

For cooking products, DOE based its product classes on energy source (*i.e.*, gas or electric) and cooking method (*i.e.*, cooktops, ovens, and microwave ovens). DOE identified five categories of cooking products:

- Gas cooktops;
- Electric cooktops;
- Gas ovens;
- Electric ovens; and
- Microwave ovens.

In its regulations implementing EPCA, DOE defines a ''conventional range'' as ''a class of kitchen ranges and ovens which is a household cooking appliance consisting of a conventional cooking top and one or more conventional ovens.'' 10 CFR 430.2. In this rulemaking, DOE is not treating gas and electric ranges as a distinct product category and is not basing its product classes on that category. Because ranges consist of both a cooktop and oven, any potential cooktop and oven standards would apply to the individual components of the range. As a result, product classes for ranges, for the purpose of standards-setting, are not warranted.

This general approach for defining product classes was validated in comments received after the Framework public meeting. EEI stated that the product classes are appropriate. (EEI, No. 7 at p. 3) Wolf stated that the burden of considering new product classes since the previous rulemaking (including modification of existing test procedures) is not justified by the small potential energy savings. (Wolf, No. 6 at p. 2)

DOE also received comments during the Framework public meeting and subsequent comment period questioning whether DOE should consider for analysis product classes for cooking products with small shipment volumes. Whirlpool noted that the rationale for excluding certain product classes from analysis in the previous rulemaking (*e.g.*, grills, griddles, induction cooktops, and warming/simmering burners) was based upon consideration of factors such as the lack of an appropriate test procedure, the niche nature of those products, and the small amount of empirical data. Since these conditions still remain today, Whirlpool commented that DOE should not analyze these classes. (Whirlpool, No. 10 at p. 5) Wolf stated during the Framework public meeting that product classes that were not analyzed in the prior rulemaking need to be considered in this standards rulemaking. (Public Meeting Transcript, No. 5 at p. 84) DOE is not aware of any data upon which to determine the measurement of energy efficiency or energy efficiency characteristics of products in these niche classes. Therefore, DOE will not conduct analyses on product classes that were identified but excluded in the previous rulemaking. DOE seeks efficiency data and inputs to characterize any limitations of the test procedure for these product classes. This topic is identified as Issue 6 under ''Issues on Which DOE Seeks Comment'' in section IV.E of this ANOPR.

The single product class that DOE proposes to use for gas cooktops is gas cooktops/conventional burners, in accordance with the previous rulemaking.

AHAM commented that if DOE decides to proceed with further analysis of cooking products, DOE should include an additional product class for high-performance, commercial-style products. AHAM stated that the unique utility and performance attributes associated with high-performance cooking products must be recognized and allowed to continue under the ''safe harbor'' provisions of NAECA, which prevent Federal energy efficiency standards from resulting in the unavailability of product types, classes, performance characteristics, and other key aspects of the product that are currently available. (42 U.S.C. 6295 (o)(4)) Due to test procedure complexities and small market share, AHAM recommends that DOE exempt high-performance, commercial-style residential cooking products. (AHAM, No. 14 at p. 2) DOE received additional comments specifically regarding commercial-type ranges. These comments are discussed in the context of gas cooktops, although it should be recognized that similar responses apply to the oven component of the range as well. During the Framework public meeting, EEI suggested a need to establish the market share of commercial-type ranges for this rulemaking. (Public Meeting Transcript, No. 5 at p. 81) Both AHAM and Wolf stated that commercial-type ranges warrant a separate product class. (Public

Meeting Transcript, No. 5 at pp. 84 and 86). Wolf further elaborated in the comment period after the Framework public meeting that the unique utility and performance attributes of commercial-type ranges (explained below) justify a separate product class. (Wolf, No. 6 at p. 1) DOE considers commercial-style ranges to be those products which incorporate gas cooktops with higher input rate burners (*i.e.*, greater than 14,000 Btu/h) and heavy-duty grates that provide faster cooking and the ability to cook larger quantities of food in larger cooking vessels. The burners are optimized for the larger-scale cookware to maintain high cooking performance. Similarly, DOE considers commercial-style ovens to have higher input rates (*i.e.*, greater than 22,500 Btu/h) and dimensions to accommodate larger cooking utensils or greater quantity of food items, as well as features to optimize cooking performance. GE stated that commercial-type products should be exempt from regulation due to their unique utility and cost, but if they are regulated, they should be categorized into a separate product class. (GE, No. 13 at p. 2) Whirlpool commented that, although shipments of commercial-type products have increased since the prior rulemaking, they still remain a niche product. Whirlpool shared GE's position that these products should be exempt from regulation, particularly since there is a lack of efficiency data available and there is little potential for meaningful energy savings. (Whirlpool, No. 10 at p. 6)

After considering stakeholder comments, DOE has tentatively decided to exclude high-performance, commercial-style gas cooktops (including the cooktop component of commercial-style ranges) from the energy efficiency standard due to the lack of available data for determining efficiency characteristics of those products. In addition, the test procedure for gas cooktops is based on measuring temperature rise in an aluminum block with a diameter dictated by the firing rate of the burner. The maximum diameter of the test block is sufficient to measure higher output residential-scale burners. For commercial-type burners that must have larger diameter burner rings to accomplish complete combustion, however, this maximum test block diameter may be too small to achieve proper heat transfer and may not be representative of the dimensions of suitable cookware. However, DOE is not aware of any data to determine the measurement of energy efficiency or energy efficiency characteristics for commercial-style cooktops. DOE seeks data and inputs regarding the energy efficiency of commerical-type cooktops as well as any limitations of the test procedure for this product class. This topic is identified as Issue 6 under ''Issues on Which DOE Seeks Comment'' in section IV.E of this ANOPR.

Whirlpool and AHAM commented that DOE should add sealed gas burners as a separate product class. (Public Meeting Transcript, No. 5 at pp. 82 and 85) Whirlpool stated that the added utility of sealed burners based upon the ease of consumer cleaning justifies this distinction. In addition, the increasing firing rates of sealed burners since the previous rulemaking coupled with the necessary grate height increase to achieve proper combustion make sealed burners less efficient than open burners. Whirlpool cited the 1983 International Gas Research Conference (IGRC)[11] report that claimed an efficiency reduction associated with sealed burners. In Whirlpool's opinion, the boiling water tests upon which this conclusion was based represented an inappropriate metric, and any efficiency determination for sealed burners must be based on the DOE test procedure. For these reasons, Whirlpool recommended development of a separate product class for sealed burners. (Public Meeting Transcript, No. 5 at pp. 82–83 and 88) AHAM stated that gas sealed burners should be considered as a separate product class within gas cooktops because changes are required to provide appropriate amounts of primary and secondary air for proper combustion, which inherently affects energy efficiency. (AHAM, No. 14 at p. 2)

DOE has observed that there are conflicting data on the impacts of sealed burners on energy efficiency measurements. In the previous rulemaking, AHAM had stated that sealed burners often have a lower gas input rating than conventional burners due to the reduction in secondary air. The sealed burner must obtain all of its secondary air from air that is available above the cooktop. To obtain sufficient air for proper combustion, it becomes necessary to either raise the grate height or to derate the burner. The IGRC report, however, states that the reduction in secondary air results in more primary aeration to the sealed burner. The increased primary aeration allows for a reduced pan-to-burner separation and increased burner efficiency.

[11] J. Flood and T. Enga, ''Energy Conservation 'Aspects of Cooking Appliances,'' *Proceedings of the 1983 International Gas Research Conference, June 13, 1983, London, UK,* pp 741–54. Available online at: *http://www.osti.gov/energycitations.*

According to the boiling water tests conducted in the report, the efficiency of conventional burners ranged from 42 percent to 48 percent, while the sealed burner was rated at an efficiency of 53 percent. Commenters have not provided data showing the correlation of boiling water tests with efficiency testing according to the DOE test procedure, as would render the IGRC report inapplicable. Accordingly, without clear indication that the performance of sealed burners is sufficiently distinct from that of conventional open gas burners, DOE will retain the single product class for gas cooktops and consider sealed burners as a design option within that class.

The American Gas Association (AGA) also proposed two product classes for gas cooktops, differentiated by the method of heat transfer associated with the burners. The two product classes suggested by the AGA would consist of direct-flame contact burners that provide conductive heat transfer and other burner types that employ convective and radiant heat transfer. (AGA, No. 12 at p. 2) DOE believes that the method of heat transfer does not provide any unique utility, nor are there data available that characterize substantially different performance based on heat transfer means. Thus, DOE will retain a single product class for gas cooktops.

For electric cooktops, DOE determined that the ease of cleaning smooth elements means that they have greater utility to the consumer than coil elements. Because smooth elements typically use more energy than coil elements, DOE has defined the following product classes for electric cooktops:

- Electric cooktop/low or high wattage open (coil) elements; and
- Electric cooktop/smooth elements.

AHAM stated that if DOE decides to proceed with further analysis of cooking products, DOE should include an additional product class for induction cooktops. AHAM commented the utility and performance attributes associated with high-performance cooking products must be recognized and allowed to continue under the safe harbor provisions of NAECA. Due to test procedure complexities, small market share, and lack of empirical data, AHAM and Whirlpool recommended that DOE exempt induction cooktops. Whirlpool further commented that if induction cooktops are analyzed, they must be treated as a separate product class, which would entail development of a new test procedure. (Public Meeting Transcript, No. 5 at p. 85; AHAM, No. 14 at pp. 2–4; Whirlpool, No. 10 at p.

5) During the engineering analysis (Chapter 5 of the TSD) DOE determined that induction cooktops cannot be tested according the existing test procedure, and, therefore, DOE will not consider this technology for the ANOPR analysis. DOE seeks efficiency data and inputs to characterize any limitations of the test procedure for induction cooktops. This topic is identified as Issue 6 under ''Issues on Which DOE Seeks Comment'' in section IV.E of this ANOPR.

For electric ovens, DOE determined that the type of oven-cleaning system is a utility feature that affects performance. DOE found that standard ovens and ovens using a catalytic continuous-cleaning process use roughly the same amount of energy. On the other hand, self-cleaning ovens use a pyrolytic process that provides enhanced consumer utility with different overall energy consumption, as compared to either standard or catalytically-lined ovens, due to the amount of energy used during the cleaning cycle and better insulation. Thus, DOE has defined the following product classes for electric ovens:

• Electric oven/standard oven with or without a catalytic line; and

• Electric oven/self-clean oven.

AHAM concurred with this approach during the Framework public meeting, stating that non-self-cleaning and self-cleaning ovens should remain as separate product classes. (Public Meeting Transcript, No. 5 at pp. 85–86) AHAM and Whirlpool both commented that the feature of a ''catalytic line'' is obsolete and, therefore, should be removed from the non-self-cleaning oven product class description. (Public Meeting Transcript, No. 5 at p. 86; Whirlpool, No. 10 at pp. 9–10) While DOE is not aware of any electric ovens currently on the market that are catalytically lined, it will retain the current description for completeness.

For gas ovens, for the same reasons as for electric ovens, DOE is using the following product classes:

• Gas oven/standard oven with or without a catalytic line; and

• Gas oven/self-clean oven.

AHAM stated that if DOE decides to proceed with further analysis, DOE should include additional product classes for high-performance, commercial-style products, which include commercial-style gas ovens (*i.e.*, with burner firing rates greater than 22,500 Btu/h). AHAM commented that the utility and performance attributes associated with high-performance cooking products must be recognized and allowed to continue under the safe harbor provisions of NAECA. Due to test procedure complexities and small market share, AHAM recommended that DOE exempt high-performance, commercial-style products. (Public Meeting Transcript, No. 5 at pp. 85–86; AHAM, No. 14 at pp. 2–4) DOE recognizes that the test procedure may not adequately measure performance of commercial-style ovens. The single test block may not adequately measure the temperature distribution that is inherent with the larger cavity volumes and higher firing rates typically found in these products. DOE is not aware of any data upon which to determine the measurement of energy efficiency or energy efficiency characteristics for commercial-style ovens, so therefore will not conduct an analysis on this product class at this time. DOE seeks data and inputs regarding the energy efficiency of commercial-type cooktopsstyle ovens as well as any limitations of the test procedure for this product class. This topic is identified as Issue 6 under ''Issues on Which DOE Seeks Comment'' in section IV.E of this ANOPR.

As discussed for electric ovens, AHAM and Whirlpool stated that the ''catalytic line'' descriptor for the standard gas oven product class is obsolete and should be removed. While DOE is not aware of any gas ovens currently on the market that are catalytically lined, it will retain the current description for completeness.

Finally, microwave ovens will constitute a single product class in this rulemaking. DOE did not break down this category of cooking product into further product classes. This product class can encompass microwave ovens with and without browning (thermal) elements, but does not include microwave ovens that incorporate convection systems. DOE is unaware of any data evaluating the efficiency characteristics of microwave ovens incorporating convection systems, so therefore this type of unit will not be included in the analysis. DOE seeks data and inputs on the performance of microwave ovens with convection systems. This topic is identified as Issue 6 under ''Issues on Which DOE Seeks Comment'' in section IV.E of this ANOPR.

AHAM stated during the Framework public meeting that additional product classes for microwave ovens are needed that would likely be a function of volume and wattage, and possibly installation configuration (*i.e.*, counter-top versus over-the-range ovens). (Public Meeting Transcript, No. 5 at pp. 86–87) In comments submitted after the Framework public meeting, AHAM reiterated these comments and added that humidity sensors would also need to be considered. However, AHAM conceded that the lack of efficiency data makes it impossible to determine the appropriate product classes at this time. (AHAM, No. 14 at p. 6) Similarly, Whirlpool stated that, without existing energy consumption standards, it does not have any data to formulate appropriate product classes for microwave ovens, and the company commented that obtaining these data would be costly and time consuming. (Whirlpool, No. 10 at p. 6) After the Framework public meeting, AHAM supplied microwave oven efficiency data to DOE that failed to identify any correlation between efficiency and either rated output power or cavity volume. Therefore, DOE has decided not to define product classes as a function of features such as volume or wattage, and instead will retain the single product class of microwave ovens with or without thermal elements.

Comments did not strongly support the inclusion of microwave/thermal ovens in the analyses. In addition, several comments used the term ''combination ovens'' to refer to not only microwave/thermal ovens but also other technologies, such as halogen bulbs. EEI questioned whether DOE would consider combination ovens for future analysis, referring to both microwave plus thermal and microwave plus convection units. (Public Meeting Transcript, No. 5 at p. 139) GE and AHAM both commented that the DOE test procedure is inadequate to measure combination ovens. AHAM further stated that the small market share of combination ovens should preclude them from the analysis. (Public Meeting Transcript, No. 5 at pp. 140–141). In comments submitted after the Framework meeting, EEI stated that, depending on market share, combination ovens could impact baseline energy usage. Although EEI did not suggest including combination ovens in the analyses, it did state that DOE should ensure that any standards do not eliminate these products from the market. (EEI, No. 7 at p. 6) Whirlpool, however, expressed its opinion that combination ovens should not be considered a separate product class due to variations in design and low market share. (Whirlpool, No. 10 at p. 6)

DOE recognizes that the microwave oven test procedure can only test the microwave heating function of microwave/thermal ovens, and that it cannot test the browning function of the radiant or halogen elements. However, such browning features are typically a secondary function of a microwave/thermal unit, with the primary cooking being accomplished via microwave heating. In combination units, the convection system performs a significant portion of the cooking process, and, therefore, the inability to measure performance of the convection component would render the test procedure inadequate. DOE has no information that demonstates a difference in energy performance between microwave/thermal ovens operating in microwave mode and microwave ovens. Therefore, DOE will include microwave ovens with thermal browning elements in the single product class. As discussed above, DOE will not conduct an analysis at this time of combination microwave ovens due to a lack of data evaluating energy efficiency or energy efficiency characteristics of microwave ovens incoporating convection systems.

DOE received several comments regarding additional product classes for cooking products not specifically covered in the above product classes. For example, EEI questioned whether outdoor natural-gas-fired or propane-fired grills are a covered product for this analysis, and, if so, it recommended that DOE conduct an investigation into shipments and usage patterns. (EEI, No. 7 at p. 5) The test procedures established in 10 CFR Part 430, Subpart B, Appendix I are specified for kitchen ranges and ovens. Further, the test procedures provide for estimating annual operating cost for conventional ranges, conventional cooking tops, conventional ovens, microwave ovens, and microwave/conventional ranges. In response, DOE believes that the specification of ''kitchen'' and ''household cooking appliance'' in the definitions of ''conventional range'' and ''conventional cooking top'' excludes outdoor gas/propane grills. Therefore, DOE has decided not to include outdoor gas/propane grills in the present analyses.

EEI also commented after the Framework public meeting that DOE should include compact cooking products such as toaster ovens in the analysis. (EEI, No. 7 at p. 3) However, the definition of ''conventional oven'' provided in 10 CFR 430.2 states, in relevant part, ''It does not include portable or countertop ovens which use electric resistance heating for the cooking or heating of food and are designed for an electrical supply of approximately 120 volts.'' Therefore, DOE is not including toaster ovens in the present analyses because they are not covered products.

In sum, in this rulemaking DOE is using the following eight product classes in analyzing and setting standards for cooking products:

- Gas cooktops/conventional burners;
- Electric cooktop/low or high wattage open (coil) elements;
- Electric cooktop/smooth elements;
- Gas oven/standard oven with or without a catalytic line;
- Gas oven/self-clean oven;
- Electric oven/standard oven with or without a catalytic line;
- Electric oven/self-clean oven; and
- Microwave oven with or without thermal elements.

d. Commercial Clothes Washers

EPACT 2005 amendments to EPCA placed all CCWs in one product class and applied a single standard for energy efficiency and a single standard for water efficiency for this equipment. (EPACT 2005, section 136(e); 42 U.S.C. 6313(e)) This class encompasses both top-loading (vertical-axis) and front-loading (horizontal-axis) units.

During the Framework public meeting and Framework comment period, DOE received comments expressing opposing viewpoints regarding the use of one or two product classes for CCWs. Alliance Laundry Systems (ALS) pressed for two product classes, because ALS believes that in the eyes of consumers, horizontal- and vertical-axis washers can be significantly differentiated in terms of utility and cost. (Public Meeting Transcript, No. 5 at p. 42) However, the Joint Comment argued for a single product class, saying that consumers only want to clean their clothes and, thus, make no distinction between washer product platforms. (Joint Comment, No. 9 at p. 5) The Joint Comment argued that, according to EPCA's definition of classes found at 42 U.S.C. 6219(a), commercial clothes washers should be treated as one class because ''the function * * * of commericial clothes washers (*i.e.*, cleaning clothes) does not depend on the orientation of the clothes washer drum axis.'' (Joint Comment, No. 9 at p. 5) In addition, the Joint Comment contended that DOE chose to maintain one product class during the residential clothes washer rulemaking [12] and, as a result, urged DOE to do the same in this rulemaking. (Joint Comment, No. 9 at p. 5) EEI also supported DOE's designation of a single commercial clothes washer product class. (EEI, No. 7 at p. 3) AHAM ''recommends that the Department conduct its analysis using the product categories currently provided for in its regulations.'' (AHAM, No. 14 at p. 7) The Multi-Housing Laundry Association (MLA) deferred to its member manufacturers' opinions regarding a single product class. (MLA, No. 8 at p. 2) All manufacturers interviewed by DOE as part of the manufacturer impact analysis opposed the elimination of vertical-axis washers, which could arise as an issue if a single product class is analyzed. (See TSD, Chapter 12.)DOE recognizes that, by analyzing a single product class and applying a single standard for energy efficiency and a single standard for water efficiency to all CCWs, absent the consideration of other relevant factors, the highest economically justified standards could be sufficiently stringent as to possibly cause manufacturers to cease production of vertical-axis washers.

As noted above, EPCA, as amended by EPACT 2005, applies a single standard for energy efficiency and a single standard for water efficiency to all CCWs. The Congress enacted a single standard for CCWs some years after DOE has established five classes for residential clothes washers, which may suggest that Congress's initial assessment was that a single class would be most reasonable when updating these standards. The statutory provisions do not, however, specifically prevent DOE from exercising its technical expertise to create separate product classes subject to the same standards, if such differentiation is determined to be appropriate.

After considering the comments on the Framework Document, DOE decided to keep the single class of commercial clothes washers for today's ANOPR, but remains open to the possibility of changing this approach if further comments demonstrate that such a change is warranted. The Joint Comment, for example, argued that the function of clothes washers is to clean clothes and that all commercial clothes washers perform this function and, therefore, should be treated as a single class. DOE has previously rejected this argument. The residential clothes washer rulemaking history clearly demonstrated that size, the axis of access and certain technologies (*e.g.*, suds savings) had consumer utility that affect performance and, therefore, warranted separate classes for residential products. Nevertheless, DOE has decided to maintain a single class

[12] DOE notes that the Joint Comment is incorrect. DOE has established five classes of residential clothes washers, including top-loading compact, top-loading standard and front-loading (See 10 CFR part 430, section 430.32(g)). DOE understands how some stakeholders could believe there is only one class of standard-size residential clothes washers in DOE's regulations since the value of the energy efficiency standard is the same for both classes. While the standards are the same, DOE notes they are separate in DOE's regulations found at 430.32(g). The max tech level for the two classes are different, because of the utility features, and are, therefore, separate classes.

for CCWs in today's ANOPR, for the reasons that follow. First, other stakeholders did not provide any compelling information to support proposing multiple product classes for CCWs, Second, even though there may be some performance-related features on existing CCWs that might warrant multiple CCW product classes (as was demonstrated in the residential clothes washer rulemaking), technologies may be available to enable top-loading units to attain the same efficiency level as front-loading units, thereby rendering any product class distinction meaningless.

In tentatively deciding to retain a single product class for CCWs, DOE was sensitive to other considerations including the likely outcome of requisite U.S. Department of Justice (DOJ) review of the potential impacts, if any, of efficiency standards on competition, given that a large percentage of the overall market for commercial washers is produced by one manufacturer that specializes in vertical-axis machines. Another consideration may be the potential effect of multiple-class standards on the market shares of vertical-axis and horizontal-axis machines. For example, if separate standards further widened the first cost differences between these two classes of washers, then the overall result might be a decline in the market share of the more energy efficient horizontal-axis machines, which could more than offset any energy savings achieved in vertical-axis machines.

DOE notes that sections 325 (o)(4) and 327(d)(4) of EPCA require DOE to consider the availability of performance characteristics, features, and other characteristics in setting standards and in considering State petitions for exemption from Federal preemption. (42 U.S.C. 6295(o)(4) and 6297(d)(4)) The California Energy Commission (CEC) submitted a petition for exemption from Federal preemption by DOE's residential clothes washer standard.[13] One of the factors on which DOE based its denial of the CEC petition was that it would make top-loading clothes washers unavailable in the market. (71 FR 78157)

Based on the discussion above, DOE requests comments on clothes washer product classes and, if DOE were to keep a single class for commercial clothes washers, how to consider the requirements of section 325(o)(4) of EPCA in considering Trial Standard Levels. DOE specifically seeks feedback on these product classes and invites interested persons to submit written presentations of data, views, and arguments as discussed in section IV.E of this ANOPR.

2. Market Assessment

AHAM is the trade association representing the majority of dishwasher, dehumidifier, and cooking product manufacturers. AHAM conducts market and consumer research studies and publishes a biennial *Major Appliance Fact Book.* AHAM also develops and maintains technical standards for various appliances to provide uniform, repeatable procedures for measuring specific product characteristics and performance features. Other trade associations relevant to this rulemaking include the Coin Laundry Association (CLA), representing the 30,000 coin laundry owners globally, and the MLA, a trade association of operator and supplier companies providing professional laundry services for the multi-housing industry.

The majority of the domestic share of CCWs is held by four major manufacturers: ALS, the Maytag Corporation (Maytag), Whirlpool, and GE. Maytag and Whirlpool merged in 2006 but have continued to maintain both product lines to this date.

DOE estimates that there are approximately 13 manufacturers of residential dishwashers that serve the domestic market. Approximately 94 percent of the market is served by four manufacturers: AB Electrolux (Frigidaire), GE, Maytag, and Whirlpool. The merger between Whirlpool and Maytag resulted in the combined company accounting for 51 percent of the domestic market.

DOE estimates that there are approximately 18 manufacturers of residential dehumidifiers that serve the domestic market. Approximately two thirds of the market is represented by two manufacturers: Whirlpool and LG Electronics (LG).

DOE estimates that there are approximately 14 manufacturers of cooking products (including ovens, cooktops, and ranges) that serve the U.S. market. The majority of the cooking products market is represented by four companies: Frigidaire, GE, Maytag, and Whirlpool. GE and Whirlpool represent nearly three quarters of the electric range products market. GE represents over a third of the gas range products market, while the combined Whirlpool and Maytag comprise over a quarter.

The microwave oven market differs from the rest of the domestic cooking product market in that many of the manufacturers are foreign-owned companies with manufacturing facilities outside of the United States. Many of the domestic appliance manufacturers rebrand foreign-manufactured microwave products. Major microwave oven manufacturers are: LG, Samsung Electronics America, Inc. (Samsung), and the Sharp Electronics Corporation (Sharp), serving 67 percent of the domestic market. The second tier of approximately 9 manufacturers serves the remaining 33 percent of the domestic market.

Due to mergers and acquisitions, the home appliance industry continues to consolidate. While the degree of market share concentration varies by product type, the market shares of a few companies provide evidence in support of this characterization. According to the September 2006 issue of *Appliance Magazine*, Whirlpool, GE, Frigidaire, and Maytag comprise 92 percent of the U.S. core appliance market share. ''Core appliances'' include dishwashers, freezers, ranges, refrigerators, and clothes washers. Whirlpool and Maytag were allowed by the U.S. Department of Justice (DOJ) to complete a merger on March 31, 2006, after an investigation that focused primarily on residential laundry but with consideration of impacts across all product lines. Although opponents of the merger had asserted that the combined companies would control as much as 70 percent of the residential laundry market and as much as 50 percent of the residential dishwasher market,[14] DOJ determined that the merger would not give Whirlpool excessive market power in the sale of its products and that any attempt to raise prices would likely be unsuccessful. In support of this claim, DOJ noted: (1) Other U.S. brands, including Sears Brands LLC (Kenmore), GE, and Frigidaire, are well established; (2) foreign manufacturers, including LG and Samsung, are gaining market share; (3) existing U.S. manufacturers are operating below production capacity; (4) the large home appliance retailers have alternatives available to resist price increase attempts; and (5) Whirlpool and Maytag substantiated large cost savings and other efficiencies that would benefit consumers. The Whirlpool-Maytag merger follows several other mergers and acquisitions in the home appliance industry. For example, Maytag acquired Jenn-Air Corporation in 1982, Magic Chef, Inc. in 1986, and Amana Appliances in 2001. Whirlpool acquired the KitchenAid division of Hobart Corporation in 1986. White Consolidated Industries (WCI)

[13] DOE Docket No. EE–RM–PET–100, submitted by the California Energy Commission.

[14] P. Hussmann, ''Justice to Extend Maytag-Whirlpool Merger Review,'' Newton Daily News Online (Feb. 14, 2006).

acquired the Frigidaire division of General Motors Corporation in 1979, and AB Electrolux acquired WCI (and therefore Frigidaire) in 1986. See Chapter 3 of the TSD for more information regarding manufacturers of CCWs and residential dishwashers, dehumidifiers, and cooking products.

In addition, DOE considers the possibility of small businesses being impacted by the promulgation of energy conservation standards for CCWs and residential dishwashers, dehumidifiers, and cooking products. At this time, DOE is not aware of any small manufacturers, defined by the Small Business Administration as having 750 employees or fewer, who produce products that fall under this rulemaking and who, therefore, would be impacted by a minimum efficiency standard. Should any small business manufacturers of the four appliance products be identified, DOE will study the potential impacts on these small businesses in greater detail during the MIA, which it will conduct as a part of the NOPR analysis. See Chapter 3 of the TSD for more information regarding small business manufacturers of CCWs and residential dishwashers, dehumidifiers, and cooking products.

Next, DOE identified distribution channels for each of the products covered by this rulemaking. For CCWs, DOE determined that the market consists of laundromats, private multi-family housing, and large institutions (*e.g.*, military barracks, universities, and housing authorities). Most large institutions and a majority of private multi-family housing (between 50 and 90 percent) do not purchase clothes washers directly. Rather, these organizations lease their laundry space to a third party known as a route operator. Route operators supply laundry equipment and maintain facilities in exchange for a percentage of the laundry revenue. Laundromats and some private building managers purchase or lease clothes washers directly from distributors. The main difference between route operators and distributors is the length of service provided to their clients. Route operators provide ongoing support while distributor support ends at the point of sale.

The distribution chain for residential appliances, including dishwashers, dehumidifiers, and cooking products, differs from commercial products, since the majority of consumers purchase their appliances directly from retailers. These retailers include: (1) Home improvement, appliance, and department stores; (2) Internet retailers; (3) membership warehouse clubs; and (4) kitchen remodelers. DOE determined that over 93 percent of residential appliances are distributed from the manufacturer directly to a retailer. See Chapter 3 of the TSD for more information regarding distribution channels for CCWs and residential dishwashers, dehumidifiers, and cooking products.

DOE considers regulatory and non-regulatory initiatives that affect CCWs and residential dishwashers, dehumidifiers, and cooking products. NAECA established Federal standards for residential dishwashers, which were subsequently amended by DOE by a final rule published in the **Federal Register** on May 14, 1994. (56 FR 22250) NAECA established prescriptive standards for gas cooking products, requiring gas ranges and ovens with an electrical supply cord not to be equipped with constant burning pilots, and directed DOE to conduct two cycles of rulemakings to determine if more stringent standards are justified. (42 U.S.C. 6295 (h)(1)–(2)) DOE issued a NOPR on March 4, 1994, proposing performance standards for gas and electric residential cooking products, including microwave ovens. 59 FR 10464. In accordance with its 1996 Process Rule, DOE refined its standards analysis of cooking products. With regard to gas cooking products, DOE focused on the economic justification for eliminating standing pilot lights. Partially due to the difficulty of conclusively demonstrating that elimination of standing pilot lights was economically justified, DOE issued a final rule on September 8, 1998, that covered only electric cooking products, including microwave ovens. 63 FR 48038. The final rule found that standards were not economically justified for electric cooking products. DOE never completed its standards rulemaking for gas cooking products.

Section 136(e) of EPACT 20005 amends section 342 of EPCA, 42 U.S.C. 6313, to add subsection (e) for CCWs. Likewise, section 135(c)(4) of EPACT 2005 amends section 325 of EPCA, 42 U.S.C. 6295, to add subsection (cc) for dehumidifiers. New subsection 342(e), 42 U.S.C. 6313(e) establishes energy conservation standards for CCWs. Further, it requires that DOE issue a final rule by January 1, 2010, to determine whether the standards for CCWs should be amended. New subsection 325(cc), 42 U.S.C. 6295(cc), establishes energy conservation standards for dehumidifiers based on a unit's capacity to extract moisture from the surrounding air (in pints/day). These Federally mandated standards for dehumidifiers will be the national standards when they take effect on October 1, 2007. In addition, EPACT 2005 requires that by October 1, 2009, DOE issue a final rule for dehumidifiers to determine whether the standards should be amended. (EPACT 2005, section 135(c)(4)) Further, in the event that DOE fails to publish a final rule requiring new standards to take effect by October 1, 2012, EPACT 2005 also prescribes a new set of amended standards for dehumidifiers. (*Id.*)

Prior to the passage of EPACT 2005, the following States proposed and adopted State-level efficiency regulations for CCWs that are identical, or very similar, to EPACT 2005 regulations: Arizona, California, Connecticut, Maryland, New Jersey, Oregon, Rhode Island, and Washington. The EPACT 2005 energy and water use standards for CCWs preempt any State efficiency standards since they became effective January 1, 2007.[15] In addition to the efficiency standards discussed above, the State of California requires that commercial top-loading, semi-automatic clothes washers and commercial suds-saving clothes washers manufactured on or after January 1, 2005 have an unheated rinse water option.

DOE reviewed several voluntary programs that promote energy-efficient CCWs, residential dishwashers, dehumidifiers, and cooking products in the United States. Many programs, including the Consortium for Energy Efficiency (CEE), Energy Star, and the Federal Energy Management Program (FEMP), establish voluntary energy conservation standards for these products. CEE issues voluntary specifications for CCWs and standard-sized dishwashers under its Commercial, Family-Sized Washer Initiative and Super-Efficient Home Appliance Initiative, respectively. Energy Star, a voluntary labeling program backed by the EPA and DOE, identifies energy efficient products through a qualification process. To qualify, a product must exceed Federal minimum standards by a specified amount, or if no Federal standard exists, exhibit selected energy-saving features. The Energy Star program works to recognize the top quartile of products on the market, meaning that approximately 25 percent of products on the market meet or exceed the Energy Star levels. Energy Star specifications exist for many products, including CCWs, dishwashers, and dehumidifiers. FEMP

[15] None of these States submitted a petition for waiver to DOE, seeking to maintain their existing efficiency standards for commercial clothes washers.

works to reduce the cost and environmental impact of the Federal government by advancing energy efficiency and water conservation, promoting the use of distributed and renewable energy, and improving utility management decisions at Federal sites. FEMP helps Federal buyers identify and purchase energy efficient equipment, including CCWs, residential dishwashers, and microwave ovens. See Chapter 3 of the TSD for more information regarding regulatory and non-regulatory initiatives. During the engineering analysis (Chapter 5 of the TSD), efficiency levels specified by many of these initiatives will be analyzed during the generation of cost-efficiency curves.

DOE reviewed data collected by the U.S. Census Bureau, EPA, and AHAM to evaluate annual residential appliance product shipment trends and the value of these shipments. As the number of new home starts and the percentage of consumers with multiple units of some appliances increases annually, the unit shipments of most appliances are expected to increase as well. The shipments of built-in dishwashers increased by over 76 percent from 1995 to 2005, while the shipments of portable dishwashers declined 35 percent in the same time period. After a period of decline from 1995 to 2002, shipments of dehumidifiers increased sharply in 2003 and have continued to rise through 2005. Shipments of dehumidifiers nearly doubled between 1995 and 2005. From 1995 to 2005, shipments of electric and gas free-standing ranges and surface cooking units, electric built-in ranges, and microwave ovens increased, while shipments of built-in gas ranges decreased. However, in real dollars, the value of shipments for the household appliance industry has declined by nearly 14 percent over the period from 1994 to 2005.

The historical shipments data shown in Tables II.1, II.2, and II.3 and the historical market saturation data shown in Table II.4 provide a better picture of the market for the four appliance products. The market saturation data indicate the percentage of the housing stock with the appliance. The data in Table II.4 also include for each of the given years the number of appliances in the housing stock. Because commercial clothes washers are not a household appliance, market saturation data are not provided. The historical shipments and market saturation data for dishwashers, dehumidifiers, and cooking products are from the 2005 AHAM *Fact Books*,[16] while the commercial clothes washer historical shipments data are based on data provided to DOE by AHAM for the years 2002–2005 and *Appliance Magazine* for the years 1988–1998.[17]

TABLE II.1.—INDUSTRY SHIPMENTS OF DISHWASHERS AND DEHUMIDIFIERS

[Domestic and import in thousands of units]

Year	Dishwashers			Dehumidifiers
	Built-In	Portable	Total	
2005	7,294	133	7,428	1,957
2004	6,953	153	7,106	1,672
2003	6,280	148	6,428	1,311
2002	6,049	158	6,207	799
2001	5,478	149	5,627	806
2000	5,663	164	5,827	975
1999	5,542	170	5,712	950
1998	4,969	175	5,144	1,031
1997	4,653	173	4,826	820
1996	4,417	189	4,606	977
1995	4,141	205	4,346	1,003

TABLE II.2.—INDUSTRY SHIPMENTS OF COOKING PRODUCTS

[Domestic and import in thousands of units]

Year	Cooking products								
	Electric ranges				Gas ranges				Microwave ovens
	Free-standing	Built-In	Surface cooking units	Total	Free-standing	Built-In	Surface cooking units	Total	
2005	4,685	973	542	6,201	3,139	64	560	3,762	13,862
2004	4,612	963	570	6,145	3,124	67	528	3,719	15,526
2003	4,238	841	543	5,622	2,897	67	455	3,419	14,274
2002	4,030	780	528	5,338	2,781	71	416	3,268	13,311
2001	3,842	726	498	5,066	2,580	72	384	3,036	13,446
2000	3,826	706	494	5,026	2,729	70	377	3,176	12,644
1999	3,785	705	493	4,983	2,698	72	367	3,137	11,422
1998	3,481	652	506	4,639	2,543	71	336	2,950	10,365
1997	3,177	617	446	4,240	2,391	73	280	2,744	8,883
1996	3,123	614	418	4,155	2,366	72	272	2,710	8,771
1995	2,931	598	389	3,917	2,391	84	240	2,715	8,162

[16] AHAM, *2005 Fact Book*, 2005. Washington, DC. Available for purchase at: *http://www.aham.org/ht/d/Store/name/FACTBOOK.*

[17] 'Statistical Review'. *Appliance Magazine*, April, 1998, 1999.

TABLE II.3.—INDUSTRY SHIPMENTS OF COMMERCIAL CLOTHES WASHERS

[Thousands of units]

Year	Units
2005	177
2004	178
2003	191
2002	175
2001	194
2000	215
1999	239
1998	265
1997	241
1996	232
1995	209
1994	205
1993	190
1992	188
1991	193
1990	225
1989	215
1988	213

TABLE II.4.—APPLIANCE MARKET SATURATIONS: NUMBER OF HOUSEHOLDS WITH PRODUCT (IN MILLIONS) AND PERCENTAGE OF U.S. HOUSEHOLDS WITH PRODUCT

Product	1970		1982		1990		2001		2005	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Dishwashers	12	18.9	37.2	44.5	50.3	53.9	61.8	59.3	80.2	73.7
Dehumidifiers	NA	NA	9.2	11	15.6	16.7	14.7	14.1	20.6	18.9
Electric Ranges/Cooktops*	25.8	40.6	48.4	58	58.4	62.6	69.2	66.3	71	65.3
Gas Ranges/Cooktops*	36.6	57.7	35.7	42.7	36.1	38.7	39.4	37.8	42.2	39
Microwave Ovens	Neg.	Neg.	21.4	25.6	77.2	82.7	94.6	** 90.7	97.2	89.3

* Cooktops not included in 1970 or 1982 data.
** Includes over-the-range and countertop microwave ovens.

During the Framework public meeting, DOE solicited comments regarding existing databases to track CCW efficiencies. ALS commented that the existing CEC database contains useful data and should be reviewed. (Public Meeting Transcript, No. 5 at p. 44) As of March 2007, the CEC database had 626 entries for dishwashers and 196 entries for CCWs. This database, however, does not specify which models are current, and it does not appear to cover the entire range of dishwasher models. DOE also consulted the Energy Star database for residential clothes washers, dishwashers, and dehumidifiers. DOE subsequently used these data to identify units for reverse engineering tear-downs and other analysis. Whenever possible, DOE investigated the design options of the listed appliances, which then helped DOE design the interview guides for the MIA interviews with stakeholders to solicit comments about design options. DOE used the data for residential clothes washers as an additional means of validation for the CCW analysis.

Natural Resources Canada (NRCan) publishes a database of electric cooking appliance performance. Although it is not completely representative of the current U.S. cooking products market, this database covers products available in the Canadian market, which overlaps with the U.S. market. Chapter 3 of the TSD presents data that detail the energy factors of standard and self-cleaning electric ranges and ovens, along with coil-element and smooth element electric cooktops.

DOE also evaluated import and export trends for CCWs and residential dishwashers, dehumidifiers, and cooking products as reported by the U.S. Census Bureau and AHAM, as well as the market saturation for dishwashers, dehumidifiers, and cooking products according to AHAM. On the whole, major appliance unit imports increased 1.8 percent in 2005 from 2004. Major appliance unit exports increased 13.5 percent over the same period. In terms of market saturation, while the percentage of U.S. households with electric ranges and/or cooktops and microwave ovens has decreased slightly since 2001, the market saturation of dishwashers, dehumidifiers, and gas cooking products has increased. See Chapter 3 of the TSD for more information regarding historical shipments and market saturation.

From AHAM data [18]18 and the U.S. Department of Labor's Consumer Price Index, DOE estimated average retail prices for residential appliances, including clothes washers, dishwashers, dehumidifiers, and cooking products. Although prices for electric and gas ranges have increased in the period from 1980 to 2005, the increase has been at a much slower rate than the annual rate of inflation. Prices of residential dishwashers, dehumidifiers, microwave ovens, and clothes washers have decreased in the same time period. DOE also developed the household appliance industry cost structure from publicly available information from the U.S. Census Bureau, the *Annual Survey of Manufacturers* (ASM), and the SEC 10–K reports filed by publicly-owned manufacturers. The statistics illustrate a steady decline in the number of production and non-production workers in the industry.

Inventory levels, expressed both in dollars and as a percentage of value of shipments, have steadily declined since 1995 for the household appliance industry, according to the ASM. DOE obtained full-production-capacity utilization rates from the U.S. Census Bureau, *Survey of Plant Capacity* from 1994 to 2004. Full production capacity is defined as the maximum level of production an establishment could attain under normal operating conditions. In the *Survey of Plant Capacity* report, the full production utilization rate is a ratio of the actual level of operations to the full production level. The full-production-capacity utilization rate for household appliances in aggregate, along with the rates for cooking appliances and household laundry appliances, show a decrease in utilization from 1994 to 2004, although trends in subsets of that time period have fluctuated. See Chapter 3 of the TSD for more information regarding retail pricing, industry cost structure, inventory levels, and production capacity utilization.

[18] Data submitted to DOE as part of this rulemaking, contained in DOE Docket No. EE–2006–STD–0127.

3. Technology Assessment

In the technology assessment, DOE identifies technologies and design options that appear to be feasible means of improving product efficiency, and characterizes energy efficiency of residential dishwashers, dehumidifiers, and cooking products, and CCWs currently available in the marketplace. This assessment provides the technical background and structure on which DOE bases its screening and engineering analyses.

a. Dishwashers

DOE identified technologies to increase the energy efficiency of residential dishwashers primarily from a review of the following three sources: (1) DOE's ANOPR initiating a standards rulemaking for dishwashers, published on November 14, 1994 (59 FR 56423); (2) recent information provided by trade publications; and (3) design data identified in manufacturer product offerings. Except where otherwise noted, design options are taken from the 1994 ANOPR. DOE derived the variable washing pressure and variable-speed drive technologies from the February 2006 edition of *Appliance Magazine.* DOE grouped these technologies together because they collectively address manufacturers' design tradeoffs between the mechanical soil removal function of the water and the cycle time and energy associated with the dishwasher pump. Condenser and fan/jet drying are technologies listed in one manufacturer's product offerings. DOE also identified supercritical carbon dioxide washing from the November 2005 issue of *Appliance Magazine.* It added low-standby-loss electronic controls based on DOE's analysis of controller standby power in dishwashers currently on the market.

In addition to these design options, the multiple water organizations commented that DOE should consider a two-drawer design or similar option which would improve efficiency under partial loads. The multiple water organizations also believe DOE should consider any design option that would reduce pre-rinsing. (Multiple Water Organizations, No. 11 at p. 3) In interviews with manufacturers, DOE determined that two-drawer designs contain no control systems to link the operation of one drawer with another, so that each drawer acts in its own capacity as a compact-size dishwasher. Therefore, a two-drawer design cannot be considered as a design option. Minimizing consumer pre-rinsing depends on maintaining cleaning performance; there are no design options that specifically address pre-rinsing. Any design option that achieves energy efficiency improvements without incurring significant performance penalties will indirectly address pre-rinsing.

DOE considered the design options that follow.

- Condenser drying
- Fan/jet drying
- Flow-through heating
- Improved fill control
- Improved food filter
- Improved motor efficiency
- Improved spray-arm geometry
- Increased insulation
- Low-standby-loss electronic controls
- Microprocessor controls and fuzzy logic, including adaptive or soil-sensing controls
- Modified sump geometry, with and without dual pumps
- Reduced inlet-water temperature
- Supercritical carbon dioxide washing
- Ultrasonic washing
- Variable washing pressure and flow rates

DOE characterized energy efficiency as an EF, expressed as cycles/kWh for dishwashers currently on the market via a survey of the CEC database of certified dishwashers.[19]

b. Dehumidifiers

DOE has not previously conducted a comprehensive analysis of energy conservation standards for dehumidifiers because there are currently no Federal standards for these products. The first such standards become effective October 2007. To build a list of possible design options, DOE surveyed the marketplace for dehumidifier design options by reviewing a wide assortment of product literature, through discovery during the teardown analysis, during stakeholder interviews, and by using its previous room-air conditioning rulemaking analysis as a source for further design options. DOE identified the following design options as possible means to improve dehumidifier performance.

- Built-in hygrometer/humidistat
- Improved compressor efficiency
- Improved condenser performance
- Improved controls
- Improved defrost methods
- Improved demand-defrost controls
- Improved evaporator performance
- Improved fan and fan-motor efficiency
- Improved flow-control devices
- Low-standby-loss electronic controls
- Washable air filters

Based on product literature research, comments, and teardown analysis, DOE has identified compressor, heat exchanger, and fan motor improvements as the most common ways by which manufacturers improve the energy efficiency of their dehumidifiers as measured by the DOE test procedure.

During the Framework public meeting and Framework comment period, stakeholders asked that DOE add improved control systems to the dehumidifier design options list. ACEEE and other energy efficiency advocates recommended that improved controls (such as fuzzy logic) be added to the design option list to better control the dehumidifier. (Public Meeting Transcript, No. 5 at p. 73; Joint Comment, No. 9 at p. 4) DOE agrees that such control technologies offering potential energy savings are being implemented by manufacturers, and, therefore, it added improved controls as a design option for dehumidifiers.

c. Cooking Products

DOE most recently analyzed energy conservation standards for cooking products in 1996 and 1997. In the 1997 analysis, DOE analyzed only gas cooking products to determine the technical and economic feasibility of eliminating standing pilot lights. In its prior analysis, DOE identified many technologies that have the potential for improving gas and electric cooking efficiency. It has considered all of these in this rulemaking. In addition, DOE identified low-standby-loss electronic controls as a design option for several cooking products, based on review of standby power data for microwave ovens and the potential applicability to conventional cooking products as well. Radiant elements for smooth electric cooktops, which were included in the previous analysis, were not considered as a design option for this rulemaking because manufacturer data provided to DOE in the prior rulemaking indicated that this technology does not offer an efficiency improvement over the baseline according to the DOE test procedure. DOE considered the technologies that follow.

For gas cooktops:

- Catalytic burners
- Electronic ignition
- Insulation
- Radiant gas burners
- Reduced excess air at burner
- Reflective surfaces
- Sealed burners
- Thermostatically-controlled burners

For open (coil) element electric cooktops:

- Electronic controls

[19] Available online at: *http://www.energy.ca.gov/appliances/appliance/excel_based_files/.*

• Improved contact conductance
• Insulation
• Low-standby-loss electronic controls
• Reflective surfaces

For smooth element electric cooktops:
• Electronic controls
• Halogen elements
• Induction elements
• Low-standby-loss electronic controls

For gas and electric ovens:
• Bi-radiant oven (electric only)
• Forced convection
• Halogen lamp oven (electric only)
• Improved and added insulation
• Improved door seals
• Low-standby-loss electronic controls
• No oven-door window
• Oven separator
• Pilotless ignition (gas only)
• Radiant burner (gas only)
• Reduced conduction losses
• Reduced thermal mass
• Reduced vent rate
• Reflective surfaces
• Steam cooking

DOE received several comments that the design options from the previous rulemaking are still relevant because there have been no major technological breakthroughs in conventional cooking products since that time. AHAM recommended looking at the same design options because there has been no change in the market other than for induction cooking, which according to AHAM is so expensive it should not be considered. (Public Meeting Transcript, No. 5 at p. 93) ACEEE and the Joint Comment agreed with retaining the design options from the previous rulemaking, stating that only modest updates are needed for conventional cooking products. (Public Meeting Transcript, No. 5 at p. 97; Joint Comment, No. 9 at p. 3) Whirlpool stated that many of the previous design options either are not economically justifiable or have safety issues (Public Meeting Transcript, No. 5 at p. 94), while Wolf commented that the cost and risk of modifying today's well-performing products with questionable design options should not be underestimated. (Wolf, No. 6 at p. 2) DOE believes the aforementioned design options are still relevant and has retained them for analysis. Consumer safety is a screening criterion that DOE has applied in the screening analysis (Chapter 4 of the TSD), and DOE assessed economic viability in the LCC and PBP analyses (Chapter 8 of the TSD).

For microwave ovens, in the previous rulemaking, DOE identified all of the technologies listed below, with the exception of cooking sensors, dual magnetrons, and low-standby-loss electronic controls. DOE identified cooking sensors from product literature, while dual magnetrons were identified in the February 2006 edition of *Appliance Design* as a means to decrease cooking times. DOE identified low-standby-loss electronic controls by reviewing AHAM data for standby power. In addition, DOE received comments stating that it needed to consider sensors and controls that detect completion of the cooking process and variable power supplies that adjust power to the magnetron during cooking. (Public Meeting Transcript, No. 5 at p. 91; Joint Comment, No. 9 at p. 3) DOE did not receive any information regarding the energy efficiency impacts of variable power supplies, and, therefore, will limit the design option relating to variable magnetron output to dual magnetrons. In view of the above, DOE considered the design options that follow.

• Added insulation
• Cooking sensors
• Dual magnetrons
• Eliminate or improve ceramic stirrer cover
• Improved fan efficiency
• Improved magnetron efficiency
• Improved power supply efficiency
• Low-standby-loss electronic controls
• Modified wave guide
• Reflective surfaces

In written comments, AHAM stated that DOE considered many design options for microwave ovens in its 1998 rule and that, after extensive analysis, DOE determined that no design options were technologically feasible or economically justifiable. AHAM also stated that there have been no technological or economic breakthroughs since the previous determination that would change the previous conclusion. (AHAM, No. 17 at p. 1) However, ACEEE disagreed, stating that there have been some significant changes in microwave oven technology since the prior rulemaking. Thus, it stated that the previous design options need to be reviewed. (Public Meeting Transcript, No. 5 at p. 97)

During the Framework public meeting and Framework comment period, DOE received comments that the lack of efficiency data for microwave ovens would hinder DOE's ability to establish efficiency levels, and that DOE should conduct a test program specifically to obtain such efficiency data since it would be difficult for the manufacturers to do so themselves. Whirlpool stated that manufacturers are not using the microwave oven test procedure and, as a result, there is a lack of efficiency data. (Public Meeting Transcript, No. 5 at p. 86) Whirlpool commented that the absence of a microwave oven energy efficiency standard has resulted in a dearth of data on microwave ovens. (Whirlpool, No. 10 at p. 10). ACEEE commented that, because there are very few data on microwave ovens, the baseline efficiency level needs to be updated from the numbers in the previous rulemaking. (Public Meeting Transcript, No. 5 at p. 91) ACEEE further stated that the process to update the data should include collecting as much information from manufacturers as possible, then supplementing these data with product testing. The purpose of these test data, according to ACEEE, should be to assess the validity of the efficiency levels analyzed in the previous rulemaking rather than to quantify a new cost-efficiency relationship. (Public Meeting Transcript, No. 5 at pp. 142–143) AHAM concurred with DOE's intention to conduct microwave oven efficiency testing as part of this rulemaking because it would take industry a significant amount of time to provide efficiency data. AHAM suggested DOE may want to commission the National Institute of Standards and Technology or some other source to do an independent evaluation. (Public Meeting Transcript, No. 5 at p. 143) The Joint Comment stated that because microwave oven technology has changed substantially since the previous rulemaking, DOE should quickly collect current data on product performance and features from manufacturers, and fill in gaps where necessary. Manufacturers could then provide incremental cost data at the selected efficiency levels. (Joint Comment, No. 9 at p. 3)

Stakeholders questioned which microwave oven test procedure should be used. he current DOE test procedure requires manufacturers to test to IEC 705–1988, Household Microwave Ovens—Methods for Measuring Performance, and Amendment 2–1993. The current IEC test procedure is designated IEC 60705 Edition 3.2–2006. Differences between the 1988 and current IEC test procedures can result in differences in measured microwave oven efficiency. In comments received during the Framework public meeting, Sharp asked which test procedure would be used to define microwave oven efficiency. (Public Meeting Transcript, No. 5 at p. 141)

Recognizing the lack of existing energy efficiency data, AHAM conducted a test program on 21 microwave ovens from nine manufacturers, representing a broad spectrum of units available in the marketplace and incorporating a variety of capacities and features. AHAM tested microwave oven efficiency according to DOE's test procedure and standby power according to IEC 62301–2005, Household Electrical Appliances—Measurement of Standby Power. AHAM found no correlation between energy efficiency and rated output power or cavity volume. Efficiencies ranged from 54.8 percent to 61.8 percent. Given the uncertainties in the test procedure, resulting in large test-to-test variations, DOE considers these efficiencies to be comparable to the efficiencies in the prior rulemaking's analysis. Standby power also showed no correlation with rated output power, varied significantly from unit to unit, and ranged from 1.5 watts to 5.8 watts. The FEMP database of microwave oven standby power indicates that 90 percent of reported microwave ovens consume greater than 2 watts in standby mode.

The energy efficiency data upon which DOE based its analysis was measured according to the DOE test procedure, which references IEC 705–1988 and Amendment 2–1993. DOE does not plan to revise the test procedure to incorporate IEC 60705 Edition 3.2–2006, to measure the cooking efficiency, because DOE is unaware of any efficiency comparison data that would justify such a change. However, as discussed above, DOE is examining changes to the test procedure to measure standby-power use.

d. Commercial Clothes Washers

DOE identified technologies to improve the energy efficiency of CCWs. The majority of these technologies are described in the 1996 report entitled *Design Options for Clothes Washers*. (LBNL–47888, October 1996, Lawrence Berkeley National Laboratory) Steam washing and improved horizontal-axis-washer drum design were identified in the September 2005 edition of *Appliance Magazine*. DOE identified the low-standby-power design option during its engineering analysis review of all AHAM product classes. It added spray rinse and advanced agitator design options in response to comments received following the Framework public meeting. DOE considered the design options that follow.

- Adaptive control systems
- Added insulation
- Advanced agitation concepts for vertical-axis machines
- Automatic fill control
- Bubble action
- Direct-drive motor
- Electrolytic disassociation of water
- Horizontal-axis design
- Horizontal-axis design with recirculation
- Improved fill control
- Improved horizontal-axis-washer drum design
- Improved water extraction to lower remaining moisture content
- Increased motor efficiency
- Low-standby-power design
- Ozonated laundering
- Reduced thermal mass
- Spray rinse or similar water-reducing rinse technology
- Steam washing
- Suds savings
- Thermostatically-controlled mixing valves
- Tighter tub tolerance
- Ultrasonic washing

The Multiple Water Organizations requested that DOE add the following design options: (1) Spray rinse, (2) nutating or other advanced agitators, (3) advanced power supplies, and (4) steam cleaning. (Multiple Water Organizations, No. 11 at p. 1) ACEEE requested that DOE consider more water-saving design options (*e.g.*, spray rinse), in addition to energy-saving design options. (Public Meeting Transcript, No. 5 at p. 51) In a joint letter, the Joint Comment requested the addition of a spray wash design option. (Joint Comment, No. 9 at p. 5)

DOE has added advanced agitation concepts for vertical-axis washers. These agitation systems include nutating plates, side-mounted mounted impellers, and any other agitation technology that eliminates the need for the traditional large and centrally-mounted agitator found in vertical-axis clothes washer tubs. While such agitation systems are currently only found on high-end residential clothes washers, they have the potential to be adapted for CCWs and can reduce the water consumption of vertical-axis clothes washers substantially.

DOE has also added spray rinse as a design option but notes that this design option may not be appropriate for the commercial laundry market. ALS commented that some water-reduction design options (such as the ''innovative rinse technology'' in its vertical-axis models) have faced strong opposition from some consumers. (ALS, No. 19 at p. 1) Whirlpool noted that commercial customers tend to overload their washers, which leads to unacceptable rinsing performance. (Whirlpool, No. 10 at p. 3) Given that the industry has fielded washers with rinse-water use reduction technologies (such as spray rinse) in the past and continues to develop other water saving approaches, DOE will consider this design option.

During the Framework public meeting, stakeholders asked DOE whether it will address standby power in CCWs. Potomac suggested that DOE consider technologies that limit standby power in CCWs. Such design options could include improved power supplies or other technologies that limit power consumption in standby mode. (Public Meeting Transcript, No. 5 at p. 52) DOE recognizes the importance of studying all aspects of power consumption by consumer appliances. With the growing trend of upgrading consumer appliances to use electronic controllers, standby power has become a topic of interest across all appliance categories.

During the Framework public meeting, DOE solicited comments regarding existing databases to track CCW efficiencies. ALS commented that the existing CEC database is a good source of information and that DOE should review it. (Public Meeting Transcript, No. 5 at p. 44) DOE subsequently used that database and others to identify CCWs that meet various modified energy factor (MEF) and WF levels. Whenever possible, DOE investigated the design options of the listed washers, which then helped DOE design the interview guides for the MIA interviews with stakeholders to solicit comments about design options.

Additional detail on the technology assessment can be found in Chapter 3 of the TSD.

B. Screening Analysis

1. Purpose

The purpose of the screening analysis is to evaluate the design options that improve the efficiency of a product, in order to determine which options to consider further and which options to screen out because they may not be technologically feasible, may exhibit practicability problems (related to manufacture, installation, or service), may result in adverse impact on product utility or product availability, or may have an adverse impact on health or safety. DOE consults with industry, technical experts, and other interested parties in developing a list of design options for consideration. DOE then applies the following set of screening criteria to determine which design options are unsuitable for further consideration in the rulemaking (10 CFR Part 430, Subpart C, Appendix A at 4(a)(4) and 5(b)).

a. Technological Feasibility

DOE will consider technologies incorporated in commercial products or in working prototypes to be technologically feasible.

b. Practicability To Manufacture, Install, and Service

If mass production of a technology in commercial products and reliable installation and servicing of the technology could be achieved on the scale necessary to serve the relevant market at the time of the effective date of the standard, then DOE will consider that technology practicable to manufacture, install, and service.

c. Adverse Impacts on Product Utility or Product Availability

If DOE determines a technology to have significant adverse impact on the utility of the product to significant subgroups of consumers, or to 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 U.S. at the time, it will not consider this technology further.

d. Adverse Impacts on Health or Safety

If DOE determines that a technology will have significant adverse impacts on health or safety, it will not consider this technology further.

2. Design Options

a. Dishwashers

For dishwashers, DOE screened out reduced inlet-water temperature, supercritical carbon dioxide washing, and ultrasonic washing technologies, for the reasons that follow.

Reduced inlet-water temperature requires that dishwashers tap the cold water line for the water supply, which would require significant alteration of existing dishwasher installations in order to accommodate newly-purchased units incorporating this design option. Whirlpool commented that such a retrofit of existing residential plumbing necessary to accommodate a reduced inlet-water temperature design would be costly, and, therefore, DOE should eliminate this design option. (Whirlpool, No. 10 at p. 4) DOE agrees that this design option does not meet the screening criterion of practicability to install. Therefore, DOE screened out reduced inlet-water temperature from further analysis. AHAM supported this decision. (AHAM, No. 14 at p. 8)

Supercritical carbon dioxide washing, in which supercritical carbon dioxide dissolves grease from the dishware instead of conventional detergent and water, is in the research stage, so DOE believes it would not be practicable to manufacture, install, and service at the time of the effective date of an amended standard. Furthermore, it is also not yet possible to assess whether it will have any adverse impacts on equipment utility to consumers or equipment availability, or any adverse impacts on consumers' health or safety. Therefore, DOE screened out supercritical carbon dioxide washing from further analysis.

For ultrasonic washing, high frequency energy input into the wash water creates cavitation bubbles that remove soil from the dishware via mechanical scrubbing action. With this technology, consumer utility is decreased due to the potential for the ultrasonic cleaning action to damage fragile dishware and due to the perception that the low temperatures do not sterilize dishes. Whirlpool also commented that ultrasonic dishwashing is beyond the technological scope of current product development. (Whirlpool, No. 10 at p. 4) Since no manufacturer currently produces ultrasonic dishwashers, it is impossible to assess whether this design option would have any impacts on consumer health or safety, or product availability. Therefore, DOE screened out ultrasonic dishwashing from further analysis. In comments submitted after the Framework public meeting, AHAM agreed that DOE should eliminate ultrasonic dishwashing. (AHAM, No. 14 at p. 8) Table II.5 lists the dishwasher design options that DOE has retained for analysis.

TABLE II.5.—RETAINED DESIGN OPTIONS FOR DISHWASHERS

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

According to Whirlpool, soil sensors have contributed to significant dishwasher water and energy savings. However, Whirlpool is unaware of any further technological breakthroughs which would dramatically change the energy consumption of dishwashers. Approximately 90 percent of dishwashers are currently Energy Star-qualified. (Whirlpool, No. 10 at p. 1) DOE has noted that many dishwashers are able to meet Energy Star requirements without the use of a soil sensor. It may be assumed that the incorporation of soil sensors to such models offers the potential for additional energy savings. DOE also notes that there are multiple technologies that can be used by themselves or to complement others to determine soiling levels inside a dishwasher. For example, it is possible to use a pressure sensor, rather than the more typical turbidity sensors, to detect clogging of a filter to infer soil loads. The maximum technologically feasible (''max-tech'') dishwasher that DOE investigated went a step further, featuring both a turbidity and a pressure sensor, implying a benefit from using both sensor technologies. Since there are many approaches to and levels of sophistication of soil sensing may be taken to depending on the underlying dishwasher platform, DOE will retain soil sensing for further analysis.

Whirlpool also stated that variable washing pressures and flow rates and condenser drying are beyond the technological scope of current product development, and therefore DOE should eliminate them from further analysis. (Whirlpool, No. 10 at p. 4) AHAM stated without elaboration that condenser drying should be eliminated from the analysis. (AHAM, No. 14 at p. 8) In reviewing current dishwasher models, DOE noted multiple instances in which manufacturer specifications indicate variable washing pressures and flow rates. For example, such a strategy may include alternating wash water to the top and bottom racks. In addition, DOE is aware of at least one dishwasher platform on the market with true condensation drying, in which relatively cool ambient air is drawn across the outside of the stainless steel dishwasher cavity, providing a surface on which moisture from the hotter dishware can condense. Since variable washing pressures and flow rates and condenser drying are already in wide distribution, DOE will retain these design options for further analysis.

AHAM also requested that DOE replace the term ''fan/jet drying'' with the term ''fan-assist drying'' and clarify the term ''flow-through heating.'' (AHAM, No. 14 at p. 8) DOE believes that the change to fan-assist drying is appropriate, and will designate the design option in further analyses accordingly.

''Flow-through heating'' is differentiated from conventional dishwasher heating by the positioning of the heating element. Conventional dishwasher heaters use a tubular electric resistance element positioned inside the dishwasher cavity, above the sump, where it is exposed to the wash and rinse water. Flow-through heaters pass the water through a metallic tube around which a resistive heating element is wrapped. Consequently, less water is typically required in the dishwasher sump for flow-through heaters since they form an integrated part of the water flow path and do not require high levels of standing water above the sump, as do tubular heating elements. Therefore, the potential exists for dishwashers using flow-through heating to have reduced water and energy consumption.

b. Dehumidifiers

For dehumidifiers, all technologies meet the screening criteria.

Table II.6 lists the dehumidifier design options that DOE has retained for analysis.

TABLE II.6.—RETAINED DESIGN OPTIONS FOR DEHUMIDIFIERS

1. Built-in hygrometer/humidistat.
2. Improved compressor efficiency.
3. Improved condenser performance.
4. Improved controls.
5. Improved defrost methods.
6. Improved demand-defrost controls.
7. Improved evaporator performance.
8. Improved fan and fan-motor efficiency.
9. Improved flow-control devices.
10. Low-standby-loss electronic controls.
11. Washable air filters.

c. Cooking Products.

For cooking products, Whirlpool commented that DOE should eliminate from this analysis all design options that DOE eliminated in the previous rulemaking for reasons of feasibility, cost, and/or consumer safety. (Whirlpool, No. 10 at pp. 5–7) DOE will evaluate each design option again, and only will eliminate from further consideration those technologies that fail to meet one or more of the screening criteria.

1. Cooktops and Ovens

For gas cooktops, DOE screened out catalytic burners, radiant gas burners, reduced excess air at burner, and reflective surfaces for the reasons that follow.

DOE is not aware of any commercialized catalytic burners for gas cooktops. Therefore, DOE believes they would not be practicable to manufacture, install, and service at the time of the effective date of an amended standard. Also, because this technology is in the research stage, it is not possible to assess whether it will have any adverse impacts on equipment utility to consumers or equipment availability, or any adverse impacts on consumers' health or safety. Therefore, DOE has decided to exclude catalytic burners from further analysis.

In the previous rulemaking, manufacturers concluded that infrared jet-impingement radiant gas burners would not be able to comply with the ANSI Standard Z21.1–2005, *Household Cooking Gas Appliances.* Field testing had shown that users were unable to turn down the burner satisfactorily, which indicated a potential health and safety risk. More recently, a silicon carbide radiant burner has been tested to the Japanese Industrial Standard (JIS) S 2103–1996, *Gas Burning Appliances for Domestic Use,* but there is no data to evaluate whether this burner would conform to the ANSI standard since it is not commercially available in the U.S. Due to potential impacts on consumer health and safety, DOE screened out radiant gas burners from further analysis.

Reduced excess air at the burner has not been definitively shown to increase efficiency. Also, because the technology has not been commercialized, DOE believes it would not be practicable to manufacture, install, and service at the time of the effective date of an amended standard. In addition, DOE cannot assess adverse impacts on consumers' utility, health, or safety or equipment availability for this technology. Further, Whirlpool suggests there are combustion-related issues with reducing excess air. (Public Meeting Transcript, No. 5 at p. 94) DOE agrees that reducing excess air at the burner increases the possibility of adverse conditions such as poor flame quality and elevated carbon monoxide levels, which would suggest adverse impacts on consumers' utility, health, and safety. For these reasons, DOE screened out reduced excess air at the burner from further analysis.

In the previous rulemaking, manufacturers reported adverse impacts on consumer utility due to the requirement for regular and careful cleaning of reflective surfaces, and this concern remains at present. In addition, since this technology has still not been commercialized, DOE cannot assess the impacts on consumer health and safety or equipment availability. Therefore, DOE screened out reflective surfaces for gas cooktops from further analysis.

Table II.7 lists the gas cooktop design options that DOE has retained for analysis.

TABLE II.7.—RETAINED DESIGN OPTIONS FOR GAS COOKTOPS

1. Electronic ignition.
2. Insulation.
3. Sealed burners.
4. Thermostatically-controlled burners.

The Joint Comment agreed with the inclusion of electronic ignition for gas ranges, and thereby for gas cooktops and ovens. They stated that earlier analysis found significant, cost-effective savings achieved by eliminating pilot lights. (Joint Comment, No. 9 at p. 3)

For electric open (coil) cooktops, DOE screened out reflective surfaces, for the reasons that follow.

In the previous rulemaking, manufacturers reported adverse impacts on consumer utility due to the requirement for regular and careful cleaning of reflective surfaces, and this concern remains at present. Furthermore, because this technology has still not been commercialized, DOE cannot assess its impacts on consumer health and safety or equipment availability. Therefore, DOE screened out reflective surfaces from further analysis for electric coil cooktops.

Table II.8 lists the electric open (coil) cooktop design options that DOE has retained for analysis.

TABLE II.8.—RETAINED DESIGN OPTIONS FOR ELECTRIC OPEN (COIL) ELEMENT COOKTOPS

1. Electronic controls.
2. Improved contact conductance.
3. Insulation.
4. Low-standby-loss electronic controls.

For electric smooth cooktops, all technologies meet the screening criteria.

Table II.9 lists the electric smooth cooktop design options that DOE has retained for analysis.

TABLE II.9.—RETAINED DESIGN OPTIONS FOR ELECTRIC SMOOTH ELEMENT COOKTOPS

1. Electronic controls.
2. Halogen elements.
3. Induction elements.
4. Low-standby-loss electronic controls.

For ovens, DOE screened out added insulation, bi-radiant oven, halogen lamp oven, no oven door window, oven separator, reduced thermal mass, and reflective surfaces, for the reasons that follow.

Although some analyses have shown reduced energy consumption by increasing the thickness of the insulation in the oven cabinet walls and doors from two inches to four inches, consumer utility would be negatively impacted by the necessary reduction in cavity volume to maintain the same oven footprint and overall cabinet volume. Therefore, DOE screened out added insulation. The improved insulation design option, however, will be retained, because insulation with a higher density (*i.e.*, greater insulating value) does not require additional space and thus would not impact oven cavity size.

The last working prototype of a bi-radiant oven known to DOE was tested in the 1970s. The technology requires a low-emissivity cavity, electronic controls, and highly absorptive cooking utensils. The need for specialized cookware and cavity maintenance issues negatively impact consumer utility. Therefore, DOE screened out bi-radiant ovens from further analysis.

While GE currently markets a line of electric ovens that incorporates halogen elements along with conventional resistance heating elements, microwave heating, and, optionally, a convection system, DOE is not aware of any ovens that utilize halogen lamps alone as the heating element, and no data were found or submitted to demonstrate how efficiently halogen elements alone perform relative to conventional ovens. DOE believes that it would not be practicable to manufacture, install, and service halogen lamps for use in consumer cooking products on the scale necessary to serve the relevant market at the time of the standard's effective date. Therefore, DOE screened out halogen lamp ovens.

The previous rulemaking's analysis reported a small annual energy savings associated with no oven door window, but that consumer practices of opening the door to inspect the food while cooking could negate any benefit. EEI commented during the Framework public meeting that DOE should eliminate the no oven door window design option due to the potential impact on utility and safety, and it is likely that the technology is not a feasible option for most ovens. EEI also suggested evaluating double-pane or similar oven door windows. (Public Meeting Transcript, No. 5 at p. 94; EEI, No. 7 at p. 6) DOE agrees that reduced consumer utility along with decreased safety due to the additional door openings justify elimination of this design option from further analysis. In addition, DOE addresses the efficiency impact of double-pane or other highly insulated oven door windows by means of the reduced conduction losses design option, which has been retained for further analysis.

An oven separator has been researched but has never been put into production. Manufacturers stated during the previous rulemaking that a separator could not be economically designed for conventional gas ovens. The use of a separator in electric ovens would require the installation of an additional element and a non-conventional control system. Manufacturers also stated that it would be difficult to obtain Underwriters Laboratory and AGA approvals and meet existing ANSI standards because of the effect the separator would have on safety and performance. Manufacturers also stated that consumer acceptance would probably be low because appliances such as microwave and toaster ovens already exist to cook small loads. In addition, the separator would have to be designed to be ''fool-proof'' to prevent consumers from accidentally installing it incorrectly. With regard to energy use, the additional metal added to the oven by the separator (increased thermal mass) might result in increased energy losses, although data provided by AHAM indicated an increase in efficiency of approximately 0.82 percentage points in an electric oven. However, the anticipated negative impacts on consumer utility and safety, along with practicability to manufacture, resulted in DOE screening out the oven separator from further analysis. Whirlpool expressed support for elimination of this design option, mentioning consumer safety as one of many issues. (Public Meeting Transcript, No. 5 at p. 95) For example, safety issues could arise in a gas oven if the separator is incorrectly installed, resulting in improper burner operation.

In the previous rulemaking, manufacturers commented that a thermal mass reduction in ovens was not possible without compromising structural integrity (during both use and transportation) and increasing heat losses. Although tests by the Gas Research Institute (GRI) showed a small efficiency improvement, the issues of structural integrity and associated consumer product safety led DOE to eliminate thermal mass reduction from further analysis.

Manufacturers stated in the previous rulemaking that reflective surfaces degrade throughout the life of the oven, particularly for self-cleaning ovens, and GRI reported tests that showed this design option can actually result in a decrease of energy efficiency. The uncertainty in energy savings, coupled with a lack of sophistication in the technology in terms of maintaining the reflective surfaces over the lifetime of the oven, led DOE to eliminate this technology from further analysis.

Table II.10 lists the gas and electric oven design options that DOE has retained for analysis.

TABLE II.10.—RETAINED DESIGN OPTIONS FOR GAS AND ELECTRIC OVENS

1. Forced convection.
2. Improved door seals.
3. Improved insulation.
4. Low-standby-loss electronic controls.
5. Pilotless ignition (gas only).
6. Radiant burner (gas only).
7. Reduced conduction losses.
8. Reduced vent rate.
9. Steam cooking.

The Joint Comment recommended that DOE study the energy used by ignition devices in gas ovens. (Joint Comment, No. 9 at p. 3) DOE will include the gas energy consumption of pilot lights and electrical energy consumption of pilotless ignition in the engineering analysis (see Chapter 5 of the TSD).

2. Microwave Ovens

For microwave ovens, all technologies meet the screening criteria.

Table II.11 lists the microwave oven design options that DOE has retained for analysis.

TABLE II.11.—RETAINED DESIGN OPTIONS FOR MICROWAVE OVENS

1. Added insulation.
2. Cooking sensors.
3. Dual magnetrons.
4. Eliminate or improve ceramic stirrer cover.
5. Improved fan efficiency.
6. Improved magnetron efficiency.
7. Improved power supply efficiency.
8. Low-standby-loss electronic controls.
9. Modified wave guide.
10. Reflective surfaces.

AHAM submitted written comments on the microwave oven design options. For improved fan efficiency, AHAM commented that, since the fan accounts for less than 2 percent of the total energy consumption in the microwave oven, a high efficiency fan would improve energy factor by less than 0.5 percent. Therefore, AHAM argued that efficient fans are not economically justified. (AHAM, No. 17 at pp. 2–3) However, AHAM did not provide any data that supported their conclusion of a lack of economic justification. Therefore, DOE will consider improved fan efficiency in its analysis.

According to AHAM, considerable effort has already been expended to optimize magnetron efficiency.

Manufacturers' specifications indicate that typical efficiency is about 73 percent with only a plus or minus 2 percentage point variance. Thus, AHAM argued that there is little opportunity to improve microwave energy efficiency for manufacturers using magnetrons. (AHAM, No. 17 at p. 3) A literature review that DOE performed, however, determined that oscillation efficiencies of up to 78 percent have been reported. DOE has decided to retain improved magnetron efficiency for analysis, because this design option: (1) Is technologically feasible; (2) is practicable to manufacture, install, and service; (3) does not result in loss of product utility or product availability; and (4) does not have adverse impacts on health or safety.

AHAM commented that there are two types of high-voltage power supplies used in microwave ovens, as described below. The most common type is the inductive capacitance transformer, which has an efficiency of about 82 percent. More expensive inverter-based power supplies are about 84 percent efficient. Higher efficiency general purpose transformers do not have stable enough output power for microwave oven application. AHAM stated that, among the units tested, there was no correlation between power supply type and cooking efficiency. AHAM also does not believe there is a cost-effective opportunity for improving the efficiency of the power supply. (AHAM, No. 17 at p. 3) However, AHAM did not submit any data demonstrating a lack of correlation between power supply type and cooking efficiency or refuting economic justification. Therefore, DOE will consider improved power supply efficiency in its analysis, during which it will assess economic viability.

For reflective surfaces, AHAM commented that manufacturers are already using surface finishes to optimize efficiency. Also, AHAM stated that proper oven cavity design would obviate the need to add any metallic plates inside the cavity to match the highest oscillation impedance of the magnetron. (AHAM, No. 17 at p. 2) Testing by manufacturers, however, has shown that a high-grade stainless steel or reflective material steel coating can improve efficiency by 0.5 percent over painted cold-rolled steel. Since DOE is aware of data demonstrating efficiency improvement as a function of surface reflectivity, DOE will retain reflective surfaces for analysis.

d. Commercial Clothes Washers

During the Framework public meeting and Framework comment period, DOE solicited comments from stakeholders regarding which design options found in residential clothes washers would be applicable to CCWs. However, multiple manufacturers of CCWs cautioned that CCWs are not just slightly modified extensions of their residential product lines, and, thus, some design options currently found on their residential lines may not be applicable for commercial use.

In addition, ALS requested that DOE recognize the unique environment in which CCWs operate and how that precludes the implementation of several design options found in the residential market. Such options could be incompatible with the requirements regarding ruggedness, reliability, and performance routinely demanded in a commercial setting. (Public Meeting Transcript, No. 5 at p. 43) For example, Whirlpool stated that design options such as spray rinse have not performed adequately in commercial settings due to the routine problem of overloading by consumers. Commenters also asserted that inadequate rinsing performance typically leads consumers to re-run loads, thereby increasing water and energy consumption.

Whirlpool, ALS, and AHAM requested that the following design options be removed from consideration: Bubble action, electrolytic disassociation of water, ozonated laundering, reduced thermal mass, suds saving, ultrasonic washing, and horizontal-axis design. Whirlpool and AHAM additionally requested that steam washing be removed from consideration. Whirlpool stated that all of the aforementioned design options were removed from consideration during the recent residential clothes washer rulemaking and, therefore, should be removed from consideration during this rulemaking as well. ALS provided a similar rationale for the design options it requested to be excluded. AHAM further requested that the improved horizontal-axis-washer drum design option be removed. (Whirlpool, No. 10 at p. 3; Public Meeting Transcript, No. 5 at p. 49; AHAM, No. 14 at p. 7)

In light of the available information, DOE subsequently screened out bubble action, electrolytic disassociation of water, ozonated laundering, reduced thermal mass, suds saving, and ultrasonic washing from further analysis, for the reasons that follow.

Although bubble washing has been incorporated into commercial products, production is extremely limited and further commercialization would require manufacturers to develop entirely new platforms. Therefore, DOE does not believe that this technology would be practicable to manufacture, install, and service on the scale necessary to serve the relevant market at the time of the effective date of an amended standard. For these reasons, DOE screened out the bubble action design option.

DOE is not considering electrolytic disassociation of water and ozonated laundering because these technologies are at the research stage. Therefore, DOE believes that it would not be practicable to manufacture, install, and service either technology on the scale necessary to serve the relevant market at the time of the effective date of an amended standard. Also, because these technologies are in the research stage, it is not possible to assess whether they will have any adverse impacts on equipment utility to consumers or equipment availability, or any adverse impacts on consumers' health or safety. Therefore, DOE screened out electrolytic disassociation of water and ozonated laundering as design options for improving the energy efficiency of CCWs.

Reduced thermal mass has not been incorporated into clothes washers, so DOE believes that it would not be practicable to manufacture, install, and service this technology on the scale necessary to serve the relevant market at the time of the effective date of an amended standard. Also, because this technology has not been incorporated into clothes washers, it is not possible to assess whether it will have any adverse impacts on equipment utility to consumers or equipment availability, or any adverse impacts on consumers' health or safety. Therefore, DOE screened out reduced thermal mass as a design option for improving the energy efficiency of CCWs.

Suds-saving residential clothes washers, in which wash water is stored for subsequent reuse, were previously commercially available, but required an adjacent washtub to store suds in between wash cycles. Due to these installation requirements, DOE believes that suds saving clothes washers would be impractical to install in many locations. Suds-saving clothes washers reduce consumer utility by requiring consumers to occupy space adjacent to the washer with an additional washtub. In a commercial setting, this may limit the number of clothes washers that may be installed. Consumers must also wash clothes sequentially to fully capture the energy saving benefits of suds saving. Delays between wash cycles allow the saved water to cool, reducing wash performance and energy savings. Finally, suds-saving clothes washers can carry over heavy soiling between clothing loads, reducing wash performance as well. Therefore, DOE will not consider suds saving as a design option for improving the energy efficiency of commercial clothes washers.

Ultrasonic washing promotes mechanical soil removal through the introduction of ultrasonic vibrations into the wash tub. This technology has been demonstrated in clothes washers, but the ultrasonic clothes washer did not adequately remove soil from the clothes. Thus, ultrasonic clothes washing would reduce consumer utility by not adequately washing clothes. In addition, bubble cavitations caused by standing ultrasonic waves could potentially damage some fragile clothing or clothing fasteners, further reducing consumer utility. Since no manufacturers currently produce ultrasonic clothes washers, it is impossible to assess whether it will have any impacts on consumers' health or safety, or product availability. For these reasons, DOE screened out ultrasonic washing as a design option for improving the energy efficiency of CCWs.

In the comment period following the Framework public meeting, EEI suggested that at least one major detergent manufacturer has formulated a cold-water detergent, capable of washing all types of clothes in cold water. According to EEI, such detergents promise significant energy savings since they could eliminate the need for heated water in CCWs. (EEI, No. 7 at p. 4) While cold-water detergents show promise, the present clothes washer test procedure does not recognize the potential energy benefits of such detergents. DOE will consider possible future amendments to the test procedure to account for cold-water detergents. Thus, in the context of the present rulemaking, DOE will not analyze the potential impact of cold-water detergents.

Table II.12 lists the CCW design options that DOE has retained for analysis. For further review of the retained design options, please see Chapter 3 of the TSD.

TABLE II.12.—RETAINED DESIGN OPTIONS FOR COMMERCIAL CLOTHES WASHERS

1. Adaptive control systems.
2. Added insulation.
3. Advanced agitation concepts for vertical-axis machines.
4. Automatic water fill control.
5. Direct-drive motor.
6. Horizontal-axis design.
7. Horizontal-axis design with recirculation.
8. Improved fill control.
9. Improved horizontal-axis-washer drum design.
10. Improved water extraction to lower remaining moisture content.
11. Increased motor efficiency.
12. Low-standby-power design.
13. Spray rinse or similar water-reducing rinse technology.
14. Steam washing.
15. Thermostatically-controlled mixing valves.
16. Tighter tub tolerance.

In general, for more detail on how DOE developed all of the technology options discussed above and the process for screening these options, refer to the technology and screening section (Chapter 4) of the TSD.

C. Engineering Analysis

In the engineering analysis DOE evaluates a range of product efficiency levels and their associated manufacturing costs. The purpose of the analysis is to estimate the incremental manufacturer selling prices for a product that would result from achieving increased efficiency levels, above the level of the baseline model, in each product class. The engineering analysis considers technologies and design option combinations not eliminated in the screening analysis. The LCC analysis uses the cost-efficiency relationships developed in the engineering analysis.

DOE typically structures its engineering analysis around one of three methodologies. These are: (1) The design-option approach, which calculates the incremental costs of adding specific design options to a baseline model; (2) the efficiency-level approach, which calculates the relative costs of achieving increases in energy efficiency levels, without regard to the particular design options used to achieve such increases; and/or (3) the reverse engineering or cost-assessment approach, which involves a ''bottom-up'' manufacturing cost assessment based on a detailed bill of materials derived from teardowns of the product being analyzed. Deciding which methodology to use for the engineering analysis depends on the product, the design options under study, and any historical data that DOE can draw on.

Traditionally, DOE used a design-approach for all of its cost-benefit analyses. However, in more recent rulemakings, DOE has shifted to using an efficiency-level approach that may or may not be supplemented with a reverse-engineering analysis. The shift is due to past input from stakeholders who were concerned about the possibility of double-counting the energy-efficiency benefits of various design options. While the efficiency-level approach has the benefit of being absolute (each appliance has a tested efficiency and derivable manufacturing cost), it depends on the appliance actually having an efficiency test that manufacturers report. For product classes where there are no published efficiencies, a design-option approach remains the best alternative to an efficiency-level approach.

1. Approach

DOE solicited comments during the Framework public meeting and subsequent comment period on the possible approaches to the engineering analysis. ALS and AHAM stated during the Framework public meeting that they support the efficiency-level approach generally, and ACEEE commented that the efficiency-level approach should be verified with the design-option approach, recognizing that there is variation in how manufacturers implement design options. (Public Meeting Transcript, No. 5 at pp. 65, 73 and 107–110) AHAM commented that manufacturers will use different design options to achieve higher efficiency levels. (Public Meeting Transcript, No. 5 at p. 55) AHAM stated that the design-option approach has validity only for cooking products, but can serve as a means of cross-checking the analysis for the other products. (Public Meeting Transcript, No. 5 at p. 110) Whirlpool, GE, and AHAM stated that DOE should analyze CCWs, dishwashers, and dehumidifiers with the efficiency-level approach, while using a design-option approach for cooking products. (Whirlpool, No. 10 at pp. 4 and 7; GE, No. 13 at p. 3; AHAM, No 14 at pp. 4–9)

In comments submitted during the comment period after the Framework public meeting, the Joint Comment disagreed with using the efficiency-level approach as the primary means to estimate efficiency costs. The Joint Comment stated that the design-option approach is very important and should be included for all products as a complement to and validation of manufacturer estimates. The Joint Comment stated that manufacturers have historically estimated higher costs during the rulemaking stage, as compared to the actual costs when the standards take effect. In addition, the design-option approach allows interactions between design options to factor into the analysis to take advantage of synergies between measures and to avoid double-counting of energy savings. The Joint Comment also expressed the need for DOE to make detailed manufacturing cost data publicly available, while maintaining manufacturers' confidentiality to protect their competitive positions. They described manufacturer cost estimates as a ''black box'' for other stakeholders. (Joint Comment, No. 9 at pp. 1–2)

DOE conducted the engineering analysis for this rulemaking using an efficiency-level approach supplemented by a design-option approach for CCWs, dishwashers, and dehumidifiers. DOE based this analysis on detailed incremental cost data primarily supplied by AHAM. DOE supplemented these industry-supplied data with its own design-option analysis by performing limited product efficiency testing and physical teardown analysis of several dishwashers and dehumidifiers, and by conducting manufacturer interviews for all three products. The teardown analysis used the reverse engineering approach and resulted in the production of detailed bills of materials for dishwashers and dehumidifiers.

For cooking products, DOE conducted the engineering analysis for this rulemaking using the design-option approach, under which it identifies incremental increases in manufacturer selling prices for each design option or combination of design options. As discussed in section I.B.1 of this ANOPR, DOE based much of this analysis on cost and efficiency information supplied in the previous rulemaking's analysis, with costs updated to reflect current pricing. DOE supplemented this analysis with new data that AHAM supplied for microwave ovens.

In summary, DOE used an efficiency-level approach supported by a design-option approach for CCWs, dishwashers, and dehumidifiers, and a design-option approach for cooking products. Stakeholders were supportive of this approach for cooking products. For CCWs, dishwashers, and dehumidifiers, DOE supplemented the industry-supplied data with consultation with outside experts and further review of publicly available cost and performance information. The supplemental design-option analysis (which included the reverse engineering) allowed for validation of the efficiency-level data, transparency in assumptions and results, and the ability to perform independent analyses for verification. In addition, the supplemental design-option analysis allowed DOE to generate analytically-derived cost-efficiency curves for product classes for which industry-supplied curves were not provided. The methodology DOE used to perform the efficiency-level and design-option analyses is described in further detail in the engineering analysis (Chapter 5 of the TSD).

The Joint Comment recommended that the computation of manufacturing costs also take into account the effect of market forces by using the simple average of the lowest cost estimate and the weighted-average cost. The Joint Comment stated that manufacturers with below-average costs will determine market prices, since higher-priced manufacturers will need to ''sharpen their pencils'' to reduce costs in order to maintain market share. Additionally, the Joint Comment stated that manufacturers should ensure that their cost estimates reflect mass production, since efficiency standards will make today's niche products commodity products in the future. (Joint Comment, No. 9 at p. 2) In response, we note that DOE conducted its analysis using the average costs provided by industry, because DOE believes these are the most representative of manufacturer costs. The AHAM-supplied average cost by efficiency level is shipment-weighted, which thus represents the most likely average cost for the industry to make an incremental efficiency change. The limited DOE reverse-engineering analysis based on two dishwasher platforms that span an efficiency range from 0.58 to 1.11 EF also largely agreed with the AHAM-supplied average incremental cost data. The effects of mass production were captured in the cost estimates and reflected in the production volume estimates that AHAM provided, as well as in the production volumes used in DOE's cost modeling.

The methodology DOE used to perform the efficiency-level and design-option analyses and reverse engineering are described in further detail in the engineering analysis chapter (Chapter 5) of the TSD.[20]

2. Technologies Unable To Be Included in the ANOPR Analysis

In performing the engineering analysis, DOE did not consider for analysis certain technologies that met the screening criteria but were unable to be further evaluated for one or more of the following reasons: (1) Data are not available to evaluate consumer usage of a product incorporating the technology, and, therefore the test procedure conditions and methods may not be applicable; (2) data are not available to evaluate the energy efficiency characteristics of the technology; and (3) available data suggest that the efficiency benefits of the technology are negligible. In the first two cases, DOE is unable to adequately assess how these technologies impact annual energy consumption. Although it did not consider these technologies further in the ANOPR analyses, DOE specifically seeks data and inputs on consumer usage, performance characteristics, and representative test methods and conditions to extend the analyses to these technologies and to evaluate the test procedures for the NOPR. This is identified as Issue 6 under ''Issues on Which DOE Seeks Comment'' in section IV.E of this ANOPR.

For technologies that lack consumer usage details (including operating conditions, duration, and frequency), DOE believes that the existing test procedures may specify conditions and methods that are not representative of actual usage. DOE further believes that even if data were available to amend the test procedure, such changes could be extensive enough to require total revision, which in turn could warrant the creation of a separate product class for that technology in the event that the test procedure changes indicated unique utility. For example, many dehumidifiers feature a built-in relative humidity (RH) sensor, or hygrometer, and most (including all units upon which DOE conducted reverse-engineering) feature a built-in humidistat, a device that allows the consumer to set the desired RH level for the room. When the humidity near the dehumidifier drops below the user-defined or pre-set value, the dehumidifier automatically shuts off. This sensor-controlled system presumably saves energy by avoiding running the dehumidifier when the RH is such that further dehumidification would be neither effective nor desirable. However, there is no industry consensus on patterns in ambient conditions and usage. If such parameters were known to DOE, the test procedure, which currently specifies constant ambient temperature and humidity, would need to be revised to measure energy savings associated with these technologies. Therefore, the built-in hygrometer/humidistat design option was not considered for further analysis. Similar exclusions based on lack of information on representative consumer usage were

[20] The engineering analysis does not take into account future increases in manufacturing efficiency which would affect the cost-efficiency relationship, due to the inherently speculative nature of such an inquiry. Accordingly, this analysis is based on extant products and manufacturing processes.

made for several other design options. For dehumidifiers, these included improved controls, improved flow-control devices, and low-standby-loss controls. For cooking products, these included thermostatically-controlled gas cooktop burners, electronic controls for electric cooktops, cooking sensors for microwave ovens, and steam cooking for electric ovens.

Furthermore, certain technologies cannot be measured according to the conditions and methods specified in the existing test procedure. For example, induction cooktops require ferromagnetic cookware in order to transfer energy to the food contents. The test block specified in the DOE test procedure is aluminum and thus is unable to measure the efficiency of induction cooktops. Although DOE is aware of a NIST study that suggests induction cooktops provide an efficiency improvement over baseline electric smooth cooktops, DOE did not consider this design option further in the ANOPR analysis because of the unresolved nature of the NIST data. DOE seeks input from stakeholders on whether the NIST data warrants further study for the NOPR. Similarly, for dehumidifiers DOE excluded improved defrost measures and washable air filters. Low-standby-loss electronic controls were not analyzed for electric cooktops, microwave ovens, and commercial clothes washer because, even though DOE considers consumer usage of these products to be well-defined, the current test procedures do not measure standby power. For microwave ovens specifically, for reasons described in section I.D.4.b, DOE is considering amending the test procedure to incorporate a measurement of standby power consumption. Other cooking product technologies that do not have energy benefits captured by the test procedures include radiant burners for gas ovens. As mentioned above, DOE specifically seeks data and inputs on representative test methods and conditions to extend the analyses to these technologies and to evaluate the test procedures for the NOPR. This is identified as Issue 6 under ''Issues on Which DOE Seeks Comment'' in section IV.E of this ANOPR.

Available data suggest that some of the design options would result in such small energy savings as to be negligible. For example, according to AHAM, dual magnetrons in microwave ovens do not improve energy efficiency due to the added losses associated with two magnetron heaters. AHAM also commented that are no significant energy savings opportunities associated with improved ceramic stirrers, modified waveguides, or added insulation. (AHAM, No. 17 at pp. 2–3) Similarly, DOE is unaware of any data that indicates a measurable energy efficiency impact of insulation in gas and electric coil cooktops. DOE will be reevaluating microwave oven design options through reverse-engineering, and will update the design options and efficiency levels as necessary for the NOPR. For commercial clothes washers, DOE removed improved drum designs for horizontal-axis clothes washers. Because DOE intends to focus on the technologies with measurable impact on efficiency, design options with negligible energy savings have been eliminated from further consideration.

For further information on these design options, refer to the market and technology assessment chapter (Chapter 3) and engineering analysis chapter (Chapter 5) of the TSD.

3. Product Classes, Baseline Models, and Efficiency Levels Analyzed

DOE conducted the engineering analysis on the single product class for CCWs and on all product classes for cooking products. For dishwashers, DOE identified baseline models and efficiency levels for the standard-sized dishwasher product class. It then scaled these standard dishwasher efficiency levels by the ratio of the current minimum efficiency standards for standard-versus-compact product classes to obtain the efficiency levels for compact-sized machines. For dehumidifiers, DOE conducted the engineering analysis on product classes for which it received incremental cost data, with the expectation that the analysis results will be extended to the remaining product classes in subsequent analyses.

For each product class, DOE selected a baseline model as a reference point, against which to measure changes resulting from energy conservation standards. The baseline model in each product class represents the basic characteristics of products in that class. Typically, it is a model that just meets current required energy conservation standards.

Tables II.13 through II.20 provide all of the efficiency levels DOE analyzed in the engineering analysis and the reference source of each level for each of the four appliance product classes analyzed. Many of these efficiency levels correspond to those set by energy efficiency programs or organizations, including the DOE and EPA Energy Star Program, and the CEE. DOE calculated other levels from existing levels to fill in gaps.

For the purpose of today's ANOPR, DOE considers the highest candidate standard levels, identified in section II.C.3 below, to be the maximum technologically feasible level. DOE notes that in some cases the highest efficiency level was identified based on a review of available product literature for products commercially available (*i.e.*, commercial clothes washers and dehumidifiers). For cooking products, the maximum levels identified in section II.C.3.c are based on data developed from the design option analysis in the previous rulemaking. (For more information, see the market and technology assessment (Chapter 3) and engineering analysis (Chapter 5) of the TSD.) Because DOE is required to determine the maximum technologically feasible energy efficiency level(s) in any notice of proposed rulemaking (42 U.S.C. 6295 (p)(2)), DOE seeks comment on the highest energy efficiency levels identified in today's ANOPR for the purpose of determining appropriate maximum technologically feasible energy efficiency levels in the proposed rule.

a. Dishwashers

For dishwashers, the energy conservation standards are expressed as a minimum EF, which is a function of cycles per kWh. In this rulemaking, DOE is using baseline models that have the following efficiencies, which are the current minimum standards for compact and standard capacity dishwashers (10 CFR 430.32(f)):

- Compact = 0.62 EF
- Standard = 0.46 EF

For standard dishwasher efficiency levels, DOE used the Energy Star criteria, CEE Tier 1 and 2 levels, and the current maximum technology that is commercially available. DOE also added two levels to fill the gap between CEE Tier 2 and the current maximum technology that is commercially available. DOE achieved scaling for compact dishwashers by using the ratio of current standard levels for standard size versus compact size units, although it determined the max-tech level by a review of technology in the current Energy Star database of certified dishwashers. Table II.13 lists the levels DOE analyzed for compact and standard dishwashers:

TABLE II.13.—EFFICIENCY LEVELS FOR RESIDENTIAL DISHWASHERS

Efficiency levels	Energy Factor, (cycles/kWh)	
	Compact	Standard
Baseline	0.62	0.46

TABLE II.13.—EFFICIENCY LEVELS FOR RESIDENTIAL DISHWASHERS—Continued

Efficiency levels	Energy Factor, (cycles/kWh)	
	Compact	Standard
1	0.78	0.58
2	0.84	0.62
3	0.88	0.65
4	0.92	0.68
5	1.01	0.72
6	1.08	0.80
7	1.74	1.11

DOE has specified the current Federal dishwasher standard as the baseline unit efficiency level, recognizing that a significant percentage of dishwashers on the market meet or exceed Energy Star levels. Whirlpool agreed with this approach, commenting that this baseline efficiency level maintains a necessary entry-level product. It noted that raising the baseline efficiency above the standard could make entry-level dishwashers unaffordable to low-end consumers, thus driving down market penetration of dishwashers and increasing hand-washing and the associated water and energy consumption. Whirlpool also commented that market-pull programs such as Energy Star are responsible for higher efficiency units on the market. (Public Meeting Transcript, No. 5 at pp. 59–60 and 66–67; Whirlpool, No. 10 at p. 8)

Northwest Power and Conservation Council (NWPCC), however, commented that the baseline EF may need to be raised above the current Federal standard. (Public Meeting Transcript, No. 5 at p. 57) Other stakeholders agreed. For example, Potomac commented that the baseline EF should represent a shipment-weighted average (likely to be between 0.46 and 0.58), which was the Energy Star level in effect at the time of the Framework public meeting. (Public Meeting Transcript, No. 5 at pp. 123–124) ACEEE commented that, since over 80 percent of the market meets the current Energy Star level, that level might be appropriate as the baseline. (Public Meeting Transcript, No. 5 at p. 124) After the Framework public meeting, the Multiple Water Organizations stated that the baseline should be above the current Federal standard, and that using the standard as the baseline would distort the analyses by making higher efficiency levels appear more costly and burdensome to achieve than they really are. (Multiple Water Organizations, No. 11 at p. 3)

In light of the above, DOE believes that setting the baseline at the current Federal standard appropriately analyzes entry-level dishwashers, and, thus, we are retaining an engineering baseline EF of 0.46 for standard-sized dishwashers. As will be discussed in section II.G.2.d, because some consumers already purchase products with efficiencies greater than the baseline levels, the LCC and PBP analysis considers the distribution of products currently sold. This is done to accurately estimate the percentage of consumers that would be affected by a particular standard level and to prevent overstating the benefits to consumers of increased minimum efficiency standards. Also, as will be discussed in section II.I.2, the resulting shipment-weighted efficiency (SWEF) that is determined from the distribution of products currently sold, as well as historical SWEFs, are accounted for in the NIA.

Whirlpool commented that, of the efficiency levels suggested in the Framework Document, efficiency levels up to an EF of 0.68 are reasonable, while the ''gap fill'' levels are arbitrary and the max-tech level is taken from an extremely expensive, niche machine from a manufacturer with negligible market share. (Whirlpool, No. 10 at p. 4) ACEEE and the Joint Comment recommended including an efficiency level for standard dishwashers between the 0.68 and 0.75 EF levels. They suggested an EF of 0.71 or 0.72 since there are three manufacturers with models currently at 0.72 EF. (Public Meeting Transcript, No. 5 at p. 124; Joint Comment, No. 9 at p. 4) DOE selected a 0.72 EF dishwasher as one of its teardown units on the basis of its highest level of design option combinations for a given platform. Additionally, AHAM stated that some efficiency levels exceed the point for which AHAM members can provide meaningful cost-efficiency data. (AHAM, No. 14 at p. 8) Thus, AHAM's aggregated manufacturer data were limited to a maximum EF of 0.72. DOE included this efficiency level in its analysis because one of the platforms upon which DOE performed the reverse-engineering analysis included a model at an EF of 0.72 as its highest efficiency version. DOE extended its analysis to include EF up to the max-tech level of 1.11 because this unit represented the high end of an additional product platform that DOE reverse-engineered.

The Joint Comment, Multiple Water Organizations, and Austin Water Utility (AWU) commented that DOE should conduct an analysis to determine whether it should define a standard for water consumption in addition to energy consumption. The Multiple Water Organizations recommended assigning a water factor to each proposed dishwasher efficiency level, and substantiating the relationship between energy and water consumption. They stated that water consumption is not so tightly correlated with energy consumption as to obviate the need for a separately stated WF. They referred DOE to databases maintained by NRCan and the Oregon Department of Energy for data on dishwasher energy and water consumption. (Public Meeting Transcript, No. 5 at p. 63; Joint Comment, No. 9 at pp. 3–4; Multiple Water Organizations, No. 11 at p. 3) DOE notes that it does not have statutory authority to prescribe a water consumption standard for dishwashers.

The City of Seattle suggested that DOE base the efficiency metric on energy and water use per place setting, rather than an EF according to the two product classes. (Public Meeting Transcript, No. 5 at p. 58) In response, we note that the current test procedure does not have any provision for defining efficiency as a function of the number of place settings a dishwasher can clean, and, therefore, DOE is currently unable to define an efficiency metric on this basis.

Whirlpool commented that cleaning performance must be taken into consideration at higher efficiency levels, and it stated that, at the max-tech level, cleaning performance would be highly suspect. (Public Meeting Transcript, No. 5 at p. 123) DOE notes that while there is no provision in the current DOE test procedure for measuring cleaning performance, interviews conducted by DOE with manufacturers indicated that the manufacturers are unwilling to compromise cleaning performance to achieve higher energy efficiency at the expense of market share. Manufacturer concerns over the potential loss of consumer utility at higher standard levels are discussed in Chapter 12, MIA, of the TSD.

b. Dehumidifiers

For dehumidifiers, each energy efficiency level is expressed as a minimum EF, which is a function of liters per kWh. In this rulemaking, DOE is using baseline models that have the following efficiencies, which are the current minimum standards for this product (EPACT 2005, section 135(c)(4); 42 U.S.C. 6295(cc); 70 FR 60407, 60414, (October 18, 2005); 10 CFR 430.32(v)):

- 25.00 pints/day or less = 1.00 EF
- 25.01–35.00 pints/day = 1.20 EF
- 35.01–45.00 pints/day = 1.30 EF
- 54.01–74.99 pints/day = 1.50 EF

DOE combined two product classes defined by EPACT 2005—25.00 pints/

day or less and 25.01–35.00 pints/day—to form a single product class of 0–35.00 pints/day for this analysis, due to the similar aggregation of data by AHAM in its manufacturer cost data submittal. EPACT 2005 also defines two other product classes, 45.01–54.00 pints/day and 75.00 pints/day or more, which DOE did not analyze since AHAM did not provide data for them. For purposes of conducting the NIA, DOE believes that the results from the product classes analyzed can be extended to the two statutorily-set product classes for which AHAM data (or comparable data) are unavailable. This approach is believed to be valid due to chassis and component similarities among the product classes, with primary differences due to scaling. DOE's approach for extending the results to the omitted product classes is discussed further in section II.I.3 of this ANOPR. DOE seeks comment on this approach to extend the engineering analysis to product classes for which a complete analysis was not performed.

In the Framework public meeting and during the Framework comment period, DOE received comments on the dehumidifier engineering analysis approach. All stakeholders agreed that DOE should analyze multiple product classes to capture the particular efficiency characteristics of varying capacity levels. Instead of extrapolating from one capacity platform, multiple stakeholders recommended analyzing a minimum of three capacities (small, medium, and large) to serve as a baseline. (Public Meeting Transcript, No. 5 at pp. 70 and 126–128; AHAM, No. 14 at p. 9; Joint Comment, No. 9 at p. 4 ; EEI, No. 7 at pp. 3 and 5) Whirlpool recommended defining ''small'' as <25 pints/day, ''medium'' as 35–45 pints/day, and ''large'' as 75+ pints/day capacity. (Whirlpool, No. 10 at p. 5) AHAM recommended that DOE analyze separately each capacity range mentioned in the Framework Document, because component availability, compressor efficiencies, and other factors vary widely. (AHAM, No. 14 at p. 9) As discussed above, DOE performed a complete analysis for the product classes for which AHAM supplied data, and extended the results to the remaining product classes in subsequent analyses.

DOE received numerous comments from stakeholders regarding the appropriateness of the dehumidifier energy efficiency levels under review in the Framework Document. AHAM stated concerns regarding the max-tech and some of the intermediate efficiency levels, recommending that DOE eliminate the EF level of 1.74 for the 35–45 pints/day product category and replace it with an EF level of 1.45–1.50, which AHAM argued is more representative of max-tech in that capacity range. (Public Meeting Transcript, No. 5 at pp. 72 and 129; AHAM, No. 14 at p. 9) EEI questioned some of the max-tech levels set for the lower capacity ranges. (Public Meeting Transcript, No. 5 at p. 126) Referring to Table 5.3 in the Framework Document, Whirlpool commented that the industry considers an EF of 1.4 for 35–45 pints/day as the *de facto* baseline efficiency standard. Thus, Whirlpool stated that DOE should drop the EF levels of 1.35 and below for this product class. Whirlpool also commented that the efficiency standards described by the EF level of 1.50 may not be attainable and should be reduced to an EF of 1.45. Whirlpool stated that an EF of 1.50 would make dehumidifiers so expensive that consumers would forgo them and live with damp, unhealthy basements instead. Thus, Whirlpool argued that an even higher EF level would not be economically justified, and it recommended that DOE drop the max-tech level EF of 1.74. (Whirlpool, No. 10 at p. 5)

Based on comments received, DOE analyzed three product classes (0–35.00 pints/day, 35.01–45.00 pints/day, and 54.01–74.99 pints/day) and five efficiency levels for each product class. The levels DOE analyzed are set forth in Table II.14. DOE also reviewed the efficiency levels proposed in the Framework Document using available databases, stakeholder interviews, and insights from the reverse engineering efforts. As discussed above, through its tear-down analysis, DOE found dehumidifiers with energy efficiency levels at the highest candidate standard level identified in section III of today's notice. Therefore, DOE believes that the efficiency levels defined in the Framework Document are representative of currently available models, and, therefore, we have retained them for further analysis. DOE seeks comment on the highest energy efficiency levels identified in today's ANOPR for the purpose of determining appropriate maximum technologically feasible energy efficiency levels in the proposed rule.

TABLE II.14.—EFFICIENCY LEVELS FOR RESIDENTIAL DEHUMIDIFIERS

Efficiency levels	Energy factor (liters/kWh)		
	0–35.00 (pints/day)	35.01–45.00 (pints/day)	54.01–74.99 (pints/day)
Baseline	1.20	1.30	1.50
1	1.25	1.35	1.55
2	1.30	1.40	1.60
3	1.35	1.45	1.65
4	1.40	1.50	1.70
5	1.45	1.74	1.80

c. Cooking Products

For residential cooking products (except for the prescriptive standard for gas products), there are no existing minimum energy conservation standards, as previous analyses failed to determine economic justification for them. The DOE test procedure uses an EF to rate the efficiency of cooking products. The EF for these products is the ratio of the annual useful cooking energy output of the residential cooking appliance (*i.e.*, the energy conveyed to the item being heated) to its total annual energy consumption. In accordance with the previous rulemaking for residential cooking products, DOE has selected the following baseline EFs for the product classes DOE is using in this rulemaking:

- Electric cooktops, open (coil) elements = 0.737 EF
- Electric cooktops, smooth elements = 0.742 EF
- Gas cooktops, conventional burners = 0.156 EF
- Electric ovens, standard with or without a catalytic line = 0.107 EF
- Electric ovens, self-clean = 0.096 EF
- Gas ovens, standard with or without a catalytic line = 0.030 EF

- Gas ovens, self-clean = 0.054 EF
- Microwave ovens = 0.557 EF

During the Framework public meeting, Whirlpool suggested that DOE might need to update baseline efficiency levels to reflect changes in current oven cavity volumes. DOE has defined baseline volumes for gas and electric non-self cleaning and self-cleaning ovens as 3.9 cubic feet in accordance with the previous rulemaking. Whirlpool believes this volume is too small to be representative of current ovens. At the Framework public meeting, Whirlpool stated that, since the mid-1990s, oven volumes have increased due to consumer usage patterns and consumer demand. As a result, Whirlpool stated that a more representative baseline volume would be five cubic feet. (Public Meeting Transcript, No. 5 at pp. 90 and 132) DOE has retained the 3.9 cubic feet volume to define the efficiency standard at baseline because there are a large number of ovens on the market sized for a 27-inch built-in installation which incorporate this cavity volume. The analysis accounts for larger oven cavity volumes by scaling the efficiency standard according to linear functions. DOE defined these scaling functions for gas and electric standard and self-cleaning ovens based on oven volume, since it is recognized that efficiency is affected by thermal mass and vent rates that are functions of volume. The scaling functions consist of linear equations relating EF to volume, which are described in greater detail in the TSD. DOE believes the slopes and intercepts of these equations from the previous rulemaking to still be valid. Whirlpool agreed that oven efficiency is a function of volume, and stated that the relationship is similar for gas and electric ovens. However, Whirlpool commented that DOE should review the linear equations from the previous rulemaking. (Public Meeting Transcript, No. 5 at pp. 90, 133, and 138) DOE has not identified any technological changes that would impact the efficiency-volume relationship, and, therefore, we are retaining the equations as defined.

Whirlpool also suggested that baseline efficiency levels might need to account for sealed burners and high-input-rate burners as separate product classes. (Public Meeting Transcript, No. 5 at p. 131) As discussed previously, DOE determined that sealed burners do not warrant a separate product class due to insufficient evidence that the performance of sealed burners is distinct from that of conventional open gas burners. Therefore, DOE analyzed a single product class for gas cooktops. Given the lack of empirical data, DOE will not analyze commercial-type ranges (the type of appliances normally incorporating high-input-rate burners) as a separate product class.

During the Framework public meeting, the AWU questioned whether baseline units would be equipped with standing pilot ignition systems, while Whirlpool stated that self-cleaning ovens do not have standing pilot lights. (Public Meeting Transcript, No. 5 at p. 136 and 138) In comments received after the Framework public meeting, EEI stated that gas pilot lights contribute to significant standby energy losses. According to EEI calculations, gas cooktop pilot lights (assuming 8000 hours of standby) account for 18.72 therms of the total annual baseline energy consumption of 33 therms, or 56.7 percent. Similarly, of the 29.6 therms annual baseline energy consumption for standard gas ovens, EEI attributes 14.0 therms, or 47.3 percent, to the pilot light. (EEI, No. 7 at p. 5) Conversely, AGA disputed DOE's presumption of significant energy savings associated with the elimination of standing pilot lights. AGA argued that it is likely that less that 20 percent of gas ranges currently have pilot ignition, and therefore potential energy savings will be less than the 0.06 quads over 30 years that DOE had estimated in the prior rulemaking. AGA concluded that pilot ignition cooking appliances are a niche product with unique utility, and their elimination would result in equity issues to consumers for whom installing electrical service adjacent to the range hookup is not economically justified. (AGA, No. 12 at pp. 2–3) DOE has structured the analysis for standing pilot igntion systems as a design option associated with the baseline configurations because DOE has determined that cooktops incorporating such ignition systems do not provide unique utility. Power outages are not frequent and long enough for residential electricity customers to consider operation during a lack of electric power a significant utility. Between 90 and 93 percent of such customers experience no electricity outages longer than four hours per year.[21]

To analyze the cost-efficiency relationships for each of the classes of cooking products, DOE retained the efficiency levels from the previous rulemaking for residential cooking products. For gas cooktops/conventional burners and gas standard ovens with or without a catalytic line, the baseline efficiency level assumes that the product is equipped with standing pilot lights and the first standards efficiency level corresponds to the elimination of standing pilot lights. However, because the cleaning cycle of gas self-clean ovens requires electrical energy use, EPCA in effect requires that such ovens currently be equipped with a non-standing pilot ignition system because a standing pilot light ignition system is disallowed if there is an electrical cord provided on the product. Therefore, the baseline efficiency level for these ovens assumes they lack a standing pilot light, as do all of the efficiency levels DOE analyzed for this rulemaking. Further, the first standards efficiency level is not based on elimination of a standing pilot, but rather on the addition of the forced convection design option. For microwave ovens, DOE used the efficiency levels corresponding to those in the previous rulemaking, after first determining that these levels are representative of the range of efficiencies of currently-available products. Tables II.15 through II.19 set forth the levels DOE analyzed for cooking products. For open coil-type and smooth electric cooktops, only a single standards efficiency level is analyzed because design options associated with higher efficiency levels were either screened out, as described in section II.B.2.c.1, or eliminated from the analysis for the reasons described in section II.C.2. For gas and electric ovens, the efficiency levels reported in Tables II.17 and II.18 are slightly different than those identified in the previous rulemaking's analysis. Refer to Chapter 5 of the TSD for an explanation of the cause for these slight differences in the oven efficiency levels.

TABLE II.15.—EFFICIENCY LEVELS FOR RESIDENTIAL GAS COOKTOPS

Efficiency levels	Conventional burners	
	Cooking efficiency	Energy factor
Baseline	0.399	0.156
1	0.399	0.399
2	0.420	0.420

Whirlpool and GE both commented that gas cooktop efficiencies should scale with burner size, in a similar manner as the relationship between oven efficiency and volume. (Public Meeting Transcript, No. 5 at pp. 134–135) The test procedure, however, currently contains provisions for testing gas cooktop burners with different size test blocks, depending on maximum burner firing rate. Because the test

[21] A. P. Sanghvi, Cost-Benefit Analysis of Power System Reliability: Determination of Interruption Costs. Prepared by RCG/Hagler Bailly, Inc., Arlington, VA for Electric Power Research Institute, Palo Alto, CA, EL–6791. Vol. 2, p. 3–3 and Vol. 3, p. 3–3. Available online at *http://www.epri.com.*

procedure already accounts for burner size, DOE will retain the existing efficiency levels without a scaling function for burner size.

TABLE II.16.—EFFICIENCY LEVELS FOR RESIDENTIAL ELECTRIC COOKTOPS

Efficiency levels	Open (coil) elements		Smooth elements	
	Cooking efficiency	Energy factor	Cooking efficiency	Energy factor
Baseline	0.737	0.737	0.742	0.742
1	0.769 (max-tech)	0.769	0.753 (max-tech)	0.753

DOE received a comment from Whirlpool that the efficiency levels for electric cooktops listed in Table II.16 are representative of currently available technology. (Public Meeting Transcript, No. 5 at p. 137)

TABLE II.17.—EFFICIENCY LEVELS FOR RESIDENTIAL GAS OVENS

Efficiency levels	Standard oven		Self-cleaning oven	
	Cooking efficiency	Energy factor	Cooking efficiency	Energy factor
Baseline	0.059	0.0298	0.071	0.0540
1	0.058 (globar ignition)	0.0536	0.088	0.0625
2	0.061	0.0566	0.088	0.0627
3	0.062	0.0572	0.089 (max-tech)	0.0632
4	0.065	0.0593		
5	0.065	0.0596		
6	0.066 (max-tech)	0.0600		
1a(1)	0.058	0.0583		

Note: Efficiency levels 1 and 1a correspond to designs that are utilized for the same purpose—eliminate the need for a standing pilot—but the technologies for each design are different. Efficiency level 1 is a hot surface ignition device while efficiency level 1a is a spark ignition device. Efficiency level 1a is presented at the end of the table because efficiency levels 2 through 6 are derived from efficiency level 1.

TABLE II.18.—EFFICIENCY LEVELS FOR RESIDENTIAL ELECTRIC OVENS

Efficiency levels	Standard oven		Self-cleaning oven	
	Cooking efficiency	Energy factor	Cooking efficiency	Energy factor
Baseline	0.122	0.1066	0.138	0.1099
1	0.128	0.1113	0.138	0.1102
2	0.134	0.1163	0.142 (max-tech)	0.1123
3	0.137	0.1181		
4	0.140	0.1206		
5	0.141 (max-tech)	0.1209		

TABLE II.19.—EFFICIENCY LEVELS FOR RESIDENTIAL MICROWAVE OVENS

Efficiency levels	Energy factor
Baseline	0.557
1	0.586
2	0.588
3	0.597
4 (max-tech)	0.602

AHAM noted that many microwave oven design features impact energy efficiency, and that the choice of features may be dictated by marketplace demands. For example, higher wattage cavity lamps produce a brightly illuminated cavity interior, but increasing the lamp wattage by only 10 watts could lower efficiency by about 0.5 percent. Even so, some manufacturers select higher wattage lamps for product differentiation. Manufacturers also may focus on features that optimize cooking performance, such as mode stirrers, that may also be accompanied by small increases in energy consumption. (AHAM, No. 17 at p. 2) DOE recognizes that manufacturers may choose to incorporate features that enhance product differentiation at the expense of energy consumption. For a given energy efficiency level, manufacturers must weigh the appropriate combination of design options and other features to meet the energy consumption requirement set forth in the relevant efficiency standard.

d. Commercial Clothes Washers

For all CCWs, EPCA establishes the following energy and water conservation standards: A minimum MEF of 1.26 and a maximum WF of 9.5. (EPACT 2005, section 136(e); 42 U.S.C. 6313(e); see also 70 FR 60416 (Oct. 18, 2005), adding 10 CFR 431.156) In this rulemaking, DOE is using a baseline model that has those efficiencies.

As indicated previously for CCWs, EPCA mandates that DOE determine both a minimum MEF and a maximum WF. For the purposes of analyzing the cost-efficiency relationships for this product, DOE based some of the efficiency levels on the MEF and WF specifications prescribed by the Energy Star program and the CEE Commercial Clothes Washer Initiative, and the maximum levels that are currently commercially available. These levels are set forth in the Table II.20:

TABLE II.20.—EFFICIENCY LEVELS FOR COMMERCIAL CLOTHES WASHERS

Efficiency levels	Modified Energy Factor (*ft³/kWh*)	Water Factor (*gallons/ft³*)
Baseline	1.26	9.5
1	1.42	9.5
2	1.60	8.5
3	1.72	8.0
4	1.80	7.5
5	2.00	5.5
6 (max-tech)	2.20	5.1

In the Framework public meeting and during the Framework comment period, DOE received comments regarding how some energy efficiency levels under consideration for CCWs could eliminate vertical-axis clothes washers. GE stated concerns regarding proposed standards levels for CCWs. GE commented that low WFs may not be attainable with vertical-axis clothes washers, thereby eliminating this low-cost platform from the CCW market, which in turn could lead to a decline in the number of clothes washers available in multi-family housing due to increased costs. GE urged DOE to consider the consumer utility of vertical-axis clothes washers, and it further argued that some proposed standards levels may not be attainable even with horizontal-axis clothes washers. (Public Meeting Transcript, No. 5 at p. 45; GE, No. 13 at p. 3) Whirlpool argued that a WF below 9.5 could render a top-loading CCW incapable of washing clothes properly and that NAECA would not allow the elimination of a product class. (Whirlpool, No. 10 at p. 7) In response to these comments, DOE notes that it placed all CCWs in one product class pursuant to EPACT 2005 (see discussion of product class definition for CCWs in section II.A.1.d of this ANOPR), which applies a single standard for energy efficiency and a single standard for water efficiency to all of the CCWs. (EPACT 2005, section 136(e); 42 U.S.C. 6313(e)) Thus, as discussed in II.C.3.d above, DOE is treating commercial clothes washers as a single class that encompasses both top- and front-loading units.

Several stakeholders requested that DOE consider additional efficiency levels for the CCW rulemaking. For example, ACEEE requested that DOE evaluate a 2.0 MEF and 5.5 WF level, since multiple clothes washer models with this efficiency level are on the market. (Public Meeting Transcript, No. 5 at p. 51; Public Meeting Transcript, No. 5 at p. 121) Potomac recommended that DOE consider the CEC waiver petition's WF breakpoint of 6.0.[22] (Public Meeting Transcript, No. 5 at p. 118) The Joint Comment and the Multiple Water Organizations requested a gap-fill level between the 1.8 MEF and the 2.79 MEF max-tech efficiency levels at 2.0 MEF/5.5 WF as per CEE Tier 3B, or 2.0 MEF/6.0 WF. (Joint Comment, No. 9 at p. 5; Multiple Water Organizations, No. 11 at p. 1) As shown in Table II.20, DOE is evaluating a level of 2.0 MEF combined with a 5.5 WF.

DOE received numerous comments regarding the appropriateness of the max-tech level defined in the CCW section of the Framework Document. AHAM objected to the hybrid approach of choosing the MEF from one washer model while choosing a WF from another, as this does not represent an actual CCW. (Public Meeting Transcript, No. 5 at p. 46) AHAM subsequently recommended the elimination of this efficiency level. (AHAM, No. 14 at p. 7) According to Whirlpool, this max-tech level was particularly objectionable because of the hybrid origin of the MEF and WF. (Public Meeting Transcript, No. 5 at p. 118) Some stakeholders countered that the hybrid approach is a reasonable way to estimate what could be attainable but that the economics of such a CCW would probably preclude such a standards level. (Public Meeting Transcript, No. 5 at p. 121; Joint Comment, No. 9 at p. 5) EEI and multiple stakeholders also suggested that, if DOE were to reject the hybrid approach, DOE could instead consider a max-tech level of 2.48 MEF and 3.5 WF, since that represents an actual clothes washer. (EEI, No. 7 at p. 6; Multiple Water Organizations, No. 11 at p. 2) In response to these comments, DOE subsequently altered the Framework Document exploratory efficiency levels to include a max-tech level where it took the MEF and WF from an existing clothes washer.

[22] DOE published a **Federal Register** notice on February 6, 2006 acknowledging receipt of and summarizing the California Energy Commission's Petition for Exemption from Federal Preemption of California's Water Conservation Standards for Residential Clothes Washers (71 FR 6022) (Docket No. EE–RM–PET–100).

In addition to comments regarding the appropriateness of the max-tech level, DOE received further comments regarding adding more efficiency levels to the CCW analysis during the Framework public meeting and through subsequent written comments. ALS agreed with analyzing all proposed effiency levels with the exception of max-tech, which ALS rejected because of the hybrid origin of the MEF and WF, and because DOE derived these levels from residential clothes washer data. (Public Meeting Transcript, No. 5 at pp. 117–118) Multiple Water Organizations recommended that DOE adopt step-like incremental increases in both MEF and WF for each efficiency level. (Multiple Water Organizations, No. 11 at p. 2)

During the Framework comment period, DOE received multiple comments regarding the applicability of residential clothes washer efficiency levels in a commerical setting. Both Whirlpool and GE submitted that the efficiency levels achieved by residential clothes washers are not representative of levels achievable by commercial products, which experience harder and more frequent use than residential products. (Whirlpool, No. 10 at p. 9; GE, No. 13 at p. 3) AHAM stated that the efficiency levels set forth in the Framework Document are not appropriate and recommended that DOE consider the different nature of CCWs. (AHAM, No. 14 at p. 7) DOE recognizes that current product offerings in the commercial laundry market do not include products at each efficiency level for which DOE is performing an analysis. DOE notes, however, that products exist that meet all the levels specified, so manufacturing cost data are available to assess CCWs that meet or exceed the levels specified. Since the standards are minimum performance standards, not presciptive standards, these levels do not represent predetermined technologies and are therefore not tied to the residential or commercial markets.

DOE also received comments regarding data requests for the CCW engineering analysis. Whirlpool stated that data for the baseline level are readily available, and that data for some higher efficiency levels are also available. (Whirlpool, No. 10 at p. 9) According to Whirlpool, the low volume of the U.S. CCW market, the limited scope of products, and the small number of manufacturers complicates the task of establishing manufacturing cost data in a way that does not lead to the disclosure of confidential information. (Whirlpool, No. 10 at p. 12) The Multiple Water Organizations requested that DOE work closely with manufacturers to obtain and make manufacturing cost data available before the ANOPR is published. (Multiple Water Organizations, No. 11 at p. 2) DOE worked with AHAM and stakeholders to obtain as much data as possible. DOE withheld from publication whatever data could not be aggregated to maintain confidentiality.

Additional detail on the product classes, baseline models, and efficiency levels can be found in Chapter 5 of the TSD.

4. Cost-Efficiency Results

DOE reports the results of the engineering analysis as cost-efficiency data (or ''curves'') in the form of incremental manufacturing costs versus EF (or MEF and WF for CCWs). These data form the basis for subsequent analyses in the ANOPR. DOE received industry-aggregated curves for CCWs, dishwashers, and dehumidifiers from AHAM. DOE validated these data through manufacturer interviews for all three products and the independent generation of similar curves for dishwashers and dehumidifiers. DOE based these curves on testing and reverse engineering activities, which resulted in the generation of a detailed bill of materials for each product.

For cooking products, DOE retained the cost data at each efficiency level that it had defined in the previous rulemaking's analysis, updated by scaling incremental manufacturing costs by the PPI from 1990 (the reference year in the prior analysis) to 2006. In addition, for microwave ovens, DOE received efficiency test data submitted by AHAM. The following table summarizes the data that DOE's engineering analysis used to generate the cost-efficiency results.

TABLE II.21.—ENGINEERING ANALYSIS METHODS

Method	Products			
	Cooking products	Dishwashers	Dehumidifiers	Commercial clothes washers
AHAM Data	√	√	√	√
Review of Past TSD	√	....	....	√
Product Teardown	....	√	√	....
Product Testing	....	√	....	....
Manufacturer Interviews	....	√	√	√

a. Dishwashers

For dishwashers, AHAM provided manufacturing cost data up to an efficiency level of 0.72 EF. DOE supplemented AHAM's efficiency-level cost data submittal with cost information generated from the efficiency testing and teardown of currently-available dishwashers. DOE conducted efficiency testing of six dishwashers, representing a range of EFs across two different product platforms. Beyond the measurements required to measure the performance according to the DOE test procedure, the testing consisted of multi-submetering to record disaggregated energy consumption associated with various design options. The EFs of the washers tested were 0.58, 0.64, 0.68, 0.78, 0.93, and 1.11.

In addition to efficiency testing, DOE performed reverse engineering on the six units tested, as well as on an additional dishwasher with an EF of 0.72. This last dishwasher was not yet available on the market at the time of testing but was released for high-volume manufacturing three weeks later. To validate the AHAM data and supply incremental cost information above the 0.72 EF level, DOE tore down the seven dishwashers (three high-efficiency dishwashers that shared the same basic platform and four other washers spanning the efficiency range 0.58–0.72 EF). A comparison of AHAM's and DOE's costs indicates that DOE's cost estimates are somewhat lower that the AHAM average costs, but above the AHAM minimum.

The purpose of comparing DOE's and AHAM's results was to assess the reasonableness of AHAM's data submission, and DOE believes this has been demonstrated. DOE's teardown sample size was very small and could not be expected to adequately capture the variability of all products in the marketplace. Another reason why DOE's results are lower than AHAM's average is the influence of product platforms. DOE's teardown analysis and manufacturer interviews confirmed that upgrading components can only raise EF to a certain point and that overall system architecture limits EF. The platform which DOE reverse-engineered is among the most efficient available from large-volume manufacturers (with an EF that spans the range of 0.58 to 0.72). Thus, it is reasonable to assume that starting from a lower efficiency platform will result in larger incremental costs. The results of the testing and teardown analysis, including the list of design options identified and other observations, can be further reviewed in Chapter 5 of the TSD. If the reverse-engineering sample size had been larger, it is reasonable to assume that the range of incremental costs by efficiency level would have broadened. As a result, DOE feels that the AHAM submission is reasonable and reflective of the gamut of dishwasher platforms and their inherent efficiencies on the market today.

Standard dishwasher cost-efficiency results are shown in Table II.22. DOE was unable to obtain incremental manufacturing cost information for compact dishwashers. Accordingly, DOE particularly seeks stakeholder feedback on how it can extend the results of the analysis for the standard-class dishwashers to compact dishwashers. This is identified as Issue 4 under ''Issues on Which DOE Seeks Comment'' in section IV.E of this ANOPR.

TABLE II.22.—INCREMENTAL MANUFACTURING COST FOR RESIDENTIAL STANDARD DISHWASHERS

Standard	
Energy factor (*cycles/kWh*)	Incremental cost
Baseline	....
0.58	$4.01
0.62	7.38

TABLE II.22.—INCREMENTAL MANUFACTURING COST FOR RESIDENTIAL STANDARD DISHWASHERS—Continued

Standard	
Energy factor (*cycles/kWh*)	Incremental cost
0.65	14.00
0.68	30.35
0.72	71.38
0.80	129.28
1.11	180.66

b. Dehumidifiers

For dehumidifiers, AHAM collected incremental manufacturing cost data from its member companies and submitted them to DOE. DOE validated AHAM's efficiency-level cost data submittal with a design-options-based/reverse engineering analysis, tearing down 14 dehumidifiers representing a range of capacities and efficiencies. In generating the cost-efficiency results, DOE combined the first two product classes proposed by EPACT 2005, 25.00 pints/day or less and 25.01–35.00 pints/day, because some manufacturers did not have shipments in the 25.01 to 35.00 pints/day category. To prevent disclosure of sensitive information, AHAM did not provide data for the EPACT 2005 categories 45.01–54.00 pints/day and 75 pints/day and greater because fewer than three manufacturers produce units in these categories. Therefore cost-efficiency curves were only generated for the following product classes: 0 to 35.00 pints/day, 35.01 to 45.00 pints/day, and 54.01 to 74.99 pints/day. Results of the reverse engineering analysis for the product classes analyzed were in good agreement with the AHAM data. The following table shows the dehumidifier cost-efficiency results. AHAM provided all of the data for the three product classes analyzed, except the value for an EF of 1.74 in the 35.01 to 45.00 product class, which DOE extrapolated from the AHAM data.

TABLE II.23.—INCREMENTAL MANUFACTURING COST FOR RESIDENTIAL DEHUMIDIFIERS

Product class, *pints/day*	Energy factor (*L/kWh*)	Incremental cost
0 to 35.00	Baseline	
	1.25	$3.12
	1.30	4.92
	1.35	10.41
	1.40	18.80
	1.45	25.61
35.01 to 45.00	Baseline	
	1.35	6.11
	1.40	14.47
	1.45	22.68
	1.50	32.84
	1.74	74.72
54.01 to 74.99	Baseline	
	1.55	4.18
	1.60	8.00
	1.65	12.36
	1.70	23.18
	1.80	33.94

c. Cooking Products

For conventional cooking products, DOE derived the cost-efficiency curves from the previous rulemaking's analysis, scaling the incremental manufacturing costs by the PPI in accordance with stakeholder comments. Tables II.24 through II.30 and Table II.32 detail the cost-efficiency results.

TABLE II.24.—INCREMENTAL MANUFACTURING COST FOR RESIDENTIAL GAS COOKTOPS

Level	Efficiency level source	EF	Incremental cost
0	Baseline	0.156	
1	0 + Electronic Ignition	0.399	$12.06
2	1 + Sealed Burners	0.420	32.06

TABLE II.25.—INCREMENTAL MANUFACTURING COST FOR RESIDENTIAL ELECTRIC COIL COOKTOPS

Level	Efficiency level source	EF	Incremental cost
0	Baseline	0.737	
1	0 + Improved Contact Conductance	0.769	$2.28

TABLE II.26.—INCREMENTAL MANUFACTURING COST FOR RESIDENTIAL ELECTRIC SMOOTH COOKTOPS

Level	Efficiency level source	EF	Incremental cost
0	Baseline	0.742	
1	0 + Halogen Lamp Element	0.753	$89.09

TABLE II.27.—INCREMENTAL MANUFACTURING COST FOR RESIDENTIAL GAS STANDARD OVENS

Level	Efficiency level source	EF	Incremental cost
0	Baseline	0.0298	
1	0 + Electric Globar Ignition	0.0536	$12.06
2	1 + Improved Insulation	0.0566	15.64
3	2 + Improved Door Seals	0.0572	16.72
4	3 + Forced Convection	0.0593	38.86
5	4 + Reduced Vent Rate	0.0596	40.48
6	5 + Reduced Conduction Losses	0.0600	44.11
1a	0 + Electronic Spark Ignition	0.0583	15.00

TABLE II.28.—INCREMENTAL MANUFACTURING COST FOR RESIDENTIAL GAS SELF-CLEANING OVENS

Level	Efficiency level source	EF	Incremental cost
0	Baseline	0.0540	
1	0 + Forced Convection	0.0625	$11.01
2	1 + Reduced Conduction Losses	0.0627	15.38
3	2 + Improved Door Seals	0.0632	16.60

TABLE II.29.—INCREMENTAL MANUFACTURING COST FOR RESIDENTIAL ELECTRIC STANDARD OVENS

Level	Efficiency level source	EF	Incremental cost
0	Baseline	0.1066	
1	0 + Reduced Vent Rate	0.1113	$1.63
2	1 + Improved Insulation	0.1163	4.84
3	2 + Improved Door Seals	0.1181	8.53
4	3 + Forced Convection	0.1206	48.14
5	4 + Reduced Conduction Losses	0.1209	51.69

TABLE II.30.—INCREMENTAL MANUFACTURING COST FOR RESIDENTIAL ELECTRIC SELF-CLEANING OVENS

Level	Efficiency level source	EF	Incremental cost
0	Baseline	0.1099	
1	0 + Reduced Conduction Losses	0.1102	$4.37
2	1 + Forced Convection	0.1123	43.98

For conventional ovens, the linear relationships for EF versus volume allow scaling of the efficiency levels to cavity volumes other than the baseline volume. Table II.31 shows the slopes and intercepts of these relationships. The table does not show values for every oven efficiency level because the previous rulemaking did not analyze data at every efficiency level, and because certain design options have been screened out in the current analysis.

TABLE II.31.—SLOPES AND INTERCEPTS FOR OVEN ENERGY FACTOR VERSUS VOLUME RELATIONSHIP

Level	Intercepts, Electric		Intercepts, Gas	
	Slope = –0.0157		Slope = –0.0073	
	Standard	Self-Clean	Standard	Self-Clean
0		0.1632	0.0865	0.0865
1	0.1752		0.0895	
2	0.1802			

TABLE II.31.—SLOPES AND INTERCEPTS FOR OVEN ENERGY FACTOR VERSUS VOLUME RELATIONSHIP—Continued

Level	Intercepts, Electric		Intercepts, Gas	
	Slope = –0.0157		Slope = –0.0073	
	Standard	Self-Clean	Standard	Self-Clean
3	0.1822		0.0935	

Note: EF = (Slope x Volume) + Intercept where Volume is expressed in cubic feet.

For microwave ovens, the design options and efficiency levels DOE analyzed are those identified in the previous rulemaking, with incremental manufacturing costs scaled by the PPI.

DOE specifically seeks stakeholder feedback on the approach of analyzing additional design options that would result in a lowering of the energy consumption of non-cooking features (*e.g.*, standby power), even though the test procedure currently does not account for such usage in EF. This is identified as Issue 5 under ''Issues on Which DOE Seeks Comment'' in section IV.E of this ANOPR. It should be noted that DOE is considering the addition of standby power measurement to the test procedure, as identified as Issue 1 under ''Issues on Which DOE Seeks Comment'' in section IV.E of this ANOPR. The table below shows the cost-efficiency results for microwave ovens.

TABLE II.32.—INCREMENTAL MANUFACTURING COST FOR RESIDENTIAL MICROWAVE OVENS

Level	Efficiency level source	EF	Incremental cost
0	Baseline	0.557	
1	0 + More Efficient Power Supply	0.586	$8.68
2	1 + More Efficient Fan	0.588	17.95
3	2 + More Efficient Magnetron	0.597	32.53
4	3 + Reflective Surfaces	0.602	51.11

d. Commercial Clothes Washers

For CCWs, DOE derived the cost-efficiency curves from AHAM-submitted data. Due to limited data collected, AHAM supplied cost data only at 1.42 MEF/9.5 WF and 2.0 MEF/5.5 WF. Based on a survey of CCWs currently sold, it is DOE's understanding that all products sold which meet an efficiency level of 1.6 EF/8.5 MEF or greater are based on a horizontal axis platform. Furthermore, based on interviews with manufacturers of CCWs, it is DOE's understanding that energy and water efficient vertical-axis-based designs currently sold in the residential market are not being considered for market introduction into the commercial laundry sector. Such designs include spray rinse and non-agitator vertical-axis clothes washers that replace the agitator with an impeller, nutating plate, or other alternative manipulator. Manufacturers commented during interviews that such designs are not appropriate for the heavy-duty demands of commercial laundry applications.

Notwithstanding the lack of manufacturing data for CCWs at several efficiency levels, the information gathered from the market research and manufacturer interviews suggests that CCWs cannot attain satisfactory cleaning performance at or above efficiency level 2 (1.6 MEF and 8.5 WF) without the use of horizontal-axis technology. Thus, since DOE believes vertical-axis CCWs cannot perform satisfactorily at these efficiency levels, DOE assumes that all units sold at efficiency level 2 and higher will be horizontal-axis CCWs and likely, more efficient than required. In determining the incremental costs associated with these efficiency levels, DOE notes that, like dishwashers, CCWs are platform-driven products where a given platform achieves an inherent efficiency based on design and an optimized control strategy. This inherent efficiency can be further enhanced via design option improvements that the control strategy can incorporate. However, a manufacturer may also choose to offer a range of product efficiencies and redesign existing products to offer a less-efficient unit for marketing or other reasons. The per-unit cost of redesigning a product to reduce the efficiency is typically low, though a manufacturer will have to pay an up-front cost to develop the new controller, pay for certifications, etc. Thus, there is a disincentive to develop less-efficient units (*i.e.*, ones that marginally meet the standard) unless the market is large enough to have the scale to support multiple price points based in part on energy efficiency.

Thus, it is not surprising that the CCW market currently does not offer a wide range of efficiencies for a given axis of rotation. The scale of the market is small, and the presence of an Energy Star program deters manufacturers from offering CCWs that have efficiencies that lie between the baseline and Energy Star efficiency levels, as such units would be more costly than a baseline unit yet not be eligible for rebates from utilities. Since all manufacturers currently produce horizontal-axis CCWs in the range of 2.0 MEF/5.5 WF, no platform change would be required to the existing horizontal-axis CCW lines to meet any efficiency level up to and including 2.0 MEF/5.5 WF.[23] During interviews with DOE, manufacturers provided estimates of the cost increment to meet 2.2 MEF/5.1 WF, ranging from $316 to $450. DOE notes that $316 is the manufacturing cost increment provided by AHAM to take a CCW from a baseline efficiency level of 1.26 MEF/9.5 WF to a level of 2.0 MEF/5.5 WF. Thus, DOE expects that the incremental costs between 1.60 MEF/8.5 WF and 2.2 MEF/5.1 WF would be constant at the same value as those provided by AHAM for

[23] DOE recognizes, however, that changes to the horizontal-axis CCW lines may be needed to meet higher production volumes. Any investment to the horizontal-axis CCW production lines to accommodate higher sales volumes were not captured in this analysis. For a qualitative discussion of capital expenditures required for such a product conversion, see the preliminary manufacturer impact analysis chapter (Chapter 12) of the TSD.

the level 2.0 MEF/5.5 WF. For further information, see Chapter 5 of the TSD.

DOE specifically seeks feedback on the validity of this approach. DOE seeks information about lower-cost alternatives to horizontal-axis designs for levels greater than 1.42 MEF/9.5 WF and lower than 2.0 MEF/5.5 WF. Additionally, DOE seeks information that would enable it to change the energy and water features of the 2.0 MEF/5.5 WF level to allow for manufacturer cost differentiation at the lower (and the higher) levels. DOE is also interested in receiving comment on how to weigh the impacts of a market-shift from vertical-axis technologies to horizontal-axis technologies. These issues are identified as Issue 3 under ''Issues on Which DOE Seeks Comment'' in section IV.E of this ANOPR.

The following table shows the preliminary commercial clothes washer cost-efficiency results.

TABLE II.33.—INCREMENTAL MANUFACTURING COST FOR COMMERCIAL CLOTHES WASHERS

Efficiency levels (MEF/WF)	Incremental cost
Baseline	
1.42/9.5	$74.73
1.60/8.5	316.35
1.72/8.0	316.35
1.80/7.5	316.35
2.00/5.5	316.35
2.20/5.1	316.35

Additional detail on the cost-efficiency results can be found in Chapter 5 of the TSD.

D. Energy Use and Water Use Characterization

The purpose of the energy use characterization, which DOE performed for the four appliance products covered in the ANOPR, is to help assess the energy-savings potential of different product efficiencies. The purpose of the water use characterization, performed only for CCWs and residential dishwashers, is to help assess the water-savings potential of more efficient products. DOE relied on existing test procedures, as well as the Energy Information Administration (EIA)'s Residential Energy Consumption Survey (RECS) and other sources (which are described below for each product) to establish a range of energy (and water) use for the four appliance products.

1. Dishwashers

DOE relied on the information in the DOE test procedure to establish the typical annual energy and water consumption of dishwashers. 10 CFR Part 430, Subpart B, Appendix C. In particular, DOE determined the annual energy and water consumption of dishwashers by multiplying the per-cycle energy and water use by the number of cycles per year, consistent with the DOE test procedure.

Dishwasher per-cycle energy consumption consists of three components: (1) Water-heating energy; (2) machine energy; and (3) drying energy. The machine energy consists of the motor energy (for water pumping and food disposal) and booster heater energy. The DOE test procedure provides equations to calculate the total per-cycle dishwasher energy consumption.

The largest component of dishwasher energy consumption is water-heating energy use, which is directly dependent on water use. AHAM stated that it was not possible to provide either disaggregated per-cycle energy use or water use data by standard level because, for any given standard level, the disaggregated energy use components and water use can vary greatly depending on dishwasher design. (AHAM, No. 14 at p. 8) However, AHAM did provide data showing how aggregate per-cycle energy use and per-cycle water use has changed over time since 1993. An analysis of the submitted AHAM data demonstrated that the relationship between energy and water use is nearly linear. This correlation is largely due to the energy required to heat water to the test procedure inlet temperature of 120 °F (49 °C) that most dishwashers use. The energy required to heat the inlet water to 120 °F (49 °C) usually represents the largest proportion of the overall per-cycle energy usage. Therefore, by knowing the aggregate per-cycle energy use, DOE determined the per-cycle water use and, in turn, the per-cycle water-heating energy consumption using DOE test procedure equations.

DOE analyzed the energy and water use for candidate standard levels ranging from 0.58 EF to 1.11 EF for standard-sized dishwashers. Because Whirlpool does not produce products with efficiencies higher than 0.68 EF, Whirlpool commented that it cannot provide energy and water consumption data for efficiency levels 0.72 EF, 0.80 EF, and 1.11 EF. (Whirlpool, No. 10 at pp. 9 and 12) However, based on the relationship between aggregate per-cycle energy use (which can be deduced from the dishwasher EF) and water use, which AHAM provided, DOE was able to estimate the energy use and water use of dishwashers at all candidate standard levels. Table II.34 shows the candidate standard levels for standard-sized dishwashers and their corresponding per-cycle energy and water use.

Per-cycle energy use is disaggregated into two general categories: (1) Water heating; and (2) machine (*e.g.*, motor energy for pumping) and dish drying from an electrical heating element. DOE estimated the per-cycle energy use by taking the inverse of the EF. It estimated the per-cycle water consumption based on the relationship between energy and water use. DOE estimated the per-cycle water-heating energy consumption by assuming the use of an electric water heater and multiplying the per-cycle water consumption by an assumed temperature rise of 70 °F (21 °C) and a specific heat of water of 0.0024 kWh/gal × °F (4.186 joule/gram × °C). The per-cycle machine and drying energy were determined by DOE by subtracting the water-heating energy consumption from the total energy consumption. The table below provides the standby power, which DOE assumed to be two watts. EEI questioned the degree to which consumers use the ''heated dry'' option to dry dishes instead of air-drying. (EEI, No. 7 at p. 5) For purposes of developing the per-cycle energy use and water use data shown below in Table II.34, DOE based the amount of time that the heated dry option is used on the DOE test procedure (*i.e.*, 50 percent of the dishwasher cycles).

TABLE II.34.—STANDARD DISHWASHERS: PER-CYCLE ENERGY AND WATER USE BY CANDIDATE STANDARD LEVEL

Candidate Standard Level	EF	Energy Use	Water Use	Energy Use Components		Standby
				Water Heating	Machine + Drying	
	cycles/kWh	*kWh/cycle*	*gal/cycle*	*kWh/cycle*	*kWh/cycle*	*kW*
Baseline	0.46	2.17	8.16	1.37	0.80	0.002
1	0.58	1.72	6.07	1.02	0.70	0.002
2	0.62	1.61	5.56	0.93	0.68	0.002
3	0.65	1.54	5.21	0.88	0.66	0.002
4	0.68	1.47	4.90	0.82	0.65	0.002
5	0.72	1.39	4.52	0.76	0.63	0.002
6	0.80	1.25	3.87	0.65	0.60	0.002
7	1.11	0.90	2.25	0.38	0.52	0.002

DOE determined the average annual energy and water consumption by multiplying the per-cycle energy and water consumption by the number of cycles per year. In 2003, DOE revised its test procedure for dishwashers to more accurately establish their efficiency and energy and water use. The 2003 test procedure amendments included a reduction in the average use cycles per year, from 264 to 215 cycles per year.[24] Arthur D. Little (ADL) conducted a comprehensive analysis of dishwasher usage in 2001 that revealed that dishwashers are used, on average, 215 cycles per year. This usage pattern is currently used to establish the annual energy consumption of dishwashers with the DOE test procedure.

In the context of the present rulemaking, DOE analyzed additional sources to determine whether the number of dishwasher cycles per year has changed. For example, DOE reviewed EIA's 2001 RECS data, which includes the annual usage of households with dishwashers. Of the more than 4,800 households in RECS, almost 2,500 have dishwashers. However, the average-use value for dishwashers is 180 cycles per year, with minimum and maximum values of 26 and 500 cycles per year, respectively. The Joint Comment argued that DOE should continue to use 215 cycles per year in its analysis of dishwashers. The organizations maintained that any estimate derived from the EIA's 2001 RECS is not nearly as robust as the estimate derived from the work conducted by ADL to revise the dishwasher test procedure. For example, the Joint Comment stated that RECS represents a much smaller sample than the one ADL used (about 2,500 households versus 26,000 households) and that the questions pertaining to dishwashers in RECS are just one component in a very large and complex survey instrument dealing with all aspects of home energy use. (Joint Comment, No. 9 at p. 4) The Multiple Water Organizations also urged DOE to retain the use of 215 cycles per year in the analysis. (Multiple Water Organizations, No. 11 at p. 3) Whirlpool also stated that DOE should retain the use of 215 cycles per year in its analysis. (Whirlpool, No. 10 at p. 9) Because the ADL survey is a much more comprehensive and larger survey than the survey performed for RECS, DOE chose an average usage of 215 cycles per year as the most representative value for average dishwasher use.

Therefore, the annual energy and water consumption shown in Table II.35 reflect an annual usage of 215 cycles per year. The annual water-heating energy consumption reflects the use of either an electric, gas-fired, or oil-fired water heater.

TABLE II.35.—STANDARD DISHWASHERS: ANNUAL ENERGY AND WATER USE BY CANDIDATE STANDARD LEVEL

Candidate standard level	Energy factor	Annual energy use				
	cycle/kWh	Water heating*				
		Electric	Gas	Oil		
				kWh/year	*MMBtu/year*	*MMBtu/year*
Baseline	0.46	295	1.34	1.24	190	1.8
1	0.58	219	1.00	0.92	168	1.3
2	0.62	201	0.91	0.85	163	1.2
3	0.65	188	0.86	0.79	160	1.1
4	0.68	177	0.80	0.74	156	1.1
5	0.72	163	0.74	0.69	153	1.0
6	0.80	140	0.64	0.59	146	0.8
7	1.11	81	0.37	0.34	129	0.5

* Electric, gas-fired, and oil-fired water heating based on water heater efficiencies of 100 percent for electric, 75 percent for gas, and 81 percent for oil.

† Standby annual energy use based on a dishwasher cycle length of one hour. Thus, Standby hours = 8766 hours − 215 × 1 hour = 8551 hours.

Whirlpool and EEI stated that DOE must account for the effects of pre-washing when establishing dishwasher energy use. EEI stated that DOE should account for pre-washing in estimating the baseline energy use of dishwashers.

[24] 68 FR 51887 (August 29, 2003).

Whirlpool stated that increasing the efficiency of dishwashers too far may result in wash performance being compromised, thereby forcing consumers to pre-wash more and resulting in increased energy and water consumption. (Whirlpool, No. 10 at p. 2; EEI, No. 7 at p. 5) EEI also stated that the analysis should capture the effects of reduced household cooking product usage on dishwasher usage. (EEI, No. 7 at p. 3) Because DOE could not identify sources of data showing whether the amount of pre-washing is impacted by dishwasher efficiency, DOE conducted its analysis by assuming that hand- or pre-washing habits are not affected by product efficiency. But because increased diswasher energy efficiency may require future designs to utlize less water, DOE recognizes the possibility that more efficient dishwashers may degrade wash performance. Therefore, DOE seeks feedback on whether more efficient dishwasher designs will lead to increased hand- or pre-washing and, if so, what increase in energy and water use can be expected. This is identified as Issue 7 under ''Issues on Which DOE Seeks Comment'' in section IV.E of this ANOPR. Considering the effects of reduced household cooking product use on dishwasher usage, and because DOE's dishwasher use assumptions are based on relatively recent survey data collected by ADL, DOE believes that any impacts from reduced cooking are captured in the updated use value of 215 cycles per year.

As previously stated, of the more than 4,800 households in RECS, almost 2,500 have dishwashers. As will be described later in section II.G on the LCC and PBP analysis, DOE used the RECS household samples with their associated baseline annual energy consumption to conduct the LCC and PBP analyses. Additional detail on the energy and water use characterization of dishwashers can be found in Chapter 6 of the TSD.

2. Dehumidifiers

The ANSI/AHAM Standard DH–1–2003, ''Dehumidifiers,'' for energy consumption measurements during capacity-rating tests, and CAN/CSA–C749–94, ''Performance of Dehumidifiers,'' for energy factor calculations, that DOE codified under EPCA in a final rule for dehumidifiers provide a method for determining the product's rated efficiency in liters/kWh—but provide no method for establishing annual energy consumption (71 FR 71340 (December 8, 2006); 10 CFR 430.23(z)). DOE determined the annual energy consumption of dehumidifiers by first dividing the capacity (in pints per day) by the unit efficiency (in liters per kWh) and then multiplying it by the usage in hours per year.

Both AHAM and Whirlpool commented on the difficulty of determining the energy consumption of dehumidifiers. Whirlpool stated that energy consumption varies considerably depending on geographic location and that average energy consumption is likely lower than the energy use DOE suggested in its Framework Document. In consultation with manufacturers and others familiar with that type of product, AHAM estimated that dehumidifier use is between 875 and 1,315 hours per year, and it recommended that DOE use the mid-point (1,095 hours) as the norm (with sensitivity analyses at 875 and 1,315 hours/year). AHAM also stated that many dehumidifiers shut off automatically once their condensation buckets are full, and the organization argued that such feature reduces use, because it is assumed that consumers do not regularly empty the bucket. (AHAM, No. 14 at p. 10; Whirlpool, No. 10 at p. 9) Because the AHAM data were developed based on the experience of manufacturers, DOE believes that the AHAM data are the most representative of actual use. Therefore, DOE relied on the data AHAM provided, but DOE did consider other sources of data for estimating annual energy consumption. In comparison with AHAM's recommendation that DOE use 1,095 operating hours per year as the norm, other literature sources from ADL, Energy Star, and LBNL, provide higher use values of 1,620, 2,851, and 4,320 hours/year, respectively. Therefore, although DOE relied on AHAM's estimate of 1,095 hours to calculate a dehumidifier's average energy consumption, DOE used the higher use values from the above sources to demonstrate how they would impact annual energy consumption.

DOE specifically seeks feedback on whether AHAM's estimate of 1,095 hours per year is representative, on average, of dehumidifier use. This is identified as Issue 8 under ''Issues on Which DOE Seeks Comment'' in section IV.E of this ANOPR.

For the six product classes of dehumidifiers, DOE calculated the baseline annual energy consumption (*i.e.*, the consumption corresponding to the standards for each product class that take effect in 2007), based on the annual use assumptions presented in Table II.36 below. As shown in the table, the calculated annual energy use has an extensive range based on the capacity and efficiency of the dehumidifier and the hours of operation.

TABLE II.36.—DEHUMIDIFIER ANNUAL ENERGY CONSUMPTION DERIVED FROM HOURLY USE

Product class	Average size		EF	Annual energy use (kWh/year)					
				AHAM			ADL	Energy Star	LBNL-high
Pints/day	Pints/day	Liters/day	Liters/kWh	Low	Mid	High			
≤25.00	20.0	9.5	1.0	345	432	519	639	1124	1703
25.01–35.00	30.0	14.2	1.2	431	540	648	798	1405	2129
35.01–45.00	40.0	18.9	1.3	531	664	798	983	1730	2621
45.01–54.00	50.0	23.7	1.3	664	830	997	1228	2162	3276
54.01–74.99	64.5	30.5	1.5	742	928	1115	1373	2417	3662
≥75.00	85.0	40.2	2.25	652	816	979	1207	2123	3218

Table II.37 presents the annual energy consumption by candidate standard level for the predominant dehumidifier product class, 25.0–35.00 pints/day. The annual energy consumption reflects an annual use corresponding to AHAM's mid-estimate of annual hourly operation (*i.e.*, 1,095 hours per year). Refer to Chapter 6 of the TSD for the annual energy consumption by candidate standard level for the other five dehumidifier product classes.

TABLE II.37 25.01.—35.00 PINTS/DAY DEHUMIDIFIERS: ANNUAL ENERGY USE BY CANDIDATE STANDARD LEVEL

Candidate standard level	Efficiency	Annual energy use
	liters/kWh	kWh/year
Baseline	1.20	540
1	1.25	518
2	1.30	498
3	1.35	480
4	1.40	463
5	1.45	447

Unlike dishwashers, RECS does not have any data that indicate the use or annual energy consumption of dehumidifiers. Therefore, DOE did not use RECS to determine the variability of annual energy consumption. Rather, DOE relied exclusively on the data that AHAM provided (see Table II.37) to characterize the variability in annual energy consumption. As discussed previously, DOE used AHAM's estimate of 1,095 hours to calculate the average annual energy consumption. To characterize the variability of use, DOE used a triangular probability distribution that had an average value of 1,095 hours per year, ranging from a minimum value of 875 hours to a maximum value of 1,315 hours. As will be described later in section II.G on the LCC and PBP analysis, DOE employed use variability in calculating annual energy consumption when it conducted the LCC and PBP analyses. Additional detail on the energy use characterization of dehumidifiers can be found in Chapter 6 of the TSD.

3. Cooking Products

a. Cooktops and Ovens

The annual energy consumption of electric and gas ranges (*i.e.*, cooktops and ovens) has been in continual decline since the late 1970s. DOE's prior rulemaking on residential cooking products identified several studies that estimated the annual energy consumption of electric and gas ranges.[25] The studies that covered the time period of 1977–1992 showed a steady decline in the annual energy consumption. Based on these studies, DOE published revisions to its test procedure as a final rule in 1997, which included a reduction in the annual useful cooking energy output and a reduction in the number of self-cleaning oven cycles per year.[26] The annual useful cooking energy output relates the energy factor of the cooking appliance to the annual energy consumption. Therefore, the lower the annual useful cooking energy output, the lower the annual energy consumption of the cooking appliance.

Whirlpool and EEI stated that the annual energy consumption of cooking products is very likely lower than it was in the mid-1990s due to changes in consumer eating habits (*i.e.*, people eating out more often). (Whirlpool, No. 10 at p. 10; EEI, No. 7 at p. 3) Based on more recent studies of cooking annual energy use, DOE confirmed that cooking energy consumption has continued to decline since the mid-1990s. Research results from the 2004 California Residential Appliance Saturation Study (CA RASS)[27] and the Florida Solar Energy Center (FSEC)[28] show that the annual energy consumption for most electric and gas cooktops and ovens is roughly 40 percent less than the energy use during the mid-1990s.

Based on the more recent annual energy use data, DOE established the annual energy consumption for cooktops and ovens by candidate standard level. Tables II.38 through II.40 show the annual energy consumption by candidate standard level for the electric coil, electric smooth, and gas cooktop product classes, respectively. Tables II.41 through II.44 show the annual energy consumption by candidate standard level for the electric standard, electric self-cleaning, gas standard, and gas self-cleaning oven product classes, respectively. For gas standard ovens (Table II.43), candidate standard level 1 (globar or hot surface ignition) and candidate standard level 1a (spark ignition) are addressed separately because the technologies have different energy use characteristics. Although both technologies are used for the same purpose (*i.e.*, to eliminate the need for a standing pilot), hot surface ignition uses a significant amount of electrical energy while spark ignition uses a negligible amount of electricity. The use of a globar ignition device is the technology most commonly used to eliminate the need for a standing pilot in gas ovens. Therefore, in the case of gas standard ovens, efficiency levels two through six follow efficiency level '1' (globar ignition) rather than level '1a' (spark ignition), and in the case of gas self-cleaning ovens, the baseline efficiency level is based on the use of a globar ignition device. For more details on how DOE developed the annual energy consumption for each product class, refer to Chapter 6 of the TSD.

TABLE II.38.—ELECTRIC COIL COOKTOPS: ANNUAL ENERGY CONSUMPTION BY CANDIDATE STANDARD LEVEL

Candidate standard level	Energy factor	Annual energy consumption
		kWh/year
Baseline	0.737	128.2
1	0.769	122.9

TABLE II.39.—ELECTRIC SMOOTH COOKTOPS: ANNUAL ENERGY CONSUMPTION BY CANDIDATE STANDARD LEVEL

Candidate standard level	Energy factor	Annual energy consumption
		kWh/year
Baseline	0.742	128.2
1	0.753	126.3

[25] U.S. Department of Energy-Office of Codes and Standards. Technical Support Document for Residential Cooking Products, Volume 2: Potential Impact of Alternative Efficiency Levels for Residential Cooking Products, April, 1996. Prepared for the U.S. DOE by Lawrence Berkeley National Laboratory, Berkeley, CA. Appendix A. Available online at: *http://www.eere.energy.gov/buildings/appliance_standards/residential/cooking_products_0998_r.html.*

[26] 62 FR 51976 (Oct. 3, 1997).

[27] California Energy Commission. *California Statewide Residential Appliance Saturation Study,* June 2004. (Prepared for the CEC by KEMA–XNERGY, Itron, and RoperASW. Contract No. 400–04–009). Available online at: *http://www.energy.ca.gov/appliances/rass/index.html.*

[28] Parker, D. S. Research Highlights from a Large Scale Residential Monitoring Study in a Hot Climate. *Proceedings of International Symposium on Highly Efficient Use of Energy and Reduction of its Environmental Impact,* January 2002. Japan Society for the Promotion of Science Research for the Future Program, Osaka, Japan. JPS-RFTF97P01002: pp. 108–116. Also published as FSEC–PF369–02, Florida Solar Energy Center, Cocoa, FL. Available online at: *http://www.fsec.ucf.edu/en/publications/html/FSEC–PF–369–02/index.htm*

TABLE II.40.—GAS COOKTOPS: ANNUAL ENERGY CONSUMPTION BY CANDIDATE STANDARD LEVEL

Candidate standard level	Energy factor	Cooking efficiency (percent)	Cooking	Pilot	Total
			MMBtu/year	*MMBtu/year*	*MMBtu/year*
Baseline	0.156	39.9	0.72	2.01	2.74
1	0.399	39.9	0.72		0.72
2	0.420	42.0	0.69		0.69

TABLE II.41.—ELECTRIC STANDARD OVENS: ANNUAL ENERGY CONSUMPTION BY CANDIDATE STANDARD LEVEL

Candidate standard level	Energy factor	Cooking efficiency (percent)	Cooking	Clock	Total
			kWh/year	*kWh/year*	*kWh/year*
Baseline	0.1066	12.2	132.4	34.2	166.5
1	0.1113	12.8	125.9	34.2	160.1
2	0.1163	13.4	119.7	34.2	153.9
3	0.1181	13.7	117.6	34.2	151.8
4	0.1206	14.0	70.7	34.2	149.0
5	0.1209	14.1	70.6	34.2	148.6

TABLE II.42.—ELECTRIC SELF-CLEANING OVENS: ANNUAL ENERGY CONSUMPTION BY CANDIDATE STANDARD LEVEL

Candidate standard level	Energy factor	Cooking efficiency (percent)	Cooking	Self-clean	Clock	Total
			kWh/year	*kWh/year*	*kWh/year*	*kWh/year*
Baseline	0.1099	13.8	116.6	21.1	33.3	171.0
1	0.1102	13.8	116.2	21.1	33.3	170.6
2	0.1123	14.2	113.5	21.1	33.3	167.9

TABLE II.43.—GAS STANDARD OVENS: ANNUAL ENERGY CONSUMPTION BY CANDIDATE STANDARD LEVEL

Candidate standard level	Energy factor	Cooking efficiency (percent)	Cooking		Ignition		Total	
			MMBtu/yr	*kWh/yr*	*MMBtu/yr*	*kWh/yr*	*MMBtu/yr*	*kWh/yr*
Baseline	0.0298	5.9	0.82		1.01		1.83	0.0
1*	0.0536	5.8	0.84			21.1	0.84	21.1
2	0.0566	6.1	0.80			21.1	0.80	21.1
3	0.0572	6.2	0.79			21.1	0.79	21.1
4	0.0593	6.5	0.75	1.8		21.1	0.75	22.9
5	0.0596	6.5	0.75	1.8		21.1	0.75	22.9
6	0.0600	6.6	0.74	1.8		21.1	0.74	22.9
1a*	0.0583	5.8	0.84				0.84	0.0

* Candidate standard levels 1 and 1a correspond to designs that are utilized for the same purpose—eliminate the need for a standing pilot—but the technologies for each design are different. Candidate standard level 1 is a hot surface ignition device while candidate standard level 1a is a spark ignition device. Candidate standard level 1a is presented at the end of the table because candidate standard levels 2 through 6 are derived from candidate standard level 1.

TABLE II.44.—GAS SELF-CLEANING OVENS: ANNUAL ENERGY CONSUMPTION BY CANDIDATE STANDARD LEVEL

Candidate standard level	Energy factor	Cooking effc'y (percent)	Cooking		Self-clean		Ignition	Clock	Total	
			MMBtu/yr	*kWh/yr*	*MMBtu/yr*	*kWh/yr*	*kWh/yr*	*kWh/yr*	*MMBtu/yr*	*kWh/yr*
Baseline	0.0540	7.1	0.68		0.17	0.7	21.1	31.5	0.86	53.3
1	0.0625	8.8	0.56	1.8	0.17	0.7	21.1	31.5	0.73	55.1
2	0.0627	8.8	0.55	1.8	0.17	0.7	21.1	31.5	0.73	55.1
3	0.0632	8.9	0.55	1.8	0.17	0.7	21.1	31.5	0.72	55.1

DOE used 2001 RECS data to establish the variability of annual cooking energy consumption for cooktops and ovens. RECS indicates which households in the survey of 4,822 households use electric and gas ranges, ovens, and cooktops. With regard to electric cooking products, 2,895 household records have cooktops; 1,159 household records have standard ovens, and 1,601 household records have self-cleaning ovens. With regard to gas cooking products, 1,597 household records have cooktops either in electric ranges or as stand-alone units; 959 household records have standard ovens, and 494 household records have self-cleaning ovens. The above totals represent cooktops and ovens in households either as a stand-alone unit or as part of a range.

Although RECS does not provide the annual energy consumption of the cooking product for each household record, it does provide the frequency of cooking use. Thus, DOE used the frequency of use to define the variability of the annual energy consumption. Conducting the analysis in this manner captured the observed variability in annual energy consumption while maintaining the average annual energy consumption shown above in Tables II.38 through II.44. To determine the variability of cooking product energy consumption, DOE first equated the weighted-average cooking frequency from RECS with the average energy use values reported in Tables II.38 through II.44. DOE then varied the annual energy consumption for each RECS household based on its reported cooking frequency.

For more details on cooking frequency variability and its impact on the variability of annual energy consumption, as well as additional detail on the energy use characterization of kitchen ranges and ovens, refer to Chapter 6 of the TSD. As will be described later in section II.G on the LCC and PBP analyses, DOE used the RECS household samples with their associated baseline annual energy consumption to conduct the LCC and PBP analyses.

b. Microwave Ovens

After an increase since the late 1970s, the annual energy consumption of microwave ovens has remained relatively steady since the late 1980s. DOE's previous rulemaking on residential cooking products identified studies that estimated the annual energy consumption of microwave ovens.[29] With the exception of one study based on the use of conditional demand analysis,[30] the studies, which covered the time period 1988–1994, showed that annual energy consumption was no more than 200 kWh/year. Based on these studies, DOE published revisions to its test procedure as a final rule in 1997 that included an increase in the annual useful cooking energy output that more than doubled the test procedure's original value from the late 1970s (62 FR 51976 (October 3, 1997)). The annual useful cooking energy output relates the energy factor of the microwave oven to the annual energy consumption. Therefore, the higher the annual useful cooking energy output, the higher the annual energy consumption.

A more recent study from the 2004 CA RASS is roughly in line with the average result from the previous studies showing that annual energy consumption has declined 15 percent since the mid-1990s. Based on the CA RASS study, DOE established the annual energy consumption for microwave ovens by candidate standard level as shown in Table II.45. For more details on how DOE developed the annual energy consumption for microwave ovens, refer to Chapter 6 of the TSD.

TABLE II.45.—MICROWAVE OVENS: ANNUAL ENERGY CONSUMPTION BY CANDIDATE STANDARD LEVEL

Candidate standard level	Energy factor	Cooking efficiency (percent)	Total
			kWh/year
Baseline	0.557	55.7	131.0
1	0.586	58.6	124.5
2	0.588	58.8	124.1
3	0.597	59.7	122.2
4	0.602	60.2	121.2

In its Framework Document, DOE requested energy use data for the individual components of the microwave oven (*e.g.*, magnetron filament, magnetron power supply, and fan and motor). Sharp stated that the measurement methods in the DOE test procedure require the establishment of only the total input power of the oven and not the input power associated with individual components. Therefore, Sharp argued that if the oven is being tested in accordance with the DOE test procedure, disaggregated energy use data is neither apposite nor readily available. (Public Meeting Transcript, No. 5 at p. 108) DOE agrees that its test procedure only requires the measurement of total energy use, so, for purposes of this analysis, DOE has decided to only consider the total energy consumption of the product.

With regard to the variability of annual cooking energy consumption, as it did for cooktops and ovens, DOE used RECS to establish microwave oven use variability. The 2001 RECS indicates that 4,149 of the 4,822 households in the survey use microwave ovens. Similar to electric and gas cooktops and ovens, although RECS does not provide the annual energy consumption of microwave ovens for each household record, it does provide the frequency of cooking use. Thus, DOE used the frequency of microwave use to define the variability of the annual energy consumption. Conducting the analysis in this manner captured the observed variability in annual energy consumption while maintaining the average annual energy consumption shown above in Table II.45. To determine the variability of cooking product energy consumption, DOE first equated the weighted-average cooking frequency from RECS with the average energy use values reported above in Table II.45. DOE then varied the annual energy consumption for each RECS household based on its reported cooking frequency.

For more details on cooking frequency variability and its impact on the variability of annual energy consumption, as well as additional detail on the energy use characterization of microwave ovens, refer to Chapter 6 of the TSD. As will be described later in section II.G on the LCC and PBP analyses, DOE used the RECS household samples with their associated baseline annual energy consumption to conduct the LCC and PBP analyses.

4. Commercial Clothes Washers

DOE determined the annual energy and water consumption of CCWs by multiplying the per-cycle energy and water use by the number of cycles per year. CCW per-cycle energy consumption has three components: (1)

[29] U.S. Department of Energy—Office of Codes and Standards. *Technical Support Document for Residential Cooking Products, Volume 2: Potential Impact of Alternative Efficiency Levels for Residential Cooking Products,* April, 1996. Prepared for the U.S. DOE by Lawrence Berkeley National Laboratory, Berkeley, CA. Appendix A. Available online at: *http://www.eere.energy.gov/buildings/appliance_standards/residential/cooking_products_0998_r.html*

[30] Electric Power Research Institute. *Residential End-Use Energy Consumption: A Survey of Conditional Demand Estimates,* October 1989. Palo Alto, CA. CU–6487. Available online at: *http://my.epri.com/portal/server.pt?space=CommunityPage&cached=true&parentname=ObjMgr&parentid=2&control=SetCommunity&CommunityID=221&PageIDqueryComId=0*

Water-heating energy; (2) machine energy; and (3) drying energy. The machine energy is comprised of the motor energy for turning an agitator or rotating a drum.

The test procedures DOE recently codified at 10 CFR 431.154 are based on measuring the performance of residential clothes washers, and, therefore, the cycles-per-year values only indirectly reflect CCW usage through comparison with their residential counterparts (71 FR 71340). However, both ALS and EEI stated that CCW use is highly variable. ALS stated that CCW use varies based on the clothes washer market (*e.g.*, laundry and multi-housing). ALS recommended contacting the MLA, the CLA, and route operators to obtain relevant use data. (Public Meeting Transcript, No. 5 at pp. 156–157; EEI, No. 7 at p. 6) As discussed in more detail below, DOE has relied on several studies including research sponsored by the MLA and the CLA (trade associations representing the commercial laundry industry) to establish typical use cycles for CCWs.

As shown in Table II.46, DOE analyzed the energy and water use for specific candidate standard levels for CCWs. GE commented that because clothes container volume (capacity) may change with product efficiency, DOE should not use a constant capacity when determining the energy and water consumption of CCWs. GE suggested that DOE evaluate energy consumption on a per-cubic-foot basis. (Public Meeting Transcript, No. 5 at p. 158) DOE agrees that capacity does impact product efficiency, but no data were provided or identified on how capacity may change with increased efficiency. Therefore, DOE maintained a constant capacity in its analysis of annual energy consumption by candidate standard level. However, DOE invites additional comments and data regarding the relationship between CCW capacity and efficiency.

EEI requested clarification as to whether the energy consumption analysis for CCWs would capture reduced dryer energy consumption as a result of higher clothes washer efficiencies. (Pubic Meeting Transcript, No. 5 at p. 154) In response, we note that CCWs are rated with an MEF, and inherent in the determination of the MEF is the energy required to dry clothes. Therefore, DOE did capture the impact of higher efficiencies on dryer energy use.

Table II.46 shows the candidate standard levels for CCWs and their corresponding per-cycle energy and water use. DOE determined the per-cycle clothes-drying energy use by first establishing the remaining moisture content (RMC) based on the relationship between RMC and the MEF, and then using the DOE test procedure equation that determines the per-cycle energy consumption for the removal of moisture. DOE took the per-cycle machine energy use from its 2000 TSD for residential clothes washers.[31] In the 2000 TSD, for MEFs up to 1.40, machine energy is 0.133 kWh/cycle. For MEFs greater than 1.40, machine energy is 0.114 kWh/cycle. With the per-cycle clothes-drying and machine energy known, DOE determined the per-cycle water-heating energy use by first determining the total per-cycle energy use (the clothes container volume divided by the MEF) and then subtracting from it the per-cycle clothes-drying and machine energy.

DOE specifically seeks stakeholder feedback on whether the residential clothes washer per-cycle energy consumption values for clothes-drying and machine use taken from its 2000 TSD are representative of CCWs. This is identified as Issue 9 under ''Issues on Which DOE Seeks Comment'' in section IV.E of this ANOPR.

EEI commented that detergents formulated for cold-water washes are now available. Because no hot water will be required if these detergents are used, the baseline energy consumption will be impacted. (EEI, No. 7 at p. 4) However, DOE cannot assume that consumers will routinely use cold-water detergents. Thus, although cold-water detergents may be available, DOE determined the water-heating energy use using the specifications set forth in the DOE test procedure. The per-cycle water-heating energy use in Table II.46 below depicts the use of an electric water heater and a 2.8 ft^3 clothes container volume. DOE determined the per-cycle hot water use by dividing the per-cycle water-heating energy use by a temperature rise of 75 °F (21 °C) and a specific heat of 0.0024 kWh/gal × °F (4.186 joule/gram × °C). DOE determined the total water use by multiplying the WF by the clothes container volume.

TABLE II.46.—COMMERCIAL CLOTHES WASHERS: PER-CYCLE ENERGY AND WATER USE BY CANDIDATE STANDARD LEVEL

Candidate standard level	MEF	WF	RMC (percent)	Energy use			Water use	
				Machine	Dryer	Water Heat	Hot	Total
	cu.ft./kWh/cyc	*gal/cu.ft.*		*kWh/cyc*	*kWh/cyc*	*kWh/cyc*	*gal/cyc*	*gal/cyc*
Baseline	1.26	9.50	53.7	0.133	1.27	0.82	4.5	26.6
1	1.42	9.50	51.2	0.133	1.21	0.63	3.5	26.6
2	1.60	8.50	48.4	0.114	1.13	0.50	2.8	23.8
3	1.72	8.00	46.5	0.114	1.09	0.43	2.4	22.4
4	1.80	7.50	45.3	0.114	1.06	0.39	2.1	21.0
5	2.00	5.50	42.2	0.114	0.98	0.31	1.7	15.4
6	2.20	5.10	39.0	0.114	0.90	0.26	1.5	14.3

DOE determined the average annual energy and water consumption for CCWs by multiplying the per-cycle energy and water consumption by the number of cycles per year. Because the predominant applications of CCWs are in multi-family buildings and laundromats, DOE focused only on these two building applications to determine the appropriate number of CCW cycles per year. Other applications include lodging establishments (*e.g.*, hotels and motels), in-patient health care facilities, and nursing homes. Relative to multi-family buildings and laundromats, these other applications are a small segment of the market. Therefore, DOE believes it is not critical to the analysis to accurately characterize CCW usage for these applications. As mentioned above, DOE relied on several

[31] U.S. Department of Energy. *Final Rule Technical Support Document (TSD): Energy Efficiency Standards for Consumer Products: Clothes Washers*, December 2000. Washington, DC. Chapter 4, Table 4.1. Available online at: *http://www.eere.energy.gov/buildings/appliance_standards/residential/clothes_washers.html*.

studies including research sponsored by the MLA and the CLA to establish typical use cycles for CCWs. Of the studies on CCW usage, seven focused on multi-family buildings demonstrating that usage ranged from one to almost eleven cycles per day.[32] The sparse data for laundromats from three studies showed a variation between three to eight cycles per day.[33]

Tables II.47 and II.48 show the annual energy and water consumption for multi-family buildings and laundromats, respectively. The energy and water consumption values provided below are based on average use cycles of 3.4 cycles per day for multi-family buildings and 6 cycles per day for laundromats. For details on the studies reviewed by DOE to develop the average use cycles of CCWs, refer to Chapter 6 of the TSD. In the tables below, the annual water-heating and clothes-drying energy consumption reflects the use of both an electric or a gas water heater and dryer.

TABLE II.47.—COMMERCIAL CLOTHES WASHERS, MULTI-FAMILY APPLICATION: ANNUAL ENERGY AND WATER USE BY EFFICIENCY LEVEL

Candidate standard level	MEF	WF	Annual energy use					Annual water use
			Water heating		Drying		Machine	
			Electric	Gas	Electric	Gas		
	cu.ft./kWh/cyc	gal/cu.ft.	kWh/yr	MMBtu/yr	kWh/yr	MMBtu/yr	kWh/yr	1000 gal/year
Baseline	1.26	9.50	1020	4.64	1583	6.05	166	33.1
1	1.42	9.50	788	3.58	1503	5.74	166	33.1
2	1.60	8.50	625	2.84	1414	5.40	142	29.7
3	1.72	8.00	532	2.42	1354	5.18	142	27.9
4	1.80	7.50	482	2.19	1315	5.02	142	26.2
5	2.00	5.50	387	1.76	1215	4.64	142	19.2
6	2.20	5.10	328	1.49	1116	4.26	142	17.8

TABLE II.48.—COMMERCIAL CLOTHES WASHERS, LAUNDROMAT APPLICATION: ANNUAL ENERGY AND WATER USE BY CANDIDATE STANDARD LEVEL

Candidate standard level	MEF	WF	Annual Energy Use					Annual water use
			Water heating		Drying		Machine	
			Electric	Gas	Electric	Gas		
	cu.ft./kWh/cyc	gal/cu.ft.	kWh/yr	MMBtu/yr	kWh/yr	MMBtu/yr	kWh/yr	1000 gal/year
Baseline	1.26	9.50	1793	8.16	2782	10.63	291	58.3
1	1.42	9.50	1385	6.30	2642	10.10	291	58.3
2	1.60	8.50	1098	4.99	2485	9.50	250	52.1
3	1.72	8.00	935	4.25	2380	9.10	250	49.1
4	1.80	7.50	847	3.85	2310	8.83	250	46.0
5	2.00	5.50	680	3.10	2136	8.16	250	33.7
6	2.20	5.10	576	2.62	1961	7.49	250	31.3

DOE determined the variability in annual energy and water consumption based on usage data from the several CCW studies cited above. The studies DOE identified provided eight average use values for multi-family buildings ranging from a low of 1.5 cycles per day to a high of 6.4 cycles per day. For laundromats, the low and high values are three and eight cycles per day, respectively. DOE weighted the usage from each study to vary the annual energy and water consumption of CCWs when it conducted the LCC and PBP analyses. To reflect the usage patterns reported in the various studies, DOE weighted the use studies equally for multi-family applications. For laundromats, DOE used a triangular distribution that ranged from three to eight cycles per day and skewed it to yield an average value of six cycles per day. This range was based solely on data from the CLA. Of the three studies that DOE used to establish usage, only the CLA study provided a range. Because the two other studies, one from Equipoise Consulting and the other from CEE, provided an average use of six cycles per day, DOE skewed the triangular distribution to yield an average value of six cycles per day.

As will be described later in section II.G on the LCC and PBP analyses, DOE used the usage variability to vary the annual energy and water consumption for multi-family and laundromat applications when it conducted the LCC and PBP analyses. Additional detail on the energy and water use characterization of CCWs can be found in Chapter 6 of the TSD.

E. Markups To Determine Equipment Price

This section explains how DOE developed the markups to equipment prices that it used to derive total installed cost for the four appliance products (see Chapter 7 of the TSD). The total installed cost is the sum of the consumer equipment price and the installation cost. DOE multiplied the manufacturing costs developed from the

[32] The seven studies were conducted or commissioned by the following organizations: (1) City of Toronto (1999); (2) Federal Energy Management Program (2000); (3),Southern California Edison (2000); (4) MLA (2002); (5) Wisconsin Focus on Energy (2004); (6) Equipoise Consulting (2004); and (7) CEE.

[33] The three studies were conducted or commissioned by the following organizations: (1) Equipoise Counsulting (2004); (2) CEE; and (3) the CLA.

engineering analysis by the supply-chain markups it developed (along with sales taxes) to arrive at the consumer equipment prices, and added to them the installation costs to arrive at the final, installed prices for baseline products, as well as higher-efficiency products.

1. Distribution Channels

Before it could develop markups, DOE needed to identify distribution channels (*i.e.*, how the product is distributed from the manufacturer to the consumer). AHAM's 2003 Fact Book shows that over 93 percent of residential appliances (including dishwashers, dehumidifiers, and cooking products) are distributed from the manufacturer directly to a retailer. Thus, DOE analyzed markups for residential dishwasher, dehumidifier, and cooking product sales on the premise that these appliances are sold based on a manufacturer-to-retailer distribution channel. Wolf commented that for commercial-style cooking products, distributors are also involved in the distribution of the equipment. (Public Meeting Transcript, No. 5 at p. 177). For its analysis of cooking products, DOE designated commercial-style equipment as a separate product class that was exempted from the analysis due to the lack of available data for determining efficiency characteristics. Therefore, DOE did not consider the distribution channels for commercial-style equipment.

For CCWs, the consumer is usually a commercial establishment. EEI and ALS both commented on the distribution channels for this product. EEI stated that national accounts may be applicable if users (*e.g.*, hotels) are purchasing units in bulk from dealers. ALS stated that the distribution channels DOE identified during its Framework workshop were correct and added that laundromat owners generally go through distributors to purchase their clothes washers, whereas multi-housing owners generally go through route operators. (Public Meeting Transcript, No. 5 at pp. 175–176).

DOE developed the distribution channels for this analysis of CCWs after reviewing data that CEE developed.[34] The CEE data indicate that the relevant portions of the commercial, family-sized clothes washer market can be divided into three areas: (1) Laundromats; (2) private multi-family housing; and (3) large institutions (*e.g.*, military barracks, universities, housing authorities, lodging establishments, and health care facilities). For these three market areas, the CEE data indicate that an overwhelming majority of CCWs are sold through either distributors or route operators. Consistent with ALS's comment, the CEE data show that laundromats generally purchase their equipment through distributors, whereas multi-family housing and large institutions generally lease their equipment from route operators. Because the CEE data do not indicate that national accounts are a significant distribution channel, DOE did not consider them in its analysis. Thus, for purposes of developing the markups for CCWs, DOE based its calculations on the distribution channel that involves only distributors. DOE estimated that the markups and the resulting consumer equipment prices for the distribution channel involving distributors would be representative of the prices paid by consumers acquiring their equipment from route operators.

DOE specifically seeks feedback on whether determining CCW consumer prices based solely on the distribution channel that includes distributors will result in representative equipment prices for all CCW consumers. This is identified as Issue 10 under ''Issues on Which DOE Seeks Comment'' in section IV.E of this ANOPR.

2. Approach for Manufacturer Markups

DOE developed an average manufacturer markup by examining the annual Securities and Exchange Commission (SEC) 10–K reports filed by four publicly-traded manufacturers primarily engaged in appliance manufacturing and whose combined product range includes residential dishwashers, dehumidifiers, and cooking products and commercial clothes washers.[35] The four manufacturers represent a nearly 50 percent market share for core appliances. Because these companies are typically diversified, producing a range of different appliances, an industry average markup was assumed by DOE to be representative for the manufacture of each type of appliance. DOE evaluated markups for the years between 2002 and 2005, inclusive.

3. Approach for Retailer and Distributor Markups

DOE based the retailer markups (for residential products) and distributor markups (for CCWs) on financial data from the U.S. Census Business Expenditure Survey (BES).[36] DOE organized the financial data into balance sheets that break down cost components incurred by firms that sell the products.

DOE developed baseline and incremental markups to transform the manufacturer sales price into a consumer equipment price. DOE used the baseline markups, which cover all of a retailer's or distributor's costs, to determine the sales price of baseline models (equipment sold under existing market conditions). The baseline markup relates the manufacturer sales price to the retailer sales price (in the case of residential products) or distributor sales price (in the case of CCWs). Incremental markups cover only those costs that scale with a change in the manufacturer's sales price. Incremental markups are coefficients that relate the change in the manufacturer sales price of higher efficiency models (equipment sold under market conditions with new efficiency standards) to the change in the retailer or distributor sales price.

DOE used financial data from the BES, in the ''Household Appliance Stores'' category, to calculate markups used by retailers that apply to residential dishwashers, cooking products, and dehumidifiers. It used financial data from the BES for the category ''Machinery, Equipment, and Supplies Merchant Wholesalers'' to calculate markups used by distributors for CCWs. Using these markups, DOE generated retail prices for each potential standard level, assuming that each level would represent a new minimum efficiency standard.

For CCWs, DOE undertook efforts to validate the retail prices that it generated through the use of distributor markups. Both the Seattle Public Utilities (SPU) and ALS suggested sources for establishing the retail price of CCWs. SPU stated that it may have relevant data that it obtained through one of its rebate incentive programs. ALS suggested that DOE contact the MLA, route operators, and property owners. (Public Meeting Transcription, No. 5 at pp. 174 and 176) DOE contacted several national distributors of commercial laundry equipment to collect CCW retail price data. DOE also identified a few company Web sites that provided retail price information. DOE did obtain the price data offered by SPU, but because all of the data corresponded to high-efficiency, front-

[34] Consortium for Energy Efficiency, *Commercial Family-Sized Washers: An Initiative Description of the Consortium for Energy Efficiency,* 1998. Available online at: *http://www.cee1.org/com/cwsh/cwsh-main.php3*

[35] Security Exchange Commission, SEC 10–K Reports, Various dates, 2002–2005, Security Exchange Commission. Available online at: *http://www.sec.gov/*

[36] U.S. Census Bureau. *1997 Economic Census, Business Expense Survey, Retail Trade, Household Appliance Stores and Merchant Wholesalers, Machinery, Equipment, and Supplies,* 1997. Washington, DC Available online at: *http://www.census.gov/csd/bes/bes97.htm*

loading, horizontal-axis washers, the data were not useful for identifying the price differential between baseline and more-efficient products. With the price data it did collect, DOE attempted to develop a retail price-versus-efficiency curve. However, most of the price data collected from distributors and Web sites did not provide the necessary information to establish the efficiency of these commercial clothes washers. Therefore, DOE was only able to establish the retail price differential between a typical top-loading, vertical-axis machine and a front-loading, horizontal-axis machine. The retail price difference (approximately $500) is very close to the retail price DOE generated through the use of markups. Therefore, for the price difference between a typical top-loading machine and a typical front-loading machine, DOE confirmed that its retail price increment for achieving CCW efficiencies in the range of 1.72 to 2.20 MEF were reasonable. Chapter 3 of the TSD provides details on DOE's CCW retail price data collection effort.

4. Sales Taxes

The sales tax component of the DOE mark-up analysis represents State and local sales taxes that are applied to the consumer appliance price. It is a multiplicative factor that increases the consumer appliance price. DOE derived State and local taxes from data provided by the Sales Tax Clearinghouse.[37] These data represent weighted averages that include county and city rates. DOE then derived population-weighted average tax values for each Census division and large State.

5. Summary of Markups

Table II.49 summarizes each product's markups at each stage in the distribution channel and the overall baseline and incremental markups, as well as sales taxes. AHAM questioned what the typical overall markup is for home appliances and stated that, for residential clothes washers, a prior standards rulemaking analysis established an overall markup of approximately 2.0. (Public Meeting Transcript, No. 5 at p. 177) As shown in Table II.49, the overall baseline markup is approximately 2.0 for all products, almost the same as the markup DOE used in its residential clothes washer standard rulemaking. The overall incremental markup, which DOE applied to an incremental change in manufacturing costs to develop an incremental change in retail price, is approximately 1.60. Additional detail on markups can be found in Chapter 7 of the TSD.

TABLE II.49.—SUMMARY OF MARKUPS

Markup	Dishwashers		Dehumidifiers		Cooking products		Commercial clothes washers	
	Baseline	Incr.	Baseline	Incr.	Baseline	Incr.	Baseline	Incr.
Manufacturer	1.26		1.26		1.26		1.26	
Retailer	1.45	1.15	1.45	1.15	1.45	1.15		
Distributor							1.43	1.18
Sales Tax	1.068		1.065		1.069*		1.068	
Overall	1.95	1.55	1.95	1.54	1.95	1.55	1.93	1.59

• Represents average of all seven product classes of cooking products.

F. Rebuttable Presumption Payback Periods

A more energy efficient device will usually cost more to buy than a device of standard energy efficiency. However, the more efficient device will usually cost less to operate due to reductions in operating costs (*i.e.*, lower energy bills). The PBP is the time (usually expressed in years) it takes to recover the additional installed cost of the more efficient device (*i.e.*, the incremental cost) through energy cost savings. EPCA establishes a rebuttable presumption that a standard for any of the four appliance products is economically justified ''[i]f 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) and 6316(a))

To evaluate the rebuttable presumption, DOE estimated the additional cost of purchasing a more efficient, standard-compliant product, and compared this cost to the value of the energy saved during the first year of operation of the product. DOE understands that the increased cost of purchasing a standard-compliant product includes the cost of installing the product for use by the purchaser. DOE calculated the rebuttable presumption PBP (rebuttable PBP), as the ratio of the value of the increased installed price above the baseline efficiency level to the first year's energy cost savings. When this PBP is less than three years, the rebuttable presumption is satisfied. When this PBP is equal to or more than three years, the rebuttable presumption is not satisfied. In such case, the Secretary must take such information into account when determining whether a standard is economically justified. (42 U.S.C. 6295(o)(2)(B)(iii))

Inputs to the PBP calculation are the first seven inputs shown in Table II.57 found in section II.G.2 of this ANOPR. The rebuttable PBPs differ from the other PBPs calculated in the LCC analysis, in that the calculation of rebuttable PBP uses discrete values (rather than distributions) for inputs. Other than the use of single-point values, the most notable difference between the distribution PBP and the rebuttable PBP is the latter's reliance on the DOE test procedure to determine a product's annual energy (and water) consumption. The distribution PBP is based on the annual energy and water consumption data described in section II.D, which are characterized with a range of values as opposed to the discrete single-point value that is used for the rebuttable PBP.

[37] Sales Tax Clearinghouse, Inc. State sales tax rates along with combined average city and county rates, 2006. Available online at: *http://thestc.com/STrates.com.*

For dishwashers, DOE based the annual energy and water consumption values that it used to determine the rebuttable PBP on the number of cycles per year specified in the DOE test procedure. The number of cycles from the DOE test procedure, 215 cycles per year, is equal to the average number of cycles that DOE used in its determination of distribution PBPs. Thus, on average, the rebuttable PBP for dishwashers is virtually the same as the average distribution PBP.

For dehumidifiers, the DOE test procedure does not provide a method for determining the product's annual energy consumption. As a result, the DOE test procedure does not offer a basis for determining the rebuttable PBP. Therefore, for its determination of rebuttable PBP, DOE decided to use the same average operational use estimate of 1,095 hours that it used in its determination of distribution PBPs. Thus, the rebuttable PBP for dehumidifiers is virtually the same as the average distribution PBP.

For cooking products, DOE determined the rebuttable PBP based on DOE test-procedure-derived annual energy consumption values which are, on average, greater than the annual energy use that DOE used to determine the distribution PBPs. Thus, the rebuttable PBPs for cooking products are shorter than the distribution PBPs. Because the distribution PBPs are based on more recent data that more accurately reflects the current energy consumption of cooking products, the distribution PBPs are more reflective of actual PBPs than the rebuttable PBPs.

For CCWs, DOE based the annual energy and water consumption values that it used to determine the rebuttable PBP on the number of cycles per year specified in the DOE test procedure. The CCW test procedure cites the residential clothes washer test procedure to establish efficiency ratings as well as annual energy and water consumption. As a result, the annual number of use cycles, 392 cycles per year, for determining the annual energy and water consumption of CCWs, is representative of residential use, not commercial use. Because residential use is significantly lower than the average usage for commercial applications—1,241 cycles per year in multi-family buildings and 2,190 cycles per year in laundromats—the average annual energy and water consumption DOE used to determine rebuttable PBP is significantly less than the consumption expected to be associated with actual usage. As a result, the rebuttable PBP is significantly longer than the distribution PBPs for both multi-family and laundromat applications. To emphasize, DOE calculated the rebuttable PBPs based on residential use to comply with the requirements of EPCA, namely, to calculate the rebuttable PBP under the applicable test procedure. DOE understands that the distribution PBP, which is based on commercial use, reflects the actual PBP of CCW.

DOE calculated rebuttable PBPs for each standard level relative to the distribution of product efficiencies that were used for the base case. Section II.G.2.d of this ANOPR provides details on the base case efficiency distributions for each of the four appliance products.

Tables II.50 through II.56 show the nationally-averaged, rebuttable PBPs calculated for all product classes and candidate standard levels for each considered product.

TABLE II.50.—STANDARD-SIZED DISHWASHERS: REBUTTABLE PAYBACK PERIODS

Candidate standard level	EF	PBP *years*
Baseline	0.46	
1	0.58	0.7
2	0.62	2.1
3	0.65	4.6
4	0.68	9.5
5	0.72	17.9
6	0.80	21.8
7	1.11	16.6

TABLE II.51.—DEHUMIDIFIERS: REBUTTABLE PAYBACK PERIODS

0–35.00 pints/day*			35.01–45.00 pints/day			54.01–74.99 pints/day		
Candidate Standard Level	EF	PBP *years*	Level	EF	PBP *years*	Level	EF	PBP *years*
Baseline	1.20		Baseline	1.30		Baseline	1.50	
1	1.25	2.4	1	1.35	4.0	1	1.55	2.3
2	1.30	1.7	2	1.40	5.5	2	1.60	2.2
3	1.35	3.0	3	1.45	5.8	3	1.65	2.6
4	1.40	4.3	4	1.50	6.5	4	1.70	4.7
5	1.45	5.7	5	1.74	8.0	5	1.80	4.2

*PBP based on the annual energy consumption and operating cost associated with the 25.01–35.00 pints/day class.

TABLE II.52.—COOKTOPS: REBUTTABLE PAYBACK PERIODS

Electric coil			Electric smooth			Gas		
Candidate standard level	EF	PBP *years*	Level	EF	PBP *years*	Level	EF	PBP *years*
Baseline	0.737		Baseline	0.742		Baseline	0.156	
1	0.769	3.7	1	0.753	410	1	0.399	1.3
						2	0.420	34

TABLE II.53. OVENS: REBUTTABLE PAYBACK PERIODS

Electric standard			Electric self-clean			Gas standard			Gas self-clean		
Candidate standard level	EF	PBP *years*	Level	EF	PBP *years*	Level	EF	PBP *years*	Level	EF	PBP *years*
Baseline	0.1066		Baseline	0.1099		Baseline	0.0298		Baseline	0.0540	

TABLE II.53. OVENS: REBUTTABLE PAYBACK PERIODS—Continued

Electric standard			Electric self-clean			Gas standard			Gas self-clean		
Candidate standard level	EF	PBP years	Level	EF	PBP years	Level	EF	PBP years	Level	EF	PBP years
1	0.1113	2.2	1	0.1102	88.6	1*	0.0536	4.2	1	0.0625	6.5
2	0.1163	3.3	2	0.1123	120.2	2	0.0566	4.8	2	0.0627	8.8
3	0.1181	5.1				3	0.0572	5.2	3	0.0632	9.0
4	0.1206	24.0				4	0.0593	20.0			
5	0.1209	25.2				5	0.0596	20.3			
						6	0.0600	21.4			
						1a*	0.0583	1.4			

* For gas standard ovens, candidate standard levels 1 and 1a correspond to designs that are utilized for the same purpose—eliminate the need for a standing pilot—but the technologies for each design are different. Candidate standard level 1 is a hot surface ignition device while candidate standard level 1a is a spark ignition device. Candidate standard level 1a is presented at the end of the table because candidate standard levels 2 through 6 are derived from candidate standard level 1.

TABLE II.54.—MICROWAVE OVENS: REBUTTABLE PAYBACK PERIODS

Candidate standard level	EF	PBP years
Baseline	0.557	
1	0.586	18.9
2	0.588	36.8
3	0.597	52.5
4	0.602	73.9

TABLE II.55.—COMMERCIAL CLOTHES WASHERS, MULTI-FAMILY APPLICATION: REBUTTABLE PAYBACK PERIODS

Candidate standard level	MEF	WF	PBP years
Baseline	1.26	9.50	
1	1.42	9.50	24.0
2	1.60	8.50	34.2
3	1.72	8.00	25.6
4	1.80	7.50	21.2
5	2.00	5.50	13.6
6	2.20	5.10	9.6

TABLE II.56.—COMMERCIAL CLOTHES WASHERS, LAUNDROMAT APPLICATION: REBUTTABLE PAYBACK PERIODS

Candidate standard level	MEF	WF	PBP years
Baseline	1.26	9.50	
1	1.42	9.50	29.8
2	1.60	8.50	39.1
3	1.72	8.00	29.1
4	1.80	7.50	24.0
5	2.00	5.50	15.0
6	2.20	5.10	10.7

Some of the candidate standard levels appear to satisfy the rebuttable presumption test, but others do not. However, PBPs calculated based on energy consumption in actual field conditions are generally more accurate than, and may differ significantly from, the PBPs calculated under the rebuttable presumption test, which are based on energy consumption under the DOE test procedure. Therefore, in the LCC and PBP analyses described in the following section, DOE evaluated the candidate standard levels for the considered products using conditions that reflect normal use of the equipment.

While DOE has examined the rebuttable presumption PBPs, DOE does not expect to determine the economic justification for any of the standard levels analyzed based on the ANOPR rebuttable presumption analysis. DOE's decision on standard levels will take into account the more detailed analysis of the economic impacts of increased efficiency pursuant to section 325(o)(2)(B)(i) of EPCA. (42 U.S.C. 6295(o)(2)(B)(i))

G. Life-Cycle Cost and Payback Period Analyses

The LCC and PBP analyses determine the economic impact of potential standards on consumers. The effects of standards on individual consumers—or commercial consumers in the case of CCWs—include changes in operating expenses (usually lower) and changes in total installed cost (usually higher). DOE analyzed the net effect of these changes for the four appliance products, first, by calculating the changes in consumers' LCCs likely to result from candidate standard levels as compared to a base case (no new standards). The LCC calculation considers total installed cost (which includes manufacturer selling price, sales taxes, distribution channel markups, and installation cost), operating expenses (energy, repair, and maintenance costs), equipment lifetime, and discount rate. DOE performed the LCC analysis from the perspective of the consumer of each product.

DOE also analyzed the effect of changes in operating expenses and installed costs by calculating the PBP of potential standards relative to a base case. The PBP estimates the amount of time it would take the individual or commercial consumer to recover the assumed higher purchase expense of more energy efficient equipment through lower operating costs. Similar to the LCC, the PBP is based on the total installed cost and the operating expenses. However, unlike in the LCC, DOE considers only the first year's operating expenses in the calculation of the PBP. Because the PBP does not account for changes in operating expense over time or the time value of money, it is also referred to as a simple PBP. DOE utilizes the simple PBP because of its simplicity, transparency, and clarity. The simple PBP is a good approximation of more complex metrics that are based on operating expenses that do not change significantly from year to year. For purposes of capturing the annual change in operating expenses, DOE uses the LCC which accounts for the lifetime operating expenses of the product. For more detail on the LCC and PBP analyses, refer to Chapter 8 of the TSD.

1. Approach

During the Framework workshop, DOE considered conducting the LCC and PBP analyses using an approach that characterized inputs to the analysis with average values and handling any uncertainties or variability in the inputs through the use of scenarios that analyzed the effect of high and low values on the results. In recent standards rulemakings for other products (*e.g.*, residential furnaces and boilers and distribution transformers), DOE conducted the LCC and PBP analyses by modeling both the uncertainty and variability in the inputs using Monte Carlo simulation and probability distributions. Although more extensive than the aforementioned approach based on the use of average inputs, the Monte Carlo approach provides additional information, specifically the percentage of consumers benefiting from and being burdened by a prospective standard. The Joint Comment supported DOE's retention of Monte Carlo-based LCC and PBP analyses for this rulemaking, as long as the additional work required to perform the analyses over a simpler approach is not extensive. The Joint Comment stated that the Monte Carlo approach provides useful information on the percentage of consumers benefiting from and being burdened by an efficiency standard. (Joint Comment, No. 9 at p. 3) EEI and NWPCC also urged DOE to retain the Monte Carlo approach due to the additional information it provides over a simpler analysis. (EEI, No. 7 at p. 5; Public Meeting Transcription, No. 5 at p. 228) DOE agrees with the comments that the benefits of conducting the LCC and PBP with a Monte Carlo approach outweigh the extra effort it takes to implement it. Therefore, DOE developed its LCC and PBP spreadsheet models incorporating both Monte Carlo simulation and probability distributions by using Microsoft Excel spreadsheets combined with Crystal Ball (a commercially available add-in program).

In addition to characterizing several of the inputs to the analysis with probability distributions, in the case of residential dishwashers, dehumidifiers, and cooking products, DOE also developed a sample of individual households that use each of the appliances. The household sample sizes for these residential products are: 2,476 household records from dishwashers; 578 for dehumidifiers; 2,895 for electric cooktops; 1,159 for electric standard ovens; 1,601 for electric self-cleaning ovens; 1,597 for gas cooktops; 959 for gas standard ovens; and 494 for gas self-cleaning ovens. By developing household samples, DOE was able to perform the LCC and PBP calculations for each household to account for the variability in energy (and water) consumption and/or energy price associated with each household. DOE used EIA's 2001 RECS to develop household samples for each of the above three sets of products. The 2001 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. The 2001 RECS consists of for 4,822 housing units and was constructed by EIA to be a national representation of the household population in the U.S. Of the household sub-samples used in the LCC and PBP analysis, only two (for dehumidifiers and gas self-cleaning ovens) have a size which is less than 20 percent of the total 2001 RECS housing unit size. Even so, the potential errors associated with these smaller sub-sample sizes are not anticipated to be so large as to affect the validity of the results. Specifically, the standard error of a sample of size 'n' is the sample's standard deviation divided by the square root of 'n'. For the full 2001 RECS sample the associated standard error is the sample's standard deviation multiplied by 1.5 percent. For the dehumidifier and gas self-cleaning oven sub-samples, the associated standard error is the sub-sample's standard deviation multiplied by 4.5 percent. Although the standard error of the sub-samples is three times the size of the entire 2001 RECS, it is still less than five percent. DOE believes a standard error of less than five percent is still small enough to yield meaningful results. Therefore, DOE believes the results generated from the household samples for dishwashers, dehumidifiers, and cooking products are representative of U.S. households using these appliances.

For dishwashers and cooking products, DOE used EIA's 2001 RECS to establish the variability in annual energy use and energy pricing. (DOE also established the variability of annual water use and water pricing for dishwashers using the 2001 RECS.) Note, as discussed previously in section II.D on the energy and water use of the four appliance products, DOE characterized the average energy use of dishwashers and cooking products on relatively recent studies (for dishwashers, a 2001 study performed by ADL, and for cooking products, studies from the 2004 CA RASS and the FSEC). Therefore, to emphasize, DOE used RECS to establish the variability in annual energy use of dishwashers and cooking products, not the average consumption. For dehumidifiers, DOE used RECS to establish only the variability in electricity pricing. By using RECS, DOE was able to assign a unique annual energy use and/or energy price to each household in the sample. Due to the large sample of households considered in the LCC and PBP analyses, the range of annual energy use and/or energy prices is quite large. Thus, although the annual energy use and/or energy pricing are not uncertain for any particular household, their variability across all households contributes to the range of LCCs and PBPs calculated for any particular candidate standard level.

For CCWs, DOE was unable to develop a consumer sample, since neither RECS nor EIA's Commercial Building Energy Consumption Survey (CBECS) provide the necessary data to develop one. As a result, DOE was not able to use a consumer sample to establish the variability in energy use (and water use) and energy pricing (and water pricing) for CCWs. Instead, DOE established the variability and uncertainty in energy and water use for CCWs by defining the uncertainty and variability in the use (cycles per day) of the equipment. The variability and uncertainty in energy and water pricing are characterized by regional differences in energy and water prices.

2. Life-Cycle Cost Inputs

For each efficiency level analyzed, the LCC analysis requires input data for the total installed cost of the equipment, the operating cost, and the discount rate. Table II.57 summarizes the inputs and key assumptions DOE used to calculate the customer economic impacts of various candidate standard levels for each product. A more detailed discussion of the inputs follows.

TABLE II.57.—SUMMARY OF INPUTS AND KEY ASSUMPTIONS USED IN THE LIFE-CYCLE COST ANALYSES

Input	Description
Baseline Manufacturer Cost	The baseline manufacturer cost is the cost incurred by the manufacturer to produce equipment meeting existing minimum efficiency standards.
Standard-Level Manufacturer Cost Increases.	Standard-level manufacturer cost increases are the incremental change in manufacturer cost associated with producing equipment at a standard level.
Markups and Sales Tax	Markups and sales tax convert the manufacturer cost to a consumer equipment price.
Installation Cost	The installation cost is the cost to the consumer of installing the equipment and represents all costs required to install the equipment other than the marked-up consumer equipment price. The installation cost includes labor, overhead, and any miscellaneous materials and parts.

TABLE II.57.—SUMMARY OF INPUTS AND KEY ASSUMPTIONS USED IN THE LIFE-CYCLE COST ANALYSES—Continued

Input	Description
Annual Energy (and Water) Consumption.	The annual energy consumption is the site energy use associated with operating the equipment. The annual water consumption, which is applicable to dishwashers and CCWs, is the site water use associated with operating the equipment. The annual energy (and water) consumption vary with the product efficiency.
Energy and Water Prices	Energy and water prices are the prices paid by consumers for energy (*i.e.*, electricity, gas, or oil) and water. Multiplying the annual energy and water consumption by the energy and water prices yields the annual energy cost and water cost, respectively.
Repair and Maintenance Costs	Repair costs are associated with repairing or replacing components that have failed. Maintenance costs are associated with maintaining the operation of the equipment.
Energy and Water Price Trends	DOE uses energy and water price trends to forecast energy and water prices into the future and, along with the product lifetime and discount rate, to establish the lifetime energy and water costs.
Product Lifetime	The product lifetime is the age at which the equipment is retired from service.
Discount Rate	The discount rate is the rate at which DOE discounts future expenditures to establish their present value.

a. Total Installed Cost Inputs

The inputs to calculate total installed cost are as follows. ''Baseline manufacturer cost'' is the cost incurred by the manufacturer to produce equipment meeting existing minimum efficiency standards. ''Standard-level manufacturer cost increases'' are the change in manufacturer cost associated with producing equipment to meet a particular energy efficiency level (*i.e.*, the incremental cost). Markups and sales tax convert the manufacturer cost to a consumer equipment price. The installation cost is the cost to the consumer of installing the equipment and represents all costs required to install the equipment other than the marked-up consumer equipment price. Thus, the total installed cost equals the consumer equipment price plus the installation cost. For a complete discussion on manufacturer costs refer back to section II.C in this ANOPR. For details on markups and sales taxes, refer back to section II.E in this ANOPR.

More specifically, installation costs include labor, overhead, and any miscellaneous materials and parts. DOE determined installation costs for dishwashers, cooktops and ovens, and CCWs based on data in the *RS Means Plumbing Cost Data, 2005*.[38] *RS Means* provides estimates on the labor required to install each of above three products.

For dishwashers, DOE based its installation cost for baseline equipment on the nationally representative average cost associated with the installation of a four-or-more-cycle dishwasher as provided by *RS Means*. In addition, DOE determined that installation costs would not be impacted by increased standard levels. In reference to a design requiring a reduction in the inlet water temperature, Whirlpool stated that because it would require a cold water line to be plumbed to the dishwasher in addition to the hot water line, this design would incur greater installation costs than a baseline dishwasher. (Public Meeting Transcript, No. 5 at p. 204) DOE agrees with Whirlpool, but in its development of the manufacturing cost-versus-efficiency relationship, DOE did not believe that any of the standard levels would require a reduction in inlet water temperature. Thus, DOE did not alter its decision to keep the installation cost constant for more efficient designs.

For cooktops and ovens, DOE based its installation cost for baseline equipment on the nationally representative average cost associated with the installation of 30-inch, free-standing cooking ranges as provided by *RS Means*. DOE estimated that the costs of installing a range are also representative of the costs of installing either a cooktop or an oven. However, Whirlpool suggested that DOE should assess whether more efficient cooking products incur increased installation costs. (Whirlpool, No. 10 at p. 10) As a basis for assessing whether installation costs vary with product efficiency, DOE used its own supplemental analysis to the previous rulemaking's TSD. In the supplemental analysis, DOE determined that only gas cooktops and ovens with electronic ignition devices would incur added installation costs.[39] Because DOE did not receive any information to the contrary, DOE retained this determination for its current analysis. For gas cooktops and ovens, the previous analysis estimated, as an upper bound, that 20 percent of households using gas cooktops and ovens that do not require electricity to operate would require the installation of an electrical outlet in the kitchen to bring electrical service to the product. DOE used data from *RS Means* to estimate the installation cost of an electrical outlet.

For CCWs, GE stated that because CCWs are more difficult to install than typical residential clothes washers, the installation costs associated with residential washers should not be used as a basis for establishing CCW installation costs. (Public Meeting Transcript, No. 5 at p. 46) DOE agrees with GE and based its installation cost for baseline equipment on the nationally representative average costs associated with the installation of a four-cycle, coin operating CCW as provided by *RS Means*. DOE determined that installation costs would not be impacted by increased standard levels because none of the CCWs currently on the market differ from each other in terms of installation requirements despite existing variations in their level of efficiency. All CCW have similar connections for electrical power, incoming water, and drains. In addition to these basic connections, CCW may require some additional cabling for vending systems and monitoring. However, neither vending systems nor system monitoring enhances CCW energy efficiency.

Lastly, for dehumidifiers and microwave ovens, DOE determined that there are no costs associated with the installation of these products as a function of energy efficiency. Both types of products only require an available outlet to begin operating. Some dehumidifiers may require some additional work to allow condensate to drain directly into a drain. However, this product functionality is not related to energy efficiency—it simply relieves the user from having to drain the condensate bucket from time to time.

Additional details on the development of installation costs can be found in Chapter 8 of the TSD.

[38] RS Means. *Plumbing Cost Data, 28th Edition*, 2005. Kingston, MA. p. 97. Available online for purchase at: *http://www.remeans.com/.*

[39] U.S. Department of Energy. *Technical Support Document Energy Conservation Standards for Consumer Products Cooking Products, Supplemental Chapter 4—Life Cycle Cost and Payback Periods*, Washington, DC. Available online at: *http://www.eere.energy.gov/buildings/appliance_standards/residential/cooking_products_0998_r.html*.

b. Operating Cost Inputs

The operating cost inputs are as follows. Annual energy consumption is the site energy use associated with operating an appliance product. Annual water consumption, which is applicable to dishwashers and CCWs, is the site water use associated with operating an appliance product. Energy and water prices are the prices paid by consumers for energy (*i.e.*, electricity, gas, or oil) and water. DOE used energy and water price trends to forecast energy and water prices into the future. Multiplying the annual energy and water consumption by the energy and water prices yields the annual energy cost and water cost, respectively. Repair costs are associated with repairing or replacing components that have failed. Maintenance costs are associated with maintaining the operation of the equipment. The product lifetime is the age at which the equipment is retired from service. The discount rate is the rate at which DOE discounted future expenditures to establish their present value. The inputs for estimating annual energy (and water) consumption are discussed in section II.D.

With regard to energy prices, DOE derived average prices for 13 geographic areas consisting of the nine U.S. Census divisions, with four large States (New York, Florida, Texas, and California) treated separately. For Census divisions containing one of these large States, DOE calculated the regional average values leaving out data for the large State—for example, the Pacific region average does not include California, and the West South Central does not include Texas. EEI stated that DOE should use commercial energy prices to conduct the LCC and PBP analyses of CCWs and residential prices to conduct the analyses for the residential products. (EEI, No. 7 at p. 4) DOE agreed with EEI's suggestion, and as described below, DOE developed residential energy prices for its analysis of dishwashers, dehumidifiers, and cooking products, and commercial energy prices for CCWs.

With regard to water prices, DOE derived average prices for the four Census regions. As described below, DOE used survey data survey covering approximately 300 water utilities and 200 wastewater utilities to develop water and wastewater prices. Because a sample of 200–300 utilities is not large enough to calculate regional prices for all U.S. Census divisions and large States (for comparison, DOE used electricity price data form more than 3000 utilities), DOE calculated regional values at the Census region level (Northeast, South, Midwest, and West). Using these energy and water price data, DOE analyzed their variability at the regional level for each of the four appliance products.

For the three residential products (*i.e.*, dishwashers, dehumidifiers, and cooking products), DOE used 2001 RECS data to develop a sample of individual households that use each of the appliances. By developing household samples, DOE was able to perform the LCC and PBP calculations for each household to account for the regional variability in energy and water prices associated with each household. Because households use either electric, gas, or oil water heaters, DOE had to develop residential electricity, natural gas, and oil prices for its analysis of dishwashers. For dehumidifiers, DOE used only residential electricity prices because this product runs strictly using electricity. Since cooking products consist of electric and gas equipment, DOE had to use both residential electricity and natural gas prices in its analysis.

For CCWs, DOE was unable to develop a consumer sample, since neither RECS nor EIA's CBECS provide the necessary data to develop one. Thus, DOE characterized energy and water price regional variability with probability distributions. It based the probability associated with each regional energy and water price on the population weight of each region. Because commercial laundry establishments use either electric or gas water heaters and dryers, DOE developed both commercial electricity and natural gas prices for its analysis of CCWs.

DOE estimated residential and commercial electricity prices for each of the 13 geographic areas based on data from EIA Form 861, *Annual Electric Power Industry Report.* These data are published annually and include annual electricity sales in kWh, revenues from electricity sales, and number of consumers, for the residential, commercial, and industrial sectors, for every utility serving final consumers. DOE calculated an average residential electricity price by first estimating an average residential price for each utility—by dividing the residential revenues by residential sales—and then calculating a regional average price by weighting each utility with customers in a region by the number of residential consumers served in that region. The calculation methodology uses recently available EIA data from 2004. The calculation methodology of an average commercial electricity price is identical to that for residential price, except that DOE used commercial sector data.

DOE estimated residential and commercial natural gas prices in each of the 13 geographic areas based on data from the EIA publication *Natural Gas Monthly.*[40] This publication includes a compilation of monthly natural gas delivery volumes and average consumer prices by State, for residential, commercial, and industrial customers. Specifically, DOE used the complete annual data for 2005 to calculate an average summer and winter price for each area. It calculated seasonal prices because, for some end uses, seasonal variation in energy consumption is significant. DOE defined summer as the months May through September, with all other months defined as winter. DOE calculated an average natural gas price by first calculating the summer and winter prices for each State, using a simple average over the appropriate months, and then calculating a regional price by weighting each State in a region by its population. This method differs from the method used to calculate electricity prices, because EIA does not provide consumer-level or utility-level data on gas consumption and prices. The calculation methodology of an average commercial natural gas price is identical to that for residential price, except that DOE used commercial sector data.

DOE estimated residential oil prices in each of the 13 geographic areas based on data from EIA's *Petroleum Navigator.*[41] From this Web site, available data include a compilation of monthly oil delivery volumes and average consumer prices by State, for residential, commercial, and industrial customers. Specifically, DOE used the complete annual data for 2005 to calculate an average oil price. It first calculated the prices for each State using simple averages and then calculated a regional price, weighting each State in a region by its population.

DOE obtained residential water and wastewater price data from the 2004 *Water and Wastewater Rate Survey* conducted by Raftelis Financial Consultants and the American Water Works Association.[42] The survey covers approximately 300 water utilities and

[40] DOE-Energy Information Administration, *Natural Gas Monthly*, available online at: *http://www.eia.doe.gov/oil_gas/natural_gas/data_publications/natural_gas_monthly/ngm.htm.*

[41] DOE Energy Information Administration, *Petroleum Navigator*, available online at: *http://tonto.eia.doe.gov/dnav/pet/pet_pri_top.asp.*

[42] Raftelis Financial Consultants, Inc. 2004 RFC/AWWA Water and Wastewater Rate Survey, 2004. Charlotte, NC, Kansas City, MO, and Pasadena, CA. Available online at: *http://www.raftelis.com/ratessurvey.html.*

200 wastewater utilities, with each industry analyzed separately. The water survey includes, for each utility, the cost to consumers of purchasing a given volume of water. In this case, the data include a division of the total consumer cost into fixed and volumetric charges. Pacific Gas & Electric Company (PG&E) suggested that DOE determine the marginal price of water and wastewater for its analysis. PG&E claimed that the marginal cost of improving wastewater treatment plants to comply with State and Federal regulations is very high. Because higher marginal costs translate into higher marginal prices, PG&E states that the marginal price would be a more accurate representation of the economic savings due to reduced water consumption. (Public Meeting Transcript, No. 5 at p. 190) As PG&E suggested, DOE calculated only the volumetric charge to determine water prices, since only this charge would be affected by a change in water consumption. Including the fixed charge in the average water price would lead to a slightly higher water price. For wastewater utilities, the format is similar, but the cost refers to the cost of treating a given volume of wastewater.

EEI stated that price of water and wastewater is highly variable depending on consumer use or volume and geographic location. (Public Meeting Transcript, No. 5 at p. 192) DOE agrees with EEI in determining regional water and wastewater prices. However, a sample of 200–300 utilities is not large enough to calculate regional prices for all U.S. Census divisions and large States (for comparison, the EIA Form 861 data include more than 3,000 utilities). For this reason, DOE calculated regional values at the Census-region level (Northeast, South, Midwest, and West). DOE calculated average per-unit-volume prices by first calculating the per-unit-volume price for each utility by dividing the total volumetric cost by the volume delivered, then calculating a State-level average price by weighting each utility in a given State by the number of consumers it serves (either residential or commercial), and finally arriving at a regional average by combining the State-level averages, weighting each by the population of that State. This third step helps reduce any bias in the sample that may occur due to relative under-sampling of large States.

For further details of the methodology that DOE used for deriving energy and water prices, see Chapter 8 of the TSD.

In terms of trends, DOE used price forecasts by the EIA to estimate the trends in natural gas, oil, and electricity prices. The Joint Comment stated that current EIA energy price forecasts are too low and will likely be revised upwards over the next few years. The Joint Comment requested that DOE use the latest available price forecasts from EIA to conduct their analyses. (Joint Comment, No. 9 at p. 2) To estimate future energy prices, DOE used EIA's *Annual Energy Outlook (AEO) 2007,* containing the latest available price forecasts from EIA.[43] To arrive at prices in future years, DOE multiplied the average prices described in the preceding section by the forecast of annual average price changes in *AEO 2007.* Because *AEO 2007* forecasts prices to 2030, DOE followed past guidelines provided to the Federal Energy Management Program (FEMP) by EIA and used the average rate of change during 2020–2030 for electricity and the average rate of change during 2015–2020 for natural gas and oil to estimate the price trends after 2030. More recent guidelines to FEMP suggest that a 10-year rather than a 15-year historical time period be used to extrapolate natural gas and oil prices. DOE intends to use the more recent guidelines to extrapolate gas and oil prices for the NOPR. For the analyses to be conducted for the NOPR and Final Rule, DOE intends to update its energy price forecasts at those stages of the rulemaking based on the latest available *AEO.*

NWPCC commented that energy rate caps will be coming off in the next few years for many States in the U.S. and asked whether EIA's energy price forecasts take this into account. (Public Meeting Transcript, No. 5 at p. 193) In response, we note that EIA conducts an annual review of changes in energy prices by supply region and State in developing its *AEO.* In estimating future energy prices, EIA determines which regions of the country are regulated (*i.e.*, with rate caps) and which are competitive or will become competitive soon (*i.e.*, without rate caps). In past *AEOs,* EIA assumed that prices in fully competitive regions would reflect spot market prices and would be passed on to consumers immediately. EIA expects that the end of price reductions and caps in many States will push competitive regions closer to that representation of competition; however, EIA anticipates that most customers in fully competitive regions will not experience price changes immediately in response to changes in market generation costs. Consequently, for *AEO 2007,* EIA built lags into the calculation of competitive energy prices to simulate the delay from the time suppliers experience cost changes to the time consumers experience price changes as a result of the length of fixed-price contracts for standard-offer service (*i.e.*, rates typically provided by regulated utilities) and competitive retail service.

National Consumer Law Council (NCLC) asked how DOE will account for the variability in future electricity prices in the analyses. (Public Meeting Transcript, No. 5 at p. 188) In response, we note that DOE addressed future variability in electricity prices by incorporating three separate projections from *AEO 2007* into the spreadsheet models for calculating LCC and PBP: (1) Reference Case; (2) Low Economic Growth Case; and (3) High Economic Growth Case. These three cases reflect the uncertainty of economic growth in the forecast period. The high and low growth cases show the projected effects of alternative growth assumptions on energy markets.

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 1970 through 2005 provided by the Bureau of Labor Statistics. DOE extrapolated a future trend based on the linear growth over the 1970–2005 time period.

For further details on DOE's method for forecasting energy and water prices, see Chapter 8 of the TSD.

With respect to repair and maintenance costs, DOE assumed that small, incremental changes in products related to efficiency result in either no or only very small changes in repair and maintenance costs, as compared to baseline products. DOE acknowledges there is a greater probability that equipment with efficiencies that are significantly greater than the baseline will incur some level of increased repair and maintenance costs because such equipment is more likely to incorporate technologies that are not widely available.

On this point, Whirlpool stated that, in general, more-efficient products use more sophisticated components and controls, thereby increasing repair and maintenance costs. (Whirlpool, No. 10 at p. 10) Whirlpool also stated, in regard to cooking products, that repair and maintenance costs for more-efficient products will be higher than these types of costs for current baseline products. For example, Whirlpool cited two design options—bi-radiant ovens and electronic controls—as technologies that would incur higher repair and maintenance costs. Whirlpool suggested that DOE should obtain data on repair

[43] U.S. Department of Energy-Energy Information Administration. Annual Energy Outlook 2007 with Projections to 2030, February, 2007. Washington, DC. DOE/EIA–0383 (2007).

and maintenance costs during the course of its data collection for the engineering analysis (similar comment provided by AHAM). (Whirlpool, No. 10 at p. 10; Public Meeting Transcript, No. 5 at pp. 199–200; AHAM, No. 14 at p. 5) With respect to CCWs, ALS stated that repair and maintenance costs for front-loading washers are much higher than for top-loading washers. (Public Meeting Transcript, No. 5 at p. 201) DOE requested that manufacturers and other stakeholders provide information regarding appropriate repair and maintenance costs if stakeholders believe such estimates are necessary. However, DOE did not receive any input, and, therefore, did not include any changes in repair and maintenance costs for products more efficient than baseline products in this ANOPR.

DOE specifically seeks feedback on its assumption that increases in product energy efficiency would not have a significant impact on the repair and maintenance costs for the four appliance products covered by this rulemaking. This is identified as Issue 11 under ''Issues on Which DOE Seeks Comment'' in section IV.E of this ANOPR.

With regard to appliance product lifetimes, DOE received several comments on the appropriate sources for establishing their length. For dishwashers, ACEEE stated that some sources indicate that dishwasher lifetime is 14 years, while Whirlpool commented that *Appliance Magazine's* estimate of nine years for dishwasher lifetime is reasonable and the most representative of actual consumer behavior. (Public Meeting Transcript, No. 5 at p. 206; Whirlpool, No. 10 at p 10) For dehumidifiers, the Joint Comment estimated a product lifetime of 15 years based on discussions with manufacturers and other sources. The Joint Comment stated that *Appliance Magazine* generally provides shorter lifetimes as compared to other sources. In contrast, Whirlpool commented that *Appliance Magazine's* estimate of eight years for dehumidifier lifetime is reasonable and the most consistent with actual consumer behavior. (Joint Comment, No. 9 at p. 5; Whirlpool, No. 10 at p 10) For cooking products, both AHAM and Whirlpool stated that the best source for cooking product lifetimes is *Appliance Magazine,* as they believe it provides estimated lifetimes which are consistent with actual consumer behavior. (AHAM, No. 14 at p. 5; Whirlpool, No. 10 at p. 10) Finally, for CCWs, ALS stated that because CCWs are typically used more often than residential clothes washers, CCW lifetime will be significantly shorter than the lifetime of residential machines. It suggested that the best sources for CCW product lifetime data are the MLA and route operators. (Public Meeting Transcript, No. 5 at p. 206)

To estimate the lifetime for each product covered by this rulemaking, DOE used only primary sources of data. For example, the Federal government's Energy Star Web site [44] provides lifetime estimates for dishwashers and dehumidifiers, but the estimates are actually based on data from *Appliance Magazine.* Because, in this case, *Appliance Magazine* is the primary source of data, DOE did not use the Energy Star Web site as a primary source to estimate product lifetimes. DOE used a variety of sources to establish the lifetime of each of the considered products, including *Appliance Magazine.* Using the primary sources of data, DOE characterized product lifetimes with uniform probability distributions ranging from a minimum to a maximum value. Microwave ovens were the exception, since DOE used a triangular probability distribution for these products instead. DOE determined the average product lifetime by calculating the average value from the applicable primary sources of data. To establish the minimum and maximum product lifetime, DOE generally used the high and low values from these sources for each of the four appliance products. See Chapter 8 of the TSD for more details.

To establish discount rates for the residential products (*i.e.*, dishwashers, dehumidifiers, and cooking products), DOE derived estimates of the finance cost of purchasing the considered products. Following financial theory, the finance cost of raising funds to purchase appliances can be interpreted as: (1) The financial cost of any debt incurred to purchase equipment, or (2) the opportunity cost of any equity used to purchase equipment. For the residential products, the purchase of equipment for new homes entails different finance costs for consumers than the purchase of replacement equipment. Thus, DOE used different discount rates for new construction and replacement installations. NCLC questioned how DOE would evaluate the cost of household equity and debt to develop discount rates for residential products. (Public Meeting Transcript, No. 5 at p. 196) As described below, DOE used the Federal Reserve Board's Survey of Consumer Finances (SCF) for the years 1989, 1992, 1995, 1998, 2001, and 2004 as the basis for using household equity and debt to calculate discount rates for residential products.[45] The SCF defines the shares of various equity and debt classes held by U.S. households, thereby allowing DOE to properly weight the equity and debt holdings to derive residential discount rates. EEI commented that because interest rates have been rising since 2003, making the cost of capital higher for residential and commercial consumers, DOE should take into account the most recent financial data when developing discount rates. (EEI, No. 7 at p. 4) As described below, DOE used the most recent data available, including data from the SCF to establish appropriate residential discount rates, and data from Damodaran Online to establish commercial discount rates.[46]

New equipment is often purchased as part of the purchase of a home, which is almost always financed with a mortgage loan. DOE estimated discount rates for new-housing equipment using the effective real (after-inflation) mortgage rate for homebuyers. This rate corresponds to the interest rate after deduction of mortgage interest for income tax purposes and after adjusting for inflation. The data sources DOE used for mortgage interest rates are the SCFs in 1989, 1992, 1995, 1998, 2001, and 2004. After adjusting for inflation and interest tax deduction, effective real interest rates on mortgages across the six surveys averaged 3.2 percent.

For residential replacement equipment, DOE's approach for deriving discount rate involved identifying all possible debt or asset classes that might be used to purchase replacement equipment, including household assets that might be affected indirectly. DOE did not include debt from primary mortgages and equity of assets considered non-liquid (such as retirement accounts), since these would likely not be affected by replacement equipment purchases. DOE estimated the average shares of the various debt and equity classes in the average U.S. household equity and debt portfolios using SCF data for 1989, 1992, 1995, 1998, 2001, and 2004. DOE used the mean share of each class across the six sample years as a basis for estimating the effective financing rate for replacement equipment. DOE estimated

[44] Energy Star Web site: *http://www.energystar.gov/.*

[45] The Federal Reserve Board. *1989, 1992, 1995, 1998, 2001, 2004 Survey of Consumer Finances,* 1989, 1992, 1995, 1998, 2001, 2004. Available online at: *http://www.federalreserve.gov/pubs/oss/oss2/scfindex.html.*

[46] Damodaran Online is a widely used source of information about company debt and equity financing for most types of firms, and was the source of data for this analysis on educational services, hotels, and real estate investment trusts. *See http://pages.stern.nyu.edu/adamodar/.*

interest or return rates associated with each type of equity and debt using SCF data and other sources. The mean real effective rate across all types of household debt and equity, weighted by the shares of each class, is 5.6 percent.

For CCWs, DOE derived the discount rate from the cost of capital of publicly-traded firms in the sectors that purchase CCWs. These companies typically finance equipment purchases through debt and equity capital. DOE estimated the cost of capital of these firms as the weighted average of the cost of equity financing and the cost of debt financing. The costs of debt and equity financing are usually obtainable from publicly available data concerning the major types of companies in the sectors that purchase CCWs. Damodaran Online is a widely used source of information about company debt and equity financing for most types of firms, and it was the source of data for this analysis on educational services, hotels, and real estate investment trusts. Since Damodaran Online does not include data for firms in the personal services sector (Standard Industrial Classification 7200), DOE used data from Ibbotson's Associates [47] for this sector.

DOE estimated the cost of equity using the capital asset pricing model (CAPM). The CAPM assumes that the cost of equity for a particular company is proportional to the systematic risk faced by that company, where high risk is associated with a high cost of equity and low risk is associated with a low cost of equity. The systematic risk facing a firm is determined by several variables: (1) The risk coefficient of the firm; (2) the expected return on risk-free assets; and (3) the equity risk premium (ERP). The risk coefficient of the firm indicates the risk associated with that firm relative to the price variability in the stock market. The expected return on risk-free assets is defined by the yield on long-term government bonds. The ERP represents the difference between the expected stock market return and the risk-free rate.

The cost of debt financing is the interest rate paid on money borrowed by a company. The cost of debt is estimated by adding a risk adjustment factor to the risk-free rate. This risk adjustment factor depends on the variability of stock returns represented by standard deviations in stock prices.

DOE estimated the weighted-average cost of capital (WACC) using the respective shares of equity and debt financing for each of the sectors that purchase CCWs. It calculated the real WACC by adjusting the cost of capital by the expected rate of inflation. To obtain an average discount rate value, DOE used additional data from the CEE on the number of CCWs in use in various sectors. Weighting each sector by its market share, DOE estimated the average discount rate for companies that purchase CCWs to be 5.7 percent, using an inflation rate of 2.5 percent (the average of inflation rates over the 2001–2005 time period). For further details on DOE's method for estimating discount rates, see Chapter 8 of the TSD.

One additional issue pertaining to the LCC operating cost inputs concerns the potential ''split incentives'' that exist in the CCW market. Several organizations commented that under a split incentive situation, the party purchasing more-efficient and more-expensive equipment may not realize the operating cost savings from the more-efficient equipment. For example, commenters asserted that under new energy efficiency standards, route operators would incur the burden of higher purchase prices due to more-efficient equipment; property owners would realize the benefits of operating cost savings, and end-users may incur the burden of increased costs to use the washers. (Public Meeting Transcript, No. 5 at p. 239; EEI, No. 7 at p. 4; MLA, No. 8 at p. 2; Whirlpool, No. 10 at p. 13; Multiple Water Organizations, No. 11 at p. 2) In its LCC and PBP analyses, DOE did not explicitly consider the potential of split incentives in the CCW market, because it believes that the probability of such a split incentive was very low. The actual consumers of this product (primarily property-owners of multi-family buildings and laundromats) realize both the burden of increased purchase prices and the benefit of reduced operating cost savings. Any split incentive that would occur for end-users in the form of increased vending prices is likely to be very low due to the competitive nature of the market. For example, if end-users feel as though they are paying excessively high prices to use a service, they will seek out cheaper options to obtain the service, thereby forcing providers to adjust their prices in accordance with what is a reasonable return on their investment. Due to the checks and balances that occur in the marketplace, DOE believes it is unnecessary to explicitly account for the possible inequities to end-users that may arise from a split incentive.

c. Effective Date

The effective date is the future date when a new standard becomes effective. Based on DOE's implementation report for energy conservation standards activities submitted under Section 141 of EPACT 2005, a final rule for the four appliance products being considered for this standards rulemaking is scheduled for completion in March 2009. The effective date of any new energy efficiency standards for these products will be three years after the final rule is published in the **Federal Register** (*i.e.*, March 2012). DOE calculated the LCC for all consumers as if they each would purchase a new piece of equipment in the year the standard takes effect.

d. Equipment Assignment for the Base Case

For purposes of conducting the LCC analysis, DOE analyzed candidate standard levels relative to a baseline efficiency level. However, some consumers already purchase products with efficiencies greater than the baseline levels. Thus, to accurately estimate the percentage of consumers that would be affected by a particular standard level, DOE took into account the distribution of product efficiencies currently in the marketplace. In other words, DOE conducted the analysis by taking into account the full breadth of product efficiencies that consumers already purchase under the base case (*i.e.*, the case without new energy efficiency standards).

DOE's approach for conducting the LCC analysis for residential products (*i.e.*, dishwashers, dehumidifiers, cooking products) relied on developing samples of households that use each of the products. DOE used a Monte Carlo simulation technique to perform the LCC calculations on the households in the sample. Using the current distribution of product efficiencies, DOE assigned each household in the sample a specific product efficiency. Because it performed the LCC calculations on a household-by-household basis, DOE based the LCC for a particular standard level on the efficiency of the product in the given household. For example, if a household was assigned a product efficiency that is greater than or equal to the efficiency of the standard level under consideration, the LCC calculation would reveal that this household is not impacted by an increase in product efficiency that is equal to the standard level.

For dishwashers, DOE characterized base case market shares based on data that AHAM provided that show the distribution of standard-sized

[47] Ibbotson Associates is a leading authority on asset allocation with expertise in capital market expectations and portfolio implementation. *See* Ibbotson's Associates Statistics for SIC 72, available online at: *http://www.ibbotson.com*

dishwasher efficiencies sold in 2005. Table II.58 presents the market shares of the candidate standard levels in the base case for standard-sized dishwashers. The market shares in Table II.58 represent the products that households would have been anticipated to purchase in the year 2012 in the absence of new standards.

TABLE II.58.—STANDARD-SIZED DISHWASHERS: BASE CASE MARKET SHARES

Candidate standard level	EF	Market share (percent)
Baseline	0.46	3.0
*	0.50	2.0
*	0.54	2.0
1	0.58	43.0
*	0.60	17.0
2	0.62	22.0
3	0.65	8.0
4	0.68	2.5
5	0.72	0.2
6	0.80	0.2
7	1.11	0.2

* Intermediate efficiency level.

For dehumidifiers, DOE characterized base case market shares based on data that AHAM provided that show the distribution of dehumidifier efficiencies in 2005 for two of the six product classes: 35.01–45.00 pints/day and 54.01–74.99 pints/day. Because DOE conducted the engineering and LCC and PBP analyses on the combined product class of 0–35.00 pints/day product class as well as these two classes, DOE had to estimate the market share data for the combined 0–35.00 pints/day product class. Without any data provided by either AHAM or manufacturers or available from other sources, DOE assumed that the market shares for the combined 0–35.00 pints/day class were equivalent to the market shares for the closest product class—the 35.01–45.00 pint/day product class. For purposes of conducting the NIA, DOE estimated that the market share data for the 35.01–45.00 pints/day and 54.01–74.99 pints/day classes could be used to characterize the base case market shares for the 45.01–54.00 pints/day and 75 pints/day and greater product classes, respectively. Table II.59 presents the market shares of the efficiency levels in the base case for the three classes of dehumidifiers that DOE used to conduct the LCC analysis. The market shares in Table II.59 represent the equipment that households would have been anticipated to purchase in the year 2012 in the absence of new standards.

TABLE II.59.—DEHUMIDIFIERS: BASE CASE MARKET SHARES

0–35.00 pints/day			35.01–45.00 pints/day			54.01–74.99 pints/day		
Level	EF	Market share (percent)	Level	EF	Market share (percent)	Level	EF	Market share (percent)
Baseline	1.20	27	Baseline	1.30	27	Baseline	1.50	31
1	1.25	35	1	1.35	35	1	1.55	0
2	1.30	0	2	1.40	0	2	1.60	57
3	1.35	0	3	1.45	0	3	1.65	12
4	1.40	38	4	1.50	38	4	1.70	0
5	1.45	0	5	1.74	0	5	1.80	0

Because DOE currently does not regulate cooking product efficiency with an energy efficiency descriptor, very little is known regarding the distribution of product efficiencies that consumers in the United States currently purchase. Therefore, for all electric cooking products, including microwave ovens, and gas self-cleaning ovens, DOE estimated that 100 percent of the market existed at the baseline efficiency levels. For gas cooktops and gas standard ovens, data are available, both from DOE's previous rulemaking analysis and the Appliance Recycling Information Center, to indicate the historical percentage of products shipped with standing pilots. Therefore, DOE was able to estimate the percentage of the gas cooktop and gas standard oven market that is still sold with standing pilot lights. Table II.60 presents the market shares of the efficiency levels in the base case for gas cooktops and gas standard ovens. In the table, candidate standard level 1 represents products without standing pilot light ignition systems. The market shares in Table II.60 represent the equipment that households would have been anticipated to purchase in the year 2012 in the absence of new energy conservation standards.

TABLE II.60.—GAS COOKTOPS AND GAS STANDARD OVENS: BASE CASE MARKET SHARES

Gas cooktops			Gas standard ovens		
Candidate standard level	EF	Market share (percent)	Candidate standard level	EF	Market share (percent)
Baseline	0.156	6.8	Baseline	0.0298	17.6
1	0.399	93.2	1*	0.0536	82.4
2	0.420	0	2	0.0566	0
			3	0.0572	0
			4	0.0593	0
			5	0.0596	0
			6	0.0600	0

TABLE II.60.—GAS COOKTOPS AND GAS STANDARD OVENS: BASE CASE MARKET SHARES—Continued

Gas cooktops			Gas standard ovens		
Candidate standard level	EF	Market share (percent)	Candidate standard level	EF	Market share (percent)
			1a*	0.0583	0

* For gas standard ovens, candidate standard levels 1 and 1a correspond to designs that are utilized for the same purpose—eliminate the need for a standing pilot—but the technologies for each design are different. Candidate standard level 1 is a hot surface ignition device while candidate standard level 1a is a spark ignition device. Candidate standard level 1a is presented at the end of the table because candidate standard levels 2 through 6 are derived from candidate standard level 1.

For CCWs, DOE was unable to develop a consumer sample. However, it took into account the base case mix of CCW efficiencies by characterizing the current mix of product efficiencies as a probability distribution. In other words, as DOE performed the Monte Carlo simulation, it evaluated each standard level analyzed against the distribution of product efficiencies in the base case.

DOE derived its base case market share data for CCWs based on shipment-weighted efficiency data that AHAM provided. Table II.61 presents the market shares of the candidate standard levels in the base case for standard-sized dishwashers. The market shares in Table II.61 represent the products that households would have been anticipated to purchase in the year 2012 in the absence of new energy conservation standards.

TABLE II.61.—COMMERCIAL CLOTHES WASHERS: BASE CASE MARKET SHARES

Level	MEF	WF	Market share (percent)
Baseline	1.26	9.50	79.7
1	1.42	9.50	0.0
2	1.60	8.50	0.0
3	1.72	8.00	0.0
4	1.80	7.50	0.0
5	2.00	5.50	20.3
6	2.20	5.10	0.0

For more details on how DOE developed the base case product efficiency distributions for the four appliance products in the LCC analysis, refer to Chapter 8 of the TSD.

DOE specifically seeks feedback on its methodology and data sources for developing the base case product efficiency distributions for the four appliance products. This is identified as Issue 12 under ''Issues on Which DOE Seeks Comment'' in section IV.E of this ANOPR.

3. Payback Period Inputs

As described above, the PBP is the amount of time it takes the consumer to recover the additional installed cost of more-efficient equipment through energy (and water) cost savings, as compared to baseline equipment. Simple payback period does not take into account changes in operating expense over time or the time value of money. Payback periods are expressed in years. Payback periods greater than the life of the product mean that the increased total installed cost is not recovered in reduced operating expenses.

The inputs to the calculation of the PBP are the total installed cost of the equipment to the customer for each efficiency level and the annual (first-year) operating expenditures for each efficiency level. The PBP calculation uses the same inputs as the LCC analysis, except that energy (and water) price trends and discount rates are not needed. The calculation needs energy prices only for the year in which a new standard is expected to take effect, in this case the year 2012.

4. Life-Cycle Cost and Payback Period Results

DOE calculated the LCC and PBP results relative to the base case forecast for each product class. As mentioned above, the base case consists of the projected pattern of equipment purchases that would occur in the absence of new efficiency standards.

The following tables (Table II.62 through Table II.75) present the findings from the LCC and PBP analyses DOE performed for this ANOPR. DOE determined the values at each candidate standard level by excluding the percentage of households not impacted by the standard (*i.e.*, those who, in base case, already purchase a unit at or above the given efficiency level). Figures showing the distribution of LCCs, LCC impacts, and PBPs with their corresponding probability of occurrence are presented in Chapter 8 of the TSD.

Table II.62 shows the LCC and PBP results for standard-sized dishwashers. For example, candidate standard level 3 (0.65 EF) shows an average LCC savings of $17. Note that for standard level 3, 10.6 percent of the housing units in 2012 are shown to have already purchased a dishwasher at standard level 3 in the base case and, thus, have zero savings due to the standard. If one compares the LCC of the baseline at 0.46 EF ($1124) to the standards case at 0.65 EF ($1025), then the difference in the LCCs is $99. However, since the base case includes a significant number of households that are not impacted by the standard, the average savings over all of the households is actually $17, not $99. With regard to the PBPs shown below, DOE determined the median and average values by excluding the percentage of households not impacted by the standard. For example, in the case of standard level 3, 10.6 percent of the households did not factor into the calculation of the median and average PBP.

TABLE II.62.—STANDARD-SIZED DISHWASHERS: LIFE-CYCLE COST AND PAYBACK PERIOD RESULTS

Candidate standard level	EF	Life-cycle cost			Life-cycle cost savings				Payback period (years)	
		Average installed price	Average operating cost	Average LCC	Average savings	Households with Net cost (percent)	Households with No impact (percent)	Households with Net benefit (percent)	Median	Average
Baseline	0.46	$700	$424	$1,124						
1	0.58	706	339	1,045	$4	0.1	92.8	7.1	0.9	1.5
2	0.62	712	318	1,029	13	11.3	32.8	56.0	2.8	5.1
3	0.65	722	303	1,025	17	32.6	10.6	56.8	5.9	10.9
4	0.68	747	291	1,038	5	58.6	3.1	38.4	11.9	22.2
5	0.72	811	275	1,086	−43	82.9	0.6	16.5	22.5	42.3
6	0.80	900	249	1,149	−106	90.1	0.4	9.5	28.3	51.5
7	1.11	980	183	1,162	−119	83.3	0.3	16.4	21.9	39.3

Tables II.63, II.64, and II.65 show the LCC and PBP results for dehumidifiers. For example, in the case of the 35.01–45.00 pints/day class, candidate standard level 3 (1.45 EF) shows an average LCC savings of $8. Note that for standard level 3, 38.2 percent of the housing units in 2012 are shown to have already purchased a dehumidifier at standard level 3 in the base case and, thus, have zero savings due to the standard. If one compares the LCC of the base case at 1.30 EF ($676) to the standards case at 1.45 EF ($657), then the difference in the LCCs is $19. However, since the base case includes a significant number of households that are not impacted by the standard, the average savings over all of the households is actually $8, not $19. With regard to the PBPs shown below, DOE determined the median and average values by excluding the percentage of households not impacted by the standard. For example, in the case of standard level 3 for the 35.01–45.00 pints/day class, 38.2 percent of the households did not factor into the calculation of the median and average PBP.

TABLE II.63.—DEHUMIDIFIERS, 0–35.00 PINTS/DAY: LIFE-CYCLE COST AND PAYBACK PERIOD RESULTS

Candidate standard level	Efficiency *liters/kWh*	Life-cycle cost *			Life-cycle cost savings *				Payback period (years) *	
		Average installed price	Average operating cost	Average LCC	Average savings	Households with Net cost (percent)	Households with No impact (percent)	Households with Net benefit (percent)	Median	Average
Baseline	1.20	$137	$422	$558	....	....	....	....	....	....
1	1.25	142	405	546	$3	0.0	73.1	26.9	2.6	2.5
2	1.30	142	389	533	11	0.0	38.4	61.6	1.7	1.8
3	1.35	153	375	528	15	0.2	38.4	61.4	3.2	3.1
4	1.40	166	361	527	15	5.5	38.4	56.2	4.6	4.5
5	1.45	176	349	525	17	25.9	0.0	74.1	5.7	5.9

* LCC, LCC savings, and PBP based on the annual energy consumption and operating cost associated with the 25.01–35.00 pints/day product class.

TABLE II.64.—DEHUMIDIFIERS, 35.01–45.00 PINTS/DAY: LIFE-CYCLE COST AND PAYBACK PERIOD RESULTS

Candidate standard level	Efficiency *liters/kWh*	Life-cycle cost			Life-cycle cost savings				Payback period (years)	
		Average installed price	Average operating cost	Average LCC	Average savings	Households with Net cost (percent)	Households with No impact (percent)	Households with Net benefit (percent)	Median	Average
Baseline	1.30	$157	$519	$676	....	....	....	....	....	....
1	1.35	167	500	666	$3	1.5	73.1	25.5	4.4	4.2
2	1.40	167	482	661	6	15.2	38.2	46.6	5.9	5.8
3	1.45	192	465	657	8	17.5	38.2	44.3	6.2	6.1
4	1.50	208	450	658	8	22.7	38.2	39.1	7.0	6.8
5	1.74	272	388	660	5	54.1	0.0	45.9	8.5	8.3

TABLE II.65.—DEHUMIDIFIERS, 54.01–74.99 PINTS/DAY: LIFE-CYCLE COST AND PAYBACK PERIOD RESULTS

Candidate standard level	Efficiency *liters/kWh*	Life-cycle cost			Life-cycle cost savings				Payback period (years)	
		Average installed price	Average operating cost	Average LCC	Average savings	Households with Net cost (percent)	Households with No impact (percent)	Households with Net benefit (percent)	Median	Average
Baseline	1.50	$189	$725	$914	....	....	....	....	....	....

TABLE II.65.—DEHUMIDIFIERS, 54.01–74.99 PINTS/DAY: LIFE-CYCLE COST AND PAYBACK PERIOD RESULTS—Continued

Candidate standard level	Efficiency *liters/kWh*	Life-cycle cost			Life-cycle cost savings				Payback period (years)	
		Average installed price	Average operating cost	Average LCC	Average savings	Households with			Median	Average
						Net cost (percent)	No impact (percent)	Net benefit (percent)		
1	1.55	195	702	897	$5	0.0	68.5	31.5	2.5	2.4
2	1.60	195	680	881	10	0.0	68.5	31.5	2.4	2.4
3	1.65	208	659	867	22	0.0	12.3	87.7	2.8	2.7
4	1.70	224	640	864	25	14.1	0.0	85.9	4.8	4.9
5	1.80	241	604	845	44	7.8	0.0	92.2	4.4	4.4

Tables II.66, II.67, and II.68 show the LCC and PBP results for cooktops. For example, in the case of gas cooktops, candidate standard level 1 (pilotless ignition with an efficiency of 0.399 EF) shows an average LCC savings of $19. Note that for standard level 1, 93.4 percent of the housing units in 2012 are shown to have already purchased a gas cooktop with pilotless ignition in the base case and, thus, have zero savings due to the standard. If one compares the LCC of the baseline at 0.106 EF ($716) to the standards case at 0.399 EF ($435), then the difference in the LCCs is $281. However, since the base case includes a significant number of households that are not impacted by the standard, the average savings over all of the households is actually $19, not $281. With regard to the PBPs shown below, DOE determined the median and average values by excluding the percentage of households not impacted by the standard. For example, in the case of standard level 1 for gas cooktops, 93.4 percent of the households did not factor into the calculation of the median and average PBP.

TABLE II.66.—ELECTRIC COIL COOKTOPS: LIFE-CYCLE COST AND PAYBACK PERIOD RESULTS

Candidate standard level	EF	Life-cycle cost			Life-cycle cost savings				Payback period (years)	
		Average installed price	Average operating cost	Average LCC	Average savings	Households with			Median	Average
						Net cost	No impact	Net benefit		
Baseline	0.737	$251	$150	$401	....	....	....	....	....	....
1	0.769	255	144	399	$3	35.0%	0.0%	65.0%	8.1	18.6

TABLE II.67.—ELECTRIC SMOOTH COOKTOPS: LIFE-CYCLE COST AND PAYBACK PERIOD RESULTS

Candidate standard level	EF	Life-cycle cost			Life-cycle cost savings				Payback period (years)	
		Average installed price	Average operating cost	Average LCC	Average savings	Households with			Median	Average
						Net cost	No impact	Net benefit		
Baseline	0.742	$288	$150	$438	....	....	....	....	....	....
1	0.753	528	148	676	−$238	100.0%	0.0%	0.0%	1,685.2	4,266.3

TABLE II.68.—GAS COOKTOPS: LIFE-CYCLE COST AND PAYBACK PERIOD RESULTS

Candidate standard level	EF	Life-cycle cost			Life-cycle cost savings				Payback period (years)	
		Average installed price	Average operating cost	Average LCC	Average savings	Households with			Median	Average
						Net cost (percent)	No impact (percent)	Net benefit (percent)		
Baseline	0.106	$289	$428	$716	....	....	....	....	....	....
1	0.399	322	113	435	$19	0.0	93.4	6.7	1.3	1.4
2	0.420	351	107	458	−5	93.2	0.0	6.8	75.3	195.1

Tables II.69 through II.72 show the LCC and PBP results for ovens. For example, in the case of gas standard ovens, candidate standard level 1 (pilotless ignition with an efficiency of 0.058 EF) shows an average LCC savings of $16. Note that for standard level 1, 83 percent of the housing units in 2012 are shown to have already purchased a gas standard oven with pilotless ignition in the base case and, thus, have zero savings due to the standard. If one compares the LCC of the base case at 0.030 EF ($697) to the standards case at 0.058 EF ($603), then the difference in the LCCs is $94. However, since the base case includes a significant number of households that are not impacted by the standard, the average savings over all of the households is actually $16, not $94. With regard to the PBPs shown below, DOE determined the median and average values by excluding the percentage of households not impacted by the standard. For example, in the case of standard level 1 for gas standard ovens, 83 percent of the households did not factor into the calculation of the median and average PBP. Also of note regarding PBPs, the large difference in the average and median values for electric self-cleaning ovens and standard level 5 for gas standard ovens are due to outliers in the distribution of results. The Monte Carlo simulation for electric self-cleaning ovens and standard level 5 for gas ovens yielded a few results with PBPs in excess of one million years. A limited number of excessively long PBPs produce an average PBP that is very long. Therefore, in these cases, the median PBP is a more representative value to gauge the length of the PBP.

TABLE II.69.—ELECTRIC STANDARD OVENS: LIFE-CYCLE COST AND PAYBACK PERIOD RESULTS

Candidate standard level	EF	Life-cycle cost			Life-cycle cost savings				Payback period (years)	
		Average installed price	Average operating cost	Average LCC	Average savings	Households with Net cost (percent)	Households with No impact (percent)	Households with Net benefit (percent)	Median	Average
Baseline	0.1066	$392	$189	$581	....	....	....	....	....	....
1	0.1113	395	182	576	$5	38.3	0.0	61.8	6.0	45.6
2	0.1163	399	175	574	7	46.5	0.0	53.5	9.1	68.7
3	0.1181	405	172	577	4	54.5	0.0	45.5	13.8	103.9
4	0.1206	462	169	631	−50	96.4	0.0	3.6	65.5	493.6
5	0.1209	467	169	636	−55	97.1	0.0	2.9	68.7	517.9

TABLE II.70.—ELECTRIC SELF-CLEANING OVENS: LIFE-CYCLE COST AND PAYBACK PERIOD RESULTS

Candidate standard level	EF	Life-cycle cost			Life-cycle cost savings				Payback period (years)	
		Average installed price	Average operating cost	Average LCC	Average savings	Households with Net cost (percent)	Households with No impact (percent)	Households with No benefit (percent)	Median	Average
Baseline	0.1099	$463	$200	$663	....	....	....	....	....	....
1	0.1102	469	199	669	−$88	74.6	0.0	25.4	196.7	1,071.7
2	0.1123	527	196	723	−142	81.9	0.0	18.1	266.7	1,453.0

TABLE II.71.—GAS STANDARD OVENS: LIFE-CYCLE COST AND PAYBACK PERIOD RESULTS

Candidate standard level	EF	Life-cycle cost			Life-cycle cost savings				Payback period (years)	
		Average installed price	Average operating cost	Average LCC	Average savings	Households with Net cost (percent)	Households with No impact (percent)	Households with No benefit (percent)	Median	Average
Baseline	0.0298	$409	$288	$697	....	....	....	....	....	....
1*	0.0536	442	162	603	$16	0.0	83.0	17.0	3.3	3.4
2	0.0566	447	154	601	18	46.1	0.0	53.9	8.4	136.1
3	0.0572	448	153	601	18	47.9	0.0	52.1	9.4	152.3
4	0.0593	481	149	630	−11	77.4	0.0	22.6	27.2	460.1
5	0.0596	483	148	632	−12	77.9	0.0	22.1	27.9	1,907.4
6	0.0600	488	148	636	−17	79.5	0.0	20.5	30.1	426.3
1a*	0.0583	446	134	580	39	0.0	0.0	100.0	2.2	2.2

*Candidate standard levels 1 and 1a correspond to designs that are utilized for the same purpose—eliminate the need for a standing pilot—but the technologies for each design are different. Candidate standard level 1 is a hot surface ignition device while candidate standard level 1a is a spark ignition device. Candidate standard level 1a is presented at the end of the table because candidate standard levels 2 through 6 are derived from candidate standard level 1.

TABLE II.72.—GAS SELF-CLEANING OVENS: LIFE-CYCLE COST AND PAYBACK PERIOD RESULTS

Candidate standard level	EF	Life-cycle cost			Life-cycle cost savings				Payback period (years)	
		Average installed price	Average operating cost	Average LCC	Average savings	Households with Net cost (percent)	Households with No impact (percent)	Households with No benefit (percent)	Median	Average
Baseline	0.0540	$529	$200	$729	....	....	....	....	....	....
1	0.0625	545	183	727	$1	58.3	0.0	41.7	11.8	158.0
2	0.0627	551	182	733	−5	67.3	0.0	32.7	16.1	235.3
3	0.0632	553	182	734	−6	68.4	0.0	31.6	16.7	149.0

Table II.73 shows the LCC and PBP results for microwave ovens. For example, candidate standard level 4 (0.602 EF) shows an average LCC cost increase of $68. The median and average PBPs for standard level 4 are 132.2 and 327.5 years, respectively.

TABLE II.73.—MICROWAVE OVENS: LIFE-CYCLE COST AND PAYBACK PERIOD RESULTS

Candidate standard level	EF	Life-cycle cost			Life-cycle cost savings				Payback period (years)	
		Average installed price	Average operating cost	Average LCC	Average savings	Households with: Net cost (percent)	Households with: No impact (percent)	Households with: Net benefit (percent)	Median	Average
Baseline	0.557	$219	$89	$308	....	....	....	....	....	....
1	0.586	232	84	316	−8	93.0	0.0	7.0	33.9	84.0
2	0.588	246	84	329	−21	98.6	0.0	1.4	65.8	163.1
3	0.597	267	83	349	−41	99.6	0.0	0.4	93.9	232.5
4	0.602	294	82	376	−68	99.9	0.0	0.1	132.2	327.5

Tables II.74 and II.75 show the LCC and PBP results for both product applications of CCWs. For example, in the case of the multi-family application, candidate standard level 5 (2.00 MEF/ 5.50 WF) shows an average LCC savings of $404. Note that for standard level 5, 20.9 percent of consumers in 2012 are assumed to already be using a CCW in the base case at standard level 5 and, thus, have zero savings due to the standard. If one compares the LCC of the base case at 1.26 MEF/9.50 WF ($3303) to the standards case at 2.00 MEF/5.50 WF ($2794), then the difference in the LCCs is $509. However, since the base case includes a significant number of consumers that are not impacted by the standard, the average savings over all of the consumers is actually $404, not $509. With regard to the PBPs shown below, DOE determined the median and average values by excluding the percentage of households not impacted by the standard. For example, in the case of standard level 5, 20.9 percent of the consumers did not factor into the calculation of the median and average PBP.

TABLE II.74.—COMMERCIAL CLOTHES WASHERS, MULTI-FAMILY APPLICATION: LIFE-CYCLE COST AND PAYBACK PERIOD RESULTS

Candidate standard level	MEF/WF	Life-cycle cost			Life-cycle cost savings				Payback period (years)	
		Average installed price	Average operating cost	Average LCC	Average savings	Households with: Net cost (percent)	Households with: No impact (percent)	Households with: Net benefit (percent)	Median	Average
Baseline	1.26/9.50	$722	$2,581	$3,303	....	....	....	....	....	....
1	1.42/9.50	840	2,454	3,294	7	42.0	20.9	37.1	8.4	8.9
2	1.60/8.50	1,224	2,189	3,413	−86	61.5	20.9	17.6	11.9	12.8
3	1.72/8.00	1,224	2,053	3,277	21	43.3	20.9	35.9	8.8	9.5
4	1.80/7.50	1,224	1,943	3,167	109	30.4	20.9	48.8	7.3	7.9
5	2.00/5.50	1,224	1,571	2,794	404	9.3	20.9	69.9	4.6	5.1
6	2.20/5.10	1,224	1,446	2,670	529	6.3	0.0	93.7	3.8	3.6

TABLE II.75.—COMMERCIAL CLOTHES WASHERS, LAUNDROMAT APPLICATION: LIFE-CYCLE COST AND PAYBACK PERIOD RESULTS

Candidate standard level	MEF/WF	Life-cycle cost			Life-cycle cost savings				Payback period (years)	
		Average installed price	Average operating cost	Average LCC	Average savings	Households with: Net cost (percent)	Households with: No impact (percent)	Households with: Net benefit (percent)	Median	Average
Baseline	1.26/9.50	$722	$2,772	$3,494	....	....	....	....	....	....
1	1.42/9.50	840	2,647	3,487	5	35.9	20.9	43.2	5.3	5.6
2	1.60/8.50	1,224	2,354	3,577	−66	61.5	20.9	17.7	6.9	7.3
3	1.72/8.00	1,224	2,207	3,431	50	29.2	20.9	50.0	5.1	5.4
4	1.80/7.50	1,224	2,085	3,308	147	13.6	20.9	65.5	4.3	4.5
5	2.00/5.50	1,224	1,661	2,885	482	0.7	20.9	78.5	2.7	2.8
6	2.20/5.10	1,224	1,532	2,755	612	0.2	0.0	99.8	2.2	2.0

DOE presents these findings to facilitate stakeholder review of the LCC and PBP analyses. DOE seeks information and comments relevant to the assumptions, methodology, and results for these analyses. See Chapter 8 of the TSD for additional detail on the LCC and PBP analyses.

H. Shipments Analysis

This section presents DOE's shipments analysis, which is an input into the NIA (section II.I). DOE will also use shipments estimates as input to the MIA, which is discussed in section II.K. DOE will undertake the MIA after the ANOPR is published, and will report the MIA findings in the NOPR.

As indicated above and in the discussion below of the NIA, for each product, DOE has developed a base case forecast to depict what would happen to energy and water use, and to consumer costs for purchase and operation of the product, if DOE does not adopt new energy conservation standards. To evaluate the impacts of such new standards, DOE compares these base case forecasts to forecasts of what would happen if DOE adopts new standards at various higher efficiency levels. One element of both types of forecasts is product shipments. In determining the base case, DOE considered historical shipments, the mix of efficiencies sold in the absence of standards, and how that mix might change over time.

1. Shipments Model

DOE estimated shipments for each of the four appliance products using a separate Shipments Model. Furthermore, in the case of cooking products, DOE developed two separate Shipments Models—one for cooktops and ovens and another for microwave ovens. Therefore, DOE developed a total of five separate Shipments Models (*i.e.*, two for cooking products and one each for dishwashers, dehumidifiers, and CCWs). Each Shipments Model was calibrated against historical shipments. For purposes of estimating the impacts of prospective candidate standard levels on product shipments, each Shipments Model accounts for the combined effects of changes in purchase price, annual operating cost, and household income on the consumer purchase decision.

In overview, each Shipments Model considers specific market segments, the results for which are then aggregated to estimate total product shipments. In the case of all of the four appliance products (with the exception of dehumidifiers), DOE accounted for at least two market segments: (1) New construction and (2) existing buildings (*i.e.*, replacing failed equipment). For dehumidifiers, DOE did not consider the new construction market since this product, unlike most major household appliances, is not standard equipment for new households. Instead, in addition to accounting for replacements, DOE accounted for the market of existing households acquiring new dehumidifiers for the first time. Furthermore, for the following products, DOE accounted for a third market segment: Cooking products (early replacements); dishwashers (existing households acquiring the equipment for the first time); and CCWs (retired units not replaced).

With regard to the market of existing households purchasing dehumidifiers, Whirlpool commented that shipments to existing households that do not already own a dehumidifier are likely very low for two reasons. First, Whirlpool stated that historical data indicate that annual dehumidifier shipments have been relatively constant, and second, the most significant new housing growth has been in the Southern and Western regions of the U.S. where central air conditioning (as opposed to dehumidifiers) is used to condition the space. (Whirlpool, No. 10 at p. 12) Contrary to Whirlpool's claim, based on historical data, DOE found that shipments have more than doubled since 1990, with an increase of nearly 50 percent over the 2003–2005 time period. In allocating shipments to existing households with a dehumidifier, DOE used the historical data to estimate which portion of the shipments went to these existing households. DOE first determined that portion of the shipments that served as replacements and then allocated the remaining portion to existing households without a dehumidifier. As a result of this calculation, DOE estimated that 0.6 percent of existing households without a dehumidifier would annually purchase this product over the period 2005–2042.

With regard to the estimation of forecasted commercial clothes washer shipments, ALS stated that the market for CCWs is already saturated and may decline in the future. ALS believes that the trend in multi-housing is to install in-apartment washers rather than provide common area commercial laundry. Both ALS and MLA stated that approximately 200,000 to 230,000 commercial washers are shipped per year. Whirlpool stated that a saturation-based Shipments Model could be developed to forecast shipments. However, because historical industry shipments have been constant, Whirlpool suggested that DOE either hold future product saturations constant or allow them to decline. (Public Meeting Transcript, No. 5 at pp. 213 and 219; MLA, No. 8 at p. 1; Whirlpool, No. 10 at p. 12)

DOE confirmed that over the period of 1988–1998, annual shipments of clothes washers stayed roughly in the range between 200,000 to 230,000 units per year. But based on data provided by AHAM, shipments dropped to approximately 180,000 units for the year 2005. DOE confirmed this shipments drop (from a peak of 265,000 units in 1998) using commercial laundry quantity index data from the U.S. Census Bureau.[48] For purposes of calibrating its Shipments Model, DOE attributed this drop to non-replacements (*i.e.*, a portion of CCWs that were retired from service over the period 1999–2005 were not replaced). Because DOE tied its CCW shipments estimates to forecasts of new multi-family construction as provided by EIA's *AEO 2007*, and because *AEO 2007* forecasts modest growth in multi-family construction starts, DOE's Shipments Model projected that shipments would recover and gradually increase after the drop witnessed over the 1999–2005 period.

Due to the dramatic drop in shipments seen in the historical data, DOE specifically seeks feedback on its assumptions regarding the shipments forecasts for CCWs. This is identified as Issue 13 under ''Issues on Which DOE Seeks Comment'' in section IV.E of this ANOPR.

In principle, each market segment and each product class responds differently to both the base case demographic and economic trends and to the implementation of standards. Furthermore, retirements, early replacements, and efficiency trends are dynamic and can vary among product classes. Rather than simply extrapolating a current shipments trend, the base case shipments analysis uses driver input variables, such as construction forecasts and product lifetime distributions, to forecast sales in each market segment.

DOE's Shipments Models take an accounting approach, by tracking market shares of each product class, the vintage of units in the existing stock, and expected construction trends. The Models estimate shipments due to replacements using sales in previous years and assumptions about the life of the equipment. Therefore, estimated sales due to replacements in a given year are equal to the total stock of the appliance minus the sum of the appliances sold in previous years that still remain in the stock. DOE must determine the useful service life of the appliance to determine how long the appliance is likely to remain in stock.

2. Data Inputs

As discussed above, shipments are driven primarily by two market

[48] U.S. Department of Commerce-Bureau of Economic Analysis. *Industry Economic Accounts, Gross-Domestic-Product-(GDP)-by-Industry-Data, 1998– NAICS data: GDPbyInd_SHIP_NAICS and SIC Data: GDPhyind_SHIP_SIC*, Commercial Laundry Quantity Index Data, NAICS code 333312. Washington, DC. Available online at: *http://preview.bea.gov/industry/gdpbyind_data.htm.*

segments: (1) New construction and (2) replacements.

New housing forecasts and market 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. As noted above for CCWs, DOE's Shipments Model used only newly-constructed multi-family units, as DOE estimated shipments are driven solely by multi-family construction starts. For new housing completions and mobile home placements, DOE used actual data through 2005, and adopted the projections from EIA's *AEO 2007* for the period of 2006–2030.[49] To determine new construction shipments for each of the four appliance products (except dehumidifiers), DOE used forecasts of housing starts coupled with the product market saturation data for new housing. DOE used the 2001 RECS to establish dishwasher and cooktop market saturations for new housing. For commercial clothes washers, DOE relied on the new construction market saturation data from CEE.[50]

In the specific case of dehumidifiers, EEI stated that DOE should account for the market saturation of dehumidifying equipment integrated into central space-conditioning systems when evaluating the overall dehumidifier market saturation. (Public Meeting Transcript, No. 5 at p. 220) In response, we note that DOE's Shipments Model for dehumidifiers takes into consideration saturation data pertaining only to dehumidifiers manufactured as independent units. Although growth in central space-conditioning systems with fully-integrated dehumidifying equipment may have an impact on forecasted dehumidifier shipments, DOE was unable to obtain any data that indicate the growth of these systems and their impact on the overall dehumidifier market.

In general, DOE estimated replacements using product retirement functions that it developed from product lifetimes. For all of the four appliance products (with the exception of microwave ovens), DOE based the retirement function on a uniform probability distribution for the product lifetime. The Shipments Models assume that no units are retired below a minimum product lifetime and that all units are retired before exceeding a maximum product lifetime. NWPCC noted that DOE should calibrate the Shipments Models to historical shipments data to ensure that the estimates of product lifetimes are reasonable. (Public Meeting Transcript, No. 5 at p. 215) As noted previously, DOE calibrated each Shipments Model against historical shipments. In its calibrations, which entailed estimating which portion of shipments are replacements, DOE used the product lifetimes that it established for the LCC analysis (refer to section II.G.2.b for more details). DOE found that the product lifetimes provided reasonable estimates of overall shipments for each of the products.

3. Shipments Forecasts

Table II.76 shows the results of the shipments analysis for the base case for each of the products. Of the products listed in Table II.76, dehumidifiers, gas cooktops and ovens, and electric cooktops and ovens are comprised of several product classes. Specifically, dehumidifiers consist of six product classes; gas cooktops and ovens consist of three classes, and electric cooktops and ovens consist of four classes. For each of these products (with each product consisting of more than one product class, except CCW) DOE's analysis estimated the aggregate shipments. Once it had established the aggregate shipments estimate, DOE then allocated the shipments to each product class based on historical market share data. Chapter 9 of the TSD provides details on the product class market shares for dehumidifiers, gas cooktops and ovens, and electric cooktops and ovens.

TABLE II.76.—FORECASTED SHIPMENTS FOR HOME APPLIANCES, 2012–2042, BASE CASE (MILLION UNITS)

Product	2012	2015	2020	2025	2030	2035	2040	2042	Cumulative
Dishwashers	8.12	8.73	9.62	10.36	11.17	11.76	12.28	12.48	328
Dehumidifiers	1.82	1.99	2.39	2.65	2.98	3.30	3.59	3.71	86
Gas cooktops and ovens	3.80	3.82	4.05	4.26	4.43	4.57	4.75	4.82	133
Electric cooktops and ovens	6.24	6.41	7.03	7.52	7.88	8.26	8.72	8.91	235
Microwave ovens	16.11	15.41	17.54	17.67	19.61	20.01	21.50	21.53	578
Commercial clothes washers	0.24	0.24	0.27	0.29	0.32	0.34	0.37	0.38	9.4

To estimate the combined effects on product shipments from increases in equipment purchase price and decreases in equipment operating costs due to new efficiency standards, DOE conducted a literature review and a statistical analysis on a limited set of appliance price, efficiency, and shipments data.

In the literature, DOE found only a few studies of appliance markets that are relevant to this rulemaking analysis, and identified no studies that use time-series of equipment price and shipments data after 1980. The information that DOE summarized from the literature suggests that the demand for appliances is price inelastic.

DOE did not find enough equipment purchase price and operating cost data to perform a complex analysis of dynamic changes in the appliance market. Rather, DOE used purchase price and efficiency data specific to residential refrigerators, clothes washers, and dishwashers over the period 1980–2002 to evaluate broad market trends and to conduct simple regression analyses. These data indicate that there has been a rise in appliance shipments and a decline in appliance purchase price and operating costs over the time period. Household income has also risen during this time. DOE combined the available economic information into one variable, termed the ''relative price,'' which is the sum of the purchase price and the present value of operating cost savings divided by household income, and used this variable to conduct a regression analysis. DOE's regression analysis suggested that the relative price elasticity of demand, averaged over the three appliances, is −0.34. For example,

[49] 49 U.S. Department of Energy-Energy Information Administration. *Annual Energy Outlook 2007 with Projections to 2030*, February, 2007. Washington, DC. DOE/EIA–0383 (2007). Available online at: *http://www.eia.doe.gov/oiaf/aeo/index.html*

[50] Consortium for Energy Efficiency. *Commercial Family-Sized Washers: An Initiative Description of the Consortium for Energy Efficiency*, 1998. Boston, MA. Available online at: *http://www.cee1.org/com/cwsh/cwsh-main.php3.*

for a relative price increase of 10 percent, shipments decrease by 3.4 percent. Note that because the relative price elasticity incorporates the impacts from three effects (*i.e.*, purchase price, operating cost, and household income), the impact from any single effect is mitigated by changes from the other two effects. The relative price elasticity of −0.34 is consistent with estimates in the literature. Nevertheless, DOE stresses that the measure is based on a small data set, using simple statistical analysis. More important, the measure is based on the premise that economic variables (including purchase price, operating costs, and household income) explain most of the trend in appliances per household in the U.S. since 1980. Changes in appliance quality and consumer preferences may have occurred during this period, but DOE did not account for them in this analysis. Despite these uncertainties, DOE believes that its estimate of the relative price elasticity of demand provides a reasonable assessment of the impact that purchase price, operating cost, and household income have on product shipments.

Because DOE's forecasts of shipments and national impacts due to standards is over a 30-year time period, consideration must be given as to how the relative price elasticity is affected once a new standard takes effect. DOE considers the relative price elasticity of −0.34 to be a short-run value. DOE was unable to identify sources specific to household durable goods, such as appliances, to indicate how short-run and long-run price elasticities differ. Therefore, to estimate how the relative price elasticity changes over time, DOE relied on a study pertaining to automobiles showing that the automobile price elasticity of demand changes in the years following a purchase price change.[51] With increasing years after the purchase price change, the price elasticity becomes more inelastic until it reaches a terminal value around the tenth year after the price change. For its shipments analysis, DOE incorporated a relative price elasticity change that resulted in a terminal value of approximately one-third (−0.11) of the short-run elasticity (−0.34). In other words, consumer purchase decisions, in time, become less sensitive to the initial change in the product's relative price.

PG&E commented that consumers will replace failed equipment regardless of the increased purchase price due to efficiency standards. (Public Meeting Transcript, No. 5 at p. 224) In its regression analysis of appliance purchase price, efficiency, and shipments data, DOE did not attempt to quantify the shipments impacts to separate markets (*i.e.*, new construction and replacements). Because DOE's regression analysis focused on the impacts to aggregate shipments, it applied the sensitivity to purchase price, operating cost, and household income equally to all markets. DOE believes this level of precision is sufficient for capturing the effect that these three factors have on overall product shipments.

Additional detail on the shipments analysis can be found in Chapter 9 of the TSD.

I. National Impact Analysis

The NIA assesses cumulative NES and the cumulative national economic impacts of candidate standards levels. The analysis measures economic impacts using the NPV metric, which represents the net present value (*i.e.*, future amounts discounted to the present) of total customer costs and savings expected to result from new standards at specific efficiency levels. For a given candidate standard level, DOE calculated both the NPV and the NES as the difference between a base case forecast and the standards case. A summary of this analysis is provided below, but additional detail on the NIA for the four appliance products may be found in Chapter 10 of the TSD.

DOE determined national annual energy consumption as the product of the annual energy consumption per unit and the number of units of each vintage. This approach accounts for differences in per-unit energy consumption from year to year. Cumulative energy savings are the sum of the annual NES determined over a specified time period. DOE calculated net economic savings each year as the difference between total operating cost savings and increases in total installed costs. Cumulative savings are the sum of the annual NPV determined over a specified time period.

1. Approach

Over time, in the standards case, more-efficient products gradually replace less efficient products. This affects the calculation of the NES and NPV, which are both a function of the total number of units in use and their efficiencies, and, thus, are dependent on annual shipments and the lifetime of a product. Both calculations start by using the estimate of shipments and the quantity of units in service that DOE derived from the Shipments Model.

With regard to the estimation of NES, because more-efficient units of a product gradually replace less efficient ones, the per-unit energy consumption of the products in service gradually decreases in the standards case relative to the base case. To estimate the resulting total energy savings for each candidate efficiency level, DOE first calculated the national site-energy consumption for each of the four appliance products for each year, beginning with the expected effective date of the standards (2012), for the base case forecast and each standards case forecast. (Site energy is the energy directly consumed by the units of the product in operation.) Second, DOE determined the annual site-energy savings, consisting of the difference in site-energy consumption between the base case and the standards case. Third, DOE converted the annual site-energy savings into the annual amount of energy saved at the source of electricity generation or of natural gas production (the source energy) using site-to-source conversion factors. Finally, DOE summed the annual source-energy savings from 2012 to 2042 to calculate the total NES for that period. DOE performed these calculations for each candidate standard level.

To estimate NPV, DOE calculated the net impact each year as the difference between total operating cost savings (including gas and/or electricity and water, repair, and maintenance cost savings) and increases in total installed costs (which consist of the incremental increase in manufacturer selling price, sales taxes, distribution chain markups, and installation cost). DOE calculated the NPV of each candidate standard level over the life of the equipment, using the following three steps. First, DOE determined the difference between the equipment costs under the candidate standard level case and the base case, to get the net equipment cost increase resulting from the candidate standard level. Second, DOE determined the difference between the base case operating costs and the candidate standard level operating costs, to get the net operating cost savings resulting from the candidate standard level. Third, DOE determined the difference between the net operating cost savings and the net equipment cost increase to get the net savings (or expense) for each year. DOE then discounted the annual net savings (or expenses) to the year 2006 for products bought in or before 2042 and summed the discounted values to provide the NPV of a candidate standard

[51] S. Hymans. Consumer Durable Spending: Explanation and Prediction, *Brookings Papers on Economic Activity,* 1971. Vol. 1971, No. 1, pp. 234–239. Available for purchase online at: *http://links.jstor.org/sici?sici=0007–2303(1970)1970%3A2%3C173%3ACDSEAP%3E2.0.CO%3B2-S.*

level. An NPV greater than zero shows net savings (*i.e.*, the candidate standard level would reduce customer expenditures relative to the base case in present value terms). An NPV that is less than zero indicates that the candidate standard level would result in a net increase in customer expenditures in present value terms.

Another aspect of the NIA is the consideration of market-pull or voluntary programs that promote the adoption of more-efficient equipment. PG&E stated that market-pull programs do not necessarily diminish the impact of mandatory efficiency standards. Whirlpool stated that the effectiveness of one type of market-pull program (Energy Star) could be diminished if mandatory standards are set prematurely. Whirlpool argued that existing product efficiencies are approaching Energy Star levels, thereby diminishing the effectiveness of the program if mandatory standards are set too high. (Public Meeting Transcript, No. 5 at p. 223; Whirlpool, No. 10 at p. 11) In response, DOE notes that for some products, market-pull programs (*e.g.*, Energy Star) have likely increased the share of energy-efficient equipment both prior to and after the implementation date of any new standards. For example, in the case of dishwashers, the shipment-weighted efficiency has increased at an average annul rate of approximately 2.5 percent since mandatory efficiency standards came into effect in 1994. The Energy Star program, which came into effect for dishwashers in 1996, was likely responsible for at least some of the gain in dishwasher efficiency. Although DOE recognizes that market-pull programs such as Energy Star play a factor in increasing the energy efficiency of appliances, DOE was not able to obtain information that quantified precisely how such programs affect equipment efficiencies on a national basis. Consequently, DOE did not explicitly incorporate the impact of market-based initiatives that may be implemented in the future into the analysis.

2. Base Case and Standards Case Forecasted Efficiencies

A key component of DOE's estimates of NES and NPV are the energy efficiencies that it forecasts over time for the base case (without new standards) and each of the standards cases. The forecasted efficiencies represent the annual shipment-weighted energy efficiency of the products under consideration over the forecast period (*i.e.*, from the estimated effective date of a new standard to 30 years after the standard becomes effective). Because key inputs to the calculation of the NES and NPV are dependent on the estimated efficiencies, they are of great importance to the analysis. In the case of the NES, the per-unit annual energy (and water) consumption is a direct function of product efficiency. With regard to the NPV, two inputs (the per-unit total installed cost and the per-unit annual operating cost), both depend on efficiency. The per-unit total installed cost is a direct function of efficiency while the per-unit annual operating cost, because it is a direct function of the per-unit energy (and water) consumption, is indirectly dependent on product efficiency.

As first discussed in section II.G.2.d on the development of base case efficiencies, for each of the four appliance products, DOE, using data provided by AHAM, based its development of the product efficiencies in the base case on the assignment of equipment efficiencies in the year 2005. The year 2005 is the latest year for which AHAM provided product efficiency data. In other words, DOE determined the distribution of product efficiencies currently in the marketplace to develop a shipment-weighted energy efficiency for the year 2005. For dehumidifiers, it is important to reiterate that DOE estimated that the product efficiencies in the base case for the 25.00 pints/day and less, 25.01–35.00 pints/day, and the 45.01–54.00 pints/day product classes were equivalent to those developed for the 35.01–45.00 pints/day class. DOE also estimated the base case product efficiencies developed for the 54.01–74.99 product class could be applied to the 75.00 pints/day and greater product class.

Using the shipment-weighted efficiency for the year 2005 as a starting point, DOE developed base case forecasted efficiencies based on estimates of future efficiency growth. For the period spanning 2005–2012 (2012 being the estimated effective date of a new standard), DOE estimated that there would be no growth in shipment-weighted efficiency (*i.e.*, no change in the distribution of product efficiencies). With the exception of dishwashers (discussed below), because there are no historical data to indicate how product efficiencies have changed over time, DOE estimated that forecasted efficiencies would remain frozen at the 2012 efficiency level until the end of the forecast period (30 years after the effective date (*i.e.*, 2042)). Although DOE recognizes the possibility that product efficiencies may change over time, DOE is not in a position to speculate as to how these product efficiencies may change without historical information. DOE did forecast the market share of gas standard ranges equipped with standing pilot lights to estimate the impact of eliminating standing pilot lights for gas cooktops and gas standard ovens.

In the case of dishwashers, historical data show that shipment-weighted efficiencies have grown at an average annual rate of approximately two percent since 1980. As discussed earlier, some of this efficiency gain during the 1990s is likely attributable to the Energy Star program. However, historical data also show that the consumer dishwasher retail price has dropped considerably (almost 50 percent) over the same time period. Because the per-unit installed cost (or consumer retail price) is tied to efficiency, using an efficiency growth of two percent per year would be expected to result in ever-increasing dishwasher retail prices over time. However, since forecasting an increasing retail price is counter to the historical data, DOE believes that the most plausible assumption is that dishwasher efficiencies will remain frozen at the 2012 efficiency level until the end of the forecast period.

For its determination of standards-case forecasted efficiencies, DOE used a ''roll-up'' scenario to establish the shipment-weighted efficiency for the year that standards would become effective (*i.e.*, 2012). DOE believed that product efficiencies in the base case, which did not meet the standard level under consideration, would ''roll-up'' to meet the new standard level. Also, DOE believed that all product efficiencies in the base case that were above the standard level under consideration would not be affected. Using the shipment-weighted efficiency in the year 2012 as a starting point, DOE developed standards case forecasted efficiencies. For all of the four appliance products, DOE made the same estimates regarding forecasted standards-case efficiencies as for the base case, namely, that forecasted efficiencies remained frozen at the 2012 efficiency level until the end of the forecast period. By maintaining the same growth rate for forecasted efficiencies in the standards case as in the base case (*i.e.*, zero growth), DOE retained a constant efficiency difference or gap between the two cases over the length of the forecast period. Although frozen trends may not reflect what happens to base case and standards case product efficiencies in the future, DOE believes that maintaining a frozen efficiency difference between the base case and standards case provides a reasonable estimate of the impact that standards have on product efficiency.

DOE specifically seeks feedback on its estimates of forecasted base-case and standards-case efficiencies and its view of how standards impact product efficiency distributions in the year that standards take effect. This is identified as Issue 14 under ''Issues on Which DOE Seeks Comment'' in section IV.E of this ANOPR.

3. National Impact Analysis Inputs

The inputs for the determination of NES are annual energy (and water) consumption per unit, shipments, equipment stock, national annual energy consumption, and site-to-source conversion factors.

Because the annual energy (and water) consumption per unit are directly dependent on efficiency, DOE used the SWEFs associated with the base case and each standards case, in combination with the annual energy (and water use) data, to estimate the shipment-weighted average annual per-unit energy (and water) consumption under the base case and standards cases.

The NIA uses forecasted shipments for the base case and all standards cases. As noted earlier, the increased total installed cost of more-efficient equipment causes some customers to forego equipment purchases. Consequently, shipments forecasted under the standards cases are lower than under the base case. For dehumidifiers and microwave ovens, to avoid the inclusion of savings due to displaced shipments, DOE used the standards-case shipments projection and the standards-case stock to calculate the annual energy consumption in the base case. However, in the case of dishwashers and CCWs, because DOE explicitly accounted for the energy and water consumption of the displaced shipments, DOE maintained the use of the base-case shipments to determine the annual energy consumption in the base case.

In the case of dishwashers, Whirlpool and AHAM commented that an increase in purchase price due to standards may result in some consumers foregoing dishwasher purchases. Any consumers who had to switch to hand washing would increase their energy and water consumption, since dishwashing is more energy and water efficient than hand washing. (Whirlpool, No. 10 at p. 10; AHAM, No. 14 at p. 9) DOE agrees with Whirlpool and AHAM. DOE envisioned in its analysis that consumers foregoing the purchase of a new unit due to an increase in the efficiency standard would hand wash their dishes, and accounted for the energy and water consumption associated with these consumers switching to hand washing. Based on the results of two recent European studies, DOE estimated that hand washing would use 140 percent more energy and 350 percent more water than dishwashing.[52] [53]

In the case of electric and gas cooking products, because the housing market is fully saturated (*i.e.*, all households have cooking appliances), available information suggested that standards would neither impact shipments nor cause shifts in electric and gas cooking product market shares. Therefore, DOE's standards case shipments for electric and gas cooking products were identical to its base case shipments.

With regard to CCWs, MLA stated some apartment builders would install in-apartment washers (*i.e.*, washers for each apartment unit) rather than common-area washers if the increase in CCW purchase prices caused by standards is too high. MLA commented that a market switch from common-area washers to in-apartment washers would result in increased energy and water consumption, since consumers would tend to use their in-apartment washers more frequently. (MLA, No. 8 at p. 3) DOE did account for the drop in CCW shipments caused by standards, but did not factor in that builders may install more in-apartment washers when faced with higher CCW purchase prices. Rather, because there is a significant used CCW market, DOE believes that establishments that forgo the purchase of a CCW due to standards would instead purchase a used clothes washer with an efficiency equal to the baseline level (*i.e.*, 1.26 MEF/9.5 WF). DOE believes that the option of purchasing used CCWs is more likely, as used CCWs are a less expensive option to builders than installing in-apartment washers.

An extensive description of the methodology for conducting and generating the shipments forecasts for each of the four appliance products can be found in Chapter 9 of the TSD.

The equipment stock in a given year is the number of products shipped and installed from earlier years and which survive in the given year. The NIA spreadsheet models keep track of the number of units shipped each year. DOE believes that the products have an increasing probability of retiring as they age.

The national energy consumption is the product of the annual energy consumption per unit and the number of units of each vintage. This calculation accounts for differences in unit energy consumption from year to year.

The site-to-source conversion factor is the multiplicative factor DOE uses for converting site energy consumption into primary or source energy consumption. In the analysis for today's ANOPR, DOE used annual site-to-source conversion factors based on the version of the National Energy Modeling System (NEMS) that corresponds to EIA's *AEO 2006*.[54] These conversion factors take into account natural gas losses from pipeline leakage and natural gas used for pumping energy and transportation fuel. For electricity, the conversion factors vary over time due to projected changes in generation sources (*i.e.*, the power plant types projected to provide electricity to the country). DOE estimated that conversion factors remain constant at 2030 values throughout the remainder of the forecast. EEI stated that mandated increases in renewable energy use throughout the country will affect the overall efficiency of electricity generation, thereby resulting in less primary energy being saved from energy savings realized at the site. (EEI, No. 7 at p. 4) In response, we note that *AEO 2006* provided a review of renewable energy programs that were in effect in 23 States at the end of 2005. Therefore, it is anticipated that the site-to-source conversion factors that DOE used in its analysis capture the effects of renewable energy use.

The Joint Comment stated that the NIA for dishwashers and CCWs should include energy saved as a result of reduced water use, including water savings in power generation, water pumping (particularly in the West), water treatment, and sewage treatment. (Joint Comment, No. 9 at pp. 3 and 5) Multiple Water Organizations also stated that DOE should account for the embedded energy in water supply and wastewater treatment when establishing the energy savings due to increases in

[52] R. Stamminger, Badura, R., Broil, G., Dorr, S., and Elschendroich, A., *A European Comparison of Cleaning Dishes by Hand,* 2004. University of Bonn, Germany. Available online at: *http://www.landtechnik.uni-bonn.de/ifl_research/ifl_research_project.php?sec=HT&no=1.*

[53] Market Transformation Programme—Briefing Note. *BNW16: A comparison of washing up by hand with a domestic dishwasher,* February 13, 2006. Market Transformation Programme, United Kingdom. Available online at: *http://www.mtprog.com/.*

[54] For the standards rulemakings, DOE will generally use the same economic growth and development assumptions that underlie the most current AEO published by EIA. For its determination of site-to-source conversion factors, DOE used the version of NEMS corresponding to *AEO 2006* for the ANOPR due to the unavailability of the *AEO 2007* version at the time DOE conducted the NIA. For its analyses for the NOPR and final rule, DOE is committed to using the latest available version of NEMS.

dishwasher and CCW efficiency. (Multiple Water Organizations, No. 11 at p. 2) To include the energy required for treatment and delivery of water in the NIA would require the development of new analytical tools. As just noted above, DOE currently takes savings in site energy consumption and uses EIA's NEMS to calculate source energy savings at the generation plant, using site-to-source conversion factors from NEMS that take into account the economic interactions between the energy sector and the rest of the economy. Proper accounting of embedded energy impacts at a national scale, including the embedded energy due to water savings, would require a new version of NEMS that analyzes spending and energy use in dozens, if not hundreds, of economic sectors. In addition, this version of NEMS would need to account for shifts in spending between these various sectors to account for the marginal embedded energy differences between these sectors. DOE currently does not have access to such a tool, nor does it have the capability to accurately estimate the source energy savings impacts of decreased water or wastewater consumption and expenditures. There are activites being conducted or initiated by the U.S. Geological Survey (USGS), EPA, and DOE to study water and wastewater issues. The USGS compiles national water data but not at the utility level. The EPA is sponsoring the WaterSense Program and programs to promote energy efficiency in water and wastewater treatment. Finally, DOE is in the midst of a National Energy-Water Roadmap Program that it initiated in 2005, as requested in congressional appropriations in FY 2005. However, none of these activites has yet provided the necessary sources of data or tools to allow calculation of the embedded energy in water. Although DOE cannot yet determine the embedded energy in water savings, both the LCC and PBP analyses and the NIA do include the economic savings from decreased water and wastewater charges. Such economic savings should include the economic value of any energy savings that may be included in the provision of consumer water and wastewater services.

The inputs to the NPV calculation are total installed cost per unit, annual operating cost savings per unit, total annual installed cost increases, total annual operating cost savings, discount factor, present value of increased installed costs, and present value of operating cost savings.

For each of the four appliance products, the NPV calculation uses the total installed cost per unit as a function of product efficiency. Because the per-unit total annual installed cost is directly dependent on efficiency, DOE used the base case and standards case SWEFs in combination with the total installed costs to estimate the shipment-weighted average annual per-unit total installed cost under the base case and standards cases.

As first discussed in the engineering analysis for dehumidifiers (see section II.C.2.b), total installed cost and efficiency relationships were defined for a subset of the six product classes. Therefore, for purposes of conducting the NIA for dehumidifiers, DOE applied the cost-efficiency data that were developed for this product class subset to those classes for which no cost-efficiency relationships were developed. Specifically, DOE applied the costs developed for the combined 0–35.00 pints/day class to the two individual classes that comprise the combined class—25.00 pints/day and less and 25.01–35.00 pints/day. Further, DOE applied the costs developed for the 35.01–45.00 pints/day and 54.01–74.99 pints/day product classes to the 45.01–54.00 pints/day and 75.00 pints/day and greater product classes, respectively. In its application of total installed costs to those product classes where no cost data were developed, DOE did not interpolate or extrapolate the cost data to account for product efficiency differences between the classes. For example, DOE utilized the exact same total installed costs that were developed for the baseline and standard levels for the 35.01–45.00 pints/day product class to characterize the baseline and standard level total installed costs for the 45.01–54.00 pints/day product class. Chapter 10 of the ANOPR provides additional details on DOE's approach for estimating the total installed costs for the dehumidifier product classes.

DOE specifically seeks feedback on its approach for characterizing the total installed costs for those dehumidifier product classes in which DOE was not able to develop cost-efficiency relationships. This is identified as Issue 15 under ''Issues on Which DOE Seeks Comment'' in section IV.E of this ANOPR.

The annual operating cost savings per unit includes changes in the energy, water, repair, and maintenance costs. DOE believed there would be no increase in maintenance and repair costs due to standards for the four appliance products. Therefore, for each of the products, DOE determined the per-unit annual operating cost savings based only on the energy (and water) cost savings due to a standard efficiency level. EEI suggested that DOE should include water and wastewater prices in the analysis. (Public Meeting Transcript, No. 5 at p. 231) In response, we note that DOE determined the per-unit annual operating cost savings by taking the per-unit annual energy (and water) consumption savings developed for each product and multiplying it by the appropriate energy (and water) price. As described previously, DOE forecasted the per-unit annual energy (and water) consumption for the base case and each standards case for all four appliance products by freezing the consumption at levels estimated for the year 2012. DOE forecasted energy prices based on EIA's *AEO 2007.* DOE forecasted water prices based on trends in the national water price index as provided by the BLS.[55]

The total annual installed cost increase is equal to the annual change in the per-unit total installed cost (difference between base case and standards case) multiplied by the shipments forecasted in the standards case. As with the calculation of the NES, DOE did not calculate total annual installed costs using base case shipments. Rather, to avoid the inclusion of savings due to displaced shipments in the case of dehumidifiers and microwave ovens, DOE used the standards case shipments projection and, in turn, the standards case stock, to calculate the costs. In the case of dishwashers, DOE believes that any consumers foregoing the purchase of a new unit due to standards would shift to hand washing. In the case of CCWs, DOE believes that any drop in shipments caused by standards would result in the purchase of used machines. Electric and gas cooking products are the notable exception. For electric and gas cooking products, because the market is fully saturated, DOE believed that standards would neither impact shipments nor cause shifts in electric and gas cooking product market shares. Therefore, for electric and gas cooking products, DOE used the base case shipments to determine costs for all standards cases.

The total annual operating cost savings are equal to the change in the annual operating costs (difference between base case and standards case) per unit multiplied by the shipments forecasted in the standards case. As noted above for the calculation of total annual installed costs, DOE did not

[55] U.S. Department of Labor—Bureau of Labor Statistics. *Consumer Price Indexes, Item: Water and sewerage maintenance, Series Id: CUUR0000SEHG01, U.S. city average (not seasonally adjusted),* 2006. Washington, DC. Available online at: *http://www.bls.gov/cpi/home.htm#data.*

necessarily calculate operating cost savings using the base case shipments.

DOE multiplies monetary values in future years by the discount factor to determine the present value. DOE estimated national impacts using both a three-percent and a seven-percent real discount rate as the average real rate of return on private investment in the U.S. economy. 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 (OMB Circular A–4 (Sept. 17, 2003), particularly section E, ''Identifying and Measuring Benefits and Costs''). For the sake of these analyses, DOE defines the present year as 2007.

The present value of increased installed costs is the annual installed cost increase in each year (*i.e.*, the difference between the standards case and base case), discounted to the present, and summed for the time period over which DOE is considering the installation of equipment (*i.e.*, from the effective date of standards, 2012, to the year 2042). The increase in total installed cost refers to both the incremental equipment cost and the incremental installation cost associated with the higher energy efficiency of equipment purchased in the standards case compared to the base case.

The present value of operating cost savings is the annual operating cost savings (*i.e.*, the difference between the base case and standards case), discounted to the present, and summed over the period from the effective date (2012) to the time when the last unit installed in 2042 is retired from service. Savings are decreases in operating costs associated with the higher energy efficiency of equipment purchased in the standards case compared to the base case. Total annual operating cost savings is the savings per unit multiplied by the number of units of each vintage surviving in a particular year. Equipment consumes energy over its entire lifetime, and for units purchased in 2042, the consumption includes energy consumed until the unit is retired from service.

Table II.77 summarizes the NES and NPV inputs to the NIA spreadsheet model. For each input, the table gives a brief description of the data source. For details, see Chapter 10 of the TSD.

TABLE II.77.—NATIONAL ENERGY SAVINGS AND NET PRESENT VALUE INPUTS

Input	Data description
Shipments	Annual shipments from Shipments Model. (See Chapter 9 of the TSD for more details.)
Effective Date of Standard	2012.
Base-Case Forecasted Efficiencies	Shipment-weighted efficiency (SWEF) determined in the year 2005 for each of the four appliance products. SWEF held constant over forecast period of 2005–2042. (See Chapter 10 of the TSD for more details.)
Standards-Case Efficiencies	''Roll-up'' scenario used for determining SWEF in the year 2012 for each standards case and for each of the four appliance products. SWEF held constant over forecast period of 2012–2042. (See Chapter 10 of the TSD for more details.)
Annual Energy Consumption per Unit	Annual weighted-average values are a function of SWEF. (See Chapter 10 of the TSD for more details.)
Total Installed Cost per Unit	Annual weighted-average values are a function of SWEF. (See Chapter 10 of the TSD for more details.)
Energy and Water Cost per Unit	Annual weighted-average values are a function of the annual energy consumption per unit and energy (and water) prices. (For more details on energy and water prices, see Chapter 8 of the TSD.)
Repair Cost and Maintenance Cost per Unit	No changes in repair and maintenance cost due to standards.
Escalation of Energy and Water Prices	Energy Prices: 2007 EIA *AEO* forecasts (to 2030) and extrapolation to 2042. (See Chapter 8 of the TSD for more details.) Water Prices: Linear extrapolation of historical trend in national water price index. (See Chapter 8 of the TSD for more details.)
Energy Site-to-Source Conversion	Conversion varies yearly and is generated by DOE/EIA's NEMS* program (a time-series conversion factor; includes electric generation, transmission, and distribution losses).
Discount Rate	3 and 7 percent real.
Present Year	Future expenses are discounted to year 2007.

*Chapter 13 on the utility impact analysis and the environmental assessment report of the TSD provide more details on NEMS.

4. National Impact Analysis Results

Below are the NES results (and national water savings results for dishwashers and CCWs) for the candidate standard levels analyzed for the four appliance products. NES results are cumulative to 2042 and are shown as primary energy savings in quads. National water savings (NWS) results are expressed in billions of gallons. DOE based the inputs to the NIA spreadsheet model on weighted-average values, yielding results that are discrete point values, rather than a distribution of values as in the LCC and PBP analyses. Chapter 10 of the TSD provides discounted NES and NWS results based on discount rates of three and seven percent.

Table II.78 shows the NES and NWS results for the candidate standard levels analyzed for standard-sized dishwashers.

TABLE II.78.—DISHWASHERS: CUMULATIVE NATIONAL ENERGY SAVINGS AND NATIONAL WATER SAVINGS RESULTS

Candidate standard level	EF	NES *quads*	NWS *billion gallons*
1	0.46	0.09	72
2	0.58	0.35	271
3	0.62	0.61	458
4	0.65	0.86	595
5	0.72	1.11	659
6	0.80	1.54	808

TABLE II.78.—DISHWASHERS: CUMULATIVE NATIONAL ENERGY SAVINGS AND NATIONAL WATER SAVINGS RESULTS—Continued

Candidate standard level	EF	NES *quads*	NWS *billion gallons*
7	1.11	2.77	1611

Table II.79 shows the NES results for the candidate standard levels analyzed for dehumidifiers.

TABLE II.79.—DEHUMIDIFIERS: CUMULATIVE NATIONAL ENERGY SAVINGS RESULTS

Candidate standard level	≤25.00		25.01–35.00		35.01–45.00		45.01–54.00		54.01–74.99		≤75.00		ALL
	EF	NES *quads*	EF	NES *quads*	EF	NES *quads*	EF	NES *quads*	EF	NES *quads*	EF	NES* *quads*	NES *quads*
1	1.10	0.01	1.25	0.01	1.35	0.01	1.45	0.01	1.55	0.01	2.38	0.00	0.04
2	1.20	0.02	1.30	0.02	1.40	0.02	1.50	0.02	1.60	0.02	2.50	0.00	0.11
3	1.25	0.02	1.35	0.04	1.45	0.04	1.55	0.04	1.65	0.05	2.55	0.00	0.18
4	1.30	0.02	1.40	0.05	1.50	0.05	1.60	0.05	1.70	0.07	2.60	0.00	0.25
5	1.38	0.03	1.45	0.06	1.74	0.13	2.02	0.18	1.80	0.12	2.75	0.00	0.53

* NES greater than zero but less than 0.005 quads.

Tables II.80 and II.81 show the NES results for the candidate standard levels analyzed for cooktops and ovens, respectively.

TABLE II.80.—COOKTOPS: CUMULATIVE NATIONAL ENERGY SAVINGS RESULTS

Candidate standard level	Electric coil		Electric smooth		Gas	
	EF	NES *quads*	EF	NES *quads*	EF	NES *quads*
1	0.769	0.04	0.753	0.02	0.399	0.10
2					0.420	0.15

TABLE II.81.—OVENS: CUMULATIVE NATIONAL ENERGY SAVINGS RESULTS

Candidate standard level	Elec standard		Elec self-clean		Gas standard		Gas self-clean	
	EF	NES *quads*	EF	NES *quads*	EF	NES *quads*	EF	NES *quads*
1*	0.1113	0.03	0.1102	0.01	0.0536	0.04	0.0625	0.09
2	0.1163	0.05	0.1123	0.04	0.0566	0.07	0.0627	0.09
3	0.1181	0.06			0.0572	0.08	0.0632	0.10
4	0.1206	0.07			0.0593	0.09		
5	0.1209	0.08			0.0596	0.09		
6					0.0600	0.10		
1a*					0.0583	0.13		

* For gas standard ovens, candidate standard levels 1 and 1a correspond to designs that are utilized for the same purpose—eliminate the need for a standing pilot—but the technologies for each design are different. Candidate standard level 1 is a hot surface ignition device while candidate standard level 1a is a spark ignition device. Candidate standard level 1a is presented at the end of the table because candidate standard levels 2 through 6 are derived from candidate standard level 1.

Table II.82 shows the NES results for the candidate standard levels analyzed for microwave ovens.

TABLE II.82.—MICROWAVE OVENS: CUMULATIVE NATIONAL ENERGY SAVINGS RESULTS

Candidate standard level	EF	NES *quads*
1	0.586	0.19

TABLE II.82.—MICROWAVE OVENS: CUMULATIVE NATIONAL ENERGY SAVINGS RESULTS—Continued

Candidate standard level	EF	NES *quads*
2	0.588	0.20
3	0.597	0.25
4	0.602	0.26

Table II.83 shows the NES and NWS results for the candidate standard levels analyzed for CCWs.

TABLE II.83.—COMMERCIAL CLOTHES WASHERS: CUMULATIVE NATIONAL ENERGY SAVINGS AND NATIONAL WATER SAVINGS RESULTS

Candidate standard level	MEF/WF	NES *quads*	NWS *billion gallons*
1	1.42/9.50	0.12	0
2	1.60/8.50	0.21	233
3	1.72/8.00	0.26	350
4	1.80/7.50	0.30	466
5	2.00/5.50	0.36	933
6	2.20/5.10	0.43	1050

Below are the NPV results for the candidate standard levels considered for the product classes of each of the four appliance products. Results are cumulative and are shown as the discounted value of these savings in dollar terms. The present value of increased total installed costs is the total installed cost increase (*i.e.*, the difference between the standards case and base case), discounted to the present, and summed over the time period in which DOE evaluates the impact of standards (*i.e.*, from the effective date of standards (2012) to the year 2042).

Savings are decreases in operating costs (including energy and water) associated with the higher energy efficiency of equipment purchased in the standards case compared to the base case. Total operating cost savings are the savings per unit multiplied by the number of units of each vintage (*i.e.*, the year of manufacture) surviving in a particular year. Equipment consumes energy and must be maintained over its entire lifetime. For units purchased in 2042, the operating cost includes energy and water consumed until the last unit is retired from service.

The tables below show the NPV results for the candidate standard levels analyzed for each of the four appliance products, based on discount rates of three and seven percent.

Table II.84 shows the NPV results for the candidate standard levels analyzed for standard-sized dishwashers.

TABLE II.84.—DISHWASHERS: CUMULATIVE NET PRESENT VALUE RESULTS BASED ON SEVEN-PERCENT AND THREE-PERCENT DISCOUNT RATES

Candidate standard level	EF	NPV	
		7% Discount rate *billion 2006$*	3% Discount rate *billion 2006$*
1	0.46	0.38	0.94
2	0.58	1.29	3.29
3	0.62	1.73	4.72
4	0.65	0.90	3.61
5	0.72	−2.75	−2.94
6	0.80	−7.25	−10.77
7	1.11	−7.28	−8.16

Tables II.85 and II.86 show the NPV results for the candidate standard levels analyzed for dehumidifiers.

TABLE II.85.—DEHUMIDIFIERS: CUMULATIVE NET PRESENT VALUE RESULTS BASED ON A SEVEN-PERCENT DISCOUNT RATE

Candidate standard level	≤25.00		25.01–35.00		35.01–45.00		45.01–54.00		54.01–74.99		≥75.00		ALL
	EF	NPV @ 7% *billion 2006$*	EF	NPV @ 7% *billion 2006$*	EF	NPV @ 7% *billion 2006$*	EF	NPV @ 7% *billion 2006$*	EF	NPV @ 7% *billion 2006$*	EF	NPV * @ 7% *billion 2006$*	NPV @ 7% *billion 2006$*
1	1.10	0.01	1.25	0.02	1.35	0.01	1.45	0.01	1.55	0.02	2.38	0.00	0.08
2	1.20	0.05	1.30	0.06	1.40	0.03	1.50	0.03	1.60	0.05	2.50	0.00	0.21
3	1.25	0.05	1.35	0.07	1.45	0.04	1.55	0.04	1.65	0.10	2.55	0.00	0.31
4	1.30	0.04	1.40	0.07	1.50	0.03	1.60	0.04	1.70	0.11	2.60	0.00	0.31
5	1.38	0.05	1.45	0.08	1.74	0.00	2.02	0.21	1.80	0.19	2.75	0.00	0.54

* NPV greater than zero but less than $0.005 billlion.

TABLE II.86.—DEHUMIDIFIERS: CUMULATIVE NET PRESENT VALUE RESULTS BASED ON A THREE-PERCENT DISCOUNT RATE

Candidate standard level	≤25.00		25.01–35.00		35.01–45.00		45.01–54.00		54.01–74.99		≥75.00		ALL
	EF	NPV @ 3% *billion 2006$*	EF	NPV @ 3% *billion 2006$*	EF	NPV @ 3% *billion 2006$*	EF	NPV @ 3% *billion 2006$*	EF	NPV @ 7% *billion 2006$*	EF	NPV * @ 3% *billion 2006$*	NPV @ 3% *billion 2006$*
1	1.10	0.04	1.25	0.04	1.35	0.04	1.45	0.04	1.55	0.06	2.38	0.00	0.22
2	1.20	0.11	1.30	0.14	1.40	0.09	1.50	0.09	1.60	0.12	2.50	0.01	0.57
3	1.25	0.13	1.35	0.20	1.45	0.13	1.55	0.14	1.65	0.27	2.55	0.01	0.87
4	1.30	0.12	1.40	0.21	1.50	0.14	1.60	0.16	1.70	0.32	2.60	0.01	0.96
5	1.38	0.15	1.45	0.25	1.74	0.19	2.02	0.66	1.80	0.55	2.75	0.01	1.81

Tables II.87 and II.88 show the NPV results for the candidate standard levels analyzed for cooktops and ovens, respectively.

TABLE II.87.—COOKTOPS: CUMULATIVE NET PRESENT VALUE RESULTS BASED ON SEVEN-PERCENT AND THREE-PERCENT DISCOUNT RATES

Candidate standard level	Electric coil			Electric smooth			Gas		
	EF	NPV @ *7% billion 2006$*	NPV @ *3% billion 2006$*	EF	NPV @ *7% billion 2006$*	NPV @ *3% billion 2006$*	EF	NPV @ *7% billion 2006$*	NPV @ *3% billion 2006$*
1	0.769	0.05	0.18	0.753	−7.48	−14.28	0.399	0.29	0.67
2	....	....	....	....	....	....	0.420	−0.65	−0.98

TABLE II.88.—OVENS: CUMULATIVE NET PRESENT VALUE RESULTS BASED ON SEVEN-PERCENT AND THREE-PERCENT DISCOUNT RATES

Candidate standard level	Elec standard			Elec self-clean			Gas standard			Gas self-clean		
	EF	NPV @ 7% *billion 2006$*	NPV @ 3% *billion 2006$*	EF	NPV @ 7% *billion 2006$*	NPV @ 3% *billion 2006$*	EF	NPV 2 @ 7% *billion 2006$*	NPV @ 35 *billion 2006$*	EF	NPV 2 @ 7% *billion 2006$*	NPV 2 @ 3% *billion 2006$*
1 *	0.1113	0.06	0.17	0.1102	−0.28	−0.53	0.0536	0.10	0.24	0.0625	−0.01	0.18
2	0.1163	0.08	0.27	0.1123	−2.87	−5.41	0.0566	0.11	0.34	0.0627	−0.12	0.02
3	0.1181	0.03	0.19	....	....	....	0.0572	0.11	0.34	0.0632	−0.14	−0.05
4	0.1206	−0.81	−1.39	....	....	....	0.0593	−0.33	−0.45	....	....	....
5	0.1209	−0.88	−1.52	....	....	....	0.0596	−0.36	−0.50	....	....	....
6	....	....	....	....	....	....	0.0600	−0.42	−0.62	....	....	....
1a *	....	....	....	....	....	....	0.0583	0.35	0.92	....	....	....

* For gas standard ovens, candidate standard levels 1 and 1a correspond to designs that are utilized for the same purpose—eliminate the need for a standing pilot—but the technologies for each design are different. Candidate standard level 1 is a hot surface ignition device while candidate standard level 1a is a spark ignition device. Candidate standard level 1a is presented at the end of the table because candidate standard levels 2 through 6 are derived from candidate standard level 1.

Tables II.89 shows the NPV results for the candidate standard levels analyzed for microwave ovens.

TABLE II.89.—MICROWAVE OVENS: CUMULATIVE NET PRESENT VALUE RESULTS BASED ON SEVEN-PERCENT AND THREE-PERCENT DISCOUNT RATES

Candidate standard level	EF	NPV	
		7% Discount rate *billion 2006$*	3% Discount rate *billion 2006$*
1	0.586	−1.40	−2.48
2	0.588	−3.52	−6.51
3	0.597	−6.58	−12.28
4	0.602	−10.35	−19.40

Table II.90 shows the NPV results for the candidate standard levels analyzed for CCWs.

TABLE II.90.—COMMERCIAL CLOTHES WASHERS: CUMULATIVE NET PRESENT VALUE RESULTS BASED ON SEVEN-PERCENT AND THREE-PERCENT DISCOUNT RATES

Candidate standard level	MEF/WF	NPV	
		7% Discount rate *billion 2006$*	3% Discount rate *billion 2006$*
1	1.42/9.50	0.04	0.20
2	1.60/8.50	−0.09	0.22
3	1.72/8.00	0.23	0.99
4	1.80/7.50	0.49	1.64
5	2.00/5.50	1.41	3.87
6	2.20/5.10	1.77	4.74

J. Life-Cycle Cost Subgroup Analysis

The LCC subgroup analysis evaluates impacts of standards on identifiable groups of customers, such as different population groups of consumers or different business types, which may be disproportionately affected by any national energy efficiency standard level. In the NOPR phase of this rulemaking, DOE will analyze the LCCs and PBPs for customers that fall into such groups. The analysis will determine whether any particular group of consumers would be adversely affected by any of the trial standard levels.

Also, DOE plans to examine variations in energy prices and energy use that might affect the NPV of a standard for customer sub-populations. To the extent possible, DOE will obtain estimates of the variability of each input parameter and consider this variability in the calculation of customer impacts. Variations in energy use for a particular product depend on a number of factors, such as climate and type of user. DOE plans to perform sensitivity analyses to consider how differences in energy use will affect subgroups of customers.

DOE will determine the effect on customer subgroups using the LCC spreadsheet model. NWPCC stated that the Monte Carlo approach, if implemented in the LCC and PBP analyses, can be used to conduct the subgroup analysis. NWPCC stated that the Monte Carlo approach is suitable for identifying different subgroups, such as regional subgroups, that may be impacted differently by standards. (Public Meeting Transcript, No. 5 at p. 235) As described in section II.G on the LCC and PBP analyses, DOE used a Monte Carlo approach to conduct the LCC and PBP analyses. The spreadsheet model it used for the LCC analysis, which incorporates the use of Monte Carlo sampling, can be used with different data inputs. The standard LCC analysis includes various customer types that use the four appliance products. DOE can analyze the LCC for any subgroup, such as low-income consumers, by using the LCC spreadsheet model and sampling only that subgroup. Details of this model are explained in section II.G.

DOE received several comments as to which subgroups it should analyze. EEI suggested that DOE consider low-income and senior subgroups. It stated that low-income consumers are more likely to use CCWs, and that seniors tend to use dishwashers and cooking products less frequently than the overall population. (EEE, No. 7 at p. 6) For CCWs, ALS stated that DOE should consider low-income consumers and senior citizens, especially if standards cause an increase in vending prices. ALS stated that the resulting increase in vending price would lead to less available disposable income for low-income and senior consumers to use commercial laundry. MLA expressed the same concerns, but only for low-income consumers. (Public Meeting Transcript, No. 5 at p. 237; MLA, No. 8 at p. 2)

GE and PG&E suggested that DOE consider regional subgroups. GE stated that regional subgroups for dishwashers and cooking products would be appropriate because the regional saturations for both sets of products vary significantly. (Public Meeting Transcript, No. 5 at pp. 240–241) PG&E stated that DOE should consider regional subgroups for dehumidifiers. (Public Meeting Transcript, No. 5 at p. 237) Lastly, the EPA thought it would be prudent to consider subgroups that are not served by water and sewer service providers, but by wells and septic systems. EPA believes that these consumers use less water than the overall population. (Public Meeting Transcript, No. 5 at p. 234)

DOE intends to analyze the impacts of candidate standards on low-income and senior subgroups. DOE also will evaluate whether regional variations are significant enough to warrant an analysis of regional subgroups for dishwashers, dehumidifiers, and cooking products. In its analysis of dishwashers and CCWs, DOE will also consider evaluating those consumer subgroups not served by water and sewer. In its analysis of subgroups, DOE will be especially sensitive to purchase price increases (''first-cost'' increases) to avoid negative impacts on identifiable population groups such as low-income households (in the case of residential products) or small businesses with low annual revenues (in the case of CCWs), which may not be able to afford a significant increase in product or equipment prices.

K. Manufacturer Impact Analysis

The purpose of the MIA is to identify the likely impacts of energy conservation standards on manufacturers. DOE has begun and will continue to conduct this analysis with input from manufacturers and other interested parties. DOE will subsequently apply a similar methodology to its evaluation of standards. During the MIA, DOE will consider financial impacts and a wide range of quantitative and qualitative industry impacts that might occur following the adoption of a standard. For example, if DOE adopts a particular standard level, it could require changes to manufacturing practices. DOE will identify and understand these impacts through interviews with manufacturers and other stakeholders during the NOPR stage of its analysis.

Recently, DOE announced changes to the MIA format through a report issued to Congress on January 31, 2006 (as required by section 141 of EPACT 2005), entitled ''Energy Conservation Standards Activities.'' Previously, DOE did not report any MIA results during the ANOPR phase of energy conservation standards rulemakings; however, under this new format, DOE has collected, evaluated, and reported some preliminary information and data in section II.K.6 of this ANOPR. For further information on the MIA process, the analysis, and the results, please refer to Chapter 12 of the TSD.

DOE conducts the MIA in three phases. In Phase I, DOE creates an industry profile to characterize the industry, and conducts a preliminary MIA to identify important issues that require consideration. Results of the Phase I analysis are presented in Chapter 12 of the TSD. In Phase II, DOE prepares an industry cash flow model and an interview questionnaire to guide subsequent discussions. In Phase III, DOE interviews manufacturers, and assesses the impacts of standards both quantitatively and qualitatively. It assesses industry and subgroup cash flow and net present value through use of the Government Regulatory Impact Model (GRIM). DOE then assesses impacts on competition, manufacturing capacity, employment, and regulatory burden based on manufacturer interview feedback and discussions. Results of the Phase II and Phase III analyses are presented in the NOPR TSD.

1. Sources of Information for the Manufacturer Impact Analysis

Many of the analyses described above provide important inputs to the MIA. Such inputs include manufacturing costs and prices from the engineering analysis, retail price forecasts, and shipments forecasts. DOE supplements this information with company financial data and other information gathered during interviews with manufacturers. As discussed below, this interview process plays a key role in the MIA because it allows interested parties to privately express their views on important issues. To preserve confidentiality, DOE aggregates these perspectives across manufacturers, creating a combined opinion or estimate for use in its analyses. This process enables DOE to incorporate sensitive information from manufacturers in the rulemaking process without specifying precisely which manufacturer provided a certain set of data.

DOE conducts detailed interviews with manufacturers to gain insight into the range of potential impacts of standards. During the interviews, DOE typically solicits both quantitative and qualitative information on the potential impacts of efficiency levels on sales, direct employment, capital assets, and industrial competitiveness. DOE prefers an interactive interview process, rather than a written response to a questionnaire, because it helps clarify responses and identify additional issues. Before each interview, DOE circulates a draft document showing its estimates of financial parameters based on publicly available information, such as filings with the SEC, articles in trade publications, etc. DOE subsequently solicits comments and suggestions on these estimates during the interviews.

DOE asks interview participants to identify any confidential information that they have provided, either orally or in writing. DOE considers all information collected, as appropriate, in its decision-making process. However, DOE does not make confidential information available in the public record. DOE also asks participants to identify all information that they wish to have included in the public record, but that they do not want to have associated with their interview or company; DOE incorporates such information into the public record, but reports it without attribution.

Finally, DOE collates the completed interview questionnaires and prepares a summary of the major issues. For more detail on the methodology used in the MIA, refer to Chapter 12 of the TSD.

2. Industry Cash Flow Analysis

The industry cash flow analysis relies primarily on the GRIM, which helps identify the effects of various efficiency regulations and other regulations on manufacturers. The basic structure of the GRIM is a standard annual cash flow analysis that uses price and volume information as an input, builds on fundamental base cost information, and accepts a set of regulatory conditions as changes in costs and investments. DOE uses the GRIM to analyze the financial impacts of more stringent energy conservation standards on the industry.

The GRIM analysis uses several factors to determine annual cash flows from a new standard: (1) Annual expected revenues; (2) manufacturer costs including cost of goods sold; (3) depreciation; (4) research and development; (5) selling, general, and administrative expenses; (6) taxes; and (7) conversion capital expenditures. DOE compares the results against base case projections that involve no new standards. The financial impact of new standards is the difference between the two sets of discounted annual cash flows. For more information on the industry cash flow analysis, refer to Chapter 12 of the TSD.

3. Manufacturer Subgroup Analysis

Industry cost estimates are not adequate to assess differential impacts among subgroups of manufacturers. For example, small and niche manufacturers, or manufacturers whose cost structure differs significantly from the industry average, could experience a disproportionate impact due to standards changes. Because DOE cannot consider the impact on every firm individually, the results of the industry characterization are typically used to group manufacturers exhibiting similar characteristics.

During MIA interviews, DOE discusses the potential subgroups and subgroup members it has identified for the analysis. DOE encourages the manufacturers to recommend subgroups or characteristics that are appropriate for the subgroup analysis. For more detail on the manufacturer subgroup analysis, refer to Chapter 12 of the TSD.

4. Competitive Impacts Assessment

Another factor which DOE must consider in standard setting is whether a new standard is likely to reduce industry competition, and the Attorney General must determine the impacts, if any, of reduced competition. DOE makes a determined effort to gather and report firm-specific financial information and impacts. In particular, the competitive impacts assessment focuses on the impacts of new energy efficiency standards on smaller manufacturers. DOE bases this assessment on manufacturing cost data and on information collected from interviews with manufacturers. Hence, manufacturer interviews also focus on gathering information to help assess asymmetrical cost increases to some manufacturers, increased proportions of fixed costs that could increase business risks, and potential barriers to market entry (*e.g.*, proprietary technologies).

5. Cumulative Regulatory Burden

DOE recognizes and seeks to mitigate the overlapping effects on manufacturers of new or revised DOE standards and other regulatory actions affecting the same equipment. Thus, DOE analyzes and considers the impact on manufacturers of multiple, product-specific regulatory actions.

Based on its own research and discussions with manufacturers, DOE has identified several regulations relevant to dishwasher, dehumidifier, cooking product, and CCW manufacturers, including existing or new standards, the phase-out of hydrochlorofluorocarbon refrigerants, the prohibition of phosphate-containing detergents in some jurisdictions, standards for other products made by dishwasher, dehumidifier, cooking product, and CCW manufacturers, including State standards, and foreign energy conservation standards. (Although foreign standards do not directly affect products entering the U.S., they do impact manufacturer operations, in that they represent additional business expenses for manufacturers selling outside the U.S. market.)

DOE will study the potential impacts of these cumulative burdens in greater detail during the MIA conducted during the NOPR phase.

6. Preliminary Results for the Manufacturer Impact Analysis

DOE conducted a preliminary evaluation of the impact of potential new regulations for the products to be covered by this rulemaking on manufacturer financial performance, manufacturing capacity and employment levels, and product utility and innovation. A primary focus was to identify the cumulative burden that industry faces from the overlapping effect of new or recent energy conservation standards and/or other regulatory action affecting the same product or industry.

The primary sources of information for this analysis were telephone interviews with manufacturers of dishwashers, dehumidifiers, and CCWs carried out during the first quarter of FY 2007. To maintain confidentiality, DOE did not identify the individual manufacturers that disclosed information. Instead, the evaluation only reports aggregated information and does not disclose sensitive information or identify company-specific information. For the preliminary MIA, DOE conducted interviews with manufacturers primarily to identify key issues and gain insights into the qualitative impacts of energy conservation standards. For each product, DOE used an interview guide to gather responses from multiple manufacturers on several issues. All the interview guides covered the same general topic areas, but DOE adapted them, as appropriate, to address each product category. (Copies of the interview guides for CCW, dehumidifier, and dishwasher manufacturers are contained in Appendix B of the TSD.)

However, DOE did not interview cooking product manufacturers at this stage due to feedback from stakeholders such as AHAM and several cooking product manufacturers, suggesting that DOE limit its efforts to updating the extensive 1996 cooking product technical analysis; these stakeholders reasoned that such an update would properly represent prices, design options, and manufacturer issues for products covered by the present rulemaking. Thus, DOE updated the 1996 cooking products analysis and plans to interview manufacturers of cooking products during the NOPR stage of this rulemaking to get feedback on its analysis and results.

During the course of the preliminary MIA, DOE interviewed manufacturers representing over 80 percent of domestic dishwasher sales, 66 percent of domestic dehumidifier sales, and practically 100 percent of CCW sales. DOE used these same interviews to review the engineering analysis cost and performance data contained in chapter 5 of the TSD. However, during the course of the MIA interviews, focus of the discussion was shifted from technology-related topics to business-related topics. DOE's objective was to become familiar with each company's particular market approach and financial structure, and its concerns and issues related to new efficiency standards. Most of the information received from these meetings is protected by non-disclosure agreements and resides with DOE's contractors. Before each visit, DOE provided company representatives with an interview guide that included the topics that DOE hoped to cover. The topics included:

- Key issues—the most important things to consider in setting new standards from the perspective of manufacturers;
- Product mix—effects of potential standard levels on a manufacturer's product mix;
- Profitability—insights into market forces which could affect a manufacturer's profitability;
- Conversion costs—estimates of costs required to meet new standards;
- Manufacturing capacity and employment levels—decisions to upgrade, remodel, or relocate existing facilities and resulting changes in employment patterns resulting from new energy efficiency standards;
- Market share and industry consolidation—changes to competitive dynamics of the marketplace and the possible consequences for consumers;
- Product utility and innovation—effect of standards on product utility and innovation; and
- Cumulative burden—assessment of the level and timing of investments manufacturers are expecting to incur as a result of other regulations.

Additionally, DOE often introduced, entertained, and discussed other topics during the course of the interviews, such as the impact of various design options on energy efficiency, how testing standards and usage patterns vary by market, and performance issues.

Perhaps the most important aspect of the preliminary MIA was the opportunity it created for DOE to identify key manufacturer issues early in the development of new standards.

During the interviews, DOE engaged the manufacturers in a discussion of their perception of the key issues in the rulemaking. DOE then added these key issues to the list of questions and topics explored during the interviews.

The concerns that rose to the level of key issues in the opinion of dishwasher manufacturers included: (1) The potential elimination of entry-level dishwashers from the market; (2) a possible reduction in dishwasher washing performance; (3) the increased likelihood of consumers hand washing and pre-rinsing dishes; and (4) the potential relocation of production facilities overseas.

The key issues expressed by dehumidifier manufacturers included: (1) The ability to pass cost increases on to consumers; (2) increased pressure from foreign competition; and (3) the ability to maintain Energy Star product offerings.

The key issues for CCW manufacturers included: (1) The risk of eliminating vertical-axis washers from the market; (2) reduced product shipments due to a move away from central laundry facilities to in-unit residential laundry and prolonging the life of existing equipment; (3) reduced cleaning performance of some energy-saving design options; (4) the possible relocation of production facilities outside the country; and (5) the potential for industry consolidation and/or the elimination of the low-volume manufacturer.

For more preliminary results for the MIA, such as other impacts on financial performance, impacts on product utility and performance, and additional details on the impacts of cumulative regulatory burden, refer to Chapter 12 of the TSD.

L. Utility Impact Analysis

The utility impact analysis estimates the effects on the utility industry of reduced energy consumption due to improved appliance efficiency. The analysis compares modeling results for the base case with results for each candidate standards case. For each of the four appliance products, the analysis will consist of forecasted differences between the base and standards cases for electricity generation, installed capacity, sales, and prices. For CCWs, as well as residential dishwashers and cooking products, the analysis also will examine differences in sales of natural gas.

To estimate these effects of proposed standards on the electric and gas utility industries, DOE intends to use a variant of the EIA's NEMS.[56] EIA uses NEMS to produce its AEO. NEMS produces a widely recognized reference case forecast for the United States and is available in the public domain. DOE will use a variant known as NEMS-Building Technologies (BT) to provide key inputs to the analysis.

The use of NEMS for the utility impact analysis offers several advantages. As the official DOE energy forecasting model, NEMS relies on a set of premises that are transparent and have received wide exposure and commentary. NEMS allows an estimate of the interactions between the various energy supply and demand sectors and the economy as a whole. The utility impact analysis will determine the changes for electric utilities in installed capacity and in generation by fuel type produced by each candidate standard level, as well as changes in gas and electricity sales to the commercial sector (for CCWs) and the consumer sector (for residential dishwashers, dehumidifiers, and cooking products). (Because dehumidifiers neither operate on gas nor rely on water heated by gas, standards for this product do not affect gas sales.)

DOE plans to conduct the utility impact analysis as a variant of the NEMS used to produce the *AEO 2007,* applying the same basic set of premises. For example, the utility impact analysis uses the operating characteristics (*e.g.*, energy conversion efficiency, emissions rates) of future electricity generating plants and the prospects for natural gas supply as specified in the *AEO* reference case.

DOE will also explore deviations from some of the *AEO 2007* reference case premises to represent alternative futures. Two alternative scenarios use the high- and low-economic-growth cases of *AEO 2007.* (The reference case corresponds to medium growth.) The high-economic-growth case uses higher projected growth rates for population, labor force, and labor productivity, resulting in lower predicted inflation and interest rates relative to the reference case. The opposite is true for the low-growth case. Starting in 2012, the high-growth case predicts growth in per capita gross domestic product of 3.4 percent per year, compared with 2.9 percent per year in the reference case and 2.2 percent per year in the low-growth case. As part of varying supply-side growth determinants in these cases, *AEO 2007* also varies the forecasted energy prices for all three economic growth cases. Different economic growth cases affect the rate of growth of electricity demand.

The electric utility industry analysis will consist of NEMS–BT forecasts for generation, installed capacity, sales, and prices. The gas utility industry analysis will consist of NEMS–BT forecasts of sales and prices. The NEMS–BT provides reference case load shapes for several end uses, including residential dishwashing and cooking, but does not provide load shapes[57] specifically for dehumidifiers and CCWs. Because most of the energy consumed by clothes washers is expended on water heating, DOE intends to use NEMS–BT's commercial water-heating load shapes to characterize CCWs. For dehumidifiers, because this end use is operated in a similar manner to air-conditioning equipment, DOE intends to use NEMS–BT residential space-cooling load shapes to characterize it. For electrical end uses, NEMS–BT uses predicted growth in demand for each end use to build up a projection of the total electrical system load growth for each region, which it uses in turn to predict the necessary additions to capacity. For both electrical and gas end uses, NEMS–BT accounts for the implementation of efficiency standards by decrementing the appropriate reference case load shape. DOE will determine the size of the decrement using data for the per-unit energy savings developed in the LCC and PBP analyses (see Chapter 8 of the TSD) and the forecast of shipments developed for the NIA (see Chapter 9 of the TSD). For more information on the utility impact analysis, refer to Chapter 13 of the TSD.

EEI commented that an accurate assessment of electric utility impacts requires an evaluation of the type of load of the appliance (*i.e.*, whether the load is primarily during system peak demand or off-peak). (Public Meeting Transcript, No. 5 at p. 264) In response, we note that in 2001, EIA conducted a review of its end-use load shapes and updated them to better reflect actual end use behavior.[58] As a result, DOE has

[56] For more information on NEMS, please refer to the U.S. Department of Energy, Energy Information Administration documentation. A useful summary is *National Energy Modeling System: An Overview 2003,* DOE/EIA–0581(2003), March 2003. DOE/EIA approves use of the name NEMS to describe only an official version of the model without any modification to code or data. Because this analysis entails some minor code modifications and the model is run under various policy scenarios that are variations on DOE/EIA assumptions, in this analysis, DOE refers to it by the name NEMS–BT.

[57] The ''load shape'' defines how the product uses energy on an hourly basis over the course of the day.

[58] *Alternative Sectoral Load Shapes for NEMS,* Department of Energy—Energy Information Administration, Washington, DC, August 2001.

Continued

confidence that the NEMS–BT provides a good representation of the type of loads exhibited by its end uses.

With regard to gas utility impacts, the AGA commented that NEMS–BT does not address these impacts in a meaningful way. AGA suggested that DOE should conduct a workshop on proposed modeling approaches to analyzing gas utility impacts. (AGA, No. 12 at p. 3) As noted above, NEMS–BT allows for the determination of changes in gas sales due to efficiency standards. Therefore, DOE's gas utility impact analysis goes no further than assessing the impact on gas sales.

Since the *AEO 2007* version of NEMS forecasts only to the year 2030, DOE would be required to extrapolate results for such forecasts to 2042. DOE conducts an extrapolation to 2042 to be consistent with the analysis period being used by DOE in the NIA. However, DOE has determined that it will not be feasible to extend the forecast period of NEMS–BT for the purposes of this analysis, in part because EIA does not have an approved method for extrapolation of many outputs beyond 2030. While it might seem reasonable in general to make simple linear extrapolations of results, in practice this is not advisable because outputs could be contradictory. For example, changes in the fuel mix implied by extrapolations of those outputs could be inconsistent with the extrapolation of marginal emissions factors. An analysis of various trends is not necessary and would involve a great deal of uncertainty. Therefore, for all extrapolations beyond 2030, DOE intends to use simple replications of year 2030 results. While these may seem unreasonable in some instances, in this way results are guaranteed to be consistent. As with the *AEO* reference case in general, the implicit premise is that the regulatory environment does not deviate from the current known situation during the extrapolation period. Only changes that have been announced with date-certain introduction are included in NEMS–BT.

Both EEI and SPU stated that DOE should factor impacts to water and wastewater utilities into the utility impact analysis. SPU claimed that, in some areas of the country, water is becoming a limited commodity and should be assessed in the context of a utility impact analysis. (EEI, No. 7 at p. 6; Public Meeting Transcript, No. 5 at p. 263) Although NEMS–BT provides estimates of changes in electrical utility infrastructure requirements as a function of end-use energy savings, it does not currently have the capability of calculating similar results for water and wastewater utilities. The water utility sector is more complicated than either the electric utility or gas utility sectors, with a high degree of geographic variability produced by a large diversity of water resource availability, institutional history, and regulatory context. DOE currently does not have access to tools that analyze water utility impacts. There are activites being conducted or initiated by the USGS, EPA, and DOE to study water and wastewater issues. However, these activites have yet to provide the necessary sources of data or tools to enable a water utility impact analysis comparable to what can be done on electric and gas utilities using NEMS. Therefore, conducting a credible water and wastewater utility analysis is beyond DOE's existing analysis capabilities.

M. Employment Impact Analysis

The Process Rule includes employment impacts among the factors to be considered in selecting a proposed standard, and it provides guidance for consideration of the impact (both direct and indirect) of candidate standard levels on employment. The Process Rule states a general presumption against any candidate standard level that would directly cause plant closures or significant loss of domestic employment, unless specifically identified expected benefits of the standard would outweigh the adverse effects. *See* the Process Rule, 10 CFR Part 430, Subpart C, Appendix A, sections 4(d)(7)(ii) and (vi), and 5(e)(3)(i)(B).

DOE estimates the impacts of standards on employment for equipment manufacturers, relevant service industries, energy suppliers, and the economy in general. Both indirect and direct employment impacts are covered. Direct employment impacts would result if standards led to a change in the number of employees at the factories that produce the four appliance products and related supply and service firms. Direct impact estimates are covered in the MIA.

Indirect employment impacts are impacts on the national economy other than in the manufacturing sector being regulated. Indirect impacts may result both from expenditures shifting among goods (substitution effect) and changes in income that lead to a change in overall expenditure levels (income effect). DOE defines indirect employment impacts from standards as net jobs created or eliminated in the general economy as a result of increased spending driven by the increased equipment prices and reduced spending on energy.

DOE expects new standards for the four appliance products to increase the total installed cost of equipment, which includes manufacturer selling price, sales taxes, distribution chain markups, and installation cost. DOE also expects the new standards to decrease energy consumption, and thus expenditures on energy. Over time, increased total installed cost is paid back through energy savings. The savings in energy expenditures may be spent on new commercial investment and other items.

Using an input/output model of the U.S. economy, this analysis seeks to estimate the effects on different sectors and the net impact on jobs. DOE will estimate national employment impacts for major sectors of the U.S. economy in the NOPR, using public and commercially available data sources and software. DOE will make all methods and documentation available for review in the TSD for the NOPR.

In overview, DOE developed Impact of Sector Energy Technologies (ImSET), a spreadsheet model of the U.S. economy that focuses on 188 sectors most relevant to industrial, commercial, and residential building energy use.[59] ImSET is a special-purpose version of the U.S. Benchmark National Input-Output (I–O) model, which has been designed to estimate the national employment and income effects of energy saving technologies that are deployed by DOE's Office of Energy Efficiency and Renewable Energy. In comparison with the previous versions of the model used in earlier rulemakings, this version allows for more complete and automated analysis of the essential features of energy efficiency investments in buildings, industry, transportation, and the electric power sectors. The ImSET software includes a computer-based I–O model with structural coefficients to characterize economic flows among the 188 sectors. ImSET's national economic I–O structure is based on the 1997 Benchmark U.S. table (Lawson, *et al.* 2002),[60] specially aggregated to 188 sectors.

Standards for the four appliance products may reduce energy

Available online at: *http://www.onlocationinc.com/LoadShapesAlternative2001.pdf.*

[59] Roop, J.M., M.J. Scott, and R.W. Schultz. 2005. *ImSET: Impact of Sector Energy Technologies.* PNNL–15273. Pacific Northwest National Laboratory, Richland, WA.

[60] Lawson, Ann M., Kurt S. Bersani, Mahnaz Fahim-Nader, and Jiemin Guo. 2002. ''Benchmark Input-Output Accounts of the U. S. Economy, 1997,'' *Survey of Current Business,* December, pp. 19–117.

expenditures and increase equipment prices in the commercial sector. These expenditure changes are likely to reduce commercial and energy sector employment. At the same time, these equipment standards may increase commercial sector investment, and increase employment in other sectors of the economy. DOE designed the employment impact analysis to estimate the year-to-year net employment effect of these different expenditure flows.

Although DOE intends to use ImSET for its analysis of employment impacts, it welcomes input on other tools and factors it might consider. For more information on the employment impact analysis, refer to Chapter 14 of the TSD.

N. Environmental Assessment

The primary environmental effect of energy conservation standards for the four appliance products would be reduced power plant emissions resulting from reduced consumption of electricity. DOE will assess these environmental effects by using NEMS–BT to provide key inputs to its analysis. The environmental assessment produces results in a manner similar to those provided in the *AEO.* In addition to electrical power, the operation of three of the four appliance products—CCWs, dishwashers, and cooking products—also requires use of fossil fuels, and results in emissions of carbon dioxide (CO_2), nitrogen oxides (NO_X), and sulfur dioxide (SO_2) at the sites where the appliances are installed. Southern California Gas Company (SoCal Gas) and PG&E questioned how DOE will evaluate the emissions from gas-fired appliances. (Public Meeting Transcript, No. 5 at pp. 271–272) In response, we note that NEMS–BT provides no means for estimating such site emissions. Therefore, DOE will calculate, and the environmental assessment will include, separate estimates of the effect of the proposed standard on site emissions of CO_2, NO_X, and SO_2, based on simple emissions factors derived from the literature.[61]

The intent of the environmental assessment is to provide emissions results estimates and to properly quantify and consider the environmental effects of all new Federal rules. The portion of the environmental assessment that will be produced by NEMS–BT considers only three pollutants, SO_2, NO_X, and mercury, and one other emission (carbon). The only form of carbon the NEMS–BT model tracks is CO_2. Therefore, the carbon discussed in this analysis is only in the form of CO_2. For each of the trial standard levels, DOE will calculate total undiscounted and discounted power plant emissions using NEMS–BT, and will use other methods to calculate site emissions.

Although DOE plans to consider only SO_2, NO_X, mercury, and CO_2 in its environmental assessment, there are other air pollutants which are of concern. Specifically, the Clean Air Act requires EPA to set National Ambient Air Quality Standards for the following six common air pollutants, also know as ''criteria pollutants'': (1) Ozone, (2) particulate matter (PM), (3) carbon monoxide (CO), (4) nitrogen dioxide, (5) SO_2, and (6) lead. [62] EPA recently added mercury to this list. But none of the ''criteria pollutants'' not considered in the environmental assessment (*i.e.*, ozone, PM, CO, and lead) are driven significantly by either electric utility power plants or fuel-fired appliances. Therefore, DOE does not intend on addressing them in the environmental assessment. In the case of ozone and PM, other pollutants are precursors to their formation, and atmospheric conditions are the driver behind their formation. Also, SO_2 and NO_X, are the primary precursors to ozone and PM, respectively, and will already be addressed by the environmental assessment. In the case of CO, electric utilities and fuel-fired appliances are not significant sources. For electric power plants, almost all carbon emissions come out in the form of CO2 as the combustion process is lean enough not to yield CO in significant amounts. For fuel-fired appliances, proper appliance maintenance, installation, and use can prevent dangerous levels of CO. A well-designed and properly functioning heating or cooking appliance should not produce toxic or lethal levels of CO, as, most often, CO poisoning occurs in the home as a result of malfunctioning appliances. Finally, with regard to lead, the ban on the use of leaded gasoline has resulted in a dramatic decrease in lead emissions since the mid-1970s. Today, industrial processes (not electric utilities), particularly primary and secondary lead smelters and battery manufacturers, are responsible for most of lead emissions and all violations of the lead air quality standards.

As to power plant emissions, DOE will conduct each environmental assessment performed as part of this rulemaking as an incremental policy impact (*i.e.*, a standard for the product under evaluation) on the *AEO 2007* forecast, applying the same basic set of assumptions used in *AEO 2007.* For example, the emissions characteristics of an electricity generating plant will be exactly those used in *AEO 2007.* Also, forecasts conducted with NEMS–BT consider the supply-side and demand-side effects on the electric utility industry. Thus, DOE's analysis will account for any factors affecting the type of electricity generation and, in turn, the type and amount of airborne emissions generated by the utility industry.

The NEMS–BT model tracks carbon emissions with a specialized carbon emissions estimation subroutine, producing reasonably accurate results due to the broad coverage of all sectors and inclusion of interactive effects. Past experience with carbon results from NEMS suggests that emissions estimates are somewhat lower than emissions based on simple average factors. One of the reasons for this divergence is that NEMS tends to predict that conservation displaces generating capacity in future years. On the whole, NEMS–BT provides carbon emissions results of reasonable accuracy, at a level consistent with other Federal published results.

NEMS–BT also reports SO_2, NO_X, and mercury, which DOE has reported in past analyses. The Clean Air Act Amendments of 1990 set an SO_2 emissions cap on all power generation.[63] The attainment of this aggregate limit, however, is flexible among generators of emissions, due to the availability of emissions allowances and tradable permits. Although NEMS includes a module for SO_2 allowance trading and delivers a forecast of SO_2 allowance prices, accurate simulation of SO_2 trading implies that the effect of efficiency standards on physical emissions will be zero because emissions will always be at or near the ceiling. However, there may be an SO_2 benefit from energy conservation, in the form of a lower SO_2 allowance price. Since the impact of any one standard on the allowance price is likely small and highly uncertain, DOE does not plan to monetize any potential SO_2 benefit.

NEMS–BT also has an algorithm for estimating NO_X emissions from power generation. The impact of these emissions, however, will be affected by the Clean Air Interstate Rule (CAIR), which the EPA published on May 12, 2005. CAIR will permanently cap

[61] U.S. Environmental Protection Agency. *Compilation of Air Pollutant Emission Factors, AP–42, Fifth Edition, Volume 1: Stationary Point and Area Sources.* 1998. Available online at: *http://www.epa.gov/ttn/chief/ap42.html.*

[62] U.S. Environmental Protection Agency. *Six Common Air Pollutants.* Washington, DC. Available online at: *http://www.epa.gov/air/urbanair/.*

[63] See 40 CFR part 50. (*See* also U.S. Environmental Protection Agency Web site at: *http://www.epa.gov/air/caa/*).

emissions of NO_X in 28 eastern States and the District of Columbia. 70 FR 25162 (May 12, 2005). As with SO_2 emissions, a cap on NO_X emissions means that equipment efficiency standards may have no physical effect on these emissions. When NO_X emissions are subject to emissions caps, DOE's emissions reduction estimate corresponds to incremental changes in the prices of emissions allowances in cap-and-trade emissions markets rather than physical emissions reductions. Therefore, while the emissions cap may mean that physical emissions reductions will not result from standards, standards could produce an economic benefit in the form of lower prices for emissions allowance credits. However, as with SO_2 allowance prices, DOE does not plan to monetize this benefit because the impact on the NO_X allowance price from any single energy conservation standard is likely small and highly uncertain.

EEI stated that new rules pertaining to power plant SO_2 and NO_X emissions will limit the impact that standards can have on reducing these emissions. (EEI, No. 7 at p. 4) As noted above, NEMS–BT accounts for the most recent regulations pertaining to power plant SO_2 and NO_X emissions and expects that appliance efficiency standards will not have any physical effect on these emissions.

With regard to mercury emissions, NEMS has an algorithm for estimating these emissions from power generation. However, the impact on mercury emissions will be affected by the Clean Air Mercury Rule (CAMR), which the EPA published on May 18, 2005. 70 FR 28606. CAMR will permanently cap emissions of mercury for new and existing coal-fired plants in all States. As with SO_2 and NO_X emissions, a cap on mercury emissions means that appliance efficiency standards may have no physical effect on these emissions. When mercury emissions are subject to emissions caps, DOE's emissions reduction estimate corresponds to incremental changes in the prices of emissions allowances in cap-and-trade emissions markets rather than physical emissions reductions. Therefore, while the emissions cap may mean that physical emissions reductions will not result from standards, standards could produce an economic benefit in the form of lower prices for emissions allowance credits. However, as with SO_2 and NO_X allowance prices, DOE does not plan to monetize this benefit because the impact on the mercury allowance price from any single energy conservation standard is likely small and highly uncertain.

The Joint Comment stated that DOE should evaluate mercury and particulate emissions as part of the environmental assessment due to their impact on public health. (Joint Comment, No. 9 at p. 3) In response, as noted above, NEMS–BT accounts for the most recent regulations pertaining to power plant mercury emissions and expects that standards will not have any physical effect on the level of these emissions. With regard to particulates, these emissions are a special case because they arise not only from direct emissions, but also from complex atmospheric chemical reactions that result from NO_X and SO_2 emissions. Because of the highly complex and uncertain relationship between particulate emissions and particulate concentrations that impact air quality, DOE does not plan on reporting particulate emissions.

Potomac and SPU urged DOE to evaluate wastewater discharge impacts due to increased efficiency standards. (Public Meeting Transcript, No. 5 at p. 269) DOE plans to conduct a separate analysis of wastewater discharge impacts as part of the environmental assessment. DOE intends to derive a simple national aggregate estimate of wastewater discharge impacts from proposed energy conservation standards, based on estimates of consumer water savings. It will first provide a simple estimate of the fraction of water savings that result in decreased wastewater discharges. Then, by applying this discharge fraction to the water savings estimate, DOE can provide an approximate wastewater discharge savings estimate.

The results for the environmental assessment are similar to a complete NEMS run as published in the *AEO 2007*. These results include power sector emissions for SO_2, NO_X, and carbon in five-year forecasted increments extrapolated to 2042. The outcome of the analysis for each candidate standard level is reported as a deviation from the *AEO 2007* reference (base) case.

For more detail on the environmental assessment, refer to the environmental assessment report in the TSD.

O. Regulatory Impact Analysis

DOE will prepare a draft regulatory impact analysis in compliance with Executive Order 12866, ''Regulatory Planning and Review,'' which will be subject to review by OMB's Office of Information and Regulatory Affairs (OIRA). 58 FR 51735 (October 4, 1993).

As part of the regulatory impact analysis, and as discussed in section II.K, ''Manufacturer Impact Analysis,'' DOE will identify and seek to mitigate the overlapping effects on manufacturers of new or revised DOE standards and other regulatory actions affecting the same products. Through manufacturer interviews and literature searches, DOE will compile information on burdens from existing and impending regulations affecting the four appliance products covered under this rulemaking. DOE also seeks input from stakeholders about relevant regulations whose impacts it should consider.

The regulatory impact analysis also will address the potential for non-regulatory approaches to supplant or augment energy conservation standards to improve the efficiency of the four appliance products. One such potential non-regulatory program is tax credits. In assessing the potential impacts from tax credits, EEI suggested that DOE should evaluate the long-term effects on market transformation to more-efficient products from short-term (*e.g.*, two-year) tax credits. (Public Meeting Transcript, No. 5 at p. 278) AHAM stated that recent Federal tax credits for dishwashers will have an effect on improving overall product efficiency and that DOE should consider such effect as part of analyzing the impact of tax credits. (Public Meeting Transcript, No. 5 at p. 277) In response, we noted that the NOPR will include a complete quantitative analysis of alternatives to the proposed energy conservation standards (including tax credits), and DOE will use the most recent information available to make its assessments. DOE will use the NES spreadsheet model (as discussed in section II.I, ''National Impact Analysis'') to calculate the NES and NPV for the alternatives to the proposed conservation standards. For more information on the regulatory impact analysis, refer to the regulatory impact analysis report in the TSD.

III. Candidate Energy Conservation Standard Levels

The Process Rule states that DOE will specify candidate standard levels in the ANOPR, but will not propose a particular standard. 10 CFR Part 430, Subpart C, Appendix A, section 4(c)(1)(i). Section II.I.4, ''National Impact Analysis Results'' identifies the candidate standard levels for each of the four appliance products. Tables III.1 through III.4 repeat the candidate standard levels for each of the four appliance products.

TABLE III.1.—STANDARD DISHWASHERS: CANDIDATE STANDARD LEVELS

Candidate standard level	Energy factor
1	0.46
2	0.58
3	0.62
4	0.65
5	0.72
6	0.80
7	1.11

TABLE III.2.—DEHUMIDIFIERS: CANDIDATE STANDARD LEVELS

Candidate standard level	≤25.00	25.01–35.00	35.01–45.00	45.01–54.00	54.01–74.99	≥75.00
	EF	EF	EF	EF	EF	EF
1	1.10	1.25	1.35	1.45	1.55	2.38
2	1.20	1.30	1.40	1.50	1.60	2.50
3	1.25	1.35	1.45	1.55	1.65	2.55
4	1.30	1.40	1.50	1.60	1.70	2.60
5	1.38	1.45	1.74	2.02	1.80	2.75

TABLE III.3.—COOKING PRODUCTS: CANDIDATE STANDARD LEVELS

Candidate standard level	Cooktops			Ovens				Microwave ovens
	Elec coil	Elec smooth	Gas	Elec standard	Elec self-clean	Gas standard	Gas self-clean	
	EF	EF	EF	EF	EF	EF	EF	EF
1*	0.769	0.752	0.399	0.1113	0.1102	0.0536	0.0625	0.586
2			0.420	0.1163	0.1123	0.0566	0.0627	0.588
3				0.1181		0.0572	0.0632	0.597
4				0.1206		0.0593		0.602
5				0.1209		0.0596		
6						0.0600		
1a*						0.0583		

* For gas standard ovens, candidate standard levels 1 and 1a correspond to designs that are utilized for the same purpose—eliminate the need for a standing pilot-but the technologies for each design are different. Candidate standard level 1 is a hot surface ignition device while candidate standard level 1a is a spark ignition device. Candidate standard level 1a is presented at the end of the table because candidate standard levels 2 through 6 are derived from candidate standard level 1.

TABLE III.4.—COMMERCIAL CLOTHES WASHERS: CANDIDATE STANDARD LEVELS

Candidate standard level	Modified energy factor/water factor
1	1.42/9.50
2	1.60/8.50
3	1.72/8.00
4	1.80/7.50
5	2.00/5.50
6	2.20/5.10

DOE will review the public input it receives in response to this ANOPR and will update the analyses appropriately for each product class before issuing the NOPR. In addition, DOE will consider any comments it receives on the candidate standard levels set forth above for the four appliance products, and on whether alternative levels would satisfy EPCA criteria for DOE adoption of standards, for example:

- A moderate increase in the efficiency level at an earlier effective date (*e.g.*, an effective date two years after the publication of the final rule); or
- A larger increase in the efficiency level at a later effective date.

For the NOPR, DOE will develop trial standard levels (TSL) from the above candidate standard levels for each of the four appliance products. DOE will consider several criteria in developing the TSLs, including, but not limited to, which candidate standard level has the minimum LCC, maximum NPV, and maximum technologically feasible efficiency. From the list of TSLs developed, DOE will select one as its proposed standard for the NOPR, while explaining the other TSLs considered and the reasons for their elimination in deciding upon the level ultimately proposed.

For a given product consisting of several product classes (*e.g.*, dehumidifiers and cooking products), DOE will develop each TSL so that it is comprised of candidate standard levels from each class that exhibit similar characteristics. For example, in the case of dehumidifiers, one of the TSLs will likely consist of the candidate standard level from each of the six classes that has the minimum LCC.

DOE will also attempt to limit the number of TSLs considered for the NOPR by dropping from consideration candidate standard levels that do not exhibit significantly different economic and/or engineering characteristics from candidate standard levels already selected as a TSL. For example, in the case of dishwashers, the candidate standard level with the minimum LCC is candidate standard level 3 with an EF of 0.65. If the sole consideration for selecting TSLs was LCC, DOE would likely drop candidate standard level 4 with an EF of 0.68 as its LCC savings are lower and not significantly different than the value for candidate standard level 3.

DOE specifically seeks feedback on the criteria it should use for basing the selection of TSLs. This is identified as Issue 16 under ''Issues on Which DOE Seeks Comment'' in section IV.E of this ANOPR.

IV. Public Participation

A. Attendance at Public Meeting

The time, date, and location of the public meeting are set forth in the **DATES** and **ADDRESSES** sections at the beginning of this document. Anyone who wishes to attend the public meeting must notify Ms. Brenda Edwards-Jones at (202) 586–2945.

B. Procedure for Submitting Requests to Speak

Any person who has an interest in today's notice, or who is a representative of a group or class of persons that has an interest in these issues, may request an opportunity to make an oral presentation at the public meeting. Please hand-deliver requests to speak to the address shown under the heading ''Hand Delivery/Courier'' in the **ADDRESSES** section of this notice, between 9 a.m. and 4 p.m., Monday through Friday, except Federal holidays. Requests also may be sent by mail, to the address shown under the heading ''Postal Mail'' in the **ADDRESSES** section of this notice, or by e-mail to *Brenda.Edwards-Jones@ee.doe.gov*.

Persons requesting to speak should briefly describe the nature of their interest in this rulemaking and provide a telephone number for contact. DOE asks each person selected to be heard to submit a copy of his or her statement at least two weeks before the public meeting, either by hand delivery, mail, or e-mail as described in the preceding paragraph. Please include an electronic copy of your statement, on a computer diskette or CD when delivery is by mail or hand delivery. Electronic copies must be in WordPerfect, Microsoft Word, Portable Document Format (PDF), or text in American Standard Code for Information Interchange (ASCII) file format. At its discretion, DOE may permit any person who cannot supply an advance copy of his or her statement to participate, if that person has made alternative arrangements with the Building Technologies Program. In such situations, the request to give an oral presentation should ask for alternative arrangements.

C. Conduct of Public Meeting

DOE will designate a DOE official to preside at the public meeting and may also use a professional facilitator to aid discussion. The meeting will not be a judicial or evidentiary-type public hearing, but DOE will conduct it in accordance with 5 U.S.C. 553 and section 336 of EPCA. (42 U.S.C. 6306) A court reporter will be present to record the transcript of the proceedings. DOE reserves the right to schedule the order of presentations and to establish the procedures governing the conduct of the public meeting. After the public meeting, interested parties may submit further comments on the proceedings and any other aspect of the rulemaking until the end of the comment period.

The public meeting will be conducted in an informal, conference style. DOE will present summaries of comments received before the public meeting, allow time for presentations by participants, and encourage all interested parties to share their views on issues affecting this rulemaking. Each participant will be allowed to make a prepared general statement (within time limits determined by DOE) before the discussion of specific topics. DOE will permit other participants to comment briefly on any general statements.

At the end of all prepared statements on a topic, DOE will permit participants to clarify their statements briefly and comment on statements made by others. Participants should be prepared to answer questions by DOE and by other participants concerning these issues. DOE representatives may also ask questions of participants concerning other matters relevant to the public meeting. The official conducting the public meeting will accept additional comments or questions from those attending, as time permits. The presiding official will announce any further procedural rules or modification of the above procedures that may be needed for proper conduct of the public meeting.

DOE will make the entire record of this proposed rulemaking, including the transcript from the public meeting, available for inspection at the U.S. Department of Energy, Forrestal Building, Room 1J–018 (Resource Room of the Building Technologies Program), 1000 Independence Avenue, SW, Washington, DC, (202) 586–9127, between 9 a.m. and 4 p.m., Monday through Friday, except Federal holidays. Any person may buy a copy of the transcript from the transcribing reporter.

D. Submission of Comments

DOE will accept comments, data, and information regarding all aspects of this ANOPR before or after the public meeting, but no later than January 29, 2008. Please submit comments, data, and information electronically to the following e-mail address: *home_appliance.rulemaking@ee.doe.gov*. Submit electronic comments in WordPerfect, Microsoft Word, PDF, or text (ASCII) file format and avoid the use of special characters or any form of encryption. Comments in electronic format should be identified by the docket number EE–2006–STD–0127 and/or RIN 1904–AB49, and whenever possible carry the electronic signature of the author. Absent an electronic signature, comments submitted electronically must be followed and authenticated by submitting the signed original paper document. DOE will not accept any telefacsimiles (faxes).

Under 10 CFR 1004.11, any person submitting information that he or she believes to be confidential and exempt by law from public disclosure should submit two copies. One copy of the document shall include all the information believed to be confidential, and the other copy of the document shall have the information believed to be confidential deleted. DOE will make its own determination about the confidential status of the information and treat it according to its determination.

Factors of interest to DOE when evaluating requests to treat submitted information as confidential include: (1) A description of the items; (2) whether and why such items are customarily treated as confidential within the industry; (3) whether the information is generally known by, or available from, other sources; (4) whether the information has previously been made available to others without obligation concerning its confidentiality; (5) an explanation of the competitive injury to the submitting person which would result from public disclosure; (6) when such information might lose its confidential character due to the passage of time; and (7) why disclosure of the information would be contrary to the public interest.

E. Issues on Which the Department of Energy Seeks Comment

DOE is interested in receiving comments on all aspects of this ANOPR. DOE especially invites comments or data to improve DOE's analysis, including data or information that will respond to the following questions or concerns addressed in this ANOPR:

1. Microwave Oven Standby Power

For the NOPR, DOE is considering purchasing, testing, and analyzing microwave ovens to better understand the utility, cost, and cost implications of reducing standby power consumption. Addition of a standby power test to the existing test procedure would be necessary before standby power could be included in an efficiency standard. DOE is considering this approach for microwave ovens because data provided by AHAM suggests that there is an opportunity for significant energy savings via the reduction of standby power levels. Therefore, DOE requests data and stakeholder feedback on how to conduct an analysis of standby power for microwave ovens. (See section I.D.4.b of this ANOPR for further details.)

2. Product Classes

In accordance with EPCA section 325(p)(1)(A), DOE identified the equipment classes covered under this rulemaking. (42 U.S.C. 6295(p)(1)(A)) Pursuant to EPCA section 325(p)(1)(B), DOE requests comments on these equipment classes and invites interested persons to submit written presentations of data, views, and arguments. (42 U.S.C. 6295(p)(1)(B)) (See section II.A.1 of this ANOPR for further details.)

3. Commercial Clothes Washer Horizontal-Axis Designs

The information available for CCWs suggests that an efficiency of 1.6 MEF and 8.5 WF will be based on horizontal-axis technology. As such, it appears that the incremental costs between 1.60 MEF/8.5 WF and 2.2 MEF/5.1 WF will be constant at the same value as those provided by AHAM for the level 2.0 MEF/5.5 WF. DOE particularly seeks comment on the validity of such an approach. DOE also seeks information about lower-cost alternatives to horizontal-axis designs for levels greater than 1.42 MEF/9.5 WF and lower than 2.0 MEF/5.5 WF. Additionally, DOE seeks information that would allow it to change the energy and water features of the 2.0 MEF/5.5 WF level to allow for manufacturer cost differentiation at the lower (and the higher) levels. Furthermore, DOE seeks comment on how to evaluate potential shifts from vertical-axis technologies to horizontal-axis. (See section II.C.4.d of this ANOPR for further details.)

4. Compact Dishwashers

DOE was unable to obtain incremental manufacturing cost information for compact dishwashers. Therefore, DOE did not analyze compact dishwashers for this ANOPR but expects to set standards for them. DOE requests feedback on how it can extend the results of the analysis for the standard class to compact dishwashers. (See section II.C.4 of this ANOPR for further details.)

5. Microwave Oven Design Options

For microwave ovens, the design options and efficiency levels that DOE analyzed are those identified in the previous rulemaking's analysis, with incremental manufacturing costs scaled by the PPI. DOE requests stakeholder feedback on the approach of analyzing additional design options that would result in a lowering of the energy consumption of non-cooking features (*e.g.*, standby power), even though the existing test procedure currently does not account for such usage in EF. (See section II.C.3 of this ANOPR for further details.)

6. Technologies Unable to be Analyzed and Exempted Product Classes

There are a number of technologies which DOE was unable to analyze for this ANOPR. Design options associated with these technologies for dehumidifiers, cooking products, and CCWs, while passing the screening analysis, were eliminated from further consideration prior to the ANOPR engineering analysis. In addition, certain product classes were exempted on a similar lack of efficiency data. DOE requests stakeholder input on (1) energy efficiency data for technologies and product classes for which such data does not exist; and (2) potential limitations of existing test procedures. The latter may include such issues as representative usage patterns, ambient conditions, and test equipment. (See sections II.A.1 and II.C.2 of this ANOPR for further details.)

7. Dishwasher Efficiency and its Impact on Cleaning Performance

DOE was not able to identify sources of data showing whether the amount of pre-washing is impacted by dishwasher efficiency. Therefore, DOE believes that, to date, hand-washing or pre-washing habits have not been affected by product efficiency. Because increased diswasher energy efficiency may require future designs to utlize less water, DOE recognizes the possibility that more efficient dishwashers may degrade wash performance. Therefore, DOE seeks feedback on whether more efficient dishwasher designs will affect cleaning performance, leading to increased hand-washing or pre-washing and, if so, what increase in energy and water use can be expected. (See section II.D.1 of this ANOPR for further details.)

8. Dehumidifier Use

DOE identified several sources of data for estimating the annual use of dehumidifiers. However, DOE gave more weight to data that AHAM provided because they were developed based on the experience of manufacturers. It appears that AHAM's average estimate of 1,095 operating hours per year is the most representative of actual use. DOE requests feedback on whether 1,095 hours per year best represents the use of dehumidifiers. (See section II.D.2 of this ANOPR for further details.)

9. Commercial Clothes Washer Per-Cycle Energy Consumption

DOE determined the per-cycle clothes drying energy use and the per-cycle machine energy use for CCWs from data in its *2000 TSD* for residential clothes washers. DOE requests feedback on whether these per-cycle energy use characteristics for residential clothes washers are also representative of CCW energy use. (See section II.D.4 of this ANOPR for further details.)

10. Commercial Clothes Washer Consumer Prices

DOE identified two distribution channels for CCWs to establish their price to consumers. One channel involved distributors that typically sell to Laundromats, and the other channel involved route operators that typically sell or lease to multi-family building property owners. For purposes of developing the markups and consumer equipment prices for CCWs, DOE based its calculations solely on a distribution channel that involves distributors. DOE believed that the markups and the resulting consumer equipment prices determined for this distribution channel also would be representative of the prices paid by consumers acquiring their equipment from route operators. DOE requests feedback on its views regarding its development of consumer prices for CCWs. (See section II.E.1 of this ANOPR for further details.)

11. Repair and Maintenance Costs

Primarily because it did not receive any specific data on the impacts that standards might have on repair and maintenance costs, DOE did not include any changes in repair and maintenance costs due to standards for any of the four appliance products. DOE requests feedback on its understanding of repair and maintenance costs. (See section II.G.2.b of this ANOPR for further details.)

12. Efficiency Distributions in the Base Case

To accurately estimate the percentage of consumers that would be affected by a particular energy conservation standard level, DOE took into account the distribution of product efficiencies currently in the marketplace. In other words, DOE conducted its LCC and PBP analyses by considering the full breadth of product efficiencies that consumers purchase under the base case (*i.e.*, the case without new energy efficiency standards) to account for those consumers who already purchase more efficient products. DOE developed base case efficiency distributions for each of the four appliance products based on a combination of data sources and estimates. DOE requests feedback on the data sources and estimates it used for developing its base case product efficiency distributions. (See section II.G.2.d of this ANOPR for further details.)

13. Commercial Clothes Washer Shipments Forecasts

Based on historical data, CCW shipments dropped significantly between 1998 and 2005. Because DOE tied forecasted shipments to the growth in new multi-family construction, DOE forecasted a continued increase in clothes washer shipments over the analysis period (*i.e.*, 2012–2042). However, due to the dramatic drop in shipments seen in the historical data, DOE is uncertain as to whether shipments will continue to increase and requests feedback on the bases for its shipments forecasts for CCWs. (See section II.H.1 of this ANOPR for further details.)

14. Base-Case and Standards-Case Forecasted Efficiencies

Because key inputs to the calculation of the NES and NPV are dependent on the estimated efficiencies under the base case (without standards) and the standards case (with standards), forecasted efficiencies are of great importance to the analysis. DOE forecasted base-case and standards-case efficiencies, believing they remained frozen throughout the analysis period (*i.e.*, 2012–2042). DOE used a ''roll-up'' scenario to establish the shipment-weighted efficiency for the year that standards are estimated to become effective (*i.e.*, 2012). Under a roll-up scenario, DOE believed that product efficiencies in the base case that did not meet the standard level under consideration would roll up to meet the new standard level. DOE requests feedback on its methodologies for both forecasting efficiencies and estimating the impact that standards have on product efficiencies. (See section II.I.2 of this ANOPR for further details.)

15. Dehumidifier Cost and Efficiency Relationships

DOE defined total installed cost and efficiency relationships for a subset of the six dehumidifier product classes, For purposes of conducting its NIA, DOE applied the cost-efficiency data that were developed for these product classes to those classes for which DOE was unable to develop cost-efficiency relationships due to lack of data. Specifically, DOE applied the costs developed for the combined 0–35.00 pints/day class to the two individual classes that comprised the combined class—25.00 pints/day and less and 25.01–35.00 pints/day. Further, DOE applied the costs developed for the 35.01–45.00 pints/day and 54.01–74.99 pints/day product classes to the 45.01–54.00 pints/day and 75.00 pints/day and greater product classes, respectively. In its application of total installed costs to those product classes where no cost data were developed, DOE did not interpolate or extrapolate the cost data to account for product efficiency differences between the classes. For example, DOE utilized the exact same total installed costs that were developed for the baseline and standard levels for the 35.01–45.00 pints/day product class to characterize the baseline and standard level total installed costs for the 45.01–54.00 pints/day product class. DOE requests feedback on its approach for characterizing the total installed costs for those dehumidifier product classes in which it was not able to develop cost-efficiency relationships. (See section II.I.3 of this ANOPR for further details.)

16. Trial Standard Levels

For the NOPR, DOE will develop trial standard levels (TSL) from the candidate standard levels for each of the four appliance products. DOE will consider several criteria in developing the TSLs, including, but not limited to, which candidate standard level has the minimum LCC, maximum NPV, and maximum technologically feasible efficiency. From the list of TSLs developed, DOE will select one as its proposed standard for the NOPR. DOE requests feedback on the criteria it should use for basing the selection of TSLs. (See section III of this ANOPR for further details.)

V. Regulatory Review and Procedural Requirements

DOE submitted this ANOPR for review to OMB under Executive Order 12866, ''Regulatory Planning and Review.'' 58 FR 51735 (October 4, 1993). If DOE later proposes energy conservation standards for any of the four appliance products, and if the proposed rule constitutes a significant regulatory action, DOE would prepare and submit to OMB for review the assessment of costs and benefits required by section 6(a)(3) of the Executive Order. The Executive Order requires agencies to identify the specific market failure or other specific problem that it intends to address that warrants new agency action, as well as assess the significance of that problem, to enable assessment of whether any new regulation is warranted. (Executive Order 12866, section 1(b)(1)). DOE presumes that a perfectly functioning market would result in efficiency levels that maximize benefits to all affected persons. Consequently, without a market failure or other specific problem, a regulation would not be expected to result in net benefits to consumers and the nation. However, DOE also notes that whether it establishes standards for these products is determined by the statutory criteria expressed in EPCA. Even in the absence of a market failure or other specific problem, DOE nonetheless may be required to establish standards under existing law.

DOE's preliminary analysis for dishwashers, dehumidifiers, some gas cooking products, and commercial clothes washers explicitly accounts for the percentage of consumers that already purchase more efficient equipment and takes these consumers into account when determining the national energy savings associated with various candidate standard levels. The preliminary analysis suggests that accounting for the market value of energy savings alone (*i.e.*, excluding any possible ''externality'' benefits such as those noted below) would produce enough benefits to yield net benefits across a wide array of products and circumstances. With the exception of electric and some gas cooking products, these results quantify the percentage of consumers that do purchase more efficient products. DOE requests additional data (including the percentage of consumers purchasing more efficient cooking products and the extent to which consumers of all product types will continue to purchase more efficient equipment), for testing the existence and extent of these consumer actions.

DOE believes that there is a lack of consumer information and/or information processing capability about energy efficiency opportunities in the home appliance market. If this is in fact the case, DOE would expect the energy efficiency for home appliances to be randomly distributed across key variables such as energy prices and usage levels. Although, with the exception of cooking products, DOE has already identified the percentage of consumers that already purchase more efficient products, DOE does not correlate the consumer's usage pattern and energy price with the efficiency of the purchased product. Therefore, DOE seeks data on the efficiency levels of existing home appliances in use by how often it is utilized (*e.g.*, how many times or hours the product is used) and its associated energy price (and/or geographic region of the country). DOE plans to use these data to test the extent to which purchasers of this equipment behave as if they are unaware of the costs associated with their energy consumption. Also, DOE seeks comment on additional knowledge of the Federal Energy Star program, and the program's potential as a resource for increasing knowledge of the availability and benefits of energy efficient appliances in the home appliance consumer market.

A related issue is the problem of asymmetric information (one party to a transaction has more and better information than the other) and/or high transactions costs (costs of gathering information and effecting exchanges of goods and services). In the case of appliances, in many instances the party responsible for the appliance purchase may not be the one who pays the cost to operate it. For example, home builders in large-scale developments often make decisions about appliances without input from home buyers, nor do they offer options to upgrade them. Also, apartment owners normally make decisions about appliances, but it may be the renters who pay the utility bills. If there were no transactions costs, it would be in the home builders' and apartment owners' interest to install appliances the buyers and renters would choose on their own. For example, a renter who knowingly faces higher utility bills from low-efficiency appliances would be willing to pay less in rent, and the apartment owner would indirectly bear the higher utility cost. However, this information is not costless, and it may not be in the interest of the renter to take the time to develop it, or, in the case of the landlord who installs a high-efficiency appliance, to convey that information to the renter.

To the extent that asymmetric information and/or high transactions costs are problems, one would expect to find certain outcomes with respect to appliance energy efficiency. For example, other things equal, one would not expect to see higher rents for apartments with high-efficiency appliances. Conversely, if there were symmetric information, one would expect appliances with higher energy efficiency in rental units where the rent includes utilities compared to those where the renter pays the utility bills separately. Similarly, for single-family homes, one would expect higher energy efficiency levels for replacement units than appliances installed in new construction. Within the new construction market, one would expect to see appliances with higher energy efficiency levels in custom-built homes (where the buyer has more say in appliance choices) than in comparable homes built in large-scale developments.

Of course, there are likely to be certain ''external'' benefits resulting from the improved efficiency of units that are not captured by the users of such equipment. These include both environmental and energy security-related externalities that are not already reflected in energy prices, such as reduced emissions of greenhouse gases and reduced use of natural gas and oil for electricity generation. DOE invites comments on the weight that should be given to these factors in DOE's determination of the maximum efficiency level at which the total benefits are likely to exceed the total costs resulting from a DOE standard.

As previously stated, DOE generally seeks data that might enable it to conduct tests of market failure for products under consideration for standard-setting. For example, given adequate data, there are ways to test for the extent of market failure for commercial clothes washers. One would expect the owners of commercial clothes washers who also pay for their energy and water consumption to purchase machines that exhibit higher energy efficiency and lower water usage compared to machines whose owners do not pay for the energy and water usage, other things equal. To test for this form of market failure, DOE needs data on energy efficiency and water consumption of such units and whether the owner of the equipment is also the operator. DOE is also interested in other potential tests of market failure and data that would enable such tests.

In addition, various other analyses and procedures may apply to such future rulemaking action, including those required by the National Environmental Policy Act (Pub. L. 91–190, 42 U.S.C. 4321 *et seq.*); the Unfunded Mandates Reform Act of 1995 (Pub. L. 104–4); the Paperwork Reduction Act (44 U.S.C. 3501 *et seq.*); the Regulatory Flexibility Act (5 U.S.C. 601 *et seq.*); and certain Executive Orders.

The draft of today's action and any other documents submitted to OMB for review are part of the rulemaking record and are available for public review at the U.S. Department of Energy, Forrestal Building, Room 1J–018, (Resource Room of the Building Technologies Program), 1000 Independence Avenue, SW., Washington, DC, (202) 586–9127, between 9 a.m. and 4 p.m., Monday through Friday, except Federal holidays.

VI. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of today's ANOPR.

Issued in Washington, DC, on September 17, 2007.

Alexander A. Karsner,

Assistant Secretary, Energy Efficiency and Renewable Energy.

[FR Doc. E7–22040 Filed 11–14–07; 8:45 am]

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