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Where can energy be saved - examples from the food industry

defra
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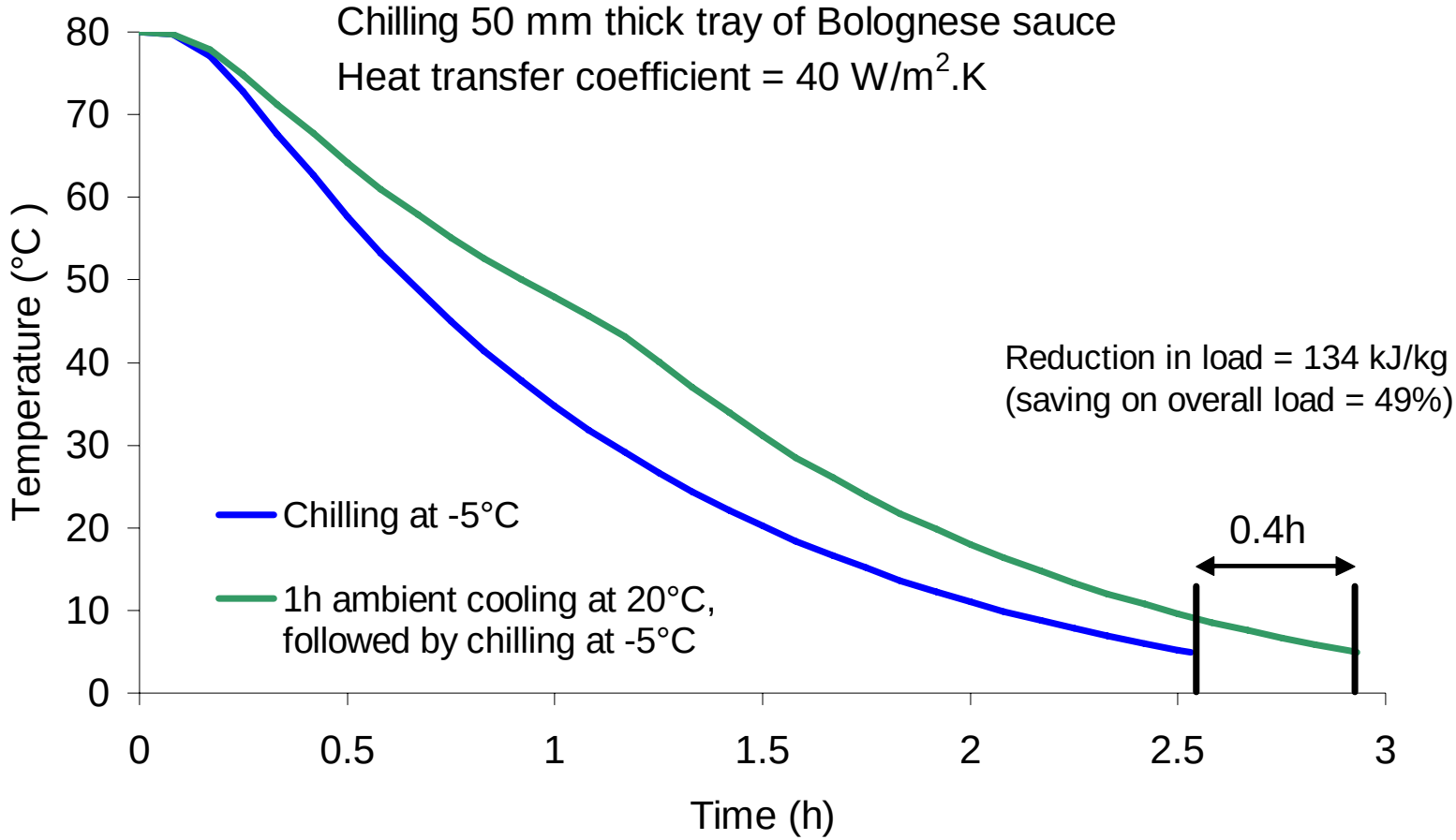
Energy saving

- Reduce heat loads from
  - Food
  - Room structure
- Optimisation/design of refrigeration system
- Operation of refrigeration system
- Choice of equipment
- Maintenance

Ambient cooling

- Many cooked products leave ovens, fryers, etc with surface temperatures over 80°C
- Ambient cooling can provide 60°C of ‘free’ heat extraction
- Reduces heat load on subsequent refrigeration systems
- Reduces defrost needs

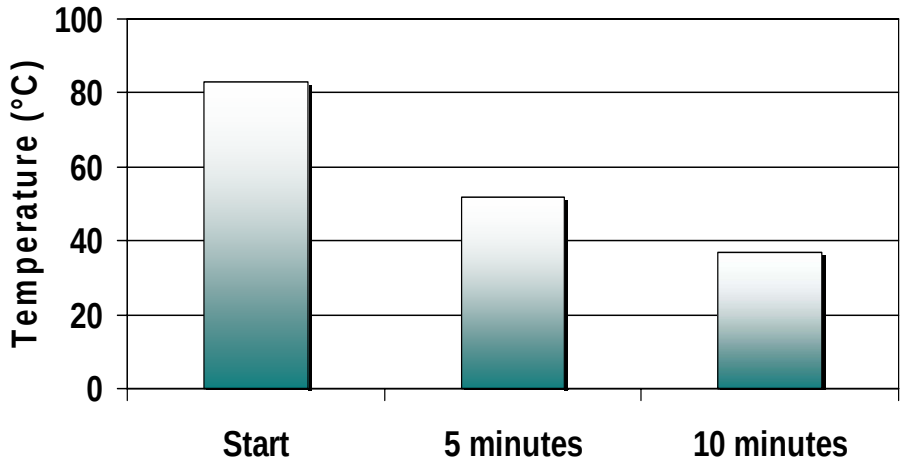
Reduce heat load – ambient cooling



Fried potato products

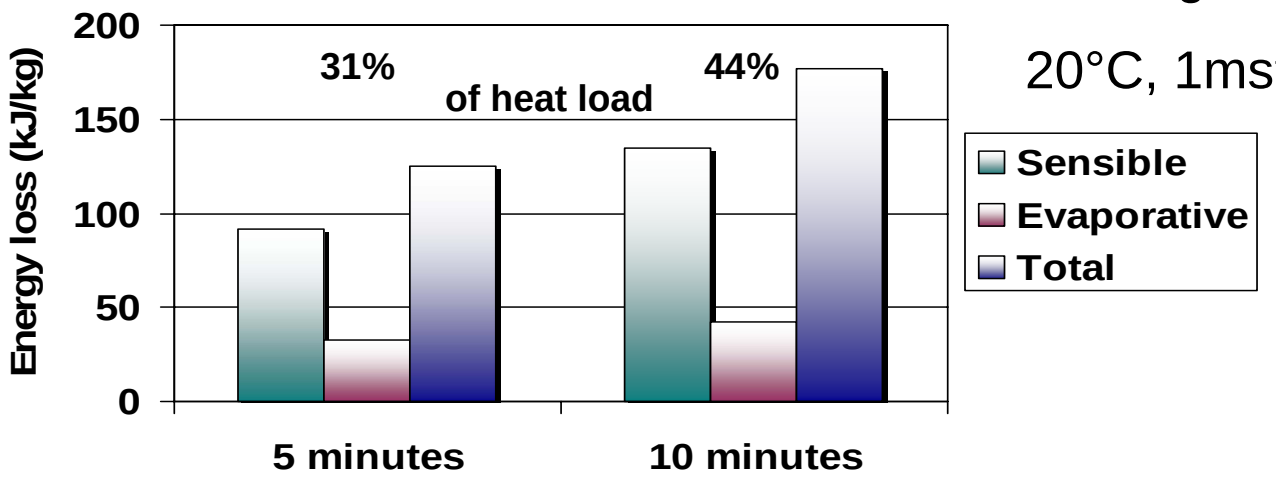
- Hash browns emerge from fryer at 80°C
- Need to be frozen to -12°C before packaging
- Process rate 4.5 tones/hr
- Spiral freezer incapable of extracting initial heat load
- Initial moisture loss freezes on coils

Average temperature and energy loss of hash browns



Cooling in

20°C, 1ms^{-1}



Cooling in

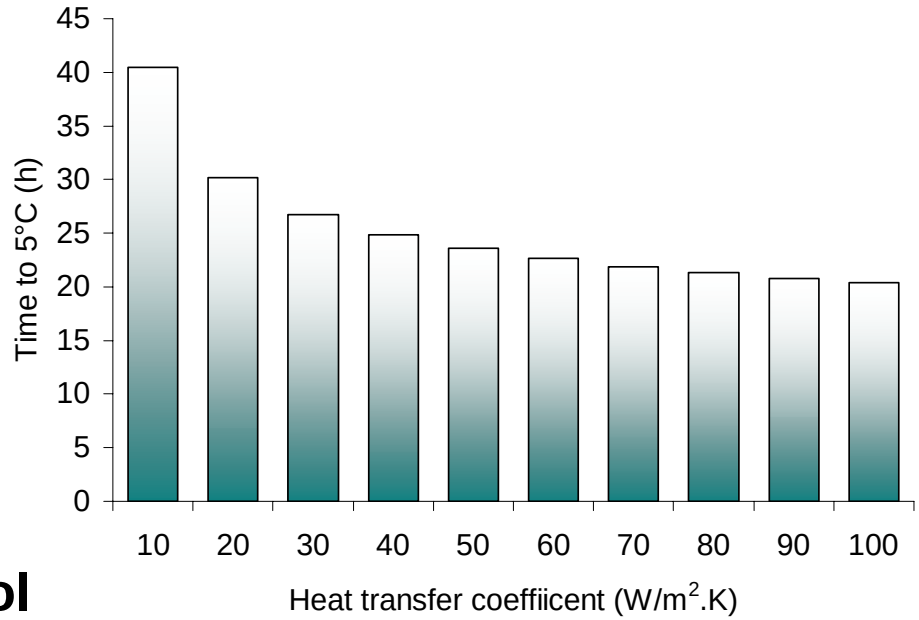
20°C, 1ms^{-1}

5 minutes of ambient cooling

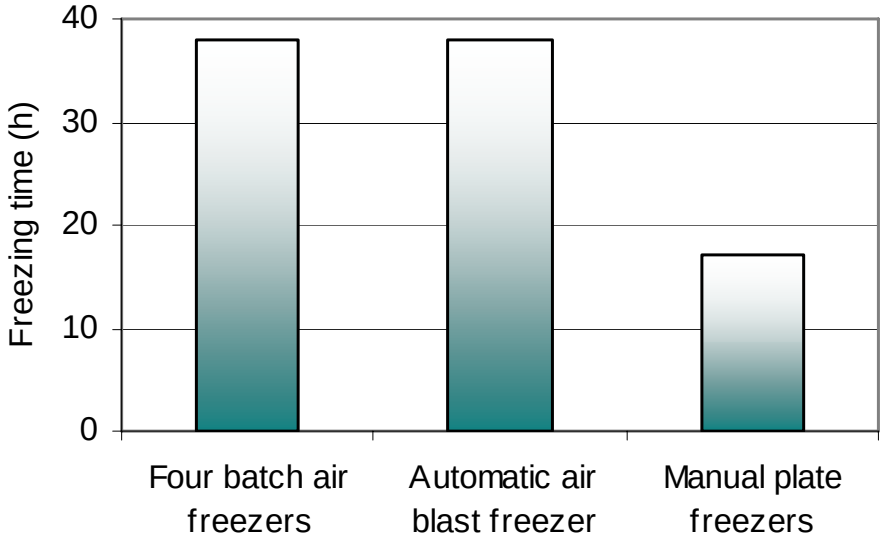
- Removes 562,500 kJ of heat energy from 4.5 tonnes of hash browns every hour
- Stops 60 kg per hour of water freezing on the coils
- Insignificant increase in total freezing time

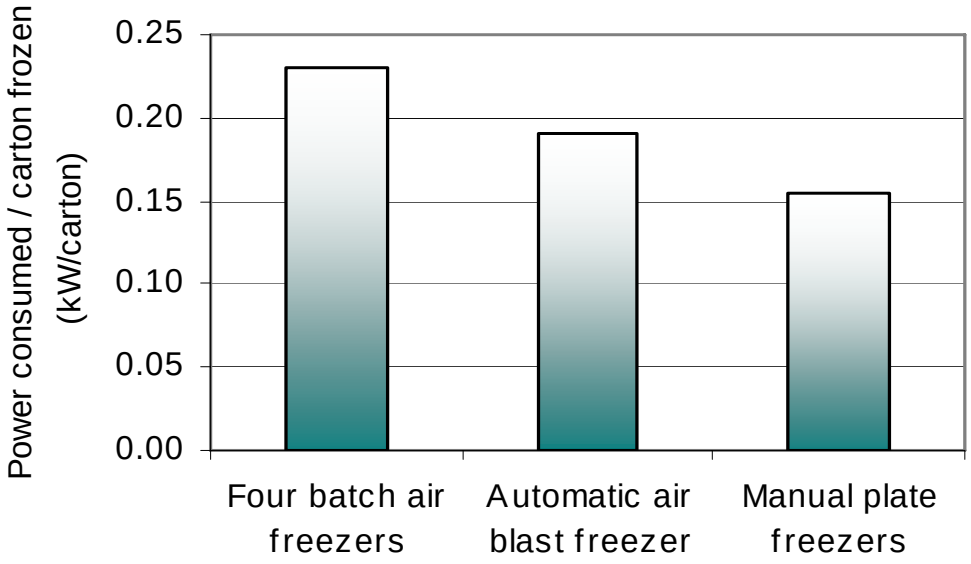
Primary chilling

- **SEC for beef carcass**
  - **Mean = 116 kJ kg^{-1}**
  - **Best = 70 kJ kg^{-1}**
- **Reasons**
  - **Wasted fan power**
  - **Infiltration**
  - **Poor air flow**
  - **Poor process control**
  - **Inefficient plant**
  - **Transmission load**



Choice of appropriate technology

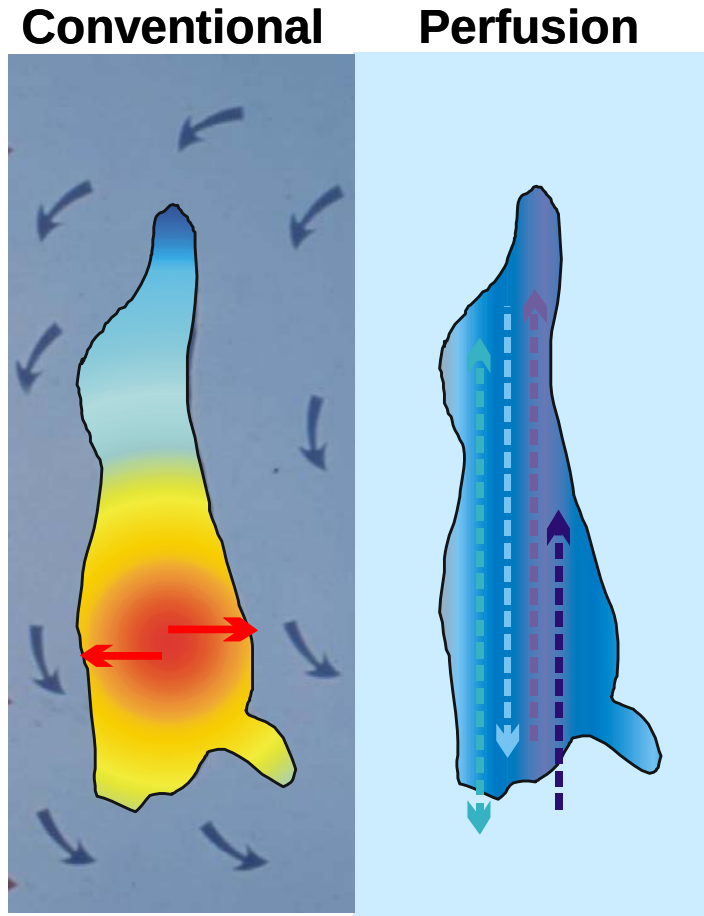




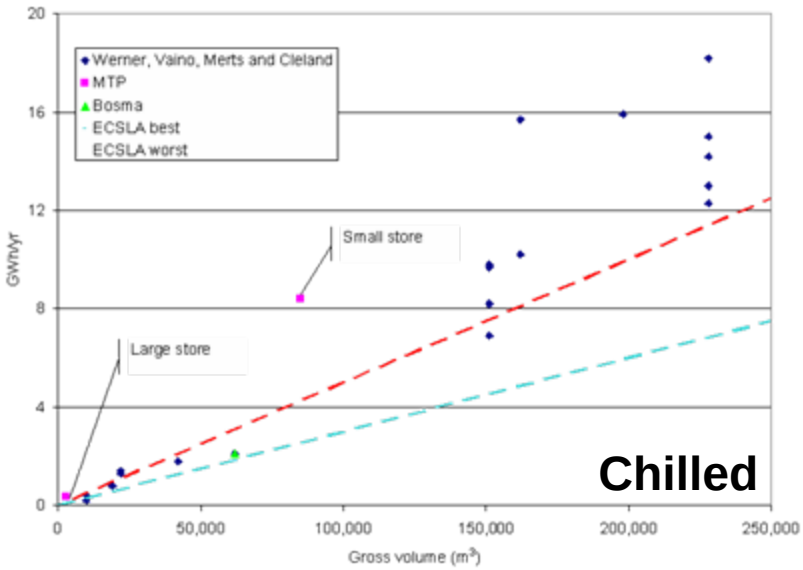
De Jong, R. S. Plate freezing technology and economics applied to the meat industry. Proceedings IRHACE Technology Conference, Paper 11 (1994).

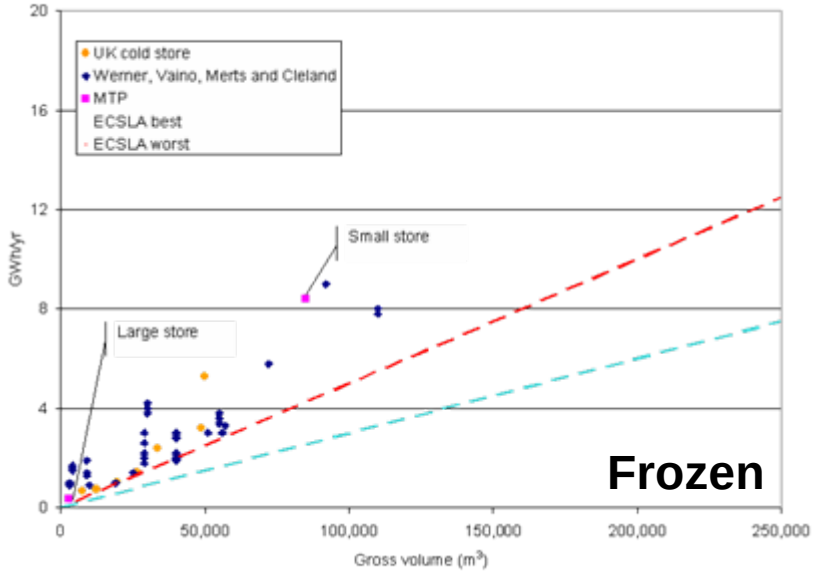
Perfusion

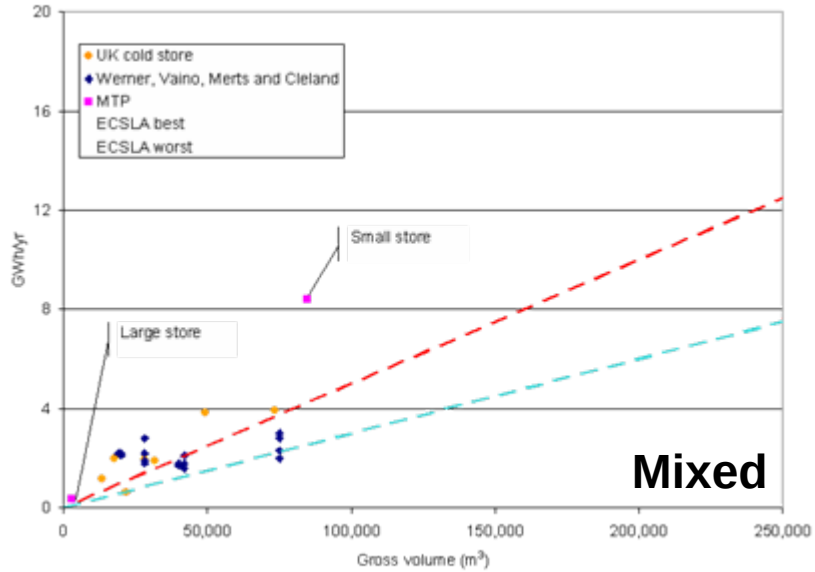
- Conventional chilling based on convection (slow and limited by conduction)
- Circulation of cold fluid through vasculature of animal post slaughter
- Substantial reductions in chilling times
- Potential to revolutionise meat chilling



Cold stores


Werner, Vaino, Merts and Cleland
MTP
Bosma
ECSLA best
ECSLA worst
Small store
Large store
GWh/yr
Gross volume (m³)
Chilled


UK cold store
Werner, Vaino, Merts and Cleland
MTP
ECSLA best
ECSLA worst
Small store
Large store
GWh/yr
Gross volume (m³)
Frozen


UK cold store
Werner, Vaino, Merts and Cleland
MTP
ECSLA best
ECSLA worst
Small store
Large store
GWh/yr
Gross volume (m³)
Mixed

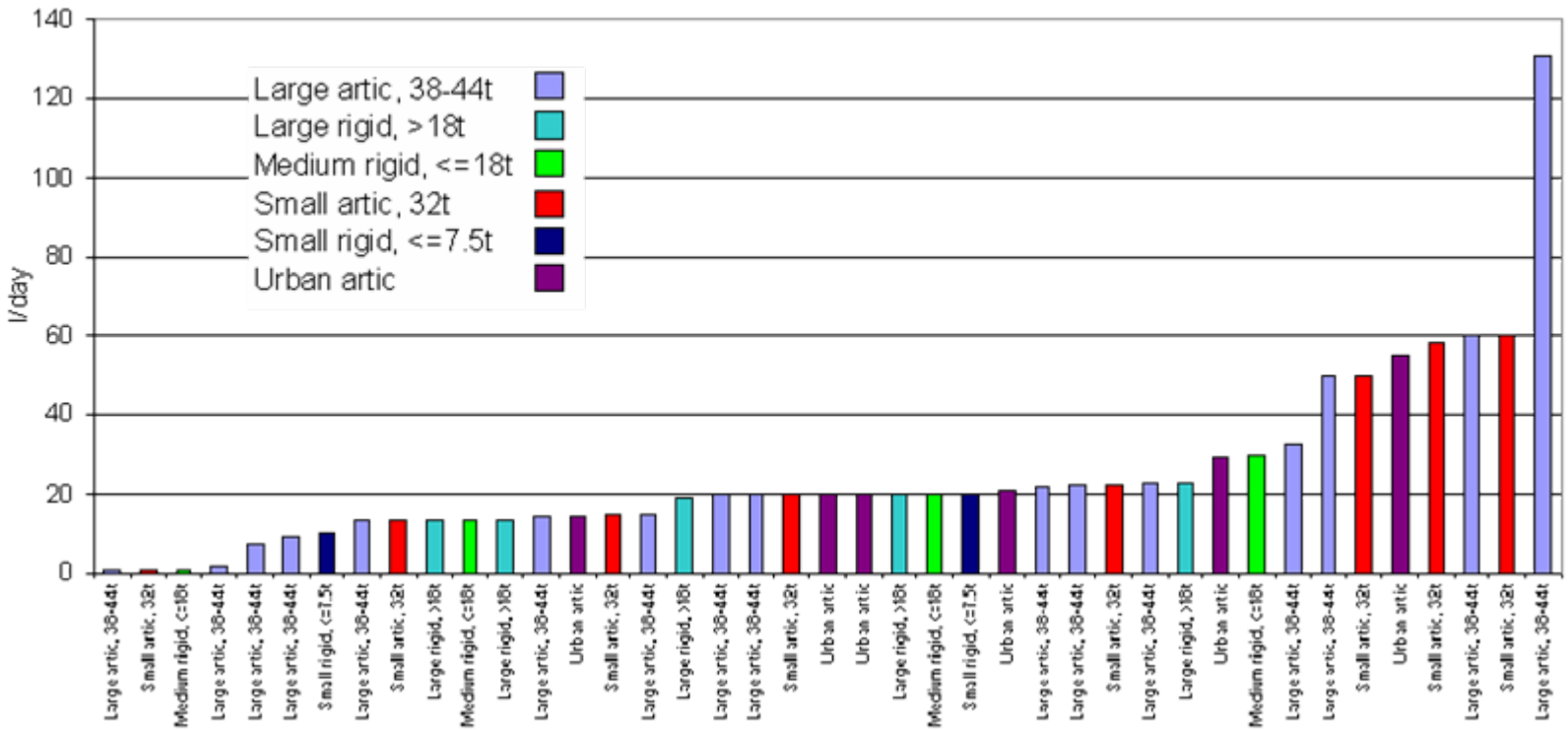
Cold stores - options to improve

	Store 1 (F)	Store 2 (F)	Store 3 (F/C)
Size (m^3)	12,399	7,347	19,659
	kWh/m^3/yr		
Current	**59**	**91**	**52**
Pedestrian doors	53	85	50
Rapid rolls doors/improved strip curtains	52	82	49
Defrost optimisation	58	91	49
Off-cycle defrost			51
Separate entrance to store	51		
Automatic closing door	57		
Preventing door being jammed open		88	
Suction liquid heat exchangers	56		44
Liquid pressure amplification	49		38
Evaporative condensers	58	56	
Low pressure receiver (lpr)	40		32
Improve insulation on walls to 10"	51	86	46
Reduce the speed and off load compressor			50
Potential saving from best technology	**>32%**	**>38%**	**>38%**
Potential achievable by updating current	**>14%**	**>10%**	**>15%**

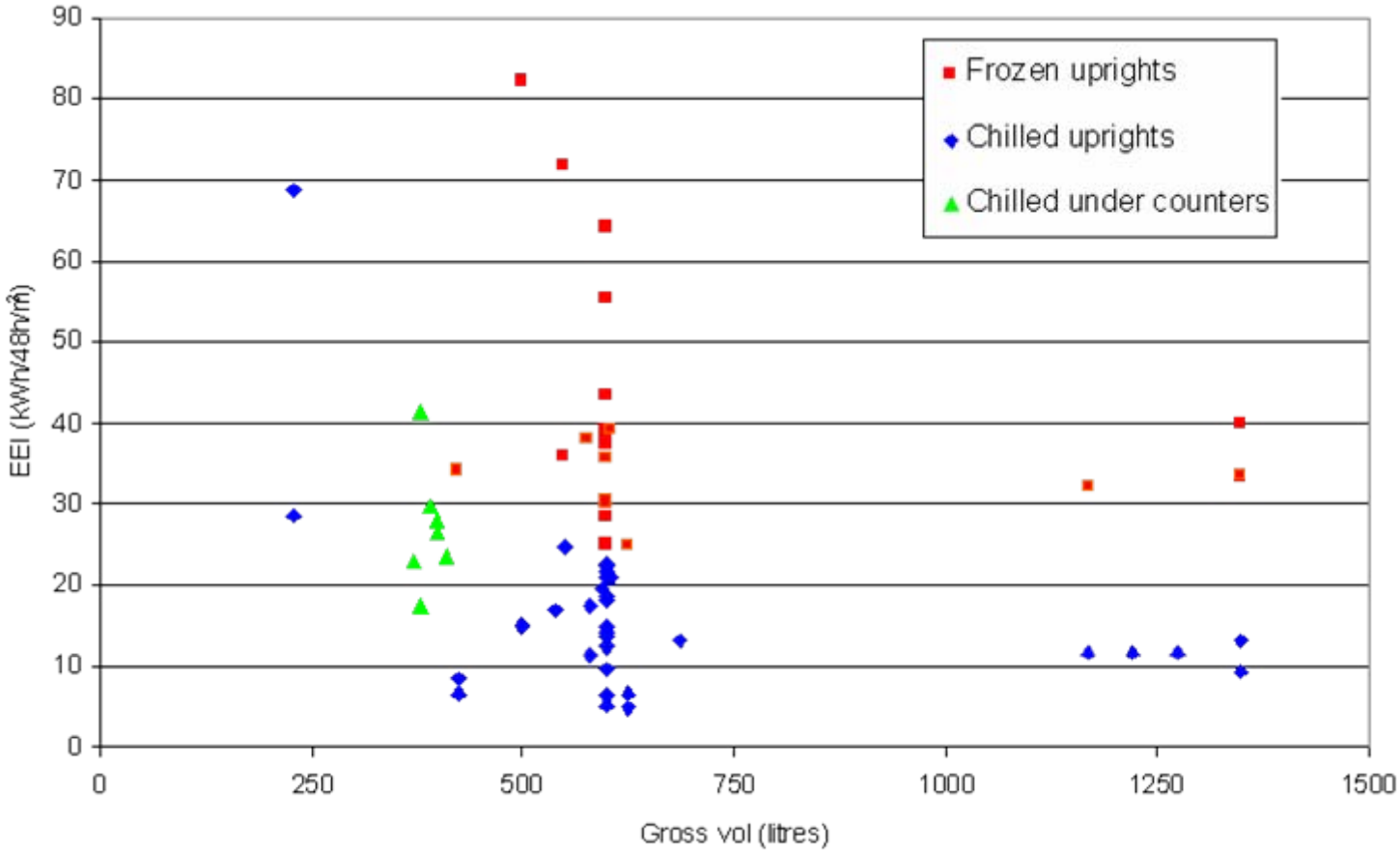
Best mixed = 27 kWh/m^3/yr (best savings = 32 kWh/m^3/yr)

Best freezer = 48 kWh/m^3/yr (best savings = 40/56 kWh/m^3/yr)

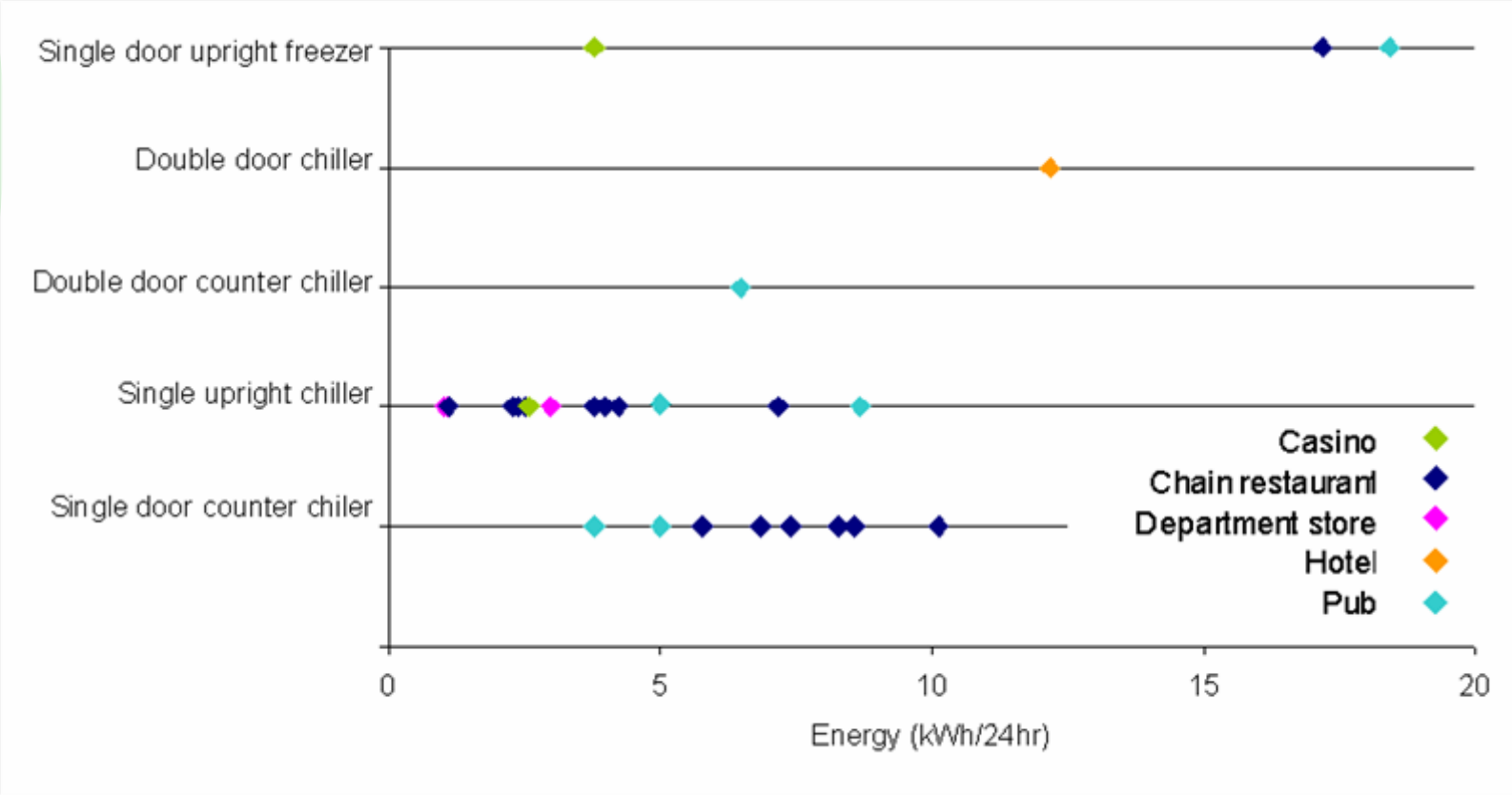
Transport


l/day
140
120
100
80
60
40
20
0
Large artic, 38-44t
Large rigid, >18t
Medium rigid, <=18t
Small artic, 32t
Small rigid, <=7.5t
Urban artic

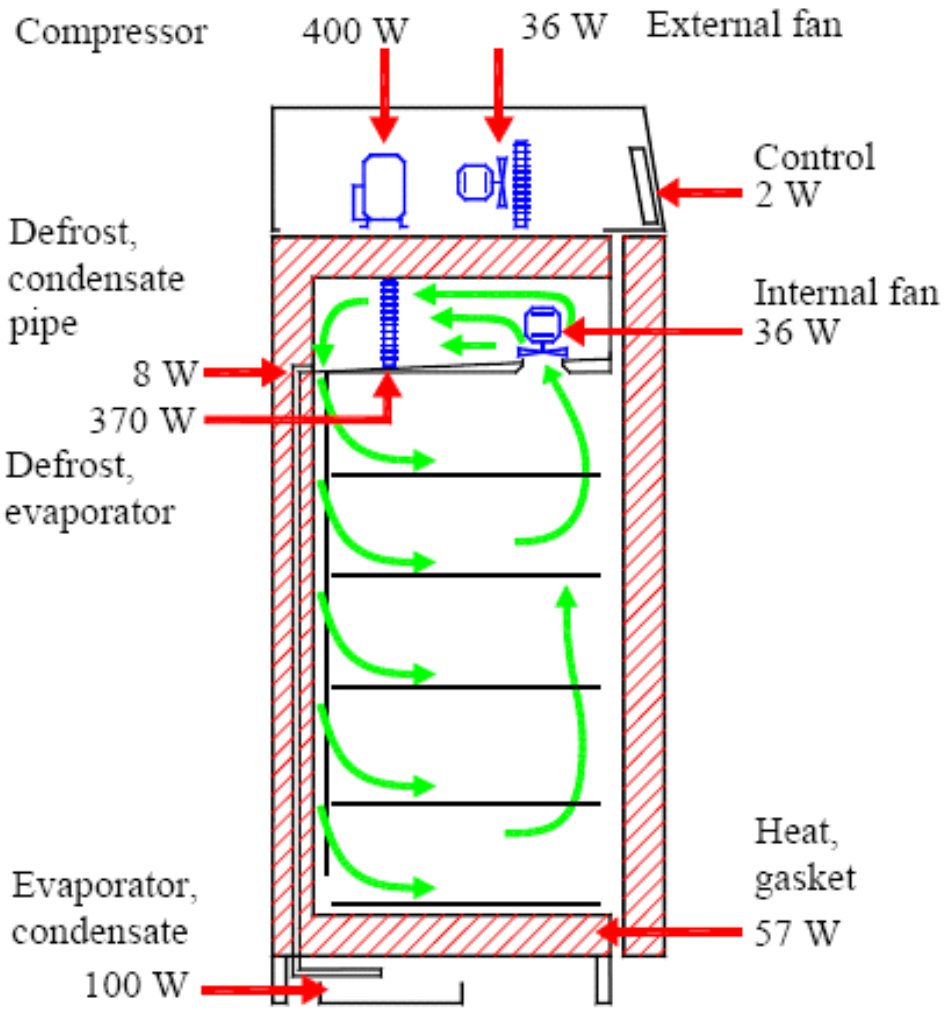
Commercial service cabinets



Performance in use



Options to improve



Suction-liquid heat exchange (10%)

Liquid line solenoid (up to 30%)

Control systems (up to 30%)

Inverter driven compressors (20%)

Off-cycle defrost (5%)

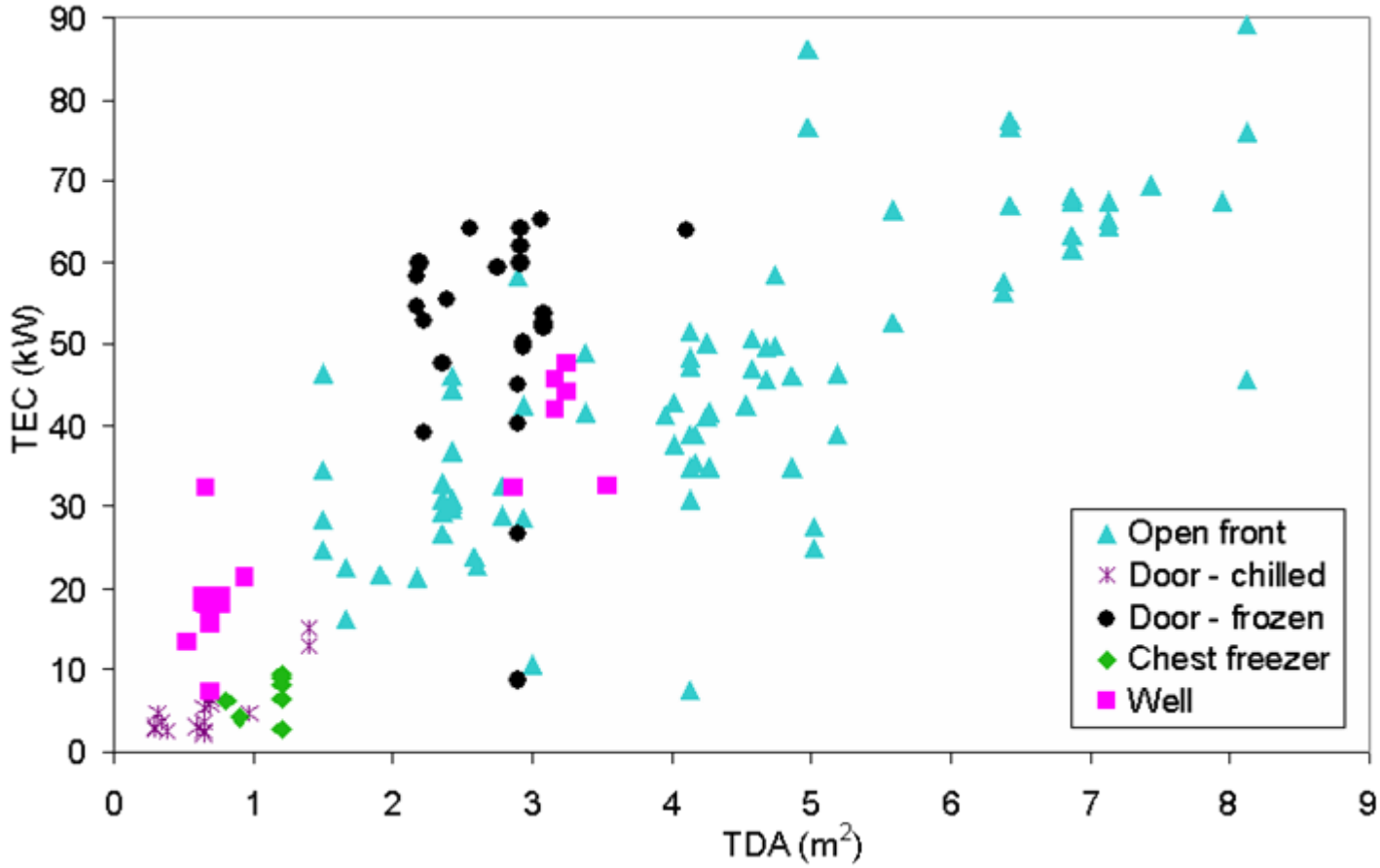
Discharge gas defrost water evaporation (2%)

DC fans (1%)

Gasket heaters (1%)

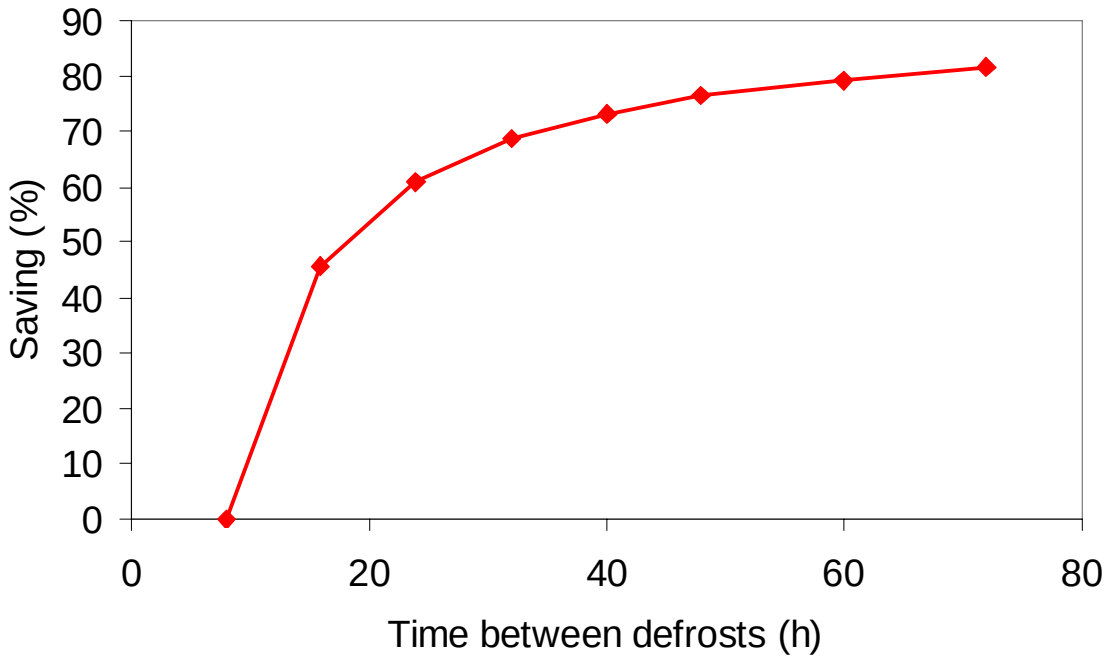
Improved insulation (20%)

Retail display cabinets



Defrosting

- **Defrost optimisation (frozen well)**
- **Defrost energy = actual energy + overhead (85%)**
- **Supermarket with 40 cabinets, 56 880 kWh/yr (saving of 24.5 tonnes of CO_2)**



Lawrence, M and Evans JA. Reducing the number of defrosts safely. International Journal of Refrigeration 31 (2008) 107 – 112.

Summary

- Large potential to improve what is already in place
- Potential to upgrade current plant
- Potential to select most efficient equipment
- Identifying improvements not always simple or easy for end users
- Data to justify investment in savings not always available
- How can we help move this process forwards?