On behalf of

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

of the Federal Republic of Germany

giz PROKLIMA

23rd Meeting of the Parties to the Montreal Protocol

Applications for low-GWP replacement of HCFC22

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Introduction

- Use of low-GWP (<150) refrigerants often raised within Montreal Protocol discussion
  - —Which low-GWP refrigerants?
  - —Suitable for what sectors?
  - —Possible implications?
- Often disagreement/lack of understanding
- GIZ Publication – short guide intended to provide Parties with general guidance as to what can be used where and how easy/difficult it is
- Based on experience in Article 5 and non-Article 5 countries

Key messages

- Publication summarises
- 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 CO2, Ammonia and R290 (propane)

Key messages

- Publication summary…
- High priorities for the introduction of low-GWP technologies are seen in particular
  - —for portable, split, window air conditioners
  - —centralised retail refrigeration
  - —Industrial and cold storage
- By targeting the high-priority sub-sectors, ~70% of the HCFC-22 consumption for new systems and installations can be avoided.
- Most suitable low-GWP options are currently natural refrigerants CO2, Ammonia and R290 (propane)

Overview of RAC sector

Sub-sector	Equipment type	low-GWP priority	Consumption of R22		
			New (kt)	Service (kt)	Share (%)
Retail refrigeration	Stand-alone	High	neg	neg	<1%
	Cond units	Med	4,500	16,000	8%
	Centralised	High	3,000	9,000	14%
Cold storage/ind	all	High	15,000	12,000	7%
Transport refrig	Road, rail, marine	High	neg	neg	<1%
Stationary air conditioning	Split, window	High	58,000	54,000	45%
	Multi-split/VRF	Low	14,000	14,000	15%
	Rooftop/ducted	Med	2,500	3,000	4%
	Chillers	High	5,000	9,500	4%
Heat pumps	hot water, central	High	900	200	<1%

Breakdown for each sub-sector

- Refrigerant options
  - —Typically HCs (R290, R1270), R717 (ammonia), R744 (CO2)
  - —Also includes some in indirect/secondary systems
- Cost effectiveness
  - —IOC and ICC
  - —Values provided are in range; due to differences amongst equipment types, location, specific refrigerant option, etc
  - —NOTE: Try to address REAL costs, not negotiated HPMP-type costs
- Emissions reduction
  - —Approx. = $M_{R22} \times GWP_{R22} \times (EF_{use} \times N + EF_{eol}) / (M_{R22} \times 1000)$

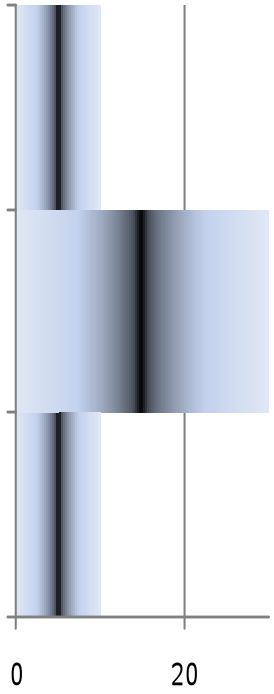
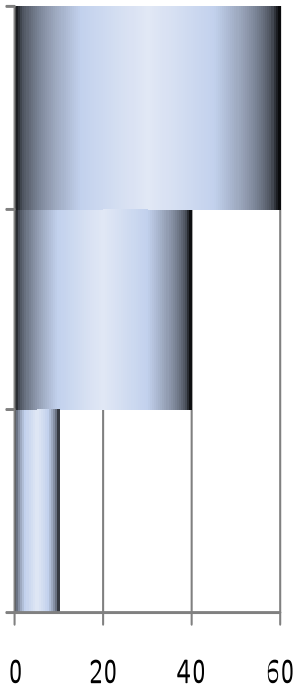
Retail refrigeration

- Stand-alone cabinets
  - —Available with
    R290, R1270, R744

- Condensing units
  - —Available with R290, R1270, R744

- Centralised supermarket systems
  - —Many installed with
    R744, R717, R290, R1270
  - —Several alternative concepts

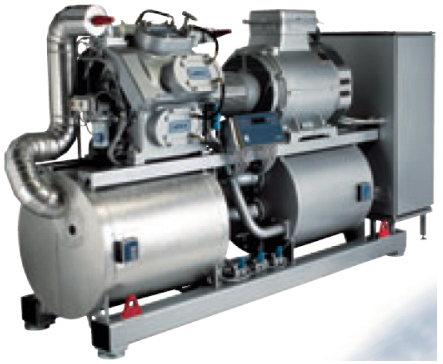
Retail refrigeration

Equipment type	Low-GWP refts	% easily applied	Cost implications		Emission red tCO2e/ 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]*	Med			8.1

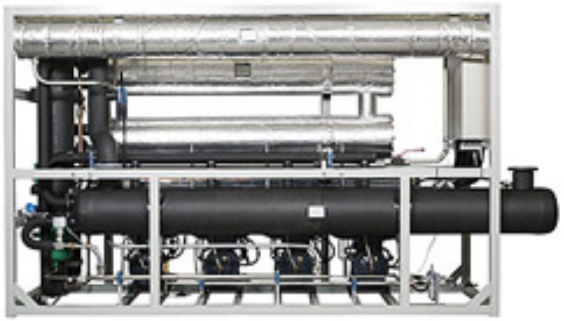
Cold storage / food processing and industrial

- Storage cabinets/coldrooms (integral)
  - —Available with R290 and R744

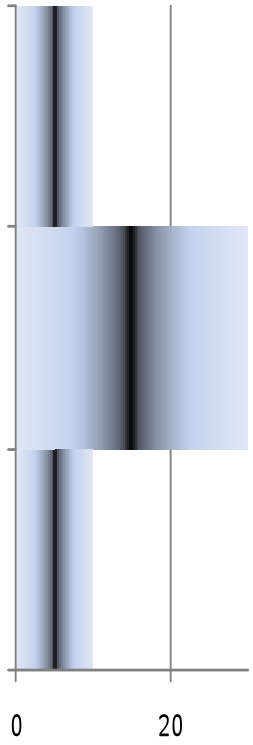
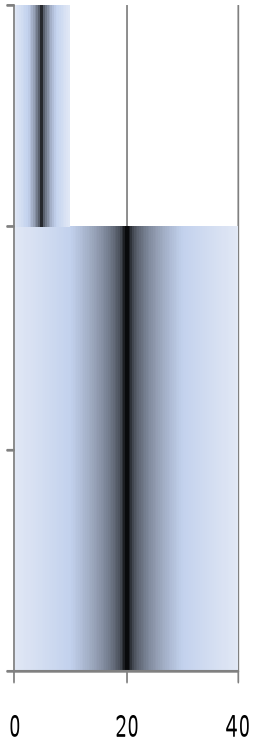
- Cold storage, process (cond. units)
  - —Available with R717, R744



- Cold storage, process (centralised)
  - —Often used with R717, R744
  - —Available with R290, R1270



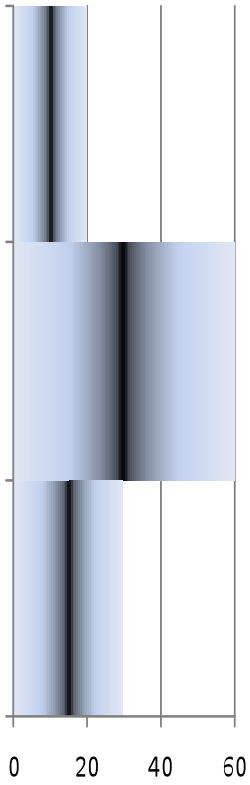
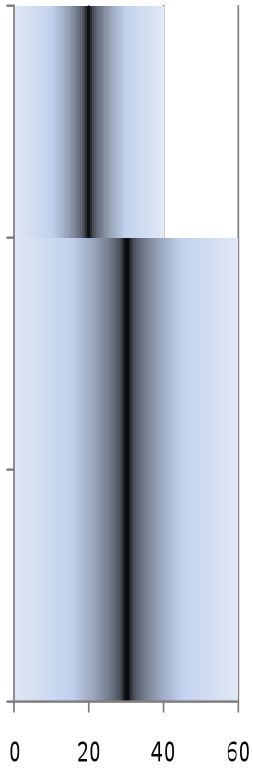
Cold storage / food processing and industrial

Equipment type	Low-GWP refts	% easily applied	Cost implications		Emission red tCO2e/ kg R22
			ICC ($/kg)	IOC ($/kg)	
Storage cabinets and coldrooms (integral)	R290, R1270, R744	High			3.2
Cold storage, process (cond units)	R290, R1270, R744, R717, [R290, R1270, R717]*	Low			5.4
Cold storage, process (centralised)	R744, R290, R1270, R717 [R290, R1270, R717]*	High			8.1

Transport refrigeration

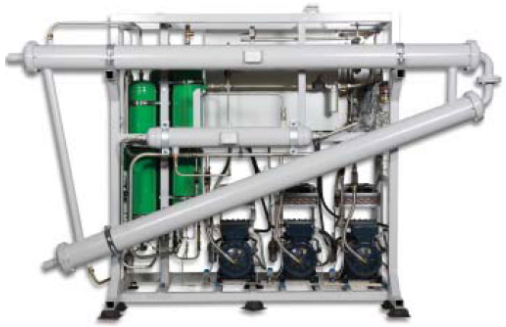
- Refrigerated trucks and trailers
  - —Available with R290 and R744
  - —Reefer containers available with R744

Transport refrigeration

Equipment type	Low-GWP refts	% easily applied	Cost implications		Emission red tCO2e/ kg R22
			ICC ($/kg)	IOC ($/kg)	
Refrig trailers, trucks	R290, R1270, R744	High			6.3
Refrig railcars	R744	High			6.3
Marine refrig	R744, R717	High			10.8

Stationary air conditioning

- Split, window
  - —Available with R290, R1290
- Multi-split
  - —Available with R744
  - —Alternatively use R290, R744, R717 chillers, etc
- Rooftop/ ducted
  - —Available with R290, R744
- Chillers
  - —Available with R290, R1270, R7



Stationary air conditioning

Equipment type	Low-GWP refts	% easily applied	Cost implications		Emission red tCO2e/ kg R22
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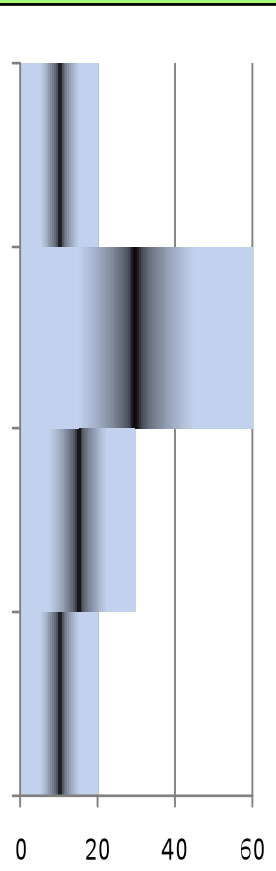
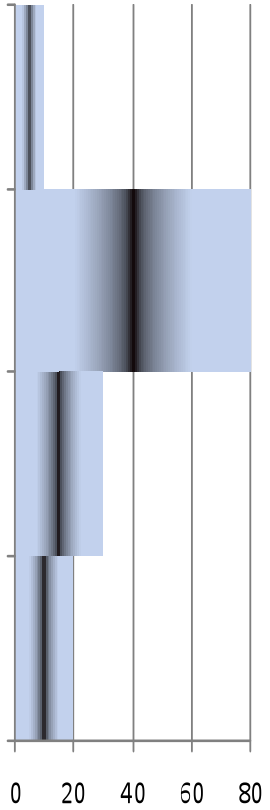
Split, window	R290, R1270, R744	High			3.2
Multi-split	R744, [R290, R1270, R717]*	Low			2.7
Rooftop/ ducted	R744, R290, R1270	Med/low			2.7
chillers	R290, R1270, R717	High			1.8

Special interventions to help overcome barriers

- Awareness-raising
  - —Highlight the importance of the (climate) problem and the possibilities of (low-GWP) options available
- Training
  - —Critical to adopt dedicated training – specific to each individual low-GWPs and specific to application/end use
- Guidance
  - —High quality guidance of what low-GWP alternative, when, where and how; also targeted to specific stakeholder groups

Special interventions to help overcome barriers

- Technical development
  - —Improving efficiency of R744 AC systems for warm climates, reducing refrigerant charge sizes for systems using flammables, safety controls for systems using flammables
- Market development
  - —Stimulate industry involvement with low-GWP alternatives; encourage local manufacturing, product directories, etc
- Financial incentives
  - —Subsidies for using low-GWP, tax incentives for low-GWP/tax disincentives for high-GWP

Special interventions to help overcome barriers

- Regulatory infrastructure
  - —Impose better control of industry to work safely, modify regulations that inhibit low-GWP alternatives, ensure safety standards are constructive
- Montreal Protocol substantive issues
  - —Decision-making bodies to introduce more incentives, HPMP consultants should be better assisted to embrace low-GWP alternatives
- ENGOs to more actively lobby on the high/low-GWP issue

Final remarks

- Short publication aimed to provide NOUs and industry with an overview of targets for low-GWPs
- Analysis of different sub-sectors and equipment types indicate suitable areas for early adoption of low-GWP refrigerants
- Large study in progress

Thank you for your attention!