Commercial, professional and domestic refrigeration

• Commercial
  – 90 million commercial refrigerated systems worldwide
  – 477,000 supermarkets
  – 45% energy for refrigeration in supermarkets

• Domestic
  – 1.5 billion appliances
Commercial, professional and domestic refrigeration

Commercial – supermarkets, retail (also beverage coolers, vending machines, water coolers, drinks fountains)

Professional – catering/kitchens

Domestic – home
Commercial, professional and domestic refrigeration

- **Commercial**
  - Majority of systems in use are plug-in (integral)
  - Usually <3 kW
  - Large supermarket system operate from a remote refrigerant plant

- **Professional**
  - Majority plug in systems
  - 300 W to 1-2 kW

- **Domestic**
  - Almost universally plug-in
  - 20-150 W
Commercial, professional and domestic refrigeration

- Control of temperature begins to be an issue

Temperature performance

- Large variations in performance of similar equipment

**Mean temperature (°C) for refrigerators**

**Mean temperature (°C) for freezers**
Emissions - direct

- Refrigerant emissions:
  - Commercial
    - Remote 3% at very best up to 20-30%/year
    - Integral <1%/year
  - Professional
    - Little information on professional
    - Similar production methods
    - 0.5-3%/year
  - Domestic
    - 0.1-0.5%/year
Emissions - direct

• Refrigerants:
  – Commercial
    • Traditionally high GWP refrigerants
    • Move to CO$_2$ (R744), HFOs and lower GWP alternatives in remote plant
    • HCs in small plant or HFO/HFO blend refrigerants
  – Professional
    • Move to HCs with low GWP
  – Domestic
    • 35-40% HCs (increasing, 70% by 2020)
Emissions

• Food loss:
  – Often related to lack of refrigeration

• Food waste:
  – Refrigeration extends storage life of food
  – Reducing storage temperature from 7°C to 4°C extend storage life by ~50%
  – Could save UK £162.9 m of waste annually (270,000 tonnes CO$_2$e)
  – Additional savings if include foods which are not always refrigerated and remove others which do not benefit from refrigeration
  – Costs and emissions associated with increased fridge energy consumption lower

Emissions - indirect

- Energy consumption - wide range in performance
Developments and perspectives

• Opportunities to reduce energy usage
  – Often prevented by cost (emphasis on initial cost rather than lifetime)
  – Large number of options available
  – Loss in sales (e.g. doors on commercial cabinets)
  – Energy labelling may have impact (has already reduced energy used by domestic refrigerators by ~50%)

• Opportunities to reduce direct emissions
  – Safety of HC and A2L refrigerants

• Number of novel systems (magnetocaloric, electrocaloric, acoustic) under development or close to market, suitable for plug-in units
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