

Emission Reductions

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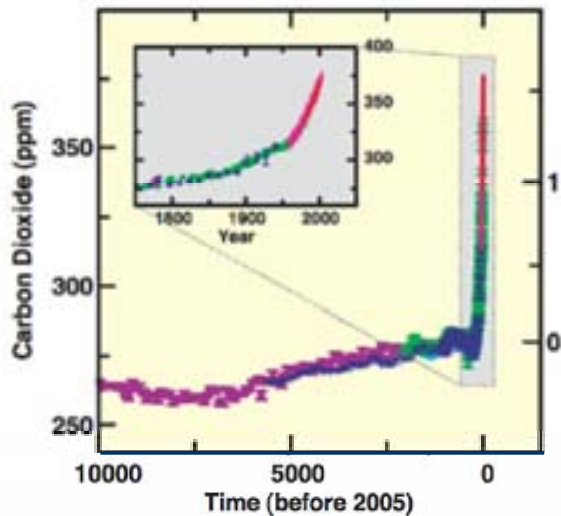
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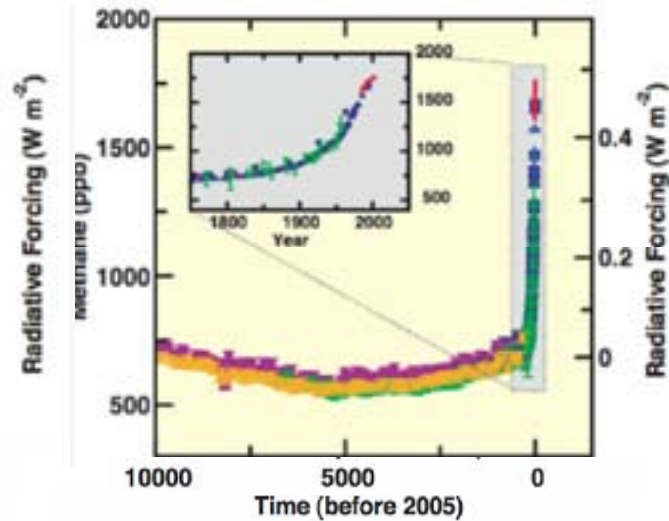


Greenhouse gas shock

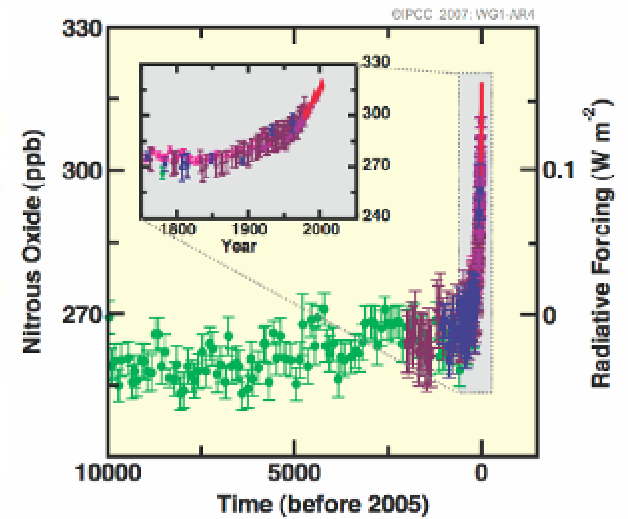
Changes in greenhouse gas concentration based on ice-core tests and modern measured data



GWP $CO_2 = 1$

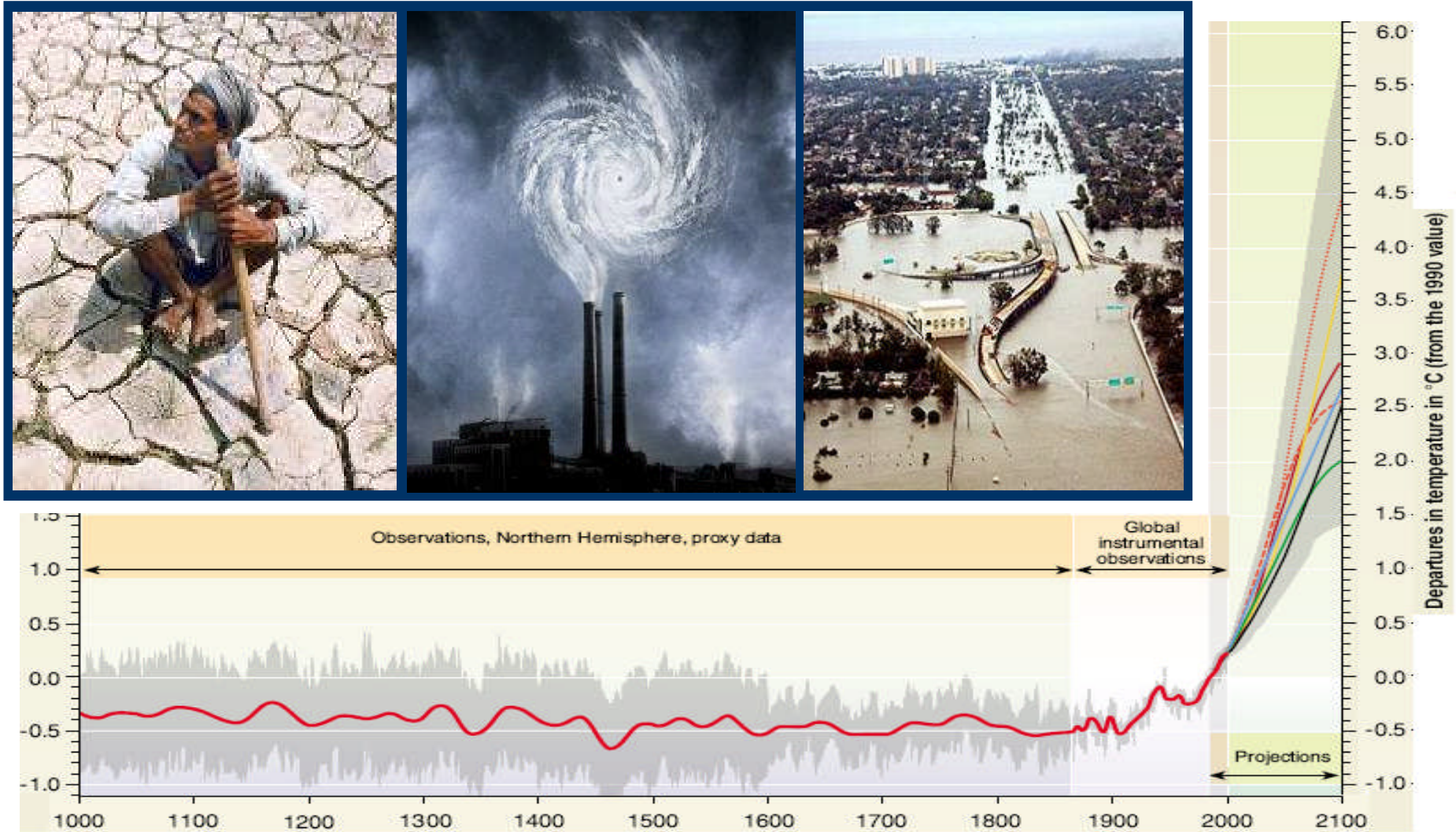


GWP $CH_4 = 23$

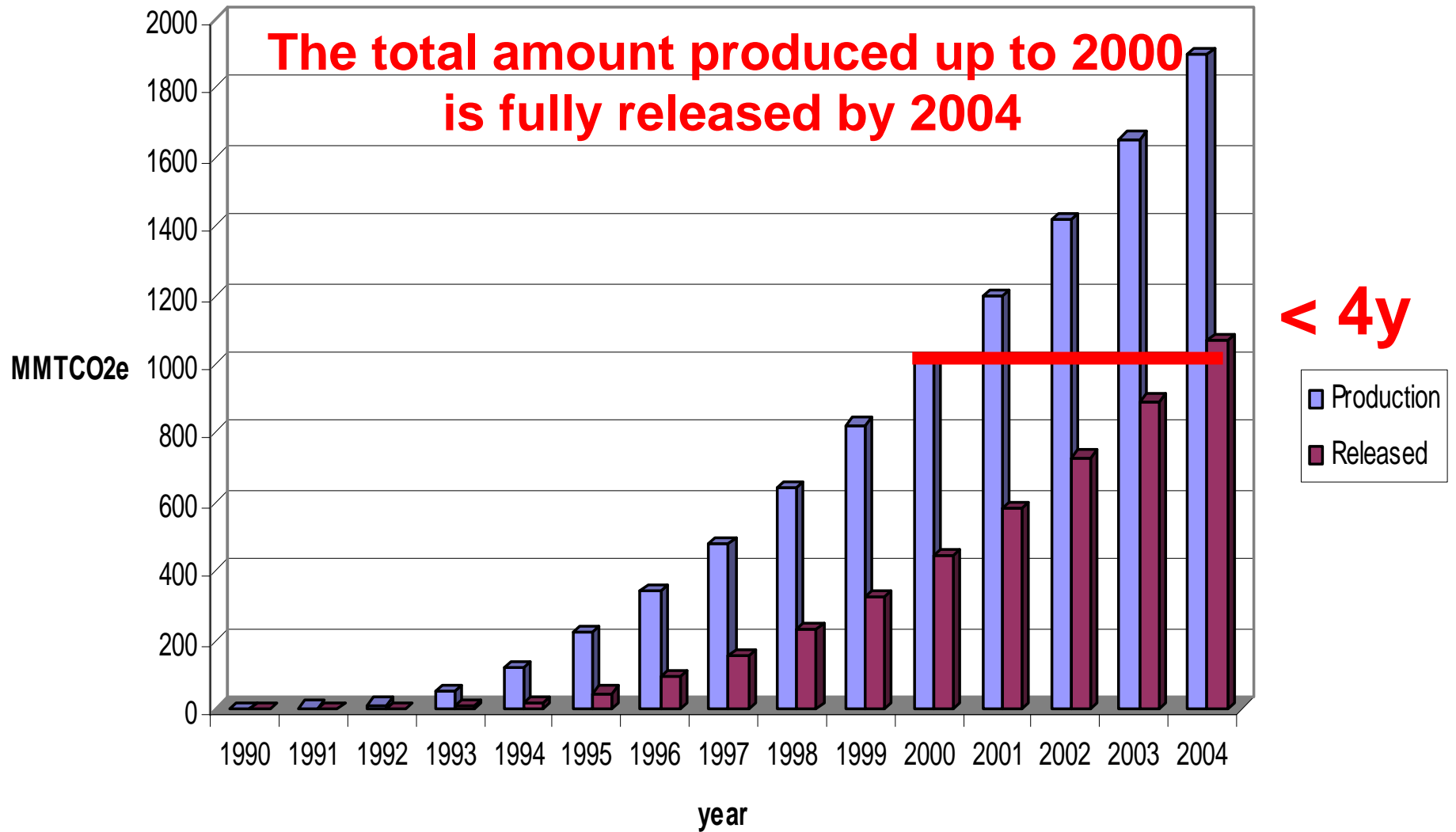


GWP $N_2O = 310$

Climate Change



Global reported cummulated Production and Release of R134a
in Million Metric Tons of CO2 equivalent



Source: AFEAS Alternative Fluorocarbons Acceptability Study

Take Home Message

- **Refrigerants leak massively**
- **The problem is not containable**
- **It is a crime on mankind if the next refrigerant has an ODP, high short term GWP, high indirect GWP, toxicity or decomposition issues**
- **We can change this and put all this to 0**
- **It is our moral obligation to make the right choice**

Criteria to be Considered

Ozone Depletion (Montreal Protocol)

Global Warming (Kyoto Protocol, EU MAC Directive, CA Bill 1493)

Toxicity (REACH)

Flammability


Known substance (REACH)

Fuel consumption (EU reduce CO₂ emissions 130gr/km)


Cost (Initial cost, cost of ownership, service cost)


Let us take a look!

Substance		R134a Banned 2011	R744
	Refrigerant complexity	pure 😊	pure 😊
Safety	Known substances	😐	😊
	No stabilisers	😊	😊
	Toxically safe	😊	😊
	No flammable substances	😊	😊
Environment	Ozone depletion	😊	😊
	Global warming (100 years)	😡	😊
	Global warming (20 years)	😡	😊
	Fuel consumption	😐	😊
Costs	Initial costs for car makers	😊	😡
	Refrigerant costs	😐	😊
	Operation costs	😐	😊
Function	Cool down performance	😐	😊
	Cooling capacity	😐	😊
	Heat pump capability	😡	😊




A1







No indirect GWP




What if ?




Good Engineering





Consumer

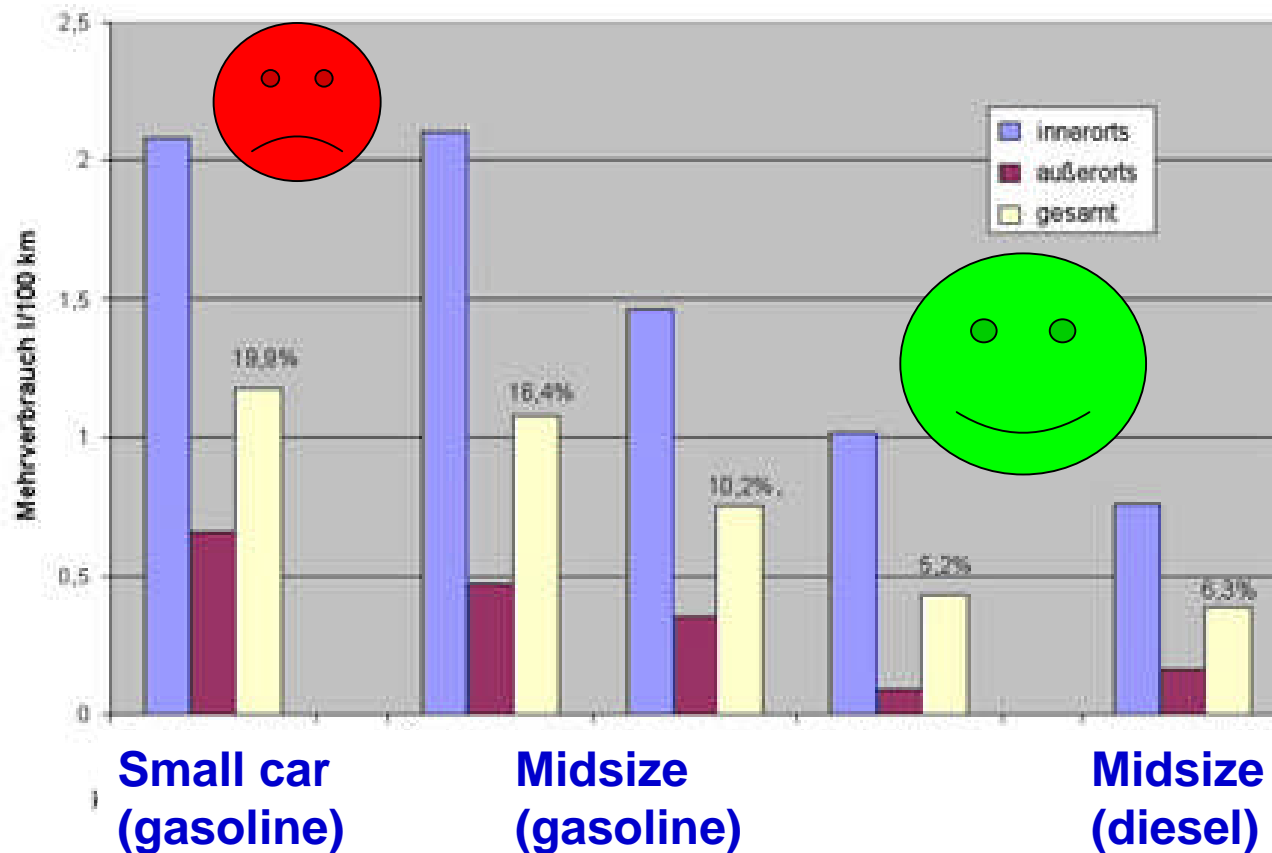


Added Value

Recent ADAC (German AAA) A/C Testing

Paulus test based on NEDC (+ 750W)

Overconsumption of A/C systems at an ambient temperature of 28° C and A/C system set point is + 22° C for the cabin: Values in liter/100 km and total consumption additionally in %:



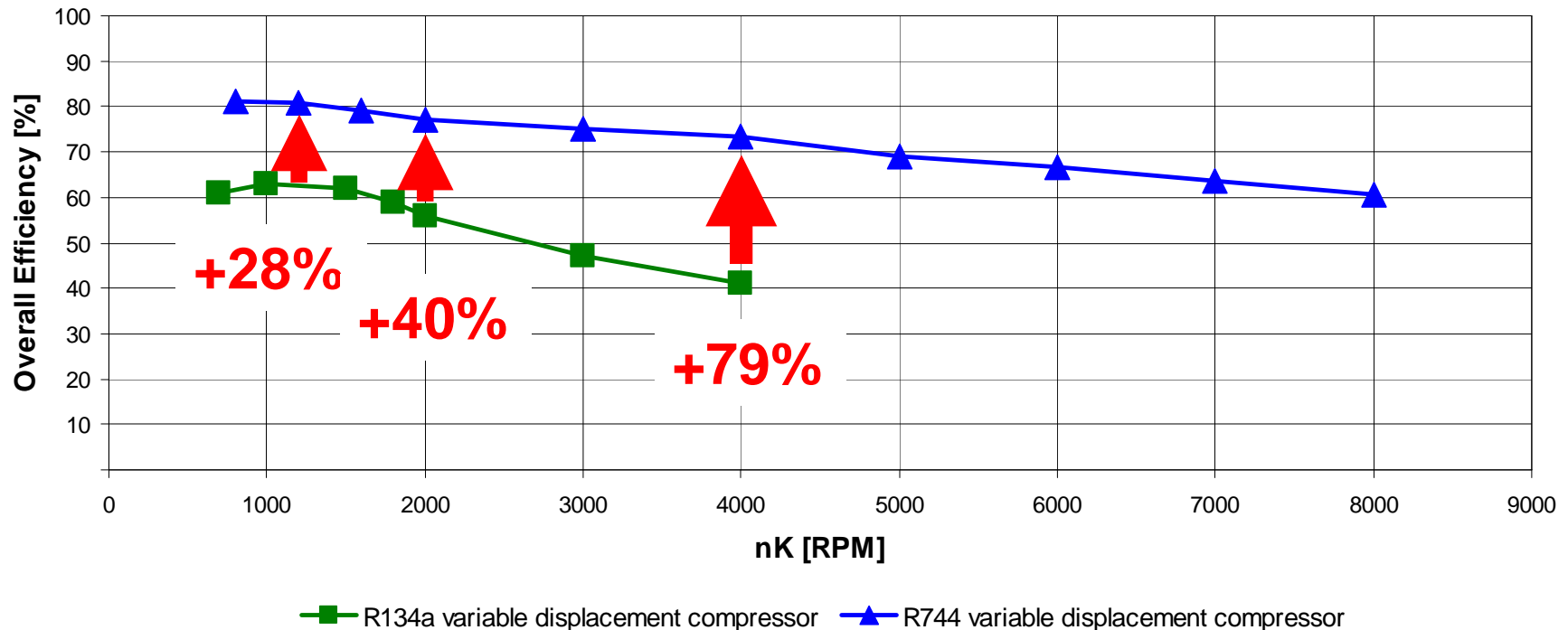
City cycle
Outside city
Total

Test Results Overall Compressor Efficiency

Compressor Comparison - Overall Efficiency

Comparable Test Conditions R134a; R744

suction press. = 3;40 bar, discharge press. = 15,7;120 bar, suction temp= ~30 °C



Project Overview

- Title: HVAC-System
- Duration: 1.10.2002 until 30.6.2006

- Projectpartners:



- Team:
 - Projectleader: ➤ R. Rieberer (IWT)
 - Key Researcher: ➤ R. Almbauer (VKM)
 - Senior Researchers: ➤ B. Lechner (vif), R. Tatschl (AVL), J. Hager (ECS), T. Moshhammer (MSF), F. Obrist (Obrist), W. Böhme (OMV)
 - Junior Researchers: ➤ G. Lang (vif)
➤ K. Martin (vif)

See also



Vehicle Measurements

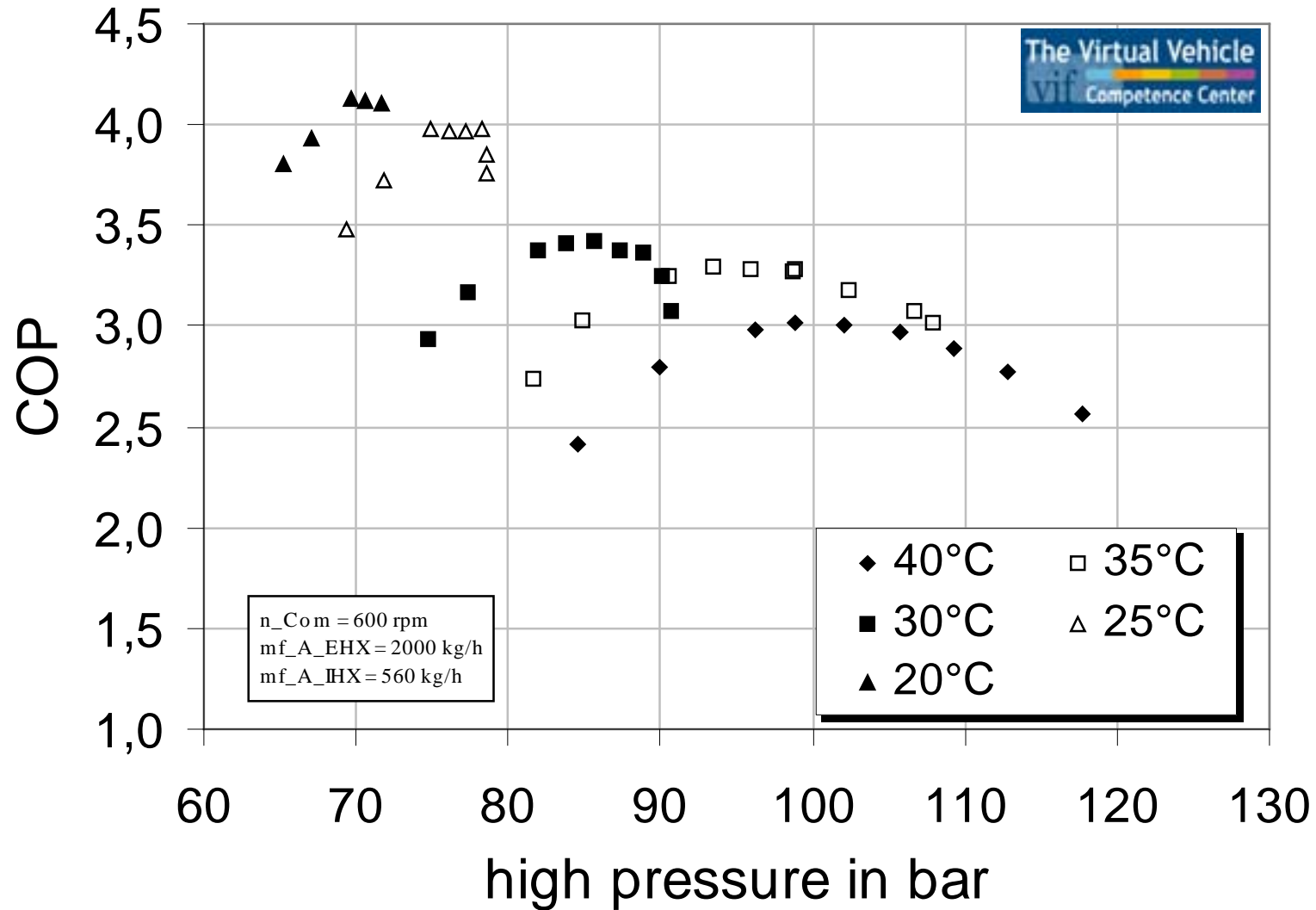
- Vehicle Measurements with Obrist-Ford Galaxy
at air-conditioned roller dynamometer test rig at Graz University of Technology



Test Rig Measurements

➤ Experimental Results in Cooling Mode

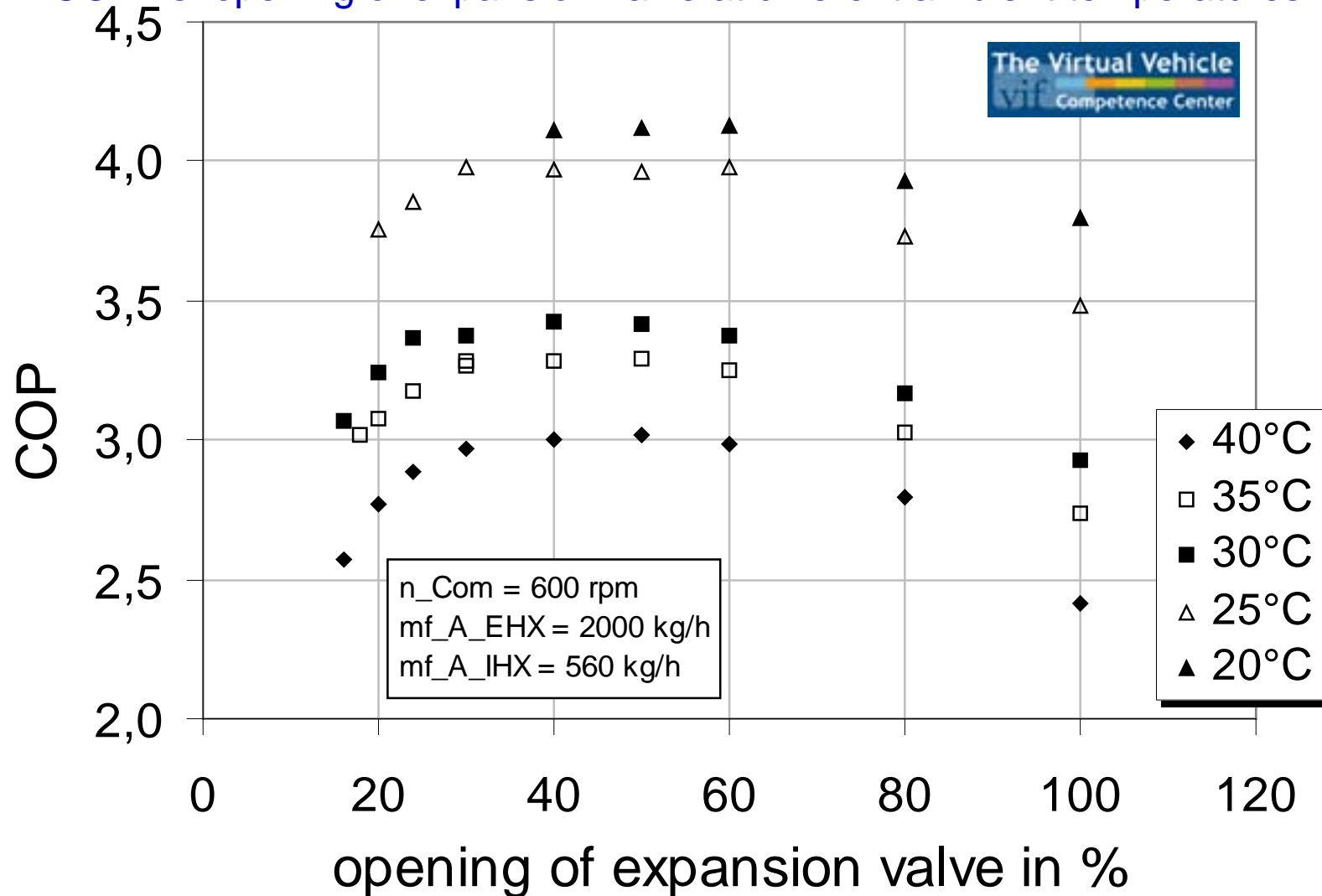
COP vs. high pressure at different high pressures



Test Rig Measurements

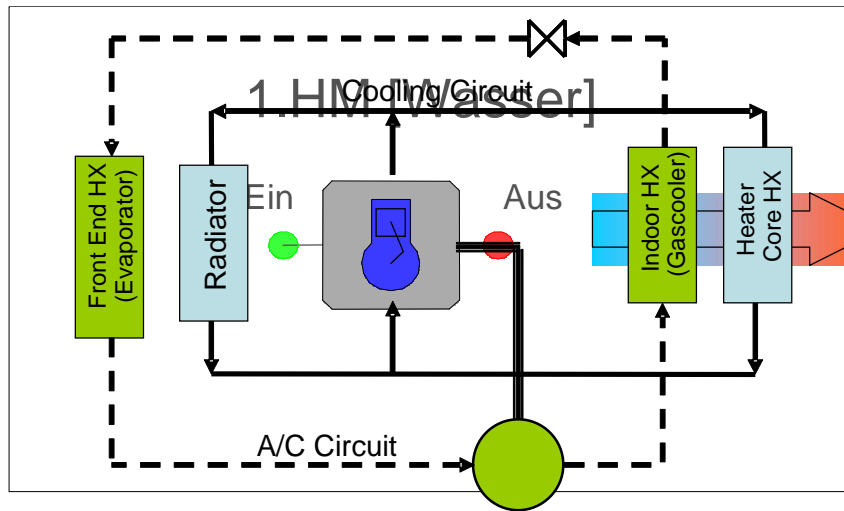
➤ Experimental Results in Cooling Mode

COP vs. opening of expansion valve at different ambient temperatures



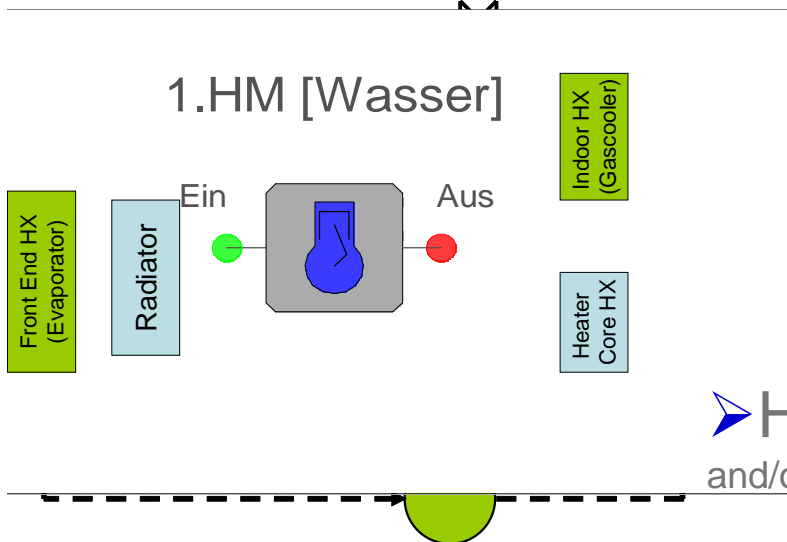
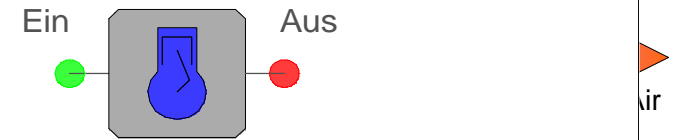
Simulations

Investigation of Different Set-Ups for Heat Pump Mode



HP1: "classic" arrangement with Gascooler upstream of Heater Core HX

1.HM [Wasser]



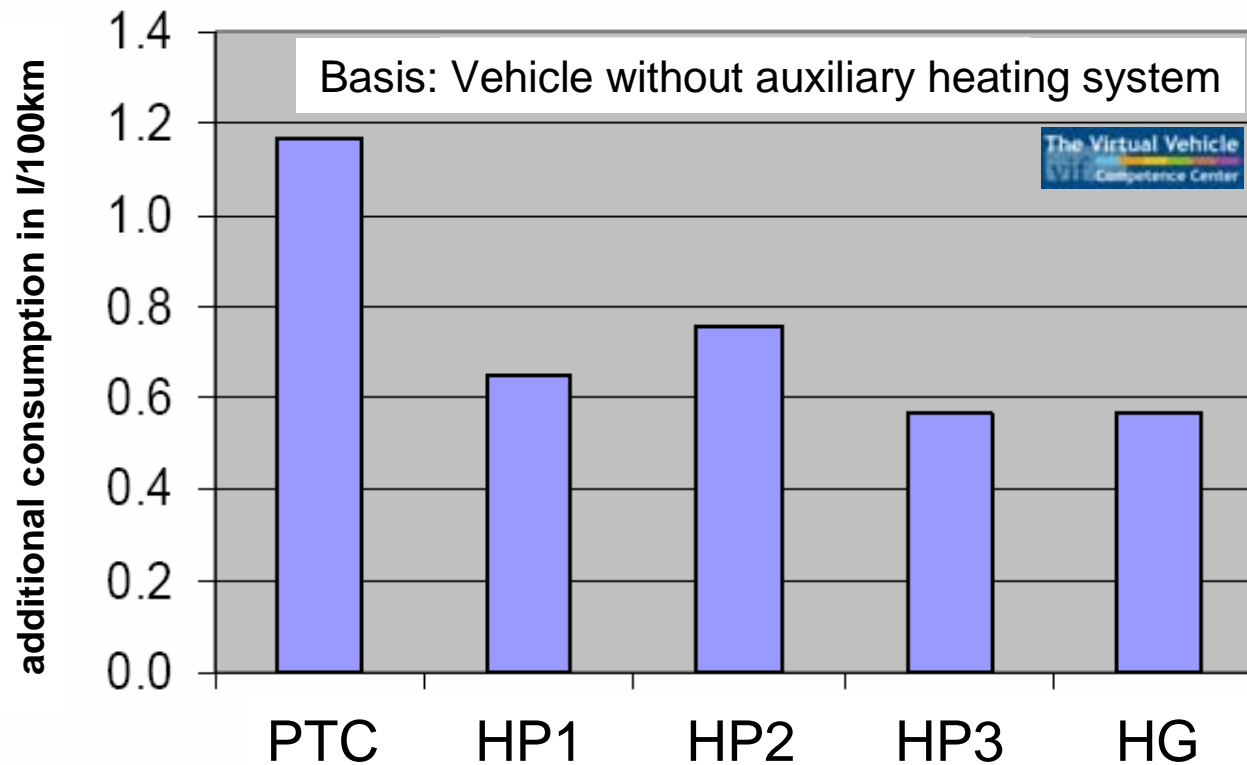
HP2: arrangement with Gascooler downstream of Heater Core HX

HP3: air flow through Gascooler and/or Heater Core HX

Simulations

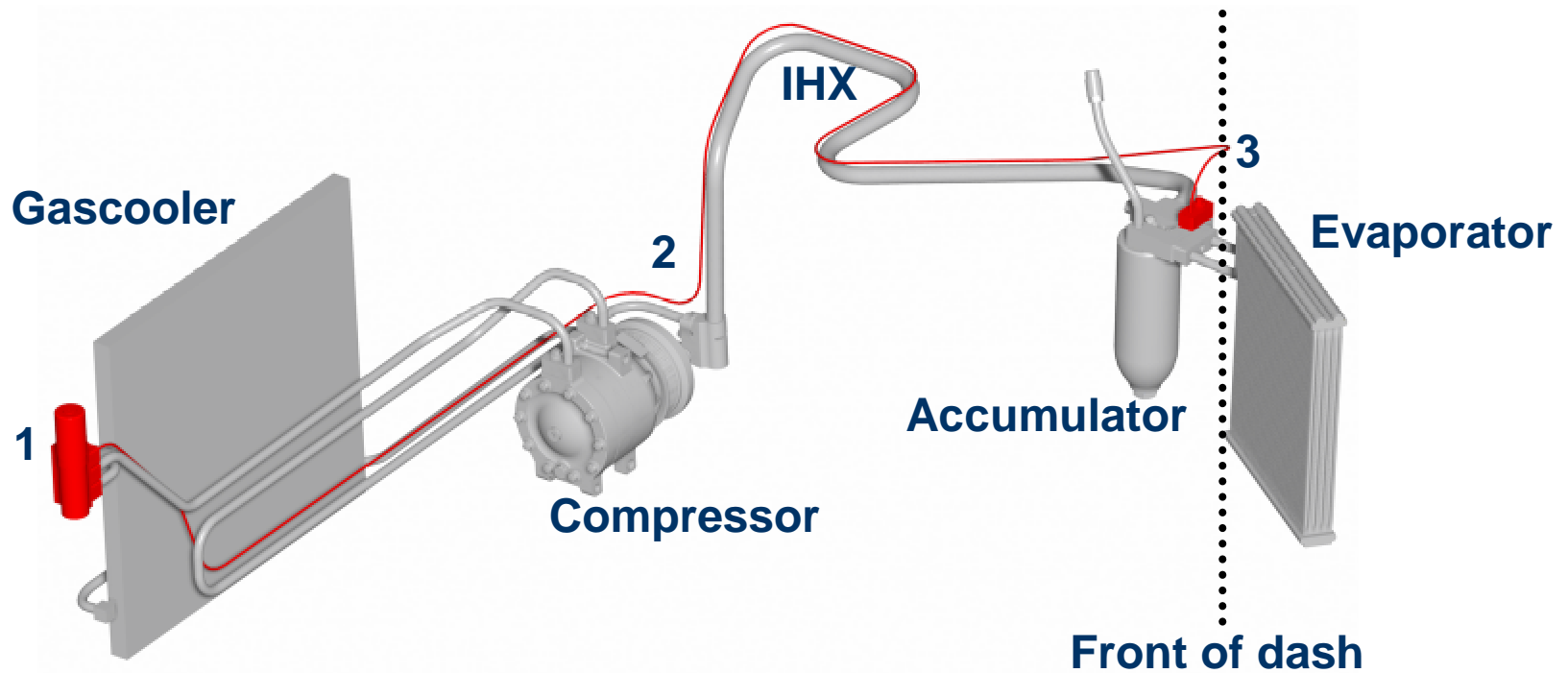
➤ Results of Simulations

additional consumption in NEDC (-7°C)



Simulation results for heating mode: Influence of different set-ups on additional fuel consumption in NEDC at -7°C

Small Car Low Cost A/C-HG-System



Additional components for heating:

- 1** 3/2-way valve
- 2** Capillary tube
- 3** T-junction

Compressor Expander and Ejector

Future possibility with great potential for R744

Targets are; *dramatically increased COP at high ambient temperatures and increased fuel efficiency under all operating conditions.*

Two options:

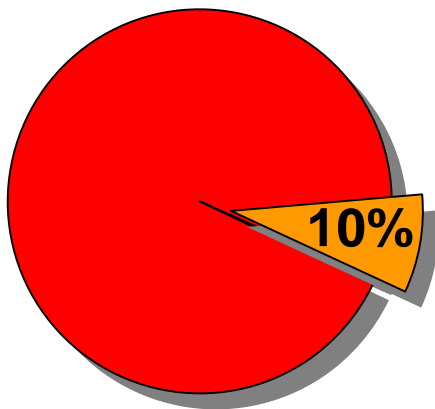
1. *Ejector system (in mass production for stationary systems. Possible MAC use)*
2. *Compressor Expander (development status for MAC)*

New system layouts for R744 will lead to further improved COP also at very high ambient temperatures

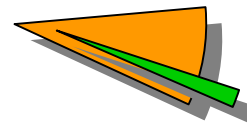
Improvement potential for R744 >> R134a

Potential Emission Reduction

Total global emissions of greenhouse gases in 2004:
18 billion tonnes* GHG



Passenger cars cause 10% of the total GHG emissions, i.e. 1.8 billion tonnes* GHG



10%

By simply implementing a new A/C system which reduces the GHG emissions from passenger cars by 10%, emission of 180 million tonnes* GHG can be avoided, i.e. 1% of the total global GHG emissions



*CO₂ equivalents

Numbers from UNFCCC (2006) and WBCSD Mobility 2030 (2004)

Summary

- **R744 is the natural refrigerant for the global A/C market**
 - **Sustainable technology**
 - best efficiency and COP over the total temperature range
 - lowest additional fuel consumption
 - weight reduction
 - low costs
 - low emissions
 - heat pump application with highest COP

10% overall vehicle emissions reduction is possible

Thank you for you attention

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www.R744.com