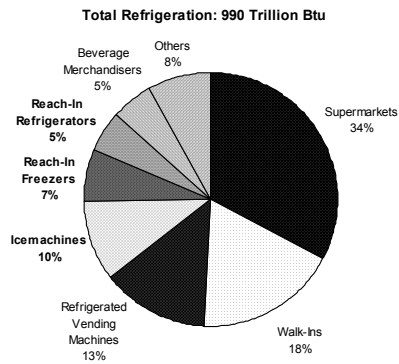


Commercial Packaged Refrigeration: An Untapped Lode for Energy Efficiency

Steven Nadel
American Council for an Energy-Efficient Economy

Types and Energy Use of Commercial Refrigeration Equipment



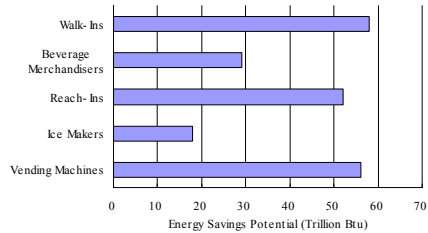
Primary Energy Usage by Equipment Type
Source: ADL



Technical Opportunities

	Per Unit Savings Potential	Average Simple Payback
Vending Machines	20 - 50%	0.5 - 3.2
Ice Makers	20 - 45%	instant - 1.1
Reach-Ins	35 - 45%	1.1 - 2.1
Beverage Merchandisers	44 - 55%	1.2 - 2.2
Walk-Ins	one-third	1.1 - 2.8

Total Savings Potential using Available Technologies
< 2 years Payback Period



Commercial Packaged Refrigeration



Energy Star Reach-In Refrigerator and Freezer Specification

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	$0.27AV - 0.71$

Notes:

1. Volume is measured in cubic feet. Adjusted volume (AV) is equal to the refrigerator volume plus 1.63 times the freezer volume.
2. Column shows formulas for calculating maximum energy use. Thus, for a 40 cf reach-in unit, the minimum efficiency standard is $(59 \times 40 + 1010)$, which is 3370 kWh/yr.

Source: EPA

Commercial Packaged Refrigeration



New Reach-In Product

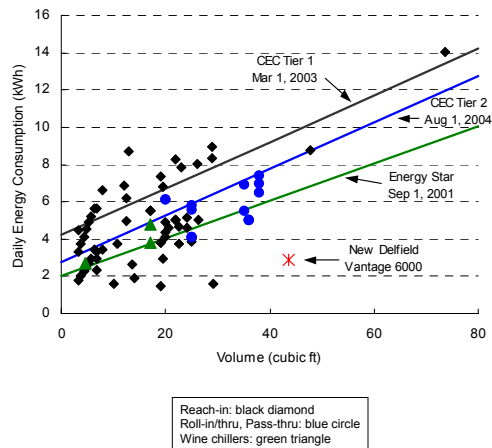
Delfield Vantage 6000

- Developed with help from DOE and ADL
- Testing on a 2-door reach-in refrigerator shows 68% energy savings relative to comparable current Delfield model.
- More efficient model less expensive to produce than baseline model (design cost savings greater than cost of efficiency)

Commercial Packaged Refrigeration



Reach-In Refrigerators in CEC Database Relative to Energy Star and CEC Standards



Commercial Packaged Refrigeration



FEMP Recommendation for Government Ice-Maker Purchases

Condenser Type	Ice Harvest Rate (lbs per 24 hrs.)	Energy Consumption (kWh per 100 lbs. 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	501-1000	5.8 or less	5.4
Air-Cooled	1001-1500	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	501-1000	4.6 or less	3.8
Water-Cooled	1001-1500	4.3 or less	4.1
Water-Cooled	> 1500	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	501-1000	6.2 or less	5.4
Air-Cooled	1001-1500	5.1 or less	4.6
Air-Cooled	> 1500	5.3 or less	4.9

Source: FEMP

Commercial Packaged Refrigeration



Comparison of Ice Maker Models

Ice Harvest (lbs/24hrs)	Worst Model		Best Model		Energy Savings (%)	Payback (years)
	Energy Use (kWh/100lbs-ice)	Market Price (\$)	Energy Use (kWh/100lbs-ice)	Market Price (\$)		
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)

Note: Market price assumes 50% off list price

Commercial Packaged Refrigeration



Market Structure

Beverage Vending Machines & Merchandisers

- Vendo
- Dixie-Narco
- Royal

Manufacturer

- Design, Assemble Machine

- True
- Beverage Air



Bottler

- Purchase from Manufacturer
- Owns the vending machine or merchandiser



Retail

- Pays utility bill



Commercial Packaged Refrigeration



Market Structure

Reach-Ins & Icemakers

- True
- Beverage Air
- Delfield
- Traulsen
- Hobart

Manufacturer

- Design, Assemble Machine
- Two grades for reach-ins -- 'standard' for commercial & 'spec' for institutional

- Manitowoc
- Scotsman /Crystal Tips
- Hoshizaki
- Ice-O-Matic
- Mile High

Distributor

- Sales to local food service businesses, hotels, etc.



Retail

- Owns the equipment, and pays utility bill



Commercial Packaged Refrigeration



Past and Current Efforts

Key Organizations

-
- Air-Conditioning and Refrigeration Institution (ARI)
[icemaker test procedure and database]
 - ASHRAE [reach-in testing standards]
 - Canadian Standards Association (CSA) [reach-in
and icemaker test procedures & voluntary standards]
 - Federal Energy Management Program (FEMP)
[icemaker procurement recommendations]
 - EPA/DOE ENERGY STAR Program for reach-ins
 - CEC database and minimum efficiency standards
for reach-ins (effective 3/03 and 8/04)

Commercial Packaged Refrigeration



Market Barriers

-
- Lack of Awareness
 - Little understanding of running cost/life cycle cost
 - Lack of information
 - Most reach-ins not tested
 - CEC database for reach-ins incomplete
 - No labeling method for icemakers
 - Intense competition
 - Focus on minimizing first cost
 - Limited availability
 - Only some manufacturers produce efficient products

Commercial Packaged Refrigeration



Recommended Next Steps

- Database development -- expand CEC database for reach-ins
- Consider Energy Star label for icemakers
- Purchaser awareness programs
 - Promote Energy Star and FEMP specs
 - Focus on food service and hotel/motel sectors
- Consider incentives
 - For products meeting Energy Star and FEMP
 - Possible tier 2 for advanced equipment
- Minimum efficiency standards
 - Additional states adopt CEC reach-in standard
 - Possibly adopt icemaker standard (e.g. CA, CT, IL, MD, PA and RI considering)

