Potential supermarket energy efficiency options

A survey has been carried out of all the published information on methods of saving refrigeration energy in supermarkets and other food retailing operations.
A US report on the 'Energy Savings Potential for Commercial Refrigeration Equipment' produced in 1996 (**Ref. 10**) summarised the potential as :

Cost-effective Refrigeration Energy Savings Potential	
Technology	**Energy Savings Potential**
Grocery store systems	14%
Reach-in refrigerators	50%
Reach-in freezers	40%

Many other studies have looked at specific technologies to reduce refrigeration usage in retail food stores and refrigerated food display cabinets. The technologies and their potential to save energy are summarised in the following table together with the source of the information.

Technology	Saving in refrigeration energy (cost to user)	Application	Notes	Ref
Adding doors to display cases	50% (up to)	Chilled and frozen multi-decks	Possibly in reality much less than reported values, depends on usage	**Ref. 8**, **Ref. 9 Ref. 16**
Strip curtains	30%	Chilled multi-decks	Assumes correct fitting and depends on usage	**Ref. 4**
Optimisation of air curtain	30%	Chilled multi-decks, well freezers		**Ref. 11**
Night blinds	20%	Chilled multi-decks, well freezers	Assuming usage for 8h per day, assumes correct fitting	**Ref. 4**
Night covers	20%	Chilled multi-decks, well freezers	Assuming usage for 8h per	**Ref. 4**

			day, assumes correct fitting	
Trigeneration	20%	Supermarket system		
Liquid pressure amplification	20% (up to)	All remote refrigeration systems	Savings resulting from reducing head pressure	**Ref. 4**
ECM/Variable Speed Compressor	15%	All integrals and remote systems		**Ref. 2**
High-Efficiency Compressors	12%	All integrals and remote systems	12% for reach-in refrigerators, and 16% for reach-in freezers	**Ref. 2**, **Ref. 6**
Defrost optimisation	10%	Freezers (chillers should be operated on off-cycle)		**Ref. 3**
Radiant heat reflectors	10%	Well freezers, HGD, FGD freezers, delicatessen cabinets		
Multi-evaporator systems	10%	Freezers (indirect through removal of defrost heat load). Only save energy if have active defrost system (i.e. electric or gas), therefore freezers	Problem with practicality of system	**Ref. 3**
Dehumidification	5-29%	All open cabinets, supermarket AC system	Reduced latent and defrost load on cabinets, reduced latent load on AC. Most work from USA	**Ref. 14 Ref. 15 Ref. 16 Ref. 17 Ref. 18 Ref. 19**
LED lighting	5-10%	All cabinets with lights	Saving depends on number of lights and radiant effect of 'conventional' lighting	**Ref. 12**
High-Efficiency Fan Blades	9%	All cabinets with forced air convection		**Ref. 2**
Condenser Fan ECM Motor	8%	All integrals and remote systems		**Ref. 2**, **Ref. 6**
Floating Head Pressure	8%	All remote refrigeration systems	3-10%	**Ref. 2 Ref. 6**

Evaporator Fan ECM Motor	2-8%	All cabinets with forced air convection. Energy savings estimated to be about 2%of refrigeration system electricity use for reach-in freezers, 7%for reach-in refrigerators, 8% for grocery store display cases		**Ref. 2**
Electronic Ballasts	7%	All cabinets with lighting		**Ref. 2**
Non-Electric Anti-sweat	6%	Freezer cabinets		**Ref. 2**
Thicker Insulation	6%	All cabinets, primarily frozen		**Ref. 2**
VIPs (Vacuum Insulated Panels)	4%	For open fronted multi-deck cabinet		**Ref. 5**
Ambient Subcooling	4%	All remote refrigeration systems		**Ref. 2**
Liquid-Suction Heat Exchangers	3%	All cabinets		**Ref. 2**
Evaporative Condensers	3%	All remote refrigeration systems	3-9% possible	**Ref. 2**, **Ref. 6**
Anti-sweat Heater Controls	3%	Freezer cabinets	Could be greater savings, dependent on store conditions	**Ref. 2**, **Ref. 6**
Evaporator Fan Shutdown	2%	All cabinets		**Ref. 2**
External Heat Rejection	2%	All integrals		**Ref. 2**
Economizer Cooling	2%	All remote refrigeration systems		**Ref. 2**
Efficient ‘standard’ lighting system	Approx. 2%	All cabinets with lights	Most options already used	Ref. 20
Tangential fans	Approx. 2%	All cabinets with fans	May have additional benefits such as improved air distribution	Ref. 20
Heat Reclaim	1%	All remote refrigeration systems, possibly integrals	Potentially greater opportunities with transcritical CO2	**Ref. 2**
Mechanical Subcooling	1%	All remote refrigeration systems		**Ref. 2**
Low emmissivity/reflective glazing	1-2K increase in	HGD, FGD, delicatessen cabinets	Reduction in radiant heat	

('K' glass)	evaporating temperature			
Alternative refrigerants	1-2K increase in evaporating temperature	All refrigeration systems	Hydrocarbons only for small or contained systems. Possibly enhanced heat transfer from CO2	
Superconductive shelving	2.5-3.5 K reduction in food temperature	Heat pipes or high conductivity metal	Still under development	**Ref. 13**
Evaporator coil rifling	No direct figures	All cabinets	Enhanced heat transfer, Increased UA	Ref. 20
Dual port TEV	No direct figures	All large cabinets	Enhanced ability to remove heat during peak loads (e.g. after defrost)	Ref. 20
Packaging (e.g. reflective, conductive)	No data	Possibly increase in evaporating temperature	No data to quantify savings	No refs
Evaporative cooling	No data	Chilled cabinets only. Possibly increase in evaporating temperature	No data to quantify savings	No refs
Maintenance	n/a (variable saving in energy, may be increase in energy)	All cabinets and refrigeration system	Cleaning of evaporators, condensers, door seal maintenance, refrigerant charge etc	No refs
DDC (Dynamic Demand Control)	No direct saving to user	Mainly small integrals	Improved efficiency to power generator	**Ref. 1**

Table 1. Potential technologies to reduce energy consumption in supermarkets and retail display cabinets and predicted energy savings (n.b. energy savings are not necessarily additive).

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