ECOS

Deutsche Umwelthilfe

How old refrigerators fuel global warming

Briefing Paper

November 2016

Profile of the signatory organisations

Environmental Action Germany (Deutsche Umwelthilfe – DUH) is a German independent environmental and consumer protection organisation and member of the European Environment Bureau (EEB). Within our Waste Unit we promote waste prevention and high standards for recycling for the purposes of resource conservation and environmental protection. We are renowned for our role in uncovering the Diesel Scandal; establishing a deposit system for non-refillable beverage containers in Germany and our campaigns against the littering of plastic bags and disposable cups. We have been active in the area of electronic waste for many years, campaigning for an environmentally sound collection and disposal of electronic devices. Household cooling appliances are a particular focus of our work, as they contain greenhouse gases which foster global warming.

ECOS is a Brussels-based environmental non-governmental organisation specialised in standardisation and technical product policies, representing 42 national and pan-European members. Among other key priority areas, ECOS works to secure conditions for the widespread uptake of low GWP refrigerants and to prevent the release of ozone depleting and high GWP refrigerants. To this effect, ECOS contributes both to the development of robust and realistic measurement methods addressing the impact of refrigerants on the environment, but also the promotion of low GWP refrigerants through the setting of specific requirements on products under Ecodesign and Energy Labelling regulations and standardisation. Further downstream, ECOS has been actively contributing to setting ambitious standards mandated by the European Commission to lay down specifications for the environmentally safe disposal of waste electrical and electronic equipment (WEEE), including temperature exchange equipment (CENELEC/TC 111x).

Abbreviations

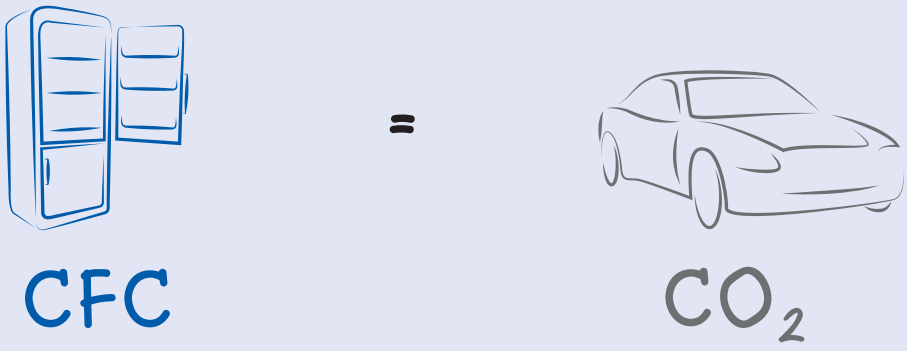
CFC	Chlorofluorocarbon
CLC	European Committee for Electrotechnical Standardisation (CENELEC)
CO_2	Carbon dioxide
DUH	Deutsche Umwelthilfe e. V.
ECOS	European Environmental Citizens' Organisation for Standardisation
EERA	European Electronics Recyclers Association
EN	European Norm
GWP	Global warming potential
HC	Hydrocarbon
H-FCKW	Hydrochlorofluorocarbon
HFC	Hydrofluorocarbon
IPCC	Intergovernmental Panel on Climate Change
PUR	Polyurethane
R11	Trichlorofluoromethane (CCl3F)
R12	Dichlorodifluoromethane (CCl2F2)
TA Luft	Technical Instructions on Air Quality Control
TEE	Temperature exchange equipment
TS	Technical specification
UBA	German Federal Environment Agency

Introduction: Why are fridges a threat to our climate?

Approximately half of all discarded household cooling appliances in Europe still contain chlorofluorocarbons and hydrochlorofluorocarbons (CFCs and HCFCs), as well as other fluorinated compounds (e.g. HFCs)[1]. These compounds have been used as refrigerants in the refrigerating system or as blowing agents in the insulating foam. When these gases enter the atmosphere, they significantly contribute to the warming of the atmosphere and the depletion of the ozone layer. This in turn accelerates global warming with an impact of up to 10,200 CO_2 equivalents[2].

What does the disposal of my refrigerator have to do with climate protection?

The CFCs contained in the refrigerant and insulating material of refrigerators have a global warming potential of 2,800 kg CO_2. This equals the CO_2 emissions of a medium-sized passenger car within one year.*



* Based on 7 litres petrol per 100 km and a mileage of 15,000 km.

Figure 1

In Central Europe, a CFC-containing refrigerator typically contains 126g of the refrigerant R12 in the cooling circuit and 316g of the blowing agent R11 in the polyurethane (PUR) foam insulation[3]. Within 100 years, one gram of the cooling agent R12 contributes 10,200 times as much to greenhouse gas effects as one gram of CO_2 would. Similarly, one gram of the blowing agent R11 contributes 4,660 times as much to the greenhouse effect as one gram of CO_2[4]. Together, the greenhouse gases in one CFC-containing cooling appliance endanger our climate as much as 2,800 kg of CO_2. Based on an average mileage of 15,000 km and a fuel consumption of 7 litres per 100 km, this equals the CO_2 emission of a medium-sized passenger car within a year (figure 1).

CFCs have been banned from household cooling appliances since 1995[5]. Newer fridges now contain hydrocarbon compounds (HCs), such as isobutane and cyclopentane as refrigerating or blowing agents, which have a very low global warming potential (GWP). However, with an average cooling appliance lifetime of 15 to 20 years[6], approximately half of all discarded cooling equipment in Europe still contains CFC. Every year, approximately 19 million refrigerators and freezers are taken out of service in Europe[7]. Out of those 19 million, approximately 9.5 million contain CFC, having a GWP of 26.6 million tons of CO_2. This equals the amount of CO_2 that 3.6 million Europeans produce on average in a single year. For reference, an average European produces approximately 7.4 tons of CO_2 in a year via heating, electricity, transport, consumption and diet (figure 2)[8].

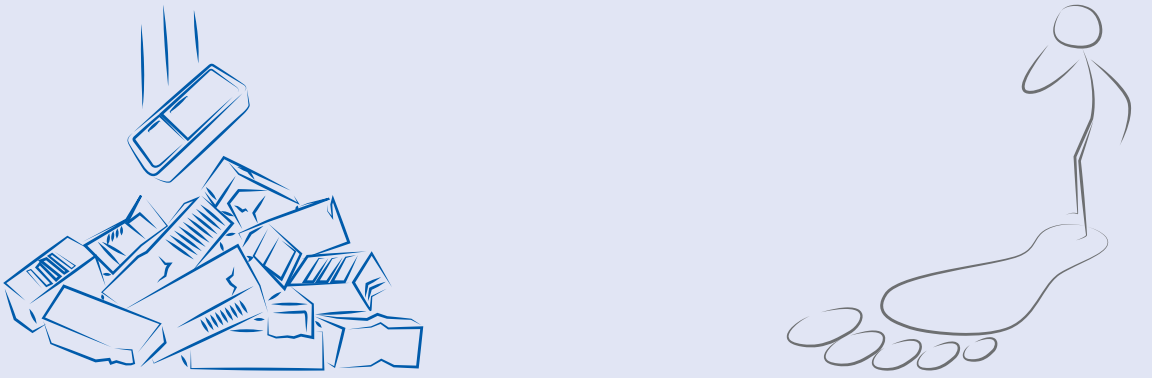
- Approximately half of all discarded refrigerators in Europe still contain CFC and other fluorinated compounds.
- Discarded refrigerators in Europe have a global warming potential of 26.6 million tons of CO_2.

How do I dispose of my old refrigerator correctly?

Discarded refrigerators should be returned to local recycling centres or to the seller. Fly-tipping is illegal and damaging to our climate and environment. In case of a communal kerbside collection, old devices should only be placed on the kerb shortly before their collection. Otherwise, scavengers may remove the iron or copper containing compressors, preventing their appropriate treatment and releasing greenhouse gases into the atmosphere. Scavengers may also take entire devices and sell them abroad. The export of CFC-containing refrigerators is highly illegal, as the recovery of CFC cannot be monitored or ensured outside the EU.

How damaging are discarded refrigerators for our climate?

Every year, 19 million refrigerators are being disposed of in Europe. Yet, approximately half still contain CFC-based refrigerants and blowing agents. Together, these substances have a global warming potential of 26.6 million tons of CO_2 – the same amount that 3.6 million Europeans produce in a single year.*



*Based on an annual average CO_2 footprint of 7.4 tons of CO_2 per person.

Figure 2

The problem: How do the CFCs from discarded refrigerators make their way into the atmosphere?

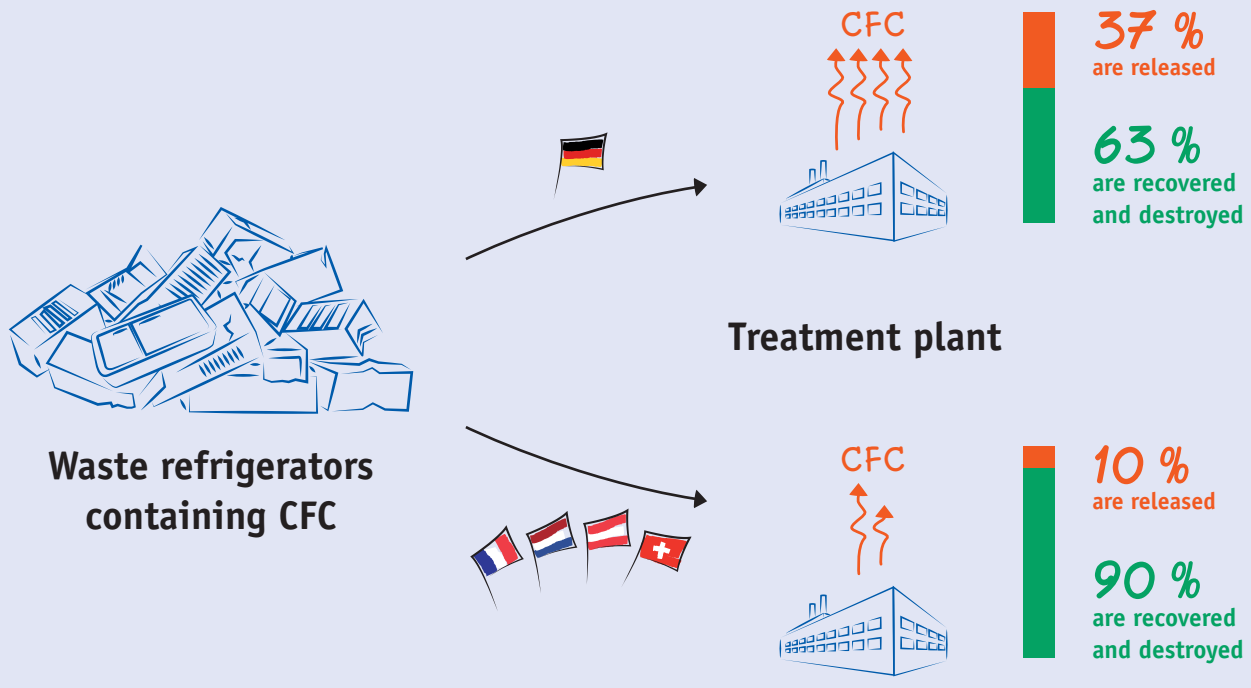
Consumers may return their discarded cooling appliances to the seller or drop them off at their local recycling centre. At disposal stage, the treatment plants are required by the European Directive 2012/19/EU on waste electrical and electronic equipment (WEEE)[9] to remove all cooling and blowing agents into an identifiable stream, so they can be monitored to verify their environmentally safe treatment. In some European Member States however, the official disposal methods are problematic, as CFCs are often not sufficiently removed from the discarded devices. In Germany for exemple, the German Federal Environment Agency (UBA)[10] as well as an investigation by the umbrella organisation for the electrical technology industry – Zentralverband Elektrotechnik- und Elektronikindustrie e.V. (ZVEI)[11] – confirm these findings. Information from industry insiders, DUH observations and research by the economy journal Capital[12] indicate that cooling appliances are too often disposed of in a way that contradicts legal requirements and entails significant emissions of greenhouse gases.

Based on individual figures of German federal states, DUH calculated that only 63 % of all CFCs had been appropriately removed from discarded cooling appliances in Germany in 2012. The remaining 37 % of greenhouse gases have leaked into the environment and compromise our climate as much as 1.5 million tons of CO_2 (figure 3).

The inadequate treatment of discarded refrigerators can lead to CFC leakages at many different stages. Therefore, we believe it is crucial that the treatment starts with the careful registration and subsequent transportation of the devices. Moreover, dropping refrigerators by forklifts into containers must be avoided as much as the crushing of devices, or the tipping of containers containing the devices. Indeed, such strong external influences can damage the black cooling hoses of the condensers at the back of refrigerators and release refrigerants. At the treatment plant, it is equally essential to ensure that the extracting devices do not leak when removing the refrigerants from the refrigerating system – the so-called step 1 treatment –, and to fully remove any refrigerants. The recovery of blowing agents – step 2 treatment – takes place using a shredder that destroys the body of the refrigerator and thereby separates metals and plastics from insulating materials.

What is bad practice and what is best practice in Europe?

In Germany only 63 %* of the CFCs contained in refrigerators are destroyed. 37 % of the greenhouse gases leak into the atmosphere, where they endanger the climate as much as 1.5 million tons of CO_2 would. As a consequence of the implemented European quality standard EN 50574, treatment plants in France, the Netherlands, Ireland, Switzerland and Austria recover 90 % or more of greenhouse gases out of waste refrigerators.



*Based on a DUH survey of German federal states in 2012.

Figure 3

The shredding of the refrigerator releases greenhouse gases and has to take place in an encapsulated environment. A double-gated sluice should ensure that no greenhouse gases are being released whilst feeding the shredder with refrigerators, or during the outward transfer of recovered materials. Any insulating materials (typically PUR foam) should be ground by way of pore degasification and subsequently be heated by a matrix degasification, in order to remove all CFCs and HC residues. If the above steps are inadequately followed or not followed at all, the risk stands that outgoing PUR foam still contains CFCs, which subsequently enter the environment. Any CFCs that are released into the process air during the pore and matrix degasification can be removed by way of cryocondensation, or with help of activated carbon filters. A high temperature furnace or an equally proofed and suitable destruction unit should then destroy it. The effectiveness of this process should be monitored continuously, in order to avoid CFC or HC residues in the emissions (figure 4).

- In some European Member States, refrigerators are not treated in an environmentally sound manner at the end of their life cycle.
- In Germany, a mere 63 % of greenhouse gases contained in discarded refrigerators are removed and destroyed.
- The careless treatment of old appliances, incomplete recovery of refrigerants and blowing agents, as well as leaking treatment processes currently contribute the most to CFC emissions.

How come CFC can leak during the treatment of waste refrigerators?

CFC emissions happen…

1. due to inappropriate transport methods, e.g. the crushing or tipping of appliances upon delivery,
2. during the extraction of refrigerants, e.g. via leaks in lines or collection tanks,
3. at dismantled compressors if the refrigerants have not been fully recovered,
4. during the feeding of the shredder, due to the lack of double-gated sluices, or leaking feed-in cabins,
5. at the exit vent for output materials,
6. via output materials, due to residues of CFC in PUR foam and PUR foam adhering to metals or plastics,
7. due to insufficient exhaust purification,
8. and leaking system parts.

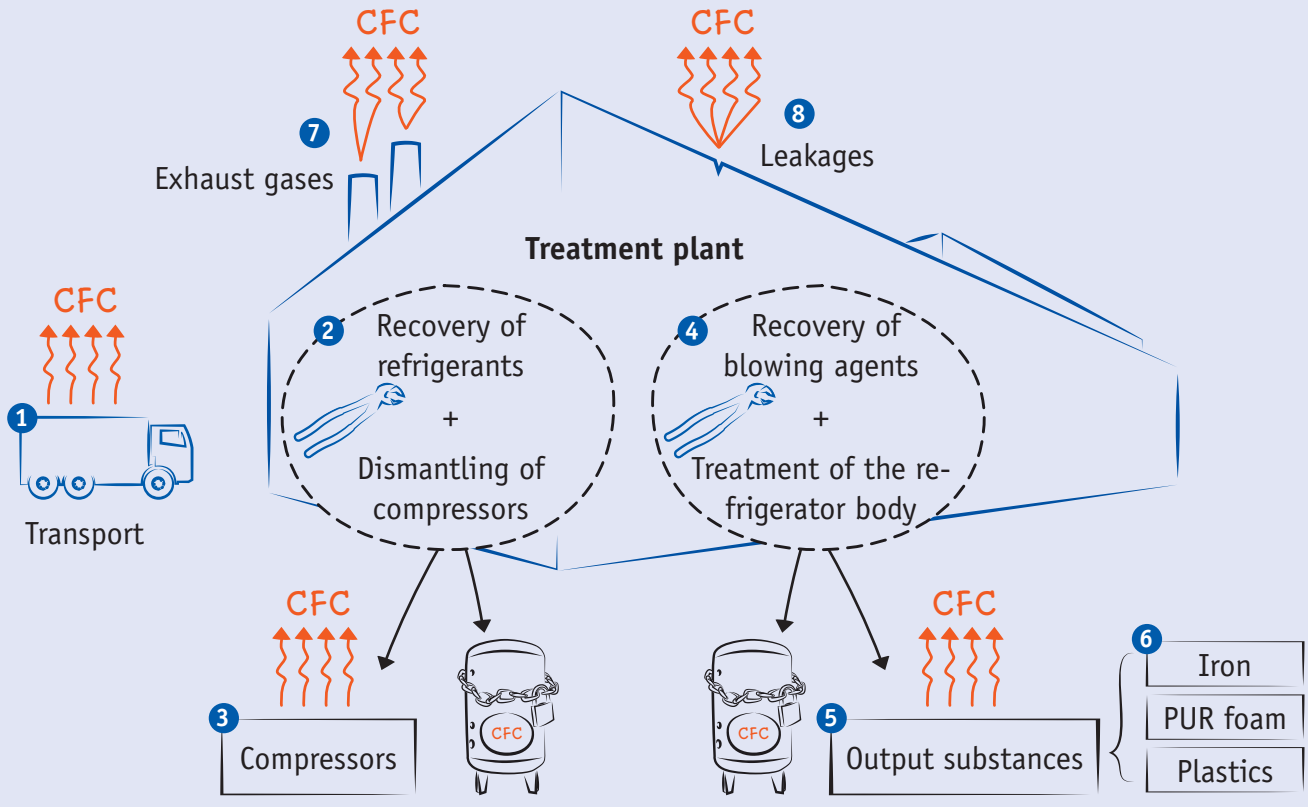


Figure 4

The solution: Why European quality standards are essential

The main cause for inappropriate disposal practices in Germany and other European Member States is their outdated regulatory framework, which does not ensure an environmentally friendly treatment of discarded cooling appliances. As a consequence, their refrigerator disposal market is exposed to tough pricing competition, often at the expense of quality aspects[13].

The European Directive 2012/19/EU on waste electrical and electronic equipment stipulates that cooling appliances must be treated in line with state of the art technology, and that any contained refrigerants or blowing agents must be removed and destroyed or recycled. In Germany, the Technical Instructions on Air Quality Control (TA Luft)[14] specifies the 'state of the art' of technology. This manual was published on the 24th of July 2002 and has not been updated in 14 years. According to the TA Luft, treatment plants merely have to be tested once a year during an evaluation notified beforehand. For step 1 treatment, plants have to demonstrate that they remove 90 % of the refrigerants from 100 devices and that there are no leaks at the time of assessment. For step 2 treatment, where the blowing agents have to be removed and captured, no such evaluation takes place. Apart from that, TA Luft sets out thresholds for the CFC content in emissions and output materials. However, these specifications do not align with the current state of technology and do not guarantee an environmentally friendly treatment of old appliances.

Modern standards and effective performance tests of treatment plants are essential in order to stop the emission of greenhouse gases during the treatment of refrigerators. For this purpose, the European Committee for Electrotechnical Standardisation (CENELEC) developed the European standard EN 50574[15], including the European technical specification CLC/TS 50574-2[16]. Based on the European Commission Mandate M/518[17] supporting the European Directive 2012/19/EU, CENELEC is currently cooperating with manufacturers, disposal companies and societal stakeholders such as ECOS to develop the European standard EN 50625-2-3[18] and European technical specification CLC/TS 50625-3-4[19], which build on the content of EN 50574 and CLC/TS 50574-2. These European quality standards specify the state of the art technology for the environmentally friendly treatment of refrigerators. They have the potential to create consistent pan-European conditions and overcome potential bureaucratic obstacles of individual, possibly diverging, national specifications.

How effective are German treatment regulations and how can they be improved?

Germany's current regulatory framework for the treatment of refrigerators – TA Luft – does not contain any specifications for an effective monitoring of treatment plants. The European standard EN 50574 is much more advanced. It specifies binding mass balances that allow for a direct comparison of the input and output of a treatment plant. It also includes tangible target values for the CFCs contained in refrigerators, making it immediately apparent how much greenhouse gases have to be recovered from waste refrigerators.

Figure 5

What do the European treatment standards EN 50574 and CLC/TS 50574-2 specify for the treatment of refrigerators?

Exact monitoring of the input and output of all materials

A mass balance puts the amount and method of treated refrigerators in relation with the production of output substances. This evaluation is key for a successful, verifiable and transparent monitoring of recovered greenhouse gases and allows for annual evaluations of the performance of individual treatment plants.

Thresholds for CFC and HC proportions in output substances

The export of CFC and HC with the output materials is to be avoided as far as technically possible. The European standard EN 50574 quotes the following thresholds for recycled materials:

- Oil may not contain more than 0.2 % of refrigerants
- PUR foam may not contain more than 0.2 % of blowing agents
- No more than 0.3 % of PUR foam may adhere to any recovered metals
- No more than 0.5 % of PUR foam may adhere to any recovered plastics

From DUH and ECOS' point of view, the threshold of admissible contingencies of refrigerants in the recovered oils and blowing agents in the recovered PUR foam must be lowered to 0.1 %. This threshold must be applied to the overall amount of recovered PUR foam and not only to the PUR foam sent to recycling. Otherwise, material utilisation would be at an advantage compared to thermal utilisation. Moreover, the destruction of CFC can often not be guaranteed in regular waste incineration plants.

Assessment of the recovered CFC and HC

It is essential to assess the exact amounts of CFC and HC in their collection vessels in order to evaluate the efficiency of refrigerant and blowing agent recovery. The standard EN 50574 specifies to determine the water proportion in relation to CFC and HC for that reason. CFC and HC values should be assessed even in so-called step 3 treatment plants that incinerate the substances immediately after their extraction.

Prescribed CFC and HC target values

The prescription of specific CFC and HC target values is a key factor in the European quality standards and allows for a straightforward assessment of the plant performance – for internal as well as external inspections. Only a straightforward assessment method enables enforcement authorities to intervene effectively when CFC and HC is not being recovered according to state of the art technology.

Monitoring of daily plant operations

The number of treated devices and the amounts of recovered refrigerants and blowing agents in their respective collection vessels need to be recorded on a daily basis. The operator of the plant must summarise the quantities of recovered refrigerants and blowing agents within the framework of a weekly evaluation. The amounts must be compared with the estimated target values of the technical specification CLC/TS 50574-2. Any shortfall must immediately result in remedial measures.

Annual performance tests of refrigerant and blowing agent recovery

An annual performance test on 100 CFC-containing refrigerators measures the effectiveness of the treatment plants. The amount of recovered refrigerants must not fall below 90 % of the content of refrigerants that is stated on the labels of the refrigerators.

The effectiveness of the blowing agent recovery is measured by an annual evaluation of 1,000 cooling appliances. The sum of all recovered blowing agents (CFC and HC) must not fall below 90 % of the expected amount.

Annual performance tests take place within the normal operating environment. During the evaluation it must be ensured that the throughput of the treatment plant, the input combinations of appliance types, and the proportion of CFC-containing and CFC-free appliances does not deviate more than 10 % from the average values recorded in the daily monitoring.

One essential aspect of these standards is the specification of a mass balance evaluating the amount of treated refrigerators in relation to the recovered refrigerants and blowing agents. Examining the mass balance in relation to the specified minimum target values of CFCs and HCs facilitates an effective control of the efficiency of any treatment plant, not only at point of assessment but across the entire year (figure 5). This mass balance has to be done during an annual performance test as well as during the weekly evaluation of the monitoring of these plants.

Across Europe, many refrigerator treatment plants already follow the European standards EN 50574 and CLC/TS 50574-2. In Austria, France, Luxemburg, Ireland, Switzerland and the Netherlands, these standards are not only mandatory and embedded in the national law or in the contracts between the operators and their clients, the national take-back schemes, but are also checked in daily practice by independent auditors. In Germany, similar requirements are missing. Although some of the producers have started to incorporate these European quality standards into their contracts with the operators, there is no evidence that these standards are cross-checked by independent and skilled auditors.

To ensure an environmentally sound treatment of cooling appliances, all European Member States should incorporate the European standards EN 50574 and CLC/TS 50574-2 in their national laws as legally-binding requirements. After their publication scheduled for 2017, the European standards EN 50625-2-3 and CLC/TS 50625-3-4 should supersede the standards EN 50574 and CLC/TS 50574-2.

- National requirements of several European Member States for the treatment of cooling appliances do not correspond to state of the art technology and are not sufficiently effective in limiting the emission of greenhouse gases.
- The European standards EN 50574 and CLC/TS 50574-2 (from 2017 onwards EN 50625-2-3 and CLC/TS 505625-3-4) must be incorporated into national laws in order to ensure an environmentally sound treatment of cooling appliances.

Conclusion

Discarded refrigerators still frequently contain greenhouse gases such as CFCs. The recovery and destruction of those gases must be the utmost priority when disposing of cooling appliances. In Germany and some other European Member States however, the policies currently in place do not ensure an environmentally sound treatment. As has been done by France and Netherlands, the European quality standards EN 50574 and CLC/TS 50574-2, or their succeeding standards EN 50625-2-3 and CLC/TS 50625-3-4, must be implemented in national law in order to ensure a state of the art recovery and destruction of greenhouse gases contained in cooling appliances.

Tip:

Why not visit our website for further information on our work to promote the environmentally friendly disposal of cooling appliances:

www.duh.de/5271.html
http://ecostandard.org/?s=refrigerants

Endnotes:

1 *'CFC' hereafter.*
2 *IPCC, Climate Change 2013: The Physical Science Basis.*
3 *Calculation based on CLC/TS 50574-2.*
4 *IPCC, Climate Change 2013: The Physical Science Basis.*
5 *CFC-Halon prohibition order dated May 6th, 1991*
6 *UBA Ratgeber 2009: Kühlgeräte Mit FCKW Immer Ein Problem.*
7 *Calculation based on United Nations University (UNU) 2014 "Study on collection rates of WEEE" and UBA Ratgeber 2009 "Kühlgeräte Mit FCKW Immer Ein Problem".*
8 *Eurostat 2012 "CO_2 emissions per inhabitant in the EU"*
9 *See http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32012L0019*
10 *UBA Ratgeber 2009: Kühlgeräte Mit FCKW Immer Ein Problem.*
11 *Institut für Energie- und Umwelttechnik e.V. (IUTA) 2011: Bericht zum Feldversuch an ausgewählten genehmigten Recyclinganlagen in Deutschland zur Ermittlung der zurückgewonnenen FCKW/HFKW Mengen aus dem heutigen Kältegerätemix (SG2) im Regelbetrieb.*
12 *Capital 09/2008: Klimaskandal: Deutschland stümpert bei FCKW- Entsorgung.*
13 *EERA, Digital Europe, CECED, WEEE-Forum 2016: "Compliance with EN 50625: Position paper". See http://www.weee-forum.org/news/compliance-with-en-50625-position-paper*
14 *Technical Instructions on Air Quality Control – TA Luft: http://www.bmub.bund.de/fileadmin/bmu-import/files/pdfs/allgemein/application/pdf/taluft_engl.pdf*
15 *EN 50574:2012 "Collection, logistics & treatment requirements for end-of-life household appliances containing volatile fluorocarbons or volatile hydrocarbons"*
16 *CLC/TS 50574-2:2014 "Collection, logistics & treatment requirements for end-of-life household appliances containing volatile fluorocarbons or volatile hydrocarbons – Part 2: Specification for de-pollution"*
17 *See http://ec.europa.eu/environment/waste/weee/pdf/m518%20EN.pdf*
18 *EN 50625-2-3 "Collection, logistics & treatment requirements for WEEE – Part 2-3: Treatment requirements for temperature exchange equipment"*
19 *CLC/TS 50625-3-4 "Collection, logistics & treatment requirements for WEEE – Part 3-4: Specification for de-pollution – temperature exchange equipment"*

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