Forschungsrat Kältetechnik

Contribution of Refrigerating and Air Conditioning Systems to Climate Protection

Improvement of Energy Efficiency
Reduction of Greenhouse-related Emissions

March 2012

Supersedes the position paper of June 2008.
In case of doubt, the German language original should be consulted as the authoritative text.

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The 'Forschungsrat Kältetechnik' (FKT) funds technical and scientific research and its practical effects in the field of refrigeration and heat pump technology. The members of the 'Forschungsrat Kältetechnik' are companies working in the fields of building air-conditioning systems, domestic, commercial, industrial and transport refrigeration (including air conditioning), heat pumps, cryogenics, chemical industry, oil industry, as well as research institutes and associations.

In June 2008 the FKT published the first position paper related to possible reductions of greenhouse-related emissions in the field of refrigerating and air conditioning technology [1].

Initiated by the FKT and managed by the department 'Refrigeration and Heat Pump Technology' of the VDMA, the German refrigeration industry founded a national working group 'Energy efficiency of refrigerating systems' in 2008 for preparing the VDMA Specification (VDMA-Einheitsblatt) 24247 'Energy efficiency of refrigerating systems'.

VDMA 24247 was published in 2011 and describes the current stage of technology.

The VDMA Specification comprises the following parts:

- Contribution of refrigerating and air conditioning systems to climate protection - Improvement of energy efficiency - Reducing greenhouse-related emissions [2]
- Requirements for system design and components [3]
- Guideline for an improved energy efficiency in cold storages [4]
- Supermarket refrigerating, commercial refrigeration, refrigerated cabinets [5]
- Industrial refrigeration [6]
- Refrigeration in air conditioning systems [7]
- Control, energy management and efficient system management [8]
- Components - heat exchangers [9]

This specification documents measures for reducing the power consumption or increasing the overall energy efficiency which can be implemented without further development efforts.

VDMA 24247 is cited in studies for preparation of the legal implementation of the Ecodesign Directive [10], and is taken as basis for further measures [11], [12].

Moreover, the results related to energy saving have been published many times [13], [14], [15], and the already implemented measures resulting from this working group have been discussed in wide public discussions on various events and symposia [16].

The Research Council has performed a new statistical survey of energy consumption of the German refrigeration industry [17].

With this updated version of the position paper the 'Forschungsrat Kältetechnik' documents the savings achieved in the field of refrigeration technology since 2008, and shows those subjects which need further action or research. Moreover, the working group "Energy Efficiency of Refrigerating Systems" prepared a catalogue of proposals for policies and strategies [11], [16].

Initial situation

The first position paper for potential energy savings in the field of refrigeration technology [1] already documented the basis for emissions related to refrigeration technology. Current data show an increase of the energy requirements from 78.317 GWh/a in 1999 to 85.163 GWh/a in 2009. A saturation of the market and an absolute reduction of energy consumptions are observed in the field of domestic refrigeration only. Other fields of refrigeration technology still show an - in some cases considerable - increase, e.g. cooling of food, air conditions in passenger cars.

It is expected that up to about 2050 the global population growth, as well as the demand on refrigerated food will strongly increase. A reduction of the absolute energy consumption seems to be very unrealistically without clear political and control regulations [16].

Figure 1 shows a list of possible measures for reducing the emissions of greenhouse-gases by 270 million tons up to 2020, compared to the end of 2006. [19]

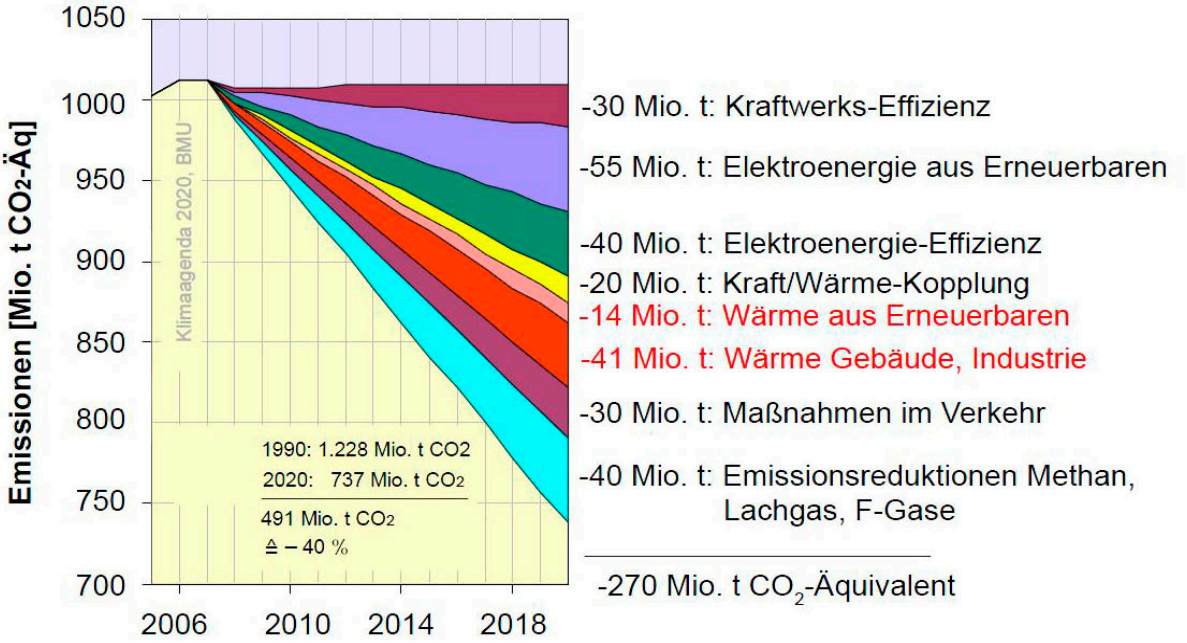

Figure 1 - National targets for reduction of emissions, BMU Climate Agenda 2020 [19]

Emissionen …	Emissions [million tons CO_2-Eq]
Kraftwerks-Effizienz	Efficiency of power plants
Elektroenergie aus Erneuerbaren	Electrical energy from renewable energies
Elektroenergie-Effizienz	Efficiency of electrical energy
Kraft/Wärme-Kopplung	Combined heat and power
Wärme aus Erneuerbaren	Heat from renewable energies
Wärme Gebäude, Industrie	Heat for buildings and industries
Maßnahmen im Verkehr	Measures for traffic
Emissionsreduktionen Methan …	Reductions of emissions of methane, nitrous oxide, F-gases
270 Mio. t …	270 million tons of CO_2 equivalent

Note: BMU - Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit
(Federal Ministry for the Environment, Nature Conservation and Nuclear Safety)

State of increase of energy efficiency in 2012 compared to the data taken from the position paper from 2008 [1]

The 'Forschungsrat Kältetechnik' estimated that it will be technically possible to achieve potential energy savings of 40 % up to 2020, if accompanying political measures will be taken.

The following savings have already been documented:

→ Supermarket refrigeration: -5,5%/year [20]

→ Domestic refrigeration: -27%/10 years [17]

→ Refrigeration in air conditioning systems: -2%/year [21]

Measures and recommendations

In a workshop [18], the 'Forschungsrat Kältetechnik', the VDMA working group 'Energy efficiency of refrigerating systems' of the VDMA, the 'Fraunhofer-Institut for solar energy systems' (ISE), the 'Fraunhofer-Institut for Systems and Innovation Research' (ISI), and the 'Fraunhofer-Institut for Resource Efficiency and Energy Strategies' (IREES) prepared recommendations which should be basically implemented by regulatory measures. The presented measures and barriers (table 1) were presented in 2011 [16] and a plenum discussion classified them to be reasonable in general. The potential energy saving achieved by implementing these measures confirms the targets listed in [1].

Sector	Proposal for regulation / Obligations / Measures	Barriers
General	Determination of the load profile, overall annual design (load profile, annual temperature distribution) Pre-defined minimum level of the energy efficiency, coefficients for energy consumption Monitoring, maintenance Energy- Contracting Certification of staff, training of users, Proof of expertise for energy efficiency R&D- Joint research with other trades Heat recovery Investment incentives versus sponsored energy consumption	
Supermarket refrigeration	Ecodesign for refrigerated cabinets (ENER Lot 12) Supportive measures	One-time promoting Requirement: minimum energy consumption[1]
Industrial refrigeration	Consultation Bonus-malus system (statistics, LEED) Concerted network programs[14] Supportive measures	No planning reliability Reliability of investments Know-how of the investor Requirement: minimum energy consumption[1]
Air conditioning	Consultation Bonus-malus system (statistics, LEED) Supportive measures	Requirement: minimum energy consumption[1]
Operation, Control	Proof that control of the system is in line with demand intelligent control systems	
Heat exchanger	Specify maximum pressure and temperature differences for different types and applications High-efficiency fans, pumps, drives Ecodesign regulation for heat exchangers	

Table 1: Proposals for political measures for a reduction of the energy consumption; Results of the workshop [18] and the plenum discussion [16] of the working group "Energy efficiency of refrigerating systems“

[1] The barrier "Requirement minimum energy consumption" is directed against the numerically fixed percentaged requirements for a reduction as criterion for decision for supportive funds. In this case a requirement related to the corresponding sector should be defined, since considerable improvements compared to supermarket refrigeration compared to industrial refrigeration are not realistically and achievable.

Need for research and further measures of the FKT

The 'Forschungsrat Kältetechnik' continuously examines the need for further research in order to achieve further improvements of refrigerating systems, and sees the following future actions:

- Examinations for implementing the targets specified in this position paper (40% potential energy savings) with regard to further need for research
- Development of a calculation method ('efficiency tool') for implementing the energy efficiency criteria of refrigerating systems developed in VDMA 24247 [22]
- Further development of the VDMA Energy Efficiency Check [23]
- Identification and development of innovation strategies for technologies in the field of refrigeration, air conditioning and heat pumps, with consideration of integration of systems and mode of operation in the context of national and European energy policies.
- Examination of the potential and the application of new technologies, for instance heat recovery and storage technologies
- Public relations (training, case studies, press relations, etc.)
- Examinations for preparing statistics for energy efficient refrigeration and air conditioning systems
- Examination for the cost of life time cycles of refrigeration and air conditioning systems in order to evaluate the arising energy cost and the related overall cost for investors or users of the system
- Orientation to the state of technology (Best Available Technology, Ecodesign Directive)

Expectations related to politics

- Implementation of commitment systems and measures (e.g. minimum COP or SEE(I)R)
- Consideration of minimum part load efficiencies (e.g. ESEER)
- Simplification and harmonisation of approval and acceptance procedures for systems operated with natural refrigerants
- Comprehensive, quick and simple promotion of particularly energy efficient and climate friendly systems
- Promotion of research projects serving to a reduction of CO_2 emissions
- Supportive measures orientated to Best Available Technologies, as described in VDMA 24247 [2] - [9]
- Sustainable regulations' policies with regard to a long-term planning reliability for the industry

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