Rulemaking Framework for Automatic Commercial Ice-Makers

United States Department of Energy
Office of Energy Efficiency and Renewable Energy
Building Technologies Program

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LIST OF ACRONYMS

AEO	*Annual Energy Outlook*
AHRI	Air-Conditioning, Heating and Refrigeration Institute
ARI	Air-Conditioning and Refrigeration Institute (now AHRI)
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
AWWA	American Water Works Association
BT	Building Technologies Program
CAIR	Clean Air Interstate Rule
CAMR	Clean Air Mercury Rule
CEE	Consortium for Energy Efficiency
CO_2	carbon dioxide
CSL	candidate standard level
DC	(Washington) District of Columbia
DOE	U.S. Department of Energy
DOJ	U.S. Department of Justice
ECM	electronically commutated motor
EERE	Office of Energy Efficiency and Renewable Energy
EGU	electricity generating unit
EIA	Energy Information Administration
EISA 2007	Energy Independence and Security Act of 2007
E.O.	Executive Order
EPA	U.S. Environmental Protection Agency
EPACT 2005	Energy Policy Act of 2005
EPCA	Energy Policy and Conservation Act
°F	degrees Fahrenheit
FR	*Federal Register*
gal	gallon(s)
GDP	gross domestic product
GHG	greenhouse gas
GRIM	Government Regulatory Impact Model
HCFC	hydrochlorofluorocarbon
Hg	mercury
ImSET	Impact of Sector Energy Technologies
IMH	ice-making head
kWh	kilowatt-hour
lb	pound(s)
LCC	life-cycle cost
MIA	manufacturer impact analysis
MPC	manufacturer production cost
NEMS	National Energy Modeling System
NES	national energy savings
NIA	national impact analysis
NOPR	notice of proposed rulemaking
NO_X	nitrogen oxides
NPV	net present value

NWS	National Water Savings
OMB	Office of Management and Budget
PBP	payback period
PM	particulate matter
PSC	permanent split capacitor
Pub. L.	Public Law
psig	pounds per square inch gauge
R&D	research and development
RIA	regulatory impact analysis
SCC	social cost of carbon
SG&A	selling, general, and administrative
SO_2	sulfur dioxide
TSD	technical support document
TSL	trial standard level
U.S.	United States
U.S.C.	U.S. Code
yr	year(s)
WACC	weighted-average cost of capital

1.0 INTRODUCTION

The U.S. Department of Energy (DOE) Appliances and Commercial Equipment Standards Program within the Office of Energy Efficiency and Renewable Energy's (EERE) Building Technologies Program (BT) develops and promulgates test procedures and energy conservation standards for certain consumer appliances and commercial equipment. The process for developing standards involves analysis, public notice and comment, and consultation with interested parties. "Interested parties" include manufacturers, consumers, energy conservation and environmental advocates, State and Federal agencies, and any other groups or individuals with an interest in these standards and test procedures.

The purpose of this document is to describe the procedural and analytical approaches DOE anticipates using to determine whether the energy conservation standards for automatic commercial ice-making equipment should be amended and, if so, to evaluate potential amended standards. (See section 1.1 for a discussion of the statutory authority for this rulemaking.). This document is intended to inform interested parties of the process DOE will follow for this rulemaking for automatic commercial ice-making equipment and to encourage and facilitate the input of interested parties. This document is the starting point for determining whether standards should be amended and, if so, for developing such standards. This document is not a definitive statement on any issue for which a determination may be made in the rulemaking.

Section 1.0 of this report provides an overview of DOE's rulemaking process. Sections 2.0 through 17.0 discuss analyses DOE intends to conduct to fulfill the statutory requirements and guidance for this energy conservation standards rulemaking. As part of this rulemaking, DOE is required to determine whether to amend existing energy conservations standards for this equipment. DOE believes that these analyses will support its determination of whether to amend the standards and, if the determination is positive, to establish any amended standards. DOE will maintain information about this rulemaking on its website at: http://www1.eere.energy.gov/buildings/appliance_standards/commercial/automatic_ice_making_equipment.html.

Item 1-1	*While DOE invites comment on all aspects of the material presented in this document, several specific issues on which DOE seeks comment are set out in comment boxes like this one. DOE uses these comment boxes to highlight issues and ask specific questions on the approaches DOE plans to follow to conduct the analyses required for the energy conservation standards rulemaking. Such requests for feedback are numbered sequentially throughout the document and are repeated in Appendix A.*

1.1 The Appliances and Commercial Equipment Standards Program

Title III, Part C of the Energy Policy and Conservation Act of 1975 (EPCA), Pub. L. 94-163 (42 U.S.C. 6311–6317, as codified), added by Pub. L. 95-619, Title IV, § 441(a), established the Energy Conservation Program for Certain Industrial Equipment, a program covering certain industrial equipment, which includes the automatic commercial ice-making equipment that is the focus of this notice.[1]

Section 136(d) of the Energy Policy Act of 2005 (EPACT 2005), Pub. L. 109-58, amended section 342 of EPCA to add paragraph (d), which set energy conservation standards for automatic commercial ice-makers that produce between 50 and 2,500 pounds (lb) of cube-type ice per 24-hour period. Automatic commercial ice-makers manufactured on or after January 1, 2010 are required to meet specific maximum allowable energy use levels and maximum allowable condenser water use levels, depending on equipment type, cooling type (water or air), and harvest rate (pounds of ice per 24-hour period).

The EPACT 2005 amendments (42 U.S.C. 6313(d)(2)) also authorize DOE to issue standards for types of automatic commercial ice makers that are not covered by 42 U.S.C. 6313(d)(1). In addition, not later than January 1, 2015, with respect to the standards at 42 U.S.C 6313(d)(1), and not later than 5 years after the effective date of any standards issued by DOE under 42 U.S.C. 6313(d)(2), DOE is to issue a final rule to determine whether amending the applicable standards is technologically feasible and economically justified. (42 U.S.C. 6313(d)(3)(A)) Any final rule issued by the Secretary establishing a new or amended standard shall provide that the new or amended standard applies to products manufactured on or after the date that is 3 years after the standard is published, unless the Secretary determines by rule that 3 years is inadequate, in which case the standard shall apply to products manufactured on or after a date no later than 5 years after the date on which the final rule is published. Any new or amended standard issued by the Secretary under 42 U.S.C. 6313(d) shall be set at the maximum level that is technically feasible and economically justified. This framework document is being published as a first step toward meeting these statutory requirements.

1.2 Definitions

Section 136(a)(4) of EPACT 2005 defines "automatic commercial ice maker" as:

[A] factory-made assembly (not necessarily shipped in one package) that –

(A) consists of a condensing unit and ice-making section operating as an integrated unit, with means for making and harvesting ice; and
(B) may include means for storing ice, dispensing ice, or storing and dispensing ice.

(42 U.S.C. 6311(19))

1.3 Current Energy Conservation Standards

Table 1.1 shows the current standard for automatic commercial ice-making equipment. This standard covers energy use and maximum condenser water use of cube ice machines. It does not apply to flake, nugget, or block ice machines.

[1] For editorial reasons, upon codification in the U.S. Code, Part C was re-designated Part A-1.

Table 1.1. Automatic Commercial Ice-Maker Standards Prescribed by EPACT 2005 Section 136(d), Effective January 1, 2010

Equipment Type	Type of Cooling	Harvest Rate *lb ice/24 hours*	Maximum Energy Use *kWh/100 lb ice*	Maximum Condenser Water Use[a] *gal/100 lb ice*
Ice-Making Head	Water	<500	7.80 - 0.0055H[b]	200 - 0.022H
		≥500 and <1,436	5.58 - 0.0011H	200 - 0.022H
		≥1,436	4.0	200 - 0.022H
	Air	<450	10.26 - 0.0086H	Not Applicable
		≥450	6.89 - 0.0011H	Not Applicable
Remote Condensing (but not remote compressor)	Air	<1,000	8.85 - 0.0038H	Not Applicable
		≥1,000	5.10	Not Applicable
Remote Condensing and Remote Compressor	Air	<934	8.85 - 0.0038H	Not Applicable
		≥934	5.3	Not Applicable
Self-Contained	Water	<200	11.40 - 0.019H	191 - 0.0315H
		≥200	7.60	191 - 0.0315H
	Air	<175	18.0 - 0.069H	Not Applicable
		≥175	9.80	Not Applicable

[a] Water use is for the condenser only and does not include potable water used to make ice.
[b] H = harvest rate in pounds per 24 hours, indicating the water or energy use for a given harvest rate.
Source: 42 U.S.C. 6313(d).

1.4 Overview of the Rulemaking Process

Under EPCA, any new or amended standards must achieve the maximum level of energy efficiency that is technologically feasible and economically justified. In setting any new or amended standards, DOE must consider: (1) the economic impact of the standard on the manufacturers and consumers of the affected products; (2) the savings in operating costs throughout the estimated average life of the product compared to any increases in the initial cost or maintenance expense; (3) the total projected amount of energy savings likely to result directly from the imposition of the standard; (4) any lessening of the utility or the performance of the 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 conservation; and (7) other factors the Secretary considers relevant. (42 U.S.C. 6295(o)(2)(B)(i) and 42 U.S.C. 6313(d)) As discussed in further detail below, the standards rulemaking process typically involves four public notices that are published in the *Federal Register*, including a notice announcing the availability of the framework document. Publication of the framework document, preliminary analysis, and notice of proposed rulemaking (NOPR) are typically accompanied by public meetings to solicit comment from interested parties to enhance the rulemaking process. DOE encourages interested parties to develop and submit joint recommendations and will carefully consider such recommendations in its decision making. Preliminary analysis results could serve as the initial basis for the development of these recommendations. As stated previously, DOE believes the conduct of the analyses accompanying these notices will support DOE's determination of whether to amend the standards and, if the determination is positive, to establish any amended standards.

- *Preliminary Analysis* (section 1.4.1). The preliminary analysis is designed to publicly vet the models and tools that DOE intends to use in the rulemaking and to facilitate public participation before the proposed rule stage. Using these models and tools, DOE performs preliminary analyses to assess candidate standard levels (CSLs), which span the range of efficiencies from baseline equipment to the most efficient technology.

- *Notice of Proposed Rulemaking* (section 1.4.2). The NOPR presents a discussion of comments received in response to the preliminary analysis, DOE's analysis of the impacts of potential standards on consumers, manufacturers, and the Nation, DOE's weighting of these impacts, and any proposed standard levels for public comment.

- *Final Rule* (section 1.4.3). The final rule presents a discussion of comments received in response to the NOPR, revised analysis, as appropriate, of the impacts of any standards, DOE's weighting of those impacts, and the standard levels, if any, that DOE is adopting. The final rule also establishes the date by which manufacturers must comply with any standards.

1.4.1 Preliminary Analysis

As part of its energy conservation standards rulemaking activity, DOE typically identifies equipment technology options and makes a preliminary determination on whether to retain each option for detailed analysis or to eliminate it from further consideration. This process includes a market and technology assessment (section 3.0) and a screening analysis (section 4.0). DOE applies four screening criteria in the screening analysis to determine which technology options to eliminate from further consideration: (1) technological feasibility; (2) practicability to manufacture, install, and service; (3) adverse impacts on equipment utility or availability; and (4) adverse impacts on health or safety. Technologies that pass through the screening analysis are evaluated, and referred to as technology or design options, in the engineering analysis.

DOE consults with interested parties and independent technical experts and researches industry literature to identify the key issues and design options or efficiency levels that DOE will consider in the rulemaking. DOE initiates dialogue with interested parties with this framework document, the public meeting following its publication, and the request for public comment. This dialogue provides an opportunity for input into the structural and analytical approach planned for the subsequent energy conservation standards rulemaking.

At the start of the preliminary analysis, DOE considers design options or efficiency levels for each equipment class. DOE uses these design options or efficiency levels to collect manufacturer cost data, historical shipment data, shipment-weighted average efficiency data, and preliminary manufacturer impact data (*e.g.*, capital conversion expenditures, marketing costs, and research and development (R&D) costs). Concurrent with the preliminary analysis, DOE also conducts other principal analyses, including:

1. Engineering analysis (section 5.0);

2. Consumer life-cycle cost (LCC) and payback period (PBP) analyses (section 8.0);

3. National impact analysis (NIA), which considers national energy savings (NES) and consumer net present value (NPV) (section 10.0); and

4. Preliminary manufacturer impact analysis (MIA) (section 12.0). DOE will present the results of these analyses in the preliminary analysis technical support document (TSD).

DOE selects CSLs from the energy efficiency or energy use levels considered in the preliminary analysis. Discussion of various CSLs in the preliminary analysis will help interested parties review the spreadsheet models that underpin the analyses. DOE will use comments from interested parties to refine the models for the next stage of the rulemaking analyses. In addition to the efficiency corresponding to the maximum technologically feasible ("max-tech") design and the efficiency corresponding to the minimum LCC point, DOE generally considers efficiency levels or design options that span the full range of technologically achievable efficiencies. The range of efficiency levels DOE typically analyzes includes the following:

- The baseline efficiency level typically represents equipment with the lowest energy efficiency on the market. For equipment where minimum energy conservation standards already exist, the baseline efficiency level is typically defined by the existing energy conservation standard.

- The level with the minimum LCC or greatest LCC savings.

- The highest energy efficiency level or lowest energy consumption level that is technologically feasible (*i.e.*, max-tech).

- Levels that incorporate noteworthy technologies or fill large gaps between other efficiency levels being considered.

At the preliminary analysis stage, DOE uses analytical models and tools to assess the different equipment classes at each efficiency or energy use level analyzed. Many of these analytical models and tools are in the form of spreadsheets, which are used to conduct the LCC and PBP analyses and to determine the NES and NPV of prospective standards.

DOE will make the spreadsheet tools and results of the preliminary analysis available on its website for review.[2] When it publishes the preliminary analysis, DOE will also make a preliminary TSD available, which contains the details of all the analyses performed to date. After publication of the preliminary analysis, DOE will provide a public comment period and hold one public meeting.

1.4.2 Notice of Proposed Rulemaking

In developing the NOPR, DOE will consider all the comments it receives on the preliminary analysis, within the stated comment period. This process may result in revisions to

[2] All materials associated with the rulemakings for automatic commercial ice-making equipment test procedures and energy conservation standards are available on DOE's website at: http://www1.eere.energy.gov/buildings/appliance_standards/commercial/automatic_ice_making_equipment.html

the preliminary analysis, including the engineering and LCC analyses. At this point, DOE will conduct additional economic and environmental impact analyses. These analyses generally include:

1. Consumer LCC subgroup analysis (section 11.0);
2. Complete MIA (section 12.0);
3. Utility impact analysis (section 13.0);
4. Employment impact analysis (section 14.0);
5. Environmental assessment (section 15.0); and
6. Regulatory impact analysis (RIA) (section 17.0).

DOE will describe the methodology used and make the results of all the analyses available on its website for review. Based on comments from interested parties, further revisions to the analysis may be made. This analytical process ends with the selection of proposed standard levels, if any, that DOE will present in the NOPR. DOE selects the proposed standard levels from the trial standard levels (TSLs) analyzed during the NOPR phase of the rulemaking. The NOPR, published in the *Federal Register*, will document the evaluation and selection of any proposed standards levels, along with a discussion of other TSLs considered but not selected and the reasons DOE did not select them.

For each equipment class, DOE will identify the max-tech efficiency level. If DOE proposes a lower level, DOE will explain the reasons for eliminating higher levels, beginning with the highest level considered. DOE will present the analytical results in the NOPR and provide the details of the analysis in an accompanying TSD.

DOE considers many factors in selecting proposed standards. These factors are contained in EPCA and take into consideration the benefits, costs, and impacts of energy conservation standards.

When DOE publishes the NOPR, it will provide the U.S. Department of Justice (DOJ) with copies of the NOPR and TSD to solicit feedback on the impact of any proposed standard levels on competition in the automatic commercial ice-maker industry. DOJ reviews standard levels in light of any lessening of competition likely to result from the imposition of such standards. (42 U.S.C. 6295(o)(2)(B)(i)(V) and (B)(ii)) Publication of the NOPR will be followed by a public comment period that includes a public meeting.

1.4.3 Final Rule

After publication of the NOPR, DOE will consider public comments it receives on the proposal and accompanying analyses. DOE will review the engineering and economic impact analyses and any proposed standards based on these comments and consider modifications where necessary. Before any final rule is issued, DOE also will consider DOJ comments on the NOPR relating to the impacts of any proposed standard levels on competition to determine whether changes to these standard levels are needed. DOE will publish the DOJ comments and DOE's response as part of the final rule.

In any final rule, DOE would determine whether to amend the standards, and if such determination is positive, would select the final standard level based on the complete record of the standards rulemaking. The final rule would set any final standard levels and the compliance date, and would also explain the basis for the selection of any final standard levels. The final rule would be accompanied by a final TSD.

1.5 Test Procedures

On December 8, 2006, DOE published a final rule (the 2006 test procedure final rule) that adopted the test procedure specified in Air-Conditioning and Refrigeration Institute (ARI) Standard 810-2003, as in effect on January 1, 2005, with a revised method for calculating the energy consumption rate. 71 FR 71340, 71350. DOE used a revised calculation to specify that the energy consumption rate be normalized to 100 lb of ice produced. ARI Standard 810-2003 references the test procedure outlined in the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 29 as the testing method.

Section 342(a)(7)(B) of EPCA states that if the ARI Standard 810-2003 is amended, the Secretary shall amend the test procedures as necessary to be consistent with the amended ARI standards. (42 U.S.C 6314(a)(7)(B))

Since the publication of the 2006 final rule, ARI has updated their Standard 810 to reflect changes in the industry. A new version, Air-Conditioning, Heating and Refrigeration Institute (AHRI) Standard 810-2007, has been published, but DOE's test procedure has not been amended.

The new AHRI Standard 810-2007 amends the previous testing procedure, ARI Standard 810-2003, in several ways. The new test procedure:

1. Expands the capacity range of covered equipment to between 50 pounds of ice per 24 hours and up to 4,000 pounds of ice per 24 hours at standard rating conditions;

2. Provides definitions and specific test procedures for cube type and continuous type ice-makers; and

3. Adds several other definitions related to quality of ice that do not pertain to values used to show compliance with the DOE energy conservation standard.

The changes in AHRI Standard 810-2007 reflect the new test procedure in ASHRAE Standard 29 that also differentiates between cube-type and continuous-type ice-makers. The previous version of ASHRAE Standard 29 did not include test procedures for continuous-type ice-makers. As such, DOE intends to modify its test procedure to reference the updated AHRI Standard 810-2007 and expand the test procedure to apply to all automatic commercial ice-makers regardless of ice type with capacities up to 4,000 lb per day.

DOE is also considering adding to the test procedure a method to calculate the total water use of automatic commercial ice-makers; it would be defined as the sum of the condenser water use and the water used to make ice. This value would use a metric of gallons per 100 lb of ice. DOE will conduct a separate rulemaking process for any modifications to the test procedure.

Item 1-2	*DOE requests comment regarding the development of updated test procedures for the automatic commercial ice-making equipment covered under this rulemaking.*
Item 1-3	*DOE requests comment on the possibility of applying the AHRI 810-2007 test procedure to larger capacity equipment and tube type ice-makers. If the AHRI 810-2007 test procedure cannot be applied to larger capacity and tube type ice-makers, what test procedure should be applied?*

1.6 Overview of Automatic Commercial Ice-Making Equipment

The automatic commercial ice-making equipment covered under this rulemaking can be primarily categorized by output (type of ice produced). The primary categories are as follows:

- Cube ice machines, including water- or air-cooled, and either self-contained or with remote condensing units;
- Flake and nugget ice machines, including water- or air-cooled, and either self-contained or with remote condensing units; and
- Block ice machines, including water- or air-cooled, and self-contained or with remote condensing units.

Other distinguishing features include process (continuous or batch method), cooling (air or water), or equipment configurations (self-contained or with a remote condensing unit). The current EPACT 2005 standard includes only cube ice machines, including water- and air-cooled, and both self-contained and those with remote condensing units. The categories and their distinguishing features are described in sections 1.6.1 through 1.6.6, and are based on *A report on Potential Best Management Practices*, prepared by Koeller and Company (Koeller 2008[3]).

Section 3.2 provides more detail on product classes, as identified in the EPACT 2005 standard and in the present rulemaking process.

1.6.1 Cube Ice Machines

Cube ice is a hard, clear ice that is well suited to beverages. Cube ice is made by recirculating water over a freeze plate that is directly cooled by the evaporation of the refrigerant. The recirculating water pumped over the surface flushes away minerals that precipitate as ice

[3] Koeller J., and H. Hoffman, *A report on Potential Best Management Practices*. 2008. Prepared by Koeller and Company for the California Urban Water Conservation Council, Sacramento, CA.

freezes. At the end of the cycle, the ice is released by warming the plate and the water in the recirculation trough is purged to dispose of the minerals removed from the ice in the freezing process. The process is controlled by an electronic control panel.

1.6.2 Flake and Nugget Ice Machines

Flake ice finds wide use where a clear, hard cube is not needed. The product is a flake of "soft" ice. Nugget ice is made in the same way as flake, except that the flake ice is recombined into chunks or nuggets of ice. For most commercial use, the ice-making head (IMH) contains cylinders wrapped by cooling (evaporator) coils. Water is fed to the inside of the tube and ice forms on the inside surface. An auger continuously scrapes the sides of the tube to remove the ice as it forms. For very large flake ice machines, a cylinder and scraper blade system is used in place of the auger. Because there is no recirculation and purge system like that of the cube machines, water is not discharged to the drain in the ice-making process. Nugget ice machines form ice in the same manner as flake machines, but the ice is formed into a unique shape by extruding the flakes through a tube or dye. The ice forms a number of chunks or nuggets that, among other things, can be conveyed through a tube to an ice bin or soft drink machine located several feet away.

1.6.3 Block Ice Machines

Block ice is commonly used for refrigeration and sculptures. Like cube ice, block ice is made with a manual batch process. The block ice machine is cooled by air, water, or a combination of propylene glycol and water. Block ice-makers typically produce blocks weighing anywhere between 8 and 275 lb.

1.6.4 Batch and Continuous Processes

The batch process consists of separate ice-making and harvesting modes. Cube ice is made by using the batch process. In contrast, flake and nugget machines use a continuous ice-making process. In the continuous process, water is fed to the inside of a tube. Ice forms on the inside surface of the tube, and an auger or cylinder and scraper blade continuously scrapes the sides of the tube to remove the ice as it forms.

1.6.5 Cooling Methods

Categorization of automatic ice-makers is often based partially on the cooling media used to remove waste heat from the refrigeration system. These media are typically water or air. In a water-cooled machine, three cooling methods can be used: once-through or pass-through cooling, chilled water loop systems, or evaporative cooling by the use of a cooling tower.

Air-cooled machines remove waste heat by drawing air over the cooling coils with a fan to cool the compressed refrigerant gas so that it will condense back to a liquid.

Item 1-4	*DOE seeks comment on the categories of automatic commercial ice-making equipment.*

1.6.6 Configurations

A typical ice-maker consists of a case, insulation, refrigeration system, and a water supply system. Some of the smaller models have an integrated storage bin, but most have only an ice-making system and are installed on top of a separate insulated ice storage bin.

An ice machine consists of two major subsystems: the refrigeration system and water supply and circulation system. Ice machines primarily use vapor compression to produce the refrigeration needed for ice production. In this process, water is circulated across the evaporator face and cooled by heat transfer with the refrigerant. The water freezes into ice and is discharged, either in a continuous or batch process using thermodynamic or mechanical processes. The refrigeration system removes heat from the warmed refrigerant and recirculates it for continued heat transfer. Water is continuously supplied to a water sump and distributed using water distribution tubing or piping to maintain sufficient water levels. As indicated in the report *Energy Savings Potential and R&D Opportunities for Commercial Refrigeration, Final Report* by Navigant Consulting, Inc. (Navigant 2009[4]), primary refrigeration components include:

- Compressor – typically conventional reciprocating refrigeration or heat pump compressors of 1/3 to 3 hp capacity
- Condenser – conventional air-cooled fin-tube or water-cooled concentric tube type
- Expansion device – both thermostatic expansion valves and capillary tubes are used
- Evaporator – typically copper tubing attached to a copper or stainless steel ice-making surface with plastic attachments to shape individual cubes
- Liquid line/suction line interchanger
- Refrigerant piping
- Hot gas bypass line (cubers only) – directs refrigerant directly from compressor to evaporator for harvesting ice
- Hot gas solenoid valve (cubers only) – controls hot gas refrigerant flow to the condenser during ice production and to the evaporator during ice harvest
- Refrigerant – traditionally 134A and R-22, transitioning to R-404A
- Suction accumulator (in certain models only)

The water system consists of the following:

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[4] 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 Efficiency and Renewable Energy, Washington, D.C. Available online at: http://apps1.eere.energy.gov/buildings/publications/pdfs/corporate/commercial_refrig_report_10-09.pdf.

- Potable water supply connection and control valve
- Water sump
- Water circulation pump
- Water circuit – plastic tubing and evaporator water distributor
- Purge drain (cubers only)

1.7 Interested Parties

Interested parties, or stakeholders, include manufacturers, consumers, energy conservation and environmental advocates, State and Federal agencies, and any other groups or individuals with an interest in the standards. DOE research into interested parties has thus far identified the following.

Manufacturers:

- A&V Refrigeration
- Arctic-Temp/Holiday-Ice
- Brema Ice Makers
- Cornelius
- Follett
- Hoshizaki
- Howe
- Ice-O-Matic
- ITV
- Kold-Draft
- Manitowoc
- North Star
- Scotsman
- Sno-Block
- Summit Appliance
- Tube-Ice/Vogt-Ice, LLC
- Whirlpool

Other Stakeholders:

- Air-Conditioning, Heating and Refrigeration Institute
- Alliance for Water Efficiency
- Alliance to Save Energy
- American Council for an Energy-Efficient Economy
- American Society of Heating, Refrigerating and Air-Conditioning Engineers
- Appliance Standards Awareness Project

- Consortium for Energy Efficiency (CEE)
- Earthjustice
- Great Lakes Ice Association
- Missouri Valley Ice Manufacturers Association
- National Electrical Manufacturers Association
- National Resources Defense Council
- Northeastern Ice Association
- Northwest Energy Efficiency Alliance
- Southern Ice Exchange
- Southwestern Ice Association
- Western Ice Association

Item 1-5	*DOE seeks information concerning any entities that should be added to the interested parties list, in particular additional manufacturers, small business manufacturers, consumers, and energy conservation and environmental advocates.*

2.0 ANALYSES FOR RULEMAKING

The purpose of the analyses is to support DOE's determination on whether to amend the energy conservation standards for automatic commercial ice-making equipment. The analyses ensure that if standards are amended, DOE selects standards that achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified and will result in significant energy savings, as required by EPCA. Economic justification includes the consideration of the factors set forth in EPCA (see section 1.4 of this framework document), which encompass economic impacts on domestic manufacturers and consumers, national benefits including environmental impacts, issues of consumer utility, and impacts from any lessening of competition.

Figure 2.1 summarizes the analytical components of the DOE standards-setting process. The analyses are presented in the center column. Each analysis has a set of key inputs, which are data and information required for the analysis. "Approaches" are the methods that DOE will use to obtain key inputs, which may vary depending on the information in question. Some key inputs exist in public databases. DOE will also collect information from interested parties or others with special knowledge and develop information independently to support the rulemaking. The results of each analysis are key outputs, which feed directly into the rulemaking. Arrows indicate the flow of information between the various analyses. DOE ensures a consistent approach to its analyses throughout the rulemaking by considering each analysis as a part of the overall standard-setting framework.

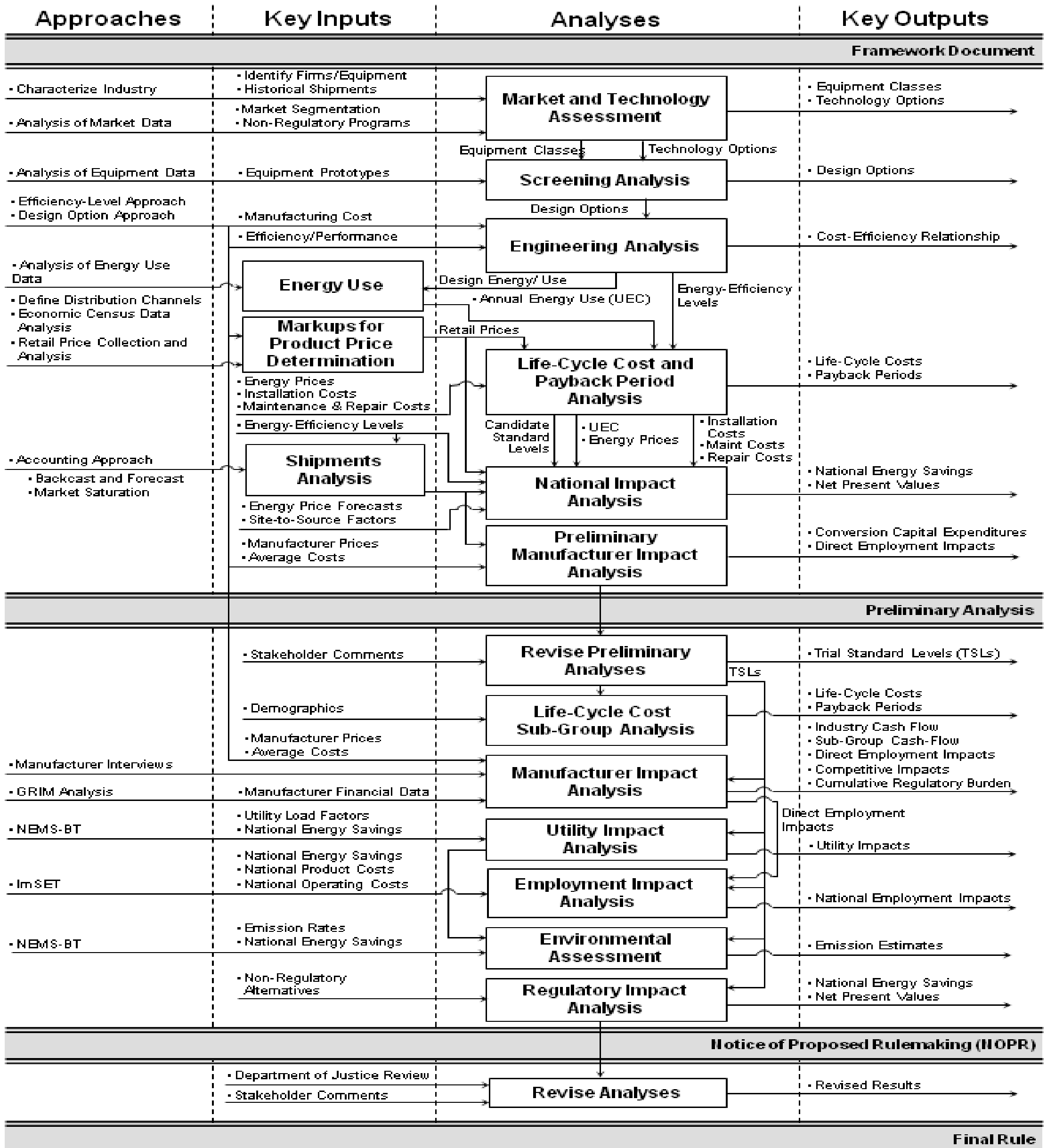

Figure 2.1. Flow Diagram of Analyses for the Automatic Commercial Ice-Maker Standards Rulemaking Process

3.0 MARKET AND TECHNOLOGY ASSESSMENT

The market and technology assessment will provide information about the automatic commercial ice-maker industry that DOE will use throughout the rulemaking. This assessment is particularly important at the outset of the rulemaking to determine equipment classes and to identify potential design options or efficiency levels for each equipment class.

3.1 Market Assessment

DOE will qualitatively and quantitatively characterize the structure of the automatic commercial ice-maker industry and market. In the market assessment, DOE will identify and characterize the manufacturers of this equipment; estimate market shares and trends in the market; address regulatory and non-regulatory initiatives intended to improve the energy efficiency or reduce the energy consumption of the automatic commercial ice-making equipment covered under this rulemaking, and explore the potential for technological improvements in the design and manufacture of such equipment.

This market assessment will establish the context for this rulemaking, and it will serve as a resource to guide the analyses that follow. For example, DOE may use historical shipments and prices as indicators of future shipments and prices. In addition, DOE plans to use market structure data for the manufacturer impact analysis (MIA), data that will be particularly useful for assessing competitive impacts. This phase also allows DOE to start updating design options by reviewing equipment literature and industry publications.

The Automatic Commercial Ice Makers and Ice Storage Bins Manufacturers Division of AHRI is the trade association for manufacturers of equipment covered under this rulemaking. DOE expects that AHRI will play a critical role in providing market information, including input on characterizing current and historical trends in equipment shipments and energy efficiency. This type of data is an important input for analyses that determine whether any amended energy conservation standards are economically justified and will result in significant energy savings.

DOE encourages interested parties to submit data that will improve DOE's understanding of the automatic commercial ice-making equipment market. DOE aggregates data provided by manufacturers and other organizations for use in its analyses.

Item 3-1	*DOE seeks information on annual shipments into the U.S. market from 1995 to 2010 (both domestic and imports) by equipment class, and the corresponding shipment-weighted average efficiency of these shipments.*
Item 3-2	*DOE seeks information on the proportion(s) of equipment shipped annually that replaces existing equipment.*

3.2 Equipment Classes

DOE classifies the automatic commercial ice-making equipment covered under this rulemaking into equipment classes (Table 3.1). The statutory criteria for separation into different classes are type of energy used and capacity or other performance-related features that justify the establishment of a separate energy conservation standard. In determining whether a performance-related feature justifies a higher or lower standard, DOE must consider such factors as utility to the consumer of such performance-related features and other factors the Secretary deems appropriate. (42 U.S.C. 6295(q) and 6313(d))

The EPACT 2005 standard, referenced in section 1.1 of this document, covered cube type ice machines with capacities between 50 and 2,500 lb per 24-hour period. (42 U.S.C. 6313(d)(1))

Section 342(d) of EPCA also provides that DOE may issue, by rule, standard levels for types of automatic commercial ice-makers not specified by Congress. (42 U.S.C. 6313(d)(2)(A))

Ice-making equipment classes are defined according to equipment type (ice-making head, self-contained or with a remote condensing unit), cooling method (air or water), harvest rate capacity (pounds per 24 hours) and output (type of ice produced). DOE is considering the equipment classes listed in Table 3.1.

DOE is considering amending the existing standard for cube machines and extending it to include machines with capacities up to 4,000 lb per 24-hour period, and is proposing to issue a new standard for continuous-type flake, nugget, and tube machines with capacities up to 4,000 lb per 24-hour period. During the public comment period for the test procedure proposed rule promulgated in 2006, which served to adopt test procedures for the EPACT 2005 automatic commercial ice-maker standards, stakeholders requested that additional product classes be considered. Specifically, Howe Corporation requested that DOE test procedures and requirements be amended and expanded to apply a revised ARI Standard 810 to all automatic ice-makers regardless of ice-cube type (docket number EE-RM/TP-05-500, Howe, No. 6 at pp. 3–4). At that time DOE stated:

> Consideration for expanding the standard for automatic commercial ice makers to include equipment that produces ice other than cube-type ice is outside the scope of this rulemaking proceeding. DOE acknowledged at the public meeting, however, that it is authorized to adopt standards for such other commercial ice makers (42 U.S.C. 6313(d)(2)), and if and when it seeks to adopt such standards, it intends to consider ice makers that produce flake type ice. (Public Meeting Transcript, No. 18.8 at pp. 46, 48)
>
> 71 FR 71340, 71351

Furthermore, as noted in section 1.5 of this document, a new version of the referenced test procedure, ARI 810-2007, has been published, and the test establishes a capacity range of 50.0 to 4,000.0 lb of ice per day at standard rating conditions, and includes continuous-type ice-makers.

Table 3.1. Proposed Classes for Commercial Ice-Makers

			Type of Ice		
Equipment Type	**Type of Cooling**	**Harvest Capacity Rate *lb/day***	**Cube**	**Flake**	**Nugget**
Ice-Making Head	Water	<500	Existing	Proposed	Proposed
		≥500 and <1,436	Existing	Proposed	Proposed
		≥1,436	Existing	Proposed	Proposed
	Air	<450	Existing	Proposed	Proposed
		≥450	Existing	Proposed	Proposed
Remote Condensing (but not remote compressor)	Air	<1,000	Existing	Proposed	Proposed
		≥1,000	Existing	Proposed	Proposed
Remote Condensing and Remote Compressor	Air	<934	Existing	Proposed	Proposed
		≥934	Existing	Proposed	Proposed
Self-Contained Unit	Water	<200	Existing	Proposed	Proposed
		≥200	Existing	Proposed	Proposed
	Air	<175	Existing	Proposed	Proposed
		≥175	Existing	Proposed	Proposed

DOE does not propose to include a class for block ice at this time. Research thus far shows domestic block ice machines tend to be manual and the automatic commercial block ice machines researched are manufactured internationally for sale internationally.

To accommodate ice machines with harvest rates between 2,500 and 4,000 lb of ice per 24-hour period, and to reflect the current market availability of automatic commercial ice-making machines, DOE will evaluate the harvest capacity rate breakdowns used in the current standard during the initial stages of the engineering analysis. If needed, DOE will identify revised harvest rate breakdowns.

Item 3-3 *DOE requests feedback on amending the current standard for cube machines.*

Item 3-4 *DOE requests feedback on promulgating a new standard to include flake, nugget, and tube machines.*

Item 3-5 *DOE requests feedback on the exclusion of block ice-makers from promulgation of a new standard at this time. DOE particularly seeks information on the potential for domestic use of automatic commercial block ice-makers.*

Item 3-6 *DOE requests feedback on tube type machines. DOE understands the machines have tube-shaped evaporators and/or make tube-shaped ice and that these machines operate cyclically like cube machines, but they do not produce clear ice. DOE requests comment on whether separate equipment classes should be established for such equipment. If yes, what are the appropriate capacity ranges for these classes? If not, with which of the proposed equipment classes should the tube machines be grouped?*

Item 3-7 *DOE requests feedback concerning the proposed harvest rate breakdowns, and if they accurately reflect the current market.*

Item 3-8 *DOE requests feedback on the proposed equipment classes for the automatic commercial ice-making equipment covered under this rulemaking, and the criteria used in creating the classes.*

Item 3-9 *DOE requests comment on including ice-makers with capacities greater than 4,000 pounds per day in this rulemaking. If DOE should include standards for ice-makers with capacities larger than 4,000 pounds per day, what should the range of capacities be in this rulemaking?*

3.3 Technology Assessment and Metrics

3.3.1 Energy

The technology assessment centers on understanding how equipment uses energy and water and what measures can reduce energy and water consumption of automatic commercial ice-making equipment.

Measures that could improve the energy efficiency of equipment are called technology options, and they are based on existing technologies as well as prototype designs and concepts. In consultation with interested parties, DOE intends to develop a list of technology options that should be considered in the analysis.

DOE is studying technology options by reviewing manufacturer catalogs, recent trade publications, technical journals, and patent filings. DOE also intends to consult with technical experts within the field and to conduct manufacturer interviews about these technology options. For the preliminary analysis, DOE is currently considering the specific technologies and designs listed below.

Current research shows the following technologies and design change options for improving ice-making equipment efficiencies:[5]

1. Higher Insulation Levels
2. Permanent Split Capacitor (PSC) Condenser Fan Motor
3. Electronically Commutated Motor (ECM) for Condenser Fan Motors
4. Higher Efficiency Compressors
5. Design Options which Reduce Harvest Meltage
6. Design Options which Reduce Evaporator Thermal Cycling
7. High Efficiency Fan Blades

Item 3-10	*What technologies or designs, if any, should be added to or removed from the above list? If certain changes to the list are not applicable to all equipment classes, what equipment classes are affected?*

3.3.2 Water

The current standards for automatic commercial ice-makers (42 U.S.C. 6313(d)(1)) regulate the maximum condenser water use (gallon per 100 lb of ice) for water-cooled products. DOE is considering whether to extend the standard to include total maximum water use, which includes water use for condenser cooling, water that becomes ice, and water drained from the sump between ice-making cycles. Water is used in both the condensing unit and to make ice. In addition, there can be large variations in the amount of water used to produce a given mass of ice depending of the type of ice-maker and type of ice being produced. Water used to produce ice can also affect ice quality. AHRI Standard 810-2007 defines "dump water" as the water drainage from an ice-maker to control the clarity of ice or to prevent scaling. Increased dump water increases the clarity of ice, but also increases overall water use. Both the previously referenced ARI Standard 810-2003 and the updated AHRI Standard 810-2007 provide a test method to measure the water used in making ice in units of gallons per 100 lb of ice. Recent research, including work by the CEE,[6] Koeller,[7] and American Council for an Energy Efficient Economy,[8] suggests significant water savings can be attained through more efficient ice-making machines. The current U.S. Environmental Protection Agency (EPA) ENERGY STAR Standard[9] and Canada's High Efficiency Standard[10] limit water use in air-cooled machines, as illustrated in

[5] Navigant 2009.
[6] CEE. *High Efficiency Specifications for Ice Machines*. 2008. Consortium for Energy Efficiency, Boston, MA.
[7] Koeller 2008.
[8] ACEEE. *Analysis of Standards Options for Commercial Packaged Refrigerators, Freezers, Refrigerator-Freezers and Ice Makers.* 2004. American Council for an Energy-Efficient Economy, Washington, D.C.
[9] See www.energystar.gov/index.cfm?c=comm_ice_machines.pr_crit_comm_ice_machines.
[10] CSA C742-08. *Energy Performance of automatic icemaker and storage bins*. Canadian Standards Association, Mississauga, Ontario, Canada.

Table 3.2. DOE is considering measuring potable water use as gallons/100 lb of ice for both air- and water-cooled machines.

Table 3.2. ENERGY STAR Efficiency Requirements for Commercial Cubed Ice Machines

Equipment Type	Harvest Rate, H *lb ice/day*	Energy Use Limit *kWh/100 lb ice*	Potable Water Use Limit *gal/100 lb ice*
Air-Cooled			
IMH	< 450	9.23 – 0.0077**H**	<= 25
	>= 450	6.20 – 0.0010**H**	<= 25
Remote Condensing Unit (without remote compressor)	< 1,000	8.05 – 0.0035**H**	<= 25
	>= 1,000	4.64	<= 25
Remote Condensing Unit (with remote compressor)	< 934	8.05 – 0.0035**H**	<= 25
	>= 934	4.82	<= 25
Self-Contained Unit	< 175	16.7 – 0.0436**H**	<= 35
	>= 175	9.11	<= 35

Item 3-11 DOE requests feedback on potable water use as a metric.

The minimum amount of water necessary to produce 100 lb of ice is 12 gallons. However, additional water is typically required because of incomplete freezing, purge water, or harvest melting. These additional sources can range between 15 and 50 gallons of water use per 100 lb of ice produced, as shown in Figure 3.1. It should be noted that Figure 3.1 displays only the water drawn to create ice; water use for cooling purposes is not included.

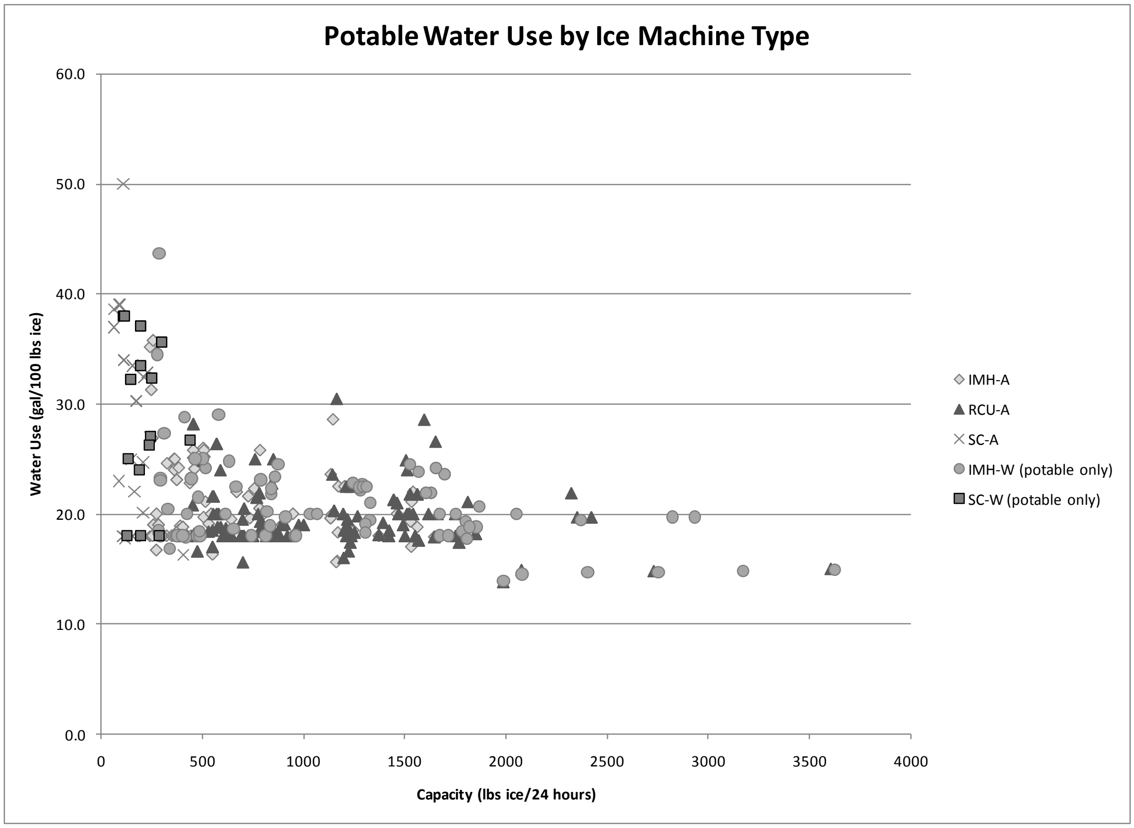

Figure 3.1. Potable Water Use by Ice Machine Type. IMH=Ice-Making Head, RCU=Remote Condensing Unit, SC=Self-Contained, A=Air-Cooled, W=Water-Cooled.

Additional water is used in the water-cooled machines to remove waste heat from the refrigeration cycle. This adds considerably to the water use and in most cases draws from the same potable water supply. Figure 3.2 shows that this additional water use can add from 75 to 200 gallons of cooling water for every 100 lb of ice produced.[11]

[11] Koeller 2008.

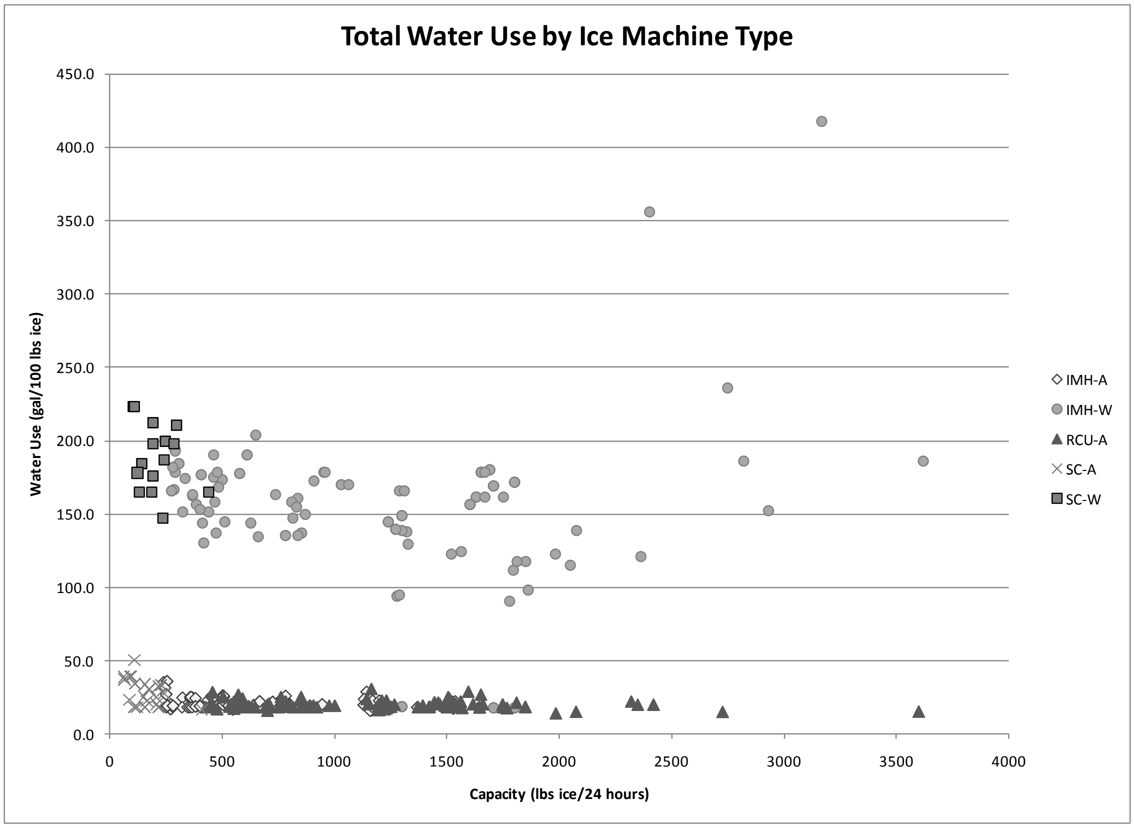

Figure 3.2. Total Water Use by Ice Machine Type

These larger machines also have greater water efficiency because their water sumps are of an appropriate size. Smaller machines tend to be equipped by manufacturers with oversized sumps designed in order to minimize the need for unique components for these smaller machines.[12]

The data presented above for energy and water consumption comes from the AHRI database. That data is provided by the manufacturers and is not independently verified by a third party. In 2007, however, the Financial Services Technology Consortium and the East Bay Municipal Utility District, with funding from Pacific Gas and Electric, Seattle Public Utilities, and Eugene (OR) Electric, conducted a field study to determine the actual energy and water use of ice machines in the field compared to their reported values in the AHRI database. The AHRI reported values were found to accurately represent the actual performance of the eight cube type machines studied within approximately 20 percent.[13]

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[12] Although manufacturers typically claim that water-cooled machines use less energy than air-cooled machines, the transportation and treatment of this additional cooling water can add considerable energy use and utility costs to their operation. The analysis done by Koeller and Company for the California Urban Water Conservation Council (Koeller 2008) found that cooling water conveyance and disposal contributed on average an additional 1.04 kWh per 100 lb of ice produced. Although water-cooled machines use an average of 1.2 kWh less electricity per 100 lb of ice than similar air-cooled ice-makers, if the additional energy cost for cooling water is taken into account, the energy use of the two cooling methods is more comparable.

[13] Koeller 2008.

DOE research shows the primary focus on water savings (direct and indirect) is from reduction of once-through cooling.

Item 3-12	*DOE requests comment on the relationship between potable water use and energy efficiency. Specifically, to what degree is potable water efficiency likely to increase with increased stringency of energy efficiency requirements for the ice-makers covered under this rulemaking without explicit potable water efficiency requirements?*
Item 3-13	*DOE seeks feedback on including total water use in the technological assessment.*
Item 3-14	*DOE seeks input on what technologies or designs should be considered to improve water efficiencies.*

3.4 Processes

The batch process consists of an ice-making mode and harvesting mode. In the ice-making mode, water fills an internal water sump with about 10 to 40 percent[14,15] more water than is required to make a given batch of ice. The refrigeration system is activated and the sump water is circulated over the evaporation plate with the compressor, water circulating pump, and compressor fan activated, if applicable. The water is cooled and ice builds up on the plate until the proper ice weight is reached as determined by the sump water level, compressor suction pressure, or the thickness of ice on the plate.

The machine then switches to "harvest mode," in which hot refrigerant vapor is directed from the compressor to the evaporator plate to melt the first layer of ice to free the cube. Some machines also use a mechanical means in combination with hot refrigerant gas to remove the ice cubes. Typically, 10 to 20 percent of ice is melted during the harvest period. Once melted, the ice falls into the storage bin. During the harvest process, the remaining water in the sump is purged and fresh potable water is circulated through the system to remove impurities. The machine then returns to ice-making, or "freeze mode," when the evaporator cools to a certain temperature or a timer resets.

The batch process can produce harder, clearer, and more regularly shaped ice, but is significantly more water- and energy-intensive.

In most commercial flake and nugget machines, the IMH contains cylinders wrapped by cooling (evaporator) coils. Water is fed to the inside of the tube and ice forms on the inside surface. An auger continuously scrapes the sides of the tube to remove the ice as it forms. For very large flake ice machines, a cylinder and scraper blade system is used in place of the auger. Because there is no recirculation and purge system like that of cube ice machines, water is not

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[14] Koeller 2008.

[15] Westphalen, D., R.A. Zogg, A.F. Varone, M.A. Foran. *Energy Savings Potential for Commercial Refrigeration Equipment*. 1996. 46230-00. Prepared by Arthur D. Little, Inc. for the Building Equipment Division Office of Building Technologies, U.S. Department of Energy, Washington, D.C.

discharged to the drain in the ice-making process. However, since the ice is harvested in a wet state, the product does contain some unfrozen water. The amount of unfrozen water can range from 1 to 4 gallons per 100 lb of ice, depending on the machine.[16]

3.5 Type of Cooling

3.5.1 Water-Cooled

The three primary cooling methods are as follows:[17]

1. Once-through or pass-through cooling, which involves connecting the ice machine directly to a potable water supply. The water is then passed through the heat exchanger and discharged to the drain. This method of cooling with water is the most commonly found and the most water-intensive.

2. Chilled water loop systems, which are found where central chilled water is used for air conditioning. The ice machine is attached to the central chilled water loop, where it rejects heat to the chilled water, which is later removed by the air-conditioning equipment.

3. Cooling towers, which provide evaporative cooling for water heated by ice-making equipment. Evaporative cooling is only used in complex mechanical systems, and would not be found in typical small to medium retail, offices, or food service facilities, but may be appropriate in health care, lodging, or larger educational, office, and retail complexes.

3.5.2 Air-Cooled

As noted in section 1.6.5, air-cooled machines remove waste heat by drawing air over the cooling coils with a fan to cool the compressed refrigerant gas so that it will condense back to a liquid.[18]

The condensing unit containing the compressor coils can be either integral to the ice-making equipment or separate. When the coils (condensing units) are located separately, they are referred to as remote condensing units. Remote condensing units are typically located outside, much like a home air conditioner.

Units that reject heat directly to the space in which they are located include those with air-cooled IMHs and those with self-contained, air-cooled units, such as under-the-counter ice-makers. The actual compressor pumps can be located either (1) at the IMH inside the building or (2) outside with the condensing coil. Remote condensing units are typically located on the roof or along an outside wall of the building.

[16] Navigant 2009.
[17] Navigant 2009.
[18] Koeller 2008.

3.6 Standby Mode and Off Mode Standards

The Energy Independence and Security Act of 2007 (section 310 of EISA 2007; Pub. L. 110-140) requires quantification of standby and off mode energy consumption in energy conservation standards for consumer products. (42 U.S.C 6295) The section which establishes energy conservation standards for commercial and industrial equipment, section 342, was not similarly amended to include requirements for addressing standby and off mode equipment. Therefore, standby and off modes will not be considered for automatic commercial ice-makers.

Item 3-15	*DOE welcomes comment on standby and off mode energy consumption as it relates to automatic commercial ice-making equipment.*
Item 3-16	*DOE seeks information that would confirm or deny the presence of secondary cooling in automatic commercial ice-maker applications.*

3.7 Baseline Units

Once DOE establishes equipment classes, it will select a baseline model as a reference point for each class, against which it can measure changes resulting from amended energy conservation standards. The baseline model in each equipment class represents the characteristics of the equipment in that class (*i.e.*, capacity or ice produced per day). Typically, a baseline unit would be a model that just meets current minimum energy conservation standards, when such a standard exists. If there is no energy conservation standard, the baseline unit would represent typical industry efficiency levels. DOE will use the baseline models in the engineering analysis and the LCC, NES, and PBP analyses. To determine energy savings and changes in price, DOE will compare each higher-energy efficiency, or lower-energy consumption, design option with the baseline model.

3.7.1 Cube Class Baseline

Within the cube class engineering analysis, DOE will compare the CLS to the existing EPACT 2005 standard, since the applicable standard exists, and may also use them in the LCC and PBP analyses.

3.7.2 Flake and Nugget Class Baseline

Within the flake and nugget class engineering analysis, LCC, PBP and NES, DOE proposes using the *average* unit energy consumption (kWh/100 lb of ice) identified in Table 3.3 as the baseline. For comparison purposes, the commercial ice-making standards presented in Table 1.1 are repeated here as Table 3.4.

Table 3.3. Unit Energy Consumption Limits by Equipment Type

Equipment Type	Type of Cooling	Capacity *lbs/day*	Unit Energy Consumption *kWh/100 lbs of ice* Average (Min – Max)		
			Cube	Flake	Nugget
Ice-Making Head	Water	<500	5.4 (4.2-9.9)	4.4 (3.8-5.6)	4.6 (4.2-4.9)
		≥500 and <1,436	4.3 (3.6-6.0)	3.5 (2.5-4.7)	3.7 (3.0-4.7)
		≥1,436	3.9 (3.4-4.3)	2.7 (2.2-3.5)	2.7
	Air	<450	6.8 (5.4-8.2)	5.6 (4.8-6.6)	6.2 (5.2-7.4)
		≥450	5.5 (4.6-7.5)	3.8 (0.6-5.8)	4.5 (3.5-6.4)
Remote Condensing (but not remote compressor)	Air	<1,000	5.8 (4.7-7.1)	4.9 (3.4-6.2)	5.3 (4.1-6.2)
		≥1,000	4.9 (4.2-6.0)	3.4 (2.8-4.0)	3.8 (3.6 – 4.2)
Remote Condensing and Remote Compressor	Air	<934	5.8 (5.0-6.7)	4.5	4.6 (4.1-5.1)
		≥934	4.7 (4.3-5.0)	3.9	4.2 (3.9-4.8)
Self-Contained Unit	Water	<200	7.8 (6.6-9.8)	N/A	N/A
		≥200	6.5 (5.7-7.3)	5.0 (4.9-5.0)	4.6 (4.0-5.1)
	Air	<175	13.0 (8.4-20.4)	N/A	8
		≥175	9.1 (6.8-13.0)	5.5 (4.1-6.7)	6.5 (5.3-7.6)

Source: Navigant 2009.

Table 3.4. Automatic Commercial Ice-Maker Standards Prescribed by EPACT 2005 Section 136(d), Effective January 1, 2010

Equipment Type	Type of Cooling	Harvest Rate *lb ice/24 hours*	Maximum Energy Use *kWh/100 lb ice*	Maximum Condenser Water Use[a] *gal/100 lb ice*
Ice-Making Head	Water	<500	7.80 - 0.0055H[b]	200 - 0.022H
		≥500 and <1,436	5.58 - 0.0011H	200 - 0.022H
		≥1,436	4.0	200 - 0.022H
	Air	<450	10.26 - 0.0086H	Not Applicable
		≥450	6.89 - 0.0011H	Not Applicable
Remote Condensing (but not remote compressor)	Air	<1,000	8.85 - 0.0038H	Not Applicable
		≥1,000	5.10	Not Applicable
Remote Condensing and Remote Compressor	Air	<934	8.85 - 0.0038H	Not Applicable
		≥934	5.3	Not Applicable
Self-Contained	Water	<200	11.40 - 0.019H	191 - 0.0315H
		≥200	7.60	191 - 0.0315H
	Air	<175	18.0 - 0.069H	Not Applicable
		≥175	9.80	Not Applicable

[a] Water use is for the condenser only and does not include potable water used to make ice.
[b] H = harvest rate in pounds per 24 hours, indicating the water or energy use for a given harvest rate.
Source: 42 U.S.C. 6313(d).

Item 3-17 DOE seeks feedback on the proposed baselines.

4.0 SCREENING ANALYSIS

The purpose of the screening analysis is to determine which technology options will be analyzed further in the engineering analysis. DOE will follow the process set forth below to screen out technology options.

DOE will use the list of technology options (developed through its own research and in consultation with interested parties in the technology assessment) for consideration in the engineering analysis (section 5.0). DOE will review each technology option or best available technology in light of the following four criteria:

1. *Technological feasibility*. DOE will screen out technologies that are not incorporated in commercially available products or working prototypes.

2. *Practicability to manufacture, install, and service*. If DOE determines that mass production of a technology in commercial products and reliable installation and servicing of the technology could not be achieved on the scale necessary to serve the relevant market by the effective date of the standard, it will not consider that technology further.

3. *Adverse impacts on product or equipment utility or availability*. If DOE determines a technology has significant adverse impact on the utility of the product for significant consumer subgroups, or would result in the unavailability of any covered product type with performance characteristics (including reliability), features, size, capacities, and volumes that are substantially the same as products generally available in the United States at the time, it will not consider that technology further.

4. *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 that technology further.

DOE will fully document the rationale for eliminating any technology options during the screening analysis and will publish this documentation for interested parties to review as part of the preliminary analysis. Those technology options not screened out by the above four criteria will be considered design options in the development of cost-efficiency curves in the engineering analysis.

Item 4-1 DOE welcomes comments on the above four screening criteria.

5.0 ENGINEERING ANALYSIS

After conducting the screening analysis, DOE performs an engineering analysis based on the remaining design options. The engineering analysis provides cost estimates of equipment at the performance levels considered in the rulemaking. Because DOE is considering establishing standards for both energy consumption and water consumption of automatic commercial ice-makers, the engineering analysis will address the costs of reducing both.

5.1 Engineering Analysis Overview

The purpose of the engineering analysis is to determine the relationship between manufacturer selling price and energy and/or water consumption for automatic commercial ice-making equipment. In determining this relationship, DOE will estimate the increase in manufacturer selling price associated with design changes that decrease energy and water consumption as compared with baseline-efficiency models. DOE recognizes that some design options will reduce both energy and water consumption, but others may reduce one and increase the other. DOE will make simplifying assumptions as appropriate to reduce the potential complexity of analyses that would fully evaluate the trade-off in benefits associated with water conservation versus energy conservation.

Item 5-1	*DOE seeks comments from stakeholders providing insights regarding such trade-offs.*

DOE will develop cost estimates for the engineering analysis disaggregated into the cost contributions of materials (including purchased parts), labor, and overhead. This information will be used in all of the downstream analyses, including the MIA. DOE will create an industry-wide analysis based on a variety of data sources, including manufacturer-supplied data.

As DOE has not yet finalized the expected product class structure, it has not yet developed specific requests for data to assist in collection of aggregated industry data. DOE hopes that industry stakeholders will be willing to participate in such an effort. DOE anticipates the data request will address such questions as costs to achieve reductions in energy and water use, shipments disaggregated by product classes or proposed new product classes, efficiency levels of current shipments, etc.

In addition, DOE must identify the model with the lowest energy and/or water consumption that is technologically feasible within each equipment class (*i.e.*, the "max-tech" model). DOE recognizes that a max-tech model minimizing energy use may not minimize water use, and vice versa.

Item 5-2	*DOE requests comments on the best ways to collect such information from the industry. DOE anticipates that such data might be collected and aggregated by AHRI for submittal to DOE.*
Item 5-3	*DOE requests input on appropriate categories and questions to be included on such requests for data.*
Item 5-4	*DOE seeks comment on simplifying assumptions that may be made to reduce the potential complexity of maximizing benefits associated with both water and energy use reductions.*

Item 5-4A DOE seeks comments and recommendations regarding the potential data collection efforts that might be made by industry participants to support this rulemaking, and the possible structure of data request forms that could be used to assist such efforts.

Item 5-5 DOE is also interested in receiving equipment test data (test procedure used, rating conditions, harvest rate, voltage, integrated average product temperature, daily energy consumption, etc.). Test data representative of the baseline model in each equipment class is particularly important.

5.2 Proposed Approach for Determining the Cost-Efficiency Relationship

DOE typically structures its engineering analysis using one of three approaches: (1) design-option, (2) efficiency-level, or (3) reverse-engineering (or cost-assessment).

A design-option approach uses individual design options, or combinations of design options, to identify increases in efficiency. Under this approach, cost estimates are based on manufacturer or component supplier data or engineering computer simulation models. Individual design options, or combinations of design options, are added to the baseline model in ascending order of cost-effectiveness. Also, the efficiency levels addressed in the analyses, including the downstream analyses, are based on groups of design options.

An efficiency-level approach establishes the relationship between manufacturer cost and increased efficiency at predetermined efficiency levels above the baseline. Under this approach, manufacturers typically provide manufacturer cost data for incremental increases in efficiency, without identifying the technology or design options they would use to achieve such increases.

A reverse-engineering or cost-assessment approach involves purchasing representative units of automatic commercial ice-making equipment, disassembling the units, and reverse-engineering the manufacturing costs based on a "bottoms-up" manufacturing cost assessment. The efficiency levels addressed in the analyses for such an analysis are based on the efficiency levels of the reverse-engineered products.

DOE plans to use a combination of all three of these approaches to determine the cost-efficiency relationship. This approach will seek to obtain information from a variety of sources, including consultation with outside experts, review of publicly available cost and performance information, modeling of equipment cost and energy consumption, interviews with manufacturers, product teardowns and reverse engineering, and data submissions provided by the industry (discussed in section 5.1). DOE expects that efficiency levels addressed in the analyses will be associated, to the extent possible, with existing voluntary programs for efficiency improvement, such as ENERGY STAR or CEE, to simplify comparison of engineering analyses with reverse engineering and/or industry data submissions.

For each equipment class, the engineering analysis will estimate manufacturer production cost (MPC) for each design option considered. DOE plans to use a cost model to estimate the cost of the condensing unit and ice-making section operating as an integrated unit.

Item 5-6	*DOE requests feedback on the use of a combined analysis approach that uses multiple information sources to determine the relationship between manufacturer selling price and energy consumption for automatic commercial ice-makers.*

5.3 Manufacturer Prices

DOE plans to apply markups to convert MPC to manufacturer selling prices. DOE will evaluate a variety of sources to estimate manufacturer markups, including publicly available financial information (*e.g.*, Securities and Exchange Commission 10-K reports), and interviews with manufacturers during the preliminary analysis phase. DOE recognizes that manufacturers of automatic commercial ice-making equipment may produce many types of equipment and that extracting the markup characteristics of automatic commercial ice-making equipment may not be feasible.

Item 5-7	*DOE seeks comment on which information sources may be the best for developing estimates of manufacturer selling prices.*

5.4 Proprietary Designs

DOE notes that the four screening criteria mentioned in section 4.0 do not include proprietary status of designs. However, DOE will consider proprietary designs in the engineering analyses only if they are not part of a unique path to a given efficiency level. If the proprietary design is the only approach available to achieve a given efficiency level, then DOE will reject that efficiency level from further analysis. Further, DOE is sensitive to manufacturer concerns regarding proprietary designs and will maintain the confidentiality of any proprietary data submitted by manufacturers, consistent with applicable law. This information will provide input to the competitive impacts assessment and other economic analyses.

Item 5-8	*Are there proprietary designs that DOE should consider in the analyses for any of the equipment under consideration by this rulemaking? If so, how should DOE acquire the cost data necessary for evaluating these designs? Conversely, are there proprietary designs that should not be considered? Which products use these designs?*

5.5 Representative Sizes

In performing the engineering analysis, DOE will select equipment models from the range of available equipment with sizes that best represent the most typical offerings within that specific equipment class. Proper selection of representative sizes will allow for the analyses to accurately model the majority of available equipment. DOE plans to select a model with representative size for each equipment class, while considering the possible design constraints at very small and very large capacities. Table 5.1 shows suggested representative sizes of cube ice-makers to represent their product classes.

The size of ice-maker refers to the harvest rate, or nominal capacity, designated as the weight of ice produced in a 24-hour period at an ambient exterior temperature of 90 degrees

Fahrenheit (°F), inlet water temperature of 70 °F, and inlet water pressure of 30 ± 3 pounds per square inch gauge (psig).[19]

Table 5.1. Representative Cube Ice-Maker Sizes to Represent Product Classes

Equipment Type	Type of Cooling	Capacity *lbs/day*	Cube Representative Capacity
Ice-Making Head	Water	<500	300
		≥500 and <1,436	750
		≥1,436	2,400
	Air	<450	300
		≥450	1,000
Remote Condensing (but not remote compressor)	Air	<1,000	600
		≥1,000	1,400
Remote Condensing and Remote Compressor	Air	<934	600
		≥934	1,400
Self-Contained Unit	Water	<200	150
		≥200	300
	Air	<175	100
		≥175	240

Item 5-9 *DOE requests feedback on the suggested representative sizes for cube ice machines. Should multiple sizes be considered for any of the product classes?*

Item 5-10 *Can any of the product groups (i.e., combination of equipment type and condenser cooling type) be represented by consideration of fewer representative products than the group's number of product classes?*

Item 5-11 *Can flake and nugget machines be represented by fewer representative products than cube machines?*

5.6 Extension of Standards

For the engineering analysis, DOE will review the automatic commercial ice-making equipment available for the equipment classes. Generally each equipment type has multiple equipment classes, so DOE selects certain classes as representative and concentrates its analytical effort on these. DOE selects representative equipment classes primarily because of their high market volumes. For equipment classes that are secondary and are not analyzed, DOE extrapolates CSLs from representative equipment classes.

[19] AHRI 810-2007, *Performance Rating of Automatic Commercial Ice-Makers*. Air-Conditioning, Heating and Refrigeration Institute, Arlington, VA.

Item 5-12 DOE welcomes comments on which product classes could be selected for focused analysis, and for which product classes the analyses could be extrapolated.

5.7 Outside Regulatory Changes Affecting the Engineering Analysis

In conducting an engineering analysis, DOE must consider the effects of regulatory changes outside DOE's statutory energy conservation standards rulemaking process that can affect the energy efficiency or energy consumption of the covered equipment, the cost of improving such efficiency or consumption, or both. The current standards took effect coincident with the EPA-mandated phaseout of the hydrochlorofluorocarbon (HCFC) refrigerant HCFC-22 for use in new equipment. DOE expects that all current products use HFC refrigerants such as R-404A, R-507C, or HFC-134a, and the analysis will consider use of such refrigerants. DOE is aware of no other such regulations that significantly affect the cost to reduce energy or water use of automatic commercial ice-making equipment. The consideration of these issues is closely related to the cumulative regulatory burden assessment that DOE will carry out as part of the MIA. Based on consideration of the comments received for the preliminary analysis, DOE will make the necessary changes to the analysis. These changes will be reflected in the documentation of the NOPR.

Item 5-13 Are there outside regulatory issues that DOE should consider in its engineering analysis of commercial automatic ice-makers?

6.0 ENERGY AND WATER USE AND END-USE LOAD CHARACTERIZATION

The purpose of the energy and water use and end-use load characterization analysis is to assess the energy and water savings potential of different equipment efficiencies. As part of the energy use analysis, DOE must make certain engineering assumptions regarding equipment application, including how and under what conditions the equipment is operated.

Many automatic commercial ice-maker machines are located inside conditioned spaces, and multiple machines may be installed in an individual building (*e.g.*, in health care, lodging, and large retail or office buildings). DOE recognizes that automatic commercial ice-maker machines will add to the cooling loads and reduce heating loads, but these impacts are believed to be modest. Furthermore, DOE believes the added complexity of determining the overall impact to the building space-conditioning loads is not warranted, particularly given the variety of building types and of the ice machine locations (e.g., outside, inside, or in vestibules) that would need to be taken into account.

Item 6-1 DOE seeks data or data sources that could be used to characterize the energy use of automatic commercial ice-making equipment.

Item 6-2 DOE seeks feedback on the assumption that commercial ice-making machine operation has a negligible impact on the building space-conditioning loads.

7.0 MARKUPS FOR EQUIPMENT PRICE DETERMINATION

DOE uses manufacturer-to-consumer markups to convert the manufacturer-selling-price estimates from the engineering analysis to consumer prices, which are then used in the LCC and PBP analyses and the MIA. Retail prices are needed for the baseline efficiency level and all other efficiency levels under consideration. DOE will obtain these retail prices by applying manufacturer-to-consumer markups (consisting of shipping and transportation charges, distribution channel markups, and sales tax) to the manufacturer-selling-price estimates.

To develop markups, DOE must identify distribution channels (*i.e.*, how the equipment is distributed from the manufacturer to the consumer). Once it establishes proper distribution channels for each equipment class, DOE will rely on economic census data from the U.S. Census Bureau and input from the industry to define how equipment is marked up from the manufacturer to the consumer. To the extent possible, DOE also will use collected retail price data to help qualify overall manufacturer-to-consumer markups.

This analysis will generate retail prices for each efficiency level that DOE considers. Because it expects to generate a range of price estimates, DOE plans to describe new retail prices within a range of uncertainty. If the range of retail prices for the equipment is large enough, DOE will conduct a sensitivity analysis to determine how high or low estimates of retail price impact the economic feasibility of potential energy conservation standard levels.

In the past, DOE developed estimates of manufacturer-to-consumer markups for related types of commercial refrigeration equipment. DOE's analysis focused on three distribution chain paths and calculated markups for individual points along these paths. Two of these paths involved selling the equipment through a distributor. One distributor path then went directly to customers while the second path included general contractors, mechanical contractors, or both, who installed the equipment for the final customer. A third ―national account" path involved the manufacturer selling the equipment directly to the end customer.

DOE's preliminary research indicates the automatic commercial ice-maker market appears to be similar. For food service equipment, including automatic commercial ice-making equipment, manufacturers sell either to dealers or directly to the customer. Some equipment, notably the remote condensing equipment, requires the assistance of a mechanical contractor for installation, and the dealer or manufacturer frequently either provides the contractor or helps the customer secure contractor services.

For this rulemaking, DOE's research suggests a set of distribution channels described as follows:

Manufacturer ⇨ Whole Distributors/Dealers ⇨ Mechanical Contractor ⇨ Customer ("Contractor" Channel)

Manufacturer ⇨ Whole Distributors/Dealers ⇨ Customer ("Distributor" Channel)

Manufacturer ⇨ Customer ("National Account" Channel)

For the equipment covered by this rulemaking, DOE plans to use a sales distribution among the three channels following the percentages shown in Table 7.1. The overall percentages for equipment covered by this current rulemaking will depend on the proportion of self-contained unit shipments relative to the proportion of remote condensing unit shipments.

Table 7.1. Proposed Percentage Distribution of Shipments of Automatic Commercial Ice-Making Equipment, by Market Channel

Remote Condensing Equipment %			
New and Replacement Construction	National Account	Distributor	Contractor
	70	15	15
Self-Contained Equipment %			
New and Replacement Construction	National Account	Distributor	Contractor
	30	35	35

DOE's understanding is that a general contractor would not normally enter into the distribution path for this equipment. DOE also understands that the relative fractions of equipment distributed in each channel could be different depending on whether the equipment is self-contained or remote condensing, as indicated by Table 7.1, and on whether the equipment is sold to a food sales establishment or a food service establishment.

Item 7-1 DOE requests information on the proposed distribution channels for the commercial ice-making equipment covered under this rulemaking.

Item 7-2 DOE requests information on whether the distribution channels differ by the types of buildings that comprise the market for automatic commercial ice-makers, namely, food sales establishments, food service establishments, health care facilities, lodging facilities, and others.

DOE intends to develop both markups for baseline equipment and incremental markups that are applied only to the incremental cost of higher-efficiency equipment. To develop markups, DOE must compile financial information for entities engaged in food service equipment distribution and for mechanical contractors in order to identify direct costs, indirect or overhead costs, and profits. DOE seeks input on data sources specific to food service equipment distribution channels. For similar rulemakings related to commercial refrigeration, DOE calculated markups from distribution chain data supplied by an association of heating, air-conditioning, and refrigeration dealers. For this rulemaking, DOE will identify and use data specific to foodservice equipment dealers supplemented with U.S. Census of Business data. State and local tax data will come from the Sales Tax Clearinghouse. Shipping costs will be considered as part of the markup analyses, as appropriate.

Item 7-3 DOE requests feedback on its proposal to use incremental distribution channel markups for the LCC analysis.

Item 7-4 DOE seeks comment on sources of food service equipment distribution chain data that could be used to characterize markups for the food service equipment industry.

Item 7-5	*DOE seeks comment on appropriate transportation and shipping costs to include in the analysis and whether those costs are likely to vary for higher efficiency equipment.*

8.0 LIFE-CYCLE COST AND PAYBACK PERIOD ANALYSIS

The effects of amended energy conservation standards on consumers include a change in operating expense (usually decreased) and a change in purchase price (usually increased). The LCC of a piece of equipment is the cost it incurs over its lifetime, taking into account both purchase price and operating expenses. The PBP represents the time it takes to recover the additional installed cost of the more-efficient device through annual operating cost savings. DOE analyzes the net effect of new or amended standards on individual consumers by calculating the LCC and PBP using the engineering performance data (section 5.0), the energy-use and end-use load characterization data (section 6.0), and the markups for equipment price determination (section 7.0). Inputs to the LCC calculation include the installed cost to the consumer (purchase price, including transportation and markups, plus installation cost), operating expenses (energy expenses, repair costs, and maintenance costs), the lifetime of the equipment or other defined period of analysis, and a discount rate appropriate for the consumer of the equipment. Inputs to the PBP calculation include the installed cost to the consumer and annual operating costs.

In addition to the LCC and PBP calculations, DOE also conducts a rebuttable presumption analysis for certain equipment. 42 U.S.C. 6295(o)(2)(B)(iii) and 6313(d) establishes a rebuttable presumption that a standard for commercial ice-making equipment 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."

While the rebuttable presumption calculation is helpful for understanding that certain standard levels have short PBPs, DOE routinely conducts a full economic analysis that considers the full range of impacts, including those to the consumer, manufacturer, Nation, and environment, as required under 42 U.S.C. 6295(o)(2)(B)(i). The results of this analysis serve as the basis for DOE to definitively evaluate the economic justification for a potential standard level (thereby supporting or rebutting the results of any preliminary determination of economic justification).

For the preliminary analysis, DOE will conduct the LCC and PBP analyses using typical values for the following to reflect actual conditions for the purchase and use of the equipment: retail price, installation costs, lifetime, energy usage and cost, water usage, water and wastewater cost, repair and maintenance costs, and discount rates. If DOE determines that there is significant variability in any of these inputs, it will conduct uncertainty analyses (*e.g.*, Monte Carlo analysis) to determine how the statistical distribution of estimates for each input affects the LCC and PBP. The detailed impact calculation, which DOE will conduct after the preliminary analysis, will include an assessment of LCC and PBP impacts on consumer subgroups, as described in section 11.0. For the NOPR, DOE will augment the analysis with inputs received from interested parties.

The following sections discuss the methodologies DOE plans to use to develop (1) energy, water and wastewater prices, (2) discount rates, (3) maintenance, repair, and installation costs, and (4) lifetimes for commercial ice-making equipment. Table 8.1 lists some of the major inputs DOE anticipates it will develop for the LCC and PBP analyses.

Table 8.1. Inputs to the Life-Cycle Cost and Payback Period Analyses

Input Type	Description
Equipment Price	DOE will establish the price of commercial ice-making equipment, including transportation charges, based on manufacturer's sales prices developed in the engineering analysis and the markups established in section 7.0, Markups for Equipment Price Determination.
Sales Tax	Sales tax is applied to convert the product price to a final consumer price. DOE will develop sales tax markups as described in section 7.0, Markups for Equipment Price Determination.
Installation, Maintenance, and Repair Costs	These inputs represent the cost to consumers of installing and maintaining commercial ice-making equipment.
Annual Operating Hours	The annual operating hours are the estimated hours that commercial ice-making equipment is in use over a full year. DOE will develop operating hours as described in section 6.0, Energy and Water Use and End-Use Load Characterization.
Product Energy Consumption Rate	The product energy consumption rate is the site-energy usage rate associated with operating the commercial ice-making equipment. DOE will develop this rate as described in section 6.0, Energy and Water Use and End-Use Load Characterization.
Electricity Prices	Electricity prices used in the analysis are the average price per kilowatt-hour ($/kWh) that consumers pay in each state for each type of business (*e.g.*, grocery, convenience store, restaurant) that uses the equipment.
Electricity Price Trends	Electricity price trends estimate the future cost of electricity.
Lifetime	Lifetime is the number of years a commercial ice-making piece of equipment is in operation before the consumer retires the case from service.
Product Water Consumption Rate	The product water consumption rate is the site-water usage rate associated with operating the commercial ice-making equipment. DOE will develop this rate as described in section 6.0, Energy and Water Use and End-Use Load Characterization.
Water / Wastewater Prices	Water and wastewater prices used in the analysis are the average price per 1,000 gallons ($/1,000 gal) that consumers pay in each state for each type of business (*e.g.*, grocery, convenience store, restaurant) that uses the equipment.
Water / Wastewater Price Trends	Water / wastewater price trends estimate the future cost of water and wastewater.
Discount Rate	The discount rate is the consumer rate at which DOE discounts future expenditures to establish their present value.
Analysis Period	The analysis period is the time span over which DOE calculates the LCC.

8.1 Energy Prices

DOE will survey average state-level electricity prices for consumers of automatic commercial ice-making equipment. Average prices will be used because automatic commercial ice-making equipment runs nearly continuously and the cost of operation is effectively captured using average electricity prices. DOE will conduct a sensitivity analysis to determine how high and low electricity price estimates might affect the economic feasibility of any amended energy conservation standards. DOE will use projections of national and regional average energy prices—principally from the most recent Energy Information Administration (EIA) *Annual Energy Outlook* (*AEO*)[20]—as inputs for future energy prices in the LCC analysis.

Item 8-1	*DOE seeks comment on the proposed approaches for estimating current and forecasted energy prices.*

8.2 Life-Cycle Cost Discount Rates

Calculation of consumer LCC requires use of an appropriate discount rate. DOE uses the discount rate to determine the present value of lifetime operating expenses. Because consumers of automatic commercial ice-making equipment are typically commercial entities, DOE will derive the discount rates for consumers by estimating the cost of capital of these types of companies. The cost of capital is commonly used to estimate the present value of cash flows to be derived from a typical company project or investment. Most companies use both debt and equity capital to fund investments, so the cost of capital is the weighted-average cost of equity and debt financing. This corporate finance approach is referred to as the weighted-average cost of capital (WACC). DOE will calculate WACC from equity and debt cost data on individual Value Line reported companies from the Damodaran Online website.[21]

Because the set of commercial companies purchasing automatic commercial ice-making equipment may differ from those who purchase other types of commercial equipment, each rulemaking requires development of its own targeted discount rates. DOE will develop the discount rates and associated calculations and provide an opportunity for interested parties to comment on this issue during the preliminary analysis comment period. DOE will make necessary changes to the preliminary analysis based on the comments it receives on the LCC and PBP analyses, and will reflect those changes in the NOPR.

Item 8-2	*DOE seeks comment on the proposed approaches for estimating discount rates for consumers of the equipment covered under this rulemaking.*

8.3 Maintenance, Repair, and Installation Costs

DOE will consider expected changes to maintenance, repair, and installation costs for the equipment covered in this rulemaking. DOE bases repair costs on annualized costs of key components and frequency of replacement in the field. Maintenance costs will be based on estimates of preventative maintenance and a separate estimate of maintenance for different ice-making technologies. DOE will project annualized maintenance costs for automatic commercial ice-making equipment from data developed in the engineering studies and using engineering cost index services such as *RS Means*.

Preventative maintenance costs related to water handling and scaling are important for automatic commercial ice-makers. At present no information is available to indicate how preventative maintenance costs vary with equipment efficiency level.

[20] See www.eia.doe.gov/oiaf/aeo/.
[21] See http://pages.stern.nyu.edu/~adamodar/.

As a default, DOE proposes to assume preventative maintenance costs will remain constant as equipment efficiency is increased. DOE will rely on input from manufacturers and other stakeholders in determining if the default assumption is appropriate, and if it is found to not be appropriate, in developing appropriate incremental repair and maintenance costs for higher efficiency equipment.

Unless the efficiency increases considered for this rulemaking result in significantly larger or heavier equipment, DOE expects that more efficient automatic commercial ice-making equipment will not incur increased installation costs.

Item 8-3	*DOE seeks answers to the question: What are the typical installation, maintenance, and repair costs and practices during the life cycle of an originally manufactured automatic commercial ice-making machine?*
Item 8-4	*What is a typical time period between the sale of a new product and the first maintenance or repairs? What are the typical cycles of maintenance and repairs?*
Item 8-5	*DOE seeks feedback on whether and how routine maintenance, repair, and installation costs will change for products that are more energy and water efficient.*
Item 8-6	*If it is not appropriate to assume that changes in maintenance, repair, or installation costs would be negligible for more-efficient products, DOE seeks feedback on appropriate methodologies for assessing changes to each of these costs.*

8.4 Equipment Lifetimes

Current research shows automatic commercial ice-maker machine life typically ranges from 7 to 10 years, with an average of 8.5 years.[22,23]

As appropriate, DOE will use information from additional various literature sources (*e.g.*, *Appliance Magazine*, handbooks published by ASHRAE) and input from manufacturers and other interested parties to better establish average equipment lifetimes for use in the LCC and subsequent analyses.

Item 8-7	*DOE seeks comment on appropriate equipment lifetimes for the classes of equipment covered in this rulemaking.*

[22] Navigant 2009.
[23] Koeller 2008.

8.5 Water and Wastewater Costs

Water is used in the manufacture of ice and in the cooling process. Total water usage ranges from 13 gallons/100 lb of ice for air-cooled flake ice-makers up to 200 gallons or more for cube ice-makers with water cooling. Water not embodied in the finished product is water that ultimately is sent into the wastewater system. Thus, water and wastewater costs represent important cost components, and in the case of water-cooled systems, significant cost components in the LCC analysis.

DOE proposes to develop nationwide estimates of water and wastewater costs and incorporate these estimates into the annual operating cost, LCC, and PBP analyses. DOE proposes to rely upon sources such as the American Water Works Association's (AWWA's) biennial price survey and other surveys of retail water purveyors to establish base year prices. AWWA has performed the biennial survey for many years, and DOE anticipates using data from multiple years' surveys to establish trends for purposes of developing water price forecasts. Base year prices will be combined with price growth rates developed from AWWA surveys, and as needed, supplemented with information from commercial macroeconomic forecast services or other sources to develop projections of water and wastewater commodity prices.

Once estimated, price projections will be combined with commodity consumption rate, consistent with section 6.0 of this framework document, and the resulting cost streams will be included in LCC and PBP analyses.

Item 8-8	*DOE seeks input on the proposed methodology for developing estimates of national water costs and potential savings associated with the proposed rule.*

9.0 SHIPMENTS ANALYSIS

Shipment forecasts are required to calculate the national impacts of standards on energy use, NPV, and future manufacturer cash flows. DOE plans to develop shipment forecasts based on an analysis of key market drivers for automatic commercial ice-making equipment.

9.1 Base Case Forecast

To evaluate the various impacts of standards, DOE must develop a base case forecast against which to compare forecasts for higher efficiency levels. The base case forecast is designed to depict what will happen to energy consumption and energy costs over time if DOE does not adopt amended energy conservation standards for the equipment covered under this rulemaking. In determining the base case forecast, DOE will consider historical shipments, the mix of efficiencies sold under current standards, and how that mix might change over time. For these purposes, DOE needs data on historical shipments and the market shares of the different efficiency levels offered in each equipment class.

DOE's Buildings Energy Data Book publishes shipment data on ice-making machines as a total product group.[24] In addition, the Census Bureau has published limited statistics on the

[24] See http://buildingsdatabook.eere.energy.gov/.

quantity and value of product shipments.[25] Census Bureau data is available online, divided into categories based on whether the machine is self-contained, the type of ice produced, the capacity of the machine, and if the machine also dispenses beverages. The data is collected every year, but is missing some categories because of issues with proprietary information or data that did not meet publication standards. EPA also collects shipments data through their ENERGY STAR program.

Between 1990 and 2000, annual ice machine sales more than doubled, from 171,000 units to 385,000 units per year. However, between 2000 and 2006, which are the most recent years available through DOE's EERE Buildings Energy Data Book, ice machine sales have shown a decreased rate of growth, increasing from 385,000 units to only 386,000 units per year. In 2006, 197,000 units of the total ice-maker shipments were commercial machines.

DOE intends to collect shipment data within each equipment class, as well as market-share efficiency data (*i.e.*, data on the distribution of product shipments by efficiency) for each class. DOE recognizes that this information may be difficult to collect, and may therefore consider other methods to estimate the efficiency distribution in the market. For example, when market-share efficiency data are not available, DOE may use efficiency distributions based on available equipment models as a proxy. DOE may also request separate shipment information for equipment sold with specific design features.

9.2 Accounting Methodology

DOE proposes to determine annual shipments in the base case by accounting for new building construction and historical rates of ownership (saturation rates) in buildings. For equipment retirements, DOE will use the same equipment lifetimes and retirement functions that it generates for the LCC and PBP analysis. This method has the distinct advantage of separately accounting for units installed in new construction and existing buildings. More importantly, DOE can express saturation rates as a function of consumer price and operating cost to capture their impact on future shipments. DOE plans to rely on EIA's *AEO* to forecast new commercial construction.

DOE will also consider any other input provided by interested parties.

Item 9-1	*DOE seeks information on historical shipments of automatic commercial ice-making equipment for each equipment class covered under this rulemaking, as well as industry-trend data regarding relative growth in each equipment class.*
Item 9-2	*DOE seeks information on representative saturation rates for each equipment class covered under this rulemaking, as well as industry-trend data regarding relative growth in each equipment class.*

[25] See www.census.gov.

9.3 Standards Impacts on Shipments

For each equipment class, DOE will develop a set of shipment forecasts for the covered equipment for each set of potential standards analyzed. DOE will use these standards case forecasts to evaluate the impacts of standards on shipments. Standards case forecasts are derived using the same datasets as base case forecasts; however, because the standards case forecasts take into account the increase in purchase price and the decrease in operating costs caused by new or amended standards, forecasted shipments could deviate from the base case. The magnitude of the difference between the standards case and base case shipment forecasts depends on the estimated purchase-price-increase as well as the operating-cost-savings caused by the standard. Because the purchase price tends to have a larger impact than operating cost on equipment purchase decisions, standards case forecasts typically show a drop in shipments relative to the base case.

DOE's past standards analyses have attempted to quantify the sensitivity of shipments to purchase price and operating-cost-savings. Because the data required to develop these sensitivities are limited and often difficult to obtain, DOE will consider modeling standards case shipments forecasts with scenarios (*i.e.*, specified impacts to equipment shipments) rather than developing sensitivities to purchase price or operating-cost-savings.

Market-pull programs, such as consumer rebate programs that encourage the purchase of more-efficient equipment and manufacturer tax credits that encourage the production of more-efficient equipment, also affect standards case forecasts. When such programs exist, DOE considers their impact on the forecast of both standards case and base case shipments.

Item 9-3	*DOE requests input from manufacturers on the potential impact of new energy conservation standards on equipment shipments. Other interested parties are also welcome to provide input. DOE also requests input on any market-pull programs that currently exist to promote the adoption of more-efficient equipment.*

10.0 NATIONAL IMPACT ANALYSIS

The national impact analysis (NIA) will discuss DOE's assessment of the aggregate impacts of potential efficiency standards at the national level. Measures of impact that DOE will report include future NES from CSLs (*i.e.*, the cumulative incremental primary energy savings from an increased energy conservation standard relative to a base case that assumes no change in the energy conservation national standard over a specific forecast period). DOE will also report the impact on the NPV for consumers in the aggregate from CSLs (*i.e.*, the cumulative incremental LCC from an increased energy conservation standard relative to the base case over a specific forecast period).

10.1 Inputs to Forecast

Analyzing impacts of Federal energy conservation standards requires a comparison of projected U.S. energy consumption for the automatic commercial ice-making equipment covered under this rulemaking with, and without, new or amended energy conservation standards. The forecasts contain projections of unit energy consumption for new equipment, annual equipment shipments, and the price of purchased equipment. Analysis of water savings is done in the same manner. The derivations of the base case shipments forecasts are discussed in section 9.1. Approaches to determining retail prices are described in section 7.0, while approaches to determining per unit net energy consumption impact are described in section 6.0.

One factor often considered in DOE rulemakings is the rebound effect. The rebound effect is generally included in the input to the NIA. Often, consumers that encounter lower operating costs associated with more energy-efficient equipment will use that equipment more often than would have used the less-efficient equipment. The rebound effect analysis accounts for this increase in consumer use. DOE assumes that there is essentially no rebound effect for automatic commercial ice-making equipment because the equipment is presumed to run nearly continuously, and its operating settings are based on the amount of ice to be produced.

Item 10-1 DOE requests information on whether a rebound effect exists and should be incorporated in the NIA.

Table 10.1 describes some of the major inputs DOE anticipates it will develop for the NIA.

Table 10.1. Inputs to the National Impact Analysis

Input Data	Description of Data Sources
Shipments	DOE develops estimates of annual shipments over a 30-year analysis period as described in section 9.0, Shipment Analysis.
Stock of Commercial Ice-Makers	This stock is calculated from the service life of equipment developed as described in section 8.0, Life-Cycle Cost and Payback Period Analysis, and annual shipments of equipment developed as described in section 9.0, Shipment Analysis.
Compliance Date of Standard	The compliance date of the standard is January 1, 2016
Analysis Period	This analysis period is 2015 to 2046 (30 years).
Base-Case Forecasted Efficiency	Distribution of base-case shipments by efficiency level over time developed as described in section 9.0, Shipment Analysis.
Standards-Case Forecasted Efficiency	Distribution of shipments by efficiency level for each standards case over time as described in section 9.0, Shipment Analysis.
Unit Energy and Water Consumption (kWh/yr) and (1,000 gallons/yr)	This is the average energy and water consumption of automatic commercial ice-making equipment established as described in section 6.0, Energy and Water Use and End-Use Load Characterization.
Total Installed Cost	Established as described in section 7.0, Markups for Equipment Price Determination, and section 8.0, Life-Cycle Cost and Payback Period Analysis.
Electricity and Water Price Forecasts	Established as described in section 8.0, Life-Cycle Cost and Payback Period Analysis.
Electricity Site-to-Source Conversion	Conversion varies yearly and is generated from detailed *NEMS* forecasts of electricity generation by technology and electricity-related losses.
Discount Rate	The discount rate is the rate at which DOE discounts future expenditures to establish their present value. DOE will use 3- and 7-percent discount rates mandated by the Office of Management and Budget (OMB).
Present Year	Future costs and savings will be discounted to 2011.
Rebound Effect	The difference between the projected and actual savings due to increased efficiency. DOE may base this effect on economics literature on energy efficiency in the commercial and industrial sectors.

10.2 Calculation of Energy and Water Savings

DOE intends to calculate national energy and water consumption for each year, beginning with the expected compliance date of the standards. It will calculate national energy consumption by fuel type for the base case and each standard level analyzed. DOE plans to perform this calculation through the use of a spreadsheet model that effectively multiplies annual equipment stock forecasts by efficiency level (based on shipments and retirements in each year) by unit electricity use at the site of use, for each efficiency level. DOE then plans to multiply the site electricity use by year-by-year marginal site-to-source conversion factors that account for energy losses in generation, transmission, and distribution of electricity in order to estimate national primary energy savings. DOE proposes to base the site-to-source conversion factors on modeled savings of primary energy in the electric utility industry of EIA's National Energy Modeling System (NEMS) (section 13.0).

National Water Savings (NWS) will be estimated in much the same fashion. Because the nation's water systems are not integrated (like the power grid), site-to-source conversion factors will require the compilation of loss factors at the various levels of the water system (distribution, transmission, and source).

In response to comments by interested parties who asked for a simple, transparent model, DOE developed NIA spreadsheet models for its standards rulemakings starting in 1996. These models project energy and water savings and demonstrate how to account for the growth in efficiency over time.[26] DOE expects the NIA spreadsheet model to provide a credible, standalone forecast of NES, NWS, and aggregate consumer NPV for automatic commercial ice-making equipment. DOE will make any necessary changes to the preliminary analysis based on the comments it receives. DOE will reflect those changes in the NOPR.

Item 10-2	*DOE welcomes comments from interested parties on the use of NIA spreadsheet models for estimating national impacts of amended energy and water conservation standards for automatic commercial ice-making equipment.*

10.3 Net Present Value of Consumer Savings

DOE calculates the national NPV of the standards in conjunction with the NES and NWS. It calculates annual energy and water expenditures from annual energy and water consumption by incorporating forecasted prices, using the shipment forecasts described in section 9.1, Base Case Forecast, and electricity and water savings forecasts described in section 10.2. DOE calculates annual equipment expenditures by multiplying the price per unit by the forecasted shipments. The difference between a base case and a standards case scenario gives the national energy and water bill savings and increased equipment expenditures in dollars. The difference each year between energy and water bill savings and increased equipment expenditures is the net savings (if positive) or net cost (if negative). DOE discounts these annual values to the present time and sums them to give an NPV. Since the national cost of capital may differ from the consumer cost of capital, the discount rate used in the NIA can be different from

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[26] Several examples of NES spreadsheet models from previous rulemakings can be found on DOE's website at www.eere.energy.gov/buildings/appliance_standards.

the rate used in the LCC. In accordance with OMB guidance, DOE will conduct two NPV calculations, one using a real discount rate of 3 percent and another using a real discount rate of 7 percent.[27]

Based on consideration of the comments received for the preliminary analysis, DOE will make any necessary changes to the analysis and the CSLs.

11.0 LIFE-CYCLE COST SUBGROUP ANALYSIS

DOE recognizes that there are potential subgroups of commercial consumers or purchasers of automatic commercial ice-making equipment who may be impacted by standards differently than consumers or purchasers generally. DOE analyzes such differences in impacts by dividing consumers into subgroups and accounting for variations in key inputs to the LCC analysis. A customer subgroup comprises a subset of the purchaser population likely to be impacted disproportionately by new or revised energy conservation standards. The purpose of a subgroup analysis is to determine the extent of this disproportionate impact. DOE will work with interested parties early in the rulemaking process to identify any subgroups for this consideration and will analyze the consumer subgroups in the NOPR stage of the analysis.

In comparing potential impacts on the different consumer subgroups, DOE will evaluate variations in regional energy and water and wastewater prices, variations in energy and water use, and variations in installation costs that might affect the NPV of a standard to consumer subgroups. To the extent possible, DOE may obtain estimates of the variability in each input variable and consider this variability in its calculation of consumer impacts. It will discuss the variability in each input variable and likely sources of information with interested parties.

Item 11-1	*DOE seeks input as to which customer subgroups DOE should consider in the present rulemaking. Examples of possible subgroups DOE could consider appropriate for automatic commercial ice-making equipment include small independent grocery and convenience stores and independently owned restaurant and motels.*

12.0 MANUFACTURER IMPACT ANALYSIS

DOE will collect, evaluate, and report preliminary manufacturer impact information and data in the preliminary analysis.[28] Such preliminary manufacturer impact information includes the anticipated capital conversion costs by efficiency level and the corresponding, anticipated impacts on jobs. DOE will solicit this information during the engineering analysis manufacturer interviews for the preliminary analysis.

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[27] OMB, Circular A-4: Regulatory Analysis (Sept.17, 2003).

[28] *See* U.S. Department of Energy. Congressional Report: *Energy Conservation Standards Activities*. 2006. p. 48. Available online at: http://www1.eere.energy.gov/buildings/appliance_standards/pdfs/congressional_report_013106.pdf (providing rationale for conducting an MIA early in the process of rulemaking).

The analysis of impacts on manufacturers is intended to provide DOE with an assessment of the potential impacts of energy conservation standards on manufacturers. In addition to financial impacts, a wide range of quantitative and qualitative effects may occur following adoption of a standard that may require changes to the manufacturing practices for this equipment. DOE will identify these effects through interviews with manufacturers and other interested parties.

12.1 Sources of Information

Many of the analyses described earlier provide important information that DOE uses as inputs for the MIA. Such information includes financial parameters developed in the market assessment (section 3.1), manufacturing costs and prices from the engineering analysis (sections 5.2 and 5.3), retail price forecasts (section 7.0), and shipments forecasts (section 9.1). DOE supplements this information with information gathered during manufacturer interviews. The interview process will play a key role in the MIA, as it provides an opportunity for interested parties to express their views on important issues.

DOE will conduct detailed interviews with manufacturers to gain insight into the range of potential impacts of standards. During the interviews, DOE will solicit information on the possible impacts of standards on manufacturing costs, equipment prices, sales, direct employment, capital assets, and industry competitiveness. Both qualitative and quantitative information are valuable. In addition, an interview guide will be provided before the interviews to allow the manufacturers to gather the appropriate information. Although a written response to the questionnaire is acceptable, DOE prefers an interactive interview process because it helps clarify responses and provides the opportunity for additional issues to be identified.

DOE will ask that interview participants identify all confidential information provided, both in writing and orally. While it will consider information gathered, as appropriate, in its decision-making process, DOE will protect confidential information from disclosure consistent with applicable law.

DOE will collate the information from interviews and prepare a summary of the major issues and outcomes. This summary will become part of the TSD produced for this rulemaking.

12.2 Industry Cash Flow Analysis

The industry cash flow analysis relies primarily on the Government Regulatory Impact Model (GRIM). DOE uses the GRIM to analyze the financial impacts of more stringent energy conservation standards on the industry that produces the equipment covered by the standard.

The GRIM analysis uses a number of factors—annual expected revenues; manufacturer costs such as costs of goods sold; selling, general, and administrative (SG&A) costs; taxes; and capital expenditures—to arrive at a series of annual cash flows beginning from the announcement of the new standard and continuing for several years after its implementation. 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. Other performance metrics, such as return on invested capital, also are available from the GRIM.

DOE will gather this information from two primary sources: (1) the analyses conducted to this point; and (2) interviews with manufacturers and other interested parties. Information gathered from previous analyses will include financial parameters, manufacturing costs, price forecasts, and shipment forecasts. Interviews with manufacturers and other interested parties will be essential for supplementing this information.

12.3 Manufacturer Subgroup Analysis

It is possible that the use of average industry cost values will not adequately assess differential impacts among subgroups of manufacturers. DOE recognizes that smaller manufacturers, niche players, and manufacturers exhibiting a cost structure that differs largely from the industry average may be differentially impacted by the imposition of standards. Ideally, DOE would consider the impact on every firm individually. In highly concentrated industries, this may be possible. In industries having numerous participants, however, DOE will use the results of the market and technology assessment to group manufacturers into subgroups, as appropriate.

Item 12-1	*DOE seeks comment on the establishment of manufacturer subgroups for automatic commercial ice-making equipment, particularly small businesses and niche manufacturers.*

12.4 Competitive Impacts Assessment

EPCA directs DOE to consider any lessening of competition that is likely to result from the imposition of standards. (42 U.S.C. 6295(o)(2)(B)(i)(V) and 6313(d)) It further directs the Attorney General to determine, in writing, the impacts, if any, of any lessening of competition. (42 U.S.C. 6295(o)(2)(B)(ii) and 6313(d))

DOE will make a determined effort to gather firm-specific financial information and impacts. DOE will then report the aggregated impact of the standard on manufacturers. The competitive impacts assessment will include a focus on the assessment of the impacts to smaller manufacturers. DOE will provide the Attorney General with a copy of the NOPR for consideration in the Attorney General's evaluation of the impact, if any, of standards on any lessening of competition. DOE will base the assessment on manufacturing cost data and on information collected from interviews with manufacturers. One focus of the manufacturer interviews will be to gather information that would help in assessing asymmetrical cost increases to some manufacturers, whether an increased proportion of fixed costs could potentially increase business risks, and potential barriers to market entry (*e.g.*, proprietary technologies).

12.5 Cumulative Regulatory Burden

Finally, DOE is aware that other regulations may be placed on equipment covered under this rulemaking as well as on other equipment manufactured by the same companies. Multiple regulations may result in a cumulative regulatory burden on these manufacturers. DOE will address and seek to mitigate the overlapping effects on manufacturers of amended DOE standards and other regulatory actions affecting the same equipment or companies. In this regard, DOE considers the impact of other rules with compliance dates within 3 years of the compliance date for this rulemaking.

Item 12-2	*What regulations or pending regulations should DOE consider in the analysis of cumulative regulatory burden?*

13.0 UTILITY IMPACT ANALYSIS

The utility impact analysis will include an analysis of the electric utility industry. DOE is considering adapting the National Energy Modeling System produced by the EIA for this analysis. NEMS is a large, multi-sectoral, partial-equilibrium model of the U.S. energy sector that has been developed over the past decade by the EIA, primarily to prepare DOE's *AEO*. In prior rulemakings, a variant of NEMS (currently termed NEMS-BT) was developed to better address the specific impacts of equipment efficiency standards.[29]

The NEMS produces a widely recognized baseline energy forecast for the United States through 2035 and is available in the public domain. The typical NEMS outputs include forecasts of electricity sales, price, and avoided capacity. DOE plans to conduct the utility impact analysis as a scenario departing from the latest *AEO* reference case. In other words, the energy savings impacts from amended energy conservation standards will be modeled using NEMS-BT to generate forecasts that deviate from the *AEO* reference case.[30]

Item 13-1	*DOE seeks input from interested parties on its proposed use of NEMS-BT to conduct the utility impact analysis.*

14.0 EMPLOYMENT IMPACT ANALYSIS

The imposition of standards can impact employment both directly and indirectly. Direct employment impacts are changes in the number of employees at the plants that produce the covered equipment, along with the affiliated distribution and service companies, resulting from the imposition of standards. DOE will evaluate direct employment impacts in the MIA, as described in section 12.0.

Indirect employment impacts from standards consist of the net jobs created or eliminated in the national economy, other than in the manufacturing sector being regulated, due to: (1)

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[29] For more information on NEMS, please refer to DOE EIA documentation. A useful summary is *National Energy Modeling System: An Overview 2009*, DOE/EIA-0581 (October 2009), available at www.eia.doe.gov/oiaf/aeo/overview/index.html. 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 EIA assumptions, DOE refers to the model by the name NEMS-BT. BT refers to DOE's Building Technologies Program, under the aegis of which this work is performed.

[30] Several descriptions of NEMS-BT models and an example of their use in a previous commercial equipment rulemaking (beverage vending machines,), can be found on DOE's website at: http://www1.eere.energy.gov/buildings/appliance_standards/commercial/beverage_machines_final_rule_tsd.html.

reduced spending by end users on energy; (2) reduced spending on new energy supply by the utility industry; (3) increased spending on new products to which the new standards apply; and (4) the effects of those three factors throughout the economy. DOE expects the net monetary savings from standards to be redirected to other forms of economic activity. DOE also expects these shifts in spending and economic activity to affect the demand for labor in the short term. The combined direct and indirect employment impacts will be investigated in the employment impact analysis using the Pacific Northwest National Laboratory's Impact of Sector Energy Technologies (ImSET) model.[31] The ImSET model was developed for EERE and estimates the employment and income effects of energy-saving technologies in buildings, industry, and transportation. In comparison with simple economic multiplier approaches, ImSET allows for more complete and automated analysis of the economic impacts of energy conservation investments.

Item 14-1 DOE requests feedback on this approach to assessing employment impacts.

15.0 ENVIRONMENTAL ASSESSMENT

To comply with the National Environmental Policy Act and the requirements of 42 U.S.C. 6295(o)(2)(B)(i)(VI) and 6316(a), DOE intends to prepare an environmental assessment of the impacts of amended energy conservation standards for automatic commercial ice-making equipment on the human environment. The primary environmental effects of these standards 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 portion of the environmental assessment that will be produced by NEMS-BT considers carbon dioxide (CO_2), nitrogen oxides (NO_x), and mercury (Hg). The environmental assessment also considers impacts on sulfur dioxide (SO_2) emissions and discusses particulate matter (PM) emissions. After a brief discussion of general methodology, this section will address each of the relevant emissions. The following section then explains how DOE plans to monetize the benefits associated with emissions reductions.

15.1 Carbon Dioxide

A DOE standard is likely to result in reductions of CO_2 emissions. The CO_2 emission reductions likely to result from a standard will be estimated using NEMS-BT and national energy savings estimates drawn from the NIA spreadsheet model. The net benefit of the standard is the difference between emissions estimated by NEMS-BT at each standard level considered and the *AEO* Reference Case. NEMS-BT tracks CO_2 emissions using a detailed module that provides results with broad coverage of all sectors and inclusion of interactive effects.

15.2 Sulfur Dioxide

SO_2 emissions from affected Electric Generating Units (EGUs) are subject to nationwide and regional emissions cap and trading programs, and DOE has preliminarily determined that

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[31] Scott M.J., O.V. Livingston, J.M. Roop, R.W. Schultz, and P.J. Balducci. *ImSET 3.1:Impact of Sector Energy Technologies Model Description and User's Guide*. 2009. PNNL-18412, Pacific Northwest National Laboratory, Richland, WA.

these programs create uncertainty about the standards' impact on SO_2 emissions. Title IV of the Clean Air Act sets an annual emissions cap on SO_2 for affected EGUs in all 50 states and the District of Columbia (D.C.). SO_2 emissions from 28 eastern States and D.C. are also limited under the Clean Air Interstate Rule (CAIR, 70 Fed. Reg. 25162 (May 12, 2005)), which created an allowance-based trading program that would have gradually replaced the Title IV program in those states and D.C. Although CAIR has been remanded to EPA by the U.S. Court of Appeals for the District of Columbia Circuit (D.C. Circuit), see *North Carolina v. EPA*, 550 F.3d 1176 (D.C. Cir. 2008), it will remain in effect until it is replaced by a rule consistent with the D.C. Circuit's earlier opinion in *North Carolina v. EPA*, 531 F.3d 896 (D.C. Cir. 2008). On July 6, 2010, EPA proposed the Transport Rule, a replacement for CAIR, which would limit emissions from EGUs in 32 states, potentially through the interstate trading of allowances, among other options. 75 FR 45210 (Aug. 2, 2010).

The attainment of emissions caps is typically flexible among EGUs and is enforced through the use of emissions allowances and tradable permits. Under existing EPA regulations, any excess SO_2 emissions allowances resulting from the lower electricity demand caused by the imposition of an efficiency standard could be used to permit offsetting increases in SO_2 emissions by any regulated EGU. However, if the standard resulted in a permanent increase in the quantity of unused emissions allowances, there would be an overall reduction in SO_2 emissions from the standards. While there remains some uncertainty about the ultimate effects of efficiency standards on SO_2 emissions covered by the existing cap and trade system, the NEMS-BT modeling system that DOE uses to forecast emissions reductions currently indicates that no physical reductions in power sector emissions would occur for SO_2.

15.3 Nitrogen Oxides

NEMS-BT also has an algorithm for estimating NO_x emissions from power generation. As with SO_2 emissions, these emissions will be affected by CAIR and its replacement. The recent legal history surrounding CAIR, including its proposed replacement by the Transport Rule, is discussed above.

Much like SO_2 emissions, a cap on NO_x emissions would mean that the standards for automatic commercial ice-making equipment may have little or no physical effect on these emissions in the 28 eastern states and the D.C. covered by CAIR or any states covered by the proposed Transport Rule. Because all states covered by CAIR opted to reduce NO_x emissions through participation in cap-and-trade programs for electric generating units, emissions from these sources are currently capped across the CAIR region.

DOE plans to use NEMS-BT to estimate the emissions reductions from possible standards in the states where emissions are not capped.

15.4 Mercury

Similar to emissions of SO_2 and NO_x, future emissions of Hg would have been subject to emissions caps. In May 2005, EPA issued the Clean Air Mercury Rule (CAMR). 70 Fed. Reg. 28606 (May 18, 2005). CAMR would have permanently capped emissions of mercury for new and existing coal-fired power plants in all states by 2010. However, on February 8, 2008, the

D.C. Circuit issued a decision in *New Jersey v. Environmental Protection Agency*, in which it vacated CAMR. 517 F.3d 574 (D.C. Cir. 2008). EPA has decided to develop emissions standards for power plants under the Clean Air Act (Section 112), consistent with the D.C. Circuit's opinion on CAMR. See http://www.epa.gov/air/mercuryrule/pdfs/certpetition_withdrawal.pdf. Pending EPA's forthcoming revisions to the rule, DOE is excluding CAMR from its Environmental Analysis. In the absence of CAMR, a DOE standard would likely reduce Hg emissions and DOE plans to use NEMS-BT to estimate these emission reductions. However, DOE continues to review the impact of rules that reduce energy consumption on Hg emissions, and may revise its assessment of Hg emission reductions in future rulemakings.

15.5 Particulate Matter

DOE acknowledges that particulate matter (PM) exposure can impact human health. Power plant emissions can have either direct or indirect impacts on PM. A portion of the pollutants emitted by a power plant are in the form of particulates as they leave the smoke stack. These are direct, or primary, PM emissions. However, the great majority of PM emissions associated with power plants are in the form of secondary sulfates, which are produced at a significant distance from power plants by complex atmospheric chemical reactions that often involve the gaseous (non-particulate) emissions of power plants, mainly SO_2 and NO_x. The quantity of the secondary sulfates produced is determined by a very complex set of factors including the atmospheric quantities of SO_2 and NO_x, and other atmospheric constituents and conditions. Because these highly complex chemical reactions produce PM comprised of different constituents from different sources, EPA does not distinguish direct PM emissions from power plants from the secondary sulfate particulates in its ambient air quality requirements, PM monitoring of ambient air quality, or PM emissions inventories. For these reasons, it is not currently possible to determine how the amended standard impacts either direct or indirect PM emissions. Therefore, DOE is not planning to assess the impact of these standards on PM emissions. Further, as described previously, it is uncertain whether efficiency standards will result in a net decrease in power plant emissions of SO_2 and NO_x, since those pollutants are now largely regulated by cap and trade systems.

Item 15-1	*DOE seeks input on its plans to use NEMS-BT to conduct the environmental impact analysis on the equipment covered by this rulemaking. DOE is particularly interested in whether there are any other approaches to the environmental assessment that it should consider and the advantages and disadvantages for each approach.*

16.0 MONETIZATION OF EMISSIONS REDUCTIONS

For those emissions for which national emission reductions are anticipated (CO_2, Hg, and NO_x for 22 states), only ranges of estimated economic values based on environmental damage studies of varying quality and applicability are available. Therefore, DOE intends to report estimates of monetary benefits derived using these values and consider these benefits in weighing the costs and benefits of each of the standard levels considered.

In order to estimate the monetary value of benefits resulting from reduced emissions of CO_2, it is DOE's intent to use in its analysis the most current Social Cost of Carbon (SCC) values developed and/or agreed to by interagency reviews. The SCC is intended to be a monetary measure of the incremental damage resulting from greenhouse gas (GHG) emissions, including, but not limited to, net agricultural productivity loss, human health effects, property damage from sea level rise, and changes in ecosystem services. Any effort to quantify and to monetize the harms associated with climate change will raise serious questions of science, economics, and ethics. But with full regard for the limits of both quantification and monetization, the SCC can be used to provide estimates of the social benefits of reductions in GHG emissions.

At the time of this notice, the most recent interagency estimates of the potential global benefits resulting from reduced CO_2 emissions in 2010 were $4.9, $22.3, $36.5, and $67.5 per metric ton in 2009 dollars. These values are then adjusted to 2009$ using the standard gross domestic product deflator value for 2008 and 2009. For emissions (or emission reductions) that occur in later years, these values grow in real terms over time. Additionally, the interagency group determined that a range of values from 7 percent to 23 percent should be used to adjust the global SCC to calculate domestic effects, although DOE will give preference to consideration of the global benefits of reducing CO_2 emissions. To calculate a present value of the stream of monetary values, DOE will discount the values in each of the four cases using the discount rates that had been used to obtain the SCC values in each case.

DOE recognizes that scientific and economic knowledge continues to evolve rapidly as to the contribution of CO_2 and other GHG to changes in the future global climate and the potential resulting damages to the world economy. Thus, these values are subject to change.

DOE also intends to estimate the potential monetary benefit of reduced NO_x emissions resulting from the standard levels it considers. Available estimates suggest a very wide range of monetary values for NO_x emissions, from $370 per ton to $3,800 per ton of NO_x from stationary sources, measured in 2001$ (equivalent to a range of $447 to $4,591 per ton in 2009$).[32] In accordance with OMB guidance, DOE will conduct two calculations of the monetary benefits derived using each of the economic values used for NO_x, one using a real discount rate of 3 percent and another using a real discount rate of 7 percent.[33]

DOE does not plan to monetize estimates of Hg in this rulemaking. DOE is aware of multiple agency efforts to determine the appropriate range of values used in evaluating the potential economic benefits of reduced Hg emissions. DOE has decided to await further guidance regarding consistent valuation and reporting of Hg emissions before it once again monetizes Hg in its rulemakings.

Item 16-1 DOE invites comments on its approach to monetization of emissions.

[32] For additional information, refer to the OMB *2006 Report to Congress on the Costs and Benefits of Federal Regulations and Unfunded Mandates on State, Local, and Tribal Entities*. Available online at: www.whitehouse.gov/sites/default/files/omb/assets/omb/inforeg/2006_cb/2006_cb_final_report.pdf.

[33] OMB, Circular A-4: Regulatory Analysis (Sept. 17, 2003).

17.0 REGULATORY IMPACT ANALYSIS

Pursuant to section 6(a)(3) of Executive Order (E.O.) 12866, "Regulatory Planning and Review," 58 FR 51735 (October 4, 1993), if DOE determines that amended energy conservation standards for automatic commercial ice-making equipment would constitute a significant regulatory action, during the NOPR stage DOE will prepare and submit to OMB (1) an assessment of the costs and benefits of the proposed regulation, and (2) if the proposed rule is also significant under section 3(f)(1) of the E.O., a regulatory impact analysis (RIA), which is subject to review under the Executive Order by the Office of Information and Regulatory Affairs at OMB. The RIA would address the potential for non-regulatory approaches to supplant or augment energy conservation standards to improve the energy efficiency or reduce the energy consumption of the automatic commercial ice-making equipment covered under this rulemaking in the market.

DOE recognizes that voluntary or other non-regulatory efforts by manufacturers, utilities and other interested parties can result in substantial improvements to energy efficiency or reductions in energy consumption. DOE intends to consider the likely effects of non-regulatory initiatives on equipment energy use, consumer utility, and LCCs. DOE will base its assessment on the actual impacts of any such initiatives to date and will consider information presented regarding the impacts that any existing initiative might have in the future.

Item 17-1	*DOE seeks comment regarding programs that should be examined as optional, non-regulatory approaches.*

APPENDIX A – LIST OF ITEMS FOR COMMENT

This appendix lists all the items for comment contained in this framework document and the page numbers on which those items can be found.