

Wuppertal Institute
for Climate, Environment
and Energy

Policy options for ecodesign and labelling of commercial refrigeration

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Consultation Forum under Article 18 of
the Ecodesign Directive (2009/125/EC)
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Science Company Wuppertal Institute

Application-oriented Sustainability Research

- President: Prof. Dr. Uwe Schneidewind
- Former President: Prof. Dr. Peter Hennicke
- Setting up: 1991 conducted by Prof. Dr. Ernst Ulrich von Weizsäcker
- Legal form: Ltd., Non-Profit-Organisation; Member of the Science Centre of North Rhine-Westphalia
- Ownership: State of North Rhine-Westphalia
- Staff: > 140 members from all disciplines
- Projects: 80 - 100 projects per year
- Budget 2008:
2.2 Mio. Euro basic funds from the state of North Rhine-Westphalia (strong decreasing trend)
ca. 8 Mio. Euro of third party funds (UN, EU, Ministries, Private Sector, NGOs)



Overview

- Product scope and definitions
- Justification for action at the Community level
- Increasing energy efficiency
- Switching to refrigerants with low GWP
- Minimum energy performance standards:
 - Overview on regulations in other countries
 - How to define specific requirements / defining an EEI
 - Proposals by the preparatory study contractor and EUROVENT
 - Generic requirements and / or specific requirements (energy, refrigerant)
- Need for harmonised standards based on EN ISO 23953 and EVA-EMP
- Information requirements / energy labelling

Definition „commercial refrigerating display appliance“

- Refrigerating appliance: Any mechanical appliance for the storage and preservation of perishable materials at specified temperatures below the ambient temperature (refrigerators and freezers)
- “Commercial”: Designed for the use by commercial, institutional or industrial facilities
- Display of chilled or frozen product for the purpose of merchandising

Main product types

Base cases: Beverage cooler, RVC2, RHF4, Ice-cream freezer

Combinations of:

- Remote / Incorporated condensing unit
- Horizontal / Vertical / Combined display of perishable materials
- Chilled / Frozen perishable materials
- Open / closed appliances



Sources of photos: BIOIS 2007; Wuppertal Institute

Separate regulation for cold vending machines



Sources of photos: Wurlitzer, Sielaff, Wittenborg

Excluded products

- Household refrigerators and freezers
-> Commission Regulation 643/2009
- Wine cellars and walk-in cold rooms
-> DG ENTR Lot 1
- “Storage only”: Service cabinets and blast cabinets with solid door or lid and minibars which are not for display of perishable materials
-> DG ENTR Lot 1
- “Production” instead of “display”: chilled drink dispensers, ice-cream making machines, ice-making machines
-> DG ENTR Lot 1
- Chillers for refrigeration processes or air conditioning
-> DG ENTR Lot 1



Sources of photos: BIOIS 2009; PhotoDisc; www.taylor-company.com

Justification for action at the Community level

- Currently no legislation specifically dealing with energy consumption of commercial refrigeration appliances
- Many smaller retailers with split incentive problem
- Energy costs are calculated to be around 3 to 4% of the total sales price of a refrigerated food or drink item
- Significant potential for energy savings and cost savings
- Significant potential for refrigerants with low GWP
- Total stock: 13.1 mln units, of which 6.3 mln are beverage coolers
- Annual sales: 1.4 mln units, with 1-3% growth expected

Increasing energy efficiency and reducing GHG emissions

With BAT at LLCC 11-57% electricity savings of base cases

Total primary energy consumption 2005/2006: **799 PJ** (36 MtCO₂eq).

Energy consumption during use phase = 98% of the product's total energy use.

Improvement potentials of base cases according to preparatory study:

- Use of night curtains (up to -26%), optimised air curtains (up to -10%), glass doors (up to -52%) or glass lids (up to -36%) for open appliances
- High efficiency compressors (-4%) and variable speed drives (-12%)
- Evaporator fans with electronically commutated motor (ECM) (-8%)
- Liquid suction heat exchangers (-2,5%) and increase of heat exchangers' surface (-15%)
- Better insulation or vacuum insulated panels (-3% to -6%)
- Improved location of anti-sweat heaters (up to -18%)
- High efficient lights (-3,5%) and light controls (-7,5%)
- Optimised loading

Switching to refrigerants with low GWP

Mostly used: R134a, R404a -> Alternatives possible

Principal options to reduce GHG emissions from refrigerants:

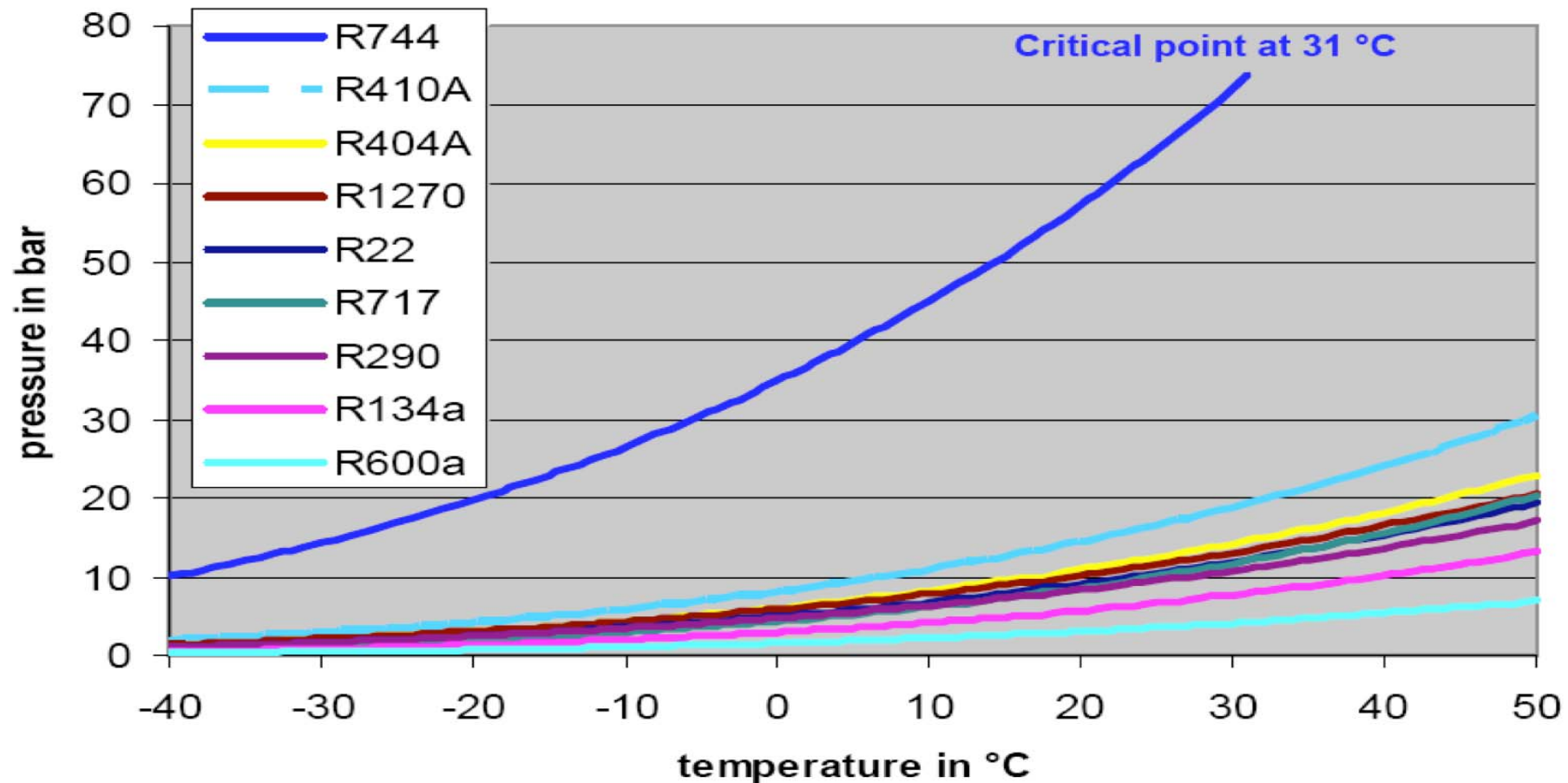
- Lower refrigerant charge
- Reduced leakage rate (expected decrease already in BAU development)
- Increased recycling rate of remaining refrigerants at end of life
- Switching to refrigerants with low global warming potential (GWP)

	GWP	Flammability	Toxicity	Price of refrigerant	Price of system	Theoretical system efficiency
HFCs R134a R404a R507	High 1,300 3,260 3,800	no	no	moderate	low	good
Hydrocarbons, e.g.: Propane (R290; C ₃ H ₈) Isobutane (R600; C ₄ H ₁₀)	Low 3 3	yes	no	low	low to medium	good
Carbon Dioxide (R744; CO ₂)	1	no	only at high concentration	low	medium	medium
Ammonia (R717; NH ₃)	0	can be ignited	yes	low	medium to high	good

Switching to refrigerants with low GWP

Constraints

Significantly higher evaporation pressure of R744 compared to other refrigerants in use. Condensing feasible below 31°C



Source: UBA 2009. Calculated with CoolPack version 1.46

Minimum Energy Performance Standards (MEPS)

Overview on regulations in other countries I

USA 2012

$$\text{Standard level}_i \left[\frac{kWh}{day} \right] = \begin{cases} a_i TDA + b_i \\ \text{or (depending on product type)} \\ a_i V + b_i \end{cases}$$

i = one of 38 different product types;
 V = Volume; TDA = Total Display Area

Standard levels not comparable to European values due to different TDA calculation and TEC measurement methods (ARI standard, ASHRAE 72-2005 test methods, different testing ambient conditions).

Source: US DOE 2009

Minimum Energy Performance Standards (MEPS)

Overview on regulations in other countries II

Canada: CAN/CSA-C827-98

$$AEC_i \left[\frac{kWh}{year} \right] = \begin{cases} a_i AV + b_i \\ or \\ a_i V + b_i \end{cases}$$

California 2007

$$MDEC_i \left[\frac{kWh}{day} \right] = \begin{cases} a_i AV + b_i \\ or \\ a_i V + b_i \end{cases}$$

AEC = Annual energy consumption max.;

i = product type;

V = Volume;

AV = Adjusted Volume:
refrigerator volume +
1.63 times freezer volume

MDEC = Maximum daily energy consumption

Source: BIOIS 2007

Minimum Energy Performance Standards (MEPS)

Proposals by the preparatory study contractor and EUROVENT

Product temperature class	Climate class	BASE CASES ONLY			
		TEC / TDA [kWh/(day*m2)]			
		Base case	BIOIS Base case Nov 2007	BIOIS MEPS Nov 2007	BIOIS MEPS_2020 BAT/LLCC* Nov 2007
M2	3	RCV2	11,04	12,15	6,58
H1-H2	4	Beverage cooler	8,80	8,33	3,82
L1	4	Ice cream freezer	8,65	9,09	6,84
L2-L3	3	RHF4	11,62	12,78	6,56
EVA-EMP measurement; for indoor use		Spiral vending machine (750 l)	7,47		4,46

BIOIS 2007

*without glass door/lid and with night curtain for the chilling appliances and with glass door/lid for the freezers

Product temperature class	Refrigerating display cabinets	
	TEC / TDA [kWh/(day*m2)]	
	Eurovent MEPS Proposal Jan 2010	
	Tier 1	Tier 2
M0	32,1	28,9
M1	27,2	24,5
M2	22,3	20,1
H1-H2	18,3	16,5
L1	54,4	48,1
L2-L3	42,8	38,5

EUROVENT 2010

Data are referring to the worst conditions for the less efficient model within RVC2 or RVC1 chilled models and within RYF3 frozen models. TEC/TDA values are representing five Eurovent Manufacturers (ARNEG-CARRIER-EPTA- NORPE-KOXKA)

Minimum Energy Performance Standards (MEPS) - Formula

How to define specific requirements / defining an EEI

$$\text{EEI} = \text{SEC} / \text{RSEC} * 100$$

with SEC = Specific energy consumption,

RSEC = Reference specific energy consumption

$$\text{SEC} = \text{measured TEC} / \text{TDA}$$

$$\text{RSEC} = f [(T_a - T_{mc}) / T_a; X]$$

with

T_a = ambient temperature;

T_{mc} = arithmetic mean temperature of all M-packages (test period)

X = vector of correction factors (like, e.g., volume correction factors for household appliances). Correction, e.g., for lighting, vertical display of products, open appliances, plug-in appliances, use of specific refrigerants?

-> how much differentiation needed?

-> data basis for determining coefficients of RSEC formula?

Minimum Energy Performance Standards (MEPS) - Level Generic requirements and / or specific requirements



**No problem for consumers to use freezers with glass lids or glass doors
⇒ generic requirement for $<0^{\circ}\text{C}$**

(or setting specific requirement so that glass door / lid will be needed to meet it)

Photos: Wuppertal Institute

In addition for appliances $>0^{\circ}\text{C}$: Requiring at least night curtains

Requirements for the refrigerant use

Generic requirements and / or specific requirements

- Option 1:
Obligation to use specific, low GWP refrigerants, or to exclude use of high GWP refrigerants
-> e. g., $GWP < 20$ for plug-in appliances?
- Option 2:
Malus (bonus) within specific energy performance requirement to set disincentive (incentive) for using high (low) GWP refrigerants
-> in the medium term including Total Equivalent Warming Impact (TEWI) instead of TEC in the formula for the specific requirement?
- Option 3:
No requirement

Need for harmonised standards based on EN ISO 23953 (taking into account current amendments) and EVA-EMP

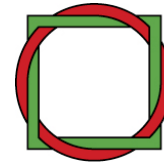
- EN ISO 23953 a good basis for any definition of MEPS and labelling scheme [EVA-EMP for cold vending machines]
- Mandate should be addressed to European Standardisation Bodies in order to translate EN ISO 23953 into a harmonised standard for the purpose of this Regulation, taking into account the currently on-going revision of this norm [similarly mandate for developing harmonised standard for cold vending machines]

Information Requirements / Energy Labelling

Market actors, ownership structures, distribution channels

- **Particularly addressing users who are not owners**
(95% of beverage coolers and ice-cream freezers sold to food & beverage industry and not to users)
- Package of information / labelling, ambitious MEPS to protect users

- **Information needs:** Product category/'model', kind of night cover used, DEC, REC, TEC, TDA, product temperature class, arithmetic mean temperatures of all M-packages for the test period θ_{mc} and test room climate class, EEI, refrigerant, GHG emissions
- Option 1: Energy label like for household appliances
- Option 2: Requirements to make information available to both purchasers and users in an appropriate manner
- Option 3: No information requirement / no labelling



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Thank you for your attention !



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