Flanders
State of the Art

Final report

Waste and disposal emissions from F-gas containing refrigeration and potential actions to improve recovery of F-gases

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ENVIRONMENT
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DEVELOPMENT

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A study commissioned by the Department of Environment and Spatial Development, Energy, Climate and Green Economy Division 2018/SEB/R/June, 2018

National Book number: D/2018/3241/247

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Samenvatting

Fluorhoudende broeikasgassen (F-gassen) staan in voor bijna 3% van de totale broeikasgasuitstoot in Vlaanderen. De gassen, zoals HFCs, worden voornamelijk gebruikt als koelmiddel en komen dus vooral vrij uit koeltoepassingen (commercieel en industrieel), stationaire en mobiele air conditioning, en warmtepompen. De emissies van F-gassen nemen sinds 2000 toe. Deze toename is voornamelijk toe te schrijven aan stijgende emissies die vrijkomen bij het buitendienststellen van toestellen en installaties die F-gassen bevatten. Het inschatten van deze emissies is echter complex door het ontbreken van statistieken.

De wetgeving rond F-gassen, inclusief de recuperatie van gassen uit toestellen, is geregeld door Europese (de F-gas verordening 517/2014) en Vlaamse regelgeving. Daarnaast is ook de wetgeving rond het elektrisch en elektronisch afval belangrijk voor een correcte ophaling, behandeling en verwerking van toestellen die koelmiddelen bevat.

De doelstellingen van deze studie zijn:

- Nagaan of de emissies bij buitendienststelling op een correcte manier worden ingeschat in de emissie inventaris en de gebruikte emissie factoren overeenstemmen met de realiteit;
- Formuleren van conclusies en beleidsaanbevelingen die een positief effect hebben op het verminderen van de emissies bij buitendienststelling.

Voor deze studie hebben we ons enkel gefocust op vier type toestellen en installaties: grote commerciële en industriële koelinstallaties, hermetisch-gesloten commerciële koelinstallaties, air conditioning en warmtepompen en gekoelde containers gebruikt voor maritiem transport.

De informatie benodigd voor deze studie werd op drie verschillende manieren verzameld. Interviews werden afgenomen bij fabrikanten, eigenaars, installateurs, afvalverwerkers en leveranciers en ophalers van gassen. Een online enquête werd opgesteld en verspreid naar relevante stakeholders via Departement Omgeving en UBF-ACA. Ten slotte werd ook relevante literatuur geraadpleegd en werden drie case studies uitgewerkt over de huidige situatie en beleid in Frankrijk, Duitsland en Nederland.

De belangrijkste conclusies en aanbevelingen staan in onderstaande tabel.

Aanbevelingen en conclusies	Commerciele en industriele installaties	Air conditioning en warmtepompen	Maritieme reefers	Hermetisch gesloted
Emissie factoren bij buitendienststelling				
In vergelijking met andere statistieken lijkt het aantal kleine, verplaatsbare air conditioners onderschat in the emissie inventaris. Deze zijn ingeschat op basis van verkoopsstatistieken van UBF-ACA.		x		
Een aandeel van de chillers die op de markt worden geplaatst wordt gedeeltelijk voorgevuld geïnstalleerd. In de huidige inventaris is de aanname dat chillers volledig worden gevuld bij installatie. De chillers worden daarom ondergebracht in de category 'installations' in de inventaris. Dit moet aangepast worden, bijvoorbeeld door emissies van chillers te baseren op assumpties over aantallen, gemiddelde hoeveelheid koelmiddel en emissiefactoren tijden levensduur en buitendienststelling. Chillers zouden dan onderdeel kunnen vormen van de categorie 'air conditioning and heat pumps'.	x	x		
Maritieme containers worden niet expliciet opgenomen in de emissie inventaris. Tijdens de studie werd bijkomende informatie verzameld over deze emissie bron waardoor het opgenomen kan worden in de inventaris als afzonderlijke categorie.			x	
Hermetisch-gesloten commerciële koeling is niet expliciet opgenomen in de emissie inventaris. Emissies kunnen ingeschat worden aan de hand van de methode waarmee ook de emissies van residentiële koelkasten en diepvriezers worden ingeschat.				x
Op basis van de online enquête en interviews is er geen aanleiding om de gebruikte emissie factoren voor commerciële en industriële installaties en air conditioning en warmtepompen bij buitendienststelling aan te passen. De interviews en online enquête tonen ook de grote mate van onzekerheid aan wat betreft deze aanname.	x	x		
De interviews en enquête tonen aan dat de meeste experten verwachten dat de recuperatie van koelmiddelen uit toestellen en installaties de komende jaren zal verbeteren. In het kader van de emissie inventaris zal het daarom belangrijk zijn om deze evolutie op een zo accuraat mogelijke manier weer op te nemen.	x	x		
Beleidsaanbevelingen				
Niet alle toestellen en installaties worden op een correcte manier buitendienst gesteld. Toestellen en installaties komen nog terecht bij schroothandelaars, waarbij koelmiddelen niet worden gerecupereerd. Om dit nog meer te vermijden kunnen bijkomende maatregelen genomen worden. In Frankrijk is er een strengere wetgeving rond schrootbedrijven (bv. het verbieden van cash		x	x	

Aanbevelingen en conclusies	Commerciele en industriele installaties	Air conditioning en warmtepompen	Maritieme reefers	Hermetisch gesloted
geld, het verplicht aansluiten van alle bedrijven die afval verzamelen, bewaren en transporteren om zich aan te sluiten bij een eco-organisme), die een positieve impact heeft gehad op de recuperatie van elektrisch en elektronisch afval. De verplichte invoering van de EN 50625 standaard zou ook een verbetering kunnen betekenen.				
Sommige toestellen en installaties komen leeg toe bij ontmantelingsbedrijven. Het vroegtijdig identificeren en correct behandelen van air conditioners en warmtepompen (en andere koelmiddel bevattende toestellen zoals warmtepomp droogkasten) kan emissies tijdens ophaling en transport vermijden.		x	x	
Eindgebruikers worden niet altijd correct geïnformeerd wanneer ze een air conditioning of warmtepomp aankopen. Deze toestellen kunnen vrij aangekocht worden, maar moeten geïnstalleerd worden door een gecertificeerd technicus. Het correct en volledig informeren van eindgebruikers zorgt mogelijk voor correcter onderhoud en uiteindelijke buitendienststelling van de toestellen.		x		
Het recupereren van koelmiddelen uit toestellen en installaties is een kost voor de eigenaar (en de koeltechnicus), wat eigenaars ertoe kan aanzetten toestellen of installaties op een incorrecte manier te ontmantelen. Dit is de meest aangehaalde reden voor de niet optimale recuperatie van koelmiddelen. Het gratis maken van de recuperatie zou hieraan tegemoet kunnen komen. Eigenaaars, voornamelijk van kleinere installaties zoals in kleine buurtwinkels of in landbouwbedrijven, zijn eveneens niet altijd voldoende geïnformeerd of zich bewust van de wetgeving. Ze zijn hier vaak afhankelijk van koeltechnici voor het aanleveren van de nodige informatie.	x	x		x
Er zijn een aantal technische maatregelen mogelijk om de recuperatie van koelmiddelen uit installaties te verbeteren en om emissies te vermijden. Een deel van de koelmiddelen is bijvoorbeeld opgelost in de compressor olie. Deze koelmiddelen komen vrij indien de olie niet correct wordt bewaard en nadien behandeld. Waar mogelijk zouden toestellen en installaties moeten geledigd worden in een gespecialiseerd bedrijf zodat recuperatie kan gemaximaliseerd worden.	x	x		
Een tweede belangrijke reden die aangehaald werd waarom de recuperatie niet optimaal verloopt, is de onvoldoende controle op de bestaande wetgeving. Recent worden deze inspecties van koelinstallaties niet langer door de Vlaamse overheid, maar door de lokale overheden uitgevoerd. Aangezien	x	x	x	x

Aanbevelingen en conclusies	Commerciele en industriele installaties	Air conditioning en warmtepompen	Maritieme reefers	Hermetisch gesloted
dit een specifieke expertise vereist, is training en capaciteitsopbouw van lokale milieu inspecteurs nodig.				
Er is een duidelijk gebrek aan informatie over het aantal, de capaciteit en de hoeveelheid koelmiddel in toestellen en installaties. Het huidige systeem van logbooks is niet waterdicht. Een performanter systeem voor het registreren van de bestaande en nieuwe installaties zou betekenen dat installaties meer doelgericht kunnen geïnspecteerd worden. Het zet eigenaars ook aan om de regels nauwgezeter te volgen, waar nodig. In verschillende landen werd ondertussen een systeem van elektronische logbooks opgezet wat een zeer stringente opvolging mogelijk maakt en meer betrouwbare statistieken beschikbaar zou maken.	x	x		
De regelgeving in Vlaanderen en de andere gewesten is niet altijd even strikt of wordt niet altijd op dezelfde manier nageleefd. Dit ondermijnt de meeste strikte regelgeving. Een betere afstemming tussen de gewesten zou hieraan tegemoet komen.	x	x	x	x

CHAPTER 1 Introduction

This report consists of 4 sections:

- In the **introduction** we present a concise overview of the applicable existing legislation.
- The **methodology**, which presents a detailed overview of the approach that was followed to collect the necessary information.
- The **results**, which provides and overview of the stakeholder consultation and online survey, the case studies and the disposal emission factors
- The **conclusions and policy recommendations** sections addresses the two objectives of this study: the evaluation of the disposal emission factors for the different applications under investigation and a number of policy recommendations to reduce disposal emissions.

1.1. BACKGROUND

Fluorinated greenhouse gases (F-gases) are a group of gases including HFCs, PFCs, and SF6. They are most commonly used in refrigeration, air conditioning and heat pump applications. Emissions of F-gases contribute to 2,6% of all Kyoto greenhouse gas (GHG) emissions in Flanders (in CO_2-eq.) [Altdorfer and Dauwe, 2018]. F-gas emissions have been increasing throughout the EU in the last decades, although in 2015 and 2016 emission levels in the EU appear to have stabilized, and are therefore considered "key category" for the national GHG emission reporting. Reducing emissions by reducing leakages from existing installations and the recovery of F-gases from end-of-life (EoL) equipment and by shifting to natural refrigerants or gases with a lower global warming potential, are appropriate ways to reduce these GHG emissions. Significant F-gas emission reductions and a move to alternatives with lower climate impact is also required by existing EU legislation [EU, 2014] and the Kigali Amendment to the Montreal Protocol.

This study investigates into greater detail emissions resulting from the decommissioning[1], dismantling and end-of-life treatment of four types of refrigeration and air conditioning equipment:

- Hermetically sealed, small commercial refrigerators such as refrigerated vending machines, refrigerated showcases.
- Air conditioning and heat pumps with one outdoor and one or more indoor units.
- Stationary commercial and industrial refrigeration equipment.
- Maritime reefers.

Emissions of F-gases can occur at different stages of equipment use: at manufacturing, during the use and at disposal. While the total fugitive emissions during the lifetime of equipment are still the largest source (see Figure 2), decommissioning of equipment containing F-gases will increasingly be important. From a policy perspective, understanding emissions arising during decommissioning is therefore very important. This is particularly the case because existing policies at EU and regional

[1] decommissioning means the final shut-down and removal from operation or usage of a product or piece of equipment containing fluorinated greenhouse gases (following EU regulation 517/2014).

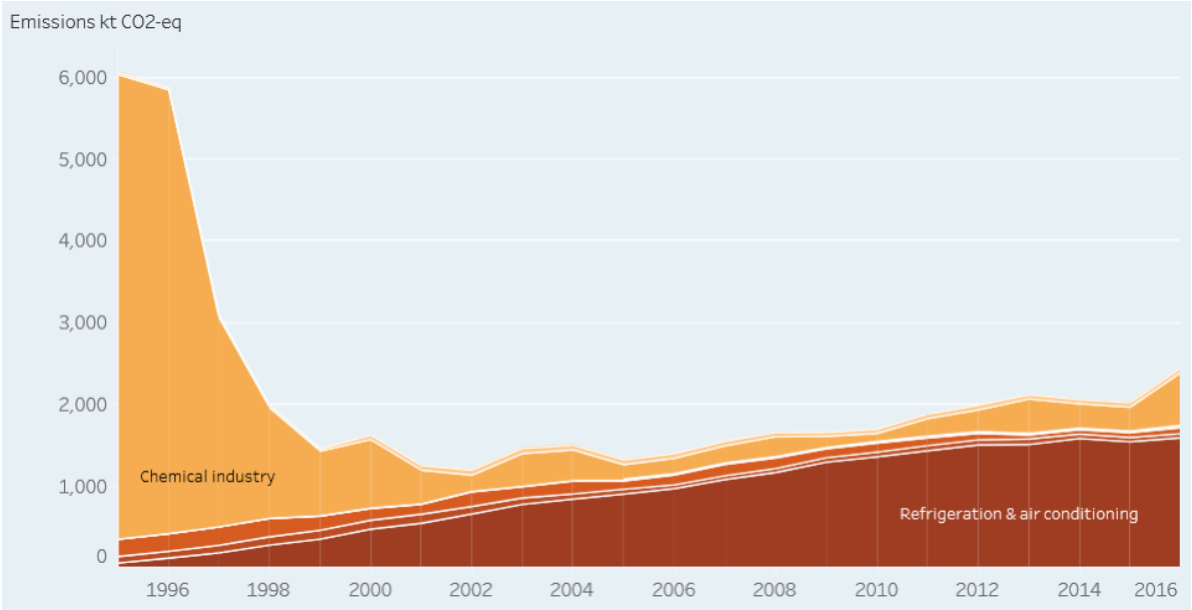
level are expected to have an impact on disposal emission factors. Regulations on the recovery of F-gases as well as increasing economic incentives due to rising prices resulting from the cap on F-gases placed on the market are likely to result in higher amounts of recovered gases.

1.2. EMISSIONS OF F-GASES IN FLANDERS

HFC, PFC and SF6 emissions in Flanders totaled 2446 kt CO2-eq in 2016. This is a decrease of 2850 kt CO2-eq since 1995. The most important sources of F-gas emissions in Flanders are the chemical industry, large commercial and industrial installations, room air conditioning and heat pumps. Important decreases in the emissions of F-gases have been achieved in the chemical sector in the second half of the 1990's.

Since the end of the 2000's emissions are slowly increasing again (Figure 1). This is caused by the switch from HCFCs and CFCs to HFCs in the fight against ozone-depleting substances, resulting in a huge increase of the use of HFCs in refrigeration. Additionally, demand for refrigeration and air conditioning also increased in Flanders. Both factor resulted in an increased bank of F-gases contained in different types of equipment and products, e.g. in commercial and industrial refrigeration, air conditioning of cars and other vehicles and room air conditioners and heat pumps.

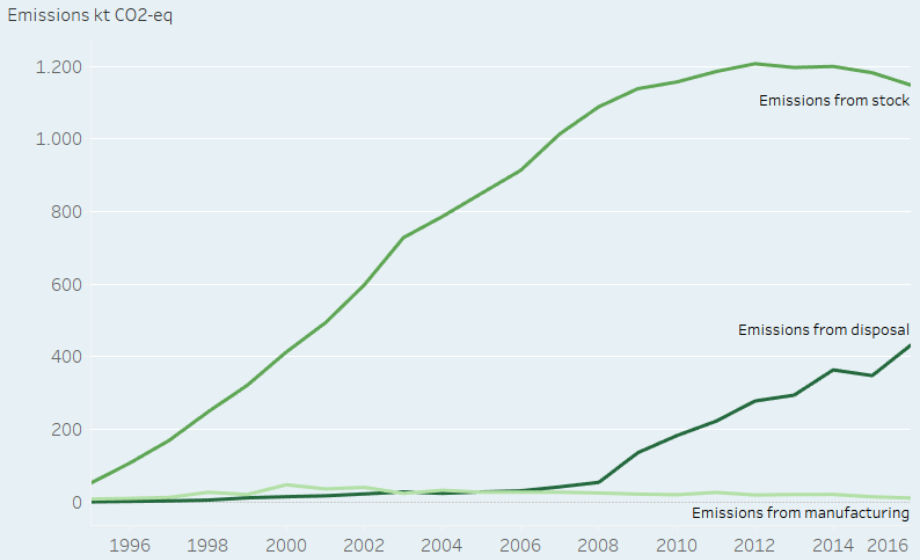
Figure 1. Emissions of F-gases in Flanders 1995-2016 (in kt CO2-eq.).



Source: [Altdorfer and Dauwe, 2018]

Policies at the European and Flemish level are slowly promoting the shift from high GWP F-gases to alternative gases in different sectors. For example, in residential refrigerators or car air conditioning systems, high-GWP F-gases are no longer allowed to be used. This is not yet visible in the emission levels in Flanders. One of the reasons is that while fugitive emissions from installations in operation are slowly starting to decrease, emissions from disposal are gaining in importance (Figure 2). More and more equipment containing F-gases are decommissioned resulting in increased disposal emissions. In the upcoming years, tackling and curbing disposal emissions will therefore become increasingly important to mitigate F-gas emissions.

Figure 2. Emissions of F-gases in Flanders 1995-2016 in the refrigeration and air conditioning sector (in kt CO2-eq.).



Source: [Altdorfer and Dauwe, 2018]

1.3. OBJECTIVES

The main objective of this study is two-fold:

- critical reflection on and evaluation of the current assumptions on disposal emissions of the four application types;
- policy recommendations to increase the recovery rate of F-gases from EoL equipment during the different stages of disposal.

1.4. OVERVIEW OF EU AND FLEMISH LEGISLATION

1.4.1. EU LEGISLATION ON EQUIPMENT CONTAINING F-GASES

Cooling and freezing appliances (domestic) represent one of the most relevant categories of Waste of Electric and Electronic Equipment (WEEE). In terms of waste flow, the amount of cooling and freezing appliances account for about 17,7 % of total WEEE produced in the European Union (EU) [Huisman et al., 2007].

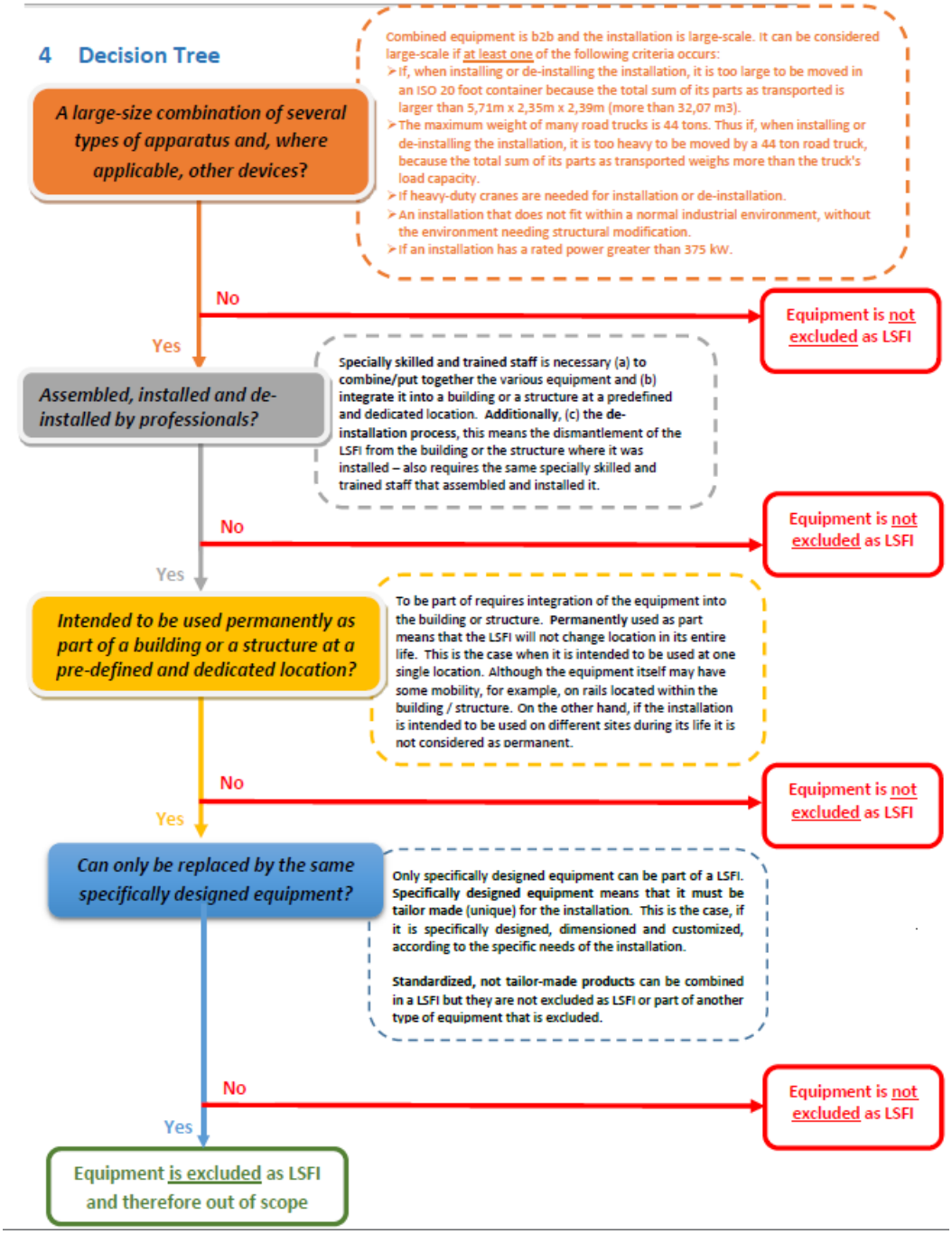
Various types of refrigerating appliances have entered within the scope of the waste legislation. Household cooling and freezing appliances (including refrigerators, freezers and air conditioning units) have been regulated by the WEEE Directive since 2002 [EU, 2002]. Thanks to the enforcement of this policy, the recycling of household refrigerating appliance has been well established in the EU. But the reference to 'household' in the headings of some waste categories of the WEEE Directive indicates that 'non-household' appliances are excluded from the scope. Also for air conditioning the scope differs depending on the country. Portable air conditioners were included in the scope of the WEEE, while for fixed installations this was not in all countries the case.

Consequently, the recycling of some categories of cooling appliances, as large commercial refrigeration appliances, has been developed differently by Member States of the EU. With the objective of harmonizing EoL treatments of WEEE across the EU, the recast of the WEEE Directive [EU, 2012] clearly stated that, starting from 15 August 2018, all the categories of electrical and electronic equipment will fall within the scope of the Directive. This will include all the types of commercial refrigeration equipment (plug-in type) such as refrigerated display cabinets, beverage coolers and ice cream freezers.

Article 2 of the WEEE Directive specifies the type of equipment that falls within the scope of the Directive. Up to 14 August 2018 this is restricted to ten categories, including large cooling appliances, refrigerators, freezers and other large appliances used for refrigeration, conservation and storage of food and air conditioner appliances (Table 1).

From 15 August 2018 the scope of the WEEE Directive is expanded to include all EEE, with several exceptions including large-scale fixed installations. These are defined in the Directive as "*large-size combination of several types of apparatus and, where applicable, other devices, which are assembled, installed and de-installed by professionals; are intended to be used permanently as part of a building or a structure at a pre-defined and dedicated location; and can only be replaced by the same specifically designed equipment*". This definition does not allow assigning broad types or classes of equipment to either category [DG ENV, 2012], but the European Commission does give some examples of types of equipment that could be considered large-scale fixed installations, including fixed installed cooling, air conditioning and refrigerating systems or heating systems designed exclusively for non-residential use. This is also further elaborated and clarified by the European WEEE Registers Network that could serve as guidance to identify large-scale fixed installations [EWRN, 2016]. To date however, a common understanding across all EU member states is missing which results in different implementations of WEEE by countries or regions.

Figure 3. Proposed decision tree for large-scale fixed installations exemption under the WEEE Directive.



Source: [EWRN, 2016]

Table 1. Categories of WEEE covered by the WEEE Directive.

Categories of EEE covered by the WEEE Directive during the transitional period (from 13 August 2012 to 14 August 2018):

1. Large household appliances (e.g. large cooling appliances; refrigerators; freezers; other large appliances used for refrigeration, conservation and storage of food; large appliances for heating rooms, beds, seating furniture; air conditioner appliances; other fanning, exhaust ventilation and conditioning equipment)
2. Small household appliances
3. IT and telecommunications equipment
4. Consumer equipment and photovoltaic panels
5. Lighting equipment
6. Electrical and electronic tools (with the exception of large-scale stationary industrial tools)
7. Toys, leisure and sports equipment
8. Medical devices (with the exception of all implanted and infected products)
9. Monitoring and control instruments
10. Automatic dispensers

Categories of EEE covered by the WEEE Directive (from 14 August 2018):

1. Temperature exchange equipment (refrigerators, freezers, equipment which automatically delivers cold products, air conditioning equipment, dehumidifying equipment, heat pumps, radiators containing oil and other temperature exchange equipment using fluids other than water for the temperature exchange)
2. Screens, monitors, and equipment containing screens having a surface greater than 100 cm 2
3. Lamps
4. Large equipment (any external dimension more than 50 cm) including, but not limited to:
5. Small equipment (no external dimension more than 50 cm) including, but not limited to:
6. Small IT and telecommunication equipment (no external dimension more than 50 cm)

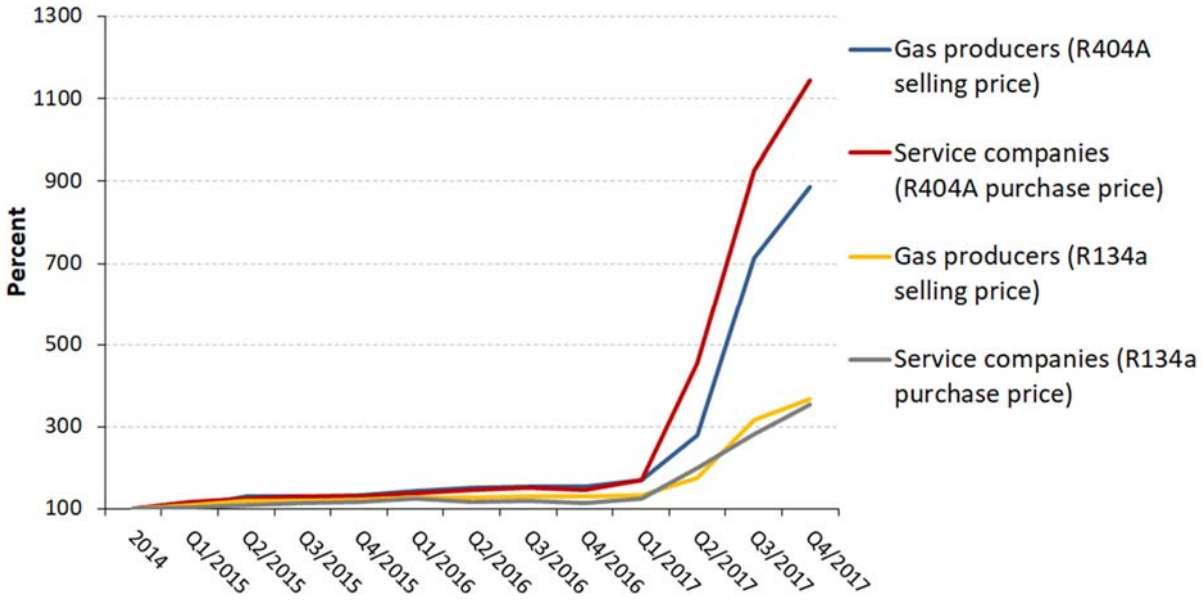
1.4.2. EU LEGISLATION ON F-GASES

Already under the EU ODS Regulation 2037/2000 Member States were required to remove ODS refrigerants from all types of refrigeration equipment before any EoL treatment [EU, 2000]. A recast of the ODS regulation was implemented in 2009. Also, the early and current F-gas regulations (842/2006 and 517/2014) require the removal of the F-gas refrigerant from EoL equipment for proper disposal. The F-gas regulation also obliges operators of stationary equipment and refrigerated trucks and trailers containing F-gases to ensure that the recovery of these refrigerants is carried out by certified technicians for recycling, reclamation or destruction (Article 8, Recovery).

The recovery of F-gases from each piece of equipment is to be documented by the operator in the equipment logbook (quantity and type of refrigerant recovered; the identity of the undertaking which performed this service and the number of its certificate; the measures taken to recover and dispose of the F-gases if the equipment is decommissioned (Article 6, Record keeping).

The F-gas Regulation also imposes a quota system for HFCs (Article 15, Reduction of the quantity of hydrocarbons placed on the market; Article 16, Allocation of quotas for placing hydrocarbons on the market). Although this does not directly influence disposal emissions, the quota system does have an important impact on the entire sector as it limits the supply for refrigerants and thus leads to price increases (Figure 4). The price signal reached all levels of the supply chain in 2017 and represents an intended effect of the regulation.

Figure 4. Impact of the HFC quota system on average R404a and R134a prices (price index, 2014 = 100%).



Source: [EU Commission, DG CLIMA, 2018]

The F-gas Regulation promotes recycling and reclamation of used refrigerants since they do not fall under the quota system and are thus not subject to the same price increases and supply limitations as virgin substances. Some have argued though that the EU F-Gas Regulation falls short when it comes to the waste management of used HFC refrigerants at EoL[2] [EIA, 2016]. The responsibility has thus fallen on national authorities to overcome this shortcoming, through the adoption of national producer responsibility schemes.

However, the amounts of refrigerants reported in the EU as "reclaimed" are still very low and range at <5% of the EU market [EEA, 2015; 2016]. This is caused by the fact that for some equipment types with an average lifetime of 15 years, disposal of installations containing F-gas is only just started. Reclamation of fluorinated gases in the EU has fluctuated, but there has been a steady increase since 2014. In 2016 the reclaimed amount doubled compared to 2015, an increase mostly caused by the reclamation of HFCs [EEA, 2017]. In addition, the amount that is recycled on site or by a refrigerant handler is not considered "reclaimed" and is not reported in these EEA figures.

1.4.3. FLEMISH LEGISLATION ON DISPOSAL OF EQUIPMENT

In Flanders, the WEEE Directive is transposed into national legislation in Article 1.2.1§2, 23° of VLAREMA. The categories of WEEE that are covered by the VLAREMA is listed in Table 2. As for the WEEE Directive, the legislation is also not applicable for certain types of equipment, including large-scale fixed installations, the definition of which needs to be aligned with the three regional governments.

[2] Article 8 of the F-gas Regulation actually contains no actual obligation to ensure that used HFC refrigerants are reclaimed or destroyed. It simply requires the operator to ensure (or arrange for) recovery "so that they are… reclaimed or destroyed" without placing the obligation on a specific stakeholder to do so.

WEEE is considered “dangerous waste”. Therefore, companies that want to store, sort and/or dismantle WEEE must comply with certain rules and regulations:

- For WEEE storage, at least an environmental permit class 2 is required. If more than 1 ton of WEEE is stored, an environmental permit class 1 is required.
- For processing, dismantling and removing dangerous components and parts, a class 1 permit to process dangerous waste is required.

Scrap-dealers with only a permit to store, sort and/or dismantle scrap waste are not allowed to accept WEEE.

Companies collecting and transporting WEEE should be registered as IHM (see below). Additionally, each transport should have and carry with it an identification form. Companies also should implement an internal quality system (intern kwaliteitsborgingssysteem) [OVAM, 2018].

The VLAREMA also includes a reporting obligation for all companies that collect, dismantle, process, recycle, and export WEEE. Producers and importers of EEE are obliged to report annual quantities of EEE placed on the market and WEEE collected. Reporting is done with the BeWeee reporting tool.

Table 2. Categories of WEEE covered by the VLAREMA.

1. Large household appliances (e.g. large cooling appliances; refrigerators; freezers; other large appliances used for refrigeration, conservation and storage of food; large appliances for heating rooms, beds, seating furniture; air conditioner appliances; other fanning, exhaust ventilation and conditioning equipment; from 1/7/1999)
2. Small household appliances (From 1/7/1999)
3. IT and telecommunications equipment (From 1/7/1999)
4. Consumer equipment (From 1/7/1999)
5. Photovoltaic panels (From 1/1/2013)
6. Lighting equipment (From 1/1/2004 and 1/7/2005)
7. Electrical and electronic gardening tools (from 1/1/1999)
8. Electrical and electronic tools (with the exception of large-scale stationary industrial tools, from 1/1/2004)
9. Toys, leisure and sports equipment (From 1/1/2004)
10. Medical devices (with the exception of all implanted and infected products, from 13/8/2005)
11. Monitoring and control instruments (From 1/1/2004)
12. Automatic dispensers (From 13/8/2005)
13. Professional WEEE (From 13/8/2005)
14. All WEEE not included in the categories above (From 15/8/2018).

1.4.4. FLEMISH LEGISLATION ON DISPOSAL OF F-GASES

Transport of F-gases

F-gases are considered “dangerous substances” and therefore transport of gases is regulated. The EU directive 2008/68/EC regulates international transport of dangerous products in the EU. Since 2015 these services have been regionalized.

The VLAREMA specifies that all transport of waste should comply with several principles:

1) all waste shall be packaged properly;

2) waste that will be handed in separately will also be transported separately, this applies specifically also to non-dangerous and dangerous waste;
3) it is prohibited to dilute waste;
4) all transport shall be accompanied with an identification form (with a number of exceptions, see below).

Whoever wants to transport waste in Flanders commercially needs to be registered as a waste transporter. Who also wants to collect and manage waste needs to have a registration as collector and processor of waste ("IHM"). Registration is in some cases not required, e.g. when transporting own waste or when transporting waste generated during servicing or maintenance. This means that sometimes F-gases (or equipment containing F-gases) collected during EoL can be transported without registration, either to a registered collector and processor of waste or to the servicing company. Waste can also be stored at the owner or the servicing company without additional registrations. In Annex more detailed information on this topic can be found (in Dutch).

Import and export to and from Belgium is regulated in the EU Directive (1013/2006/EC) and thus requires a written notification and consent of the competent authorities. Importing waste into Flanders is only allowed if the company is registered as transporter. However, companies registered in the Brussels Capital Region, in the Walloon Region or in any EU country as transporter can transport waste to and from Flanders. For companies collecting and managing waste, a registration as IHM in Flanders is mandatory (registrations in other regions or EU countries is not sufficient).

VLAREM

Flemish legislation controlling the use and handling of F-gases transposes the requirements laid down in the European F-gas Regulation. Article 5.16.3.3. stipulates that the installation, maintenance, repair and decommissioning of stationary refrigeration containing F-gases (or ODS) must be performed by certified technicians from certified companies. Performing leak checks (corresponding with article 4 of the F-gas regulation) and recovery of F-gases must be performed by certified technicians. In the Flemish region there are approximately 165 certified companies and over 3000 certified technicians (category I, II, III or IV[3]) [LNE, 2016].

F-gases must be recovered from disposed installations within one month. This must be done with the appropriate equipment, by certified technicians and F-gases must be recovered in marked containers. For installations that require a logbook, information on the measures that have been taken to remove and recover F-gases during disposal and information identifying the technician who performed these activities must be recorded.

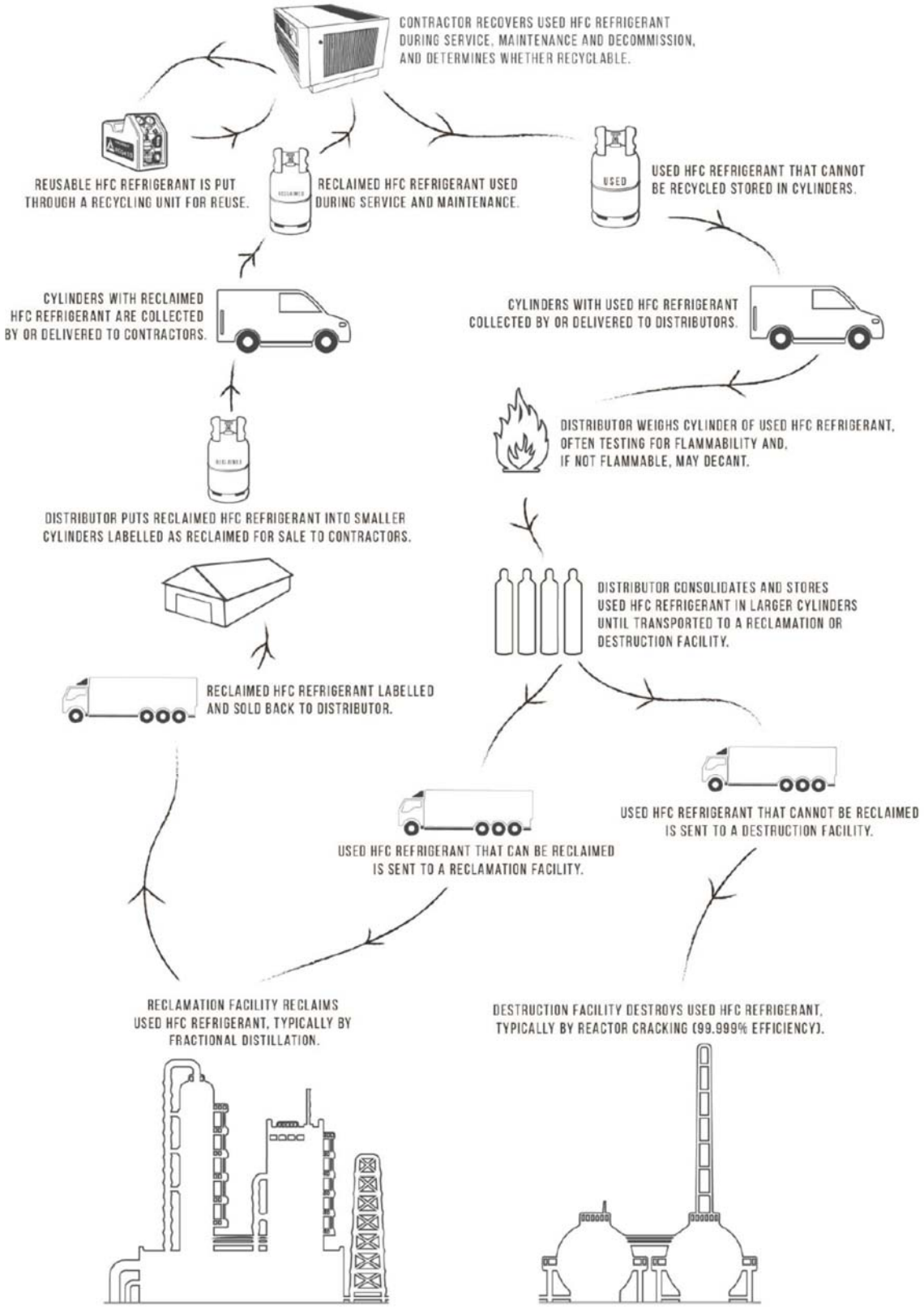
The action plan on F-gas emissions

In 2016 the Flemish government published the action plan on F-gas emissions [LNE, 2016]. In this action plan, Department LNE, proposes additional measures to reduce the emissions from F-gases. The action plan covers all major emission sources in Flanders, including the chemical industry, stationary and mobile refrigeration and switch gear. Most actions are directed towards stationary

[3] Category I: all manipulations, Category II: leakage checks and other manipulations up to 3 kg fill weight (6 kg hermetically sealed equipment), Category III: recovery up to 3 kg fill weight (6 kg hermetically sealed equipment), Category IV: leakage checks.

refrigeration though. The instrument types that are proposed are diverse ranging from increasing information and education, enhancing enforcement of the existing legislation and financial support via the EFRO program and ecology premium. The action plan does not encompass measures specifically targeted to reduce disposal emissions (except for SF6 from switch gear). Most additional measures are aimed to minimize leakage of F-gases during the lifetime of refrigeration installations and to enhance the market penetration of alternative refrigerants in commercial and industrial cooling.

Figure 5. Waste management cycle of F-gas refrigerants.



Source: Environmental Investigation Agency, 2016

CHAPTER 2 Methodology

2.1. CHARACTERISING THE TYPE OF EQUIPMENT

In the following, the four equipment categories this report if focusing on are described in detail.

Hermetically-sealed commercial refrigeration	
Description	Commercial hermetically-sealed refrigeration includes for instance upright freezer with glass/transparent door, ice cube machine and refrigerated showcases. Only equipment types that Recupel considers to be commercial (rather than domestic) is included. Typical refrigerant charge: 0,5 – 1 kg. Common refrigerants: R404A, R134a, hydrocarbons.
Typical owner of installation	Small and large retailers, hospitals, restaurants, hotels, etc.
Disposal of equipment	Small hermetically-sealed commercial refrigeration needs to be collected via a recycling company (list available on the Recupel website).
Recovery of the gases	At a WEEE dismantling plant (for example by Coolrec).
What is done with gases	Recycled, reclaimed or destroyed.

Air conditioning and heat pumps	
Description	Split and multi-split air conditioning and heat pumps. No movable or window air conditioning equipment is included under this category. Typical refrigerant charges: Single split AC: 1,5 kg. Multi-split AC: 10-15 kg. Heat pumps: 2,6 kg. Common refrigerants: R410A. R32 is slowly entering the market, in particular in split and multi-split AC, although the F-gas quota could contribute to speed-up this transition.
Typical owner of installation	Residential and commercial sector.
Disposal of equipment	Recovery of F-gases is mandatory and needs to be compliant with the VLAREM regulation (Article 5.16.3.3).
Recovery of the gases	Gases need to be recovered within one month by certified technician from certified companies either on site or at recycling plant.
What is done with gases	Recycled, reclaimed or destroyed.

Commercial and industrial refrigeration	
Description	Large commercial and industrial refrigeration, non-hermetically sealed. Filled and serviced mostly on-site. Typical refrigerant charges: Ranging from small quantities to several hundred kilograms to tons. Typical refrigerants: Commercial centralized systems: R404A, R134a, increasingly R744 and HFC-HFO blends. Industrial systems: R717 (NH3), R134a, R404A.
Typical owner of installation	Commercial sector (large retailers) and industry.
Disposal of equipment	Disposal needs to be compliant with the VLAREM regulation (Article 5.16.3.3) concerning recovery of F-gases.
Recovery of the gases	Gases need to be recovered within one month by certified technician from certified companies.
What is done with gases	Collected and recycled, reclaimed or destroyed.

Maritime reefers	
Description	Cooled containers for maritime transport, equipped with an integral refrigeration unit. Typical refrigerant charge: 3,8-5,3 kg. Typical refrigerants: R134a (worldwide 85%), R404A (worldwide 15%).
Typical owner of installation	Transport companies or specialized firms that rent out reefers to transport companies.
Disposal of equipment	By maintenance firms, specialised in maritime reefers.
Recovery of the gases	By maintenance firms, specialised in maritime reefers.
What is done with gases	Collected and recycled, reclaimed or destroyed

2.2. GENERAL APPROACH

To collect the necessary information to achieve the objectives listed above, two approaches are used:

1) Information will be collected from online surveys and telephone interviews with different actors involved in the disposal of EoL equipment. The interviews and surveys will be tailored to the sector and/or equipment type. Because for small hermetically sealed commercial refrigeration and maritime reefers the number of actors is more limited only interviews will be scheduled.
2) Case studies have been developed for Germany, the Netherlands, and France.

2.3. INTERVIEWS

19 relevant stakeholders from 19 different companies were interviewed:

- covering each of the four equipment types (i.e. hermetically sealed commercial refrigeration, maritime reefers, commercial and industrial refrigeration and air conditioning and heat pumps)
- active in different stages of the disposal process (manufacturers, owners, installation and maintenance companies, recycling and disposal, and F-gas suppliers).

Not all steps are relevant for each of the type of equipment. Additionally, governmental organisations (for example, OVAM) were interviewed as well. This will help to identify if and what the specific problems are in each step of the process. In setting up the interviews a balance between large and small companies, for example large retailers versus small independent shops, was also maintained.

Telephone interviews with the different identified actors were scheduled March to May 2018. The date for the interviews was set-up with each actor via email and a list of preliminary questions was forwarded so that the contact person was aware of the questions asked during the interview. The telephone interview was organized around this set of scripted questions (tailored to the contact person) complemented with follow-up questions.

2.4. ONLINE SURVEY

We made an online survey in SurveyMonkey distributed by UBF-ACA to their relevant members and Departement Omgeving. The survey focused on only two equipment types: commercial and industrial refrigeration, and air conditioning and heat pumps. For hermetically sealed commercial refrigeration and maritime reefers an online survey is less suited because the quantities of emissions from disposal are smaller and the disposal processes appears to be much more straightforward than for commercial and industrial refrigeration and for air conditioned and heat pumps.

The survey consisted of three parts:

1) General information of the respondent;
2) Questions relating to the current situation of disposal;
3) Questions relating to potential improvements.

The survey included 16 questions and can be found in the Annex at the end of the report.

The survey was closed on 14 May and there were 97 respondents at that point in time.

2.5. CASE STUDIES

For three countries, the Netherlands, Germany and France, case studies were developed based on literature search. The principal objective of the case studies is to provide insight into the legislation in neighbouring countries concerning this topic. The outcome feeded into drafting policy recommendations. The structure of the case studies is:

1) Emissions and emission factors from disposal of the four equipment types: a concise description of the four sectors in each country. Where this is available, quantitative data will be given on disposal emissions and emission factors used for each sector.
2) Disposal process of the equipment types: gives an overview of the main actors involved in the disposal process of the equipment types, where available.
3) Policies and measures: an overview of implemented policies and measures to improve the recovery of F-gases from dismantled equipment. This includes instrument types that are used by national governments such as regulations, voluntary agreements, information campaigns, education via certification, … This also includes an analysis of the barriers within the countries that have hampered the recovery of F-gases from the selected equipment types, where available.

Additional to the case studies, the results provide a comparison between the three countries and the Flemish situation, identifying elements that are effective and what are lessons learned that could be useful for the policy recommendations. This was supplemented with a wider literature search of best practices.

Information sources that were used for the case studies are:

- Reporting to the UNFCCC, for example the NIR and the GHG inventories;
- Specific national studies and assessments regarding the recovery and treatment of refrigerants;
- Possibly statistical information on the recovery and treatment of F-gases;
- Company publications on e.g. take-back systems for EoL equipment.

2.6. DETERMINATION OF DISPOSAL EMISSION FACTORS

Based on the surveys and interviews it will not be possible to determine a very accurate disposal emission factor for each of the equipment types. For this, more detailed statistics on the stock of F-gases, F-gases in dismantled installations, recovered quantities, etc. per type of equipment would be needed. The objective is therefore to assess the appropriateness of the current assumptions on disposal emission factors based on the expert's opinion and expected future trends in disposal emission factors.

For installations a mass balance approach is used to estimate emissions. The potential adoption of new disposal emission factors therefore would have an impact on for example the calculated amounts for 'in systems at time of disposal' and 'amounts put into new systems'. Ultimately it will affect the amount of the refrigerant stock and operation emissions. The impact on the overall emission level is therefore more difficult to predict. To assess the impact of potentially adjusted

disposal emission factors on F-gas emissions, the emissions for the year 2016 were recalculated based on the adjusted emission factor. This will give an indication of the impact on overall F-gas emissions.

2.7. FORMULATING POLICY RECOMMENDATIONS

Policy recommendations were formulated to improve the recovery of F-gases at different steps in the decommissioning process: from emptying the equipment to reuse or destruction of F-gases by a recovery company. These policy recommendations:

- Start from the information from the data collection to identify where (applications and sectors) and when (emptying of equipment, transport, recycling, reclamation, destruction) the main losses occur that result in the most important emissions. The interviews also identified what the current most important barriers are for more effective recovery. This will help in identifying the specific actions most likely to have the biggest impact.
- Consider the actions listed in 'VLAAMS ACTIEPLAN REDUCTIE UITSTOOT VAN F-GASSEN 2015-2020' which already includes a number of policies and measures that have been and will be taken to reduce emissions of F-gases.
- Are based on input and insights from the online survey and interviews. During the interview dedicated questions on potential improvements to the decommissioning process and policy interventions were asked to all actors. This will feed directly into the policy recommendation task.
- Draw evidence from the case studies from neighbouring countries on policies and measures to improve recovery of F-gases and potential good practices.

CHAPTER 3 Results

3.1. INTERVIEWS

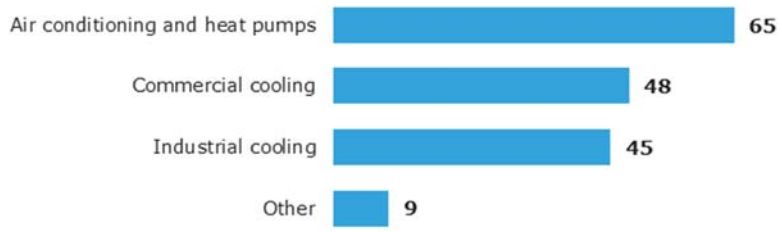
The results and outcomes of the stakeholder consultation are directly integrated into the conclusions and policy recommendations.

3.2. ONLINE SURVEY

3.2.1. RESPONDENTS

In total 97 persons responded to the questionnaire, split over the different sectors (Figure 6). The sector “other” was reported several times, with responses relating to higher education (i.e. respondents were instructors or teachers), the chemical sector, process cooling, etc.

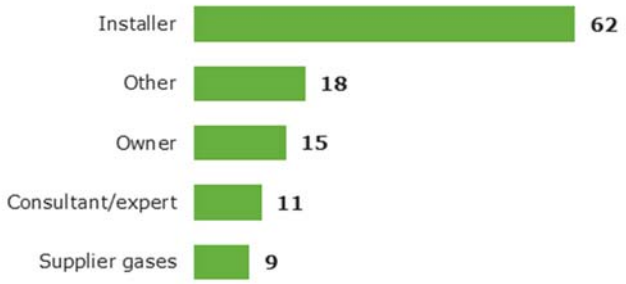
Figure 6. Number of respondents per sector.



Source: Own analysis, 2018.

Concerning the respondents per type of activity, the clear majority of respondents were installers of air conditioning, heat pumps and commercial and industrial refrigeration. The category other included manufacturers, importers and distributors of equipment (Figure 6). Because of the sample size, a split between activity type is considered only for installers and one group including all other activities.

Figure 7. Number of respondents per activity.



Source: Own analysis, 2018.

3.2.2. THE QUANTITY IN EQUIPMENT AT EOL

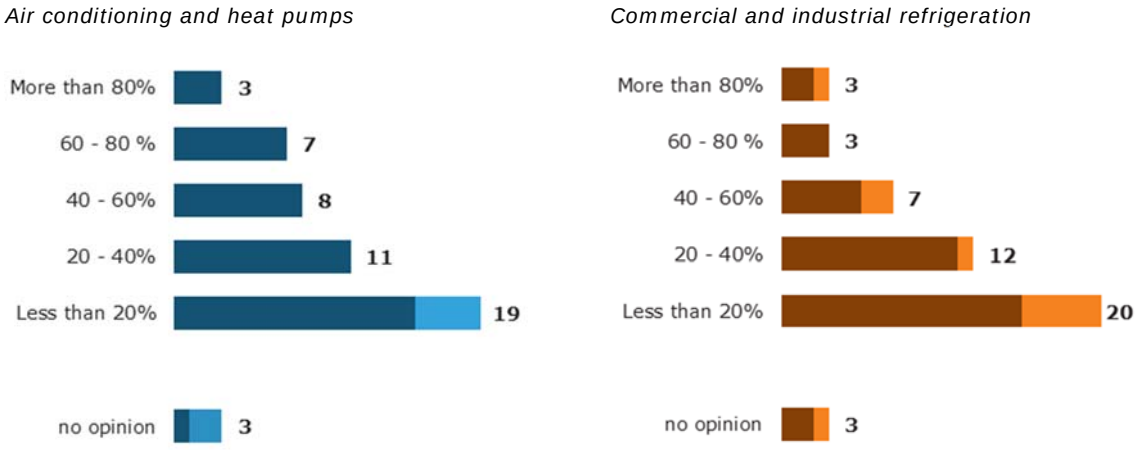
Most respondents indicated that a small share of the installations is completely empty at EoL (Figure 8). “Less than 20%” was the most popular response for both types of installations, while “more than 80%” was a rarely chosen response. This was independent of the activity of the respondents. Nevertheless, more than 50% of the respondents replied that 20% or more installations is empty at EoL. Respondents specified several reasons for empty installations:

- “generally air conditioning is only replaced after major problems, with often major leakage of refrigerants”;
- “non-qualified people dispose of equipment often, releasing refrigerants intentionally often done by demolition or renovation companies”;
- “owners are not willing to pay for the recovery of the refrigerants, postponing disposal”

On the other hand, respondents also mentioned that:

- “all installations are part of service contract ensuring correct follow-up and limited loss of refrigerants at EoL”
- “in order to be operational, the load in the installation should be close to the nominal load”.

Figure 8. What is the share of installations that are (almost) completely empty at EoL.

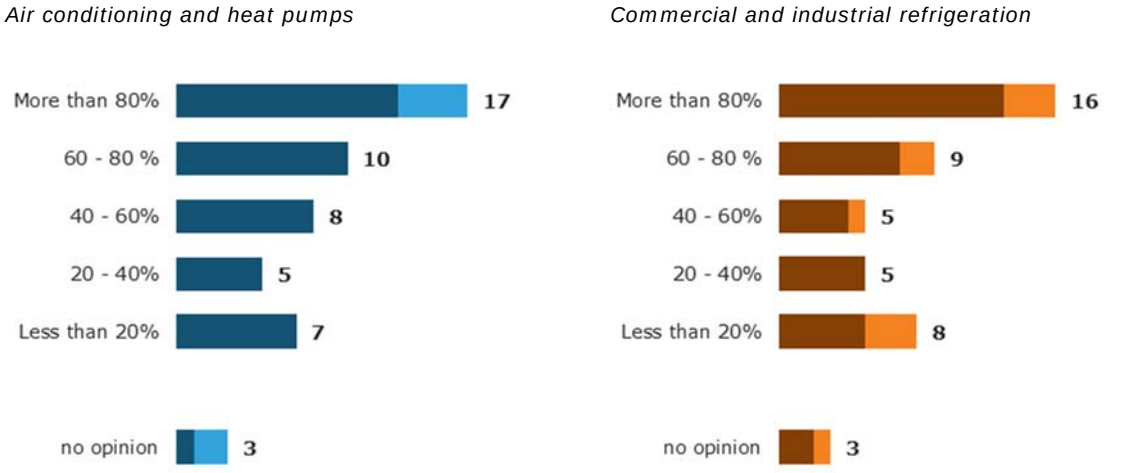


Note: Dark: responses from installers, Light: responses from other activity categories.

Source: Own analysis, 2018.

Most respondents replied that installations are still largely, more than 80% of initial charge, filled at EoL (Figure 9). This is again consistent for both types of installations considered and for installers and other activities. Interestingly, the second most popular response is at the other end of the spectrum, less than 20% of the initial charge being in the installation at EoL. This seems contradictory and comparing responses on this and previous questions could shed some additional context (Figure 10). This shows that people responding that installations contain only a small share of the initial charge at the EoL also responded often that a small share of installations are empty at EoL. This could be interpreted as: only a small share of installations is completely empty, but the quantity of refrigerant remaining in the installation is on average small. The most popular combination of responses is however that most installations are not empty and still have most of the initial charge of refrigerants.

Figure 9. What is the share of refrigerants in installations at EoL (compared to quantity originally in the installation, excluding installations that are completely or almost empty).



Note: Dark: responses from installers, Light: responses from other activity categories.

Source: Own analysis, 2018.

Figure 10. Relationship between responses to the share of installations that are (almost) completely empty and the share of refrigerants in installations at EoL.

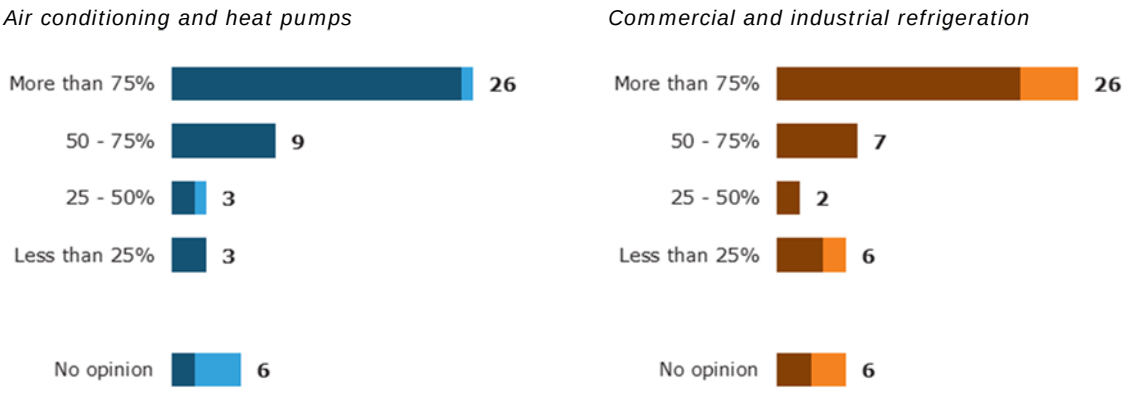
share of refrigerants in installations at EoL	More than 80%	60 - 80 %	40 - 60%	20 - 40%	Less than 20%	no opinion
no opinion	0	0	0	0	4	6
Less than 20%	3	4	1	0	16	0
20 - 40%	4	7	5	3	0	0
40 - 60%	0	1	5	8	0	4
60 - 80 %	0	0	10	13	13	0
More than 80%	3	2	6	18	34	0
	share of installations that are (almost) completely empty at EoL					

Note: Dark: responses from installers, Light: responses from other activity categories.

Source: Own analysis, 2018.

The recovery efficiency of refrigerants from installations at EoL is reported to be high (more than 75%) in most cases, irrespective of the installation type or the activity (Figure 11). Out of the three questions under this section, the responses to this question were the most similar. More than 60% replied that more than 75% of the refrigerants in EoL installations is recovered.

Figure 11. What is the recovery efficiency of refrigerants from installations at EoL (compared to quantity in the installation at EoL)?



Note: Dark: responses from installers, Light: responses from other activity categories.

Source: Own analysis, 2018.

3.2.3. DIFFERENCES IN RECOVERY AT EOL

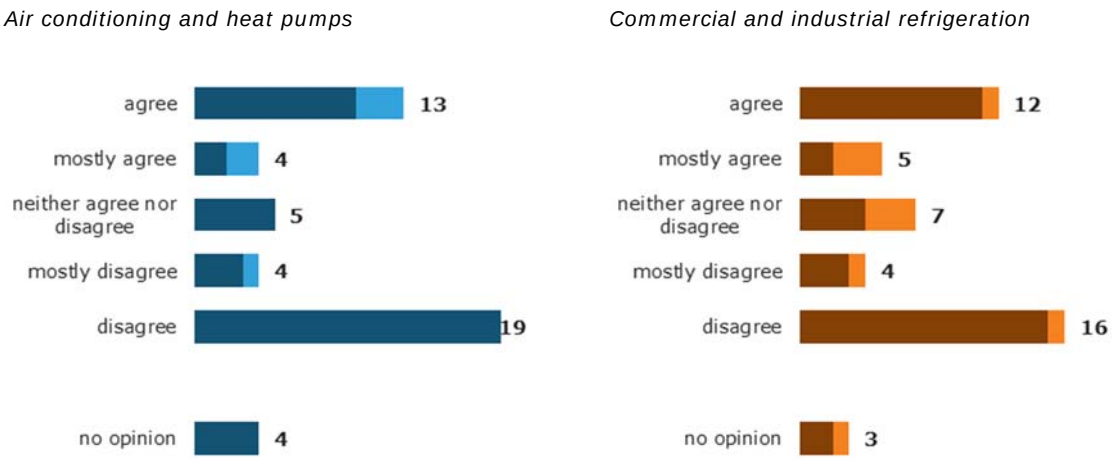
The survey also asked whether respondents think if there are differences in recovery efficiency depending on the characteristics of the installation (Figure 12). Concerning the size or type of installation (commercial versus industrial or commercial versus residential) the responses are very split and almost as many people responded that there are no differences as there were people who responded that there are differences.

Respondents agreeing mentioned the higher environmental awareness at larger companies and industry; better maintenance of larger installations; for large installations disposal is done by

certified technicians which is not always the case for small installations, and; for smaller installations recovering refrigerants is relatively more time consuming.

On the type of refrigerant gases, responses where clearer and showed that a majority of respondents think that there are differences in recovery efficiency depending on the type of gas (Figure 13).

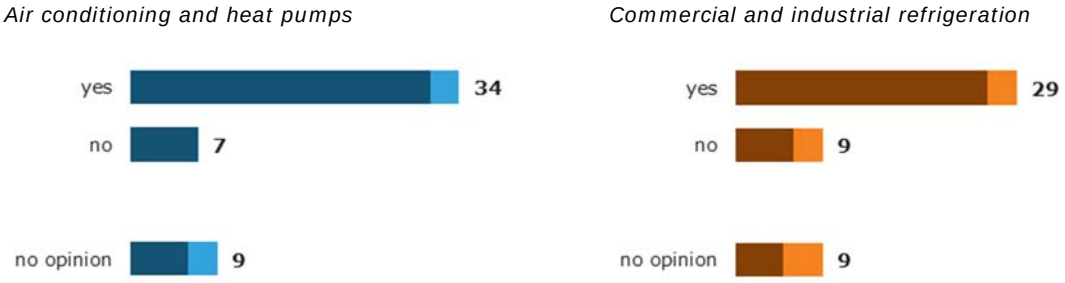
Figure 12. There are differences in the recovery depending on the size and type of equipment?



Note: Dark: responses from installers, Light: responses from other activity categories.

Source: Own analysis, 2018.

Figure 13. Are there differences in the recovery depending on the type of F-gas?



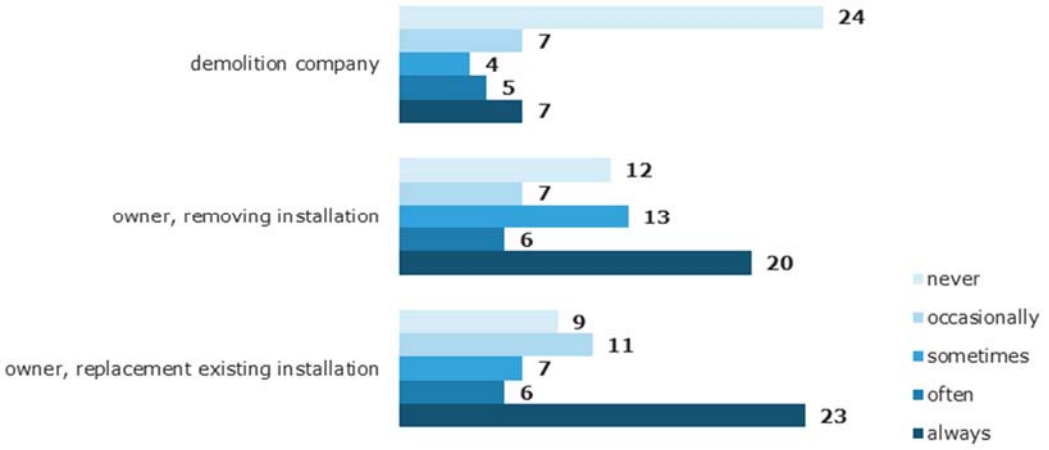
Note: Dark: responses from installers, Light: responses from other activity categories.

Source: Own analysis, 2018.

3.2.4. RECOVERY OF REFRIGERANTS

The survey also looked at the recovery of refrigerants. A first question asked who initiated the recovery of the gases. Installers responded that “owners of installations are not informed and not interested in recovery, we have to convince them” and “my client is an industrial company and they monitor meticulously that I comply with the legislation”. An owner of refrigerant installation reported that “we take our responsibility”.

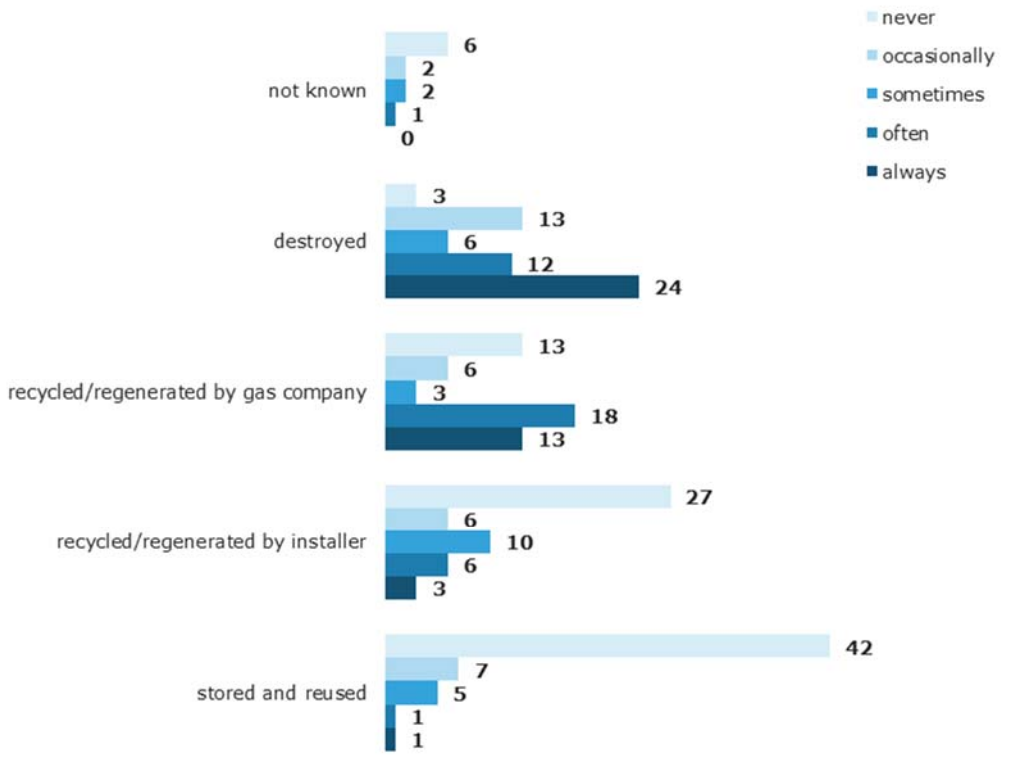
Figure 14. Who asks for the recovery of refrigerants?



Source: Own analysis, 2018.

Respondents replied that recovered refrigerants are never or only occasionally stored and reused on site or recycled by the installer (Figure 15). Respondents indicated that in most cases refrigerants are either returned to gas companies for recycling/regeneration, reclamation or destruction.

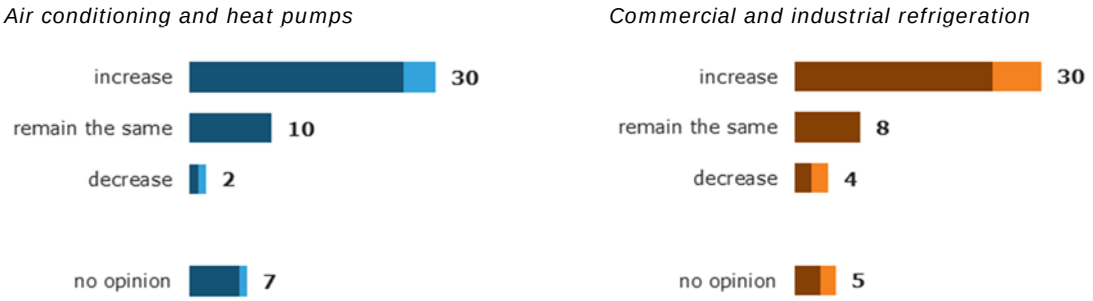
Figure 15. What happens to recovered refrigerants?



Source: Own analysis, 2018.

The online questionnaire asked the respondents whether they think the recovery of refrigerants will increase, stay the same or decrease in the upcoming five years (Figure 16). The responses show that for both types of equipment, most respondents think the recovery will increase, with increasing prices and quota as most cited reasons.

Figure 16. In the next five years, the recovery of refrigerants will…



Note: Dark: responses from installers, Light: responses from other activity categories.

Source: Own analysis, 2018.

3.2.5. POLICIES: COMPLIANCE AND ENFORCEMENT.

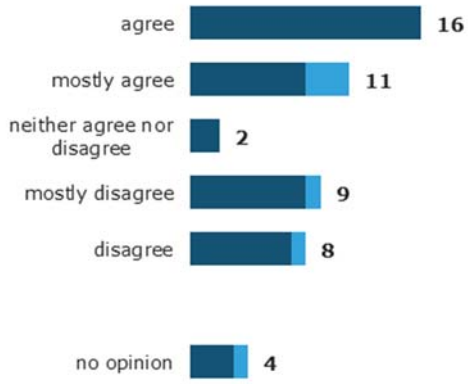
While most respondents think that the recovery of refrigerants is done according to and compliant with Flemish and EU legislation (Figure 17), the responses show mixed opinions. A significant share of the respondents think that recovery is not always done correctly for air conditioning and heat pumps (36%) and commercial and industrial refrigeration (24%).

Most respondents (more than 60%) believe that the existing legislation is however sufficient to guarantee effective recovery of refrigerants in both type of installations. Especially for the group of installers a large proportion agrees or largely agrees with the statement that the existing legislation is sufficient.

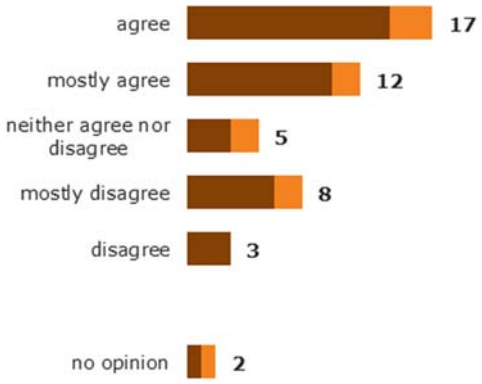
Respondents to the survey are more inclined to agree with the statement that enforcement of the existing legislation is not sufficient (Figure 18). Although there are still differences in opinion, the respondents appear to think more alike.

Figure 17. Is the recovery of refrigerants done in compliance with Flemish and EU legislation?

Air conditioning and heat pumps



Commercial and industrial refrigeration

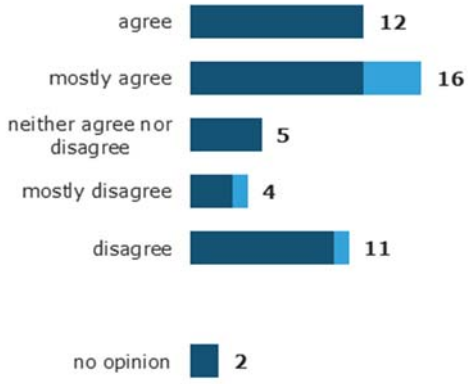


Note: Dark: responses from installers, Light: responses from other activity categories.

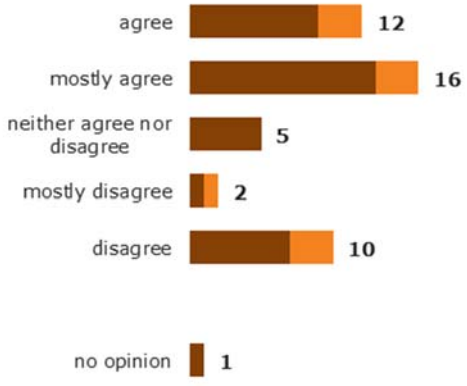
Source: Own analysis, 2018.

Figure 18. The existing Flemish and EU legislation is sufficient to guarantee the effective recovery of refrigerants?

Air conditioning and heat pumps



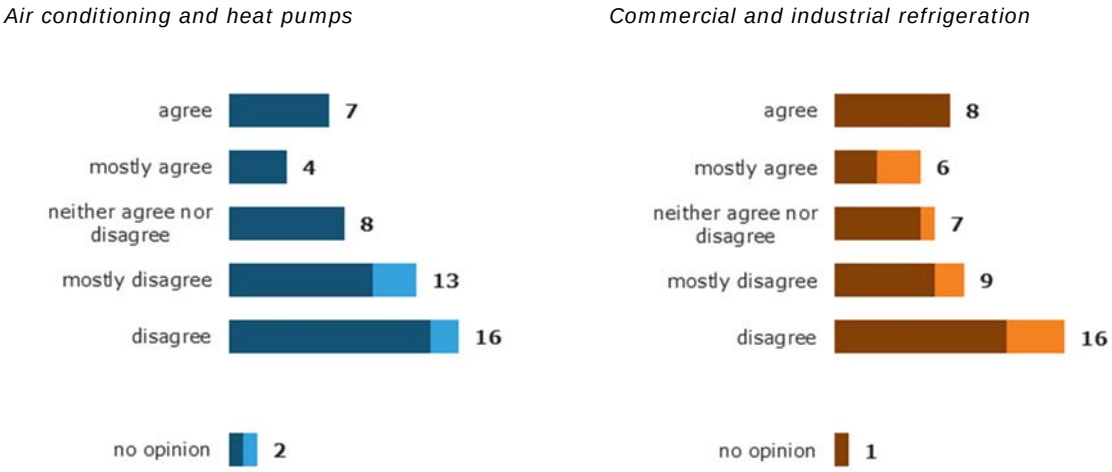
Commercial and industrial refrigeration



Note: Dark: responses from installers, Light: responses from other activity categories.

Source: Own analysis, 2018.

Figure 19. The enforcement (controlling) of the existing Flemish and EU legislation is sufficient to guarantee the effective recovery of refrigerants?



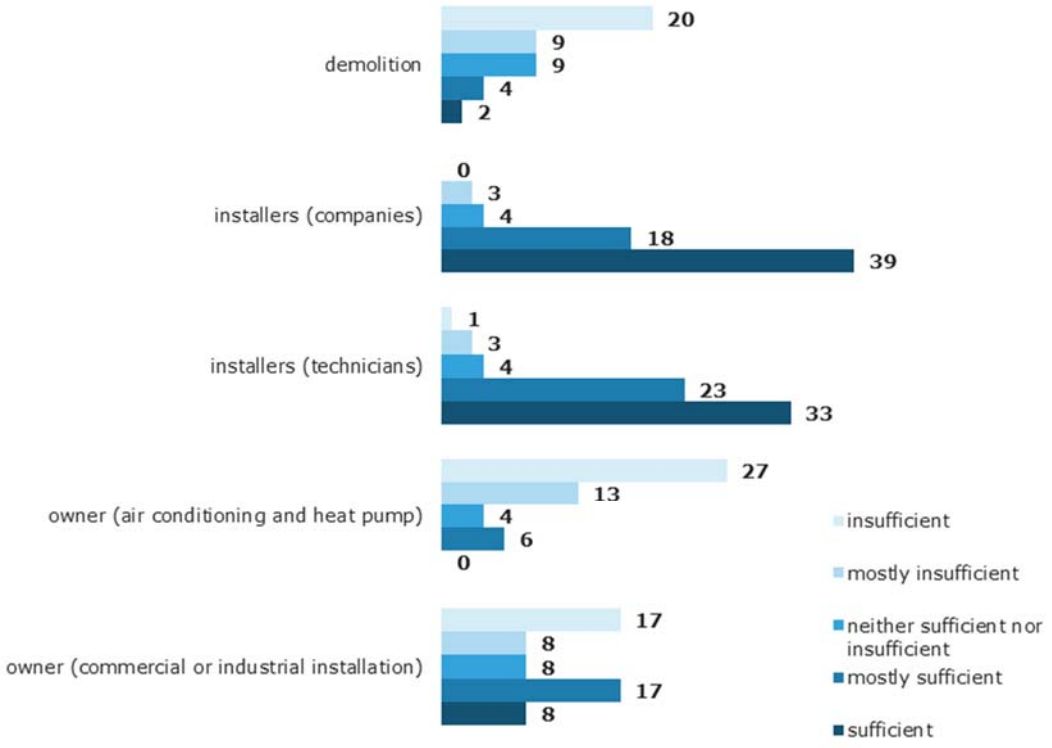
Note: Dark: responses from installers, Light: responses from other activity categories.

Source: Own analysis, 2018.

Most respondents to the survey replied that demolition companies and owners of air conditioning and heat pump installations have insufficient knowledge of the Flemish and EU legislation. Installers (both technicians and companies) on the other hand are reported to have sufficient knowledge of Flemish and EU legislation. Note however that most respondents are installers (62 out of 97 respondents; see Figure 5), which could lead to a biased result. The group of other respondents is too small to split this up and have meaningful results.

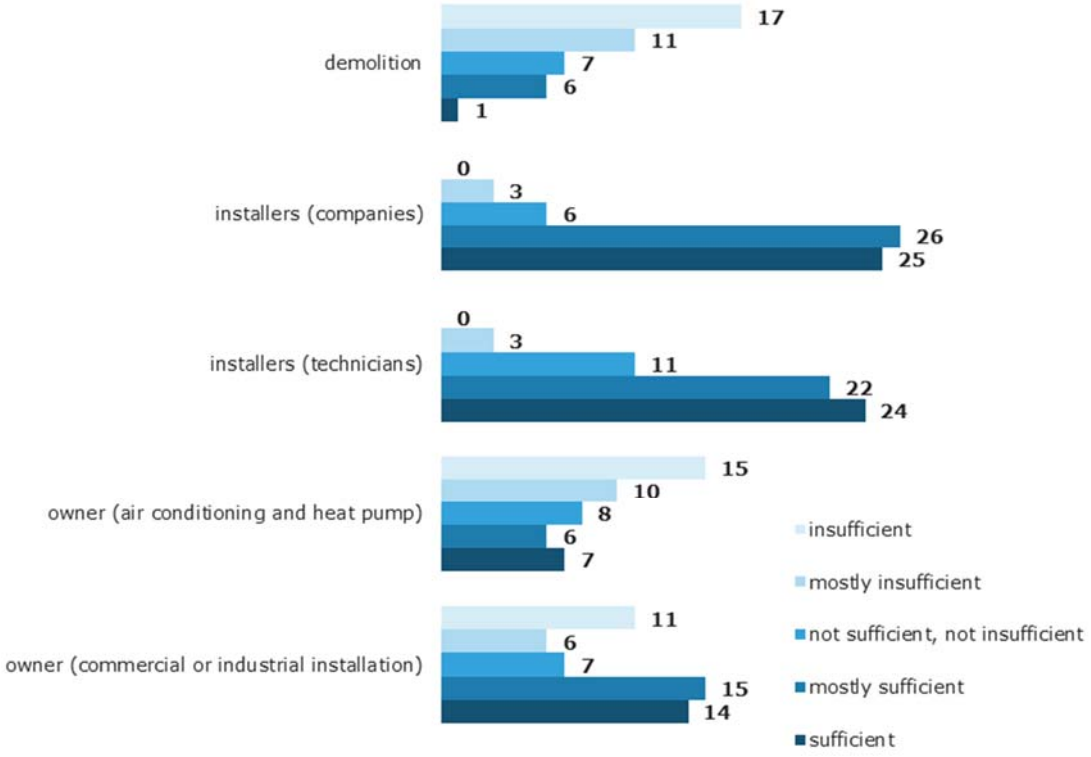
Similarly, as for previous question, demolition companies and owners of air conditioning and heat pump installations comply least sufficiently with Flemish and EU legislation. Installers (both technicians and companies) are again the two groups that score best.

Figure 20. Do the following actors have sufficient knowledge on the existing Flemish and EU legislation?



Source: Own analysis, 2018.

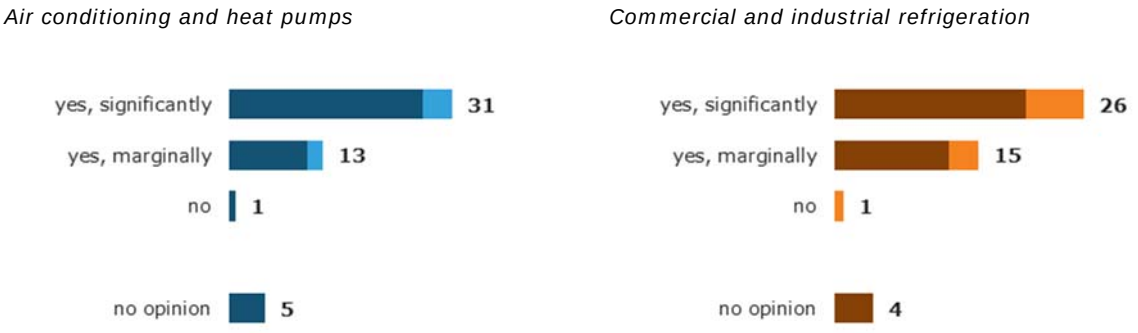
Figure 21. Do the following actors comply with existing Flemish and EU legislation?



Source: Own analysis, 2018.

Even though the opinion on the effectiveness of the current policies and measures differs among the respondents, almost all respondents believe that the recovery of refrigerants from EoL installations can be further improved.

Figure 22. Can the recovery of refrigerants further be improved?



Note: Dark: responses from installers, Light: responses from other activity categories.

Source: Own analysis, 2018.

3.3. CASE STUDIES

3.3.1. GERMANY

→ **Emissions and emission factors from disposal of the four equipment types**

In the German F-gas emission reporting disposal emission accounted for about 8% of the HFC emissions estimated for the refrigeration and air conditioning category (2.F.1) in 2015.

Hermetically sealed commercial refrigeration

In the German F-gas inventory this equipment type is reported under the commercial refrigeration subcategory (2.F.1.a). It relates to vending machines, bottle coolers, ice cream freezers and other types of small plug-in commercial equipment.

A general lifetime of 10 years and a recovery efficiency rate of 40% is assumed for this equipment type. The amount of refrigerant remaining in each unit at end-of life is set at 90% of the initial charge.

Industrial and commercial refrigeration

The commercial refrigeration subcategory (2.F.1.a) includes supermarkets, discounters as well as other commercial applications. The equipment lifetime is estimated at 14 years and the recovery efficiency rate at 75%.

The industrial refrigeration subcategory (2.F.1.c) is subdivided into various industries and based on their product output as well as the refrigeration capacity needed for the production. The equipment lifetime is set at 30 years and the recovery efficiency rate at 75%. The amount remaining in the system at EoL is estimated at 85% of the initial charge.

Air conditioning and heat pumps

The air conditioning subcategory relates to moveable units, single split systems, multi-split and VRF systems and heat pumps. Chillers form a separate subcategory.

For moveable and single split systems the lifetime is 10 years, for multi-split and VRF systems 13 years and for heat pumps 15 years. The recovery efficiency for moveable room air conditioners is 25%, for single split systems 40%, for multi-split systems 60% and for heat pumps 50%.

Maritime reefers

Reefer containers are reported in the transport refrigeration subcategory (2.F.1.d). Their lifetime is estimated at 12-15 years.

Table 3. Assumed recovery efficiency rates for various applications from literature.

	Clodic & Barrault 2011		Öko-Recherche 2011
	2006	**2030**	**2010**
Supermarkets: Centralized systems	80	80	75
Condensing units	18	60	60
Hermetically sealed systems in small shops	> 1	35	40
Food industry	79	80	75
Milk tanks	17	50	75
Other industrial processes	74	80	75
Mobile room air conditioners	2	30	25
Split air conditioners < 5 kW	5	20	40
Split air conditioners > 5 kW	5	50	40
Rooftop air conditioners (multi-split)	40	50	60
Scroll Chillers	43	80	75
Centrifugal Chillers	80	80	75
Heat pumps (heating only)	8	30	50

Source: [Schwarz et al 2011].

→ **Disposal process of the equipment types**

Generally, the waste streams for small, mass-produced appliances such as hermetically sealed commercial refrigeration appliances and small air conditioning units, differs from the end-of life treatment for large commercial and industrial refrigeration and cooling systems: For the smaller appliances collection, storage and EoL treatment is organized under WEEE schemes.

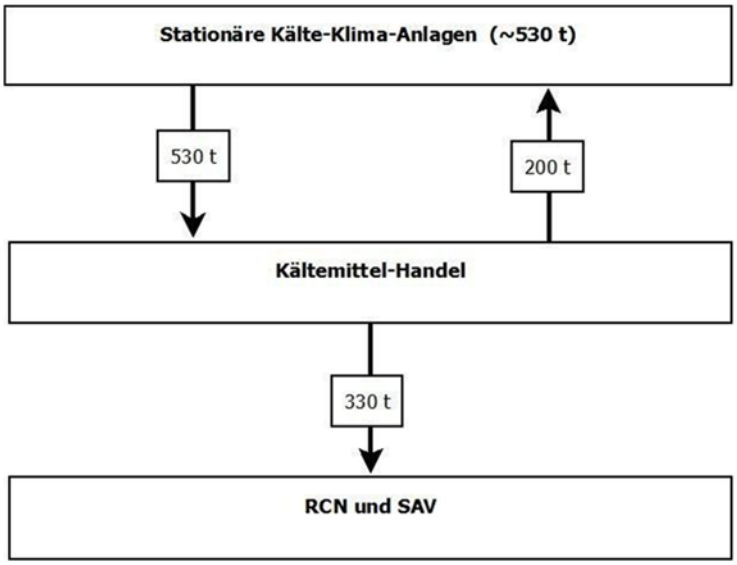
For the larger systems and units in commercial and industrial applications certified technical personnel is needed for the mandatory recovery of the refrigerant according to the F-gas Regulation. The recovered refrigerants are then immediately separately treated (for re-use, regeneration or final destruction).

The German Climate Protection Ordinance contains the obligation for producers, importers and distributors of refrigerants to take back recovered refrigerants for proper reclamation or disposal. This has resulted in the set-up of refrigerant reclamation facilities by two refrigerant distributors such as Tega and Westfalen. However, the demand for refrigerant reclamation is mainly limited to high-GWP substances as R404A which has experienced relevant price increases in 2016 and 2017.

The waste stream for bulk F-gases has been investigated in a study by the German Umweltbundesamt some years ago (Schwarz et al., 2011). The total annual quantity of refrigerant recovered from stationary EoL equipment and systems was estimated at 530 tonnes. The reclaimed amounts (at that time 200 tonnes) is believed to be higher today but no empirical data are available. Most of the refrigerant was destroyed in two facilities. One facility (RCN in Goch) serves as collection point for subsequent thermal decomposition. This process allows for further use of the chemical components in other production processes in chemical industry. This is also done at

another site (Daikin Chemicals in Frankfurt). The other facility (SAV near Munich) performs high-temperature burning processes.

Figure 23. Quantities in and recovery of F-gases from stationary installations.



SAV = Sonderabfall-Verbrennungsanlagen. RCN = RCN Chemie GmbH in Goch (collection point for refrigerants which are treated in the thermal decomposition plant of Solvay in Frankfurt).

Source:

→ **Policies and measures**

The German Chemicals-Climate Protection Ordinance, which is implementing the EU F-gas Regulation at national level, contains a provision: Refrigerant producers, importers and distributors are obliged to take back recovered refrigerants. In this way, service companies can hand in recovered refrigerants. However, the take-back is often not free of charge which might discourage certain technicians to do so.

Only in the last two years the reclamation of refrigerants in specialized facilities has been getting more interesting for (larger) equipment operators, in particular regarding R404A which has been facing significant price increases under the HFC phase down scheme. Reclaiming recovered R404A for further use is becoming an option to continue operation of existing R404A-equipment at reasonable cost compared to the prices for virgin R404A.

3.3.2. THE NETHERLANDS

→ **Emissions and emission factors from disposal of the four equipment types**

The methodological approach for the Dutch inventory is based on a stock model which considers the annual refrigerant market in the Netherlands. No separate assumptions are made for different subcategories or product groups but an average lifespan for the installations of 12 years, and a disposal emission factor of 5% during the dismantling of the installation are applied. This means

that, in year (t) the installations are dismantled that in year (t-12) were noted as new installations (ENINA report, 2016; p.62).

The 2017 NIR states that the Netherlands "are working on the replacement of the current method by a new method. The new method will use a "refrigerants registration system" with among others information about leakages, filling of new installation, dismantling, etc. In next submission a new time series will be presented. This time series will be made with the help of the current time series and new emission figures for the period 2013-2015." [NIR,2017, p152].

→ **Disposal process of the equipment types**

The collection and recycling of e-waste in the Netherlands is organised by the non-profit organization "Wecycle", on behalf of 1,600 producers and importers (https://www.wecycle.eu). Wecycle was one of the first organisations in Europe, active since 1999. The organization works together with many parties like municipalities, shops, and installation companies. The share of fridges and freezers collected within the scheme amounted to 22% in 2015 but also air conditioning appliances are covered. Wecycle organises appropriate removal and destruction of refrigerants from cooling and freezing appliances.

In 2016, there was 89 tonnes of refrigerants in total, including R11 (trichlorofluoromethane), R12 (dichlorodifluoromethane), R13 (chlorotrifluoromethane), R22 (chlorodifluoromethane), R114 (dichlorotetrafluoroethane), R125, R134a, R141b, cyclopentane, isopentane, propane, and butane. Their removal corresponded to more than 261,000 tonnes of avoided CO2-equivalents. The refrigerant recovery and treatment accounted for the major part of the total avoided CO2 emissions throughout the years. Yet, in general, there was a decrease in the quantity of avoided CO2 emissions over time, namely, from about 84% of the total avoided CO2 in 2009 to 60% in 2015. This was found to be related to the phase-out of ODS and increasing use of natural refrigerants. The table below shows the collected amounts of e-waste per year since 2009 and the amount of refrigerants recovered from refrigeration and air conditioning equipment [Goldsteijn and Valencia Martinez, 2017]. Please note that separate data for ODS, HFCs and other refrigerants are not available.

Table 4. Quantities collected e-waste per year, and the amount of refrigerants removed from cooling and freezing appliances.

Year	Collected amount of e-waste (tonnes)	Removed amount of refrigerants (tonnes)
2009	83 000	120
2010	106 000	100
2011	110 000	130
2012	121 000	110
2013	115 000	125
2014	111 000	107
2015	110 000	85
2016	110 000	89

Source: Goldsteijn and Valencia Martinez, 2017

In the Netherlands the national system for WEEE take-back and end-of life treatment also includes large commercial and industrial refrigeration systems.

→ **Policies and measures**

STEK system

Within the Dutch STEK system the certification of service technicians and emission reductions due to enhanced containment measures and regular maintenance have been implemented since 1992. Under the programme, some 2,000 companies were certified for stationary RAC systems. These companies were visited and assessed once every 18 months by independent bodies and inspected by government authorities. All STEK certified companies are obliged to keep a Refrigerant Registration at company level and a logbook at the installation indicating the type and quantities of refrigerants used as well as their purpose, i.e. new filling for new RAC circuits, maintenance or recovery. Since 1999 figures have been presented on an aggregated level. The system has generally increased awareness for the environmental impact of refrigerants. It is reported that the measures set out by STEK have cut the annual leakage rate in the Netherlands from more than 11% to less than 5% within 5 years in this sector.

Retail programme

When households buy new equipment, they can hand in the old item ('old for new'). About 3 000 retailers have a contract with the compliance schemes so that received equipment will be handed over to recyclers that are under contract of the compliance schemes.

Barriers

Despite of the available collection facilities, during the last few years, an additional 30% of e-waste was found in the Dutch municipal waste. Assuming that the composition of the waste equipment in the municipal waste is the same as that of the separately collected e-waste, the potential extra benefit for the environment is in the order of 1,2 · 105 tonnes of avoided emitted CO2-equivalents [Goldsteijn and Valencia Martinez, 2017].

3.3.3. FRANCE

→ **Emissions and emission factors from disposal of the four equipment types**

Hermetically sealed commercial refrigeration

In the French inventory, this application is part of the commercial refrigeration subcategory. The recovery efficiency is estimated at 81% in 2015 (table 53, p. 293; NIR 2016).

Industrial and commercial refrigeration

In the French inventory the industrial refrigeration sector is sub-divided in 12 industrial applications including meat industry, fish industry, dairy industry, chocolate industry, soft drink industry, beer and wine industry, deep-freeze industry, milk tanks, Chemical and heavy industry, pharmaceutical industry, caoutchouc industry, ice rinks.

The recovery efficiency is considered high at 95% except for ice rinks, for which 80% were assumed for 2015 (table 53, p. 293; NIR 2016).

The commercial refrigeration subcategory relates to 4 application types such as supermarkets, hypermarkets, small hermetically sealed units used in small businesses and condensing units. For supermarkets and hypermarkets, the recovery efficiency was assumed at 81% while it was at 42% for condensing units in 2015 (table 53, p. 293; NIR 2016).

Air conditioning and heat pumps

Air conditioning includes 9 subcategories such as moveable room air conditioners, window-type AC, split AC, multi-split AC, roof-top AC, VRF systems, console AC, central AC.

The assumed recovery efficiency for the larger equipment types (central AC, VRF, roof-top) ranged at 70-77% in 2015 while it was much lower for the smaller equipment categories (19% for split AC; 22% for multi-split) in 2015 (table 53, p. 293; NIR 2016).

Heat pumps relate to 4 subcategories including air-to-water heat pumps, (ground)water-to-water heat pumps, brine-to-water heat pumps and water heaters. The recovery efficiency was 35% in 2015, except for water heaters (30%) in 2015 (table 53, p. 293; NIR 2016).

Maritime reefers

Reefers are part of the transport refrigeration subcategory. A recovery efficiency of 29% is described in the 2017 NIR. Recovery efficiency was estimated at 29% in 2015 (table 53, p. 293; NIR 2016).

→ **Disposal process of the equipment types**

The French national legislation implementing the EU WEEE Directive since 2005 introduced an “eco-fee” to cover for the costs of EoL treatment” [B2BWEEE, 2018]”. When a new electrical and electronic appliance is purchased in a shop or on the internet, each consumer pays an "eco-fee" which varies according to the product purchased and the type of treatment it requires once it has reached the end of its service life. In compliance to French law, the eco-fee is visibly indicated on labels and is separate from the product price. The eco-fee is then paid to a take-back organisation accredited by Public Authorities, which recovers used appliances to decontaminate and recycle them. The eco-fee is not paid to the public authorities. It is, therefore, not a tax.

For the EoL treatment of “cooling large household appliances” 71 WEEE treatment centres were identified in France (including overseas territories) in 2010 [al., 2013].

→ **Policies and measures**

In France, recovery of CFCs, HCFCs and HFCs was mandatory from 1992 onwards (Decree of 7 December 1992).

In July 2017, the introduction of an HFC tax onwards was announced to become part of the national budget from January 2018 onwards. However, no follow-up action took place so far.

In this context, extensive information has been provided by the Environment Ministry relating to the use and recovery of F-gases [ecologique-solidaire, 2018]. According to the document, HFCs recovered from an installation in good enough condition to be reused after recycling (according to EU Regulation 517/2014) or to be regenerated are not classified as waste. The act of selling or reselling an HFC deemed suitable for reuse makes the person concerned a distributor in the eyes of the law (Point 5, Article 543-76, French Environment Code). HFCs recovered with no guarantee of being in a fit state for reuse after recycling or regeneration must be considered as waste. It is illegal to resell them.

From 1993 to 2007, France operated a deposit-and-refund scheme based on a voluntary industry agreement called the Convention of 1993. Since 2007 France has implemented a legally binding "take-back" scheme. The scheme relied heavily on its well-developed network of distributors to collect, store and deliver used HFC refrigerants to reclamation and destruction facilities. In 2015 it was amended to require that used HFC refrigerants be taken back at no cost although distributors are allowed to place an upfront levy on the sale of virgin or reclaimed HFC refrigerants to recover costs associated with waste management at end-of-life.

The main elements of the latest French "take-back" scheme can be summarized as follows:

- Recovery Obligation on the Operator. Article 8 of the EU F-Gas Regulation places the obligation on operators to ensure or arrange for the recovery of used HFC refrigerants by certified personnel or other appropriately qualified persons (i.e. contractors)
- Drop-Off Obligation on Contractor. Article 3(1) of the EU F-Gas Regulation prohibits contractors from intentionally releasing used HFC refrigerants into the atmosphere, thus requiring them to deliver the used HFC refrigerant that cannot be recycled onsite to a responsible third party.
- "Take-Back" Obligation on Distributors. Distributors must make containers available to contractors to ensure recovery of used HFC refrigerants, and take back quantities up to the overall tonnage of HFC refrigerants distributed the previous year at no cost, although distributors can levy a fee upfront during the sale of reclaimed or virgin HFC refrigerants to cover the costs associated with EoL management.

The take-back obligation does not apply to used HFC refrigerants recovered during the dismantling of vehicles operated under the MAC Directive or WEEE Directive.

The French system relies heavily upon its well-established network of distributors and diffuse points of sale to promote waste management, in effect a national distributor responsibility scheme. Producers have no formal obligations during the waste-management cycle of used HFC refrigerants in France [EIA, 2018].

3.4. DISPOSAL EMISSION FACTORS

3.4.1. INTRODUCTION

The 2006 IPCC Guidelines (Vol. 3, 7.51) suggest the following formula for the estimation of end-of life emissions:

EQUATION 7.14
EMISSIONS AT SYSTEM END-OF-LIFE

$$E_{\text{end-of-life, t}} = M_{(t-d)} \bullet p \bullet (1-\eta_{rec,d})$$

where:

$E_{end-of-life,t}$	=	amount of HFC emitted at system disposal in year t expressed in kilograms
$M_{(t-d)}$	=	amount of HFC initially charged into new systems installed in year (t-d) expressed in kilograms
p	=	Residual charge of HFC in equipment being disposed of expressed in percentage of full charge.
$\eta_{rec,d}$	=	Recovery efficiency at disposal, which is the ratio of recovered HFC referred to the HFC contained in the system

The 2006 IPCC Guidelines provide relatively large ranges for the recovery efficiency and the initial charge remaining (table 7.9).

- Parameters to be entered in the CRF tables for the emission reporting are
- amount remaining in products at decommissioning (activity data; tonnes),
- disposal loss factor (%),
- disposal emissions (tonnes) and
- recovery (tonnes).

These parameters are interlinked because recovered amounts out of the amounts remaining in products at decommissioning do not result in disposal emissions. In practice, however data on recovery are hardly available and disposal loss factors are often based on estimates. Within several EU workshops on F-gas emission reporting the following approach has been discussed and was subsequently implemented by some Member States:

Recovery = amount in products at decommissioning minus emissions from disposal.

3.4.2. ESTIMATE OF THE SIZE OF THE DISPOSAL EMISSIONS

The size of the disposal emissions is not known and can only be roughly estimated, based on a number of assumptions. Emissions from maritime reefers and hermetically sealed commercial refrigeration are not included explicitly in the current F-gas inventory method. Emissions from commercial and industrial installations are combined into one category in the emission inventory. This category (called “installations”) includes commercial and industrial refrigeration, chillers and large-scale air conditioning. Small air conditioning and heat pumps are included in the category room air conditioning and heat pumps.

Installations

The methodology is based on an annual estimation of the total bank (all refrigerants contained in installations), which is calculated as:

$$Bank_t = Bank_{t-1} + Deliveries_t – Emissions_t - A_t$$

Using following basic assumptions:

The life expectancy of the installations is estimated to be 15 year on average.

Annual emissions (leakages) from installations have been estimated as 20% in 1996 and a linear decrease to 8,8% in 2016.

Deliveries are collected statistics from all major gas delivering companies for each year placed on the market. From these statistics, gases used for other equipment types (e.g. mobile air conditioning) are subtracted.

To estimate the quantities used for filling new equipment, the bank in year t is divided by 15.

A is the quantity contained in EoL installations. The quantity in EoL equipment is estimated as the quantity in new installation in year t-15 and assuming a residual charge of 70%. These quantities are either emitted or recovered.

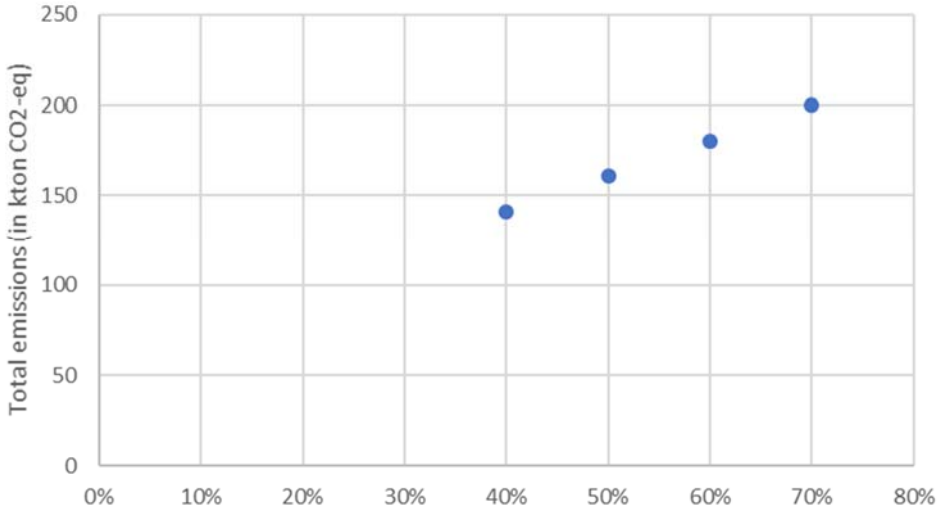
To calculate the disposal emissions an emission factor of 75% of the residual charge is assumed (which was based on the quantity of F-gases that are recovered and returned to gas companies).

Room air conditioning and heat pumps.

A similar approach is used for room air conditioning and heat pumps. But while for installations the bank is estimated based on the quantity of gases placed on the market, for room air conditioning and heat pumps this is based on sales statistics of appliances and assumptions on the share and quantity of F-gases used. The average life time of the equipment is assumed to be 15 years and annual losses of refrigerants is 2,5%, which could be a conservative (high) assumption based on input from manufacturers.

Disposal emissions are already an important part of total emissions and therefore reducing emission factors will have an important impact on reducing the total emissions from this category in the emission inventory. A reduction of 10% in the disposal emission factor corresponds with a reduction of 9,9% (due to the higher share of disposal emissions compared to fugitive emissions and differences in the refrigerants).

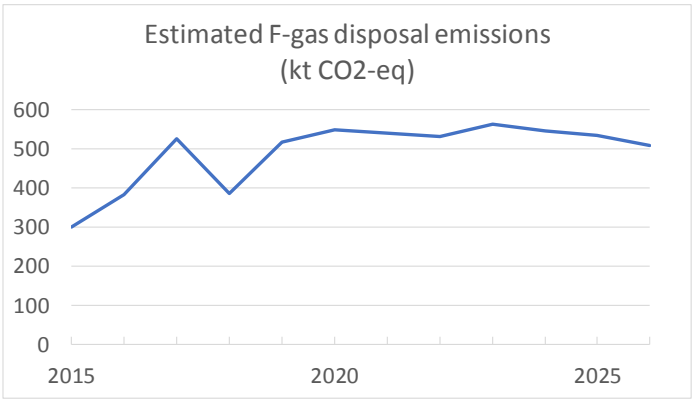
Figure 24. Impact of the disposal emission factor in the sector room air conditioning and heat pumps on total emissions in 2016 (in kt CO_2-eq.).



Source: own calculations.

The figure below presents an estimate of the future evolution of disposal emissions based on the data and assumptions of the emission inventory, which models the F-gas flows on the basis on annual refrigerant sales, amounts of recovered refrigerants and sales of room air conditioners and heat pumps [Altdorfer and Dauwe, 2018]. It should be kept in mind that there is a considerable uncertainty of the level of these emissions and that they rather provide an order of magnitude.

Figure 25. Estimated F-gas disposal emissions (2015-2030) from installation and room air conditioning and heat pumps.



Source: own calculations.

CHAPTER 4 Conclusions and policy recommendations

4.1. DISPOSAL EMISSION FACTORS

Irrespective of the type of equipment, the EoL emissions are determined by several factors. The first factor is not related to the decommissioning process, but relates to the quantity remaining in equipment at EoL and the amount of F-gases remaining in the installation. The interviews and the online survey showed that the quantity in installations at EoL can be very low because most refrigerants were emitted because of a leakage.

Emissions during the dismantling and disposal process can occur during different stages.

1) The installation is not dismantled correctly and most F-gases are emitted without the recovery of gases. There are two reasons identified during the interviews and online survey: owners of installations postpone dismantling of the installation resulting in a gradual release of all F-gases after which the installation is dismantled; or installations are dismantled by (non-certified) companies and F-gases are intentionally released without recovery.
2) The installation is dismantled and disposed correctly, but F-gases are emitted during transport or during the recovery of the gases. Emissions occur because small quantities cannot be removed from the installation.
3) The recovered F-gases are sent to a gas company where gases are either recycled and regenerated or sent for destruction. During recycling or regeneration very small quantities of refrigerants are emitted.

For the emission inventory, the emissions occurring at these different steps are integrated in one assumption on the overall emission factor during disposal.

4.1.1. QUANTITY IN EQUIPMENT AT THE TIME OF DISPOSAL

This falls outside the scope of this report but will have an important impact on the emissions of F-gases. We therefore included the relevant information we received here, which could be considered also for the F-gas emission inventory.

During the interviews information was provided on the stock and bank of air conditioning and heat pumps in Belgium, from different sources [BSRIA, 2006] [DG TREN, 2008]. Some of this information is not public and therefore is not included in this report. The comparison shows however that statistics on the sales and stocks of air conditioning and heat pumps can deviate significantly. The data used in the inventory for the category room air conditioning and heat pumps is based on statistics from UBF-ACA. The sales figures are lower than in the above references, as UBF-ACA does not cover the entire Belgian market. This is particularly the case for movable equipment. For the category split and multi-split the sales statistics for the period 2004-2008 appear to be more similar. Information received on the share and quantity of F-gases in air conditioning and heat pump equipment [SKM-Enviros, 2012] are largely consistent with the assumptions in the inventory.

Observation: A comparison of different statistics showed that the bank of movable air conditioning could be underestimated in the emission inventory.

Recommendation: Reassess assumptions on movable air conditioning, based on information and statistics received and which are public.

During interviews and meetings with the steering group, it was stressed that a significant part of large installations, including chillers, are prefilled. For industrial and commercial installations this has only become more common in recent years. A trend that is likely to continue in future.

Observation: Chillers are prefilled with refrigerants. In the current inventory, chillers are included in the category 'installations' and it is assumed that these are completely filled on site. In future, also commercial and industrial refrigeration could be pre-filled more frequently (although evidence collected during the interviews is not conclusive). The evidence from the interviews is mixed on how often this is already occurring now. The current methodology thus underestimates the bank of refrigerants to some extent.

Recommendation: Move chillers to the sector 'air conditioning and heat pumps' and use assumptions on charge, refrigerants and emission factors to estimate the bank and annual emissions. For large commercial and industrial refrigeration consider the fact that more and more installation will be pre-filled in future.

Stakeholder consultation revealed that it is difficult to estimate the number of maritime reefers. The assumption that 7% of all container traffic is refrigerated (based on personal communication with an expert from the Havenbedrijf Antwerpen) was deemed likely. The consultation revealed that reefer containers can sometimes be in storage on shore for 50% of the time, however other interviews showed that this is much lower (1 to 2 months maximum) and that reefer containers are mostly used. The difference could be related to different type of activities of the respondents. It seems likely that in most cases, reefer containers are used to the maximum extent and are only in storage for a limited amount of time per year.

There are four global manufacturers of reefer containers, three of which use R134a and one uses R404a. All manufacturers are considering changing the refrigerant used in their reefer containers in future. There is already a partial shift to R513A. In the longer term, manufacturers are considering different options: HFO-1234yf, CO2, R452A and propane. When this shift will happen is not certain. The average load of refrigerants in reefer containers is between 3 and 5,5 kg, on average it is most likely around 5 kg.

Lifetime emissions occur in most cases because of rough handling of the reefer containers and because of exposure to a harsh environment and salt water. It is difficult to assess when emission occur, but it is likely that emissions occur both at sea and on land. Reefers are monitored when in operation, to ensure that the temperature in the reefer can be maintained and potential problems are detected on time. However, reefer containers are designed for harsh environments and can operate with only 50% of refrigerant charge remaining. Potential problems might thus be detected at a late stage. Lifetime emissions are estimated to be between 1% and 10% per year.

4.1.2. INCORRECT DISPOSAL OF EQUIPMENT

With incorrect disposal we mean the disposal of the equipment without taking into consideration the recovery of F-gases, resulting in the emission of all refrigerants in the equipment. It is difficult to make a distinction between accidental and intentional release of refrigerants from EoL installations, but for the inventory this is not relevant.

Industrial and commercial refrigeration

Only a small fraction of industrial and commercial installations reaches the refrigeration dismantling plant. A significant amount of equipment ends up at scrap metal plants where the installation is either exported for use abroad or dismantled for metals. Generally, there is a difference between owners of installations: Large companies (industrial or commercial) are more aware and informed and therefore dispose equipment correctly with due care for the recovery of F-gases. Small companies are less aware of their obligations.

During the interviews it was mentioned that up to 50% of industrial installations were empty when arriving at the refrigeration dismantling plant. A significant amount of installations is emptied by certified companies and technicians on site though.

Air conditioning and heat pumps

During the interviews it was mentioned that up to 75% of small air conditioning and heat pump installations still contained F-gases when dismantled at the dismantling plant[4]. Of the remaining 25% F-gases were either emitted, intentionally or unintentionally if the equipment had a leak, or F-gases were recovered. Emissions occurring during transport have not been quantified, but are expected to be low. Air conditioning, heat pumps and commercial refrigerators can easily be identified as containing refrigerants and treated properly. For other equipment types containing F-gases, such as heat pump tumble driers, this is less the case, which could lead to additional emissions.

Combining information from the online survey showed that respondents replied on average that 35% of air conditioning and heat pump installations are (almost) completely empty at time of disposal. Several respondents to the online survey and interviews mentioned that often air conditioning and heat pumps are only serviced or replaced when the equipment stops functioning properly, often resulting in higher leakages.

Hermetically sealed commercial installations

For household refrigeration, still a significant fraction of equipment is disposed of incorrectly and ends up in small scrap metal. It is likely that this also applies to hermetically sealed commercial equipment.

Maritime reefers

For EoL maritime reefers there are three routes of disposal:

[4] Excludes equipment that is dismantled at scrap metal companies.

- The most significant share of EoL reefers (up to 80%) are exported outside the EU and will be used in other countries, for example Russia. They are used either for stationary or mobile refrigeration.
- Part of the reefers are used for stationary use in Flanders, but appears to be common in other countries as well. They are used for example as additional storage capacity for shops. From that moment onwards, this is the responsibility of the owner and it is not clear how reefers are serviced and disposed. According to one respondent this practice is now less common than in the past due to the F-gas regulation.
- Only a small section of the reefers is dismantled, usually after a major incident and the container is beyond repair. Both respondents confirmed that refrigerants are recovered and either reused for servicing or send to gas companies where it is mostly send for destruction. However, because disposal only occurs after major incidents, the leakage rate could be very high. No quantification could be given though.

Observation: Reefer containers are not included separately in the emission inventory. They are however implicitly included in the sector (industrial/commercial) installations. In the 2017 F-gas emission inventory report, an estimate is given on lifetime emissions of F-gases from reefers. Considering that most reefers are exported at EoL, disposal emissions are likely not very high.

Recommendation: Based on information collected during the interviews, an updated estimate of lifetime emissions from reefers would be appropriate.

Observation: Hermetically-sealed commercial refrigeration is not included in the inventory as a separate category.

Recommendation: Add this category to the emission inventory as a separate category with specific assumptions on lifetime and disposal emission factors, in line with asusmptions for residential refrigeration.

4.1.3. EMISSIONS DURING F-GAS RECYCLING, RECLAMATION AND REGENERATION

All the emissions that occur, occur when F-gases are recovered from the installation, transferred from one container to another, handled during recycling, and processed for reclamation, regeneration and/or destroyed.

The stakeholder interviews showed that emissions from these steps are small and often limited to the losses from small quantities of gases that cannot be extracted from an installation, that remain in pipes when transferring gases, etc. During the interview, one expert noted that from installations on site emissions from emptying an installation could amount to 5-10%.

Another potential source of emissions are F-gases dissolved in compressor oil. These gases can be extracted and recovered. To do so, gases need to be collected without exposure to air to avoid the release of the dissolved F-gases to the atmosphere.

4.1.4. RECOVERY OF F-GASES FROM DISPOSED EQUIPMENT.

A similar study on F-gas recovery, reclamation and destruction has been carried out in Germany in 2011 (see also the case study of Germany, [Schwarz et al., 2011]). Interviews and a review of technical literature resulted in the establishment of sector-specific recovery-efficiency rates[5].

Table 5. Assumed sector specific recovery efficiency rates in Germany.

Installation type	Recovery efficiency (%)
Large commercial and industrial refrigeration systems (centralized systems, industrial refrigeration systems, chillers)	75%
Medium-sized systems (multi-split air conditioning, condensing units)	60%
Medium-sized systems (heat pumps)	50%
Small systems (plug-in units for commercial use, split air conditioning)	40%
Small systems (plug-in units, mobile room air conditioning)	25%

Source: [Schwarz et al., 2011]

The online survey showed diverse responses for installations (commercial/industrial) and air conditioning and heat pumps regarding:

- the share of equipment empty at EoL;
- the quantity of refrigerants in equipment;
- the recovery efficiency.

Some responses were nevertheless chosen more often than others.

Based on the individual responses to the online survey we can aggregate the answers on these three questions to determine the emission factor from disposal. This is not very accurate because:

- responses were given as an interval (we used the mean for each interval in our calculation);
- respondents did not know that this information would be aggregated (and might have responded differently);
- the three questions do not capture all emissions (e.g. emissions after recovery are not included).

It does give an indication of whether the assumptions used in the current inventory are within the same order of magnitude or should be revised. The results showed that for both air conditioning and heat pumps and commercial and industrial installations, the median emission factor is 69%, ranging between 99% to 29%[6]. An overall emission factor of 69% corresponds, for example, with:

- 50% of installations are empty at EoL;
- the installations that are not empty at EoL contain 70% of initial charge;
- the recovery of refrigerants from the installation is almost 90%.

[5] Recovery-efficiency rates are based on the quantity of recovered gasses compared with the quantity of gasses in the installation at the time of disposal.
[6] This is also the lowest emission factor that could be calculated, because of the ranges.

The emission factor used in the inventory for commercial and industrial installations is 75%, while for air conditioning and heat pumps the emission factor is 70%.

Observation: The median emission factor calculated based on responses to questions 1, 2 and 3 of the online survey was 69% for both equipment types. This is a very rough estimate, but in the same order of magnitude with the assumpions used to date in the emission inventory.

Recommendation: Considering the high level of uncertainty and based on the information received, an update of the assumption on the disposal emission factor does not seem warranted at this point in time for installations and air conditioning and heat pumps.

Observation: There was a high level of agreement among respondents to the online survey that the recovery of F-gases from installations (whether commercial, industrial, air conditioning or heat pumps) is likely to increase in upcoming years, because of the quota system. Quantifying the impact of the F-gas regulation on the recovery of F-gases will be challenging, but needs to be reflected in the assumptions made in the emission inventory and a static assumption on disposal emission factors for upcoming years seems inappropriate.

Recommendation: A more detailed follow-up of disposal emission factors from the installations within the scope of this study is needed in upcoming years. To quantify improvements in recovery efficiency, time series of the quantities of F-gases collected by or returned to gas companies could be used as a proxy.

4.2. POLICY RECOMMENDATIONS

The EU F-gas regulation has resulted in a significant increase of HFC prices (see Figure 4). This is an important incentive to recover and reclaim F-gases and this trend is likely to continue. HFC emissions from disposal are therefore likely lower than in the past. Even without additional measures, disposal emissions are also likely to continue to decrease in the near future. This study also identified a number of barriers that are not necessarily addressed effectively with an increased price incentive only.

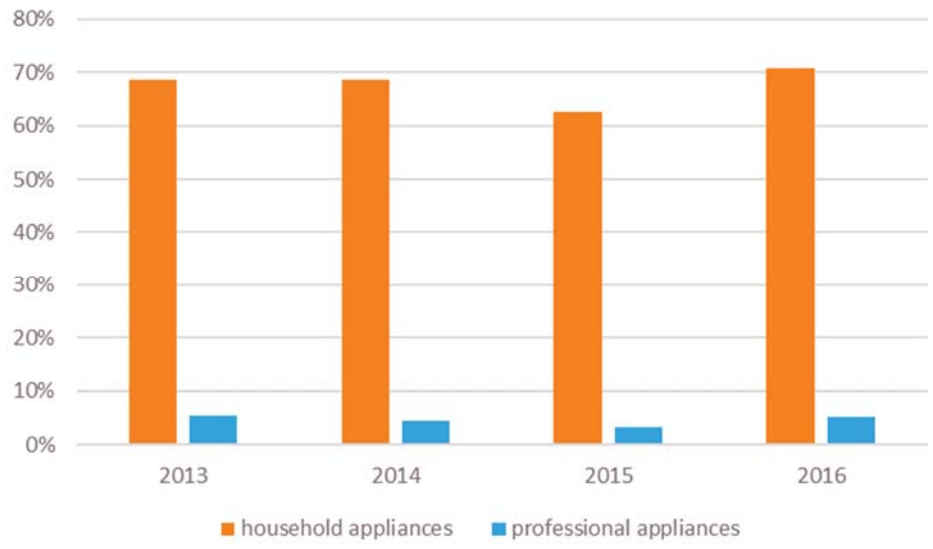
4.2.1. DISPOSAL OF EQUIPMENT

Domestic appliances are mostly collected, transported and treated in the Recupel system. An all-in fee is paid when purchasing the equipment and this fee covers the administrative and operational costs to collect, store, transport and dismantle the WEEE. For professional appliances, which includes air conditioning, heat pumps and smaller commercial and industrial refrigeration, there is only an administrative fee and the owner must pay for the collection, storage, transport and dismantling of EoL equipment. Recupel oversees and controls the collection and processing system,

but does not cover the operational costs. Large stationary refrigeration installations completely fall outside the scope of the Recupel system.

The evidence collected during this study shows that WEEE that are collected via the Recupel system, end up at the correct facility and the Recupel system is in general effective. WEEE that is not collected via the Recupel system however does not end up at the correct facility and equipment containing F-gases is not always treated correctly resulting in emissions of F-gases. Comparing domestic (residential refrigerators and freezers) and commercial (air conditioning, heat pumps and larger refrigeration) WEEE category 1b, the statistics of Recupel show that compared to the quantity of equipment that is placed on the market, the quantity of EoL equipment processed is much lower for commercial than for domestic WEEE.

Figure 26. Share of processed household and professional WEEE (category 1b) compared to equipment placed on the market (%, based on quantities in kg).



Source: Recupel [2013, 2014, 2015, 2016]

For small installations, such as hermetically sealed equipment, there is no incentive to recover refrigerants, while the metals of the installation or parts of the equipment are more valuable. As a result, the pirating of compressors and other refrigerator parts is a factor that reduces proper recycling [interviews; ICF, 2010]. Therefore, emissions from these installations could be still rather high. Also for residential air conditioning and heat pumps, part of the EoL installations will not be recycled correctly. Air conditioning and heat pumps can still end up at scrap metal companies and it is very unlikely that F-gases are recovered there. Quantitative data however is missing.

For equipment that falls under the WEEE (i.e. hermetically sealed commercial refrigeration, but also other F-gas containing equipment such as heat pump tumble driers and movable air conditioning), measures to increase the correct collection, transport and dismantling of WEEE will have a significant impact on reducing emissions of F-gases contained in this equipment. The European standard EN 50625 provides a detailed set of guidance and requirements for the collection, logistics and treatment of WEEE. In France and the Netherlands this standard is mandatory for all companies in the WEEE cycle. As CECED [CECED, 2016] pointed out mandatory compliance with the EN 50625 standards for all WEEE treatment facilities in the EU would create a

level playing field in the EU. Additionally, it would also mean that all actors handling WEEE are subject to the same requirements in terms of reporting collected and treated quantities.

Some of the additional measures taken by France to make the waste sector more transparent had a very positive impact on the recycling rate of WEEE. France has become one of the front runners in Europe with respect to recycling WEEE. This means for example that the share of commercial and industrial equipment that is recycled in much larger in France than in Belgium/Flanders.

Additional companies that collect refrigerators, air conditioning equipment, etc. are given a financial reimbursement if the equipment is transferred to a recycling company. This compensates for missed revenue from scrap metal and gives a financial incentive for demolition companies and scrap metal companies to deliver F-gas containing equipment to the dismantling facility.

Barrier: Not all EoL equipment ends up at a correct facility for dismantling. Too often residential and professional equipment (such as hermetically-sealed commercial installations, air conditioning and heat pumps) ends up at a scrap metal company where HFCs are not recovered. These companies do not have an incentive to do otherwise and enforcement is not sufficient to change practices.

Recommendation: Ensure that more EoL equipment ends up at a correct facility for dismantling. This applies to all appliances that fall under the WEEE directive. France provides some examples of how this could be improved:

- Do not allow the use of cash money.
- A mandatory registration of all companies that collect, store, transport, treat and process WEEE to an *éco-organisme* (cfr. Recupel).
- Ensure a financial incentive to scrap metal companies to hand-in HFC-containing equipment to compensate for missed revenue, either financed by the sector or with governmental support (could be foreseen as part of the Recupel system).
- Mandatory compliance to the EN 50625 standard for all companies in WEEE cycle.

Large-scale fixed installations do not fall under the Recupel system or the WEEE Directive and therefore there is less control on the correct dismantling of installations. During interviews it was mentioned that large industrial and commercial companies in most cases follow regulations and ensure a correct recovery of F-gases. For smaller installations, this appears to be less the case (see section below). From 2018 onwards, the scope of the WEEE Directive will be extended. Large-scale fixed installations will be excluded from the scope of the WEEE Directive however, and there is still some uncertainty as to what is understood under this category.

Barrier: Some professional equipment (e.g. air conditioning and heat pumps, chillers) are empty upon arrival at dismantling facility.

Recommendation: In the disposal process, it is important to identify e.g. air conditioning and heat pumps (and other HFC containing equipment such as heat pump tumble driers) early on, so the equipment can be treated and processed with due care to avoid leakages during transport.

The interviews and online survey also showed that the correct disposal of smaller installations could already be improved by taking actions earlier. Small air conditioning and heat pumps can be bought by non-certified technicians and end-users (even online). There is a requirement for this equipment to be installed by certified technicians, which is not always the case. A share of this equipment is therefore installed by non-certified technicians (such as electricians and plumbers) or even the end-user. This leads to installations that are not properly installed with a higher risk of leakages and a higher risk that installations are not properly disposed. Some manufacturers inform customers that F-gas containing equipment must be installed by certified technicians (see for example below).

Verplichte informatie

F-Gassen Regeling (EU) 517/2014

Van harte gefeliciteerd met uw aankoop van een

In verband met de nieuwe F-gassenverordening (EU) 517/2014 zoals van toepassing vanaf 1 januari 2015, stellen wij u hierbij op de hoogte van de verplichting om dit toestel te laten in gebruik nemen door een erkend installateur in overeenstemming met artikel 10 van Verordening (EU) 517/2014

Het betreft een in gebruik name van niet-hermetisch afgesloten apparatuur, dwz apparatuur zoals niet verzegeld door lassen, solderen of soortgelijke vaste verbindingen en die gefluoreerde broeikasgassen bevatten. Dergelijke apparatuur moet volgens deze EU regeling in gebruik genomen worden door een erkend installateur.

(Gecertificeerde installateurs kunnen onder andere worden gevonden via https://www.lne.be/overzichtslijsten-erkende-personen)

Recommendation: End-users buying air conditioning or heat pumps should be aware of the requirements. In a number of countries, people buying air conditioning or heat pumps must fill in a form underlining that equipment has to be installed by a certified technician. Additionally, it is important to move to alternatives. For the small applications where recovery is problematic the promotion of low-GWP alternatives is also an option and might be more cost-effective than setting up measures for soon outdated HFC equipment.

Most EoL maritime reefers are exported to outside the EU and therefore disposal emissions are not occurring within the EU or in Flanders. About 20% of reefers end up as stationary refrigeration

units or are dismantled (usually only after a major incident). In most cases, refrigerants are recovered from dismantled reefers, although part or all refrigerants might already have been emitted to the air. It is unclear what happens with the reefers that are used as stationary refrigerators until their EoL. To avoid disposal emissions from reefers, this activity is most likely the most important to address, e.g. informing people buying second-hand reefer containers that refrigerants should be recovered.

A low recovery of stationary installations does not necessarily mean that all F-gases are emitted. There is an increasing financial incentive for installers to recover F-gases from installations and during interviews it was mentioned several times that recovery of F-gases has improved because of this. EU statistics also show this across EU, although the quantity of reclaimed HFCs remains low.

4.2.2. RECOVERY AND RECLAMATION OF F-GASES

→ **Owners of installations**

The interviews and online survey showed that owners of installations are not always informed or aware of the existing legislation. This seems particularly the case for smaller companies, shops, etc. One installer testified that in 20 - 30% of cases, installations are already dismantled (by owner or company hired by owner) in case of a replacement. Installations in smaller supermarkets are also often empty (20-40% refrigeration, 40-60% air conditioning), for example because installations are not dismantled immediately and F-gases are slowly released into atmosphere over several months or even years. Respondents to the online survey also confirmed this and several respondents mentioned that the lack of knowledge of the owner of the installation is a barrier for a more effective recovery.

As a result, smaller owners depend on information provided by the installer on the existing legislation. Respondents to the questionnaire confirmed that they do this, but this is surely not done by all. Owners stated that installers do not always provide information or certificates voluntarily, and have to ask for this explicitly.

At the website of Departement Omgeving, a test is available https://www.lne.be/zelftest-koelinstallaties for owners of installations. Based on several questions, owners of air conditioning, heat pumps or refrigerators, can get information on the regulations that are applicable for their installation.

The cost of recovery and reclamation to owners and installers

There is also a lack of motivation in some owners of installations to recover refrigerants because of the recovery costs. Owners want to avoid this extra cost of recovery (and sometimes will look for a company that does not recover the gases). Also, installers are reported to not want to ask this additional cost to their customers. The cost of the recovery of F-gases from installations imposes thus a competitive disadvantage of companies acting according to the legislation compared to companies that do not. By far the most frequently reported barrier for a more effective recovery of refrigerants was the high cost (or time). Almost 60% of people who responded to this question of the online survey mentioned high costs as a barrier.

One installer mentioned that even if gas is recovered by a company, gases are on occasion released intentionally (even if the owner paid for the recovery). Such practices are possible, because owners are not informed and do not ask for certificates of regeneration or destruction of the gases.

In addition, recovered refrigerant is considered hazardous waste (VLAREMA, annex 2.1), which introduces additional administrative and cost barriers associated with transport [ICF, 2010]. This also leads to confusion and installers do not always know whether they are allowed to transport refrigerants and under which circumstances. The cost of the transport by an external company are not negligible, especially for smaller companies dealing with smaller volumes of gases. A clarification of the regulation could mean that installers can avoid these additional costs, while complying with the existing legislation.

Larger companies and retailers on the other hand have mostly implemented internal procedures to comply with the existing legislation. Several respondents to interviews and online survey indicated that problems are much smaller at larger companies because of a combination of more knowledge about the legislation, higher awareness of the problem and motivation to mitigate emissions and more environmental inspections.

Barrier: Owners of equipment containing F-gases (such as air conditioning, heat pumps, commercian and industrial installations) are not always informed or do not have an incentive for disposing and recovering F-gases correctly. In contrast, often the owners incur a cost for the recovery and processing of F-gases from their installation. Service companies that do not abide to the rules and do not recover F-gases therefore can decommission installations at a lower cost to the owner.

Recommendation: Raising awareness of owners on the environmental hazards linked to F-gas emissions, the existing legislation related to the disposal of F-gas containing equipment and appropriate measures they can implement to avoid unneccesary emissions. Now owners of F-gas containing equipment are sometimes informed by installers on the legal requirements.

Recommendation: Additionally, an incentive could be given to owners to recover F-gases from their installations according to the existing legislation. One option is to make recovery of F-gases from installations always free of charge. Currently, some installation companies and refrigerant gas companies already have set-up measures to increase the recovery of gases, e.g. by offering discounts.

An issue that has been discussed already years ago in the scope of the review of the former F-gas Regulation 842/2006 addresses the return of recovered refrigerants by the service company to the distributor/importer/producer of refrigerants. It is common that the service company is charged a fee when handing in recovered refrigerants. The argument for such fee is that the refrigerant distributor/importer/producer would have further costs for storage, transportation and treatment of the refrigerant. There are even environmental taxes to be paid. However, the fee does not give an incentive to owners to recover refrigerants and for refrigeration and air conditioning technicians to recover and return refrigerants for proper reclamation and/or destruction. Hence other ways for covering the costs to reclaim and treat waste could be identified, such as a deposit-and-refund scheme. This would however also means transaction and administrative costs.

One step further than making recovery of F-gases from installations free for the owner of the installation, is a fee system. EIA [2016] for example recommended that national authorities should explore adopting a take-back obligation, coupled with a deposit-and-refund scheme (such as in

France and Denmark). In this scheme contractors and distributors are compensated upon delivery of recovered F-gases. This can be funded via a levy or fee on virgin HFC refrigerants placed on the market by producers. This means that ultimately the owners of installations must pay a fee on the F-gases contained in new equipment or on the gases that are used during servicing. This fee is then returned when gases are recovered. It is important that such a system would benefit the end-user. If it benefits only the installer, misuse may occur.

This has a dual added value: this increases the incentive to keep leakages low (although the higher prices of certain F-gases from the quota system are already contributing to this) and to recover all gases at EoL. As one respondent stressed, the implementation could be difficult as large quantities of F-gases are already in installations for which no fee has been paid. Furthermore, the EU HFC phase down is being implemented and has strong effects on the market and the refrigerants selected. An additional national system might interfere with this EU mechanism and would further increase costs.

In Poland, a system of emission fees for 'using the environment' applies to emissions of HFCs. The government collects these emissions fees from companies releasing or emitting HFCs. The revenue is directed to the Polish State Fund for Environmental Protection and Water Management to be used for managing F-gases, both through the maintenance of reporting databases and other F-gas emission reduction projects. The fee for HFCs (used for servicing/topping up leaked refrigerants) was about 30,19 PLN/kg in 2018 [Brack, 2015] [Solana Cipres, 2017].

Information for maritime reefers is scarcer. Information received from respondents showed that the EU or Flemish legislation is not always very clear. For example, reefers are not included in the quota system of the F-gas regulation. It was also not clear whether technicians working on containers have to be certified or not.

→ **Close the loop**

If installations are disposed of correctly, emissions are small and are caused because:

1) Not all gases can be retrieved from the installation.
2) Part of the gases are dissolved in the compressor oil. Gases can be extracted from the oil, but to do this the oil cannot be exposed to air.
3) Small emissions occur during all subsequent manipulations to recycle or regenerate the F-gases. These emissions are relatively marginal.

Ardente et al. (2015) analysed EoL treatments of commercial refrigerating appliances. Concerning refrigerants and oils they concluded on additional design options to improve recovery (such as additional valves) that "considering all the drawbacks and limitations of these potential design options, no prescriptive recommendation […] can here be formulated."

There is an obligation for installations to be emptied on site by a certified technician within one month. In some cases, recovery of gases at a dismantling plant, rather than on-site could be beneficial as it would mean that recovery can be done more efficiently. Recovery of F-gases from installations can be very high at dismantling plants. Most of the installations in Flanders are processed by Coolrec, which has a recovery efficiency of 96%.

Barrier: Part of the F-gases in installations could be dissolved in the oil of the compressor of air conditioning, heat pumps and commercial and industrial installations. These HFCs are recovered in some instances, for example by Coolrec, but it is unlikely that this is done always. If oil is not treated and is exposed to the air, these HFCs might be emitted. Experts estimate that between 10% and 20% of the remaining HFC charge are dissolved in the compressor oil [Schwarz et al., 2011].

Recommendation: There are a number of technical measures that could be taken to increase the recovery efficiency of refrigerants from installations. One is to take into account that HFCs could be dissolved in compressor oil. Whenever this is technically possible, recovery of F-gases at specialized facilities rather than on site should be promoted.

The F-gas regulation and higher prices for HFCs have resulted in an increase of the quantity of recovered HFCs that are delivered by installers to specialised gas companies. Additionally, gas companies noticed that empty containers (to collect and store recovered F-gases) are either sold or rented more often and for a longer period of time by installers. This suggests that installers are recovering, storing, recycling and reusing F-gases themselves, without sending the gases to specialised companies for regeneration[7]. This contradicts the results of the online survey where most installers replied that F-gases are send to the gas company for regeneration or destruction. The evidence collected during the interviews and online survey is therefore not very conclusive, which could point at the fact that installers have very different practices in this respect.

After recovery of F-gases there are generally three options for recovered F-gases to be reused:

	Technology	Description
1	Recycling	Slightly polluted gas can be filtered (e.g. to remove compressor oil) and reused for filling existing installations.
2	Regeneration Reclamation	Moderately polluted gas can be filtered and reused. The gases are tested on its chemical composition and can be placed on the market as reclaimed gas. The quality of the regenerated gases is sufficient to be used in existing and new installations.
3	Distillation	Mixtures of HFCs are split into individual compounds and then used again to compose mixtures.

In some cases, reclamation is not possible. The most frequently mentioned reason being that different gases or blends are mixed and these cannot be split at reasonable cost. In these cases, the gases are destroyed. Most gases are exported for destruction, either to Germany or France. Based on the interviews only a small fraction of the gases is destroyed in Flanders (at Indaver). In

[7] The impact on the quantity of recovered gases is not clear though. Some companies have seen increase in recovery, while others have not.

Germany and France, F-gases are mainly cracked and therefore cost of destruction is lower then in Flanders were F-gases are burned.

Respondents underlined the importance of proper recycling and regeneration of F-gases as these gases are needed to service existing installations. However, reuse does exclude that part of these gases still will end up in the atmosphere either because of accidental leakages during the lifetime of the installation or at disposal.

→ **Control and certification**

During the interviews, experts mentioned that there are still non-certified companies and/or technicians performing activities on commercian and industrial installations and air conditioning and heat pumps that only certified companies and technicians are allowed to do.

For residential air conditioning and heat pumps there are a lot of companies, even do-it-yourself stores, that can sell equipment. This is not illegal as such, but when they sell there should be evidence that the installation is done by a certified installer. More market surveillance could help to increase the awareness of these shops about their duty to check how installation will be done. People might not be sufficiently informed when buying an air conditioning or heat pump that the installation should be done by a certified technician. This could also affect the proper maintenance and disposal of this equipment.

The online survey showed that there was a high level of agreement among respondents that the enforcement of the legislation is not sufficient. Controls and inspections are often limited to installation companies and owner of large industrial and commercial installations. Owners of smaller installations are not inspected. Additionally, also certified installation and servicing companies need to be inspected. While many companies work by the rules and regulations, others might not do so. Inspection of refrigerant bookkeeping could provide an indication (e.g. what are the quantities recovered from EoL equipment).

Barrier: Apart from new measures, enforcement of the existing legislation is important and as many respondents indicated should be strengthened, e.g. by increasing the number of environmental inspections. Recently, this has become the responsibility of local administrations that do not necessarily have the resources or the technical expertise to do this effectively.

Recommendation: Training and capacity building of local administrations so that they can enforce and control refrigeration installations more intensely, correctly and consistently. In 2017 two workshops were already organized by Departement Omgeving and three will be organized in 2018: https://www.lne.be/workshops-inspectie-en-toezicht-op-koelinstallaties

For maritime reefers there appears to be a level of uncertainty to what extent existing legislation (whether F-gas regulation or VLAREM) applies to this sector. Jurisdiction depends on the flag of the ship where the maritime reefers are used.

→ **Information and data**

The logbook is the most important instrument to follow-up installations regarding the quantities emitted and added to installations over its entire lifetime. The logbook system is however not watertight. Several respondents replied that logbooks are not complete, up-to-date or can even be missing. This is in line with the finding of the environmental inspection (https://www.lne.be/logboek-koelinstallaties-wat-moet-er-in-en-wie-is-verantwoordelijk). While the logbook is mandatory for each installation (when the quantity in the installation is 5 t CO_2-eq. or more), there is no harmonised platform for reporting. In a number of European countries an electronic logbook/database has been operationalised. Two examples are given below with a centralized reporting system:

In Poland all the entities that import, export, use, recover, recycle, reclaim or destroy ODS or F-gases and the entities that manufacture, import or export products or equipment containing ODS or F-gases have to register to the BDS database (http://www.bds.ichp.pl/en). Each year entities have to report on :

- Import
- Export
- Quantities placed on the market (in containers)
- Quantities used (in equipment)
- Recovery , recycling, reclamation or destruction
- Quantities stored
- Quantities lost

Data submitted to that database are then analyzed by the institution listed in the relevant legislation and are presented to the competent authority. Companies are also obliged to set up a separate logbook for each piece of equipment holding 3 kg or more (or 5 tons of CO2 -eq or more) of ODS and F-gases in a centralized system. Each logbook contains the coordinates of the operator and equipment manager/contact person and data concerning the equipment (equipment type, exploitation address, type and quantity of ODS/F-gas it contains). The logbook also allows the servicing technician to make online notes on any activity conducted on the equipment (leakage checks, recovery/topping up of ODS/F-gas, repair, installation, decommissioning).

Currently, approximately 30.000 equipment operators and 230.000 pieces of equipment installed in Poland are covered by this system [UNEP, 2017]. The system is designed to generate reports containing aggregated data from the logbooks. Such reports allow the competent authority to acquire information on e.g. quantities of particular type of ODS or F-gas (including mixtures) contained in particular type of equipment, number of pieces of particular type of equipment holding 3 kg or more (or 5 tons of CO2-eq or more) of ODS/F-gas, quantity of particular ODS/F-gas recovered from or added to particular type of equipment, etc [UNEP, 2017]. The system also allows the equipment operator to produce similar reports, but containing only the data concerning that particular operator's equipment.

In Macedonia FYR a complex electronically operated database has been established where the servicing technicians, service shops and equipment owners are obliged to register and where data on quantities of refrigerants (HCFCs, HFCs and alternatives) used for servicing as well as quantities of those refrigerants recovered, recycled or reclaimed are stored and can be analysed [UNEP, 2017].

Many installation and servicing companies in Flanders are already working with centralized electronic logbooks.

Barrier: There is a lack of information on the number and capacity of existing commercial and industrial installations, especially for smaller installations. These installations therefore remain under the radar and are not checked by the environmental inspection. The current logbook system is not watertight: logbooks are not always up to date or can even be missing.

Recommendation: A registry where all new installations need to be recorded could have two positive effects: one is that authorities have a good overview of all the owners of F-gas containing installations and can make targeted environmental inspections and second is that owners of installations can be informed and, because the installation is registered, have an incentive to comply with legislation regarding maintenance and disposal. This registry can be at the level of installation and servicing companies (recording quantities used for new and existing installations and quantities recovered) or, preferably, at the level of the installation. The latter covering more reporters and imposing higher administrative burden, but providing more detailed information.

Recommendation: Some countries have implemented electronic logbook systems that allow for a more stringent follow-up of the refrigerants in installations. A centralised system also has the advantage that targeted environmental inspections of installations can be done based on the information in the electronic logbooks.

→ **Other conclusions on recovery and reclamation of F-gases.**

The 2016 action plan on F-gases contain already numerous additional actions to reduce emissions from installations. The action plan focuses on fugitive emissions from installations and enhancing the transition to low-GWP and natural refrigerants. Disposal emissions are largely missing in the 2016 action plan though. In the short term, reducing disposal emissions would nevertheless have a positive effect on GHG emission reductions and contribute to 2020 and 2030 emission reduction targets.

Observation: Disposal emissions are largely missing in the 2016 action plan, which emphasises more on supporting the transition to low-GWP or alternative refrigerants. In the short term, reducing disposal emissions would have a positive effect on GHG emissions and contribute to 2020 and 2030 emission reduction targets.

Recommendation: Include recovery of F-gases from disposed refrigeration equipment in the actions listed in the 2016 action plan. There are several opportunities in the action plan to do this more explicitly:

- Action 3: Intensifying consultation and increase accountability of key stakeholders.
- Action 4: Sensitisation of owners of refrigeration installations, certified companies and technicians.

- Action 6: Support and, if needed, increase the effectiveness of enforcement of existing measures.

Involving and working closely with the sector to tackle disposal emissions is important.

Barrier: There are regional differences in legislation and enforcement. This creates an unlevel playing field and opens loopholes to avoid the most stringent legislation.

Recommendation: More harmonisation of the rules and legislation among regions could be beneficial. As CECED [CECED, 2016] argued and different respondents mentioned, a level playing field is important to avoid leakage of WEEE to the least stringent country or region, resulting in a lowered recycling quantity.

In the short term, the price incentive means that F-gases are recovered and reused, resulting in lower disposal emissions. The price incentive is caused by decreased supply (imposed by the EU F-gas regulation), while demand is only slowly changing. Higher prices for F-gases are expected to cause a shift from high-GWP to low-GWP alternative refrigerants. Demand for high-GWP refrigerants is therefore already decreasing. The dynamic between demand and supply will determine how prices and recovery of F-gases will evolve over the longer term.

4.2.3. TRANSITION TO LOW GWP REFRIGERANTS

An effective way to reduce disposal emissions in the long term is to speed-up the transition to low-GWP or natural refrigerants in new and existing installations. This was also stressed during the interviews. For F-gases where only reclaimed gases can be placed on the market from 2020 onwards, this transition has already started and almost no new installations with these gases are put into operation. Additionally, high prices mean an incentive for owners to replace the refrigerants either by drop-in or refurbishment of existing installations or at least improve tightness.

Although a tax on HFC consumption falls outside the competence of the Flemish government, a number of Member States have implemented an F-gas tax in the past, including Norway, Slovenia, Denmark, Poland, and Spain, mainly before the entry into force of the EU Regulation though. Taxation is often considered an effective environmental policy instrument type. In Denmark the F-gas tax (height of the tax depending on the GWP of the gases) has been an incentive to switch to low-GWP refrigerants, for example in commercial refrigeration [Madson, 2009]. Revenue from the tax was used to support R&D activities to ensure rapid development of alternative technologies in refrigeration. Additionally, Denmark also introduced product category bans. As a consequence, Denmark is the country with the highest share of super-critical refrigeration in the EU. Taxes also have downsides as it could lead to misuse and could increase illegal trade. As the Slovenian case showed, lack of taxes in neigbouring countries (and internet purchases) could lead to an HFC black market, making the tax ineffective [Solana Cipres, 2017]. The F-gas regulation and quota system resulted already in an increase of the prices of high-GWP refrigerants across the EU, which would makes taxes redundant.

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Abbreviations

F-gas	Fluorinated greenhouse gas
HFC	Hydrofluorocarbon
PFC	Perfluorocarbon
SF6	Sulphur hexafluoride
GHG	Greenhouse gas
WEEE	Waste of Electric and Electronic Equipment
EEE	Electric and Electronic Equipment
EoL	End-of-Life

Annex – vervoer van afvalkoelmiddelen

Raf Verlinden (OVAM)

WANNEER WORDT HET KOELMIDDEL EEN AFVALSTOF?

In principe wordt het koelmiddel een afvalstof als men er zich van ontdoet of als er bewerkingen nodig zijn om het koelmiddel terug te kunnen gebruiken.

Het koelmiddel wordt geen afvalstof als het bij de eigenaar van de installatie blijft voor het hervullen van een (andere) installatie, eventueel na een eenvoudig reinigingsproces (filter/droger). Het wordt ook geen afvalstof als het koelmiddel, direct of na een eenvoudig reinigingsproces (filter/droger) ter plaatse, kan worden hergebruikt als koelmiddel.

Het regenereren of het vernietigen van het koelmiddel zijn behandelingen op afvalstoffen. Zij moeten gebeuren in installaties die de nodige milieu- of omgevingsvergunning heeft voor het verwerken van afvalstoffen. Het koelmiddel wordt een afvalstof bij het aftappen ervan en blijft een afvalstof tot het terug voldoet om te worden hergebruikt of tot de vernietiging.

De producent van de afvalstof is de koeltechnicus/koeltechnische firma die het koelmiddel aftapt.

VERVOER VAN EEN KOELMIDDEL ALS AFVALSTOF.

Naast de ADR-reglementering is ook het VLAREMA van toepassing als men de afvalkoelmiddelen vervoert. Het VLAREMA bepaalt, naast algemene voorwaarden voor het vervoer van afvalstoffen:

- Dat de verantwoordelijke van een transport geregistreerd moet zijn als inzamelaar, afvalstoffenhandelaar en/of –makelaar (IHM);
- Dat de uitvoerder van een transport moet geregistreerd zijn als vervoerder;
- Dat elk transport moet vergezeld zijn van een identificatieformulier.

Op deze voorwaarden zijn er echter ook uitzondering opgenomen, o.a. als de afvalproducent het vervoer zelf uitvoert. Ook in VLAREM II zijn uitzonderingen opgenomen op de vergunningsplicht, o.a. voor opslag in functie van een regelmatige afvoer.

In de onderstaande scenario’s worden verschillende mogelijkheden van afvoer weergegeven die elk hun eigen verplichtingen voor de koeltechnische firma met zich meebrengen.

Scenario 1: de koeltechnische firma laat de koelmiddelen die kunnen worden herbruikt bij de eigenaar van de koelinstallatie.

Scenario 2: de koeltechnische firma neemt de koelmiddelen die rechtstreeks hergebruikt kunnen worden mee naar het eigen bedrijf.

Scenario 3: de koeltechnische firma neemt de afvalkoelmiddelen afkomstig van onderhoud en die niet rechtstreeks herbruikt kunnen worden, mee naar zijn bedrijfsterrein in afwachting van ophaling door een IHM.

Scenario 4: de koeltechnische firma neemt de afvalkoelmiddelen afkomstig van onderhoud en die niet rechtstreeks herbruikt kunnen worden, mee naar zijn bedrijfsterrein om te regenereren.

Scenario 5: de koeltechnische firma brengt de afvalkoelmiddelen afkomstig van onderhoud en die niet rechtstreeks herbruikt kunnen worden, rechtstreeks van plaats van productie naar een vergunde verwerker.

Scenario 6: de koeltechnische firma met minder dan 10 werknemers, brengt de afvalkoelmiddelen afkomstig van onderhoud en die niet rechtstreeks herbruikt kunnen worden, van het eigen bedrijfsterrein naar een vergunde verwerker.

Scenario 7: de koeltechnische firma met meer dan 10 werknemers, brengt de afvalkoelmiddelen afkomstig van onderhoud en die niet rechtstreeks herbruikt kunnen worden, van het eigen bedrijfsterrein naar een vergunde verwerker.

Scenario 8: de koeltechnische firma neemt bij het plaatsen van een nieuwe koelinstallatie de oude koelinstallatie inclusief de koelmiddelen mee naar het eigen bedrijf in afwachting van ophaling door een IHM.

Scenario 9: de koeltechnische firma neemt bij het plaatsen van een nieuwe koelinstallatie de oude koelinstallatie inclusief de koelmiddelen mee naar het eigen bedrijf om de koelmiddelen zelf te regenereren of recycleren.

Scenario 10: de koeltechnische firma brengt bij het plaatsen van een nieuwe koelinstallatie de oude koelinstallatie inclusief de koelmiddelen rechtstreeks naar een vergunde verwerker.

Scenario 11: de koeltechnische firma met minder dan 10 werknemers, brengt bij het plaatsen van een nieuwe koelinstallatie de oude koelinstallatie inclusief de koelmiddelen, van het eigen bedrijfsterrein naar een vergunde verwerker.

Scenario 12: de koeltechnische firma met meer dan 10 werknemers, brengt bij het plaatsen van een nieuwe koelinstallatie de oude koelinstallatie inclusief de koelmiddelen, van het eigen bedrijfsterrein naar een vergunde verwerker.

Scenario 13: de koeltechnische firma verwijdert een koelinstallatie inclusief de koelmiddelen zonder dat een nieuwe koelinstallatie wordt geplaatst en brengt deze naar zijn eigen terrein of naar een vergunde verwerker.

Scenario 14: De eigenaar (of werknemer van de eigenaar) van de koelinstallatie voert zelf een afgedankte koeltoepassing die nog koelmiddel bevat af naar een inzamelpunt, bedrijfsrecyclagepark, vergund verwerker.

Scenario 15: De eigenaar (of werknemer van de eigenaar) van de koelinstallatie laat een afgedankte koeltoepassing die nog koelmiddel bevat afvoeren door een derde firma naar een inzamelpunt, bedrijfsrecyclagepark, vergund verwerker.

In onderstaande tabel worden per scenario de wettelijke verplichting voor de koeltechnische firma weergegeven.

	afval	**Registratie vervoerder**	**Registratie IHM**	**Identificatie-formulier**	**Omgevings-vergunning voor verwerken van afvalstoffen**
Scenario 1	Nee	nvt	nvt	nvt	Nee
Scenario 2	Nee	nvt	nvt	nvt	Nee
Scenario 3	Ja	Nee	Nee	Nee	Nee
Scenario 4	Ja	Nee	Nee	Nee	Ja
Scenario 5	Ja	Nee	Nee	Nee	Nee
Scenario 6	Ja	Nee	Nee	Nee	Nee
Scenario 7	Ja	Nee	Ja	Ja	Nee
Scenario 8	Ja	Nee	Nee	Nee	Nee
Scenario 9	Ja	Nee	Nee	Nee	Ja
Scenario 10	Ja	Nee	Nee	Nee	Nee
Scenario 11	Ja	Nee	Nee	Nee	Nee
Scenario 12	Ja	Nee	Ja	Ja	Nee
Scenario 13	Ja	Nee	Nee	Nee	Nee

In scenario's 14 en 15 komt er geen koeltechnische firma tussen in het transport en worden de verplichtingen voor de eigenaar weergegeven.

	afval	Registratie vervoerder	Registratie IHM	Identificatie-formulier	Omgevings-vergunning voor verwerken van afvalstoffen
Scenario 14	Ja	Nee	Nee	Nee	Nee
Scenario 15	Ja	Nee	Nee	Ja	Nee

In scenario 15 moet de eigenaar gebruik maken van een vervoerder die bij de OVAM geregistreerd is om deze afvalstof te vervoeren. Dit hoeft niet noodzakelijk een koeltechnisch firma te zijn.

De registratie als vervoerder of IHM gebeurt online: https://services.ovam.be/sso/pages/login.xhtml. Naast de registratie moet de IHM voldoen aan nog bijkomende verplichtingen, waaronder het bijhouden van een afvalstoffenregister en het werken volgens een extern gekeurd kwaliteitsborgingssysteem (http://www.ovam.be/transport-van-afvalstoffen-en-materialen).

Annex - Online Survey

Deel 1: Algemene informatie

VITO, ECONOTEC en OEKO-RECHERCHE voeren een studie uit naar de fluorhoudende koelmiddelen die vrijkomen bij de buitendienststelling van commerciële en industriële koeling, en air conditioning en warmtepompen.

Projecties tonen aan dat de totale emissies bij de buitendienststelling van deze toestellen sterk kunnen toenemen in de nabije toekomst. Het doel van deze studie is om een zo accuraat mogelijk beeld te krijgen over de recuperatie en de emissies van fluorhoudende koelmiddelen bij buitendienststelling. Daarnaast zullen aanbevelingen geformuleerd worden om de recuperatie van koelmiddel verder te bevorderen.

De informatie van deze enquête zal gebruikt worden voor beide doelstellingen.

Naast onderstaande algemene vragen bestaat de enquête uit 16 vragen (duurtijd 12 minuten om in te vullen).

We danken u alvast voor uw medewerking.

Indien u vragen hebt over deze studie of de enquête, gelieve een email te sturen naar tom.dauwe[at]vito.be.

* 1. Naam

* 2. Naam bedrijf

* 3. De resultaten worden gedeeld met de opdrachtgever van deze studie. Geef aan indien u anoniem wenst te blijven bij de verwerking van de resultaten (persoonlijke gegevens zullen dan niet worden gedeeld met de opdrachtgever):

- ◯ Ja
- ◯ Nee

* 4. Contact gegevens (email of telefoonnummer)

Alle contactgegevens zullen confidentieel worden behandeld en enkel in het kader van deze studie worden gebruikt.

* 5. Bent u eventueel beschikbaar om uw antwoorden telefonisch verder toe te lichten?

- ◯ Ja
- ◯ Nee

* 6. Ik wil op de hoogte blijven van de resultaten van deze studie?

- ◯ Ja
- ◯ Nee

* 7. Sector waarin u actief bent

(meerdere opties mogelijk)

- ☐ air conditioning en warmtepompen
- ☐ commerciële koeling (klein- en groothandel)
- ☐ industriële koeling
- ☐ Andere:

* 8. Activiteit

(meedere opties mogelijk)

- ☐ Exploitant
- ☐ Koeltechnisch bedrijf
- ☐ Leverancier / ophaler gassen
- ☐ Consultant / expert / studiebureau
- ☐ Andere (specifieer):

* 9. Geef aan voor welke sectoren u vragen kan en wil beantwoorden:

- ◯ commerciële en industriële koeling
- ◯ air conditioning en warmtepompen
- ◯ beide (zowel commerciële en industriële koeling als air conditioning en warmtepompen)

Deel 2: Commerciële en industriële koeling

De onderstaande vragen polsen naar uw ervaringen wat betreft de recuperatie van fluorhoudende koelmiddelen uit commerciële en industriële koelinstallaties bij buitendienststelling.

Gebruik het tekstveld onder elke vraag om bijkomende toelichting te geven, waar nodig.

1. Het aantal commerciële en industriële installaties dat op het einde van de levensduur geen of zeer weinig fluorhoudend koelmiddel bevat bedraagt gemiddeld:
(% lege of bijna lege installaties voor de ontmanteling)

- ◯ minder dan 20%
- ◯ tussen 20 en 40%
- ◯ tussen 40 en 60%
- ◯ tussen 60 en 80%
- ◯ tussen 80 en 100%
- ◯ geen idee

Verdere toelichting (optioneel)

2. De hoeveelheid fluorhoudend koelmiddel in commerciële en industriële installaties die niet leeg zijn op het einde van de levensduur bedraagt gemiddeld:
(% ten opzichte van de oorspronkelijk aanwezige hoeveelheid koelmiddel in de installatie)

- ◯ minder dan 20%
- ◯ tussen 20 en 40%
- ◯ tussen 40 en 60%
- ◯ tussen 60 en 80%
- ◯ tussen 80 en 100%
- ◯ geen idee

Verdere toelichting (optioneel)

3. De recuperatie van fluorhoudend koelmiddel tijdens de ontmanteling van commerciële en industriële installaties bedraagt gemiddeld:
(% ten opzichte van de hoeveelheid koelmiddel in de installatie op het moment van buitendienststelling)

- ◯ minder dan 25%
- ◯ tussen 25 en 50%
- ◯ tussen 50 en 75%
- ◯ meer dan 75%
- ◯ geen idee

Verdere toelichting (optioneel):

4. Geef aan in hoeverre u het eens bent met volgende stelling:
Er zijn belangrijke verschillen in recuperatie tussen kleine en grote, commerciële en industriële koelinstallaties:

- ◯ eens
- ◯ grotendeels eens
- ◯ noch eens, noch oneens
- ◯ grotendeels oneens
- ◯ oneens
- ◯ geen mening

Indien (grotendeels) eens, wat zijn de redenen voor deze verschillen:

5. De recuperatie van fluorhoudende koelmiddelen uit commerciële en industriële installaties is hetzelfde voor alle gassen:

- ◯ ja, alle gassen hebben een gelijkaardige efficiëntie van recuperatie (de hoeveelheid gerecupereerd gas ten opzichte van de totale hoeveelheid gas in de installatie)
- ◯ nee, er zijn verschillen in de recuperatie efficiëntie afhankelijk van het type fluorhoudend koelmiddel
- ◯ geen idee

Indien nee, welke gassen worden het minst gerecupereerd:

6. Indien relevant, geef aan hoe frequent koelmiddelen worden verwijderd bij buitendienststelling van commerciële en industriële koelinstallaties ...

	bijna nooit (0 tot 10% van de hoeveelheid gerecupereerde gassen)	zelden (10 tot 40% van de hoeveelheid gerecupereerde gassen)	soms (40 tot 60% van de hoeveelheid gerecupereerde gassen)	vaak (60 - 90% van de hoeveelheid gerecupereerde gassen)	bijna altijd (90 - 100% an de hoeveelheid gerecupereerde gassen)
op vraag van de exploitant, voor de vervanging van een bestaande installatie	◯	◯	◯	◯	◯
op vraag van de exploitant, voor het definitief verwijderen van een bestaande installatie	◯	◯	◯	◯	◯
op vraag van een sloopbedrijf	◯	◯	◯	◯	◯
andere	◯	◯	◯	◯	◯
ik weet het niet	◯	◯	◯	◯	◯

Verdere toelichting (optioneel):

7. Indien geweten, wat gebeurt er met de gerecupereerde gassen:

(recyclage of regeneratie omvat alle technieken om koelmiddelen te zuiveren, zoals destillatie of filterdrogen)

	bijna nooit (0 tot 10% van de hoeveelheid gerecupereerde gassen)	zelden (10 tot 40% van de hoeveelheid gerecupereerde gassen)	soms (40 tot 60% van de hoeveelheid gerecupereerde gassen)	vaak (60 - 90% van de hoeveelheid gerecupereerde gassen)	bijna altijd (90 - 100% an de hoeveelheid gerecupereerde gassen)
koelmiddelen worden opgeslagen voor het bijvullen van bestaande installaties bij de exploitant	○	○	○	○	○
koelmiddelen worden hergebruikt na recyclage of regeneratie door een koeltechnisch bedrijf	○	○	○	○	○
koelmiddelen worden hergebruikt na recyclage of regeneratie door een ophaler/verdeler van gassen	○	○	○	○	○
koelmiddelen worden vernietigd	○	○	○	○	○
ik weet het niet	○	○	○	○	○

Verdere toelichting (optioneel):

8. De recuperatie van koelmiddelen uit commerciële en industriële installaties zal de komende vijf jaar:

- ○ eerder afnemen
- ○ eerder hetzelfde blijven
- ○ eerder toenemen
- ○ geen idee

Verdere toelichting (optioneel):

De onderstaande vragen peilen naar de huidige stand van zaken in Vlaanderen en mogelijke verbeteringen aan het huidige beleid over de recuperatie van koelmiddelen

9. Geef aan in hoeverre u het eens bent met volgende stelling:
In Vlaanderen verloopt de recuperatie van koelmiddelen uit commerciële en industriële koelinstallaties bij buitendienststelling volgens de geldende Europese en Vlaamse wetgeving.

Informatie over de Vlaamse wetgeving kan je vinden via deze link: https://www.lne.be/algemene-bepalingen-voor-alle-koelinstallaties

- ○ eens
- ○ grotendeels eens
- ○ noch eens/ noch oneens
- ○ grotendeels oneens
- ○ oneens
- ○ ik ken de wetgeving niet voldoende
- ○ geen mening

Verdere toelichting (optioneel):

10. Geef aan in hoeverre u het eens bent met volgende stelling:
De wetgeving is voldoende om de volledige recuperatie van koelmiddelen uit commerciële en industriële koelinstallaties bij buitendienststelling te waarborgen.

- ○ eens
- ○ grotendeels eens
- ○ noch eens/ noch oneens
- ○ grotendeels oneens
- ○ oneens
- ○ ik ken de wetgeving niet voldoende
- ○ geen mening

Verdere toelichting (optioneel):

11. Geef aan in hoeverre u het eens bent met volgende stelling:
De controle op de naleving van de wetgeving is voldoende om de recuperatie van koelmiddelen uit commerciële en industriële koelinstallaties bij buitendienststelling te waarborgen.

- ◯ eens
- ◯ grotendeels eens
- ◯ noch eens/ noch oneens
- ◯ grotendeels oneens
- ◯ oneens
- ◯ geen mening

Verdere toelichting (optioneel):

12. Geef aan in hoeverre volgende groepen kennis hebben over de bestaande wetgeving over de recuperatie van koelmiddelen bij buitendienststelling van commerciële en industriële installaties:

	voldoende	grotendeels voldoende	noch voldoende, noch onvoldoende	grotendeels onvoldoende	onvoldoende	geen mening
exploitanten van grote commerciële of industriële koelinstallaties	◯	◯	◯	◯	◯	◯
exploitanten van kleine commerciële of industriële koelinstallaties	◯	◯	◯	◯	◯	◯
koeltechnici	◯	◯	◯	◯	◯	◯
koeltechnische bedrijven	◯	◯	◯	◯	◯	◯
sloopbedrijven	◯	◯	◯	◯	◯	◯

13. Geef aan in hoeverre volgende groepen de bestaande wetgeving over de recuperatie van koelmiddelen bij buitendienststelling van commerciële en industriële installaties naleven:

	voldoende	grotendeels voldoende	noch voldoende, noch onvoldoende	grotendeels onvoldoende	onvoldoende	geen mening
exploitanten van grote commerciële of industriële installaties	◯	◯	◯	◯	◯	◯
exploitanten van kleine commerciële of industriële installaties	◯	◯	◯	◯	◯	◯
koeltechnici	◯	◯	◯	◯	◯	◯
koeltechnische bedrijven	◯	◯	◯	◯	◯	◯
sloopbedrijven	◯	◯	◯	◯	◯	◯

14. De recuperatie van fluorhoudende koelmiddelen uit commerciële en industriële installaties bij buitendienststelling kan nog verbeteren in Vlaanderen:

- ◯ ja, in belangrijke mate
- ◯ ja, in beperkte mate
- ◯ nee
- ◯ geen mening

Waarom wel/niet:

15. Wat zijn de voornaamste redenen (barrières) die op dit moment een betere recuperatie van fluorhoudende koelmiddelen uit commerciële en industriële installaties bij buitensdienststelling in de weg staan?

16. Welke bijkomende maatregelen zouden een positieve impact kunnen hebben op de recuperatie van fluorhoudende koelmiddelen bij buitendienststelling van commerciële en industriële installaties.

* 17. Gelieve te bevestigen dat de vragen volledig zijn ingevuld en u de enquête wil afsluiten?

- ja, ik ben klaar met het invullen van de enquête

Deel 2: Air conditioning en warmtepompen

De onderstaande vragen polsen naar uw ervaringen wat betreft de recuperatie van fluorhoudende koelmiddelen uit air conditioning en warmtepompen bij buitendienststelling.

Gebruik het tekstveld onder elke vraag om bijkomende toelichting te geven, waar nodig.

1. Het aantal air conditioning en warmtepompen dat op het einde van de levensduur geen of zeer weinig fluorhoudend koelmiddel bevat bedraagt gemiddeld:
(% lege of bijna lege installaties voor de ontmanteling)

- minder dan 20%
- tussen 20 en 40%
- tussen 40 en 60%
- tussen 60 en 80%
- tussen 80 en 100%
- geen idee

Verdere toelichting (optioneel)

2. De hoeveelheid fluorhoudend koelmiddel in air conditioning en warmtepompen die niet leeg zijn op het einde van de levensduur bedraagt gemiddeld:

(% ten opzichte van de normale hoeveelheid koelmiddel in de installatie)

- ◯ minder dan 20%
- ◯ tussen 20 en 40%
- ◯ tussen 40 en 60%
- ◯ tussen 60 en 80%
- ◯ tussen 80 en 100%
- ◯ geen idee

Verdere toelichting (optioneel)

3. De recuperatie van fluorhoudend koelmiddel tijdens de ontmanteling van air conditioning en warmtepompen bedraagt gemiddeld:

(% ten opzichte van de hoeveelheid koelmiddel in de installatie op het moment van buitendienststelling)

- ◯ minder dan 25%
- ◯ tussen 25 en 50%
- ◯ tussen 50 en 75%
- ◯ meer dan 75%
- ◯ geen idee

Verdere toelichting (optioneel):

4. Geef aan in hoeverre u het eens bent met volgende stelling:
Er zijn belangrijke verschillen in recuperatie tussen kleine en grote, residentiële en commerciële air conditioning en warmtepomp installaties:

- ◯ eens
- ◯ grotendeels eens
- ◯ noch eens, noch oneens
- ◯ grotendeels oneens
- ◯ oneens
- ◯ geen mening

Indien (grotendeels) eens, wat zijn de redenen voor deze verschillen:

5. De recuperatie van fluorhoudende koelmiddelen uit air conditioning en warmtepompen is hetzelfde voor alle gassen:

- ◯ ja, alle gassen hebben een gelijkaardige efficiëntie van recuperatie (de hoeveelheid gerecupereerd gas ten opzichte van de totale hoeveelheid gas in de installatie)
- ◯ nee, er zijn verschillen in de recuperatie efficiëntie afhankelijk van het type fluorhoudend koelmiddel
- ◯ geen idee

Indien nee, welke gassen worden het minst gerecupereerd:

6. Indien geweten, wat gebeurt er met de gerecupereerde gassen:

(recyclage of regeneratie omvat alle technieken om koelmiddelen te zuiveren, zoals destillatie of filterdrogen)

	bijna nooit (0 tot 10% van de hoeveelheid gerecupereerde gassen)	zelden (10 tot 40% van de hoeveelheid gerecupereerde gassen)	soms (40 tot 60% van de hoeveelheid gerecupereerde gassen)	vaak (60 - 90% van de hoeveelheid gerecupereerde gassen)	bijna altijd (90 - 100% an de hoeveelheid gerecupereerde gassen)
koelmiddelen worden opgeslagen bij de eigenaar voor het bijvullen van bestaande installaties	○	○	○	○	○
koelmiddelen worden hergebruikt na recyclage of regeneratie door een koeltechnisch bedrijf	○	○	○	○	○
koelmiddelen worden hergebruikt na recyclage of regeneratie door een ophaler/verdeler van gassen	○	○	○	○	○
koelmiddelen worden vernietigd	○	○	○	○	○
ik weet het niet	○	○	○	○	○

Verdere toelichting (optioneel):

7. Indien relevant, geef aan hoe frequent koelmiddelen worden verwijderd bij buitendienststelling van air conditioning en warmtepomen ...

	bijna nooit (0 tot 10% van de hoeveelheid gerecupereerde gassen)	zelden (10 tot 40% van de hoeveelheid gerecupereerde gassen)	soms (40 tot 60% van de hoeveelheid gerecupereerde gassen)	vaak (60 - 90% van de hoeveelheid gerecupereerde gassen)	bijna altijd (90 - 100% an de hoeveelheid gerecupereerde gassen)
op vraag van de eigenaar, voor de vervanging van een bestaande installatie	○	○	○	○	○
op vraag van de eigenaar, voor het definitief verwijderen van een bestaande installatie	○	○	○	○	○
op vraag van een sloopbedrijf	○	○	○	○	○
andere	○	○	○	○	○
ik weet het niet	○	○	○	○	○

Verdere toelichting (optioneel):

8. De recuperatie van koelmiddelen uit air conditioning en warmtepompen zal de komende vijf jaar:

- ○ eerder afnemen
- ○ eerder hetzelfde blijven
- ○ eerder toenemen
- ○ geen idee

Verdere toelichting (optioneel):

De onderstaande vragen peilen naar de huidige stand van zaken in Vlaanderen en mogelijke verbeteringen aan het huidige beleid over de recuperatie van koelmiddelen

9. Geef aan in hoeverre u het eens bent met volgende stelling:
In Vlaanderen verloopt de recuperatie van koelmiddelen uit air conditioning en warmtepompen bij buitendienststelling volgens de geldende Europese en Vlaamse wetgeving.

Informatie over de Vlaamse wetgeving kan je vinden via deze link: https://www.lne.be/algemene-bepalingen-voor-alle-koelinstallaties

- ◯ eens
- ◯ grotendeels eens
- ◯ noch eens/ noch oneens
- ◯ grotendeels oneens
- ◯ oneens
- ◯ ik ken de wetgeving niet voldoende
- ◯ geen mening

Verdere toelichting (optioneel):

10. Geef aan in hoeverre u het eens bent met volgende stelling:
De wetgeving is voldoende om de volledige recuperatie van koelmiddelen uit air conditioning en warmtepompen bij buitendienststelling te waarborgen.

- ◯ eens
- ◯ grotendeels eens
- ◯ noch eens/ noch oneens
- ◯ grotendeels oneens
- ◯ oneens
- ◯ ik ken de wetgeving niet voldoende
- ◯ geen mening

Verdere toelichting (optioneel):

11. Geef aan in hoeverre u het eens bent met volgende stelling:
De controle op de naleving van de wetgeving is voldoende om de volledige recuperatie van koelmiddelen uit air conditioning en warmtepompen bij buitendienststelling te waarborgen.

- ◯ eens
- ◯ grotendeels eens
- ◯ noch eens/ noch oneens
- ◯ grotendeels oneens
- ◯ oneens
- ◯ geen mening

Verdere toelichting (optioneel):

12. Geef aan in hoeverre volgende groepen kennis hebben over de bestaande wetgeving over de recuperatie van koelmiddelen bij buitendienststelling van air conditioning en warmtepompen:

	voldoende	grotendeels voldoende	noch voldoende, noch onvoldoende	grotendeels onvoldoende	onvoldoende	geen mening
eigenaars van air conditioning en warmtepompen	◯	◯	◯	◯	◯	◯
koeltechnici	◯	◯	◯	◯	◯	◯
koeltechnische bedrijven	◯	◯	◯	◯	◯	◯
sloopbedrijven	◯	◯	◯	◯	◯	◯

13. Geef aan in hoeverre volgende groepen de bestaande wetgeving over de recuperatie van koelmiddelen bij buitendienststelling van air conditioning en warmtepompen naleven:

	voldoende	grotendeels voldoende	noch voldoende, noch onvoldoende	grotendeels onvoldoende	onvoldoende	geen mening
eigenaars van air conditioning en warmtepompen	○	○	○	○	○	○
koeltechnici	○	○	○	○	○	○
koeltechnische bedrijven	○	○	○	○	○	○
sloopbedrijven	○	○	○	○	○	○

14. De recuperatie van koelmiddelen uit air conditioning en warmtepompen bij buitendienststelling kan nog verbeteren in Vlaanderen:

- ○ ja, in belangrijke mate
- ○ ja, in beperkte mate
- ○ nee
- ○ geen mening

Waarom wel/niet:

15. Wat zijn de voornaamste redenen (barrières) die op dit moment een betere recuperatie van koelmiddelen uit air conditioning en warmtepompen bij buitensdienststelling in de weg staan?

16. Welke bijkomende maatregelen zouden een positieve impact kunnen hebben op de recuperatie van koelmiddelen bij buitendienststelling van air conditioning en warmtepompen.

* 17. Gelieve te bevestigen dat de vragen volledig zijn ingevuld en u de enquête wil afsluiten?

- ○ ja, ik ben klaar met het invullen van de enquête

Deel 2: Commerciële en industriële koeling, air conditioning en warmtepompen

De onderstaande vragen polsen naar uw ervaringen wat betreft de recuperatie van fluorhoudende koelmiddelen uit commerciële en industriële koelinstallaties en air conditioning en warmtepompen bij buitendienststelling.

Gebruik het tekstveld onder elke vraag om bijkomende toelichting te geven, waar nodig.

1. Het aantal installaties dat op het einde van de levensduur geen of zeer weinig fluorhoudend koelmiddel bevat, bedraagt gemiddeld:
(% lege of bijna lege installaties voor de ontmanteling)

	Voor commerciële en industriële koelinstallaties	Voor air conditioning en warmtepompen
minder dan 20%	☐	☐
tussen 20 en 40%	☐	☐
tussen 40 en 60%	☐	☐
tussen 60 en 80%	☐	☐
tussen 80 en 100%	☐	☐
geen idee	☐	☐

Verdere toelichting (optioneel)

2. De hoeveelheid fluorhoudend koelmiddel in installaties die niet leeg zijn op het einde van de levensduur bedraagt gemiddeld:

(% ten opzichte van de oorspronkelijk aanwezige hoeveelheid koelmiddel in de installatie)

	Voor commerciële en industriële koelinstallaties	Voor air conditioning en warmtepompen
minder dan 20%	☐	☐
tussen 20 en 40%	☐	☐
tussen 40 en 60%	☐	☐
tussen 60 en 80%	☐	☐
tussen 80 en 100%	☐	☐
geen idee	☐	☐

Verdere toelichting (optioneel)

3. De recuperatie van fluorhoudend koelmiddel tijdens de ontmanteling van installaties bedraagt gemiddeld:

(% ten opzichte van de hoeveelheid koelmiddel in de installatie op het moment van buitendienststelling)

	Voor commerciële en industriële koelinstallaties	Voor air conditioning en warmtepompen
minder dan 25%	☐	☐
tussen 25 en 50%	☐	☐
tussen 50 en 75%	☐	☐
meer dan 75%	☐	☐
geen idee	☐	☐

Verdere toelichting (optioneel):

4. Geef aan in hoeverre u het eens bent met volgende stelling:
Er zijn belangrijke verschillen in recuperatie tussen kleine en grote installaties:

	Voor commerciële en industriële koelinstallaties	Voor air conditioning en warmtepompen
eens	☐	☐
grotendeels eens	☐	☐
noch eens, noch oneens	☐	☐
grotendeels oneens	☐	☐
oneens	☐	☐
geen mening	☐	☐

Indien (grotendeels) eens, wat zijn de redenen voor deze verschillen:

5. De recuperatie van fluorhoudende koelmiddelen is hetzelfde voor alle gassen:

	Voor commerciële en industriële koelinstallaties	Voor air conditioning en warmtepompen
Ja, alle gassen hebben een gelijkaardige efficiëntie van recuperatie (de hoeveelheid gerecupereerd gas ten opzichte van de totale hoeveelheid gas in de installatie)	☐	☐
Nee, er zijn verschillen in de recuperatie efficiëntie afhankelijk van het type fluorhoudend koelmiddel	☐	☐
Geen idee	☐	☐

Indien nee, welke gassen worden het minst gerecupereerd:

6. Indien geweten, wat gebeurt er met de gerecupereerde gassen:

(recyclage of regeneratie omvat alle technieken om koelmiddelen te zuiveren, zoals destillatie of filterdrogen)

	bijna nooit (0 tot 10% van de hoeveelheid gerecupereerde gassen)	zelden (10 tot 40% van de hoeveelheid gerecupereerde gassen)	soms (40 tot 60% van de hoeveelheid gerecupereerde gassen)	vaak (60 - 90% van de hoeveelheid gerecupereerde gassen)	bijna altijd (90 - 100% an de hoeveelheid gerecupereerde gassen)
koelmiddelen worden opgeslagen bij de eigenaar/exploitant voor het bijvullen van bestaande installaties	○	○	○	○	○
koelmiddelen worden hergebruikt na recyclage of regeneratie door een koeltechnisch bedrijf	○	○	○	○	○
koelmiddelen worden hergebruikt na recyclage of regeneratie door een ophaler/verdeler van gassen	○	○	○	○	○
koelmiddelen worden vernietigd	○	○	○	○	○
ik weet het niet	○	○	○	○	○

Verdere toelichting (optioneel):

7. Indien relevant, geef aan hoe frequent koelmiddelen worden verwijderd bij buitendienststelling van een installatie ...

	bijna nooit (0 tot 10% van de hoeveelheid gerecupereerde gassen)	zelden (10 tot 40% van de hoeveelheid gerecupereerde gassen)	soms (40 tot 60% van de hoeveelheid gerecupereerde gassen)	vaak (60 - 90% van de hoeveelheid gerecupereerde gassen)	bijna altijd (90 - 100% an de hoeveelheid gerecupereerde gassen)
op vraag van de eigenaar, voor de vervanging van een bestaande installatie	○	○	○	○	○
op vraag van de eigenaar, voor het definitief verwijderen van een bestaande installatie	○	○	○	○	○
op vraag van een sloopbedrijf	○	○	○	○	○
andere	○	○	○	○	○
ik weet het niet	○	○	○	○	○

Verdere toelichting (optioneel):

8. De recuperatie van koelmiddelen zal de komende vijf jaar:

	Voor commerciële en industriële koelinstallaties	Voor air conditioning en warmtepompen
eerder afnemen	☐	☐
eerder hetzelfde blijven	☐	☐
eerder toenemen	☐	☐
geen idee	☐	☐

Verdere toelichting (optioneel):

De onderstaande vragen peilen naar de huidige stand van zaken in Vlaanderen en mogelijke verbeteringen aan het huidige beleid over de recuperatie van koelmiddelen

9. Geef aan in hoeverre u het eens bent met volgende stelling:
In Vlaanderen verloopt de recuperatie van fluorhoudende koelmiddelen bij buitendienststelling volgens de geldende Europese en Vlaamse wetgeving.

Informatie over de Vlaamse wetgeving kan je vinden via deze link: https://www.lne.be/algemene-bepalingen-voor-alle-koelinstallaties

	Voor commerciële en industriële koelinstallaties	Voor air conditioning en warmtepompen
eens	☐	☐
grotendeels eens	☐	☐
noch eens/noch oneens	☐	☐
grotendeels oneens	☐	☐
oneens	☐	☐
ik ken de wetgeving niet voldoende	☐	☐
geen mening	☐	☐

10. Geef aan in hoeverre u het eens bent met volgende stelling:
De wetgeving is voldoende om de recuperatie van koelmiddelen bij buitendienststelling te waarborgen.

	Voor commerciële en industriële koelinstallaties	Voor air conditioning en warmtepompen
eens	☐	☐
grotendeels eens	☐	☐
noch eens/ noch oneens	☐	☐
grotendeels oneens	☐	☐
oneens	☐	☐
ik ken de wetgeving niet voldoende	☐	☐
geen mening	☐	☐

Verdere toelichting (optioneel):

11. Geef aan in hoeverre u het eens bent met volgende stelling:
De controle op de naleving van de wetgeving is voldoende om de recuperatie van koelmiddelen uit installaties bij buitendienststelling te waarborgen.

	Voor commerciële en industriële koelinstallaties	Voor air conditioning en warmtepompen
eens	☐	☐
grotendeels eens	☐	☐
noch eens/ noch oneens	☐	☐
grotendeels oneens	☐	☐
oneens	☐	☐
geen mening	☐	☐

Verdere toelichting (optioneel):

12. Geef aan in hoeverre volgende groepen kennis hebben over de bestaande wetgeving over de recuperatie van koelmiddelen bij buitendienststelling:

	voldoende	grotendeels voldoende	noch voldoende, noch onvoldoende	grotendeels onvoldoende	onvoldoende	geen mening
exploitanten van commerciële of industriële installaties	○	○	○	○	○	○
eigenaars van air conditioning en warmtepompen	○	○	○	○	○	○
koeltechnici	○	○	○	○	○	○
koeltechnische bedrijven	○	○	○	○	○	○
sloopbedrijven	○	○	○	○	○	○

13. Geef aan in hoeverre volgende groepen de bestaande wetgeving over de recuperatie van koelmiddelen bij buitendienststelling naleven:

	voldoende	grotendeels voldoende	noch voldoende, noch onvoldoende	grotendeels onvoldoende	onvoldoende	geen mening
exploitanten van commerciële of industriële installaties	○	○	○	○	○	○
eigenaars van air conditioning en warmtepompen	○	○	○	○	○	○
koeltechnici	○	○	○	○	○	○
koeltechnische bedrijven	○	○	○	○	○	○
sloopbedrijven	○	○	○	○	○	○

14. De recuperatie van fluorhoudende koelmiddelen bij buitendienststelling kan nog verbeteren in Vlaanderen:

	Voor commerciële en industriële koelinstallaties	Voor air conditioning en warmtepompen
ja, in belangrijke mate	☐	☐
ja, in beperkte mate	☐	☐
nee	☐	☐
geen mening	☐	☐

Waarom wel/niet:

15. Wat zijn de voornaamste redenen (barrières) die op dit moment een betere recuperatie van koelmiddelen uit commerciële en industriële koelinstallaties, air conditioning en warmtepompen bij buitensdienststelling in de weg staan?

16. Welke bijkomende maatregelen zouden een positieve impact kunnen hebben op de recuperatie van koelmiddelen bij buitendienststelling van commerciële en industriële koelinstallaties, air conditioning en warmtepompen.

Hartelijk dank om aan deze enquête te hebben deelgenomen!

Meer weten over de regelgeving en het beleid rond fluorhoudende koelmiddelen?

Ga naar: https://www.lne.be/f-gassen

Indien u vragen hebt over deze enquête of studie kan u een email sturen naar:
tom.dauwe[at]vito.be

DEPARTMENT OF
ENVIRONMENT
& SPATIAL
DEVELOPMENT