

# Costs involved in HC conversions

## Experiences from production & commercialization

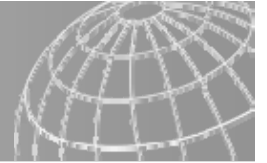
- For climate-friendly cooling -

Presented at ATMOsphere 2010  
Brussels, 27 September 2010  
by: **Dr. Volkmar Hasse**

commissioned by

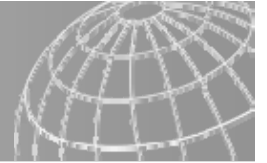


Federal Ministry  
for Economic Cooperation  
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- **Objective**
- **General approach**
- **Description of projects**
- **Summary of cost implications**
- **Emissions reduction potential**
- **Cost effectiveness**

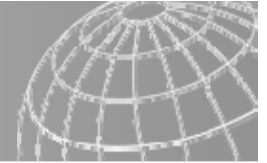


## **Reliable cost information on**

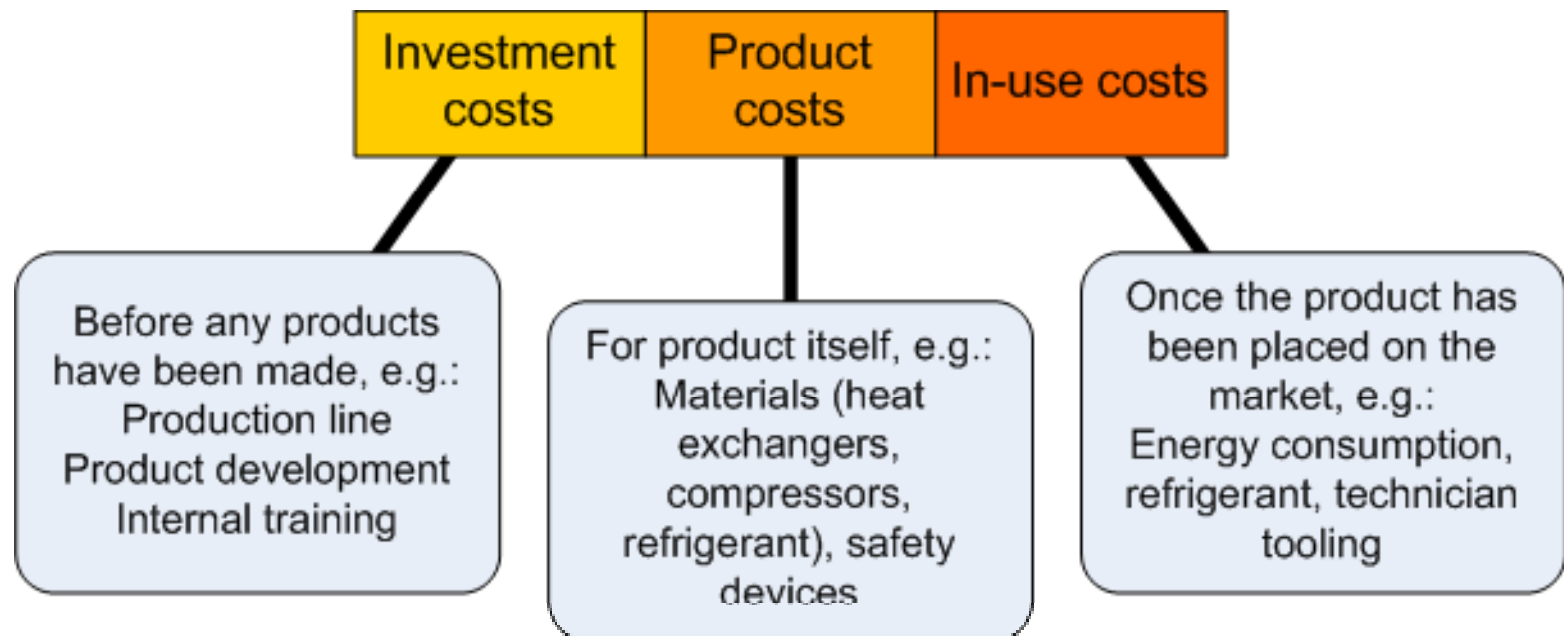
- **Cost of conversion to HC refrigerants**
- **CO<sub>2</sub>-eq cost-effectiveness**

## **Information was gathered by**

- **Analysing costs of demonstration projects already carried out**
- **Discussions with other manufacturers**

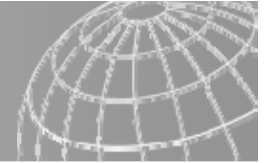


## Costs associated with change of refrigerant change comprise three aspects



**Here, we neglect in-use for simplicity (< 1%)**





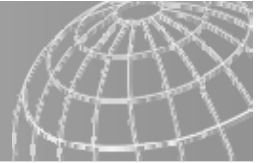
## Concerned with two different types of product



**Split type  
room air conditioner**



**Stand-alone  
commercial refrigeration**



Design  
production  
layout

Install new  
production line

In-house and  
technician  
training

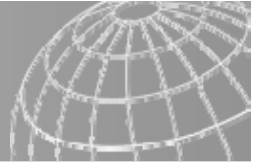
Product  
development  
- safety  
- performance

Test/refine  
prototypes

Begin production







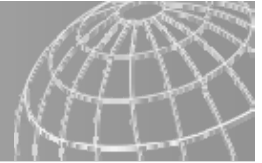
In “Revised analysis of relevant cost considerations surrounding the financing of HCFC phase-out” (UNEP/OzL.Pro/ExCom/55/47)

**Incremental capital cost (ICC) of converting manufacturing**

- technology transfer, charging equipment, gas detection and ventilation, training and safety inspection, etc

**Incremental operational costs (IOC) associated with funding the new alternative**

- compressors, heat exchangers, safety features, etc



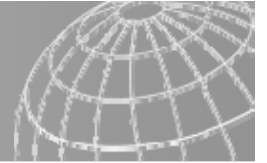
## Room air conditioners (AC) based on 250,000 units per year

	R410A	R290
ICC	\$1 - \$4 per unit	\$2 - \$3 per unit
IOC	\$11 - \$33 per unit	\$18 per unit

## Stand-alone commercial refrigeration (SACR) based on 10,000 units per year

	R410A	R290
ICC	\$7 per unit	\$32 - \$80 per unit
IOC	\$14 per unit	\$15 - \$23 per unit





## Product development/R&D

- **Highly variable:**  
around  $<1/2\%$  to  $>5\%$  of one-years' product turnover

## In-house training, internal infrastructure and admin

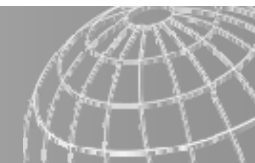
- **Approx. \$50,000 - \$150,000**

## Production line equipment

- **SACR: approx. (\$150,000) + \$100,000 extra for HC**
- **AC: approx. (\$200,000) + \$150-200,000 extra for HC**

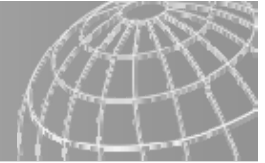
## Production area safety systems

- **SACR: approx. \$90,000 - \$130,000**
- **AC: approx. \$150,000 - \$200,000**



## Average investment costs per unit

Cost element	AC	SACR
Product development	\$8	\$3
In-house training	<\$1	<\$1
Internal infrastructure/admin	\$1	\$1
Production line equipment	\$2	\$3
Production area safety systems	\$2	\$3
<b>Total</b>	<b>\$13</b>	<b>\$11</b>
<b>Over 10 years</b>	<b>\$1.3</b>	<b>\$1.1</b>



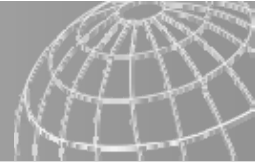
## For room air conditioners

	R22 → R290	R22 → R410A	R410A → R290
HX costs	-\$15/unit	-\$2/unit	-\$13/unit
Refrigerant	+\$1/unit	+\$18/unit	-\$17/unit
Compressor	+\$2 to +\$28/unit	+\$10 to +\$28/unit	-\$8 to \$0/unit
Safety items	+\$5/unit	n/a	\$5/unit
<b>Overall</b>	<b>+\$4/unit (average)</b>	<b>+\$35/unit (average)</b>	<b>-\$29/unit (average)</b>

**More in-depth R&D will yield lower costs for new systems, e.g. through**

- **Smaller heat exchangers (HX), cheaper safety features, lower charge size, etc**



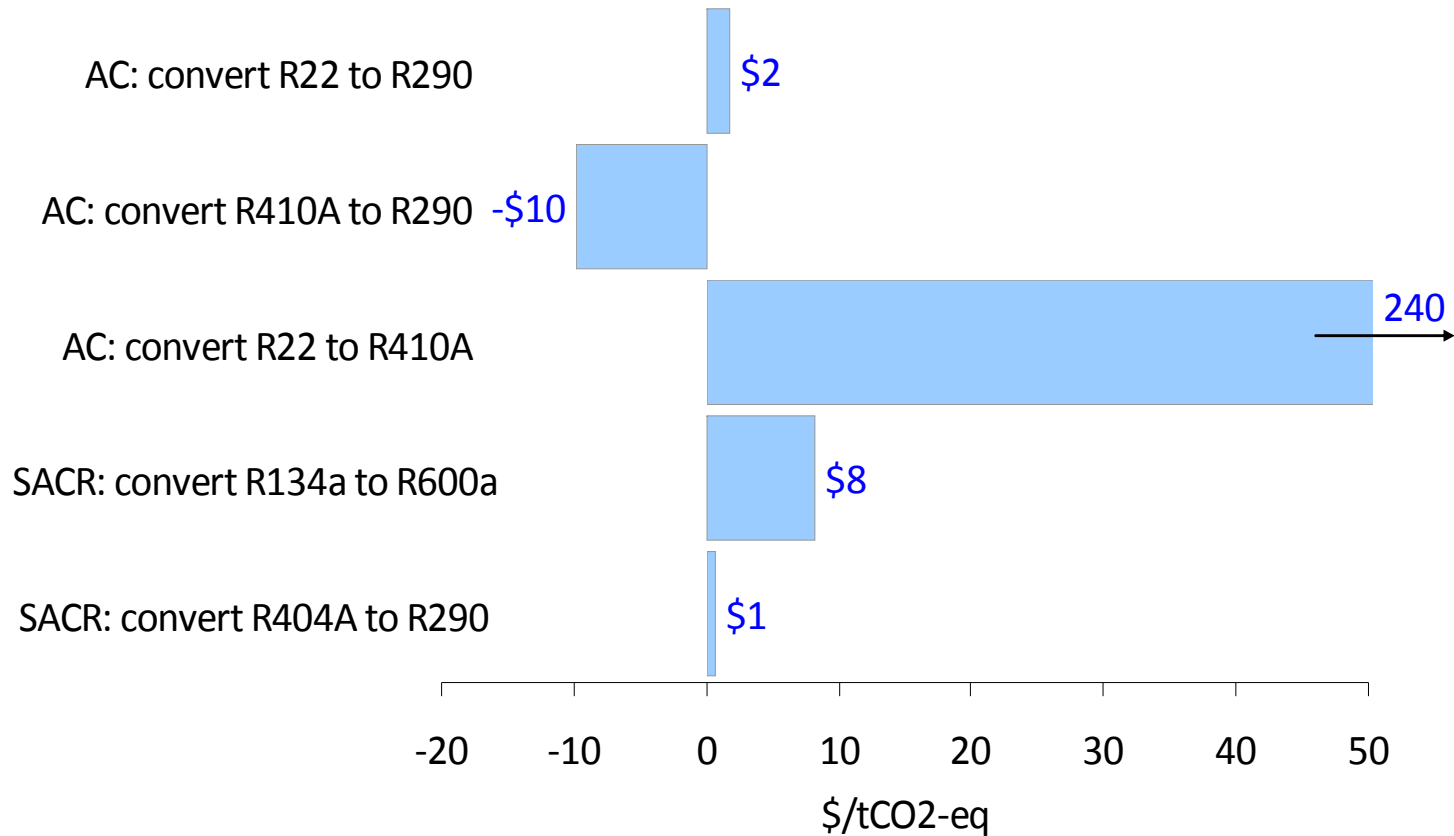
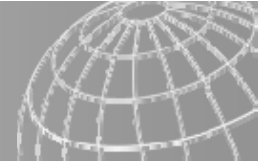


## For stand alone commercial refrigeration

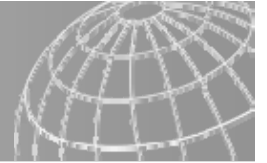
	R134a → R290	R404A → R290
HX costs	+\$1/unit	-\$1/unit
Refrigerant	-\$1/unit	-\$4/unit
Compressor	\$0 to +\$2/unit	\$0 to +\$2/unit
Safety items	+\$5/unit	+\$5/unit
<b>Overall</b>	<b>+\$6/unit</b>	<b>+\$1/unit</b>

However, opportunity to redesign products yielded massive cost savings:

- 10% to 40% lower product cost

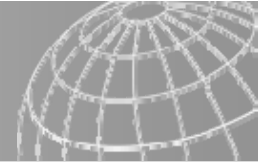


**For commercial refrigeration, the “practical” value is much better (around -\$50/tCO<sub>2</sub>-eq) due to reduced product cost**



- **UNEP values seem to overestimate cost requirements (for product construction)**
- **Shifting to HC provides excellent cost-effective emissions reduction**
- **Greater R&D expenditure greatly improves cost effectiveness in long term**
- **For some manufacturers, investment in conversion can yield massive benefits**
  - **through improved production and product design**
  - **(But this applies regardless of refrigerant type)**





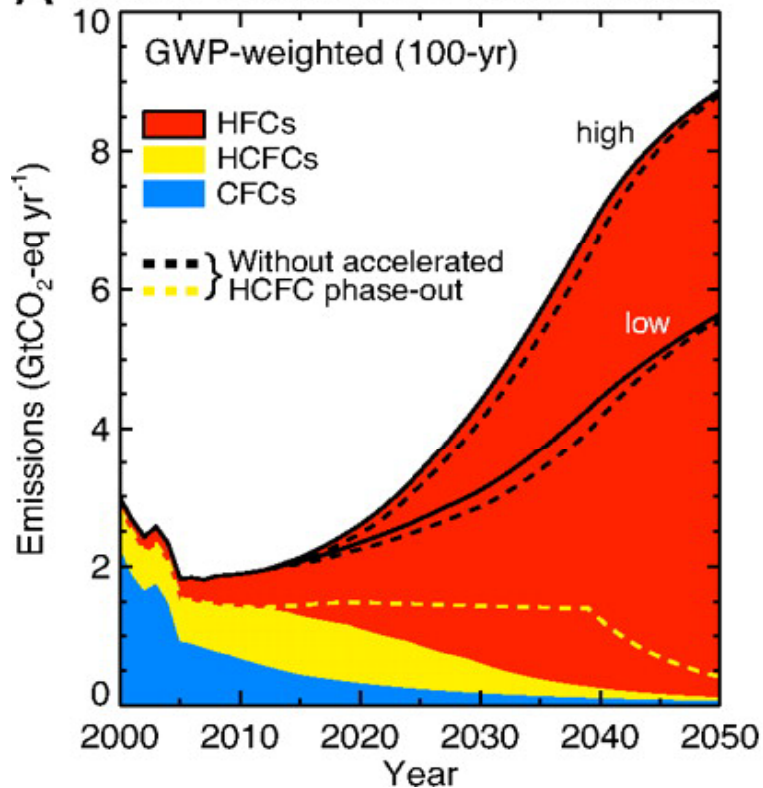
**Fig1: Predicted Growth of HFCs without constraint**

**Fig2: HFC share of global GHG-emissions**

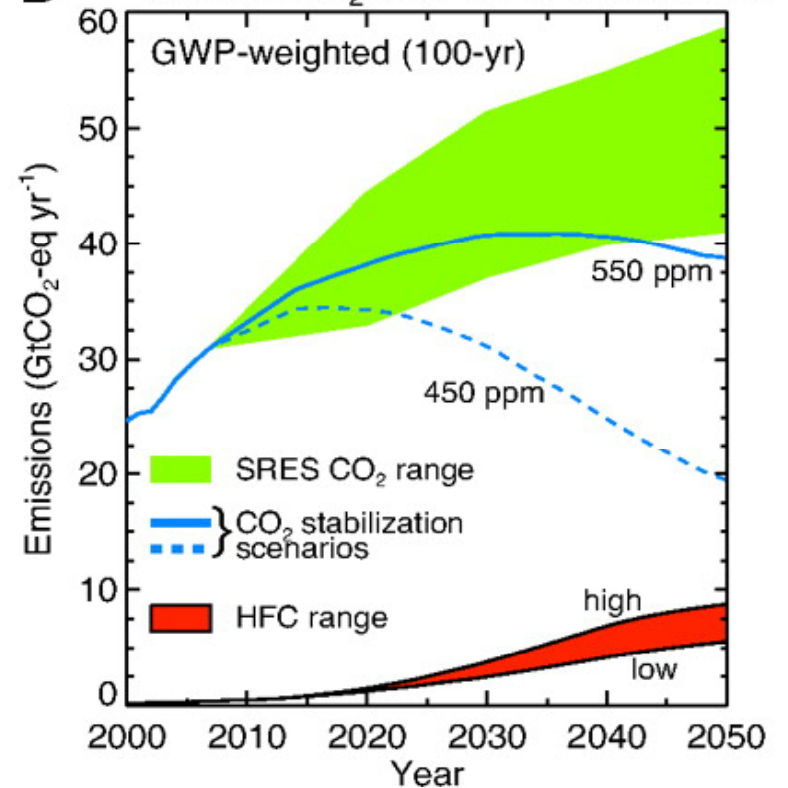
(compare HFC high vs. 450 ppm stabilization szenario → blue dotted line)

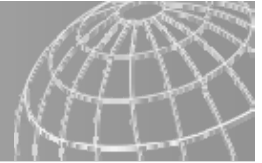
Source: Velders, Guus J.M. et.al., 2009

**A Global ODS and HFC emissions**



**B Global CO<sub>2</sub> and HFC emissions**



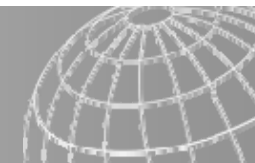


## Air conditioners

	R22	R410A	R290
Charge (kg)	1.1	0.9	0.3
GWP	1810	2100	3
Leak rate/year	5%	5%	5%
Disposal release	95%	95%	95%
Unit lifetime (years)	10	10	10
<b>Lifetime tCO2-eq/unit</b>	<b>2.9</b>	<b>2.7</b>	<b>0.001</b>

For a production line with a capacity of 180,000 units per year:

- **525,000 tCO2-eq per year**



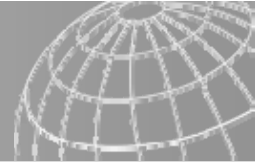
## Stand alone commercial refrigeration

	R134a	R600a	R404A	<b>R290</b>
Charge (kg)	0.35	0.15	0.5	<b>0.2</b>
GWP	1410	3	3800	<b>3</b>
Leak rate/year	5%	5%	5%	<b>5%</b>
Disposal release	100%	100%	100%	<b>100%</b>
Unit lifetime (years)	15	15	15	<b>15</b>
<b>Lifetime tCO2-eq/unit</b>	<b>0.9</b>	<b>0.001</b>	<b>3.3</b>	<b>0.001</b>

For the conversion of production capacity of 100,000 units per year:

- **150,000 tCO2-eq per year**





## **Advantage of HC equipment manufacture:**

**Considerable economic benefits associated with the conversion of refrigeration equipment production to HC**

## **Barrier encountered here:**

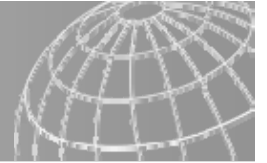
**Safety risk is perceived as unacceptable**

**This preconception is reinforced by industry interests associated with synthetic fluorinated refrigerants**

## **Approach to remove this particular barrier:**

**Accumulate and publicize economic evidence to show advantages of the production of HC equipment**

**Accumulate and publicize actual evidence plus risk analysis information to show the technical nature of safety issues and their available solutions.**



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## Additional Information:

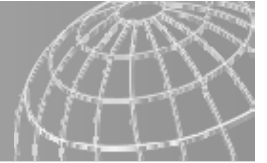
One of our PROKLIMA demonstration projects with **GREE Electrical Appliances Inc. of Zhu Hai, China** is getting ready to produce state of the art R290 split air conditioners.

Should you wish to introduce HFC-free air conditioning, kindly write to

[Linda.Ederberg@proklima.net](mailto:Linda.Ederberg@proklima.net)

We are ready to assist you.

[volkmar.hasse@gtz.de](mailto:volkmar.hasse@gtz.de)



**PROKLIMA**

**Thank you for your support in the complex and  
challenging task to cool ourselves without  
destroying our children's future.**

**Thank You!**

[volkmar.hasse@gtz.de](mailto:volkmar.hasse@gtz.de)