FACT SHEET 3
Domestic Refrigeration

1. Description of market sector

This market sector includes domestic refrigeration appliances used for the storage of chilled and frozen food and drink products.

Market sub-sectors: The sector includes refrigerators, freezers and fridge-freezers. The information in this Fact Sheet has not been split into sub-sectors as the technology used is very similar for all types of domestic refrigeration appliance.

Typical system design: Most domestic refrigeration appliances are factory produced electrically driven hermetically sealed systems using a vapour compression refrigeration cycle.

Alternative technologies: A small proportion use a heat driven absorption cycle. These are used for low noise (e.g. in a hotel room) or when no electricity is available (e.g. in a boat), but high cost and low efficiency make them unsuitable for mainstream applications. R&D is on-going on various alternative technologies, but there is no likelihood of such systems competing with current vapour compression systems in the next 10 years.

Changes driven by ODS phase out: Prior to 1990 most refrigeration appliances used CFC-12. In non-Article 5 countries there was a shift to HFC-134a from around 1993. Many countries have subsequently moved to systems using hydrocarbon HC-600a which is now the predominant refrigerant for new domestic refrigeration appliances. North America has not adopted HCs to a large extent. HCFCs have not been used in this market sector.

Table 1: Domestic refrigeration: summary of characteristics for HFC equipment

Typical refrigerant charge	0.1 to 0.3 kg
Typical cooling duty	0.1 to 0.5 kW
HFC refrigerants used	HFC-134a (GWP 1430[1])
Refrigeration circuit design	Hermetically sealed vapour compression
Manufacture / installation	Factory built
Typical location of equipment	Class A (access by persons not acquainted with safety precautions)
Typical annual leakage rate	< 0.5%
Main source of HFC emissions	Losses at end-of-life
Approximate split of annual refrigerant demand	New equipment: 95% Maintenance: 5%

[1] All GWP values are based on the IPCC 4th Assessment Report

2. Alternatives to currently used HFC refrigerants

Table 2: Lower GWP alternatives for domestic refrigeration

Refrigerant	GWP	Flammability[2]	Comments
HC-600a	3	3	Already in widespread use in most regions
HFO-1234yf	4	2L	Not currently used, but being investigated where larger refrigerant charges required (> 0.15 kg) and in countries with HC restrictions
HFO-1234ze	7	2L	

There is wide-spread use of hydrocarbons (HCs) in this market sector. In 2014 the RTOC estimated that 75% of new domestic refrigeration appliances globally will use HC-600a by 2020, without any further regulatory intervention. In the EU over 90% of new domestic refrigeration appliances already use HC-600a.

3. Discussion of key issues

Safety and practicality

HFC-134a is non-flammable. HC-600a is classified as higher flammability, so refrigerators using HC-600a must be designed to safely utilise this refrigerant. There are over 500 million HC-600a refrigerators and freezers in use globally. Safety issues related to higher flammability have been successfully addressed. Safety standard IEC 60335-2-24 allows up to 0.15 kg of HC-600a to be used in domestic applications provided the correct design guidelines are used. Most HC-600a domestic units require substantially less than 0.15 kg (HC-600a equipment requires about half the charge in kg of an equivalent HFC-134a appliance).

In the US and Canadian markets, HCs have not been widely used. The UL 250 standard does not allow use of more than 0.057 kg which restricts use of HCs to small refrigerators and freezers (many appliances sold in the US need a higher charge).

In most geographic regions it can be expected that HCs will be widely adopted. If HCs cannot be used either due to regional safety standards or for especially large domestic refrigerators (i.e. requiring above 0.15 kg), then HFO-1234yf or HFO-1234ze may be introduced as a suitable low GWP alternative. Safety issues still need to be addressed, as these HFOs have lower flammability. Standards such as IEC 60335-2-24 do not currently distinguish between flammability classes, which is a barrier to use of lower flammability refrigerants.

Commercial availability

HC-600a is widely available for domestic refrigeration applications and suitable components (such as compressors) are widely available.

HFOs are not yet used for this application. Compressors optimised for HFO-1234yf or HFO-1234ze in domestic refrigeration appliances are not yet widely available.

[2] Flammability classes based on ISO 817 and ISO 5149
3 = higher flammability; 2 = flammable; 2L = lower flammability; 1 = no flame propagation

Cost

To use HC-600a there are initial capital investments required to ensure safety in factories handling large quantities of HCs. Once these investments have been made the on-going costs are slightly reduced as HC-600a charge is low and it is well suited to high efficiency designs. Life cycle electricity costs can be reduced due to the high energy efficiency of HC systems. Those markets that are currently using HCs for domestic refrigeration have made the move from HFC-134a to HC-600a on a completely voluntary basis, illustrating that there is a positive commercial driver to switch to HCs.

Costs to use HFOs have not been established. Initial production line investment costs are likely to be lower than for HCs because the flammability issues are easier to address. HFOs are more expensive than HFC-134a, so there could be a small increase in the cost per refrigerator.

Energy efficiency

HC-600a has very good thermophysical and chemical properties and can be used to make highly efficient domestic refrigerators. Most new HC equipment has equal or better efficiency than new HFC-134a equipment.

Energy efficiency of HFO-based refrigerators is not yet known.

Applicability in high ambient temperature

There are no extra difficulties designing HC-600a domestic refrigeration systems for operation in high ambient temperatures (compared to using HFC-134a). HC-600a will operate with a considerably lower condensing pressure than HFC-134a at high ambient temperature.

Opportunities to retrofit existing equipment

It is not appropriate to retrofit existing domestic refrigeration and other small hermetically sealed systems.

Technician training

Technicians doing refrigerator maintenance need training to work with HC-600a that addresses handling of higher flammability refrigerants. There are well established training courses available in regions already using HCs, including Article 5 countries.

Minimising HFC emissions from existing equipment

The majority of HFC emissions from domestic refrigerators occur at end-of-life (operational leak rates are very low and mostly occur through accidental damage). End-of-life recovery facilities must be available to minimise these emissions.