

Informationszentrum für  
Kälte-, Klima- und Energietechnik gGmbH

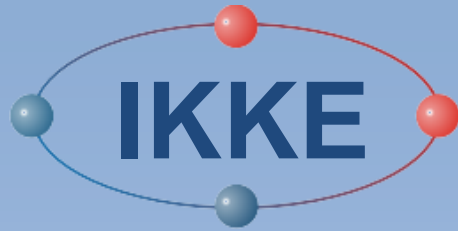
# Welcome

in the frame of the project CC-IRAN  
Climate Competence IRAN

Dipl.-Ing. Karsten Beermann, Dipl.-Ök. Dirk Kolo



CLIMATE COMPETENCE IRAN  
(Refrigeration - Ventilation - Heat Pumps)

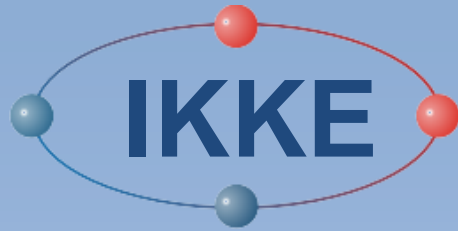


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# Environmental EU-policy for reduction of CO<sub>2</sub> – emission considering the new alternative refrigerants

- Montreal- and Kyoto-Protocol
- Future refrigerants
- Safety aspects
- Certification of personal

Dipl.-Ing. Karsten Beermann, IKKE gGmbH

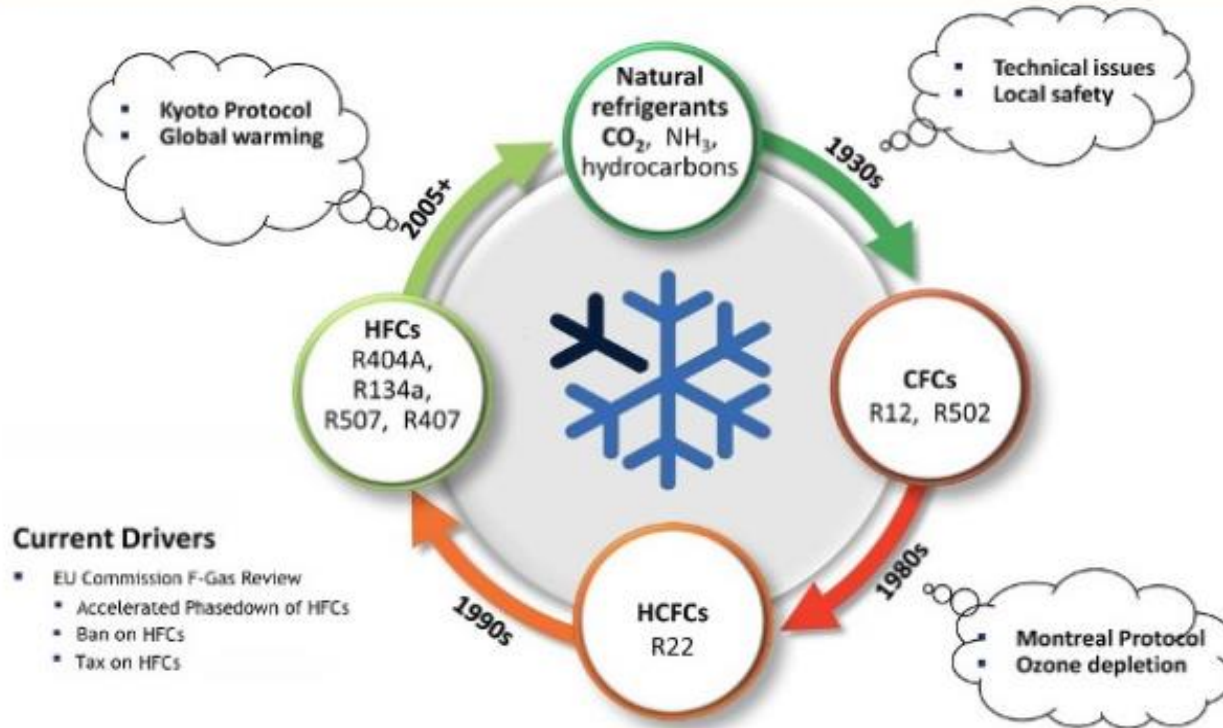


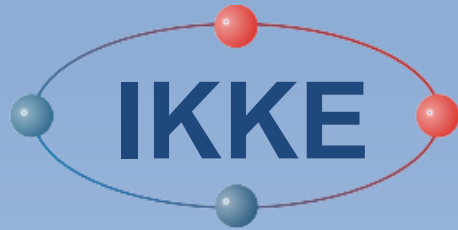
## Content

- Environmental aspects and developments
- EU- regulations
- Future refrigerants
- Safety aspects
- Maintenance & Service
- Fault finding
- New technologies and energy efficiency
- Certification and qualification procedures
- EU-project “REAL Alternatives 4 Life“ /  
e-learning-program

# Environmental aspects - history

## The Closed Cycle .....Driving Natural & Alternative Refrigerant Solutions





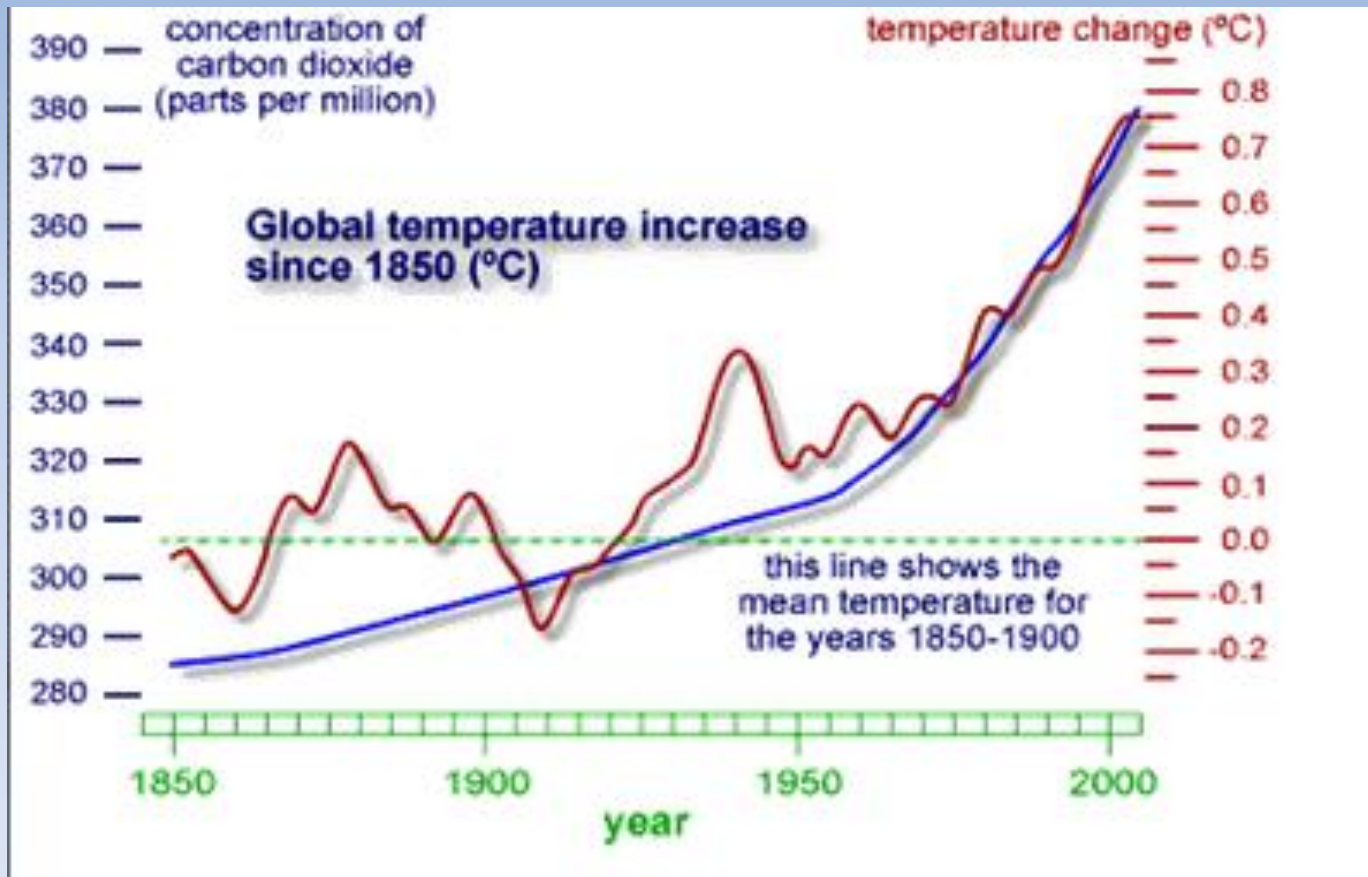
# ODP - Ozone Depletion Potential

(Montreal – Protocol)

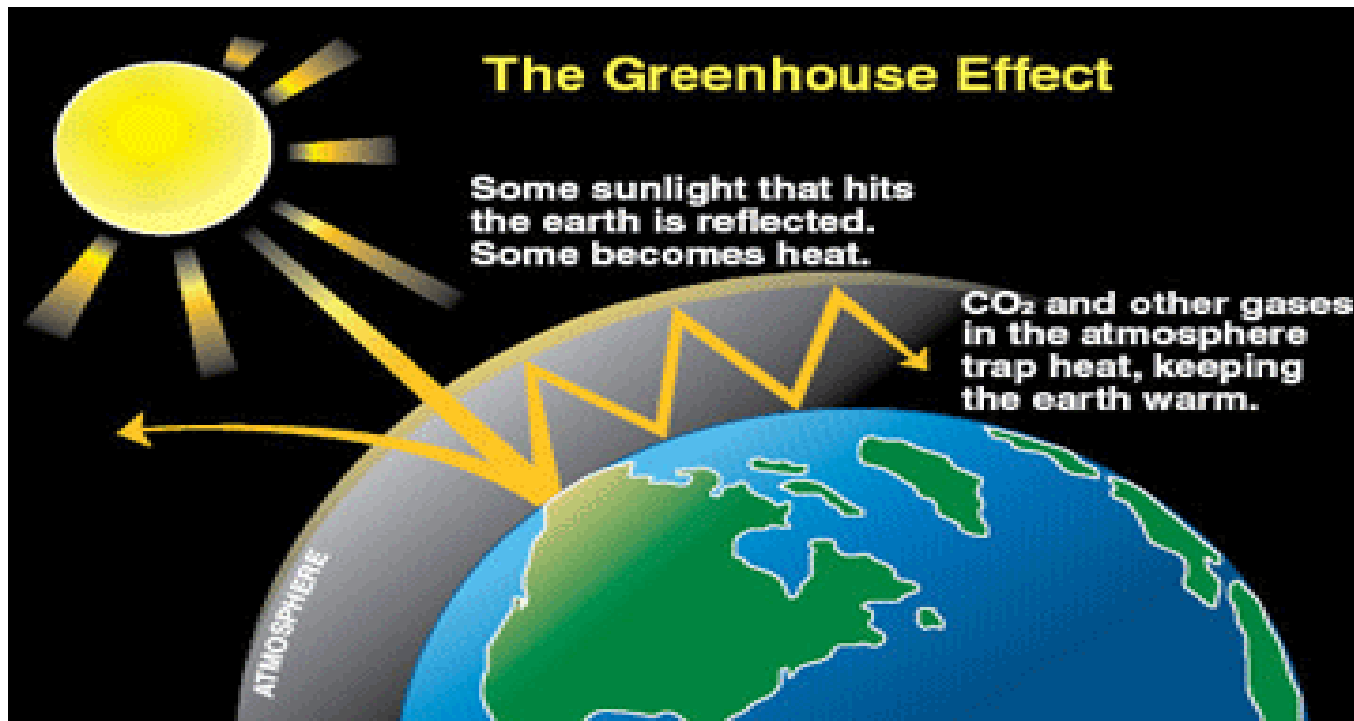
**Goal → ODP = 0 !**

- **BAN of CFC and H-CFC**
- **No application of this systems**
- **In Europe no R12 and R502 and no refilling of R22 anymore since 2015**

# Global temperature increase



# GWP – Global Warming Potential



The greenhouse effect is thrown out of balance by too much man-made carbon dioxide.

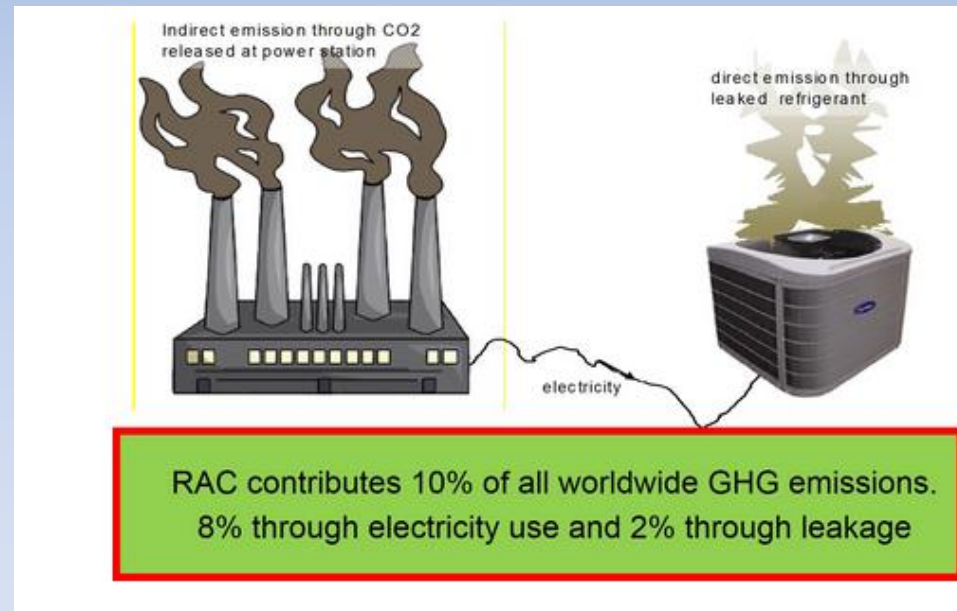
Image courtesy of Washington State Department of Ecology

# TEWI – Total Equivalent Warming Impact

direct contribution of refrigerant emissions  
into the atmosphere

+

indirect contribution  
of the CO<sub>2</sub> resulting  
from energy to  
operate the system



Kyoto-Protocol → reducing of emissions of F-gases and CO<sub>2</sub>



# EU 517 / 2014

## Actual changes of F-gas-regulation (I)

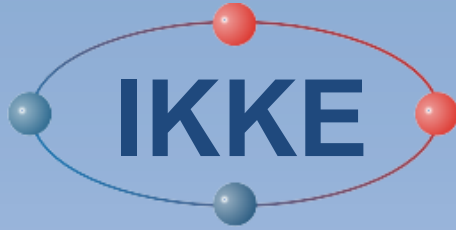
→ Reducing F-gases to 21 % (09-12) until 2030 !

- Duty of owner → leaktight systems
- Leakage control **CO<sub>2</sub>-equivalent** (min. 1x/anno)  
e.g.: 5 to → 1,3 kg R404A or 3,5 kg R134a
- Certified personal
- Duty of monitoring
- Reclaim is work of certified personal
- Education and certification → **updates !**
  - ➡ (EU) 2015/2067 (min. requirements of certific.)
  - ➡ skills and knowledge (personal categories)

# Actual changes of F-gas-regulation (II)

## (Europe)

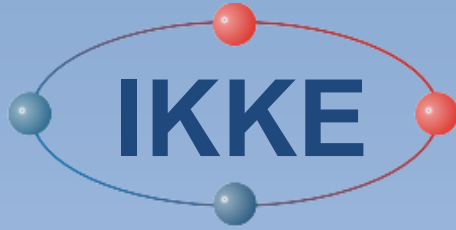
- Duty of labeling “content of global warming gas”
- **BAN of refilling**
  - of 40 to (10 kg R404A) → **GWP > 2500 1.1.2020**  
**(recycled gas 1.1.2030)**
- **Quota control** (2009-2012 sales quantity)
  - since 2017 shortage of R404A !!!, price!
- **in force since 1.1.2015**
- **2023 Review– possible future intensification ?**



# Concrete BAN (Appendix III)

( Putting into circulation )

- Household since 1.1.2015 GWP > 150
- Commercial small systems since 1.1.22 GWP > 150
- stationary cooling since 1.1.2020 GWP > 2500  
(limit < - 50 °C)
- Supermarket ( > 40 KW cooling capacity)  
since 1.1.2022 GWP > 1500/GWP > 150 (cascade)
- small mobile AC since 1.1.2020 GWP > 150
- Split-AC (single < 3kg) since 1.1.2025 GWP > 750

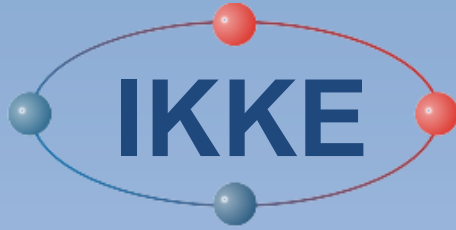


# Actual Refrigerants

## HFC (GWP)

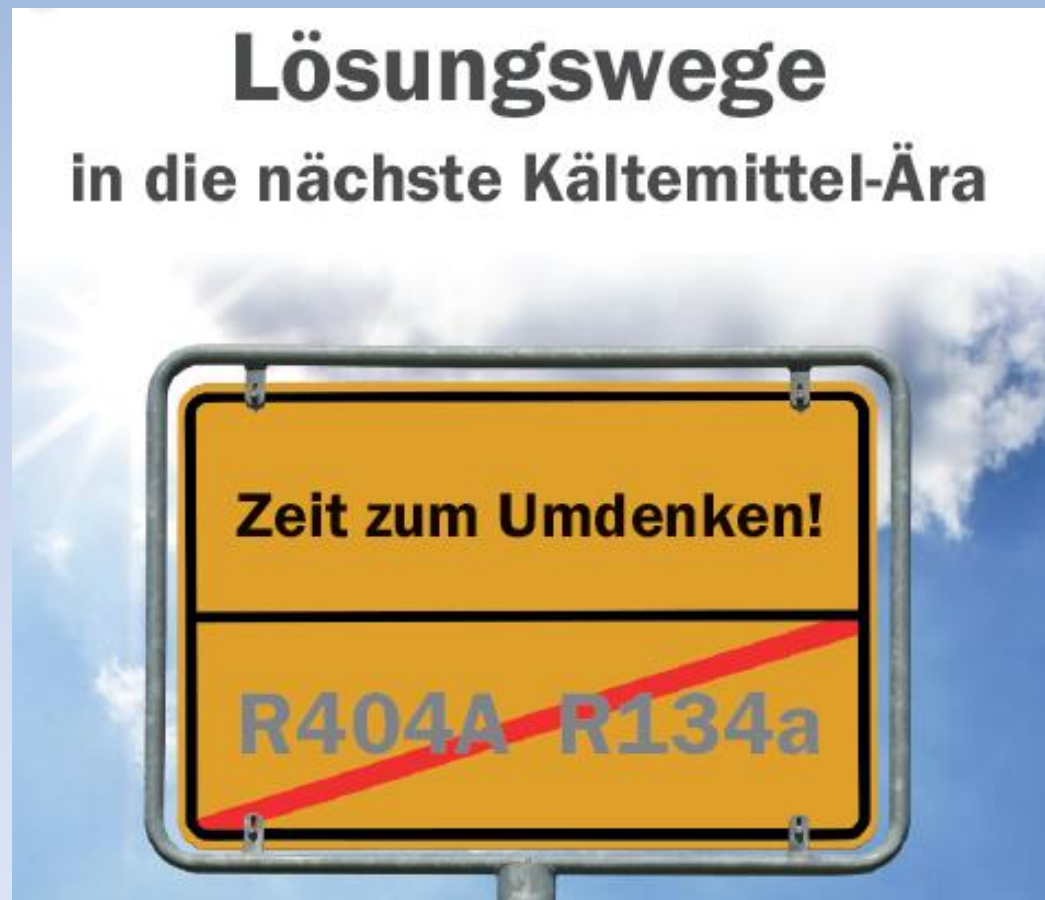
R134a (1430)	$\text{CF}_3\text{CH}_2\text{F}$	- 26 °C
R404A (3922)	R143a/R125/R134a	- 47 °C
R407C (1774)	R32/R125/R134a	- 44 °C
R410A (2088)	R143a/R125	- 51 °C
R32 (675)	$\text{CH}_2\text{F}_2$	- 52 °C

.....



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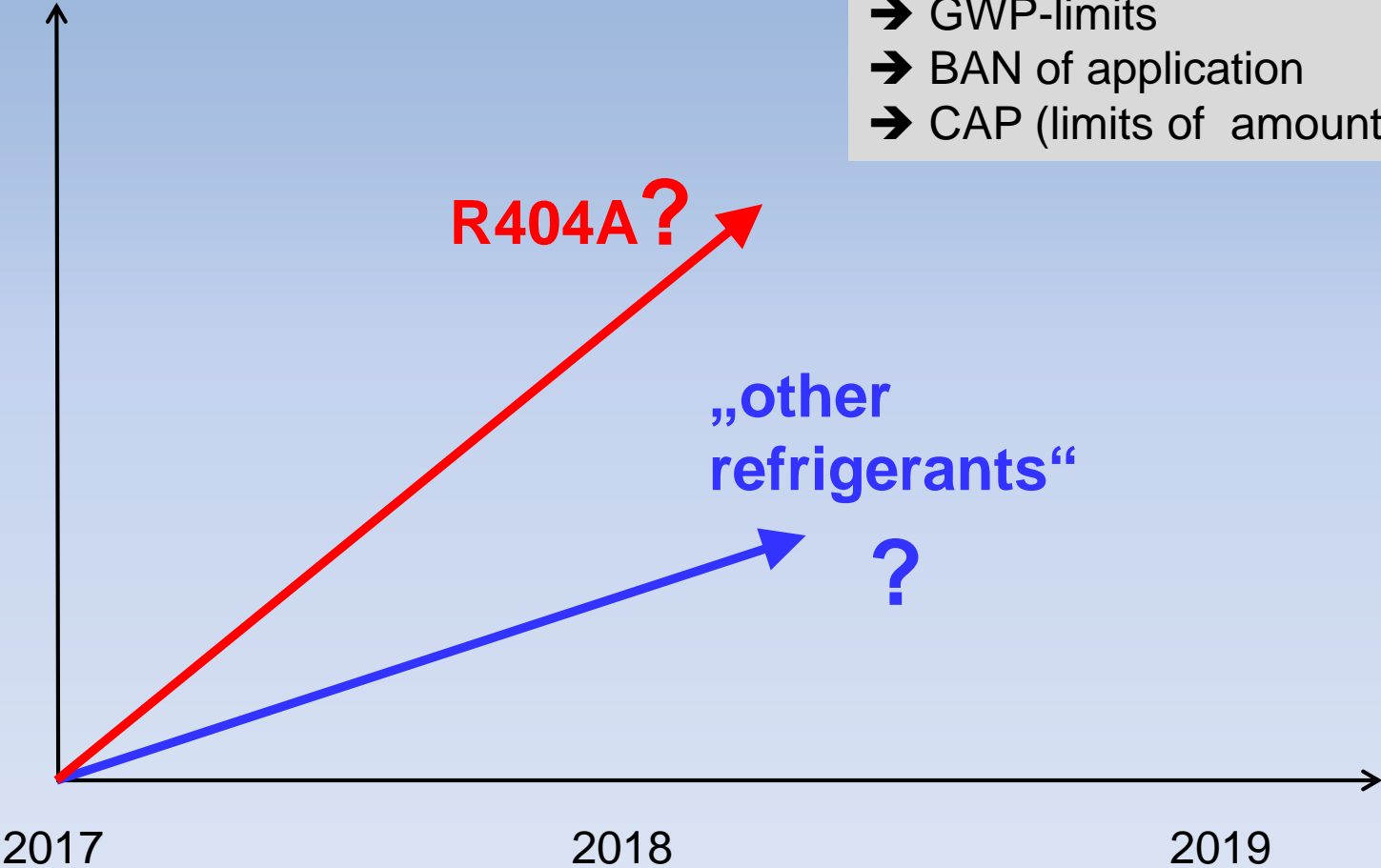
## New refrigerant generation



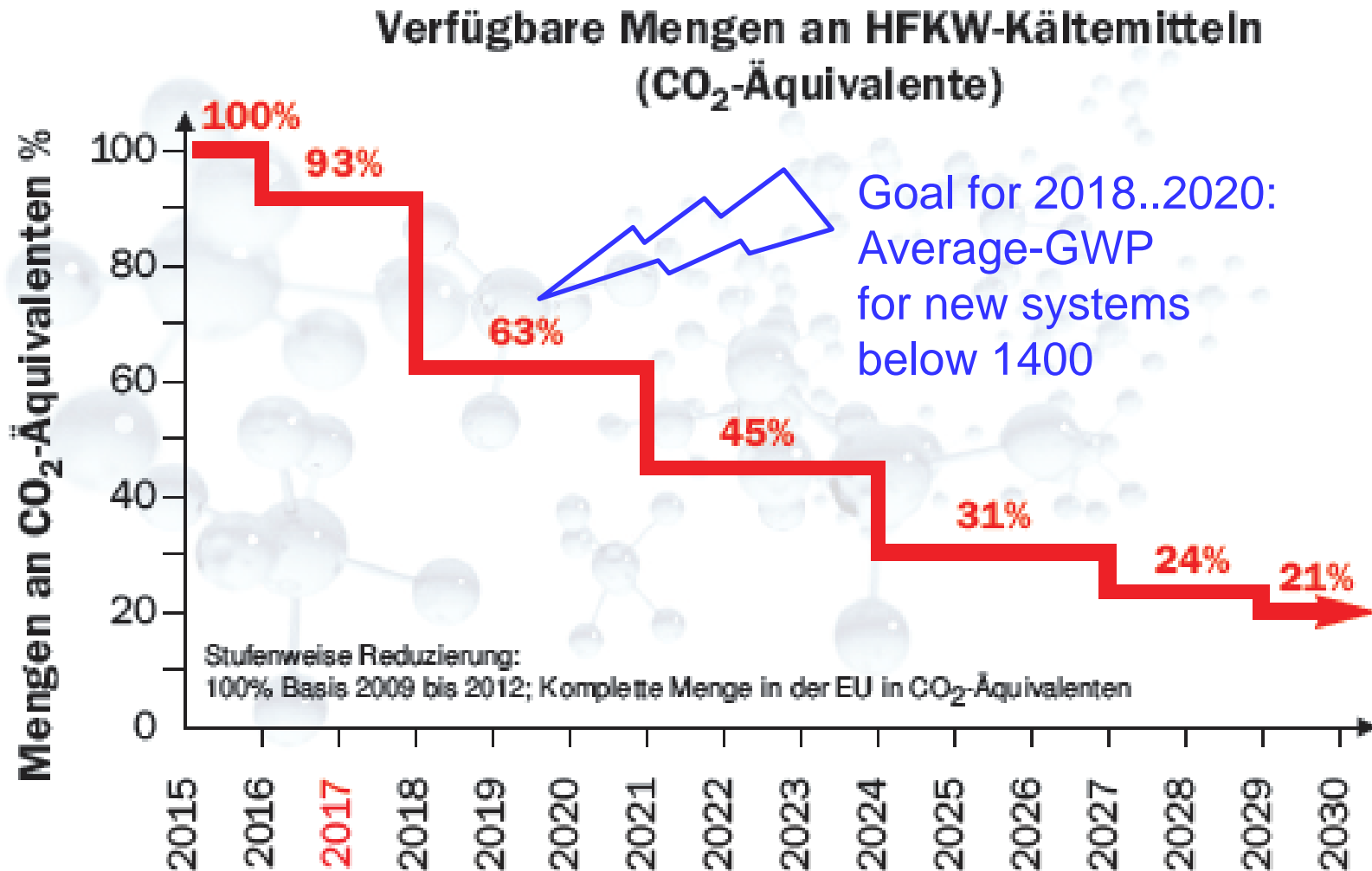
# Situation of refrigerants and possible future developments

Price increase

- Influence factors:
- GWP-limits
  - BAN of application
  - CAP (limits of amounts)



# Situation of refrigerants and possible future developments



(middle-/longterm) future options: A2L-HFO, R32, R290, R744, R717



**H-FKW**  
(A1)      **HFO-FKW**  
(A1)      **HFO-FKW**  
(A2L)

R404A  
R134a  
R410A  
R407C\*

R449A\*  
R448A\*  
R452A\*  
R513A

R454A\*  
R454B\*  
R454C\*  
R452B\*

**HFO (A2L)**  
R1234yf  
R1234ze(E)  
...

Max. charge-limits  
according EN378-1:2017-03

appropriate equipment

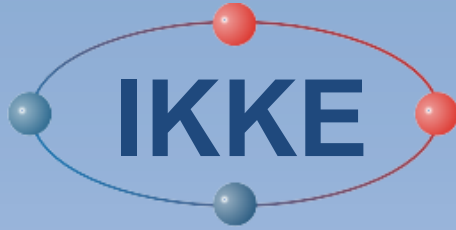
Education and  
briefing

approval acc DGR  
and BetriebsSichVO (DE)

(e.g., list not complete !)

\*Zeotrope Blends = temperature-glide



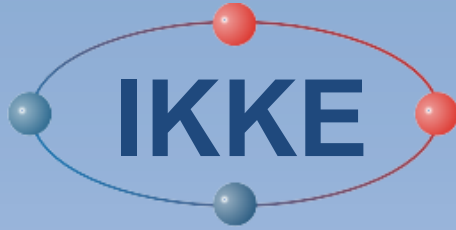


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# Safety aspects

1. Flammability
2. Toxicity
3. High pressures
4. Asphyxiant

**For all refrigerants – risk is reduced by minimising leak potential !**



## Safety classification

The classification has two parts: A or B followed by 1, 2L, 2 or 3.

A or B represents the degree of toxicity

A is lower toxicity (most refrigerants are class A)

B is higher toxicity (R717 is class B)

1, 2L, 2 or 3 represents the degree of flammability

1 non flammable

2L lower flammability

2 flammable

3 higher flammability

(See ISO 817:2014 and EN378-1:2016)

## I. Selected refrigerants of new generation

HFKW (A1)	<del>R404A</del> /R507	3922*	0,7/0K**	
HFO (A1)	<b>R449A</b>	1397*	4,5K**	Chemours
	R452A (TK)	2140*		Chemours
	R448A	1387*	6,2K**	Honeywell
	R449B	1412*		Arkema
	R460B	2103*		Mexichem
HFKW (A1)	<b>R407H</b>	1495*	7K**	Daikin Chemical
HFO (A2L)	R454A	239*		many manufacturer
	R454C	148*		Chemours
	R455A	148*		Honeywell
	R460B			Mexichem

\*GWP (AR4, 100y)

\*\*Glide at application point

Natural Refrigerants:

R744 (subcritical, transcritical) // R290 / R1270 // R723 // R717

## I. Selected refrigerants of new generation

HFKW (A1) ~~R407C~~

---

HFO (A1)      no technical direct comparable solution available  
(maybe R404A-replacement usable)

---

HFO (A2L)      R444B                                  Honeywell

---

Natural Refrigerant:

R744 (subcritical, transcritical) // R290 / R1270 // R723 // R717

## I. Selected refrigerants of new generation

HFKW (A1) ~~R410A~~

---

HFO (A1)      no technical direct comparable solution available

---

HFKW (A2L)	R32		many manufacturer
HFO (A2L)	<b>R454B</b>	466	Chemours
	R452B		Chemours
	R447B		Honeywell
	R459A		Arkema

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Natural Refrigerant:

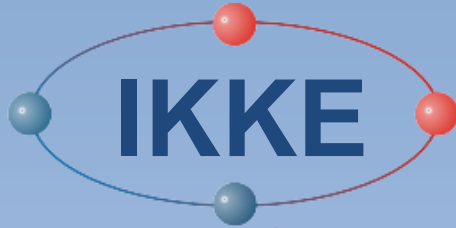
R744 (subcritical, transcritical) // R290 / R1270 // R723 // R717

## I. Selected refrigerants of new generation

HFKW (A1) <del>R134a</del>	1430*	-	
HFO (A1)	<b>R513A</b> R450A	0	Chemours Honeywell
	<b>R513B</b> R456A	0	Daikin Chemical Mexichem
HFO (A2L)	R1234yf <b>R1234ze[E]</b> R444A		many manufacturer many manufacturer Mexichem

Natural Refrigerant:

R744 (subcritical, transcritical) // R290 / R1270 // R723 // R717



## Trend of prices, availability:

+ R404A → + 700 % !!!

(8,- € → 64,- €), supply shortage

+ R134a → + 300 %

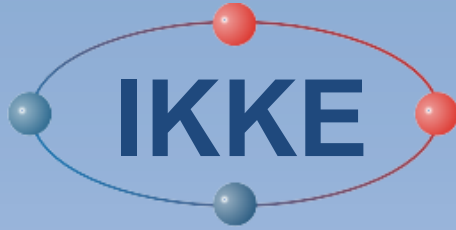
(6,- € → 22,- €), quite good available

+ R410A → + 300 %

(8,- € → 25,- €), supply shortage

→ Quota control !!

→ minus cold room → retrofit, new systems, service ??



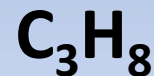
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## Natural Refrigerants

ODP = 0

GWP = 0 ... 3

propane (R290)



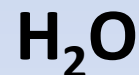
ammonia (R717)



carbon dioxide (R744)



water (R718)



air

### Safety aspects!

flammable (A3)

toxic (B2L)

asphyxiant (A1),

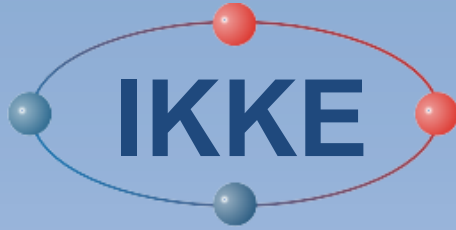
high pressure

limit 0 °C



[www.realalternatives4life.eu](http://www.realalternatives4life.eu)





# Future of refrigerants

## + Low-GWP- refrigerants

HFO R1234yf, R1234ze

mixtures GWP < 2500, 1500, 750, 150

from HFO/HFC → flammable, toxic !

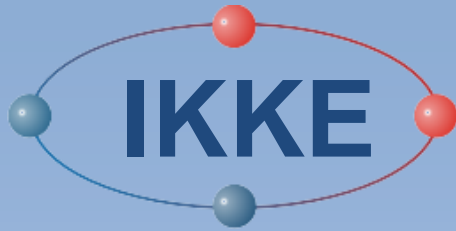
## + natural refrigerants R290, R717, R744



tight refrigeration systems



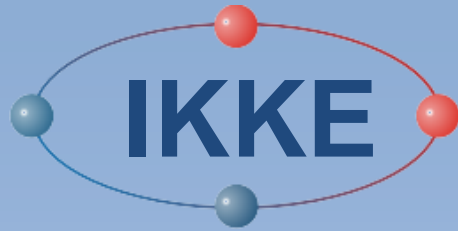
energy efficiency



# Maintenance & Service

Safe working environment and following procedures are relevant:

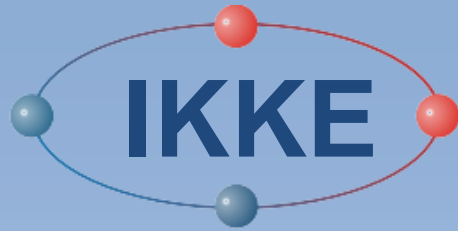
- Leak testing
- Recovery / disposal
- Evacuation
- Unbrazing and brazing
- Charging
- Component replacement



# Fault finding & Repair

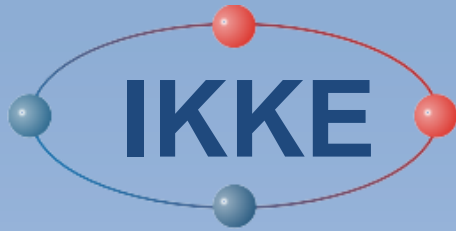
Understand the refrigeration system!

- Thermodynamic
- Refrigeration circuit
- Function of components
- Refrigerant behaviour
- Electrical circuit
- Control and adjustment setting



# New technologies

- Heat Pumps with Natural Fluids
- Geothermie-Heat Pumps
- Water Chillers with A2L- and A3-refrigerants
- Supermarket with CO<sub>2</sub> as refrigerant  
(booster-systems or cascade with R134a)
- Absorbtion–systems using heat sources  
in combination with power plants



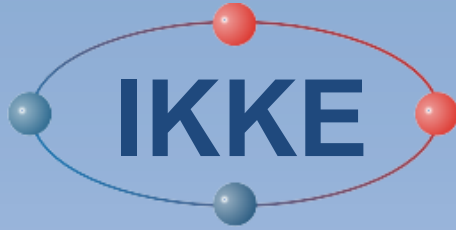
## Certification in Germany

### **Certification of companies:**

- according § 6 ChemikalienKlimaschutzverordnung
- regulation (EU) 517 / 2014

### **Certification of personal:**

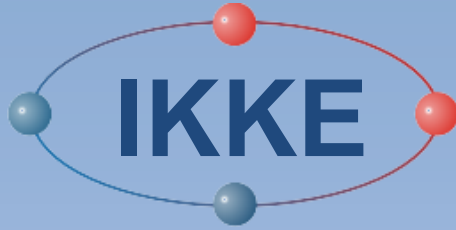
- regulation (EU) 517/2014 and (EU) 2015/2067
  - personal categories cat. I, II, III and IV



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## Dual vocational education system in Germany

- Employment in company (3,5 years)
- Vocational school (12 weeks / year)
- Additional practical seminars (8 weeks / 3,5 years)  
- new: handling with flammables and CO<sub>2</sub>
- Further education at IKKE  
- e.g.: “Design and practice with propane-system“
- [www.realalternatives4life.eu](http://www.realalternatives4life.eu)  
**e-learning-program**
- **EN13313 “competence of personnel“ (Refrig./AC and HP) (ISO)**



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**Thank you for your attention !**

