EXECUTIVE SUMMARY

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EXECUTIVE SUMMARY

ES.1 OVERVIEW OF PRELIMINARY ANALYSIS ACTIVITIES

The Energy Policy and Conservation Act of 1975 (EPCA), as amended, requires the U.S. Department of Energy (DOE) to establish energy conservation standards that achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified. See 42 U.S.C. 6295(o)(3)(B) and 6313(d)(4). This executive summary provides an overview of the activities associated with the preliminary analysis that DOE conducted as part of the current rulemaking to set energy conservation standards for automatic commercial ice makers. The executive summary describes the preliminary analysis activities and summarizes key results from DOE's analyses. Detailed analysis methodologies and results are presented in the preliminary technical support document (preliminary TSD). Additionally, the executive summary identifies and lists the issues on which DOE requests comment from interested parties. These issues are also highlighted in the public meeting presentation.

Figure ES.1.1 presents a summary of the DOE rulemaking phases and the key analyses that constitute each phase. The rulemaking process typically begins with a framework document, which is followed by a preliminary analysis. DOE then publishes and seeks comment on a notice of proposed rulemaking (NOPR). After considering these comments and other relevant data and information, DOE publishes a final rule establishing any amended standards. The figure presents the major analyses in each phase in rectangular boxes. Core analyses for the rulemaking are lined in the center column of the figure, and they provide a logical sequence that DOE follows in carrying out the rulemaking process. Inputs to the analyses are shown with arrows pointing toward their respective analysis boxes, and outputs are shown with arrows directed away from their respective analysis boxes. Many outputs also form inputs for the downstream analyses. DOE obtains data for the inputs from various sources including, but not limited to, technical publications, market-survey reports, trade publications, interested parties' comments, industry experts and consultants, interagency guidance, and interactions with end users and the manufacturers. Key outputs from the analyses form the basis for setting the new energy conservation standards.

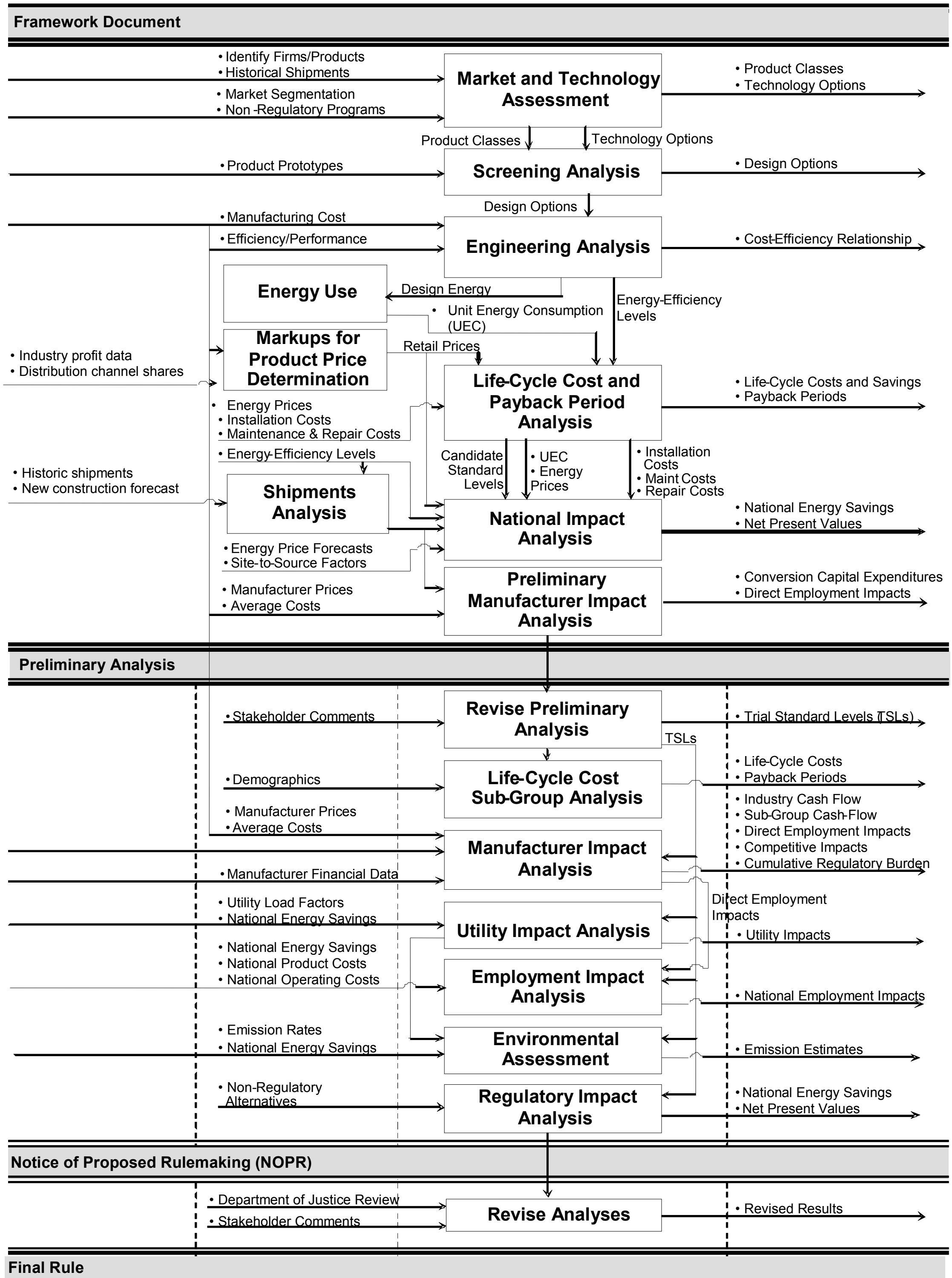

Figure ES.1.1 Flow Diagram of Analyses for the Automatic Commercial Ice Maker Rulemaking Process

ES.2 OVERVIEW OF THE PRELIMINARY ANALYSIS AND THE TECHNICAL SUPPORT DOCUMENT

For the preliminary analysis, DOE publishes a notice of public meeting (NOPM) in the *Federal Register*, which announces the availability of the preliminary TSD, the date and place of the public meeting, and presentation materials interested parties may review before the public meeting. In addition, the NOPM highlights the major analyses DOE developed in the preliminary analysis.

The preliminary TSD describes each preliminary analysis in detail, providing thorough descriptions of inputs, sources, methodologies, and results. Chapter 2 of the preliminary TSD provides an overview of each preliminary analysis, the comments received in response to the analytical approaches DOE described in the Framework document, and DOE's responses to those comments. The following chapters of the preliminary TSD address the preliminary analysis performed by DOE. These include:

- A market and technology assessment (MTA), which characterizes the relevant equipment markets and technology options, including prototype designs (chapter 3 of the preliminary TSD).

- A screening analysis, which reviews each technology option to determine whether it is technologically feasible; is practicable to manufacture, install, and service; would adversely affect equipment utility or equipment availability; or would have adverse impacts on health and safety (chapter 4 of the preliminary TSD).

- An engineering analysis, which develops cost-efficiency relationships that show a manufacturer's cost of achieving increased efficiency. DOE uses manufacturer markups to convert manufacturer production cost (MPC) to manufacturer selling price (MSP) (chapter 5 of the preliminary TSD).

- A markups analysis, which converts the MSP derived from the engineering analysis to consumer equipment prices based on distribution chain markups (chapter 6 of the preliminary TSD).

- An energy use analysis, which determines the annual energy use of the equipment (chapter 7 of the preliminary TSD).

- Life-cycle cost (LCC) and payback period (PBP) analysis, which calculates, at the consumer level, the discounted savings in operating costs throughout the estimated average life of the covered equipment, compared to any increase in the equipment's installed cost likely to result directly from the imposition of a given standard (chapter 8 of the preliminary TSD).

- A shipments analysis, which forecasts shipments of equipment, which are then used to calculate the national impacts of standards on energy consumption, the net present value (NPV) of consumer costs and savings, and future manufacturer cash flows (chapter 9 of the preliminary TSD).

- A national impact analysis (NIA), which assesses the cumulative national energy savings (NES) from standards, national water impacts,[a] and the NPV of consumer costs and savings associated with standards at different efficiency levels (chapter 10 of the preliminary TSD).

- A preliminary manufacturer impact analysis (preliminary MIA), which assesses the potential impacts of energy conservation standards on manufacturers, such as effects on expenditures for capital conversion, marketing costs, shipments, and research and development costs (chapter 12 of the preliminary TSD).

The remaining chapters of the preliminary TSD address the analyses to be performed for the NOPR stage, including:

- An LCC analysis for subgroups, which evaluates the effects of energy conservation standards on various national subgroups of the population (chapter 11 of the preliminary TSD).
- A utility impact analysis, which examines impacts of energy conservation standards on the generation capacity of electric utilities (chapter 13 of the preliminary TSD).
- An employment impact analysis, which examines the effects of energy conservation standards on national employment (chapter 14 of the preliminary TSD).
- An environmental assessment, which examines the effects of energy conservation standards on various airborne emissions and other environmental factors (chapter 15 of the preliminary TSD).
- A regulatory impact analysis, which examines the national impacts of non-regulatory alternatives to mandatory energy conservation standards (chapter 16 of the preliminary TSD).

ES.3 KEY RESULTS OF THE ANALYSIS

The following sections describe in detail the key analyses DOE performed in support of the preliminary TSD.

[a] In the preliminary analysis, no design options were analyzed that cause changes in water usage. As discussed in chapter 4 (screening) and chapter 5 (engineering), in the NOPR stage such options will be analyzed. Because there were no water impacts, national water impacts are not discussed further.

ES.3.1 Market and Technology Assessment

When initiating an analysis of potential energy efficiency standards for commercial equipment, DOE develops information for that equipment based on the present and past industry structure and market characteristics. This activity assesses industries and equipment both quantitatively and qualitatively, based on publicly available information.

When evaluating and establishing energy conservation standards, DOE divides covered equipment into classes based on the type of energy used, capacity, and/or other performance-related features that affect efficiency that DOE determines justify a different standard. Table ES.3.1 lists the equipment classes being considered in this rulemaking. These consist of two subsets of equipment: (1) automatic commercial ice makers for which standards were set by Energy Policy Act of 2005 (EPACT 2005) amendments to EPCA (42 U.S.C. 6313(d)(1)); and (2) new classes of automatic commercial ice makers for which standards are being considered in this rulemaking. The former group includes cube type ice makers with harvest capacities from 50 to 2,500 pounds of ice per 24-hour period (lb/24 hours[b]), where cube type ice is as defined in 10 CFR 431.132. In the preliminary analysis, DOE expects to define a new family of equipment consisting of all machines operating in a batch mode (*i.e.*, machines like cube and tube machines that have alternating freezing and harvesting cycles). Automatic commercial ice makers that produce cube type ice will be included in this new batch process equipment family, as well as batch process automatic commercial ice makers that produce ice that does not fit the definition of cube type ice, as defined in 10 CFR 431.132. New equipment for which DOE is considering standards in this rulemaking include batch process ice makers with harvest capacities above 2,500 lb/24 hours up to 4,000 lb/24 hours, batch process ice makers that produce other than cube type ice with harvest capacities between 50 and 4,000 lb/24 hours, and continuous process ice makers with harvest capacities from 50 to 4,000 lb/24 hours. Continuous process ice makers differ from batch process ice makers in that they freeze and harvest ice at the same time and typically produce flake and nugget ice. Although in this rulemaking DOE is considering revised standards for automatic commercial ice makers that produce cube type ice with capacities between 50 and 2,500 lb/24 hours and new standards for other types of batch process equipment, the existing standards still only apply to automatic commercial ice makers that produce cube type ice with capacities between 50 and 2,500 lb/24 hours.

[b] The term "pounds of ice per 24-hour period" is abbreviated herein as lb/24 hours for brevity.

Table ES.3.1 Automatic Commercial Ice Maker Equipment Classes

Type of Ice Maker	Equipment Type	Type of Cooling	Harvest Capacity Rate *lb/24 hours*
Batch	Ice-Making Head (IMH)	Water	≥50 and <500
			≥500 and <1,436
			≥1,436 and ≤4,000
		Air	≥50 and <450
			≥450 and ≤4,000
	Remote Condensing (RCU) (but not remote compressor)	Air	≥50 and <1,000
			≥1,000 and ≤4,000
	Remote Condensing (RCU) and Remote Compressor	Air	≥50 and <934
			≥934 and ≤4,000
	Self-Contained Unit (SCU)	Water	≥50 and <200
			≥200 and ≤4,000
		Air	≥50 and <175
			≥175 and ≤4,000
Continuous	Ice-Making Head (IMH)	Water	≥50 and <1000
			≥1,000 and <4,000
		Air	≥50 and <1000
			≥1,000 and <4,000
	Remote Condensing (RCU) (but not remote compressor)	Air	≥50 and <1000
			≥1,000 and <4,000
	Remote Condensing (RCU) and Remote Compressor	Air	≥50 and <1000
			≥1,000 and <4,000
	Self-Contained Unit (SCU)	Water	≥50 and <175
			≥175 and <4,000
		Air	≥50 and <175
			≥175 and <4,000

For the automatic commercial ice makers addressed by this rulemaking, DOE examined (1) manufacturer market share and characteristics; (2) existing regulatory and non-regulatory initiatives for improving equipment efficiency; and (3) trends in equipment characteristics and retail markets. This information provided data and resource material throughout the analysis.

DOE reviewed literature and interviewed manufacturers to develop an overall understanding of the automatic commercial ice maker industry in the United States. Chapter 3 of the preliminary TSD describes the market analysis.

DOE typically uses information about existing and past technology options and prototype designs to determine which technologies and combinations of technologies manufacturers use to attain higher energy efficiency levels. In consultation with interested parties, DOE develops a list of technologies to be considered.

DOE developed its list of technologies for automatic commercial ice makers after examining various documents (*e.g.*, trade publications, technical papers, and manufacturer literature) and consulting with manufacturers. Because existing equipment contains many technologies for improving equipment efficiency, equipment literature and direct examination provided additional information.

ES.3.2 Screening Analysis

In the screening analysis, DOE, in consultation with interested parties, examined the technologies identified in the MTA. DOE first examined whether it was possible to test the energy efficiency of these technologies using the DOE test procedure for automatic commercial ice makers. DOE is conducting a separate rulemaking to amend the current test procedure for automatic commercial ice makers (Docket No. EERE-2010-BT-TP-0036). DOE expects that any amended test procedure would be used to determine compliance with any revised energy conservation standards. In April 2011, DOE published a NOPR proposing to amend the current DOE test procedure for automatic commercial ice makers. 76 FR 18428 (April 4, 2011). The screening analysis for the energy conservation standards used the proposed test procedure to assess which technologies could be quantified by the test procedure. At this time, DOE is not further considering those technologies whose impact on energy efficiency cannot be measured using the proposed test procedure and data available to DOE.

Second, DOE evaluated the technologies using four screening criteria. Technologies are removed from further consideration if they (1) are not technologically feasible; (2) are not practicable to manufacture, install, and service; (3) have an adverse impact on equipment utility or availability; and/or (4) have adverse impacts on health and safety. In the subsequent engineering analysis, DOE further examines the technology options that are not removed from consideration in the screening analysis.

ES.3.3 Engineering Analysis

In the engineering analysis (chapter 5 of the preliminary TSD), DOE establishes the relationship between the cost of manufacturing automatic commercial ice makers and the energy consumption of this equipment. This relationship serves as the basis for calculating costs and benefits of modified equipment designs for consumers, manufacturers, and the nation. Chapter 5 of the preliminary TSD describes the equipment classes that DOE analyzed, the representative baseline units, the efficiency levels DOE considered, the methodology that DOE used to develop the manufacturing production cost and energy consumption models, and the cost-efficiency results.

ES.3.3.1 Equipment Classes Analyzed

DOE is considering 25 equipment classes for automatic commercial ice makers. The preliminary engineering analysis is based on the direct analysis of 19 units from 9 equipment classes. These are the 19 units that DOE purchased for reverse engineering. DOE also conducted energy testing for a subset of 10 of these units. For the remaining 16 equipment classes, DOE expects to develop standards based on extension of the direct engineering analyses of the first 9 equipment classes.

The characteristics of the 19 reverse-engineered units are summarized in Table ES.3.2. The table also indicates which products were tested. Chapter 5 of the preliminary TSD includes additional details on the representative equipment classes and the cost-efficiency curves developed as part of the engineering analysis.

Table ES.3.2 Reverse-Engineered Automatic Commercial Ice Makers

Equipment Type	Tested?	Ice Type	Harvest Rate *lb/24 hours*	Rated Energy Use *kWh/ 100 lb*[*]	DOE Energy Standard *kWh/100 lb*[*]	Potable Water Use *gal/100 lb*	Condenser Water Use *gal/100 lb*[*]	Dimensions (W × D × H) *inches*	Weight *lb*[**]
IMH-A	Y	Cube	257	8.0	8.1	20.0	NA	30 × 24.5 × 16.5	136
IMH-A	Y	Cube	324	5.8	7.5	22.6	NA	22 × 24 × 24	161
IMH-A		Cube	780	5.7	6.0	20.5	NA	30 × 24 × 26	230
IMH-A		Cube	844	5.0	6.0	18.4	NA	30 × 24 × 29	235
IMH-A		Cube	1,460	5.0	5.3	20.0	NA	48 × 24.5 × 29.5	317
IMH-A	Y	Cube	1,560	4.1	5.2	18.8	NA	48 × 27 × 36	415
IMH-W		Cube	851	4.4	4.6	19.7	153	30 × 24 × 29	235
IMH-W	Y	Cube	2,619	3.9	4.0	18.4	174	48 × 31 × 36	501
RCU-A		Cube	1,510	4.6	5.1	20.0	NA	48 × 24.5 × 29.5	324
RCU-A	Y	Cube	1,694	3.8	5.1	18.1	NA	36 × 40 × 36	415
RCU-A		Cube	2,350	4.6	5.3	19.7	NA	48 × 31 × 36	423
SCU-A	Y	Cube	121	8.4	12.3	17.8	NA	23.5 × 28 × 32.5	155
SCU-A		Cube	112	11.8	12.8	34.0	NA	24 × 24 × 33	160
SCU-W	Y	Cube	285	5.5	7.6	18.0	180	30 × 30 × 33	200
IMH-A		Nugget	310	7.4	NA	Note[†]	NA	22 × 27.4 × 21.9	175
IMH-A		Nugget	822	5.4	NA		NA	30 × 24.5 × 26.5	260
IMH-A	Y	Flake	845	3.4	NA		NA	21 × 24 × 27	215
RCU-A	Y	Flake	1,780	2.5	NA		NA	42 × 24 × 27	395
SCU-A	Y	Nugget	280	5.7	NA		NA	23.5 × 16.1 × 32.5	199

IMH: ice-making head; RCU: remote condenser unit; SCU: self-contained unit; A: air-cooled; W: water-cooled
[*] Using current DOE energy test (not proposed test) for cube ice makers, American Heating and Refrigeration Institute (AHRI) 810-2007 with Addendum 1 for flake and nugget ice makers.
[**] Does not include condenser for RCU ice makers.
[†] Potable water use is assumed to be 12 gallons per 100 lb for continuous ice makers.

ES.3.3.2 Manufacturing Cost Assessment

DOE estimated the manufacturing costs associated with each engineering efficiency level for all of the equipment classes analyzed. The assessment used information gained during manufacturer site visits and manufacturer interviews; information gathered by DOE in previous energy conservation standard rulemakings covering equipment manufactured using similar manufacturing methods; and a detailed cost model. Using aggregated manufacturer data, DOE developed the manufacturing cost model to estimate the MPC for various design option configurations. DOE obtained additional input from interested parties on the manufacturing cost model inputs. DOE also estimated the manufacturer markup and the MSP, which includes the shipping cost (the cost of shipping the equipment from the manufacturer to the distributor or customer). DOE calculated the MSP as the product of the MPC and the manufacturer markup. Chapter 5 of the preliminary TSD includes information on the inputs used to determine the manufacturing cost, including material, labor, and overhead costs. Chapter 5 also includes information on the various components and features incorporated into designs for automatic commercial ice makers.

ES.3.3.3 Energy Consumption Model

The complementary analysis to the manufacturing cost model is the energy consumption model. This model includes separate energy consumption models for batch process machines and continuous process machines. Both models calculate compressor energy use based on refrigeration system operating conditions. However, the batch model calculates energy use for the range of operating conditions experienced by the product as the ice layer builds up on the evaporator, whereas the continuous model examines just one operating state. Energy use of the compressor and ice production rate are based on thermal models for the evaporator and condenser, which influence the compressor suction and discharge pressures. Additional energy use associated with components such as fan motors, pump motors, and auger motors is included in the overall product energy use calculation. The energy consumption model calculates energy use per hundred pounds of ice produced based on a given design option configuration and numerical specification of the conditions at which a unit would be physically tested.

DOE's engineering analysis produced cost-efficiency curves for the equipment classes represented by the 19 reverse-engineered ice makers. The cost-efficiency curves are described by (1) the energy consumption values determined by the energy consumption model for the corresponding equipment configuration; and (2) the increase in MPC and MSP associated with each of the calculated levels. An example of a cost-efficiency curve is illustrated in Table ES.3.3 for air-cooled ice-making head (IMH) batch machines with capacities less than 450 lb/24 hours (IMH-A-Small-B), which is a high-shipment equipment class used in many applications. The table presents the energy consumption, percent energy use reduction from baseline energy consumption, MPC, and MSP results as well as the ordering of design options for this equipment class. Cost-efficiency curves for all directly analyzed equipment classes can be found in chapter 5 of the preliminary TSD. The cost-efficiency curves based on specific design option changes were converted to curves based on the selected efficiency levels for use in the downstream analyses.

Table ES.3.3 Manufacturing Cost and Energy Consumption Data for Air-Cooled IMH Batch Ice Machines with Capacities less than 450 lb/24 hours

Energy Consumption ***kWh/100 lb***	**Percent Energy Use Reduction**	**Manufacturer Production Cost**	**Manufacturer Selling Price**	**Design Options Successively Added**
8.04	0.0%	$1,671	$2,089	Baseline
7.46	7.2%	$1,678	$2,097	Increase compressor EER from 4.86 to 5.25
7.27	9.6%	$1,680	$2,100	2-inch wider condenser
7.08	12.0%	$1,686	$2,108	PSC condenser fan motor
6.94	13.7%	$1,690	$2,113	ECM condenser fan motor
6.82	15.2%	$1,696	$2,119	Additional 2-inch wider condenser
6.69	16.8%	$1,702	$2,127	ECM pump motor
6.26	22.1%	$1,727	$2,158	Harvest assist

kWh: kilowatt-hours; EER: energy efficiency ratio; PSC: permanent split capacitor; ECM: electronically commutated motor

ES.3.4 Markups to Determine Equipment Price

Distribution channel markups are multipliers that convert the MSP into customer purchase price. As noted, in the engineering analyses, manufacturer markups convert the MPC into MSP. These additional markups are applied to the MSP based on the distribution channel through which customers purchase the equipment. DOE identified that automatic commercial ice makers are purchased by the customers (end users) through three major distribution channels:

Manufacturer → Wholesaler → Contractor → Customer (**Contractor Channel**)

Manufacturer → Wholesaler → Customer (**Wholesaler Channel**)

Manufacturer → Customer (**National Account Channel**)

Table ES.3.4 shows the percentage of automatic commercial ice maker shipments that are purchased through each distribution channel.

Table ES.3.4 Shipment Percentage by Distribution Channel

	National Account Channel	Wholesaler Channel	Contractor Channel
Automatic Commercial Ice Makers, All	6%	32%	62%

Source: U.S. Census Bureau, Sector 42: EC0742SXSB01: Wholesale Trade: Subject Series - Misc Subjects: Sales by Class of Customer for the United States: 2007, data for NAICS code 423740, Refrigeration equipment and supplies merchant wholesalers. Downloaded March 4, 2011.

The three distribution channels can also be viewed as a single-step (national accounts) channel, a two-step (wholesaler) channel, and a three or more step (contractor) channel. There is one markup value associated with each step in a distribution channel. The product of all the markups in one distribution channel gives the overall markup of that channel. For example, the wholesaler channel markup is the product of the national account markup and the wholesaler markup.

DOE obtained one average markup value for each level of a distribution channel to calculate the overall markup. These values were then weighted by the respective distribution channel shares to obtain an overall markup. DOE calculated separate markups called "baseline markups" that are applied to the baseline equipment price and "incremental markups" that are applied to cost increments in the MSP for higher efficiency equipment.

Sales tax is one additional markup that is applicable to all the distribution channels. DOE calculated a weighted national average sales tax rate of 7.26 percent by applying the population of a state as the weight to its combined state and local tax rate. Table ES.3.5 and Table ES.3.6 present calculated overall weighted markups as well as individual markups for each level in a distribution channel.

Chapter 6 and appendix 6A of the preliminary TSD provide additional details for the markups analysis. Chapter 2 addresses comments received following the public release of the Framework document. As noted in chapters 2 and 6 of the preliminary TSD, DOE seeks input on additional or better data sources that can be used to characterize the costs associated with the third step in the contractor channel.

Table ES.3.5 Baseline Markups by Distribution Channel and Overall Weighted Average Markup, Including the Weighted Average Sales Tax Multiplier

	Wholesaler	Contractor	National Account	Overall Markup
Markup	1.3624	2.0086	1.1812	1.7522
Sales Tax	1.0726	1.0726	1.0726	1.0726
Overall Markup	1.4613	2.1544	1.2670	1.8794

Table ES.3.6 Incremental Markups by Distribution Channel and Overall Weighted Average Markup, Including the Weighted Average Sales Tax Multiplier

	Wholesaler	Contractor	National Account	Overall Markup
Markup	1.0913	1.2925	1.0456	1.2133
Sales Tax	1.0726	1.0726	1.0726	1.0726
Overall Markup	1.1705	1.3863	1.1216	1.3014

ES.3.5 Energy Use Analysis

Energy use analysis is generally carried out for appliance standards rulemakings to calculate the energy consumption or efficiency of the equipment being analyzed. For automatic commercial ice makers, DOE calculated the energy consumption of the equipment as part of the engineering analysis using an energy consumption model. The result of the DOE energy consumption model is an estimate of an ice maker's energy efficiency in terms of kilowatt-hours per 100 lb of ice. To translate the engineering results into annual energy usage, DOE needed to develop assumptions regarding annual utilization factors of automatic commercial ice makers.

In the Framework document, DOE suggested a set of annual utilization factors for each of the building types being explicitly studied in the LCC and PBP analysis. DOE suggested that the analysis would assume a 50-percent utilization factor for all building types, for all equipment classes. Interested parties were invited to comment on this set of assumptions. While numerous interested parties questioned the assumed annual utilization factors, none supplied DOE with superior data or better estimates, and DOE has retained the assumed 50-percent utilization factors. DOE seeks comments on utilization factors, or potential data sources for said factors.

Interested parties commented during the Framework public meeting that air-cooled self-contained equipment may have an impact on the building's heating, ventilation, and air-conditioning (HVAC) loads because, unlike the ice makers connected to a remote condensing unit or using water cooling in the condenser, this equipment rejects heat inside the conditioned building space. In another rulemaking, DOE performed building energy simulations for commercial refrigeration equipment, evaluating the impacts of improved efficiency of the equipment on building space conditioning energy use. In that study, when the study accounts for the positive impacts on cooling energy, the negative impacts on heating energy, and the fact that the variable of interest is the incremental change, not the total or absolute impacts, DOE found the HVAC impacts to be insignificant.[1] DOE expects the impact of self-contained commercial refrigeration equipment on HVAC loads to be larger than that for automatic commercial ice makers because there are typically fewer automatic commercial ice makers installed per square foot of conditioned space than pieces of self-contained commercial refrigeration equipment.[2] As such, DOE believes the impact of incremental increases in efficiency of ice makers will not have a significant or measurable impact on building HVAC loads.

ES.3.6 Life-Cycle Cost and Payback Period Analysis

DOE performs the LCC and PBP analysis to estimate the impact of standards on the customers (end users) of automatic commercial ice makers. The effect of standards on individual customers includes a change in operating cost and a change in purchase cost. LCC is the total customer cost of the equipment over the entire lifetime of the equipment. It includes installed cost (purchase price and installation costs) and operating cost (maintenance, repair, energy, and water/wastewater costs). Typically, the initial cost of more efficient equipment is higher than the baseline equipment, but the annual operating costs are lower, mainly due to lower energy consumption. PBP for higher efficiency equipment (compared to baseline equipment) can be calculated by dividing the installed cost increment by the annual operating cost savings. In other words, PBP is the amount of time (in years) required to offset the initial increase in installed costs through annual savings in operating costs.

In conducting the LCC and PBP analysis, DOE analyzed up to six efficiency levels. The MSP and equipment energy and water consumption values, in kilowatt-hours and gallons per 100 lb of ice, were obtained from the engineering analysis. Inputs for the LCC and PBP analysis are summarized in Table ES.3.7. To account for the uncertainty associated with many of the inputs in the LCC and PBP analysis, DOE carried out the analysis in the form of Monte Carlo simulations that use a distribution of values for certain inputs, instead of assuming one average value. Equipment lifetime is assumed to be represented by Weibull distributions with an average value of 8.5 years. Building type and the state where the equipment is installed is another variable in the simulations.

DOE modeled condenser water as if all water-cooled equipment is installed in a single-pass configuration. This means that condenser water is used one time and rejected to a wastewater treatment system. While DOE recognizes that some automatic commercial ice makers are installed on closed-loop cooling systems, DOE lacks data regarding the percentage of ice makers installed on this type of system or the cost of a closed-loop cooling system that could be attributed to the automatic commercial ice maker. DOE seeks input on this assumption or data on which to base further analysis that would account for both a single-pass and closed-loop cooling configuration.

Table ES.3.7 Inputs for LCC and PBP Analysis

Input	Description
Building Type	Discount rates and electricity prices will vary by building type in which the equipment is installed. Seven building types are assumed for automatic commercial ice makers: health care, lodging, foodservice, retail, education, food sales, and office.
Inputs for Installed Cost Calculations	
Baseline MSP	MSP of baseline equipment (obtained from engineering analysis).
Experiential Learning-Based MSP Adjustment	One-time adjustment made to MSP to reflect the fact that MSP was estimated using current (2011) prices, and MSP would be expected to decline between 2011 and 2016—the first year when standards might be in effect. The price decline results from experiential learning.
Efficiency Level MSP Increases	Difference between baseline MSP and MSP of higher efficiency level (obtained from engineering analysis).
Markups and Sales Tax	Converts MSP to customer purchase price (obtained from markups analysis).
Installation Price	Material and labor cost to install the equipment. Currently an estimated percentage of the MSP, approximated at 10 percent in the preliminary analysis. Assumed constant for all efficiency levels within an equipment class. Varies by state.
Inputs for Operating Cost Calculations	
Equipment Energy Consumption	Energy used by equipment in kilowatt-hours per 100 lb of ice (obtained from energy analysis).
Electricity Prices	Vary by state and building type.
Equipment Water Consumption	Water used by equipment in gallons (obtained from energy analysis). All water-cooled units are assumed to be on a single-pass cooling system in the preliminary analysis period of this rulemaking.
Water/Wastewater Prices	Vary by state.
Maintenance Costs	Material and labor costs for preventative maintenance. Currently estimated as a percentage of the MSP, approximated at 3 percent in the preliminary analysis. Assumed constant for all efficiency levels within an equipment class, except as otherwise noted in the LCC and PBP analysis (chapter 8 of the preliminary TSD).
Repair Costs	Material and labor cost to repair and replace failed components in the equipment. Currently an estimated percentage of the MSP, approximated at 3 percent in the preliminary analysis.
Equipment Lifetime	Assumed average lifetime of the equipment: 8.5 years for all equipment classes and building types. Actual lifetimes used in the LCC analysis represented by Weibull distributions.
Discount Rate	Rate at which future costs are discounted to establish their present value. This varies with building type.

The LCC and PBP analysis is based on the differences between base conditions without new standards and conditions after setting new standards. DOE notes that manufacturers recently needed to comply with the efficiency levels set by EPACT 2005 for cube type machines with harvest rates between 50 and 2,500 lb/24 hours, which went into effect on January 1, 2010. (42 U.S.C. 6313(d)(1)) In the LCC and PBP analysis, for batch machine classes, the energy consumption of the baseline level is assumed to equal the standard prescribed by EPACT 2005 for the corresponding equipment class because this represents the least efficient equipment that can be sold for cube type machines, with one exception. For IMH, air-cooled, batch machines, the large class baseline has been adapted from the EPACT 2005 standard to account for issues arising from applying the current standard to equipment with harvest rates in excess of 1,500 lb/24 hours. For more information, see the discussion in chapter 5 of the preliminary TSD (engineering analysis). For continuous type machines, the baseline level of the equipment was established using engineering analyses to determine the least efficient products that could potentially be available. For more information, see the discussion in chapter 5.

DOE notes that it is unable to identify equipment currently being sold that corresponds to the base efficiency levels, so DOE is not able to check this assumption. As such, DOE requests comment on setting the standards baseline for continuous type equipment. DOE also requests comment on using the EPACT 2005 standard levels as the baseline standard level for batch process equipment, including equipment covered by those standards as well as equipment for which there are no existing standards (*i.e.*, batch process equipment that makes other than cube type ice and batch process equipment with capacities between 2,500 and 4,000 lb/24 hours).

As noted in Table ES.3.7, DOE applied an experiential learning factor to the MSP to reflect that prices are expected to decline between 2011 and 2016. Experiential learning captures the effect of learning as producers manufacture more of their products. Over time, manufacturers uncover ways to reduce production costs and in turn reduce selling prices. In the LCC and PBP analysis, DOE applied a one-time adjustment to MSP to account for experiential learning. DOE also applied experiential learning time trends to manufacturer sales prices in the NIA, covering the 2016−2045 analysis period. DOE seeks comment on the use of experiential learning in the estimation of equipment prices.

The output of the Monte Carlo simulations for the LCC and PBP analysis are in the form of distributions. The LCC savings and PBP results for all the efficiency levels in each equipment class are presented in the preliminary TSD (appendix 8B) and shown here as an example for equipment class air-cooled IMH batch type ice machines with capacities less than 450 lb/24 hours (IMH-A-Small-B) in Figure ES.3.1 and Figure ES.3.2, respectively. The plots in both figures present the mean (red marker) and median (blue marker) LCC savings or PBP, the 25th and 75th percentile LCC savings or PBP (lower and upper edges of the elongated rectangular box, respectively), and 5th and 95th percentile LCC savings or PBP (lower and upper ends of the vertical black line, respectively).

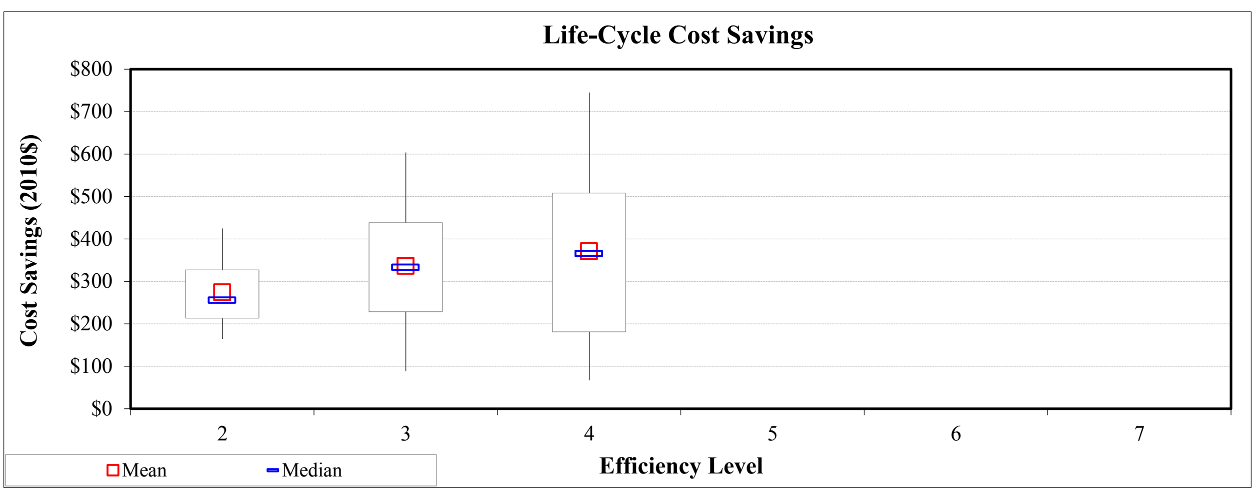

Figure ES.3.1 LCC Savings Results for All the Efficiency Levels for the Equipment Class IMH-A-Small-B

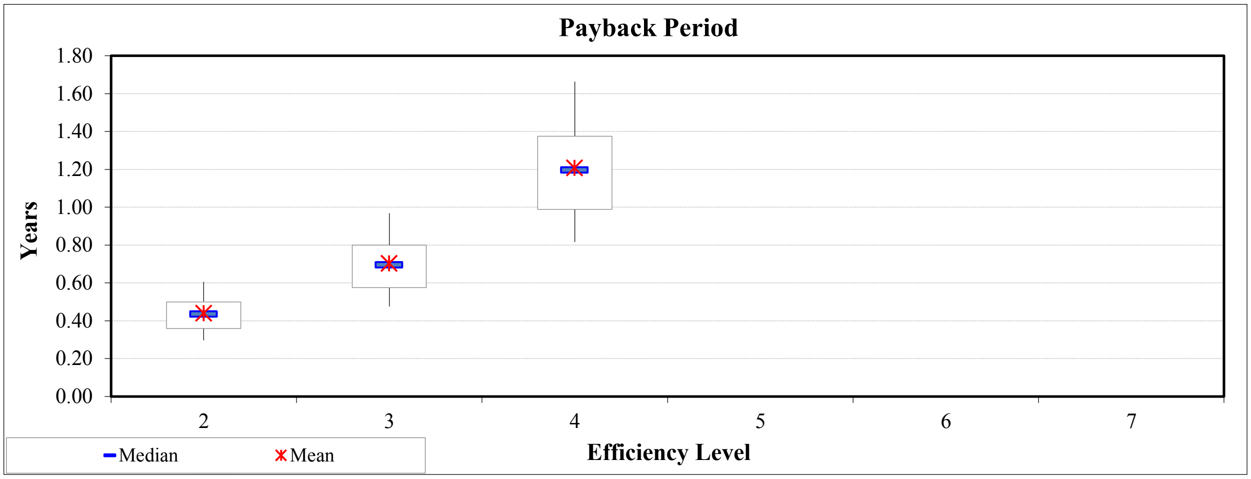

Figure ES.3.2 Payback Period Results for All Efficiency Levels for the Equipment Class IMH-A-Small-B

Appendix 8B also contains summary tables for each equipment class, similar to Table ES.3.8 for IMH-A-Small-B (presented here as an example). This table presents the mean values of installed costs, annual operating costs, LCC, LCC savings, and median PBP values for all the efficiency levels. It also presents the percentage of customers who experience net cost, no impact, and net benefit. The average LCC savings and the percentage of customers experiencing a net benefit or cost are based on a distribution of efficiency choices. In the base case, not all customers are assumed to be buying equipment at the baseline efficiency level (Level 1). Some are assumed to be buying at higher efficiency levels. The LCC savings is an average of the savings achieved by customers who, in the base case, were buying less efficient equipment than the efficiency level examined. Customers who experienced no impact were assumed in the base case to be already buying more efficient equipment, so the efficiency level in question would not affect them.

Table ES.3.9, Table ES.3.10, and Table ES.3.11 present the mean values of LCC savings, median PBP, and median "rebuttable presumption payback period" (RPBP) results for each efficiency level in each equipment class. RPBP is a special PBP case calculated to determine whether the rebuttable presumption set forth in EPCA is satisfied. RPBP values are calculated by dividing the installed cost increment of higher efficiency equipment by only the first-year energy savings (unlike total operating cost savings for PBP). EPCA provides that if the additional cost to the consumer of purchasing a product compliant with any amended standard is less than three times the value of the energy savings during the first year, there shall be a rebuttable presumption that such standard is economically justified. (42 U.S.C. 6295(o)(2)(B)(iii) and 6313(d)(4)) However, in addition to presenting the RPBP values, DOE routinely conducts a full economic analysis that considers the full range of impacts, including those affecting the customer, manufacturer, nation, and environment, as required under 42 U.S.C. 6295(o)(2)(B)(i) and 6313(d)(4). DOE anticipates conducting all of these analyses as part of the rulemaking to set and amend standards for automatic commercial ice makers.

Table ES.3.8 Summary of Results of LCC and PBP Analysis for the IMH-A-Small-B Equipment Class

Efficiency Level Number	Efficiency Level *kWh/yr*	Life-Cycle Cost, All Customers			Life-Cycle Cost Savings				Payback Period, Median *years*
		Installed Cost *2010$*	Total Discounted Operating Cost *2010$*	LCC, All Customers *2010$*	Affected Customers' Average Savings *2010$*	% of Customers that Experience			
						Net Cost *%*	No Impact *%*	Net Benefit *%*	
1	4,227	4,227	5,243	9,471	NA	NA	NA	NA	NA
2	3,806	4,243	4,954	9,197	275	0	41	59	0.44
3	3,596	4,266	4,809	9,075	337	0	24	76	0.70
4	3,386	4,315	4,664	8,980	373	0	8	92	1.20

Table ES.3.9 Mean Life-Cycle Cost Savings for All Product Classes and Efficiency Levels

Equipment Class	Mean LCC Savings*'** *2010$*					
	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7
IMH-W-Small-B	181.36	210.32				
IMH-W- Med -B	457.50					
IMH-W-Large-B	735.46	801.32				
IMH-A-Small-B	274.55	337.06	372.65			
IMH-A-Large-B	586.00	625.47	818.02			
RCU-Small-B	472.48	577.29	622.51			
RCU-Large-B	842.31	1,062.49	1,092.62			
SCU-W-Small-B	74.53	112.99	132.54	161.68		
SCU-W-Large-B	185.35	399.47	450.19	453.86	425.55	659.02
SCU-A-Small-B	108.82	152.12	218.59	289.87	302.66	
SCU-A-Large-B	146.05	231.09	336.82	416.00		
IMH-W-Small-C	–	277.88	366.99	429.83	546.01	
IMH-W-Large-C	–	–	286.81	204.51		
IMH-A-Small-C	319.56	370.65	368.30	383.24	269.74	
IMH-A-Large-C	–	–	384.30	570.01	848.66	1,101.70
RCU-Small-C	–	450.57				
RCU-Large-C	–	810.55				
SCU-W-Small-C**						
SCU-W-Large-C	–	–	132.25	186.12		
SCU-A-Small-C	–	–	–			
SCU-A-Large-C	–	–	–	132.44	188.73	(39.92)

IMH: ice-making head; RCU: remote condenser unit; SCU: self-contained unit; A: Air cooled; W: Water cooled; B: Batch; C: Continuous

* A value of "–" means that there are no affected customers at this efficiency level. Values on this table represent LCC savings for customers affected by the standard, and a "–" means that in the base-case efficiency distribution, all customers are expected to be purchasing equipment that is more efficient. Blank cells mean no LCC savings were calculated for this efficiency level because design options were unavailable to constitute an additional efficiency level.

** Data available to DOE show there are no existing SCU-Water-Small-Continuous products available, so this class is not currently defined in the models.

Table ES.3.10 Median Payback Period for All Product Classes and Efficiency Levels

Equipment Class	Median Payback Period*** *years*					
	Level 2	**Level 3**	**Level 4**	**Level 5**	**Level 6**	**Level 7**
IMH-W-Small-B	1.74	1.47				
IMH-W- Med -B	0.63					
IMH-W-Large-B	0.20	0.27				
IMH-A-Small-B	0.44	0.70	1.20			
IMH-A-Large-B	0.25	1.25	1.31			
RCU-Small-B	0.31	0.77	0.95			
RCU-Large-B	0.23	0.71	0.82			
SCU-W-Small-B	1.40	1.76	2.01	2.24		
SCU-W-Large-B	0.63	0.59	0.59	0.60	0.68	0.76
SCU-A-Small-B	1.01	1.47	1.60	1.59	1.57	
SCU-A-Large-B	1.24	1.19	1.18	1.23		
IMH-W-Small-C	0.11	0.18	0.22	0.24	0.52	
IMH-W-Large-C	0.35	0.37	0.49	1.02		
IMH-A-Small-C	0.75	0.83	0.87	0.90	1.93	
IMH-A-Large-C	0.40	0.36	0.34	0.33	0.67	0.98
RCU-Small-C	0.26	0.88				
RCU-Large-C	0.17	0.76				
SCU-W-Small-C**						
SCU-W-Large-C	0.61	0.67	0.68	0.65		
SCU-A-Small-C	2.43	2.18	2.01			
SCU-A-Large-C	-†	0.84	1.11	1.34	1.53	3.17

IMH: ice-making head; RCU: remote condenser unit; SCU: self-contained unit; A: Air cooled; W: Water cooled; B: Batch; C: Continuous

* Blank cells mean no payback period was calculated for this efficiency level because design options were unavailable to constitute an efficiency level.

** Data available to DOE show there are no existing SCU-Water-Small-Continuous products available, so this class is not currently defined in the models.

† The "-" value for Level 2 indicates that the first efficiency level improvement has a $0 capital cost.

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Table ES.3.11 Median Rebuttable Presumption Payback Periods by Efficiency Level and Equipment Class

Equipment Class	Payback Period Under Rebuttable Presumption*** *years*					
	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7
IMH-W-Small-B	1.59	1.35				
IMH-W- Med -B	0.58					
IMH-W-Large-B	0.18	0.25				
IMH-A-Small-B	0.40	0.64	1.09			
IMH-A-Large-B	0.23	1.14	1.20			
RCU-Small-B	0.28	0.70	0.87			
RCU-Large-B	0.21	0.65	0.75			
SCU-W-Small-B	1.28	1.61	1.83	2.05		
SCU-W-Large-B	0.57	0.54	0.54	0.55	0.62	0.69
SCU-A-Small-B	0.93	1.34	1.46	1.45	1.44	
SCU-A-Large-B	1.13	1.09	1.07	1.12		
IMH-W-Small-C	0.10	0.16	0.20	0.22	0.47	
IMH-W-Large-C	0.32	0.34	0.45	0.94		
IMH-A-Small-C	0.68	0.76	0.80	0.82	1.76	
IMH-A-Large-C	0.36	0.33	0.31	0.30	0.61	0.90
RCU-Small-C	0.24	0.80				
RCU-Large-C	0.15	0.69				
SCU-W-Small-C**						
SCU-W-Large-C	0.55	0.61	0.62	0.59		
SCU-A-Small-C	2.22	1.99	1.84			
SCU-A-Large-C	-[†]	0.77	1.01	1.22	1.40	2.90

IMH: ice-making head; RCU: remote condenser unit; SCU: self-contained unit; A: Air cooled; W: Water cooled; B: Batch; C: Continuous

* Blank cells mean no RPBP value was calculated for this efficiency level because design options were unavailable to constitute an efficiency level.

** Data available to DOE show there are no existing SCU-Water-Small-Continuous products available, so this class is not currently defined in the models.

[†] The "-" value for Level 2 indicates that the first efficiency level improvement has a $0 capital cost.

ES.3.7 Shipments Analysis

DOE carries out the shipments analysis to estimate the equipment stock and annual shipments of automatic commercial ice makers in the years following the compliance date of the standard. These data are then used as inputs into the NIA, to calculate the NES and NPV of future savings, and the MIA, to calculate the industry NPV.

Shipments of automatic commercial ice makers are split into two categories: (1) equipment for new construction; and (2) equipment for replacements. In the first scenario, equipment for new construction is the equipment that is being purchased for newly constructed commercial space during a year. DOE calculated new shipments based on the DOE Energy Information Administration (EIA) *Annual Energy Outlook* (*AEO*) forecast of new construction of floor space in seven building types: (1) health care; (2) lodging; (3) foodservice; (4) retail; (5) education; (6) food sales; and (7) office. Equipment for replacements is the equipment that is purchased to replace existing equipment that either has failed or is replaced for other reasons. In each year of the analysis, DOE calculates the probability of equipment failure and replacement by using a Weibull distribution based survival function, with mean values of 8.5 years for all equipment classes and building types.

DOE uses historical shipment data to estimate the share of each equipment class in the total shipments in a year. Table ES.3.12 shows the percentage of automatic commercial ice makers shipped by equipment class based on 2010 shipment data, which was calculated using data from American Heating and Refrigeration Institute (AHRI) submitted to DOE for use in this rulemaking. Future market share of each equipment class is assumed to remain the same as shown in Table ES.3.12. Forecasted new and replacement shipments are presented in Table ES.3.13 from 2016 to 2045. Table ES.3.14 presents the forecasted shipments for each equipment class from 2016 to 2045.

Table ES.3.12 Percentage of Automatic Commercial Ice Makers Shipped in the Year 2010

Equipment Class	Percentage of Shipments
IMH-W-Small-B	4.54%
IMH-W- Med -B	2.92%
IMH-W-Large-B	0.46%
IMH-A-Small-B	27.08%
IMH-A-Large-B	16.14%
RCU-Small-B	5.43%
RCU-Large-B	6.08%
SCU-W-Small-B	0.68%
SCU-W-Large-B	0.22%
SCU-A-Small-B	13.85%
SCU-A-Large-B	6.56%
IMH-W-Small-C	0.78%
IMH-W-Large-C	0.08%
IMH-A-Small-C	4.45%
IMH-A-Large-C	0.16%
RCU-Small-C	1.22%
RCU-Large-C	0.48%
SCU-W-Small-C	0.00%
SCU-W-Large-C	0.15%
SCU-A-Small-C	4.61%
SCU-A-Large-C	4.14%

IMH: ice-making head; RCU: remote condenser unit;
SCU: self-contained unit; A: Air cooled; W: Water cooled;
B: Batch; C: Continuous

Table ES.3.13 Forecasted Shipments of New and Replacement Automatic Commercial Ice Makers by Building Type, 2016–2045

Building Sector	Units							
	2016	2020	2025	2030	2035	2040	2045	Total
Health Care								
–New	11,800	12,074	12,441	12,753	13,184	14,160	15,120	392,180
–Replacement*	90,163	78,604	100,308	97,093	106,814	112,089	114,283	2,987,182
Lodging								
–New	8,317	8,236	8,767	8,974	9,309	9,928	10,542	274,548
–Replacement*	50,861	44,240	56,999	56,216	61,839	66,529	67,715	1,727,652
Foodservice								
–New	4,937	5,073	5,500	5,716	6,001	6,393	6,791	173,677
–Replacement*	32,366	28,186	36,470	35,571	39,521	42,081	43,265	1,099,160
Retail								
–New	2,859	2,908	3,190	3,386	3,591	3,843	4,104	102,628
–Replacement*	20,807	18,102	23,127	22,506	24,804	26,401	27,007	694,632
Education								
–New	1,610	1,719	1,689	1,801	1,904	1,987	2,078	54,878
–Replacement*	18,495	16,080	19,779	19,120	20,406	21,367	21,317	582,985
Food Sales								
–New	1,417	1,454	1,577	1,637	1,716	1,827	1,939	49,716
–Replacement*	9,247	8,053	10,426	10,168	11,301	12,033	12,372	314,225
Office								
–New	1,424	1,720	1,654	1,662	1,680	1,784	1,879	51,282
–Replacement*	9,247	8,026	10,053	10,451	11,077	12,279	12,235	313,669
Total								
–New	32,365	33,184	34,819	35,928	37,386	39,921	42,453	1,098,909
–Replacement*	231,187	201,292	257,162	251,126	275,762	292,779	298,195	7,719,505
–Total	263,552	234,476	291,981	287,055	313,147	332,700	340,648	8,818,414

* Replacement includes equipment replaced from original stock (installed before standards) and the standards level equipment replaced in subsequent years.

Table ES.3.14 Forecasted Shipments for Automatic Commercial Ice Makers by Equipment Class, 2016–2045

Equipment Class	Units by Year and Equipment Class							
	2016	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**Cumulative**
IMH-W-Small-B	11,966	10,646	13,257	13,033	14,218	15,106	15,467	400,387
IMH-W- Med -B	7,693	6,844	8,522	8,379	9,140	9,711	9,943	257,392
IMH-W-Large-B	1,215	1,081	1,347	1,324	1,444	1,534	1,571	40,669
IMH-A-Small-B	71,357	63,484	79,054	77,720	84,785	90,079	92,230	2,387,589
IMH-A-Large-B	42,530	37,838	47,118	46,323	50,533	53,689	54,971	1,423,049
RCU-Small-B	14,306	12,728	15,849	15,582	16,998	18,060	18,491	478,681
RCU-Large-B	16,016	14,249	17,743	17,444	19,029	20,218	20,701	535,879
SCU-W-Small-B	1,789	1,592	1,982	1,949	2,126	2,258	2,312	59,862
SCU-W-Large-B	570	507	632	621	678	720	737	19,084
SCU-A-Small-B	36,510	32,482	40,448	39,765	43,380	46,089	47,190	1,221,605
SCU-A-Large-B	17,290	15,382	19,155	18,831	20,543	21,826	22,347	578,506
IMH-W-Small-C	2,056	1,829	2,277	2,239	2,442	2,595	2,657	68,779
IMH-W-Large-C	200	178	221	218	237	252	258	6,688
IMH-A-Small-C	11,721	10,428	12,985	12,766	13,926	14,796	15,149	392,177
IMH-A-Large-C	422	376	468	460	502	533	546	14,136
RCU-Small-C	3,204	2,851	3,550	3,490	3,807	4,045	4,142	107,219
RCU-Large-C	1,256	1,118	1,392	1,368	1,492	1,586	1,624	42,029
SCU-W-Small-C*	0	0	0	0	0	0	0	0
SCU-W-Large-C	392	348	434	427	465	494	506	13,103
SCU-A-Small-C	12,151	10,811	13,462	13,235	14,438	15,340	15,706	406,585
SCU-A-Large-C	10,908	9,705	12,085	11,881	12,961	13,770	14,099	364,992
Total	263,552	234,476	291,981	287,055	313,147	332,700	340,648	8,818,414

IMH: ice-making head; RCU: remote condenser unit; SCU: self-contained unit; A: Air cooled; W: Water cooled; B: Batch; C: Continuous

* Data available to DOE show there are no existing SCU-Water-Small-Continuous products available, so this class is not currently defined in the models.

DOE based the forecast on data provided by AHRI and also on data derived from the U.S. Census Bureau's Current Industrial Reports. The Census Bureau data consistently showed higher shipments of automatic commercial ice makers than the AHRI data over a 10-year historical period. DOE seeks industry help in determining the differences between these data sets.

DOE acknowledges that the shipment projections under the standards cases could be lower than those in the base-case projection, because the higher installed costs could cause some customers to forego or delay discretionary equipment purchases. Based on input received during manufacturer interviews, DOE calculated an average impact factor of -0.625. In other words, the interviews indicated a linear shipments-to-price relationship hypothesizing a 6.25-percent reduction in shipments for a 10-percent price increase. This information was compiled after DOE completed the work underlying this preliminary TSD. DOE will consider performing sensitivity analyses during the NOPR stage of the rulemaking to analyze the impact of higher prices on shipments. DOE requests comment on the potential impacts of higher installed costs on future shipments in standards-case scenarios.

ES.3.8 National Impact Analysis

DOE estimates the national impacts of the future energy conservation standards by calculating NES and NPV of future energy savings. Both NES and NPV are estimated by calculating the difference in energy consumption between the standards-case scenario and the base-case scenario that would exist if the current proposed standards were not promulgated. The base-case distribution of efficiencies by efficiency level is shown in Table ES.3.15. For the preliminary analysis, DOE analyzed up to six efficiency levels. As part of the calculation of NPV, DOE also calculated the total national installed cost increases and total national operating cost savings at each efficiency level.

Table ES.3.15 Base-Case Equipment Efficiency Distribution

Equipment Class	Efficiency Level						
	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7
IMH-W-Small-B	50.9%	21.8%	27.3%				
IMH-W- Med -B	73.8%	26.2%					
IMH-W-Large-B	82.1%	0.0%	17.9%				
IMH-A-Small-B	59.3%	16.7%	16.7%	7.4%			
IMH-A-Large-B	68.5%	21.3%	7.9%	2.2%			
RCU-Small-B	57.1%	29.8%	1.2%	11.9%			
RCU-Large-B	55.2%	24.0%	6.3%	14.6%			
SCU-W-Small-B	37.5%	37.5%	18.8%	0.0%	6.3%		
SCU-W-Large-B	40.0%	0.0%	10.0%	20.0%	20.0%	10.0%	0.0%
SCU-A-Small-B	32.3%	48.4%	0.0%	0.0%	9.7%	9.7%	
SCU-A-Large-B	33.3%	44.4%	0.0%	5.6%	16.7%		
IMH-W-Small-C	0.0%	3.2%	6.5%	12.9%	35.5%	41.9%	
IMH-W-Large-C	0.0%	0.0%	6.3%	18.8%	75.0%		
IMH-A-Small-C	3.9%	2.0%	3.9%	5.9%	7.8%	76.5%	
IMH-A-Large-C	0.0%	0.0%	9.1%	9.1%	0.0%	0.0%	81.8%
RCU-Small-C	0.0%	13.6%	86.4%				
RCU-Large-C	0.0%	15.0%	85.0%				
SCU-W-Small-C*	100.0%						
SCU-W-Large-C	0.0%	0.0%	77.3%	0.0%	22.7%		
SCU-A-Small-C	0.0%	0.0%	0.0%	100.0%			
SCU-A-Large-C	0.0%	0.0%	0.0%	5.3%	5.3%	23.7%	65.8%

IMH: ice-making head; RCU: remote condenser unit; SCU: self-contained unit; A: Air cooled; W: Water cooled; B: Batch; C: Continuous

* Data available to DOE show there are no existing SCU-Water-Small-Continuous products available, so this class is not currently defined in the models.

DOE seeks input on the information contained on Table ES.3.15. The distribution is based on available products identified from AHRI, the California Energy Commission (CEC), Natural Resources Canada (NRCan), and manufacturer websites. From the available data, DOE was not able to identify currently manufactured models falling within some energy efficiency levels for some equipment classes. DOE seeks input as to whether this is correct, or whether other sources of data may lead to a more complete picture of the range of equipment that is available.

A key component of DOE's estimates of NES and NPV is the trend in energy efficiency forecasted for the base case and each of the standards cases represented by the efficiency levels. To forecast the base-case efficiency for each equipment class, DOE assumed that the least efficient level analyzed in the engineering analysis currently prevails in the marketplace. To determine the standards-case efficiency distributions, DOE assumed that product efficiencies in the base case that are below the standard level under consideration would "roll up" to meet the new standard level in 2016. The market share of the product efficiencies higher than the standard level under consideration would remain the same as the base case. Chapter 10 of the preliminary TSD has detailed description and results for the NIA.

The inputs for NES and NPV calculations are summarized in Table ES.3.16. The cumulative NES is presented in Table ES.3.17 for each efficiency level in each equipment class for the equipment shipped from 2016 to 2045. Table ES.3.18 and Table ES.3.19 present the cumulative NPV results with discount rates of 7 percent and 3 percent, respectively.

Table ES.3.16 NES and NPV Inputs

Input	Description
Forecasted Shipments	Forecasted annual shipments from shipments analysis.
Potential Compliance Date of Standard	2016
Base-Case Efficiencies	Distribution of base-case shipments by efficiency level.
Annual Energy Consumption per Unit	Unit energy consumption per 100 lb of ice for each efficiency level in each equipment class is obtained from engineering analysis. This is converted into annual weighted-average kilowatt-hour values for each efficiency level.
Annual Water Consumption per Unit	Unit water consumption for condenser water and potable water per 100 lb of ice for each efficiency level in each equipment class is obtained from engineering analysis. This is converted into annual weighted-average water usage for each efficiency level.
Total Installed Cost per Unit	Annual weighted-average values are a function of efficiency level, expressed per unit.
Experiential Learning-based MSP Changes	Annual adjustment to MSP and to total installed cost per unit are applied to reflect estimated price decreases as manufacturers improve production efficiencies over time, thereby decreasing production costs.
Repair Cost per Unit	Annual weighted-average values are constant with efficiency level, expressed per unit.
Maintenance Cost per Unit	Annual weighted-average maintenance cost, expressed per unit.
Escalation of Electricity Prices	2011 EIA *AEO* forecasts (to 2035) and extrapolation for 2036 and beyond.
Water/Wastewater Price Escalation	American Water Works Association (AWWA) data and escalation of water-related price indexes.
Electricity Site-to-Source Conversion	Conversion varies yearly and is generated by DOE's version of the EIA National Energy Modeling System (NEMS) program (a time series conversion factor; includes electric generation, transmission, and distribution losses).
Discount Rate	3 and 7 percent real, in accordance with U.S. Office of Management and Budget guidance.
Present Year	2011. Future costs are discounted to the present year.

Table ES.3.17 Cumulative National Energy Savings for All Efficiency Levels in All Equipment Classes Analyzed for Preliminary Analysis (2016–2045)

Equipment Class	National Energy Savings by Standard Level*** *quadrillion British thermal units (quads)*					
	Level 2	**Level 3**	**Level 4**	**Level 5**	**Level 6**	**Level 7**
IMH-W-Small-B	0.005	0.008				
IMH-W- Med -B	0.010					
IMH-W-Large-B	0.003	0.003				
IMH-A-Small-B	0.043	0.070	0.104			
IMH-A-Large-B	0.062	0.102	0.146			
RCU-Small-B	0.014	0.028	0.032			
RCU-Large-B	0.027	0.052	0.059			
SCU-W-Small-B	0.000	0.001	0.001	0.001		
SCU-W-Large-B	0.000	0.000	0.000	0.001	0.001	0.001
SCU-A-Small-B	0.005	0.020	0.029	0.038	0.044	
SCU-A-Large-B	0.003	0.013	0.019	0.025		
IMH-W-Small-C	0.000	0.000	0.000	0.001	0.003	
IMH-W-Large-C	0.000	0.000	0.000	0.000		
IMH-A-Small-C	0.001	0.001	0.002	0.003	0.005	
IMH-A-Large-C	0.000	0.000	0.000	0.000	0.000	0.000
RCU-Small-C	0.000	0.001				
RCU-Large-C	0.000	0.001				
SCU-W-Small-C†						
SCU-W-Large-C	0.000	0.000	0.000	0.000		
SCU-A-Small-C	0.000	0.000	0.000			
SCU-A-Large-C	0.000	0.000	0.000	0.000	0.001	0.004

IMH: ice-making head; RCU: remote condenser unit; SCU: self-contained unit; A: Air cooled; W: Water cooled; B: Batch; C: Continuous

* A blank value indicates the associated efficiency level was not specified or analyzed.

** 0.000 indicates savings round to less than 0.001 quads.

† Data available to DOE show there are no existing SCU-Water-Small-Continuous products available, so this class is not currently defined in the models.

Table ES.3.18 Cumulative NPV Results Based on a 7-Percent Discount Rate

Equipment Class	Cumulative NPV at 7%*** *billion 2010$*					
	Level 2	**Level 3**	**Level 4**	**Level 5**	**Level 6**	**Level 7**
IMH-W-Small-B	0.009	0.015				
IMH-W- Med -B	0.022					
IMH-W-Large-B	0.006	0.007				
IMH-A-Small-B	0.097	0.151	0.200			
IMH-A-Large-B	0.143	0.194	0.277			
RCU-Small-B	0.032	0.059	0.064			
RCU-Large-B	0.062	0.111	0.123			
SCU-W-Small-B	0.000	0.001	0.002	0.002		
SCU-W-Large-B	0.000	0.001	0.001	0.002	0.002	0.003
SCU-A-Small-B	0.011	0.036	0.052	0.069	0.081	
SCU-A-Large-B	0.007	0.025	0.037	0.049		
IMH-W-Small-C	0.000	0.000	0.001	0.002	0.005	
IMH-W-Large-C	0.000	0.000	0.000	0.000		
IMH-A-Small-C	0.001	0.002	0.004	0.006	0.006	
IMH-A-Large-C	0.000	0.000	0.000	0.000	0.001	0.001
RCU-Small-C	0.000	0.002				
RCU-Large-C	0.000	0.001				
SCU-W-Small-C†						
SCU-W-Large-C	0.000	0.000	0.000	0.000		
SCU-A-Small-C	0.000	0.000	0.000			
SCU-A-Large-C	0.000	0.000	0.000	0.001	0.002	(0.003)

IMH: ice-making head; RCU: remote condenser unit; SCU: self-contained unit; A: Air cooled; W: Water cooled; B: Batch; C: Continuous

* A blank value indicates the associated efficiency level was not specified or analyzed.

** 0.000 indicates NPV rounds to less than $0.001 billion.

† Data available to DOE show there are no existing SCU-Water-Small-Continuous products available, so this class is not currently defined in the models.

Table ES.3.19 Cumulative NPV Results Based on a 3-Percent Discount Rate

Equipment Class	Cumulative NPV at 3%*** *billion 2010$*					
	Level 2	**Level 3**	**Level 4**	**Level 5**	**Level 6**	**Level 7**
IMH-W-Small-B	0.019	0.032				
IMH-W- Med -B	0.046					
IMH-W-Large-B	0.013	0.014				
IMH-A-Small-B	0.205	0.322	0.431			
IMH-A-Large-B	0.302	0.420	0.598			
RCU-Small-B	0.068	0.126	0.138			
RCU-Large-B	0.132	0.237	0.263			
SCU-W-Small-B	0.001	0.003	0.004	0.005		
SCU-W-Large-B	0.001	0.002	0.002	0.003	0.004	0.007
SCU-A-Small-B	0.023	0.079	0.113	0.150	0.175	
SCU-A-Large-B	0.015	0.055	0.080	0.105		
IMH-W-Small-C	0.000	0.000	0.001	0.004	0.011	
IMH-W-Large-C	0.000	0.000	0.000	0.000		
IMH-A-Small-C	0.003	0.004	0.008	0.013	0.013	
IMH-A-Large-C	0.000	0.000	0.000	0.001	0.001	0.001
RCU-Small-C	0.000	0.003				
RCU-Large-C	0.000	0.003				
SCU-W-Small-C†						
SCU-W-Large-C	0.000	0.000	0.001	0.001		
SCU-A-Small-C	0.000	0.000	0.000			
SCU-A-Large-C	0.000	0.000	0.000	0.001	0.004	(0.003)

IMH: ice-making head; RCU: remote condenser unit; SCU: self-contained unit; A: Air cooled; W: Water cooled; B: Batch; C: Continuous
* A blank value indicates the associated efficiency level was not specified or analyzed.
** 0.000 indicates NPV rounds to less than $0.001 billion.
† Data available to DOE show there are no existing SCU-Water-Small-Continuous products available, so this class is not currently defined in the models.

ES.3.9 Preliminary Manufacturer Impact Analysis

The purpose of the preliminary MIA is to identify and quantify the likely impact of energy conservation standards on automatic commercial ice maker manufacturers. DOE examined both quantitative and qualitative impacts that may lead to changes in manufacturing practices for automatic commercial ice makers. DOE conducted the preliminary MIA by first identifying equipment, methods, and practices used in the automatic commercial ice maker industry. Next, DOE determined how energy efficiency improvements affect cost, production, and various other manufacturing metrics. Finally, DOE interviewed manufacturers for feedback on these issues.

Through these interviews, DOE identified several key issues relevant to the MIA for automatic commercial ice makers. One issue raised by manufacturers is that it is unclear whether more stringent standards will be cost effective or will result in significant benefits. Other key issues include:

- establishing separate equipment classes for batch and continuous ice makers;
- variation in ice hardness of different continuous ice makers;
- alternatives to ice makers, such as purchasing bagged ice;

- conversion costs;
- testing burden;
- customer impact; and
- potential threat to U.S. jobs.

In addition to identifying these key issues, DOE also examined any additional effects on competition, manufacturing capacity, direct employment, and the cumulative burden of other regulations affecting manufacturers. DOE adjusted the analysis, as appropriate, based on the feedback received during these interviews. Chapter 12 of the preliminary TSD provides additional details on this and other aspects of the preliminary MIA.

ES.4 ISSUES ON WHICH DOE SEEKS PUBLIC COMMENT

DOE is particularly interested in receiving comments and views of interested parties concerning the following issues.

ES.4.1 Ice Maker Size

Ice maker efficiency could be improved in some cases by increasing the size of heat exchangers (condensers and/or evaporators). Other design options also may require more space within a given ice maker, including some compressor replacements and consideration of drain water heat exchangers. DOE did not consider design options that increase package size in the preliminary analysis, because of the limited space available in many applications for larger products, and because of the importance of the replacement market, for which space restrictions may be dictated by the size of the replaced equipment. This restriction did not extend to remote condensing units, for which end users are expected to have greater flexibility for fitting larger designs. DOE requests comment on whether ice maker package size increase should be considered in this rulemaking. If so, DOE requests comment on how to select reasonable maximum sizes for ice makers in the analysis.

ES.4.2 Potable Water Use Minimum for Batch Ice Makers

Batch ice maker efficiency is affected by potable water use. However, interested parties have pointed out that very low potable water use increases scaling of wet surfaces in the ice maker, leading to increased maintenance costs and potentially higher energy use in the field. To help DOE determine whether practical energy conservation opportunities associated with potable water use reduction exist, DOE requests input on what levels of potable water use can be considered reasonable minimums for consideration in the analysis, whether the minimums depend on equipment class, and, if so, what this relationship is.

ES.4.3 Equipment Classes

DOE seeks comment regarding the suggested equipment classes as outlined in this executive summary as well as in chapter 3 of the preliminary TSD.

ES.4.4 Efficiency Levels

DOE requests comment on the suggested efficiency levels to be used in the analysis for all of the equipment classes. DOE requests comment on the baseline efficiency levels for continuous ice machines. DOE also requests comment on using the EPACT 2005 standards for cube type equipment as the baseline for all batch equipment. In addition, DOE requests comment on the interim efficiency levels and maximum technology levels for all analyzed equipment classes.

ES.4.5 Remote Condensing Unit Equipment Classes

The current DOE standards for remote condensing unit (RCU) cube ice makers include different energy use levels for equipment with remote compressors and equipment without remote compressors. DOE's initial, brief analysis of the energy use impact of the remote compressor suggests that the 0.2 kWh/day differential for large-capacity remote compressor ice makers is appropriate (see the discussion on this topic in chapter 5 of the preliminary TSD). DOE requests comment on this analysis and on DOE's intent to maintain separate equipment classes for large-capacity RCU equipment (either batch or continuous) using this same differential. DOE requests data and information showing that this, or an alternative energy use differential, is appropriate.

ES.4.6 Large Batch Ice Maker Efficiency Levels

DOE requests comment on the following approaches for development of energy standards for large-capacity batch ice makers in the harvest capacity range from 2,500 to 4,000 lb/24 hours.

- For batch ice makers for which the current standard in the highest harvest capacity range is a flat standard that is not dependent on harvest capacity, extend the harvest capacity range up to 4,000 lb/24 hours. DOE is considering setting a standard for the extended range that is equal to the future standard selected for equipment in the current highest-capacity equipment class. This applies to batch ice makers of types IMH-W, RCU, and SCU.

- For batch ice makers of type IMH-A, DOE is considering setting standards based on the modified interim efficiency level description for this harvest capacity range discussed in chapter 5 of the preliminary TSD. Briefly, such a standard would be as follows:

  1. Starting at 1,600 lb/24 hours harvest capacity, the standard would level out so that it is not dependent on harvest capacity.

  2. If, for harvest capacity between 1,600 lb/24 hours and 2,500 lb/24 hours, the current standard is more stringent than a standard described by number 1, the current standard must take precedence to avoid backsliding.

3. If the situation described in number 2 occurs, DOE would consider selecting a standard for equipment with harvest capacity greater than 2,500 lb/24 hours equal to the current standard for equipment with harvest capacity equal to 2,500 lb/24 hours.

ES.4.7 Manufacturer Markups

DOE requests comment on whether the proposed markup factor of 1.25 to mark up between MPC and MSP is appropriate, too high, or too low.

ES.4.8 Proprietary Evaporator Designs

DOE requests information regarding the proprietary status of low-thermal-mass evaporator designs, such as the designs found in Hoshizaki batch ice makers. Specifically, DOE seeks input on which relevant patents are still active, and what other forms of intellectual property ownership might be associated with such designs. DOE also seeks input on whether proprietary status is the key reason that other manufacturers would not be able to adopt such designs.

ES.4.9 Balance of Condenser Water Use and Energy Use in the Analyses

DOE requests comment on its suggested approach to include consideration of condenser water use increase as a design option in the analysis (see chapter 2 of the preliminary TSD). This approach uses estimates of LCC in the engineering analysis to evaluate the cost effectiveness of design options that affect both energy and water use. DOE also requests comment on its intent to use such an approach to develop condenser water use standards for continuous ice machines.

ES.4.10 Manufacturer Impact

As part of the NOPR, DOE will seek further comments from manufacturers about their potential loss of market share, changes in the efficiency distribution of covered equipment within each industry, and the total change in equipment shipments at each energy conservation standard level. DOE will then estimate the impacts on the industry quantitatively and qualitatively. DOE seeks further comment about the impact of standards on domestic manufacturers. See chapter 12 of the preliminary TSD for more details.

ES.4.11 Markups to Determine Price

DOE identified three major distribution channels through which commercial ice-making equipment is purchased by the end user: (1) manufacturer to end user (direct channel); (2) manufacturer to wholesale distributor to end user (wholesaler channel); and (3) manufacturer to distributor to dealer or contractor to end user (contractor channel). DOE requests interested parties' comments on the share values for these three distribution channels. DOE also requests additional data or data sources to use to characterize the costs of the local contractor or dealer segment of the contractor channel.

ES.4.12 Experiential Learning

DOE developed five different scenarios representing how MSP changes over time: one scenario holds prices constant, one scenario is consistent with a commercial sector price index used in the National Energy Modeling System, and the other three scenarios were developed from historical data on automatic commercial ice maker shipments and producer prices. DOE seeks comment about the use of experiential learning to adjust MSP for expected future price changes.

ES.4.13 Energy Usage in Life-Cycle Cost and Payback Period Analyses

DOE seeks information on utilization factors or potential data sources that can be used to improve upon the current assumption of 50-percent utilization factors.

ES.4.14 Condenser Water Usage in Life-Cycle Cost and Payback Period Analyses

DOE requests comment on the modeling of condenser water usage assuming all ice makers are installed in a single-pass configuration.

ES.4.15 Equipment Lifetimes

Based on the data from available sources, DOE proposes to use an equipment lifetime value of 8.5 years for all equipment classes in all building types. DOE used Weibull survival functions to represent the equipment lifetime values in the LCC and PBP analysis and shipments analysis. DOE welcomes input from interested parties on these assumptions.

ES.4.16 Installation, Maintenance, and Repair Costs

DOE assumes that higher efficiency equipment would not incur any additional installation costs when compared to the baseline equipment. DOE requests interested parties' comments about this assumption and specific information, if appropriate, for DOE to consider in this approach.

With respect to maintenance cost, DOE assumes that manufacturers prescribe routine annual or bi-annual preventative maintenance procedures for commercial ice-making equipment. DOE requests input from interested parties on maintenance costs, and the relationship between maintenance costs and the type and size of equipment.

DOE is currently modeling the repair cost for equipment as a simple percentage of the baseline selling price of the equipment. DOE requests comment on this approach and specific information, if appropriate, for DOE to reconsider this approach.

The technology options under consideration for the rulemaking are presented in chapter 5 of the preliminary TSD. DOE requests input from interested parties concerning the effect that these technology options have on the installation, maintenance, and repair costs.

ES.4.17 Shipments of Ice Makers

DOE seeks industry support in determining the differences between the historical shipment data provided by AHRI and data derived from the U.S. Census Bureau's Current Industrial Reports. The Census Bureau data consistently showed higher shipments of automatic commercial ice makers than the AHRI data over a 10-year historical period.

ES.4.18 Base-Case Equipment Efficiency Distribution

DOE seeks industry support in determining whether the base-case equipment efficiency distribution correctly captures all equipment currently available for purchase by customers of ice-making equipment. DOE also seeks input about the impact of higher equipment purchase prices on shipments in standards cases.

ES.4.19 General Analytical Assumptions

During each stage of the preliminary analysis, DOE made assumptions related to key parameters of the analytical process on the premises that the assumed parameters reflect the actual conditions that automatic commercial ice maker experiences. These assumptions are described in the respective TSD chapters. DOE welcomes comments on these assumptions.

REFERENCES

1. U.S. Department of Energy–Office of Energy Efficiency and Renewable Energy. Preliminary Technical Support Document (TSD): Energy Conservation Program for Certain Commercial and Industrial Equipment: Commercial Refrigeration Equipment, Chapter 2: Analytical Framework, Comments from Interested Parties, and DOE Responses. March 2011. Washington, D.C. <http://www1.eere.energy.gov/buildings/appliance_standards/commercial/pdfs/cre_pa_tsd_ch2_analytical_framework.pdf>

2. Navigant Consulting, Inc. *Energy Savings Potential and R&D Opportunities for Commercial Refrigeration, Final Report*. 2009. Prepared for the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy, Washington, D.C. <http://apps1.eere.energy.gov/buildings/publications/pdfs/corporate/commercial_refrig_report_10-09.pdf>