Sector Focus

Transport

	Sector	GWh/y
1	Retail display	9,233
2	Catering – kitchen refrigeration	4,380
3	Transport	4,822
4	Frozen storage – generic	900
5	Blast chilling – (hot) ready meals, pies	425
6	Blast freezing – (hot) prepared products	316
7	Dairy processing – milk/cheese	250
8	Milk cooling – raw milk on farm	207
9	Potato storage – bulk raw potatoes	165
10	Primary chilling – meat carcasses	129

Mean estimated annual UK energy usage

Facts

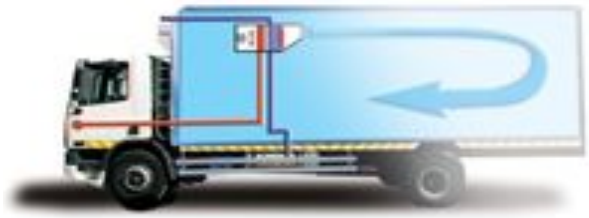
- Food transport (motive power and refrigeration) is responsible for 1.8 % of total UK greenhouse gas emissions
- There are 650,000 refrigerated road vehicles in the EU
- Around 600 mio t.km of European road freight is refrigerated.
- The UK is responsible for 8% of EU refrigerated road traffic, 48 mio t.km.
- It has been estimated that the same amount of fuel can transport 5 kg of food only 1 km by personal car, 43 km by air, 740 km by truck, 2,400 km by rail, and 3,800 km by ship.

Energy used in sector

Refrigeration systems on transport vehicles in the UK are estimated to use 4,822 GWh of energy per year.

Systems in use

Vehicles

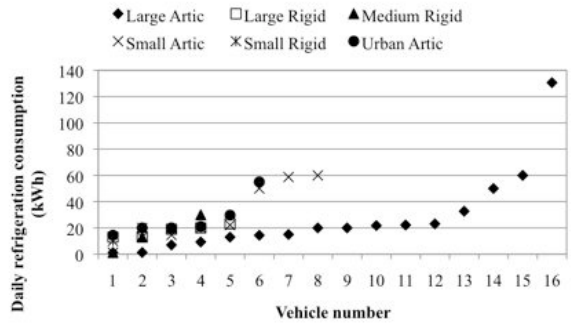


The following table shows 'typical' values for the fuel consumption of the refrigeration systems on different types of refrigerated vehicles.

Vehicle class	Refrigeration fuel consumption	Refrigeration to motive energy
	Litres/day	%
Medium Rigid	21.0	18.9
Large Rigid	17.7	19.5
City artic	26.1	23.2
32 tonne artic	34.1	24.2
38 tonne artic	24.9	15.6

Only one example has been located where the amount of fuel consumed by the refrigeration systems in different commercial refrigerated vehicles in the UK was actually measured. The data,

transformed into kWh consumed on the day of measurement, are shown below.



There are large (6 fold) unexplained differences in the energy consumed by different vehicles of the same type.

Further work is clearly required on energy use in food transportation.

Type of refrigeration units

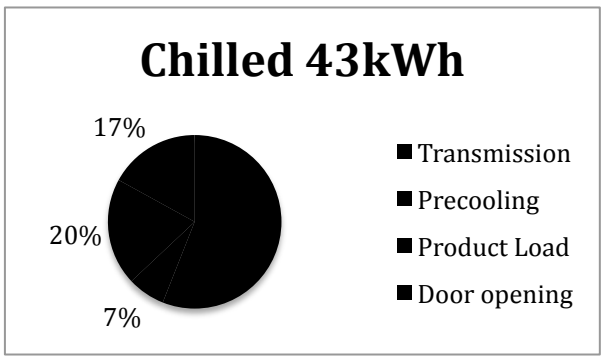
- Independent diesel engine with direct drive to compressor and fans –chosen by majority of trailer transporters

- Independent diesel engine driving generator to electrically power compressor and fans – majority of truck transporters
- Vehicle diesel engine driving generator / alternator to electrically power compressor and fans –small truck and van transporters
- Cryogenic refrigerant held under pressure and released as required (CO_2 or Nitrogen for example)
- Eutectic systems charged at bay/RDC
- Hybrid systems.

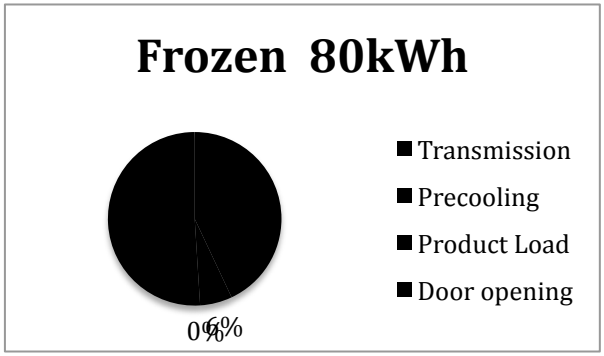
Thermal loads

Normally insulated vans have a K (thermal conductivity) of 0.7 W/m^{2}K and heavily insulated a K of 0.4 W/m^{2}K.

Transmission through the van body is by far the largest heat load in chilled distribution.



In frozen distribution door openings are equally as important.



Insulation ages and conductivity increases by 3 to 7% per year.

K increases from 0.4 to 0.62 in 9 years and transmission load increases by 50%.

Simple low cost energy savings

Reducing Main heat inputs

- Make sure food is fully cooled prior to loading.
- Minimise heat generated.
  - Fit energy efficient fans with drive motors outside freezer.
  - Switch off fans when systems are empty.
- Minimise heat infiltration.
  - Select an insulated box with low K-value (minimise heat gain)
  - The use of vacuum insulation can reduce K value by 50% and resulting in 30% energy savings (payback period of around 6 years)
  - Select an insulated box of the correct dimensions for the application to minimise surface area (minimise heat gain)
  - Select a light-coloured -ideally white -body colour (minimise heat gain)
  - Have box cleaned frequently and check for damaged insulation (thermal imaging)

System loading

- Load the vehicle avoiding blockage of air passages & use maximum load - height lines to guide operators (maximise air circulation, minimise resistance)
- Load goods fully pre-cooled to required set-point or below it (minimise heat load on unit)
- Use a temperature controlled sealed loading dock (minimise heat gain)
- Minimise frequency and duration of door openings
- Use door curtains (up to 40% savings in frozen food multi- drop operation)

- When the system is only partially loaded:
  - Make sure the loading pattern does not allow air to short circuit and return to the evaporator without extracting heat from the food.

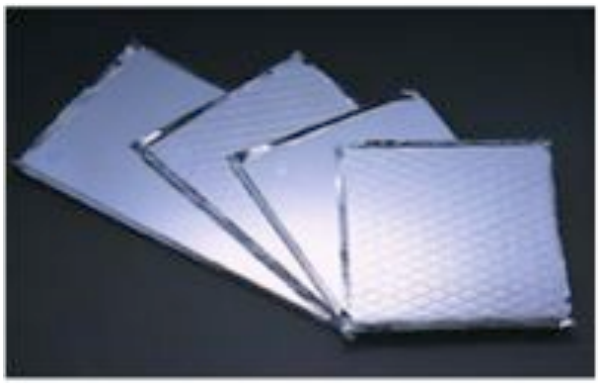
Maintenance/Operation

- Use door switches to automatically turn unit off when doors are open
- Select the appropriate refrigeration unit set-point for food transported, not a lower one (avoid unnecessary unit operation)
- Select the appropriate unit-operating mode: stop/start for frozen, modulation for fresh (optimum unit efficiency)
- Park vehicle out of direct sunlight where possible
- Maximise vehicle utilisation -avoid partial loads
- Provide a thorough driver training & established Standard Operating Procedures

- Ensure that refrigeration systems are checked to ensure heat exchangers are free of dirt and that refrigerant is not leaking. Check operation of refrigeration components to ensure operating at installed capacity and efficiency.
- Replace and adjust worn or badly fitted door and food entry protection systems.
- Replace worn door seals.
- Check for any breakdown in insulation and replace.

Retrofit options

- Advanced insulation such as VIPs (Vacuum Insulated Panels) has the ability to reduce heat load across insulation. VIPs could replace current insulation and reduce energy consumption by 5-10%.



Energy saving potential of future technologies

A number of technologies are under development for use in the near future.

- The application of photovoltaics (PV) to refrigeration for the distribution of chilled supermarket produce has been pioneered in the UK. In 1997 Sainsbury's, a major UK supermarket chain, commissioned the world's first solar powered refrigerated trailer. The trailer operated for four years with the operating power being solely derived from solar energy. In further developments the performance was increased by 27% and the total cost was claimed to be competitive with current competition.

Fostering the Development of Technologies and Practices to Reduce the Energy Inputs into the Refrigeration of Food

This project was funded by defra Department for Environment Food and Rural Affairs

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For further information on saving energy see: www.grimsby.ac.uk/What-We-Offer/DEFRA-Energy