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Mitsubishi Electric Guide to Low GWP Refrigerant Gases in Chillers

Information Guide 66

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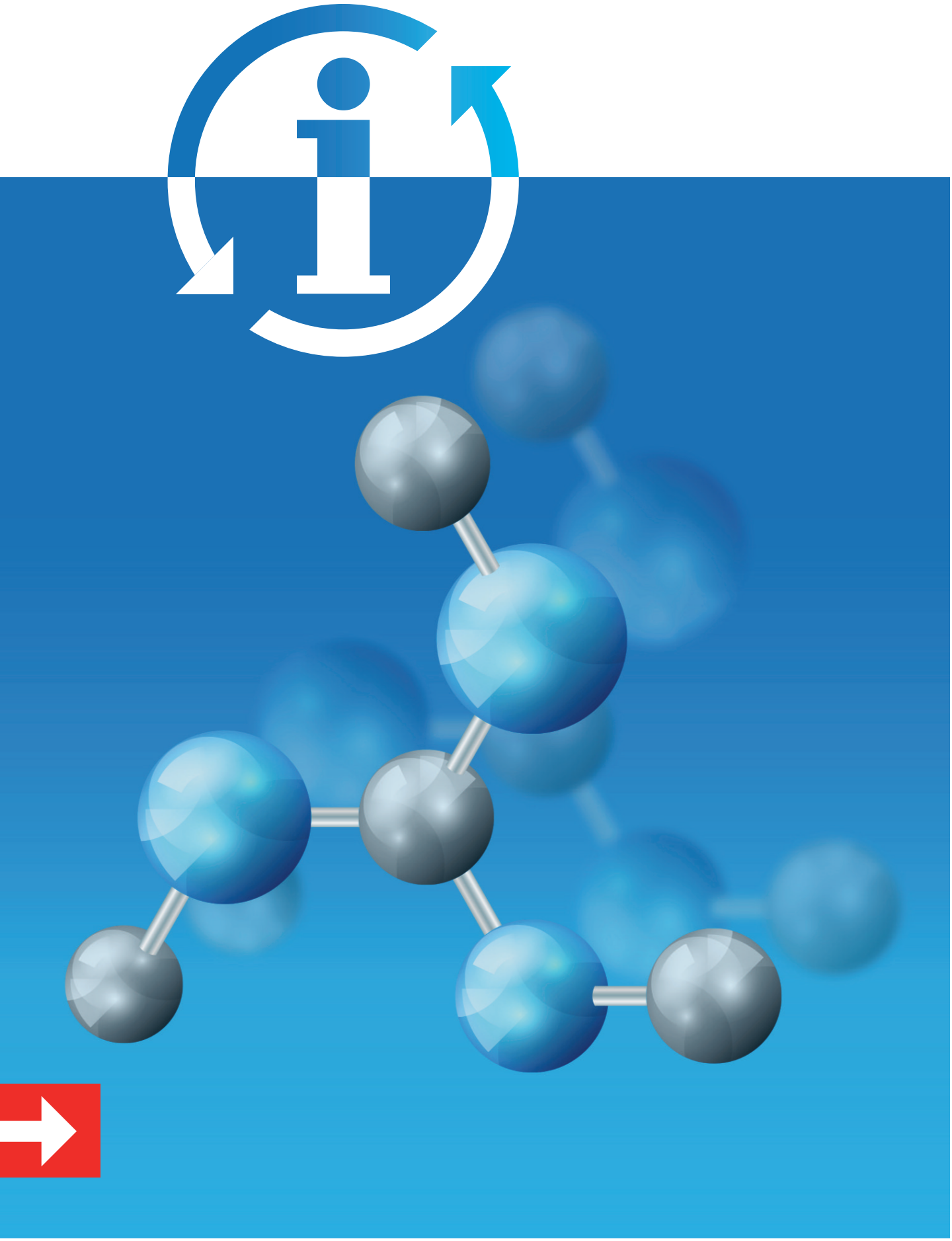


Mitsubishi Electric Guide to Low GWP Refrigerant Gases in Chillers

This is an independent guide produced by Mitsubishi Electric to enhance the knowledge of its customers and provide a view of the key issues facing our industry today.

This guide accompanies a series of seminars, all of which are CPD certified.

Contents

F-Gas Regulations - an overview

In May 2006, the European Union introduced Regulation (EC) No 842/2006 of the European Parliament and of the Council, now widely referred to as the F-Gas Regulation. It was the first step in a programme to reduce the use and release of man–made gases which impact on the environment.

Under these rules, HFC (hydrofluorocarbon) gases were allocated a Global Warming Potential (GWP) number. These numbers are an indication of how much heat a gas traps in the atmosphere, leading to global warming. These gases include those which are commonly used in air conditioning systems.

HFCs with the highest GWPs have been phased out - R22 is one of these, and it is no longer legal to use this refrigerant in new systems or for maintenance purposes. Other HFCs with lower GWPs, such as R410A, are being phased down over time.

- **The F-Gas Regulation has two key methods for reducing the potential release of these chemicals into the atmosphere:**

1. Improving the prevention of leaks from equipment containing F-gases

- Containment of gases
- Proper recovery of equipment
- Certification of personnel and of companies handling these gases
- Labelling of equipment

2. Avoiding F-gases in some applications where environmentally-superior alternatives are cost effective

- Restrictions on marketing and use of products and equipment containing F-gases

The regulation has been supplemented by 10 implementing acts or 'Commission Regulations' and it was recently updated (and is now known as Regulation (EU) No 517/2014).

For those involved in the air conditioning sector (designers, installers and end-users) one of the most important aspects of the F-Gas Regulation is the phase down of HFCs (hydrofluorocarbons).

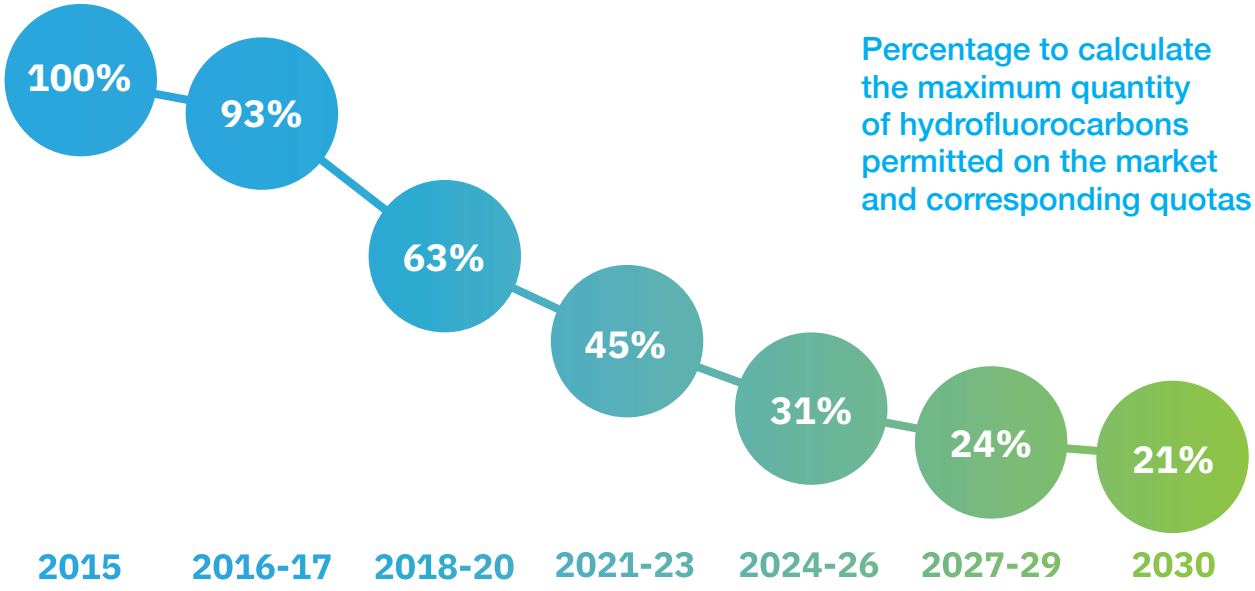
Table 1 below shows the amount of HFCs permitted to be placed into the EU market as a whole.

The reference amount (against which reductions are calculated) is based on the amounts on the market between 2009 and 2012. The phase down takes place gradually up to 2030, when the goal is to achieve a **79% cut in HFCs** against 2009-12 levels.

The maximum quantity, reference values and quotas for placing HFCs on the market are calculated as the aggregated quantities of all types of HFCs expressed in tonnes of CO_2 equivalent.

By measuring HFCs in the terms of CO_2 equivalent, the aim is to target the gases with the highest global warming potential (GWP) first. The greenhouse gas emissions savings delivered by the F-Gas Regulations contribute to the UK's overall carbon targets under the Climate Change Act.

Table 1: Phase down of HFCs to 2030
(source Regulation (EU) No 517/2014)



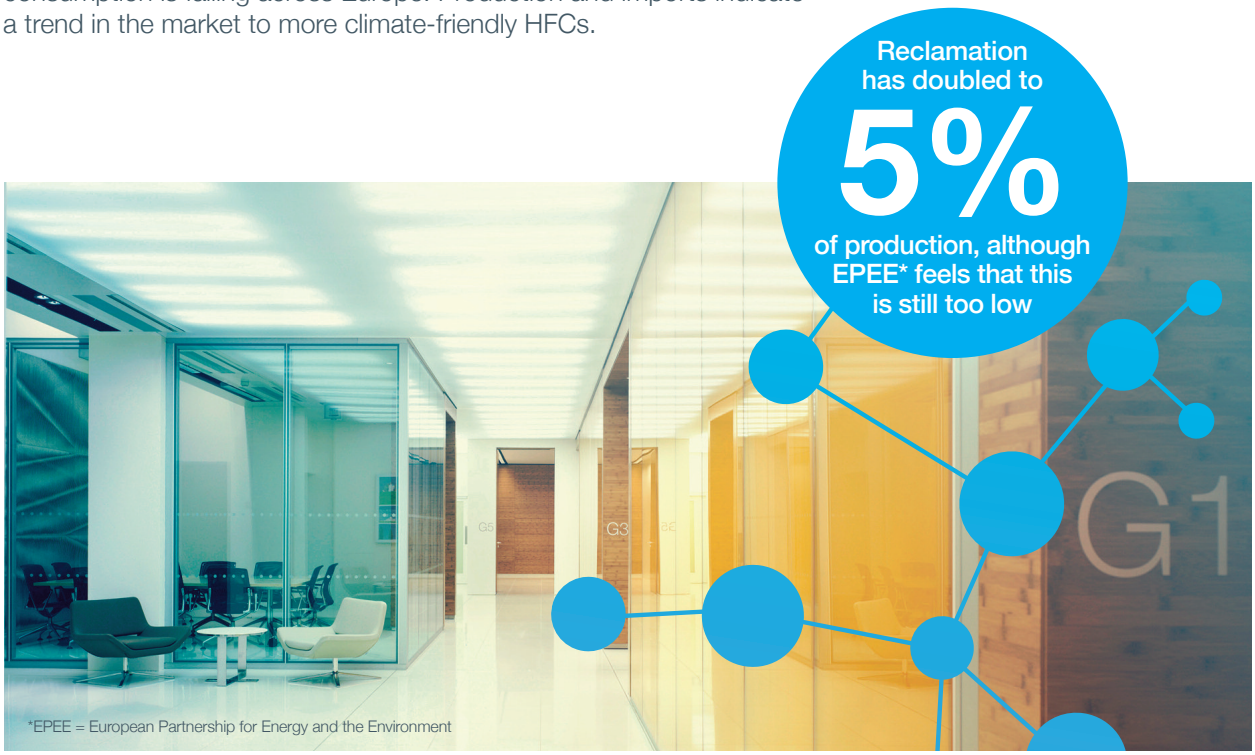
The impact on pricing and the HFC market

The HFC phase down process was intended to bring about market change, and it certainly seems to have achieved that. The price of refrigerants has risen, in the case of some types of refrigerant very significantly, affecting the air conditioning market as well as retail where the gases are used for food cooling.

For example, UK associations report that R404A and R507A saw price rises of 1,000%, and the cost of buying R410A and some R22 service blends increased by 600%.

At its meeting in March 2018, of the F-Gas Consultation Forum[1], the EU Commission informed the meeting of the result of its continuous monitoring of gas prices. It reported that HFC prices continue to rise and that there is an increasing correlation between price and GWP - 'in line with the intended workings of the quota system mechanism'.

The European Economic Area (EEA) 2017 report shows that high-GWP HFC consumption is falling across Europe. Production and imports indicate a trend in the market to more climate-friendly HFCs.



The Commission had no patience for those countries intimating that HFC quotas should be relaxed in order to lower refrigerant prices. Instead, it regards the price rises as an indication that the phase down process is working. It also recommends a number of different actions that can be taken to avoid the price rises:

- Installing new alternative equipment
- Retrofitting existing equipment
- Reclaiming gases
- Avoiding leakage
- The Commission also points to a 'number of new blends' which are available as alternatives to the higher GWP refrigerants

These points are important for those with responsibility for air conditioning systems. The fluctuating costs of refrigerants will continue to impact the cost of maintaining a system. The EPEE Gapometer Roadmap[2] which is tracking the refrigerant market across Europe noted that the rising costs of refrigerants had generally all been passed on to end-users.

Industry installers and maintenance specialists should also be aware of which refrigerants are scheduled for phase down and consider advising clients appropriately. For example, from 2020 it will not be permissible to use some virgin gases to refill existing refrigeration systems, and eventually it will be illegal to use phased out refrigerants for replacement into existing systems.

It will be important to consider the long-term impact of refrigerants in chiller systems - how long will the refrigerant be on the market? Will it be readily available for maintenance and servicing? It's clear that planning ahead is vital to ensure that customers have an air conditioning system that will be usable and maintainable in the long-term.

The alternatives

As the Commission pointed out, a number of lower GWP refrigerants are now on the market and offer a long-term solution for future proofing air conditioning in buildings. In the chiller arena, there are a number of refrigerants available as shown in *Table 2*. The most common new alternatives are HFOs - hydrofluoro olefins. These include R1234ze and R1234yf, for example.

Table 2: Lower GWP refrigerants

Refrigerant	GWP	Notes
R1234ze	7	HFO
R1234yf	4	HFO
R513A	631	A blend of R1234yf and R134a
R454b	466	A blend of R1234yf and R32
R32	675	

(For comparison, R410A has a GWP of 2088)

HFCs have been so popular for air conditioning systems because they work well - providing efficient and effective cooling at a reasonable cost. However, with growing concerns about the environment, the industry has already been exploring and developing alternatives.

But choosing alternative refrigerants is challenging. The alternative must operate at the right temperatures and pressures; provide the right cooling levels; and be safe for installers to use and for end-users to have in their buildings. R32 is one of the most common alternatives entering UK air conditioning market today, and many leading manufacturers offer high-performing split systems based on this F-Gas.

There have been a number of warnings from industry bodies such as FETA (the Federation of Environmental Trade Associations) about using the new low-GWP refrigerants. For example, in March 2018, FETA warned against using R32 as a 'drop in' replacement in R410A systems, stating: "It is not good practice to charge a system with a refrigerant that the system was not originally designed to use and is strongly discouraged."

Looking to the future, with the greater use of HFOs particularly in the chiller market, the 'drop in' approach is even less likely to be an option for air conditioning. Systems will have to be designed with the properties of low GWP refrigerants in mind.

Future-proofed systems are already available on the market, **for example chillers from Mitsubishi Electric's Climaveneta brand are already using the R1234ze refrigerant - and are designed to operate optimally using the characteristics of this refrigerant. As an extremely low-GWP refrigerant, the system is well ahead of the phase down process.**

New refrigerants and safety

The industry is ready to embrace new refrigerants, but there are some issues with switching to this new approach.

R32, for example, has been classified as 'mildly flammable' and the US air conditioning body, ASHRAE has given it a new category of A2L. Some of the newer refrigerants, such as R32 and R1234yf, are also classed as A2L. This is a higher level of flammability than A1 refrigerants such as R410A, but much lower than A3 refrigerants like propane (R290).

FETA has issued a guidance note on A2L refrigerants. "In practical terms, it is very difficult to ignite A2L gases, but some precautions must be taken to prevent accidental build-up of refrigerant, particularly during charging of systems," it states. "Manufacturers are suggesting that extract fans be used during this process, especially if the outdoor unit is in an enclosed area."

It is important to note that R32 is not an unknown quantity: over 10 million split systems in Japan use this refrigerant, and it should be regarded as safe, providing correct procedures are followed.

For those working with A2L refrigerants, BS EN378 is a standard (rather than a legal requirement) that offers guidance on conforming with two key European directives: The Pressure Equipment Directive (PED) and the Machinery Directive. These apply when a refrigerant classified as A2L is used in an air conditioning system in an amount that falls under these regulations.

Manufacturers supply information on correct installation procedures for equipment that uses these new refrigerants, and this should be followed. Other precautions need to be taken during maintenance, for example the use of spark-free vacuum pumps and refrigerant reclaim machines.

The key points covered in BS EN378 are:

- **Access to machinery rooms** (plant rooms) - access must only be to instructed personnel carrying out maintenance.
- **Venting from or through a machinery room** - refrigerants must be prevented from entering neighbouring rooms, staircases or other spaces. There must be no airflow to an occupied space through the machinery room.
- **Combustion equipment and air compressors** - where these are located in the machinery room that contains refrigeration equipment, the supply for the combustion/compression equipment must be supplied from outside the room.
- **Open flame** - naked flames are not permitted in machinery rooms except for welding/brazing and then only provided the refrigerant concentration is monitored and there is adequate ventilation.
- **Storage** - machinery rooms must not be used for storage except for tools, spare parts etc. for the installed equipment.
- **Ventilation and ducting** - ventilation of machinery rooms must be adequate for normal operation and emergencies. Provisions shall be made for adequate supply of outside air.

An important point to note about A2L- designated refrigerants is that in the UK the Health & Safety Executive (HSE) does not recognise the term 'mildly flammable'. In their view, this type of refrigerant is designated as 'flammable', and their use falls under the Dangerous Substances and Explosive Atmospheres Regulations (DSEAR).

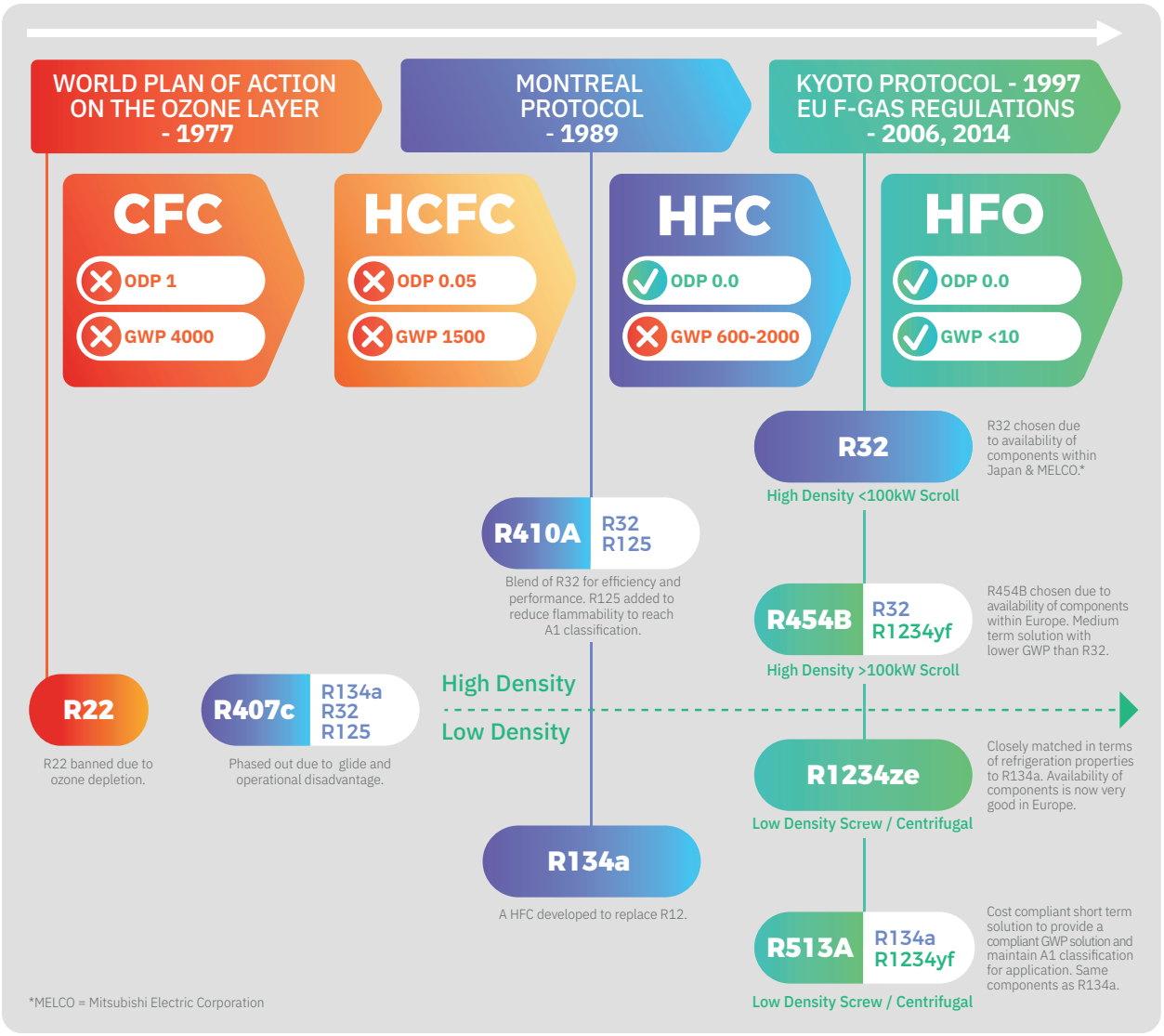
The Federation of Environmental Trade Associations (FETA) has worked with the Health and Safety Executive (HSE) and the Institute of Refrigeration to produce guidance on DSEAR requirements, which offers useful insights into carrying out required safety assessments.[3]

It is highly recommended that installers and those involved in the maintenance of non-domestic air conditioning equipment ensure that they are fully trained on the equipment; and that employers undertake the correct risk assessments where these new refrigerants are being applied.

Timeline of refrigerants

The diagram below shows a timeline of phase down for refrigerant, as well as suggestions for how the new generation of refrigerant will be used. There is also an indication of the characteristics of the less familiar refrigerants, and where they are most likely to be applied in air conditioning equipment.

The future of refrigerants



Low density refrigerants - Screw compressors and Turbocor

R1234ze

- Zero environmental impact
- Small reduction in capacity
- Efficiency remains the same
- Increase in cost
- A2L refrigerant

R513A

- Reduced environmental impact
- A2L
- Negligible change in efficiency and capacity when using same components as R134a
- Cost neutral

High density refrigerants - Scroll compressors

R32 - Good for <50kW inverter driven applications

- Efficiency remains the same
- Capacity increases
- Technology only available for small inverter driven compressors
- Cost neutral
- Specified due to availability of small DX compressors using inverters to manage higher discharge temperature

R454B - Good for >100kW fixed speed applications

- Increase in efficiency
- Small increase in capacity
- Technology only available for larger fixed speed compressors
- Cost neutral
- Can be used as a 'drop in' for R410A chillers.
- Specified due to ready availability of components for manufacturer of cooling equipment

Useful links:

1. https://ec.europa.eu/clima/events/articles/0106_en
2. www.epeeglobal.org
3. FETA guide to DSEAR is downloadable free from: https://www.feta.co.uk/publications/feta-publications

Refrigerant comparison

The table below outlines for both high density / low density, the impact on GWP, capacity and efficiency when moving from current refrigerants (R410A & R134a), to new lower GWP alternative refrigerants.

Refrigerant	GWP*	Capacity	EER	Safety class ISO 817; PED (EU)
High Density				
R410A	2088	-	-	A1 (non-flammable) Group 2 (non-dangerous)
R32	675	▲	=	A2L (mildly flammable) Group 1 (dangerous)
R454B	466	▼	▲	A2L (mildly flammable) Group 1 (dangerous)
R452B	698	=	=	A2L (mildly flammable) Group 1 (dangerous)
Low Density				
R134a	1430	-	-	A1 (non-flammable) Group 2 (non-dangerous)
R513A	631	=	▼	A1 (non-flammable) Group 2 (non-dangerous)
R1234ze	7	▼	=	A2L (mildly flammable) Group 2 (non-dangerous)
R1234yf	4	▼	▼	A2L (mildly flammable) Group 1 (dangerous)

*IPCC AR4

To receive a CPD seminar on Low GWP Refrigerant Gases in Chillers, you can call your Mitsubishi Electric Regional Sales Office to arrange an in-house presentation of this information.

If you would like to receive invitations to future CPD events, please email **livingenvironmentalsystems@meuk.mee.com**

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