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GIZ Proklima: Applications for low-GWP replacement for HCFC-22

High priorities for the introduction of low-GWP technologies are seen in particular for portable, split & window air conditioners, centralised retail refrigeration and cold storages. By targeting the high-priority sub-sectors, some 70% of the HCFC-22 consumption for new systems and installations can be avoided. Most suitable low-GWP options are natural refrigerants CO_2, Ammonia and R290 (propane).

Introduction

The adjustment to the Montreal Protocol requires accelerated phase-out of HCFCs.

Under this adjustment the Executive Committee to the Montreal Protocol directed Article 5-countries to adopt climate-friendly alternatives with a low-GWP.

However, it is recognised that there is considerable confusion amongst countries about which low-GWP alternatives are viable for use in different systems and applications.

It is also known that whilst certain low-GWP options may be viable, there may be a number of obstacles that make their application seem challenging.

This leaflet is aimed at assisting Article 5-countries to identify which sub-sectors should be targeted first in order to assist with HCFC-22 phase-out in the near-term, to help achieve a climate-friendly cost-effective transition.

The HCFC phase-out is an opportunity for developing countries to lead in the global uptake of climate-friendly cooling and directly convert their applications to low-GWP refrigerants. Climate-friendly alternatives exist for almost all applications and can be introduced in all countries.

GIZ Proklima on behalf of the German Federal Ministry for Economic Cooperation and Development supports partner countries in overcoming barriers in technology transfer and facilitates the access of climate-friendly technologies to growing markets in developing and emerging countries.

Air conditioners in developing countries

Photo: © GIZ Proklima

Production of ozone layer and climate friendly refrigeration equipment in Swaziland

Systems and applications that use HCFC-22

The table below provides an indication as to the consumption of HCFC-22 amongst all Article 5-countries according to the sub-sector.

By targeting the high-priority sub-sectors, some 70% of the HCFC-22 consumption for new systems and installations can be avoided.

The following tables provide the most suitable low-GWP, natural refrigerant options for the major refrigeration and air conditioning application and system types that currently employ HCFC-22.

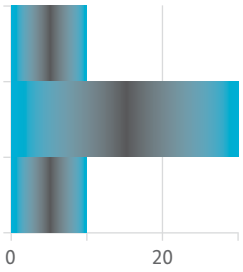
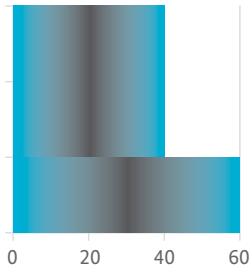
For the use of natural refrigerants within a particular sub-sector, the tables also indicate the proportion of the sector where the natural refrigerants can be easily applied without significant effort. The corresponding cost implications – incremental capital costs (ICC) for production line conversion and incremental operating costs (IOC) for handling changes to production and installation material requirements – are also given. These values are based to some extent on experience, although the range implies the differences in costs associated with different styles of equipment, conversion techniques adopted, scale of the operation, geographical location and so on.

However, it is important to clarify the meaning of these incremental costs in order to avoid confusion. Within the Montreal Protocol process, the guidelines for estimating incremental costs is different from the actual cost burden for switching to an alternative refrigerant. Often the cost effectiveness is capped at certain values, whereas the actual cost burden to the manufacturer and end user can be significantly above that value. Notwithstanding, in some cases, the overall cost impact of adopting certain alternatives can be negative.

Lastly, the lifetime emissions reductions are an estimation of the avoidance of direct CO_2-equivalent emissions associated with the refrigerant only, over the lifetime of the equipment, per kg of HCFC-22 replaced. These values are based on typical leakage rates and equipment lifetimes.

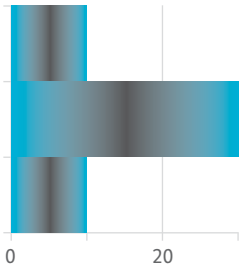
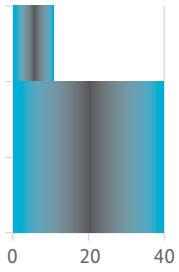
Sub-sector	System type	Priority for low-GWP	Consumption of R22		
			New (ktonnes)	Servicing (ktonnes)	Share of total (%)
Retail refrigeration	Integral/stand-alone	Low	negligible	negligible	<1%
	Condensing units	Medium	4,500	16,000	8%
	Centralised	High	3,000	9,000	14%
Cold storage/food processing/ industrial refrigeration	Including storage units and cold-rooms (integral, condensing units, centralised)	Medium	15,000	12,000	7%
Transport refrigeration	Including refrigerated trucks/ trailers, railcars, marine	Medium	negligible	negligible	<1%
Stationary air conditioning	Portable, split, window	High	58,000	54,000	45%
	Multi-split/VRF	Low	14,000	14,000	15%
	Packaged rooftop/ducted splits	Medium	2,500	3,000	4%
	Chillers (positive displacement, centrifugal)	High	5,000	9,500	4%
Heat pumps	Including for hot water heating, central heating	Low	900	200	<1%

Retail refrigeration

Equipment type	Suitable low-GWP refrigerants	Proportion of sector easily applied to	Cost implications		Lifetime emissions reduction tCO_2e/kg R22
			ICC ($/kgR22)	IOC ($/kgR22)	
Refrigerated/ freezer cabinets (integral)	R290, R744	High			2.7
Refrigerated/ freezer cabinets (condensing units)	R290, R744	Low			4.5
Refrigerated/ freezer cabinets (centralised)	R744, [R290, R1270, R717][1]	Medium			8.1

For this sub-sector, integral/stand-alone units and centralised systems (such as those for supermarkets) should take priority since their conversion to low-GWP refrigerants will yield the greatest CO_2e emissions reduction at a high cost-effectiveness.

Cold storage / Food processing and Industrial

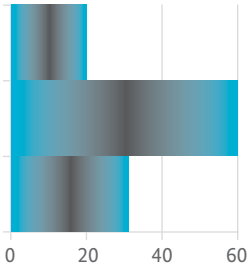
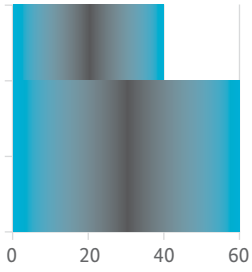
Equipment type	Suitable low-GWP refrigerants	Proportion of sector easily applied to	Cost implications		Lifetime emissions reduction tCO_2e/kg R22
			ICC ($/kg)	IOC ($/kg)	
Storage cabinets and coldrooms (integral)	R290, R1270, R744	High			3.2
Cold storage and process cooling/ freezing (condensing units)	R290, R1270, R744, R717, [R290, R1270, R717][1]	Low			5.4
Cold storage and process cooling/ freezing (centralised)	R744, R290, R1270, R717 [R290, R1270, R717][1]	High			8.1

For this sub-sector, integral type cabinets and centralised systems (such as large cold storage facilities) should take priority since their conversion to low-GWP refrigerants will yield the greatest CO_2e emissions reduction at a high cost-effectiveness.

Installation of ozone layer and climate friendly supermarket refrigeration in South Africa

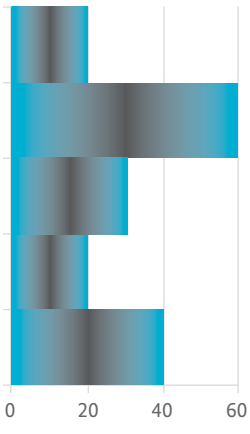
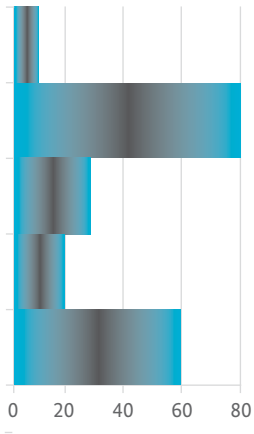
Photo: © GIZ Proklima

Transport refrigeration

Equipment type	Suitable low-GWP refrigerants	Proportion of sector easily applied to	Cost implications		Lifetime emissions reduction tCO_2e/kg R22
			ICC ($/kg)	IOC ($/kg)	
Refrigerated trailers and trucks	R290, R1270, R744	High			6.3
Refrigerated railcars	R744	High			6.3
Marine refrigeration	R744, R717	High			10.8

For this sub-sector, refrigerated trucks and trailers should take priority since their conversion to low-GWP refrigerants have the best cost-effectiveness.

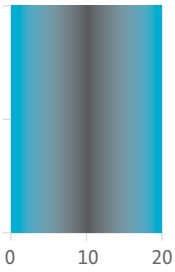
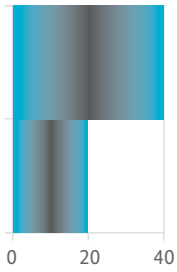
Stationary air conditioning

Equipment type	Suitable low-GWP refrigerants	Proportion of sector easily applied to	Cost implications		Lifetime emissions reduction tCO_2e/kg R22
			ICC ($/kg)	IOC ($/kg)	
Portable, split and window units (condensing unit)	R290, R1270, R744	High			3.2
Multi-split/VRF (centralised)	R744, [R290, R1270, R717] [1]	Low			2.7
Packaged rooftop/ducted splits	R744, R290, R1270	Medium/ low			2.7
Positive displacement chillers	R290, R1270, R717	High			1.8
Centrifugal chillers	R718, [R290, R1270, R717][1]	High			1.3

For this sub-sector, small sizes air conditioners (split, window, portables) should take priority since their conversion to low-GWP refrigerants has the most favourable cost effectiveness, will yield the greatest CO_2e emissions reduction at a high cost-effectiveness, whilst chillers also offer a good cost effectiveness.

1 Implies a different type of system, such as the use of an indirect circuit

Heat pumps

Equipment type	Suitable low-GWP refrigerants	Proportion of sector easily applied to	Cost implications		Lifetime emissions reduction tCO_2e/kg R22
			ICC ($/kg)	IOC ($/kg)	
Hot water heating	R290, R1270, R744	Medium			2.7
Central heating	R290, R1270, R744	High			2.7

For this sub-sector, both types of heat pumps would be equally of interest to apply low-GWP refrigerants.

Special interventions to overcome barriers to low-GWP alternatives

The following interventions should be applied in order to overcome particular issues associated with certain alternatives in certain applications.

Awareness-raising of using low-GWP refrigerants

- Manufacturers, contractors, technicians, end-users
- Seminars, workshops and similar events
- Creation and presentation of case-studies

Training

- Specialised training for specific stakeholder groups
- Focussed on individual refrigerants/applications
- Local trainers/experts sent for intensive training
- Training schemes devoted to changing the culture of the workforce to help deal with the particular characteristics of HCs, CO_2 and ammonia

Guidance, manuals, information resources

- On national legislation
- Safe handling of refrigerants
- Training material
- Production conversion for manufacturers

Proklima chiller projects in different countries

Photo: © GIZ Proklima

Photo: © GIZ Proklima

Installation of ozone layer and climate friendly supermarket refrigeration in South Africa

Technical development

- Improving efficiency of R744 systems for air conditioning under warm climate conditions
- Reducing refrigerant charge sizes for systems using HCs
- Use of mini-channel heat exchangers
- Safety control mechanisms for system using flammable refrigerants
- Carry out trials

Market development

- Component availability and sourcing – compressors, other system components and spares
- Local availability of refrigerants (HCs, R744, R717)
- Sector bans for high-GWP refrigerants
- Permits for using high-GWP refrigerants

Financial incentives

- Financial subsidies for low-GWP system purchases
- Import duty of high-GWP refrigerants
- Tax rebates for low-GWP refrigerants
- GWP-weighted deposit scheme for refrigerants

Regulatory aspects

- Develop infrastructure to improve the safe and responsible working practices of the industry
- Formation of certification and registration schemes for technicians
- Current legislation is reviewed in light of storage, distribution, handling and application of HCs and ammonia
- Develop constructive national safety standards (not prohibitive)
- Develop national codes of practice

About GIZ Proklima

Proklima is a programme of the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. It started in 1995 to support the implementation of the Montreal Protocol and also other international conventions and initiatives in the field of ozone layer and climate protection (e.g. Kyoto Protocol) in developing countries.

On behalf of the BMZ (since 1995) and the BMU's International Climate Initiative (since 2008), Proklima's activities comprise technology transfer and capacity development in several sectors (mainly in the foam, refrigeration and air-conditioning sector). Proklima is working towards phasing-out ODS (such as CFCs and HCFCs), all being potent greenhouse gases including HFCs in production, application, and recycling processes, and introducing ozone- and climate-friendly natural substances as alternatives.

Proklima also helps to enable partner countries to develop their own sector strategies for national climate protection measures, which can be implemented for instance under the climate protection regime as National Appropriate Mitigation Actions (NAMAs).

BMU	**German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety**
BMZ	**German Federal Ministry for Economic Cooperation and Development**
CFC	**Chlorofluorocarbon**
GWP	**Global Warming Potential**
HC	**Hydrocarbon**
HCFC	**Hydrochlorofluorocarbon**
HFC	**Hydrofluorocarbon**
ODS	**Ozone-depleting substances**

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