



**eurammøn**  
refrigerants delivered by mother nature

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www.eurammøn.com

Sao Paulo/Brazil, 21-22 November 2007

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**eurammøn - task force**

eurammøn is a joint initiative of companies, institutions and individuals who advocate an increased use of natural refrigerants.

Objectives

- Competence center for natural refrigerants: providing a platform for sharing information
- Increase awareness and acceptance of natural refrigerants
- Support sustainable solutions in refrigeration



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**eurammøn - information**

- eurammøn provides a competent contact for all matters involving natural refrigerants.
- eurammøn delivers specific project experience for users and planners of refrigeration projects.



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**eurammon - responsibility**

- eurammon contributes to the development of progressive solutions in refrigeration as a partner to the business and politics.
- eurammon is committed to sustainable solutions at the international level because the impact on climate doesn't stop at country borders.



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**eurammon - members**

- eurammon has a worldwide network:
  - 32 ordinary members
  - 20 extraordinary members
  - 9 reciprocal members



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**eurammon - ordinary members**



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**eurammon – reciprocal members**

- Mutual memberships and close, hands-on cooperation agreements exist with AFF's Le Club Ammoniac, ANEFRYC, ECCLA, IIR, NRTB, NVKL, OSAR, SARDA and SDHK.



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European Ammonia Refrigeration Association

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**Activities**

Participation at trade fairs and congresses 2007/2008

- IIR Conference, March 2007, Nashville/USA
- IIR Conference Ammonia Refrigeration Technology, April 2007, Ohrid/Macedonia (programme sponsor)
- Big 5 Dubai, November 2007, Dubai/United Arab Emirates
- CholodExpo Rossija, February 2008, Moscow/Russia
- IIR Gustav Lorentzen Conference on Natural Working Fluids, September 2008, Copenhagen/Denmark

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**Activities**

Participation at trade fairs and congresses 2007/2008

- Chillventa, October 2008, Nuremberg/Germany

Special event on "Industrial Refrigeration Applications with Natural Refrigerants"

Date: 16 October 2008

Sponsorship by eurammon

Lecture series by international refrigeration experts

Brunch for Friends of Natural Refrigerants at the eurammon booth



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**Activities**

Lobbying

- Liaison office in Brussels
- eurammøn accredited at the EU as stakeholder
- Collaboration with the European Cold Storage and Logistics Association (ECSLA)
- Submitting of a Policy Statement and position letters to Members of the European Parliament
- Talks with servants of the European Commission/Directorates-General



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**Activities**

Support

- Website with news, backgrounds and a member area
- Survey on the refrigerants' situation in Europe
- Product directory of refrigerating plants and units for applications with natural refrigerants
- Information papers
- Member information kit
- Image presentation



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**eurammøn - internet**

- Information on natural refrigerants and eurammøn is available at [www.eurammøn.com](http://www.eurammøn.com).



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AGENDA

The EU Experience on NATURAL REFRIGERANTS  
-  
STATUS and TRENDS

1. Introduction
2. Standards, Regulations in the EU
3. Experience in „new technics“
4. Status - Trends



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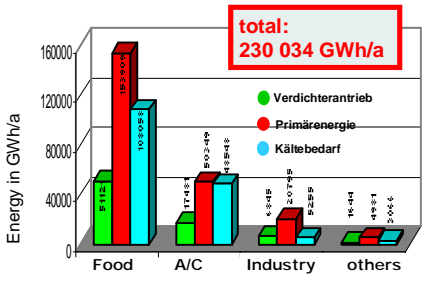
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1. Introduction



Category	Verdichterantrieb (GWh/a)	Primärenergie (GWh/a)	Kältebedarf (GWh/a)
Food	6112	152002	100008
A/C	1748	80028	40000
Industry	4248	20078	8000
others	1444	4881	2000

Source: DKV-Statusericht Nr. 22



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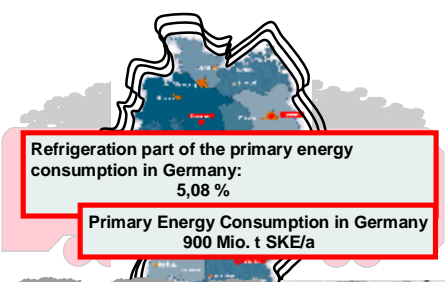
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1. Introduction




Refrigeration part of the primary energy consumption in Germany:  
5,08 %

Primary Energy Consumption in Germany  
900 Mio. t SKE/a

Train with a length of 10168 km

Source Güntner GmbH, Germany



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1. Introduction

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1. Introduction

Environment:  
**FLIGHT Kaltenbrunner – Austria - Sao Paolo**

[www.atmosfair.de](http://www.atmosfair.de)

Emissions of the flight: 7.080 kg  
Costs for an environmental project: € 4,-

Budget on a human being on CO2 per year: 3.000 kg

only 2kg of R404a (3260kg)!!!!

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1. Introduction Reduktion von Treibhausgasen infolge Kyoto-Protokoll

Greenhousegas Emissions 1995

Land	Treibhausgas-emissionen Veränderung
Portugal	+ 27%
Irland	+ 13%
Schweden	+ 4%
Norwegen	+ 1%
USA	- 6%
Schweiz	- 8%
EU (Gesamt)	- 8%
Dänemark	- 21%
Deutschland	- 25%
Luxemburg	- 28%

Stand Juni 1998

CO<sub>2</sub> + CH<sub>4</sub> + NO<sub>2</sub> + HFC + PFC + SF<sub>6</sub>

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**1. Introduction**

Example 2005/2006

Supermarket 3.500m<sup>2</sup>  
R404a: 600kg  
Leakage Sept. 2005 – Feb. 2006:  
**770kg**  
**CO2 Potential:**  
3260 x 770 = 2,510.200kg =  
**2.510 t CO2**  
**= 19.309.230 km (Car 130g/km)**  
**approx. 482 times round the world!**  
or  
**Kaltenbrunner – 382 flights Austria Sao Paulo!**



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**Reduce Emissions of Greenhouse Gases**

Table 1.1.1: Examples of measures to reduce greenhouse gas emissions in the building sector. The table lists various measures, the methods applied, the percentage of IPCC reduction of building emissions, and the climate benefits of such measures.

Application area	Method applied	Percentage of IPCC reduction of building emissions (with leakage and other factors, GWP 100)	Climate benefits of such measures (avoided CO <sub>2</sub> emissions)
WFO	1.50	100% (with leakage and other factors)	From 1990 to 2010: 1.1 Gt CO <sub>2</sub> avoided
25% reduction in energy use	2.50	25% (with leakage and other factors)	From 1990 to 2010: 0.28 Gt CO <sub>2</sub> avoided
Prevention of gas leaks	3.50	20% (with leakage and other factors)	From 1990 to 2010: 0.22 Gt CO <sub>2</sub> avoided

Commercial Refrigeration  
Central Refrigeration System: between 20 and 50 % are direct greenhouse gas emissions

*IPCC/TEAP: Safeguarding the Ozone Layer and the Global Climate System, 2005*



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**AGENDA**

The EU Experience on NATURAL REFRIGERANTS  
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STATUS and TRENDS

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2. Standards, Regulations in EU

1. EN 378 1-4 (2000)
2. EN 842/2006
3. Several other regulations in e.g.: Danmark, Sweden, Norway, Austria, Luxemburg, Netherlands



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2. Standards, Regulations in EU EN 378

EN 378 – 1  
Basic requirements, definitions, classification and selection criteria

EN 378 – 2  
Design, Construction, testing, marking and documentation

EN 378 – 3  
Installation site and personal protection

EN 378 – 4  
Operation, maintenance, repair and recovery



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2. Standards, Regulations in EU EN 842/2006

The **primary objective** of this Regulation is to **reduce the emissions** of the fluorinated greenhouse gases (F-gases) covered by the Kyoto Protocol and thus to protect the environment.

The Regulation addresses the **containment, use, recovery** and **destruction** of these gases

Main **measures** are:

- improvement of containment,
- labelling of products and equipment containing fluorinated greenhouse gases,
- marketing and use restrictions for certain applications,
- recovery of F-gases,
- training and certification of personnel (and companies),
- reporting obligations.



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2. Standards, Regulations in EU EN 842/2006

Regulation on certain F-gases (2006)

4 July 2006 – 4 July 2007 – 4 July 2008

Entering into force

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2. Standards, Regulations in EU EN 842/2006

Regulation on certain F-gases (2006)

4 July 2006 – 4 July 2007 – 4 July 2008

Entering into force

Commission Regulations

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2. Standards, Regulations in EU EN 842/2006

**Commission regulations**

- 1-5. **Minimum qualification for personnel (stationary refrigeration, fire protection systems, switchgear...)**  
check for leakage  
installation, maintenance or servicing  
recovery (some more areas)
- 6+7. **Leak checking requirements (stationary refrigeration & fire protection systems)**
- 8. **Labelling requirements**
- 9. **Reporting requirements**

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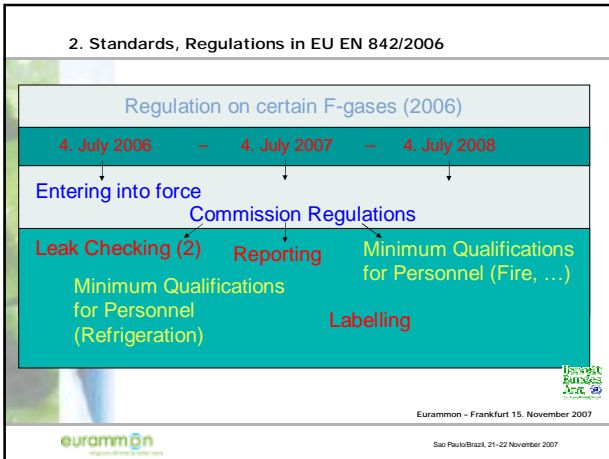
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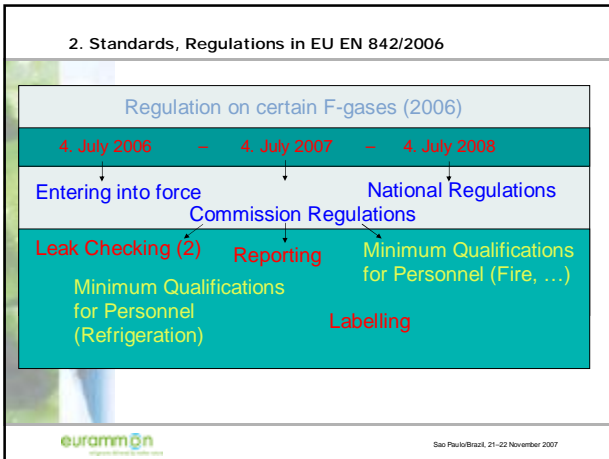
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2. Standards, Regulations in EU EN 842/2006

**Article 3 "Containment"**

1. Operators of stationary refrigeration, air conditioning and heat pump equipment shall prevent leakage as soon as possible repair any detected leakage.

2. Operators shall ensure that the equipment is inspected for leakage by certified personnel according to the following schedule:

Refrigerant charge	Inspection
3-30 kg	once every twelve months
30-300 kg	once every six months
300 or more kg	once every three months / install leakage detection systems

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2. Standards, Regulations in EU EN 842/2006

**Article 3 "Containment"**  
**6. Operators have to keep records**

**Article 4 "Recovery"**  
**1. Operators are responsible for a proper recovery by certified personnel to ensure the recycling, reclamation or destruction:**  
**(a) the cooling circuits of refrigeration, air-conditioning and heat pump equipment**



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2. Standards, Regulations in EU EN 842/2006

**Article 5 "Training and Certification"**

1. The Commission shall establish minimum requirements (companies and personnel)
2. Member States shall establish or adapt their own training and certification requirements
3. The operator shall ensure that the relevant personnel have obtained the necessary certification
4. Member States shall ensure that the companies shall only take delivery of fluorinated greenhouse gases where their relevant personnel hold the certificates



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2. Standards, Regulations in EU EN 842/2006

**The use of F-gases is or will be prohibited in certain applications/products (Article 8+9, Annex II)**  
**As of today virtually no refrigerant equipment containing HFCs or PFCs is included in Annex II**  
**Exception: nonconfined direct-evaporation systems**



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2. Standards, Regulations in EU EN 842/2006

**Article 10 "Review"**

Air conditioning systems, other than in passenger vehicles, shall be reviewed à report by 31 December 2007

Assessment whether the inclusion of further products and equipment in Annex II is technically feasible and cost-effective à report within four years after the entry into force of the Regulation

Where necessary, the Commission shall present appropriate proposals for revision of the relevant provisions of the Regulation



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The EU Experience on NATURAL REFRIGERANTS  
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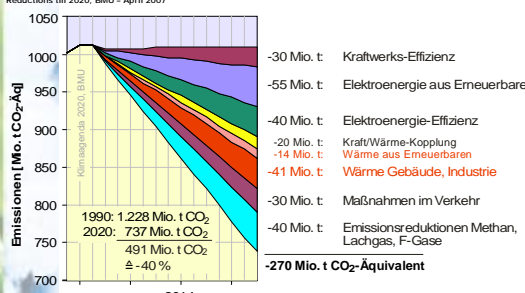
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3. Experience in „new technics“

Greenhousegas Emissions  
Reductions till 2020, BMU - April 2007




1990: 1.228 Mio. t CO<sub>2</sub>  
2020: 737 Mio. t CO<sub>2</sub>  
491 Mio. t CO<sub>2</sub>  
± -40 %

- 30 Mio. t: Kraftwerks-Effizienz
- 55 Mio. t: Elektroenergie aus Erneuerbaren
- 40 Mio. t: Elektroenergie-Effizienz
- 20 Mio. t: Kraft/Wärme-Kopplung
- 14 Mio. t: Wärme aus Erneuerbaren
- 41 Mio. t: Wärme Gebäude, Industrie
- 30 Mio. t: Maßnahmen im Verkehr
- 40 Mio. t: Emissionsreduktionen Methan, Lachgas, F-Gase
- 270 Mio. t CO<sub>2</sub>-Äquivalent

-226 Mio. t: Bundesregierung Aug. 2007

Klekk, Jörn Schwarz, Vortrag DKV/UBr/Kaiserslautern 2.10.2007



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3. Experience in „new technics“

In spring 2007 Germany founded an Expert group in order to prove reduction potentials on HFCs in Supermarkets

- Ministry of Environment
- Federal Environmental Agency
- Ecofys Germany
- Karlsruhe University of Applied Sciences  
Institute of Refrigeration, Air Conditioning and Environmental Engineering
- Supermarket Chains: Rewe, Lidl, Metro, Aldi
- Producers of Components: Güntner, Bitzer, Bock, DuPont
- Refrigeration Companies: Linde, Epta, Dresdner Kühlenanlagenbau
- Planning Engineers: Tebeg, KWN

- DKV, Eurammon, Öko-Recherche, GTZ



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3. Experience in „new technics“

What technics are “in the market”. What are the experiences of parties involved in the market?

Are there existing technologies to reduce the usage of HFCs in Supermarkets.

Are this technologies competitive?



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3. Experience in „new technics“

- 1: HFC DX
- 2: HFC secondary loop
- 3: HFC secondary loop + direct Expansion
- 4: HFC secondary loop (Slurry Ice)
- 5: HFC/R744-Kascade
- 6: HFC secondary loop/R744-Kascade
- 7: HFC/R744-Kascade – HT CO2
- 8: NH3 secondary loop
- 9: R717/R744 Kascade: R717 secondary loop in Kascade with
- 10: R717/R744 Kascade: R717 in Kascade with R744, HT R744 as brine
- 11: HC secondary loop
- 12: HC / R744 Kaskade
- 13: R744 DX
- 14: R744 DX in Kascade zu (HF-)KW
- 15: Distributed Systems



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3. Experience in „new technics“

	GWP	Flam-mability	Toxicity	Price of Refrigerant	Price of System	Theoretical system efficiency
HFCs	high	no	no	moderate	low	good
Hydrocarbons	low	yes	no	low	medium	good
Carbon Dioxide	low	no	only at high concenr.	low	medium	medium
Ammonia	low	can be ignited	yes	low	high	good

... but many other aspects to be considered, e.g. real system efficiency

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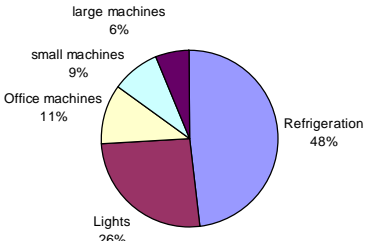
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3. Experience in „new technics“

Consumption of Electricity in a typical Supermarket



**Refrigeration 48%**  
**Lights 26%**  
**Office machines 11%**  
**small machines 9%**  
**large machines 6%**

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3. Experience in „new technics“

During design / installation

- Glass door or lid
- Improved insulation
- Fan motor outside cabinet
- Improved evaporator fan and/or fan motor
- Improved air flow in open multidecks
- Infrared reflecting shades or baldachines
- Improved antisweat heaters / dew point control
- Siphon in defrost drain
- Hot gas defrost
- Speed control of compressors, pumps, fans
- Improved expansion valve
- Expansion machine

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3. Experience in „new technics“



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3. Experience in „new technics“

During design / installation

- Improved evaporator
- Flooded evaporator
- Defrost on demand
- Improved lights
- Reduced condensation temperature
  - Outside air temperature adjusted condensing temperature
  - Evaporative cooling of condenser
  - Condenser heat to soil
- Free cooling
- Heat recovery
- Cold storage

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3. Experience in „new technics“

During operation

- Correct loading of products
- Air humidity in shop area
- Evaporator and condenser cleaning

Reduction of energy consumption is important due to :

- Reduction of running cost – **increase of profit** refrigeration accounts for 40 to 60 % of store energy consumption; energy costs some times in the same order of magnitude as profit (1 to 2 % of turnover).

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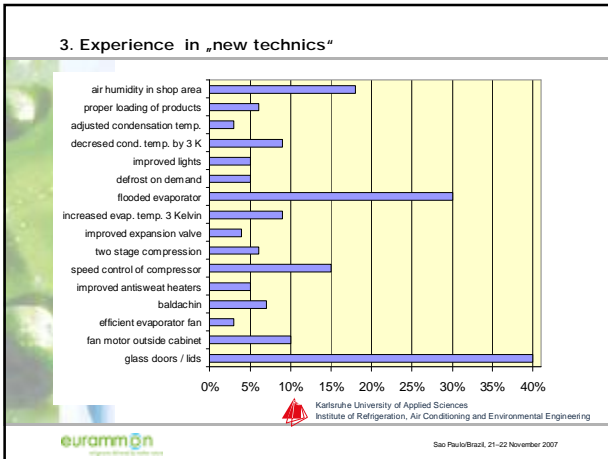
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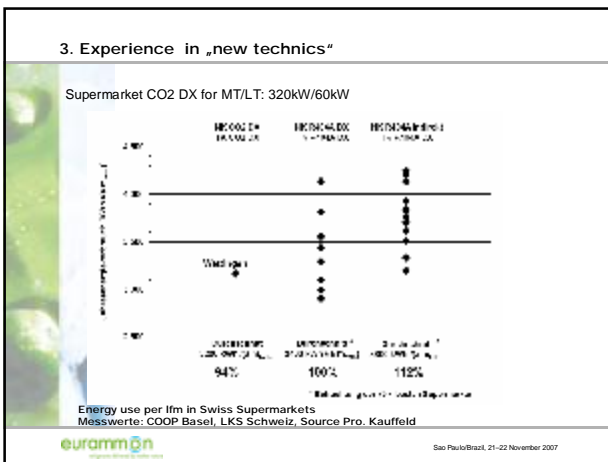
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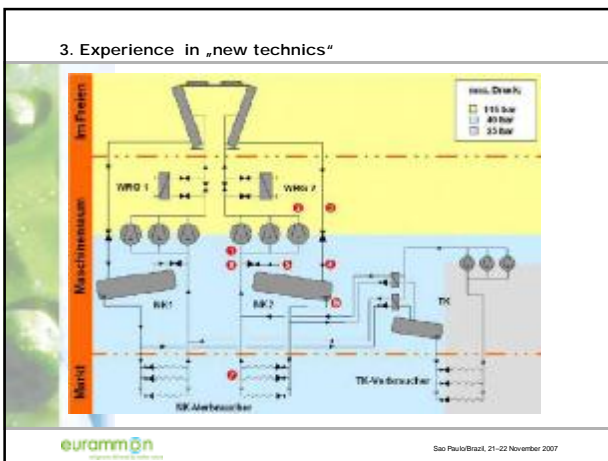
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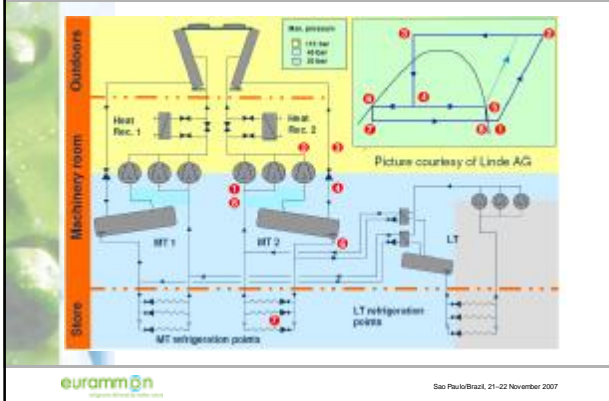
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3. Experience in „new technics“




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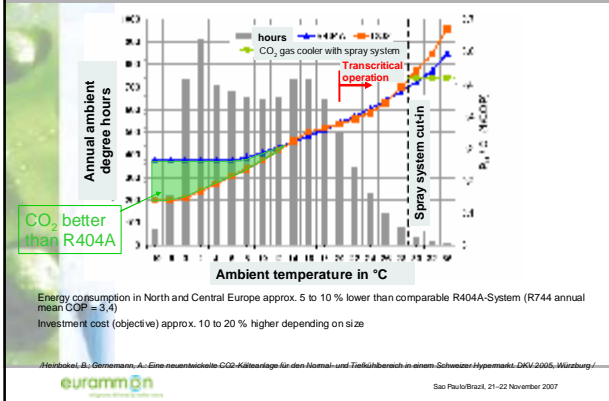


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3. Experience in „new technics“




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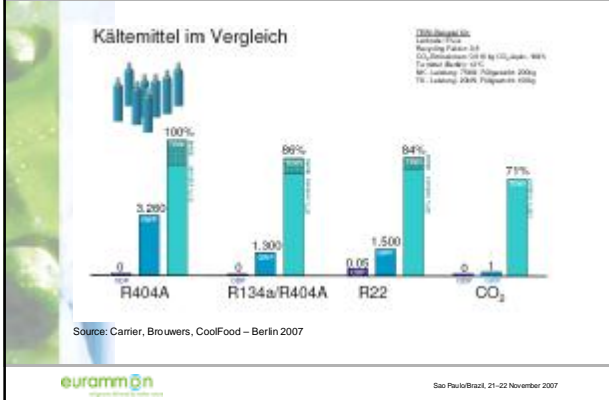


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3. Experience in „new technics“




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3. Experience in „new technics“

CO2 Supermarket Installations in EU

About 60 over Europe  
Italy, Sweden, Norway, Germany, Switzerland, Luxemburg, Great Britain, Sweden, Belgium

Capacity:  
MT: 17-320kW  
LT: 2-80kW



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4. Status - Trends  
Climate Change  
*Proposed German Regulation*

Germany has to implement/specify some general measures given in the Regulation (EC)

- Ø Leakage test / containment
- Ø Training and certification

The German Ministry for the Environment drafted a regulation (October 15, 2007)  
Comments until November 9, 2007



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4. Status - Trends  
Climate Change  
*Proposed German Regulation*

**Main aspects of the regulation**

1. It sets out maximum leak rates for systems depending on their age and refrigerant charge.
2. These leak rates are based on VDMA values.
3. It defines qualified personnel
4. It defines certification bodies



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4. Status - Trends  
Climate Change  
*Proposed German Regulation*

existing systems:	10 kg or less:	6%
	10-100 kg:	5%
	above 100 kg:	4%
systems installed after 30 June 2008:		
	3 kg or more (sealed):	1%
	10 kg or less:	3%
	10-100 kg:	2%
	above 100 kg:	1%

Additionally each connection of the system shall not have a leak rate of more than 5g/year.



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4. Status - Trends  
Climate Change  
*Proposed German Regulation*

The German Environmental Ministry will support the Commission in its assessment whether further products and equipment can be included in Annex II.

We want to promote energy efficient refrigeration systems with natural refrigerants.

Germany will use the money gained from auctioning carbon allowances for climate related projects.

Over a quarter of revenues will be dedicated to adaptation and technology transfer to developing countries.



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4. Status - Trends Customers as Trendsetters

**McDonald's goes for natural refrigerants**  
The Coca-Cola Company will only use HFC-free technology from 2004

**Unilever wants to use HFC-free technology**  
**Nestlé wants to use natural refrigerants wherever possible**  
**Danish Coop and Danish Supermarket value natural refrigerant supermarkets higher than conventional**  
**British insurance companies are said to reduce investments in greenhouse warming industry**  
**Aldi Süd buys only low energy consumption plug-in freezer and develops new lighting system for refrigerated shelves**  
**But these are only spear heads! Governmental laws and enforcements needed for wide application, e.g. Denmark, Norway, Sweden**



Karlsruhe University of Applied Sciences  
Institute of Refrigeration, Air Conditioning and Environmental Engineering  
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4. Status - Trends

There are a lot of applications which reach the goals in reducing the output of greenhouse gases.  
A lot of systems are now in the race – and it is not clear which systems will win at the end.



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4. Status - Trends - Applications without HFCs



**Supermarket:**  
**MT 380kW**  
**LT 120kW**



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4. Status - Trends - Applications without HFCs

ID/NH3  
Minimizing R404a DX with Option CO2  
built 2002

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4. Status - Trends - Applications without HFCs

CO2 as a secondary - 1999, 2x120kW

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4. Status - Trends - Applications without HFCs

NH3 secondary, CO2 DX 180kW

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4. Status - Trends - Applications without HFCs



R723 - secondary, 230kW



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4. Status - Trends - Applications without HFCs



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4. Status - Trends - Applications without HFCs



NH3 secondary, 900kW



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Back to Future: Natural refrigerants!

3 Advertisement  
1922

Advertisement  
1943

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Back to Future: Natural refrigerants!

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„Heavier – than – air machines are impossible“

Lord Kelvin, 1895

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