PACKAGED COMMERCIAL REFRIGERATION EQUIPMENT: A BRIEFING REPORT FOR PROGRAM PLANNERS AND IMPLEMENTERS

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ABSTRACT

Packaged refrigeration systems include reach-in refrigerators and freezers, ice-makers, refrigerated vending machines, beverage merchandisers, and walk-in refrigerators and freezers. Packaged refrigeration equipment accounts for about two-thirds of commercial refrigeration electricity use. Most efforts to date to reduce energy used for refrigeration have focused on supermarket refrigeration systems, leaving packaged systems as a major untapped opportunity.

In particular, reach-in refrigerators and freezers and ice-makers are ripe for efficiency programs, as there is now an ENERGY STAR® program for reach-ins and Federal Energy Management Program (FEMP) recommendations for ice-makers, and the Consortium for Energy Efficiency (CEE) has just finalized tier 1 and tier 2 specifications for both types of equipment. Work to develop specifications to identify efficient vending machines and beverage merchandisers is also proceeding, and these specifications should be ready for efficiency programs by 2004 or perhaps even mid-2003. Moreover, one type of vending machine control, the Vending Miser™, has been shown in many tests to be a cost-effective way to reduce vending machine energy use and should be considered for use in energy efficiency programs today.

We recommend that energy efficiency program operators begin a program in 2003 to promote reach-ins and ice-makers meeting the CEE tier 1 and tier 2 specifications. We provide specific program recommendations at the end of this report. We also advise that program operators promote the Vending Miser control for vending machines in 2003. In addition, we propose that program implementers support efforts to (1) develop ENERGY STAR and CEE specifications for vending machines and beverage merchandisers (so that this equipment can be promoted in 2004) and (2) enact minimum-efficiency standards on reach-ins and ice-makers at the national and state levels in order to complete the market transformation process. (California and other states as well as the U.S. Department of Energy [DOE] are now working on such standards.)

ACKNOWLEDGEMENTS

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BACKGROUND

In 1996, refrigeration systems accounted for approximately 7% of U.S. commercial sector primary energy use and 10% of electricity use. The two major categories of commercial refrigeration products are packaged and built-up systems. Packaged systems, alternatively called "self-contained" systems, incorporate components of the refrigeration system along with the refrigerated compartment in a single package. The whole component is built at the factory and then shipped to the site. Examples of packaged refrigeration systems include commercial refrigerators and freezers, vending machines, ice-makers, beverage merchandisers, and walk-in refrigerators and freezers.[1] Built-up systems, alternatively called "remote" or "centralized" systems, typically involve a single compressor or compressor rack that serves a number of refrigerated cases and are usually custom designed and built on-site. These systems are extensively used in supermarkets.

To date, more attention has been given to the energy use of built-up systems. However, as shown in Figure 1, packaged systems comprise approximately two-thirds of commercial refrigeration energy use (ADL 1996; Easton 1993). Furthermore, because packaged systems have not received much attention, there are generally large, highly cost-effective opportunities to improve the efficiency of packaged systems—in some cases reducing energy use by as much as 50% relative to typical equipment on the market today.

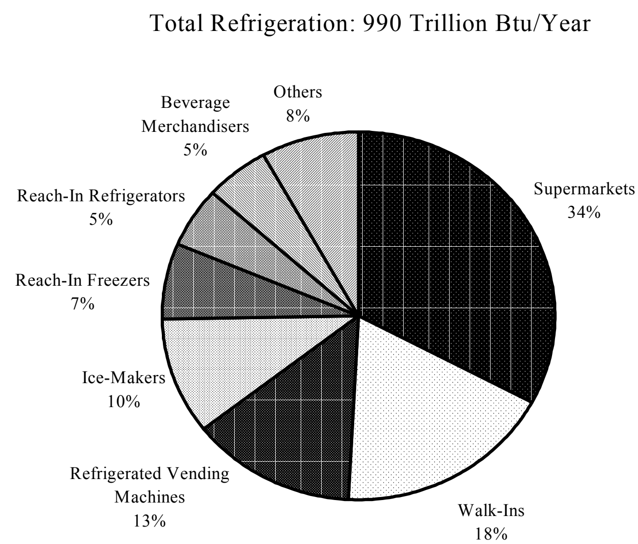

Figure 1. Primary Energy Usage by Equipment Type
Source: ADL 1996

As shown in Figure 1, there are five major types of packaged commercial refrigeration equipment—walk-ins, vending machines, reach-ins, ice-makers, and beverage merchandisers. Of these products, reach-ins and ice-makers are a ripe target for energy efficiency programs today, and most of this report concentrates on these two products. These two products account for approximately 22% of commercial refrigeration energy use and about 33% of packaged commercial refrigeration energy use. There is presently an ENERGY STAR specification for efficient reach-ins and a FEMP specification for efficient ice-makers. In addition, CEE has just finished developing tier 1 and tier 2 specifications for this equipment and many manufacturers are introducing or developing new efficient products.

[1] Most walk-in refrigerators and freezers have their own refrigeration system and thus are "packaged" systems, but the "room"—the refrigerated compartment—is generally built on-site from prefab kits.

Vending machines and beverage merchandisers will likely provide a good opportunity for energy efficiency programs in 2004 (or perhaps even mid-2003). In the case of vending machines, EPA is starting to develop an ENERGY STAR specification, but this specification will not be completed until 2003. As of this writing, EPA has circulated an initial draft specification for comment but hopes to collect additional data on vending machine energy use before this specification is finalized. In addition, energy can be saved with retrofit controls for vending machines. This opportunity is discussed later in this report. Data availability has also constrained development of an efficiency specification for beverage merchandisers. Progress has been made on this issue and it is likely that a specification can be developed in 2003. Walk-ins provide a longer-term opportunity, as work is still needed on test procedures before accurate energy consumption data can be compiled. The California Energy Commission is starting to look into this issue, potentially laying the groundwork for program efforts in 2005 or thereabouts. Further information on vending machines, beverage merchandisers, and walk-in refrigerators and freezers can be found in other ACEEE papers (Kubo and Nadel 2002; Nadel 2002).

TECHNOLOGY DESCRIPTION

Reach-in refrigerators and freezers are upright, refrigerated cases with solid or transparent doors. They consist of a case, insulation, shelves, refrigeration system, and defrost system. For reach-in refrigerators and freezers, about 80% of the electricity is consumed by the refrigeration system (compressor, evaporator fans, and condenser fan), while the remainder is used for the defrost system.

Reach-in systems include standard reach-in (with doors on one side), roll-in (the bottom is level with the outside floor, permitting wheeled carts to be rolled in), pass-through (with doors on opposite sides), and roll-through (combination of roll-in and pass-through) cabinet types. Beverage merchandisers are a special type of reach-in with glass doors and sometimes glass sides to permit customers to see beverages for sale (see Figure 2 for illustrative examples). Beverage merchandisers also generally have a fluorescent lighting system to illuminate logos and contents.

Reach-In Refrigerator & Freezer

Roll-In Refrigerator & Freezer

Beverage Merchandiser

Figure 2. Illustrations of Common Food Service Refrigeration Systems

The energy use of reach-in refrigerators is measured with the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE) test procedure 117. The test procedure does not specify interior temperatures. To address this limitation, the ENERGY STAR specification requires testing to be done with the interior temperature at 38°F for refrigerator compartments and 0°F for freezer compartments.

A typical ice-maker consists of a case, insulation, refrigeration system, and a water supply system. Some of the smaller models have an integrated ice storage bin, but most ice-makers have only an ice-making system and are installed on top of a separate insulated ice-storage bin. Approximately 80% of ice-makers sold have integrated air-cooled condensers, while others have remote air-cooled or integral water-cooled configurations. All rated ice-makers use vapor compression refrigeration to produce ice.

Ice-makers consist of two major subsystems: the refrigeration system and water supply system. Most of the energy savings potential exists in the refrigeration system. Energy use for commercial ice-makers can vary considerably from product to product– depending on the machine's capacity, the type of ice produced (e.g., cubes, flakes, chips, nuggets, etc.), and the coolant used—but in general, energy use per pound of ice produced decreases as the capacity of the machine increases.

The Air-conditioning and Refrigeration Institute (ARI) publishes a voluntary energy usage test standard for ice cube machines. This standard, based on an earlier ASHRAE test method, measures ice harvest rate, energy use, and water use for the following types of ice cube makers.

- Ice-making head units: standard ice-makers with the ice-making mechanism and the condensing unit in a single package, but with a separate ice storage bin
- Self-contained units: models in which the ice-making mechanism and storage compartment are in an integral cabinet
- Remote condensing units: split-system models in which the ice-making mechanism, the condensing unit, and the ice storage bins are in separate sections

Ice-making head units and self-contained units are subdivided into models that use air or water as their cooling medium.

MARKET STRUCTURE

The reach-in and ice-maker markets are highly fragmented due to the diversity of system types; complex distribution, sales, and service chains; and the large variety and size of food stores, food service establishments, hospitals, schools, hotels, and other users. Typically, manufacturers work through regional sales offices or manufacturers' representatives to sell equipment to equipment dealers, beverage and food distributors, or franchises. These various parties in turn sell equipment to end-users. However, manufacturers will often sell direct to large chains such as McDonalds, cutting out the middlemen.

Major classes of end-users include food service establishments (e.g., restaurants, institutional cafeterias, fast food establishments, delicatassens, and bars), food sales (e.g., convenience stores), hospitals, and hotels. However, many of the refrigeration units used in food sales are either beverage merchandisers (i.e., low-cost units designed to display and market soft drinks) or built-up systems (multiple display cases served by a set of refrigeration compressors) and not the reach-in units covered by this report. Of these end-users, many make purchase decisions on an individual facility basis, but some chains make decisions or recommendations at a corporate or regional level, providing a useful leverage point for influencing sales. In addition, there is also a sizable used equipment market. For example, according to the North American Food Equipment Manufacturers (NAFEM), roughly 50% of units purchased by restaurants are of used equipment (ADL 1996).

For reach-in refrigerators and freezers, equipment tends to be grouped into two lines—"standard-line" units, representing about 70% of the market, and "specification-line" units. Standard-line units, which tend to be less expensive, are primarily sold to commercial food establishments. Specification-line units have improved cosmetics and durability (but not necessarily reduced energy consumption) and are sold primarily to institutional food service establishments (Easton 1993). Major manufacturers and their market shares for reach-ins are summarized in Table 1.

Table 1. Market Share by Manufacturer for Reach-In Refrigerators and Freezers

Standard Line		Specification Line	
Manufacturer	Market Share (%)	Manufacturer	Market Share (%)
True	20	Traulsen	30
Beverage Air	12	Hobart	20
Delfield	12	Victory	15
Hobart	6	Delfield	9
McCall	6	Beverage Air	9
Glenco-Star	4	McCall	8
Other	40	Other	10
Total	100	Total	100*

Source: Easton Consultants 1993
* does not equal 100 due to rounding

Ice-makers are commonly used in hospitals, hotels, food service, and food preservation. Figure 3 shows the end-use segments of the ice-maker market by electricity consumption. Ice cube-makers account for more than 80% of ice-maker sales, but models are also available that produce ice flakes, chips, crushed ice, and nugget ice. End-users usually purchase ice-makers from manufacturers' regional distributors. There are five major manufacturers: Manitowoc Equipment Works; Scotsman Ice Systems/Crystal Tips; Hoshizaki America; Mile High Equipment; and IMI Cornelius, all members of ARI. The approximate market share of these manufacturers is shown in Figure 4. ARI sets test procedures and requires manufacturers to submit energy consumption data for all ice cube models on the market. Ice-makers are the only commercial refrigeration system with comprehensive data on comparative energy usage of different models.

MARKET BARRIERS TO EFFICIENCY IMPROVEMENTS

While opportunities for improving energy efficiency are large, the barriers hindering adoption of these measures are also large. Among the major barriers are: (1) a focus by most purchasers on first cost; (2) limited information about and awareness of energy use differences among competing products; and (3) the fact that historically manufacturers have made little effort to differentiate equipment on the basis of energy efficiency or operating costs, with the result that many options for improving efficiency are not incorporated into commercial models.

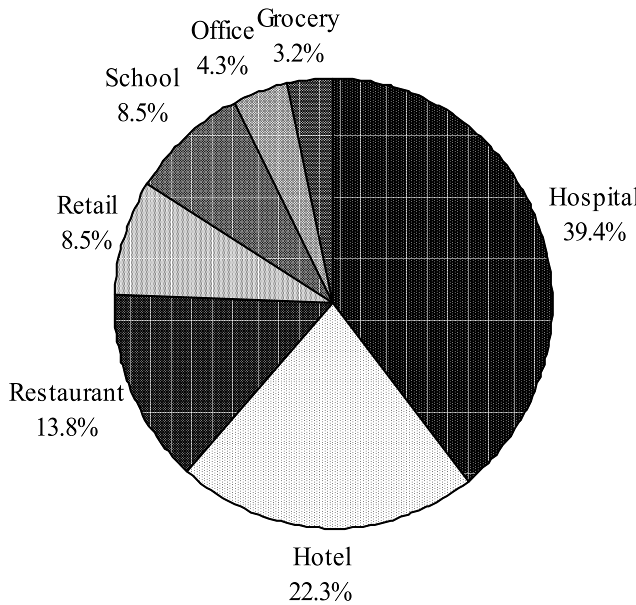

Figure 3. End-Use Segments of the Ice-Maker Market by Electricity Consumption
Source: ADL 1996

The annual energy cost for a model that produces 800 pounds of ice per 24 hours is as much as $480. Since the end-user who owns the ice-maker usually pays the energy bill, ice-maker manufacturers tend to pay more attention to energy efficiency (as well as water-use efficiency) than they do for other refrigeration products. In fact, several manufacturers such as Manitowoc and Mile High promote energy efficiency as a selling point over other manufacturers' models. However, the focus on energy efficiency varies widely among manufacturers and therefore it is very difficult to gain consensus on higher-efficiency standards or voluntary labeling programs. Furthermore, end-users are often unaware of how significant the difference in life-cycle costs can be and tend to focus on design, size, and additional functions at the time of purchase, which in turn discourages manufacturers from in-vesting in energy-efficient products.

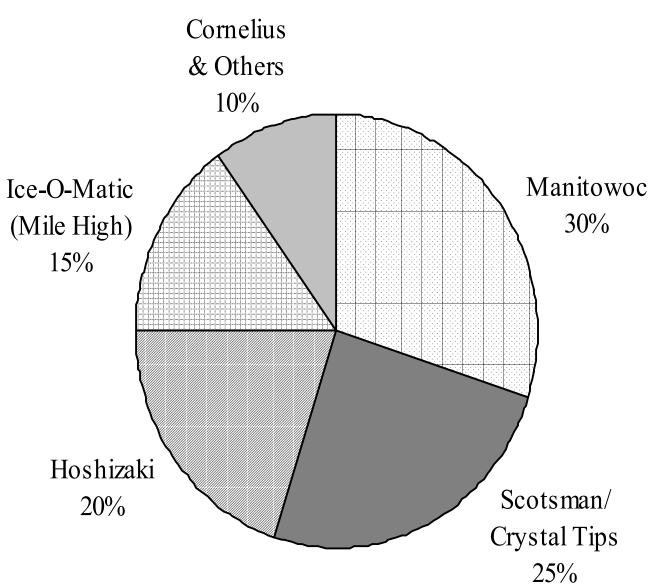

Figure 4. Major Ice-Maker Manufacturers and Approximate Market Share
Source: ADL 1996

ENERGY SAVINGS POTENTIAL AND CONSUMER PAYBACK

There are substantial opportunities to improve the efficiency of food service refrigerators. For example, ADL (1996) found that the energy use of reach-in refrigerators and freezers can be reduced by approximately 45% using measures with an average simple payback of just over 2 years. The ADL findings for reach-in refrigerators and freezers are summarized in Tables 2 and 3. These findings are relative to 1996 baseline models. Data comparing 1996 and current baseline models are limited, but indicate that typical 2002 models may be slightly more efficient than those in 1996.

Table 2. Reach-In Refrigerator Energy Savings (Relative to 1996 Base Model)

Technology	Electricity Savings (%)	Cost Premium ($)	Annual Savings ($) (@$.0782/ kWh)	Payback (years)
High-Efficiency Compressors	12	16	40	0.4
Non-Electric Anti-sweat	20	93	67	1.4
Condenser Fan ECM Motor	3.3	22	11	2.0
Evaporator Fan ECM Motor	7	48	23	2.1
ECM/Variable Speed Compressor	16	150	54	2.8
Thicker Insulation	2	100	8	13
Total for Measures with <2-Year Payback	35	131	118	1.1
Total for Measures with <5-Year Payback	45	313	152	2.1

Source: ADL 1996

Note: Savings not additive due to interactions between measures, ECM = electrically commutated motor.

Table 3. Reach-In Freezer Energy Savings (Relative to 1996 Base Model)

Technology	Electricity Savings (%)	Cost Premium ($)	Annual Savings ($) (@ 0.0782/ kWh)	Payback (years)
High-Efficiency Compressors	16	24	65	0.4
Non-Electric Anti-sweat	14	67	58	1.2
ECM/Variable Speed Compressors	19	160	77	2.1
Condenser Fan ECM Motor	2.7	24	11	2.2
Evaporator Fan ECM	2.3	24	9	2.6
Hot Gas Defrost	6.3	83	26	3.2
Thicker Insulation	3.8	84	15	5.5
Liquid-Suction Heat-Exchanger	3.4	75	14	5.5
Total for Measures with <2-Year Payback	30	91	123	0.7
Total for Measures with <5-Year Payback	44	382	178	2.1

Source: ADL 1996

Note:Savings not additive due to interactions between measures, ECM = electrically commutated motor.

Recently, Delfield, with assistance from DOE and Arthur D. Little, Inc., developed the Vantage 6000 series reach-in refrigerators, which yield up to 68% energy savings relative to comparable prior Delfield models. According to Delfield, the more efficient models cost less to produce than the baseline models due to production cost savings from improved design (production cost savings are greater than the cost to improve efficiency). The new series uses a new cabinet design and innovative materials to improve insulation and decrease thermal leakage. Figure 5 (on p. 10 of this report) illustrates how one of the new Delfield products is significantly superior to other current models in terms of energy efficiency (ADL 2001; Sunderman 2002).

The ADL 1996 study for DOE also estimates that energy savings of 18% can be realized in ice-makers through the use of high-efficiency compressors and fan motors, thicker insulation, and other measures, at an added cost that is expected to pay back in a little over 2 years (ADL 1996). A comparison of the most and least efficient units on the market today also illustrates the potential for cost-effective energy savings. Such an analysis for each type of ice-maker and various harvest rates is summarized in Table 4 and shows that the best models achieve energy savings of 18–46% over the worst models, with a payback period of 1.1 years or less. In some cases, the more efficient models are listed at a lower first cost than the less efficient models.

Table 4. Payback Analysis of Most and Least Energy-Efficient Ice-Makers

	Worst Model		Best Model			
Ice Harvest (lbs./24hrs.)	Energy Use (kWh/100 lbs. of ice)	Market Price ($)	Energy Use (kWh/100 lbs. of ice)	Market Price ($)	Energy Savings (%)	Payback (years)
Air-Cooled Ice-Making Head Unit						
200	11.1	1,410	7.9	1,463	29%	0.9
500	8.3	1,940	5.8	1,940	30%	0 (instant)
1000	7.8	3,020	5.1	3,285	35%	1.1
Water-Cooled Ice-Making Head Unit						
500	7.0	2,585	4.6	1,940	34%	0 (instant)
1000	7.1	3,020	3.8	2,820	46%	0 (instant)
Air-Cooled Remote Condensing Unit						
500	8.4	1,895	6.1	1,895	27%	0 (instant)
1000	7.6	2,970	4.9	3,235	36%	1.1
Air-Cooled Self-Contained Unit						
150	13.0	1,565	10.7	1,485	18%	0 (instant)
Water-Cooled Self-Contained Unit						
250	9.0	1,830	7.2	1,775	20%	0 (instant)

Sources: ACEEE analysis based on data from ARI 1999; catalogs of major manufacturers
Notes: Assumes 50% discount from list price (based on communication with local distributors), 3000 operating hours/year, and an electricity rate of $0.07/kWh.

From the above analysis, 30% of the energy can be saved from replacing the least efficient model with the most efficient model with little or no incremental cost. Assuming that the weighted average efficiency is somewhere between these models, approximately 15% of the total energy use, can be saved annually across the country based on the best designs now on the market.

Furthermore, more efficient designs are also possible. A major manufacturer (who wishes to remain anonymous) has indicated to us that it has developed designs for products that can reduce energy use of the best current models by an additional 25%. It estimates the simple payback to the consumer at approximately 6–9 months. It is now planning to start introducing these models to the market in 2003. Another major manufacturer has told us that it is now designing a new set of efficient models, targeting 20% energy savings relative to its current models.

PAST AND CURRENT EFFORTS

Reach-In Refrigerators and Freezers

In the 1980s, the California Energy Commission (CEC) adopted regulations requiring manufacturers that sell commercial refrigerators and freezers in California to provide energy performance and other basic information to the commission (based on ASHRAE test procedures). These regulations cover new refrigerators with interior volumes up to 39 cubic feet and freezers with volumes up to 30 cubic feet. CEC compiles this information in a database and posts this database on their Webpage (CEC 2002). CEC recently updated its regulations in order to refine coverage and requirements and close a few loopholes. This database provides a fairly good foundation for setting specifications and standards on most reach-in products.

During the 1996–1998 period, the Canadian Standards Association (CSA) developed an *Energy Performance Standard for Food Service Refrigerators and Freezers* (CSA 1998b). The standard includes testing requirements (building on ASHRAE standard 117), minimum-efficiency levels, and recommended efficiency levels (labeled "high efficiency"). The minimum levels were selected to allow about 75% of existing units to pass while the high-efficiency levels include the top 25% of existing units. The Canadian federal government is considering adopting the CSA minimum levels as a mandatory Canadian federal standard, perhaps in the next ammendment cycle in 2003 (Cockburn 2002). However, a glitch in the analysis process for glass-door units (including beverage merchandisers) led to much weaker standards for these products. According to an ACEEE analysis, nearly all glass-door units in the CSA database meet the high-efficiency levels (Nadel 1998).

Table 5. Energy Star Specifications for Reach-In Refrigerators/Freezers

Equipment Type	Maximum Daily Energy Consumption (kWh)
Refrigerators	
Reach-In	0.10V + 2.04
Freezers	
Reach-In	0.40V + 1.38
Ice Cream	0.39V + 0.82
Refrigerator/Freezers	
Reach-In	0.27AV - 0.71

Also in 1999, EPA began investigating the possibility of establishing an ENERGY STAR program for reach-in refrigerators and freezers. EPA circulated a draft specification to collect comments from manufacturers and interested parties in early 2001, and finalized its specification in September 2001 (EPA 2001). The EPA specification (shown in Table 5) is based on an analysis of the CEC database and is designed to differentiate the most efficient quartile of products. As such, it is more stringent than the CEC minimum-efficiency standards (discussed below).

CEC recently amended its appliance efficiency regulations to include minimum-efficiency standards for commercial food service refrigerators. The CEC standard levels listed in Table 6 are based on an analysis of the CEC database by ACEEE. The CEC standard has two tiers—the first becoming effective in February 2003 and the second in August 2004. tier 1 is approximately the 25th percentile (25% of models do not meet the standard) and tier 2 is approximately the 50th percentile. Figure 5 illustrates the efficiency distribution of products in the CEC database and the two CEC standard levels as well as the ENERGY STAR specification.

Table 6. CEC Standards for Food Service Refrigerators

Appliance	Door Type	Maximum Daily Energy Consumption, kWh	
		March 1, 2003	August 1, 2004
Reach-In, Roll-In, Roll-Through, Pass-Through, and Wine Chilling Refrigerators	Solid	0.125 V + 4.22	0.125 V + 2.76
Reach-In, Roll-In, Roll-Through, Pass-Through, and Wine Chilling Refrigerators	Transparent	0.172 V + 5.78	0.172 V + 4.77
Reach-In, Roll-In, Roll-Through, Pass-Through, and Freezers	Solid	0.398 V + 2.83	0.398 V + 2.28
Reach-In, Roll-In, Roll-Through, Pass-Through, and Freezers	Transparent	0.94 V + 5.10	0.94 V + 5.10
Reach-In, Roll-In, Roll-Through, Pass-Through, and Refrigerator/Freezers	Solid	0.273 AV + 2.63	0.273 AV + 1.65

Source: CEC 2002
Note: V = internal volume, AV = adjusted volume (fresh food compartment volume + 1.63 x freezer compartment volume).

The energy bill passed by the United States Senate in April 2002 directs DOE to set minimum-efficiency standards for reach-in refrigerators (U.S. Senate 2002). This provision had bipartisan support but the legislation died when Congress recessed in late 2002. It is likely that similar legislation will be considered in 2003 by the new Congress. Under the rulemaking schedule called for in the bill, federal standards would be set 3 years after enactment of the legislation (i.e., sometime in 2006) and take effect 3 years later (i.e., mid- to late 2009).

In addition, utilities and other program implementers are beginning to explore promotion and incentive programs for ENERGY STAR reach-in units. CEE has formed a committee to develop a program (Schwom 2002) and the Northwest Power Planning Council has developed a calculator for estimating savings from programs operated by Northwest utilities (Eckman 2002). In addition, NYSERDA has just amended its “Smart Equipment Choices” program and is now providing incentives of $75–150 for reach-in refrigerators and freezers that meet the ENERGY STAR specification (incentives vary as a function of unit size) (Henderson 2002). Other efficiency programs are also exploring options for promoting efficient reach-ins (and ice-makers), including the Energy Trust of Oregon, California utilities, Wisconsin's Focus on Energy program, and several New England utilities.

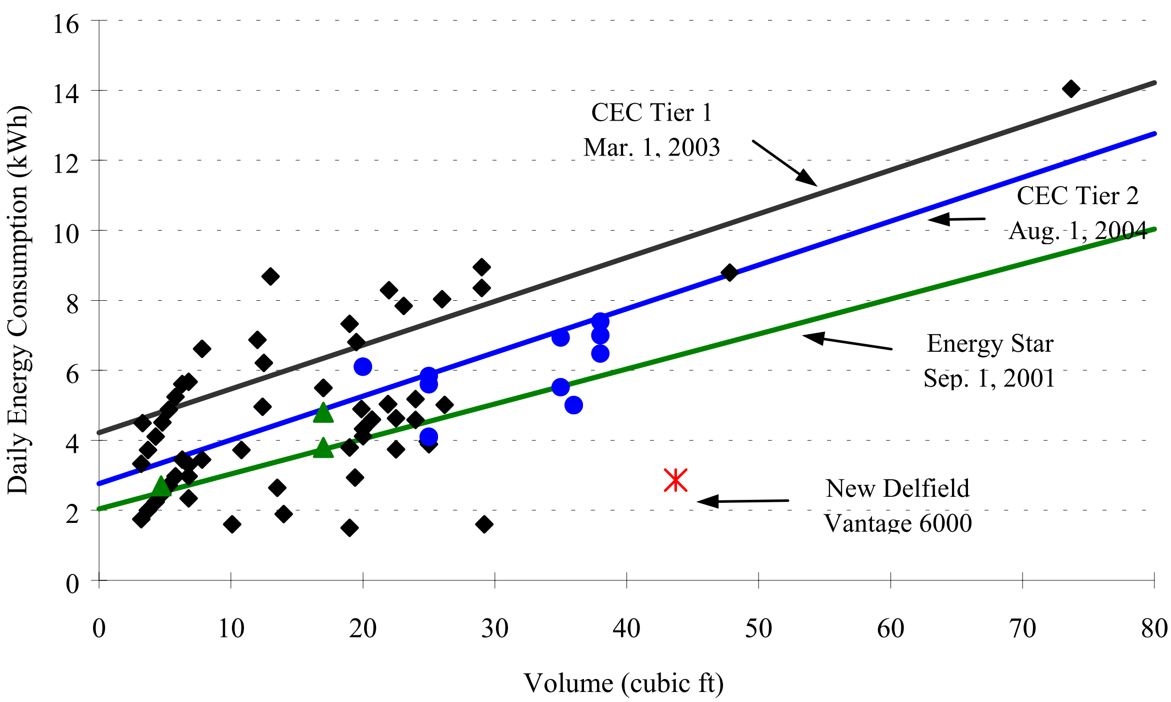

Figure 5. CEC Tier 1 and Tier 2 Standards and ENERGY STAR Criteria for Solid-Door, Reach-In, Roll-In/Through, Pass-Through, and Wine Chilling Refrigerators[2]
Sources: CEC 2000, 2002; EPA 2001; Sunderman 2002

The CEE committee has just completed development of a two-tier specification for reach-in refrigerators and freezers, based on analysis of the EPA database of ENERGY STAR models. CEE's tier 1 is identical to the ENERGY STAR specification. CEE's tier 2 is based on the most efficient models now on the market. The intent of tier 2 is to encourage additional manufacturers to produce these very efficient models. The CEE specifications are shown in Table 7 and Figures 6 and 7.

Table 7. CEE Specification for Solid-Door Reach-in Refrigerators and Freezers

Equipment	Tier	Description of Specification	Maximum Energy Use (kWh/day)
Refrigerator	1	ENERGY STAR	0.10 V + 2.04
	2	ENERGY STAR + 40%	0.06 V + 1.22
Freezer	1	ENERGY STAR	0.40 V + 1.38
	2	ENERGY STAR + 30%	0.28 V + 0.097

Note: V = internal volume.

[2] Reach-ins are shown in diamonds, roll-in/through and pass-through are shown in circles, and wine chillers are shown in triangles.

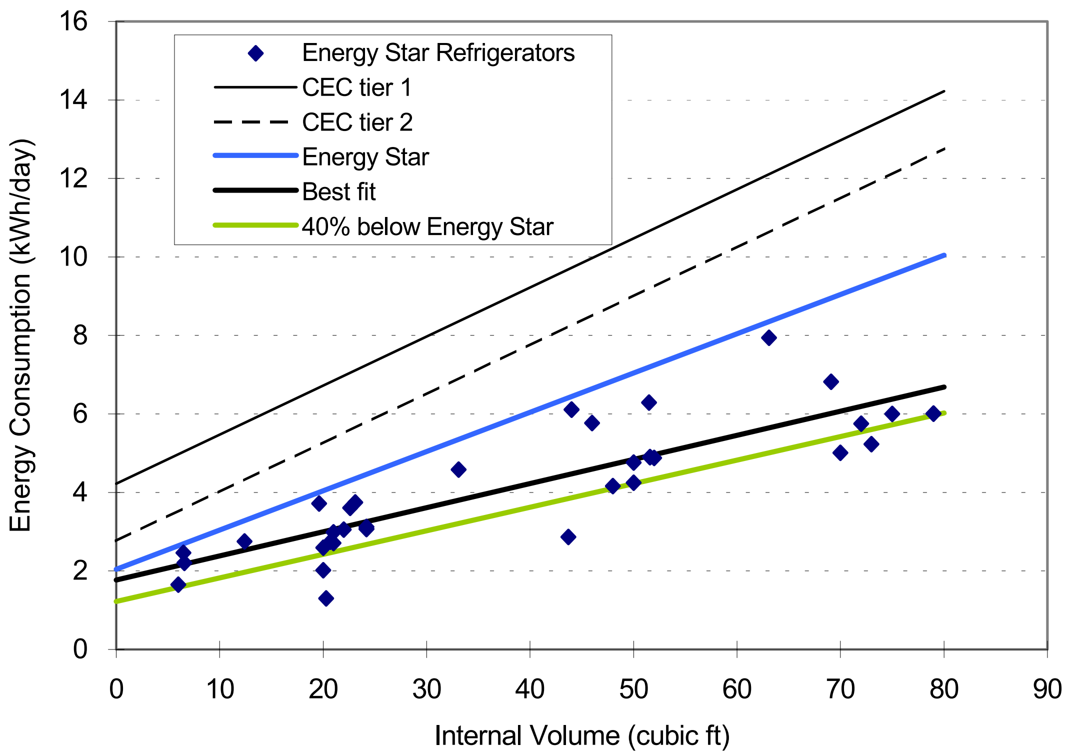

Figure 6. Distribution of ENERGY STAR Reach-In Refrigerators Relative to ENERGY STAR, CEC Standards, and CEE Tier 2 Specification

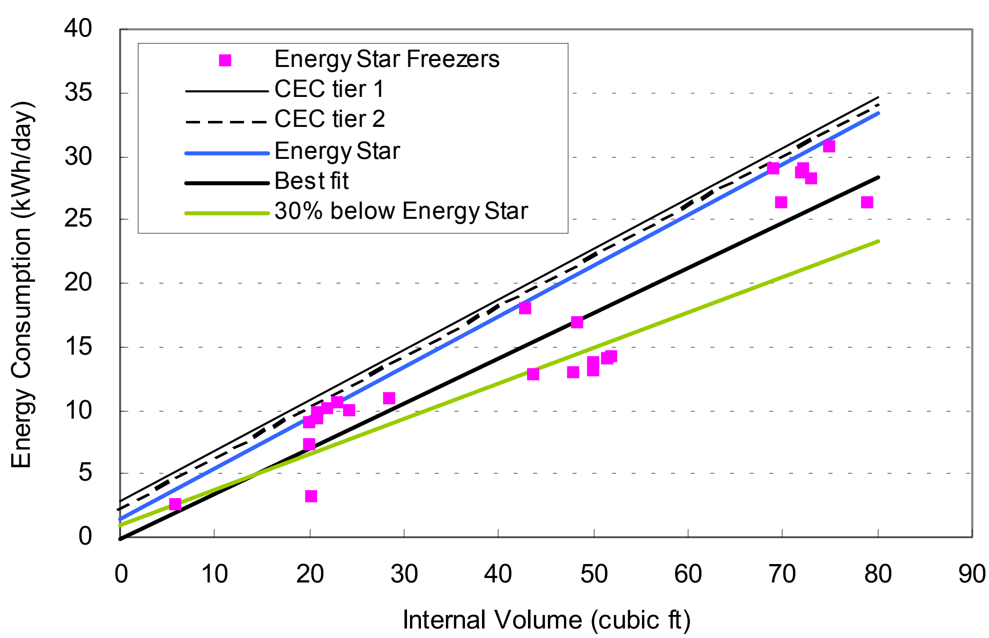

Figure 7. Distribution of ENERGY STAR Reach-In Freezers Relative to ENERGY STAR Specification, CEC Standards, and CEE Tier 2 Criteria

These specifications were approved by CEE's Board of Directors in December 2002.

Ice-Makers

As explained earlier in this section, the first (and most difficult) step in energy efficiency initiatives—establishing a testing standard and collecting data—has been achieved by ARI. It has developed a certification program and lists that contain all eligible models in a directory that is updated every 6 months.

Using this database, Lawrence Berkeley National Laboratory (LBNL) developed purchasing recommendations for FEMP. The first recommendations were made in 1996, which it updated in 1999 with input from ACEEE and EPA. FEMP generally recommends the top 15–25% of models on the market, with respect to energy efficiency, but adjusts the criteria so at least two manufacturers have complying models in each category. Using the March 2000 ARI directory, 19% of available models meet FEMP recommendations. Table 8 shows the current FEMP recommendations.

CSA developed its own voluntary standards using the ARI database and later the Canadian government adopted this as a mandatory standard, effective December 31, 1998 (CSA 1998a). Again using the March 2000 ARI database, 83.7% of available models meet the Canadian standard.

EPA has periodically worked to develop an ENERGY STAR ice-makers program. Although some manufacturers who produce the most efficient models showed initial interest in the program, when ARI declined to support the program, these manufacturers chose to back the association's decision. Difficulty in gaining support from the trade association has led EPA to put the program on hold (Shmeltz 2001).

Recently, utilities in the Northwest have begun considering purchasing incentive programs for ice-makers. They are now developing specifications based on the FEMP qualification levels, but in which the qualifying energy use varies continuously as a function of ice-making capacity rather than the "stair-step" pattern in the FEMP specification (Eckman 2002). NYSERDA recently began providing incentives of $50 for ice-makers meeting the FEMP specification (Henderson 2002). And as discussed above under reach-ins, several efficiency programs are considering efforts to promote both efficient reach-ins and ice-makers.

Table 8. FEMP Recommendations for Ice-Cube Makers

Condenser Type	Ice Harvest Rate (lbs./24 hrs.)	Energy Consumption (kWh/100 lbs. of ice)	
		Recommended	Best Available
Ice-Making Head Units			
Air-Cooled	101–200	9.4 or less	8.6
Air-Cooled	201–300	8.5 or less	7.9
Air-Cooled	301–400	7.2 or less	7.1
Air-Cooled	401–500	6.1 or less	5.8
Air-Cooled	501–1,000	5.8 or less	5.4
Air-Cooled	1,001–1,500	5.5 or less	5.1
Water-Cooled	201–300	6.7 or less	5.9
Water-Cooled	301–500	5.5 or less	4.7
Water-Cooled	501–1,000	4.6 or less	3.8
Water-Cooled	1,001–1,500	4.3 or less	4.1
Water-Cooled	> 1,500	4.0 or less	3.7
Self-Contained Units			
Air-Cooled	101–200	10.7 or less	9.5
Water-Cooled	101–200	9.5 or less	7.5
Water-Cooled	201–300	7.6 or less	7.2
Remote Condensing Units			
Air-Cooled	301–400	8.1 or less	7.9
Air-Cooled	401–500	7.0 or less	6.1
Air-Cooled	501–1,000	6.2 or less	5.4
Air-Cooled	1,001–1,500	5.1 or less	4.6
Air-Cooled	> 1,500	5.3 or less	4.9

Source: FEMP 2002

In addition, CEE has developed specifications for ice-makers. As with reach-ins, CEE developed a two-tier specification. Tier 1 is designed to approximate the FEMP specification, but using a straight-line function rather than a stair-step pattern. According to manufacturers, capacity ratings for ice-makers are inexact, and if a small change in the rating can result in a large change in the qualifying level, some manufacturers may “game” their ratings. Using a straight-line function avoids this problem. Tier 2 is to provide a target for manufacturer design efforts and is based on designs that at least two manufacturers are working on (of which at least one is planning to bring product to market in mid-2003). The CEE specification for ice-makers is shown in Table 9. The specification for water-cooled ice-making heads is shown graphically in Figure 8.

Table 9. CEE Specifications for Ice-Makers

Harvest Rate (100 lbs. of ice/ 24 hrs.)	Tier	Corresponding Base Specification	Max. Daily Energy Use (kWh/100 lbs. of ice)	Max. Daily Water Use (gallons/100 lbs. of ice)
Ice-Making Head , Water Cooled				
<500 lbs./day	1	Approx. FEMP	7.80 – 0.0055H	200 - 0.022H
	2	20% below tier 1	6.24 – 0.0044H	200 – 0.022H
≥500 lbs./day	1	Approx. FEMP	5.58 – 0.0011H	200 – 0.022H
	2	20% below tier 1	4.46 – 0.0008H	200 – 0.022H
Ice-Making Head , Air Cooled				
<450 lbs./day	1	Approx. FEMP	10.26 – 0.0086H	Not Applicable
	2	20% below tier 1	8.21 - 0.0069H	Not Applicable
≥450 lbs./day	1	Approx. FEMP	6.89 – 0.0011H	Not Applicable
	2	20% below tier 1	5.51 – 0.0009H	Not Applicable
Remote-Condensing, Air Cooled				
<1000 lbs./day	1	Approx. FEMP	8.85 – 0.0038H	Not Applicable
	2	20% below tier 1	7.08 – 0.0030H	Not Applicable
≥1000 lbs./day	1	Approx. FEMP	5.10	Not Applicable
	2	20% below tier 1	4.08	Not Applicable
Self-Contained,Water Cooled				
<200 lbs./day	1	Approx. FEMP	11.40 – 0.0190H	191 – 0.0315H
	2	20% below tier 1	9.12 – 0.0152H	191 – 0.0315H
≥200 lbs./day	1	Approx. FEMP	7.60	191 – 0.0315H
	2	20% below tier 1	6.08	191 - 0.0315H
Self-Contained, Air Cooled				
<175 lbs./day	1	Approx. FEMP	18.0 – 0.0469H	Not Applicable
	2	20% below tier 1	14.4 – 0.0375H	Not Applicable
≥175 lbs./day	1	Approx. FEMP	9.80	Not Applicable
	2	20% below tier 1	7.84	Not Applicable

Note: H = harvest rate in lbs/day.

The CEE specification for water-cooled units also includes a limit on water use per 100 pounds of ice produced. This water specification was set at a level met by 75% of the machines now on the market and is designed to ensure that energy-efficiency targets are not met at the expense of water waste. The CEE specification was approved by CEE's Board of Directors in December 2002.

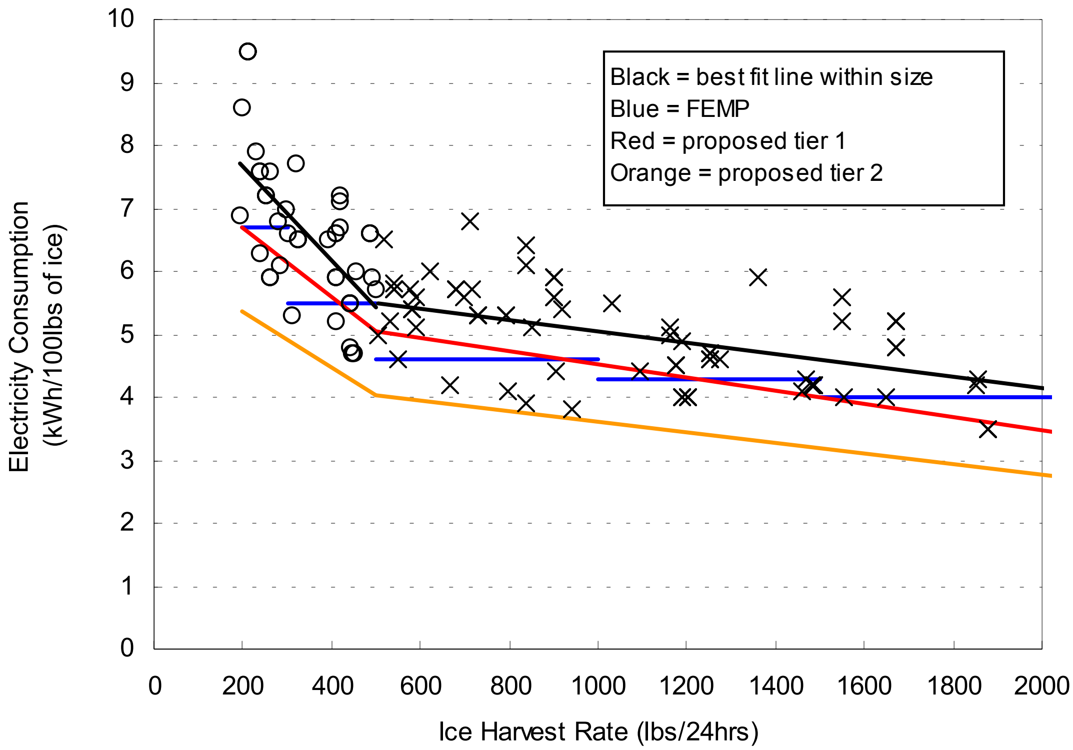

Figure 8. Performance Data and Efficiency Tiers for Ice Making Head-Water (IMH-W) Units

Efficiency standards for ice-makers have also been suggested. Ice-makers are on the list of products being considered for standards by CEC (Martin 2002).

Measure Screening Data

Energy Savings

The energy use of reach-in refrigerators varies with unit size and efficiency. Based on the "best fit" line developed by ACEEE as part of the CEC standard-setting process, the ENERGY STAR specification, and the CEE tier 2 specification, the annual energy use of typical units and the annual savings with ENERGY STAR and tier 2 can be estimated. These figures are provided in Table 10.

For reach-in refrigerators, energy savings for ENERGY STAR units range from approximately 500 to 1100 kWh/year, depending on unit size. Savings from the CEE tier 2 values are more than twice as great (ranging from about 1100 to 2400 kWh/year). In other words, CEE tier 2 will provide incremental savings of 600 to 1300 kWh/year beyond what the ENERGY STAR specification provides. For reach-in freezers, savings from ENERGY STAR units are a little smaller than for refrigerators (since the ENERGY STAR specification is only marginally different from the average unit on the market). Savings for ENERGY STAR freezers range from approximately 500-800 kWh/year, depending on unit size. On the other hand, savings from CEE tier 2 for freezers are more than three times greater than savings from ENERGY STAR.

tier 2 freezer savings range from about 1600 to 4000 kWh/year for each unit (1100–3200 kWh/year more than ENERGY STAR).

Table 10. Base Case Energy Use for Reach-In Refrigerators and Freezers and Savings for ENERGY STAR and CEE Tier 2 Specifications

Unit Capacity (cubic feet)	Annual Energy Use of Average Base Case Model (kWh/year)	Annual kWh Savings Relative to Base Case	
		ENERGY STAR (Tier 1)	Tier 2
Refrigerators			
24 (one door)	2,102	563	1,179
48 (two door)	3,197	826	1,774
72 (three door)	4,292	1,088	2,370
Freezers			
24 (one door)	4,319	511	1,654
48 (two door)	7,805	669	2,810
72 (three door)	11,292	827	3,966

Notes: Base case energy use from "best fit" line from ACEEE analysis for CEC. Tier 1 and tier 2 savings assume average qualifying model is 5% below the qualifying threshold.

The energy use of ice-makers varies with unit type, size, and efficiency. ACEEE has analyzed the data in the ARI directory and developed a set of "best fit" lines that indicates the average energy performance of units now on the market as a function of system type and capacity. Comparing these "best fit" lines to the CEE tier 1 and tier 2 specifications allows us to estimate energy savings. Table 11 provides these figures. For ice-making heads (the most widely sold equipment type), savings range from about 300–1000 kWh/year for tier 1 (depending on equipment type and size) and from 700–2400 kWh/year for tier 2.

Equipment Costs

Reach-In Refrigerators and Freezers

Reach-in refrigerators and freezers typically cost more than $2000, with price generally increasing as unit size increases. For example, a May 2002 analysis for NYSERDA (NYSERDA 2002) found that prices are approximately $1450 for a typical one-door refrigerator (20 cubic feet), $1980 for a typical two-door refrigerator (48 cubic feet), and $2710 for a typical three-door refrigerator (70 cubic feet). For freezers, the respective prices are $1900 for a one-door, $2600 for a two-door, and $3590 for a three-door. The 1996 ADL study previously discussed estimates slightly higher costs for typical models—$2500 for a typical two-door refrigerator and $2200 for a typical one-door freezer.

In September 2002, ACEEE examined the catalogs and price lists of many manufacturers, comparing the discounted price[3] per square foot of reach-in refrigerator and freezers in three categories: (a) units that meet CEE tier 2; (b) units that meet ENERGY STAR but not tier 2; and (c) units that do not meet ENERGY STAR. Results are summarized in Table 12. Overall, the analysis found that tier 2 equipment is the least expensive while standard and ENERGY STAR

[3] Price lists provide list price; we assumed a 40% average discount off of list as found by ADL (1996).

equipment cost roughly the same. Similar results were found when outliers were removed from the analysis.

Table 11. Comparison of Base Case, Tier 1, and Tier 2 Energy Use for Ice-Makers

Unit Type and Capacity (lbs. of ice/24 hours)	Annual Energy Use of Average Base Case Model (kWh/year)	Annual kWh Savings Relative to Base Case	
		Tier 1	Tier 2
Ice-Making Heads (water cooled)			
200	2,213	316	695
500	4,154	578	1,293
1000	7,373	1028	2,190
Ice-Making Heads (Air-Cooled)			
200	2,768	349	834
500	4,920	431	1,337
1000	8,964	765	2,436
Remote-Condensing (Air-Cooled)			
400	4,257	105	926
800	7,580	998	2,278
1200	10,056	1,389	3,123
1600	13,596	2,039	4,351
Self-Contained (Water Cooled)			
100	1,609	264	533
175	2,041	40	440
250	2,847	156	694
Self-Contained (Air Cooled)			
50	1,260	152	373
100	2,018	133	509
150	2,272	0	408
200	3,066	290	845

Notes: Base case energy use from "best fit" line from ACEEE analysis. Energy use figures assume average unit operates at 40% of capacity (based on data in ADL 1996). Tier 1 and tier 2 savings assume average qualifying model of 3% below the qualifying threshold.

These results are consistent with the information from Delfield that a tier 2 unit is less expensive to produce when the equipment is completely redesigned. Absent a full redesign, we doubt that tier 2 equipment is less expensive to produce, but instead surmise that other factors are causing the price differences shown, and energy efficiency has a minor impact on price. Overall, these data indicate that in the market, the price of higher efficiency is either zero or very low. One limitation to these results are that they assume the same discount from list price for both standard and efficient units, but this assumption was not verified in the field. If high-efficiency units are in high demand, the discount on them could be lower and prices higher than shown in Table 12.

Table 12. Average Price Per Cubic Foot for Standard, ENERGY STAR, and Tier 2 Reach-In Refrigerators and Freezers

Type	Not Energy Star	ENERGY STAR, Not Tier 2	Tier 2
Refrigerators	$96.33	$94.09	$66.09
Freezers	$104.13	$115.23	$84.54

Source: ACEEE analysis of price lists from 10 manufacturers. Data based on a 40% discount from list price.

In addition, two other data points are also available. First, the 1996 study by Arthur D. Little, Inc. for DOE estimated the incremental cost to achieve different energy savings for reach-in refrigerators and freezers. Data from this study are summarized in Table 12. The ADL analysis and the data in Table 10 use different estimates of base case energy use, so probably the simplest way to interpret the ADL data relative to ENERGY STAR is by percentage savings. The ENERGY STAR specification saves an average of approximately 22% and the tier 2 specification an average of approximately 53%, implying an incremental cost based on the ADL analysis of roughly $100 for ENERGY STAR and $200 for tier 2.

For reach-in freezers, the issue of differing bases also applies. Relative to its base case, ENERGY STAR achieves less than 10% savings while tier 2 involves approximately 35% savings. These figures imply costs of around $30 for ENERGY STAR and about $140 for tier 2.

Table 13. Summary of Reach-In Cost and Savings Data from ADL Study

	Annual kWh	Savings Relative to Base		Incremental Cost Relative to Base
		kWh	%	
Refrigerator				
Base (48 cf)	4321	—	—	—
Level 1	2896	1425	35	$131
Level 2	2529	1792	44	179
Freezer				
Base (24 cf)	5198	—	—	—
Level 1	3739	1359	30	$ 91
Level 2	3279	1819	35	139
Level 3	2912	2287	44	382

Source: ADL 1996

Third, NYSERDA conducted limited research on the incremental cost of ENERGY STAR reach-in refrigerators and freezers relative to baseline models. It examined three different size units and found incremental costs as follows (NYSERDA 2002):

Unit Type and Size	Incremental Cost
20 cubic feet	$200
48 cubic feet	250
70 cubic feet	300

The same incremental costs were found for ENERGY STAR refrigerators and freezers. This analysis involved a very small number of data points and was also conducted in the spring of

2002 when there were only a limited number of ENERGY STAR products available from distributors, meaning that these products could potentially command a price premium. Since many more models now qualify for ENERGY STAR, the increase in competition since the NYSERDA study may well make it more difficult to command a substantial price premium for ENERGY STAR units.

Overall, we place more faith in the ACEEE data and in the ADL analysis. The ACEEE data demonstrate that list prices of efficient units are essentially the same as less efficient units. However, the ACEEE analysis is based on the assumption that due to competition in the market, both the standard- and high-efficiency models will receive the same discount off of list price. If there is not sufficient competition in the market, the discount on high-efficiency units may be smaller and the price higher. The ADL data show that absent equipment redesign to reduce overall product costs, improving efficiency costs money. These two data sources provide a reasonable range for incremental costs—from $0 to $100 for a tier 1 two-door refrigerator, and from $0 to $200 for a tier 2 two-door refrigerator. Incremental costs for freezers appear to be within these same ranges.

Ice-Makers

Data on typical ice-maker costs are provided in Table 4. This table provides typical costs for different size and type units and also shows that the higher efficiency units now on the market often cost consumers no more than less efficient units. These data are several years old (from 1999), so ACEEE recently prepared an updated price analysis. For this analysis, we examined the typical purchaser price (50% of list price) per unit of ice-maker capacity for 113 models, including 21 models that meet CEE tier 1 and 92 that do not. Overall, we found the two prices virtually identical—an average of $3.62/lb. of capacity for tier 1 units versus $3.79/lb. for units that did not meet tier 1. And this small difference is explained by the fact that tier 1 units in our sample were slightly larger than non-tier 1 units (price per unit capacity tends to decline as unit size increases). These results are fully consistent with discussions we had with several ice-maker manufacturers. According to these manufacturers, due to competition between manufacturers, it is difficult to charge more in the market for improved efficiency units. Another cost point is provided by ADL's 1996 analysis. It estimates that on average, ice-maker energy use can be reduced by 10% (similar to the savings in Table 11 for tier 1) at an average cost premium of $60. We suspect that this latter estimate is a reasonable estimate of manufacturer's cost, but often that these costs cannot be passed on to consumers in the market.

Since there are no units meeting tier 2 on the market, it is very difficult to estimate the cost of tier 2 units. There are two data points available. First, a manufacturer (who wishes to remain anonymous) estimates that reducing energy use by about 25% will increase the price of a 500 lbs./day icemaker by about $200. Second, the ADL 1996 study estimates that reducing energy use by 18% relative to a typical machine will result in a $146 price premium. These two data points are very consistent with each other.

Equipment Life

The expected equipment life of reach-in refrigerators and freezers is approximately 8–10 years. The expected equipment life of ice-makers is in the range of 7–10 years (ADL 1996).

Equipment Stock and Annual Sales

Arthur D. Little, Inc., in a 1996 study for DOE, estimated the size of the equipment stock for reach-in refrigerators and freezers. This information is summarized in Table 14. We also provide a rough estimate of annual sales in the United States based on a 9-year average equipment life (the midpoint of the range discussed above).

Arthur D. Little, Inc. also estimated the size of the equipment stock for ice-makers. It estimated that there are approximately 1.2 million ice-makers in use in the United States. The U.S. Census Bureau collects data annually on ice-maker sales (Census Bureau 2002). These data are provided in Table 15. The FEMP and CEE specifications essentially cover the first three categories, with sales of about 230,000 units annually

Table 14. Inventory, Energy Consumption, and Annual Sales for Reach-In Refrigerators and Freezers

Unit Type	Estimated Inventory	Average Unit Energy Consumption (kWh/year)	Total Energy Consumption (TWh/year)	Percentage of Total Energy Consumption	Approximate Annual Sales in U.S.
Refrigerators					
One-door	390,000	2,300	0.90	8	43,000
Two-door	845,000	4,300	3.63	33	94,000
Three-door (or more)	65,000	6,300	0.41	4	7,000
Subtotal	1,300,000		4.94	45	144,000
Freezers					
One-door	440,000	5,200	2.29	21	49,000
Two-door	320,000	9,800	3.14	29	36,000
Three-door (or more)	40,000	14,400	.58	5	4,000
Subtotal	800,000		6.00	55	89,000
TOTAL	2,100,000		10.94	100	233,000

Source: ADL 1996 for all but annual sales. Annual sales estimated by ACEEE based on inventory and average equipment life.

Table 15. Ice-Making Machine Sales in 2001

Equipment Description	Unit Sales
Self-contained cubers 200 lbs./day and under	124,326
Self-contained cubers over 200 lbs./day	64,405
Not self-contained cubers	44,189
Self-contained flake machines 300 lbs./day and under	3,421
Self-contained flake machines over 300 lbs./day	8,688
Combination ice machines and ice/drink dispensers	49,506
TOTAL	294,535

Source: Census Bureau 2002

THE "VENDING MISER"

The Vending Miser is a control developed by Bayview Technologies, a company based in Denver, Colorado. The Vending Miser is a control installed on a vending machine that powers down the machine (including lights and refrigeration) whenever there is no foot traffic in front of the vending machine for a period of time. The Vending Miser does this through use of a motion sensor. Other controls in the Vending Miser periodically power-up the refrigeration system to maintain product temperature and sense for machine operation so that the machine is only powered-down when the compressor is not operating (in order to prevent adverse impacts on compressor life). The Vending Miser sells for $179 each in quantities under 500 units; for higher quantities, price drops ($170 for 500–999, $161 for 1000–4999, and $151 for larger quantities) (Bayview Technologies 2002). These prices do not include installation, which typically costs on the order of $30–55 (Horowitz 2002).

Bayview has extensive information on energy saving studies on its Web site, with savings ranging from 24–76% and an average savings of about 46%. However, it further notes that savings vary depending on site use. It estimates 36% average savings in high-traffic locations that are used in evenings and on weekends, because only late at night does the machine go into savings mode. Conversely, it estimates 56% average savings in applications such as office buildings that are generally used only during the work day. Bayview estimates that the average vending machine uses 3557 kWh/year, so 46% savings works out to 1636 kWh/year (Bayview Technologies 2002). The Northwest Power Planning Council's Regional Technical Forum has reviewed many of the available evaluation reports and developed a "deemed savings" estimate for the Vending Miser. This estimate is 1292 kWh/year for illuminated machines and 861 kWh/year for non-illuminated machines. This estimate is used by the Bonneville Power Administration and many other Northwest program operators (R. Miller 2002).

Many utilities have promoted the Vending Miser, both through incentive and direct installation programs. Quite a few program operators give rebates for Vending Misers such as NYSERDA ($80), Northeast Utilities ($75), Puget Sound Energy ($40), Efficiency Vermont ($45), and California's Express Efficiency program operated by the three large investor-owned utilities ($30 normally, but $60 during special promotions). Other program operators have operated direct installation programs in which they hire Bayview or another contractor to market the Vending Miser and install them for free. For example, the Bonneville Power Administration, Sacramento Municipal Utility District, and Wisconsin

Focus on Energy Program have taken this route (Wisconsin for schools only), negotiating prices per installed unit with Bayview, including marketing (Bayview Technologies 2002). Participation rates are much higher with direct installation (e.g., the Bonneville Power Administration already has installed 18,000—B. Miller [2002]) and the Sacramento Municipal Utility District is targeting 8,500 (Bayview Technologies 2002), resulting in higher savings but also bigger budgets. In California, somewhat similar direct installation programs were operated in 2001 by independent firms under contract with utilities.

RECOMMENDED PROGRAM STRATEGIES

Based on the all of the data and information presented in this report, it appears that there is an opportunity for capturing substantial cost-effective energy savings from more efficient reach-ins and ice-makers. We recommend that program operators develop programs to promote CEE tier 1 and tier 2 reach-ins and ice-makers to their customers in 2003. Program operators should consider the following program components:

- Develop educational material for equipment purchasers on the availability of high-efficiency reach-ins and ice-makers and the benefits and economics of this high-efficiency equipment.

- Offer financial incentives for tier 1 and tier 2 equipment in order to encourage manufacturers, distributors, dealers, and consumers to pay more attention to high-efficiency equipment and to help pay any incremental costs for this more efficient equipment relative to standard equipment. For this equipment, incremental costs are small, so rebates can be small. The prime purpose of the rebates would be to attract consumer and manufacturer interest to more efficient equipment. We estimate that a rebate of about 5% of equipment cost would attract attention. For reach-ins, this means about $75 for a one-door reach-in, $100 for a two-door, and $125 for a three-door (similar to the incentives NYSERDA is now offering). For tier 2, we recommend incentives about double the tier 1 levels. These incentives are similar to the incremental cost for this equipment as estimated in the ADL 1996 study. If budgets are tight, we recommend offering just the tier 2 incentives in order to encourage manufacturers to develop more units in this category.

- For ice-makers, based on the ADL cost estimate, we recommend an incentive of about $45 for a 200 lbs./day machine, $60 for a 500 lbs./day unit, and $90 for a 1000 lbs./day unit. For tier 2, based on the cost estimate from the anonymous manufacturer, we recommend incentives of about $150 for a 200 lbs./day machine, $200 for a 500 lbs./day unit, and $300 for a 1000 lbs./day unit.

  For both reach-ins and ice-makers, incentive levels should be significantly higher for tier 2 than for tier 1 in order to attract more consumer and manufacturer attention (the latter being particularly important since availability of tier 2 units is now limited).[4] As

[4] For tier 2, there are sufficient reach-ins on the market for consumer promotions to work. But presently there are no tier 2 ice-makers on the market. Thus, in promoting tier 2 ice-makers to consumers, care must be used to indicate that these are forthcoming models that are not presently available.

market share for tier 1 and tier 2 equipment grows, incentives can be reduced or eliminated. For example, it may be possible to eliminate the tier 1 incentives in the second year of the program and concentrate incentives on tier 2.

- Keep manufacturers informed about program offerings so they can take state and local programs into account when making product design and stocking decisions and can work with local wholesalers and suppliers in areas with programs. To assist with these efforts, CEE is planning to compile information on local programs and to periodically provide summaries to equipment manufacturers.

- Encourage equipment vendors in local service areas to stock tier 1 and tier 2 equipment and promote it to their customers.

- Actively market this program to product purchasers, particularly companies and institutions that will often buy multiple pieces of equipment each year such as restaurant and hotel chains, large institutions, and engineering and food service firms that work with these chains and institutions. For national chains, coordinate promotion efforts with ENERGY STAR, CEE, FEMP, and other state and regional programs.

- Support establishment of new state and/or federal minimum-efficiency standards for reach-ins and ice-makers to complete the market transformation process. Initial standards are likely to be similar to the tier 1 specifications but in the longer term standards could approach the tier 2 levels of performance. Standards played a critical role in bringing down the electricity consumption of residential refrigerators from over 1,200 kWh/year to 480 kWh in a 20-year period. Commercial refrigerators today use about three times more energy per cubic foot than their residential counterparts–standards can play a major role again to drive energy and economic savings.

In addition, program operators should consider promoting the Vending Miser in 2003 in order to save energy and also educate vending machine hosts on how much energy vending machines use and how they should pay attention to vending machine efficiency. This will lay the groundwork for a more extensive vending machine program in 2004. We recommend providing an incentive for the Vending Miser of about $75 (based on incentives provided by other utilities, as discussed above) and marketing the Vending Miser incentives in parallel with the reach-in and ice-maker program discussed above, since many reach-in and ice-maker purchasers are also vending machine hosts. Another option would be a direct installation program for Vending Misers, drawing on the experience of the Bonneville Power Adminstration, Sacramento Municipal Utility District, and Wisconsin Focus on Energy Programs. The direct installation option will result in more installations, and higher energy savings in 2003.

Finally, program operators should support establishment of ENERGY STAR and CEE specifications for vending machines and glass-door refrigerators (including beverage merchandisers) in 2003, laying the groundwork for more extensive program activities in 2004. EPA is now actively working on establishing an ENERGY STAR specification for vending machines and has expressed interest in a specification for glass-door refrigerators.

CEE has also expressed interest in both products. In October 2002, EPA circulated a draft ENERGY STAR specification for vending machines for comment and CEE agreed to start development of a specification for efficient glass-door units. An initial draft will likely be circulated to the CEE membership for comment in December 2002.

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