28 November 2012
Working Group Orientation Debate

REVISION OF THE F-GAS REGULATION: POLICY PRIMER

OVERVIEW

The Commission's proposal for a revised F-Gas Regulation, released in November 2012,[1] contains the basic elements required to tackle HFC emissions but lacks ambition and advances an incomplete regulatory framework. Parliament and the Council should amend the Commission proposal by including specific policies targeting critical moments in the lifetime of HFC-based equipment - before use (bans), during use (containment) and end of use (recovery) - supported with an economy-wide phase-down.

The current proposal lacks critical measures. Its centre-piece is an industry-wide phase-down with bans in hermetically sealed and pre-charged equipment.[2] Despite clear evidence of the technical and economic feasibility of additional bans in other sub-sectors, these have not been included. This represents a dramatic departure from the successful regulatory framework applied to ozone-depleting substances (ODS Regulation) where a phase-out was coupled with robust bans in refrigeration, air-conditioning, aerosols and foams when CFC or HCFC-based products and equipment were no longer needed.[3] There are good reasons to adopt this same regulatory approach for reducing HFC emissions here. In addition, HFC quotas are over-allocated and as a result the actual reduction steps in the phase-down are not sufficiently restrictive to promote the adoption of alternative technologies, encourage better containment and recovery practices or prevent the uptake of medium-global warming potential (GWP) HFCs over low-GWP solutions. Further amendments are also required to strengthen containment and recovery measures, which were at the heart of the original F-Gas Regulation but have failed to significantly reduce HFC emissions due to unclear obligations.

The Environmental Investigation Agency (EIA) and the European Environmental Bureau (EEB) propose the following revisions and rationale.

INTRODUCE ADDITIONAL BANS

Safe, energy-efficient and cost-effective alternatives to HFCs are on the market today.[4] When those alternatives can fully meet market demand for any given application new equipment using HFCs should be banned in that sub-sector. Although the leaked Commission proposal circulated in inter-services included bans in commercial and industrial refrigeration on this basis, the current proposal omits them. It is not clear on what grounds they have been excluded from the final proposal, and we urge their reintroduction in the final Regulation.

The current proposal includes only additional bans in Annex III in domestic and hermetically sealed commercial refrigerators and freezers, hermetically sealed movable room air-conditioning appliances and in fire protection systems using HFC-23. In terms of refrigeration, the sectors chosen for bans are essentially considered leak-proof since equipment is sealed during manufacture and not reopened for charging. The *Impact Assessment* and *Preparatory Study* recognise that bans in these small sub-

sectors will not result in significant emission reductions compared to other sub-sectors. For example, in refrigeration, the bans in domestic and commercial hermetically sealed appliances are estimated to yield emission reductions of 159 $ktCO_2eq$ by 2030, whereas 2020 bans in new condensing units and centralised systems would yield reductions of 2,849 $ktCO_2eq$ and 12,055 $ktCO_2eq$, respectively.[5] Similarly, in air-conditioning, the ban in movable air-conditioning units is estimated to reduce emissions by 2,781 $ktCO_2eq$ while emission reductions expected from a ban on HFC-containing single-split air-conditioning units would be more than ten times higher at 22,970 $ktCO_2eq$.[6] Bans "lock-in" benefits in sub-sectors capable of transitioning.

The *Impact Assessment* and *Preparatory Study* have identified when bans can be adopted using the concept of "penetration rates."[7] The penetration rate is defined as "the maximum market potential of a technical choice (i.e. abatement option) to replace new products or equipment relying upon HFCs in a particular sector."[8] It incorporates safety concerns and constraints in addition to cost constraints while also factoring in the availability of materials and components, system complexity and know-how.[9] It also ensures, as its basic guiding principle, that abatement options (alternatives) achieve "*at least the same level of efficiency as the existing refrigerants.*"[10] When penetration rates reach 100% for any given sector, the presumption should be strongly in favor of inclusion in the list of bans in Annex III. Since penetration rates represent conservative assessments, they also serve as the latest date from which a prohibition should take effect. Earlier action is advised under the precautionary principle, bedrock Union law in the Lisbon Treaty.[11]

The following revisions to Annex III are needed:

1. **Re-introduce the bans in commercial and industrial refrigeration that were included in the draft Commission proposal circulated during inter-services consultation**. Bans in refrigeration are supported by an unparalleled body of technical evidence,[12] and an abundance of real-world experiences.[13] This sector also comprises the highest proportion of HFC emissions. The *Impact Assessment* and *Preparatory Study* show that alternatives are cost-effective and achieve clear reductions in HFC emissions, with penetration rates reaching 100% in 2020 or before.[14] Given the clear energy efficiency of alternatives, bans also reduce indirect GHG emissions. The bans included in the draft Commission proposal circulated during inter-services should therefore be re-introduced in Annex III.[15]

2. **Introduce bans in foams starting in 2015**. Foams can have long lifetimes of up to 50 years, with the *Impact Assessment* indicating that "a lack of public intervention today would result in higher emissions up to several decades into the future."[16] The *Impact Assessment* and *Preparatory Study* show that alternatives are cost-effective and achieve clear reductions in HFC emissions, with penetration rates reaching 100% in 2015.[17] In addition, it is costly to recover F-gases from foam products. A March 2012 report commissioned by DG Climate demonstrated that no end-of-life recovery measures were possible within €50 per tCO_2, whereas a phase-out of HFC use in XPS and PU spray foam sectors would generate substantial emission reductions at reasonable cost-effectiveness.[18] These bans should be included in Annex III.

3. **Introduce bans in aerosols (except metered-dose inhalers) starting in 2015**. The *Impact Assessment* and *Preparatory Study* show that alternatives to aerosols are cost-effective and achieve clear reductions in HFC emissions, with penetration rates reaching 100% in 2015.[19] These bans should be included in Annex III.

4. **Introduce bans in stationary air-conditioning when penetration rates reach 100%**. Bans in stationary air-conditioning are also supported by a large body of technical evidence.[20] This sector comprises the second highest proportion of HFC emissions and is the fastest growing

source of emissions. The *Impact Assessment* and *Preparatory Study* show that alternatives are cost-effective and achieve clear reductions in HFC emissions, with penetration rates reaching 100% in 2020 in all sub-sectors (single-split, multi-split, rooftop, displacement chillers) except centrifugal chillers.[21] Given that improvements in energy efficiency are inherent in technology generation, and alternative technologies are much earlier in the innovation curve than HFC technologies, significant energy savings can be expected. New bans for this sector should be included in Annex III.

5. **Introduce bans in refrigerated vans, trucks and trailers**. The *Impact Assessment* and *Preparatory Study* show that bans are cost-effective and achieve clear reductions in HFC emissions in transport refrigeration, with penetration rates reaching 100% in 2020 for refrigerated vans and in 2030 for refrigerated trucks and trailers.[22] These bans should be included in Annex III.

6. **Introduce bans in cargo ship air-conditioning**. The *Impact Assessment* and *Preparatory Study* show that bans are cost-effective and achieve clear reductions in HFC emissions in cargo ship air-conditioning, with penetration rates reaching 100% in 2020.[23] This ban should be included in Annex III.

Strengthen Phase-Down

It is vital that the phase-down is as robust as possible, which requires that HFC quotas are not over-allocated. While a crucial measure, by itself a phase-down has many limitations. In particular, a phase-down without additional bans fails to send clear market signals. Providers of both HFC and HFC-free technologies must divine the future marketplace and speculate whether HFC-based equipment will continue to compete in their sub-sector. A phase-down approach that is not sub-sector specific fails to level the playing field, something that is urgently required to allow for resource allocation and strategic planning. The chronic market uncertainty across all sub-sectors penalises smaller enterprises, which have less room to manoeuvre than their larger competitors and rely more on outside investment. In contrast, bans send *clear market signals with concrete timeframes for companies and investors in each sub-sector*, spurring the necessary planning and capital investments to achieve scale of production and meet market demand.

A phase-down alone does not guarantee transitions to climate-friendly alternatives in new equipment. Without bans, the much more likely scenario is a transition to slightly lower-GWP HFCs and blends owned by mostly Japanese and American multinationals, thus failing to position European businesses as global leaders and undermining their first-mover advantage with tremendous implications for climate policy at the international level.

Case Study: "Lower-GWP" HFC Lobby

Chemical producers such as Arkema, Daikin, Dupont, Honeywell and Mexichem are offering a range of "lower-GWP" options. For example, Honeywell's HFC-407F (GWP 1,850), known by the name Genetron® Performax™ LT, is targeted to replace HFC-404A (GWP 3,922) in refrigeration. Other examples include several mid-GWP HFCs and HFC blends: (i) HFC-32 (GWP 675) produced by Daikin for use in stationary air-conditioning and to make other HFC blends; and (ii) HFC-1234yf (GWP 4) and HFC-1234ze (GWP 7) produced by Honeywell and DuPont and mixed with high-GWP HFCs to create new HFC blends (GWP 600-800) for refrigeration. These chemical companies are lobbying heavily for a phase-down structured to facilitate their market dominance – one that removes their high-GWP HFC competition while allowing unfettered access to lower-GWP HFCs and HFC blends in the future one (i.e. more strict in early years, more relaxed in later years with a significant "tail" after 2030). Including bans limits the ability of chemical companies to manipulate the phase-down schedule to favour medium-GWP HFCs over low-GWP alternatives in new equipment.

Unlike other GHGs, HFCs have considerable differences in GWP, ranging from 4 to 14,800. Since the phase-down is CO_2-weighted, the downward pressure can be eliminated (at least initially and possibly long-term) through the use of slightly lower-GWP HFCs or blends. The continued market dominance of HFC-based equipment is the single greatest threat to the transition to alternatives. In addition, bans are needed to "lock-in" benefits that are possible through the move to truly low-GWP alternatives and prevent the long-term reliance on expensive and difficult containment and recovery given equipment lifetime is 10-30 years. The use of bans can ensure that sub-sectors capable of transitioning do so as soon as they are able, and that the benefits of this are not offset by laggard sectors.

This means that the first and most important measure to support and tighten the phase-down is through the inclusion of bans in Annex III (see above).

With a comprehensive set of bans in place, a properly calculated phase-down which significantly restricts the quantities of HFCs available can play a vital supporting role: by promoting the uptake of alternatives before bans take effect and ensuring a smooth transition; by limiting the HFC quantities available for refill or recharge, thereby encouraging tighter systems and less leakage; and by incentivising the reclamation and recycling of used HFCs. It can also drive technical innovation and early transitions in the few sub-sectors where bans are not feasible and sends a clear economy-wide signal that the long-term use of HFCs is unsustainable. A phase down could further generate revenue to cover Member State expenditures through an allocation system that distributes HFC quotas at a cost. But these benefits depend on avoiding over-allocation of HFC quotas.

But a phase-down is never a substitute for the other measures. Only containment measures can establish mandatory leakage checks or maximum leakage rates and only recovery measures can mandate recovery or producer responsibility schemes, as discussed below. Nor does a phase-down ensure that only alternatives are used when HFC-based equipment is no longer needed in a given sub-sector, which only bans can do. For these reasons, a phase-down is a critical part of a package of policies to address HFC emissions but a substitute for none.

The following improvements to the phase down are needed:

1. **Adopt a tighter HFC baseline to prevent over-allocation**. Proposed Annex V calculates the HFC baseline as the "annual average of the total quantity produced and imported into the Union during the period from 2008 to 2011."[24] This contrasts with the *Preparatory Study*, which relied on a bottom-up approach in the *AnaFgas* model developed specifically for this revision to calculate actual HFC demand for new and existing equipment based on current and future HFC infrastructure.[25] The last-minute switch to reported data, in which even the *Impact Assessment* acknowledges overestimation is possible,[26] serves to inflate the HFC baseline, in particular by locking in historical noncompliance with containment and recovery, which resulted in higher leakage and lower reclamation rates than what should have been achieved under full implementation (thus rewarding bad behaviour).[27] To the extent reported data is used, it should be adjusted to reflect what should have occurred under full compliance.

2. **Amend reduction steps before 2020 to avoid deliberate over-allocation**. There is no need for the first two reduction steps in 2016 and 2018 to deliberately over-allocate HFCs by 10% and 5%, respectively.[28] The reductions steps *must* be downward adjusted so that the reduction step in 2016 is 83% (not 93%) and the reduction step in 2018 is 58% (not 63%).

3. **Amend reduction steps after 2020 to take account of the ban on servicing and maintenance of existing refrigeration equipment with high-GWP HFCs.** Article 11 in the draft Regulation prohibits the use of HFCs or HFC blends with GWP 2,500 or more in the servicing and maintenance of refrigeration equipment with a charge sizes 5 tCO_2eq or more, from 1 January

2020. This will ban the use of HFC-404A, an HFC blend (GWP 3,922) that is extensively used in refrigeration equipment across the European Union and responsible for the largest proportion of HFC emissions. According to the industry-funded *SKM Enviros* report, HFC-404A consumption in refrigeration represents 44% of GWP-weighted consumption of refrigerants in 2010.[29] The SKM Enviros report analysed a scenario where 50-75% of existing stationary refrigeration systems (commercial and industrial) was retrofilled with lower-GWP refrigerants during 2014-2017 and all new systems avoided the use of HFC-404A during 2015-2019, demonstrating deep cuts in HFC demand.[30] Indeed, the *SKM Enviros* report even acknowledges that an earlier start and faster move away from HFC-404A is technically feasible.[31] Phasing out HFC-404A therefore will have a significant impact on CO_2-weighted demand after 2020 but the reduction steps in the current proposal did not consider this impact, resulting in significant over-allocation of HFC permits in 2021, 2024, 2027 and 2030.[32] In addition, there is no reason to wait until 2020 for HFC-404A to be banned; this date should be brought forward to 2017, at least for medium temperature systems which represent the majority of the systems.

4. **Require allocation fees to access HFC quotas**. HFC quotas are grandfathered at no cost.[33] The only other option explored by the Commission was an auction, which was rejected because of the small number of actors (collusion) and administrative burden (hassle).[34] In addition, it would likely yield very low prices, as in the EU Emissions Trading Scheme (ETS), due to HFC over-allocation described above. However grandfathering violates the polluter pays principle, bedrock Union law in the Lisbon Treaty.[35] A better approach is to require payment of fixed allocation fees, which is administratively simple and will secure a revenue stream to compensate Member States for costs associated with training and certification,[36] collection of emissions data,[37] and enforcement.

STRENGTHEN CONTAINMENT MEASURES

Once HFC-based equipment is placed on the market, leakage is unavoidable and containment is needed. At the time of adoption of the original F-Gas Regulation, the effectiveness of containment was largely unknown. The Commission imagined that containment measures would result in Union-wide leakage rates of 5.5%, something which now seems hopelessly ambitious.[38] The failure of the original F-Gas Regulation to reduce HFC emissions is precisely due to overreliance on containment. Containment is also expensive, with costs primarily borne by Member States, taxpayers and end-users, rather than the HFC producers. The new proposal from the Commission, however, just exchanges one set of unclear legal obligations for another and overlooks well-known compliance and enforcement problems.

The following revisions to containment measures are needed:

1. **Outline precautionary measures that must be taken to prevent leakage**. The original F-Gas Regulation required operators to take "*all measures which are technically feasible and do not entail disproportionate cost*." That language was discarded because it created too much uncertainty, compounded by the fact that the original F-Gas Regulation did not state what it considered to be "*technically feasible*" or "*disproportionate cost*." The Commission proposal now requires operators of HFC-based equipment to "*take precautions to prevent their unintentional release."* However, the proposal does not include an annex of precautionary measures or delegate to the Commission the task of detailing them. From a legal perspective, these unclear obligations are effectively inoperative.

2. **Maximum leakage rates are an important backstop to unabated leakage**. Maximum leakage rates already exist in some Member States, namely Germany, Belgium and Luxembourg.[39]

From both a compliance and enforcement perspective, maximum leakage rates provide clear benchmarks that set out impermissible limits and allow violations to be pursued. Findings in the *Preparatory Study* support the inclusion of maximum leakage rates: "[f]rom a legal point of view, the establishment of maximum leakage rates would lead to clear identification of leaks and hence provide an additional tool for control and enforcement of containment measures resulting in F-gas emission reductions."[40] The *Preparatory Study* also notes that maximum leakage rates are already set out in several sectors by international and European standards.[41] It does caution, however, that "the choice of maximum leakage rates would need to be supported by experiences on best practices and determination of such rates." Opponents of maximum leakage rates make two main arguments against their inclusion. First, they argue that including maximum leakage rates will result in operators only taking precautionary measures to reduce leakage up to the maximum leakage rate and no more. This argument is disingenuous since maximum leakage rates can exist *without prejudice* to the overall obligation to "take precautions to prevent their unintentional release." Second, they argue that maximum leakage rates depend on the sub-sector in question. This is a fair point. Although Germany, Belgium and Luxembourg outline across-the-board maximum leakage rates applicable across all sub-sectors, sub-sector specific maximum leakage rates should be adopted to account for the particularities of each sub-sector in question and ensure best practices. Either sub-sector specific maximum leakage rates should be included in the Regulation or the Commission should adopt them through delegated or implementing acts.

3. **Containment should be extended to maritime applications**. In the original F-Gas Regulation, leakage prevention applied to *stationary* applications in refrigeration, air conditioning and heat pumps.[42] This meant that fire protection, transport refrigeration and mobile air conditioning were excluded. In addition, within those listed sectors, leakage checks only applied to equipment that contained 3 kilograms (kg) or more of fluorinated gases. Some Member States extended leakage checks to charges less than 3kg, such as France (2 kg) and Denmark (1.5 kg).[43] In the Commission proposal, measures on leakage checks apply to equipment containing fluorinated greenhouse gases with a GWP of 5 tCO_2-equivalent or more (unless hermetically sealed then it is 10 tCO_2-equivalent or more) in: (i) stationary refrigeration equipment; (ii) stationary air-conditioning equipment; (iii) stationary heat pumps; (iv) stationary fire protection systems; and (v) refrigerated trucks and trailers.[44] All other sectors are excluded. The *Impact Assessment* and *Preparatory Study* show that extending containment to maritime and refrigerated trucks and trailers is cost-effective and achieves reductions in HFC emissions.[45] The Commission declined to extend to maritime because at the time it was considering a separate instrument to address GHG emissions in the maritime sector, but that instrument is no longer under immediate consideration or forthcoming.[46]

4. **Improve enforcement with mandatory reporting to competent authorities.** There is no uniform requirement for operators and certified personnel to forward records to competent authorities, only to maintain them.[47] This increases the administrative burden of enforcement and results in differential treatment across the Member States. Operators and certified personnel should be required to submit records to competent authorities with summaries of compliance for inclusion in a central electronic database.

5. **Improve enforcement with detailed rules on the nature and frequency of checks**. To ensure harmonized enforcement and compliance across the Union, the Commission should adopt detailed rules on the nature and frequency of checks by competent authorities, as in other Union legislation.[48]

STRENGTHEN RECOVERY MEASURES

Recovery is required once HFC-based equipment is placed on the market, meaning HFCs will need to be reclaimed, recycled or destroyed. Given the lifetimes of HFC-based equipment, the full implications of recovery have yet to be felt. Experiences with ozone-depleting substances, however, make clear that it is burdensome and expensive. The Commission proposal on recovery is inadequate, allowing HFC producers to avoid responsibility for recovery and overlooking well-known compliance and enforcement problems.

The following revisions to recovery measures are needed:

1. **Require Member States to adopt producer responsibility schemes to promote recovery**. Several Member States have adopted producer responsibility schemes, including take-back schemes in Sweden and Germany[49] and deposit-refund scheme in Denmark.[50] This serves to internalise the costs of HFC recovery into the prices of new HFC-based equipment, and promotes compliance. In the *Impact Assessment*, producer responsibility schemes are discarded "because no generic scheme seems to be universally applicable" and national circumstances make it "preferabl[e] to be implemented at MS level and not at EU level."[51] This is true, but in order to promote cost-effective recovery and ensure a level playing field while taking into account national circumstances, Member States should be required to adopt their own producer responsibility schemes for equipment outside the scope of the WEEE Directive.

2. **Strengthen recovery of foams**. The *Impact Assessment* acknowledges that "[r]ecovery of F-gases from foams is rather costly."[52] Mandatory recovery measures therefore exclude foams, and only require recovery "to the extent that it is practicable."[53] The lifetime of foams can reach 50 years with significant emissions only occurring thereafter, a point too far into the future for a traditional producer responsibility scheme. Therefore, not only should bans on foams enter into effect by 2015, but Member States should be required to adopt specific measures on producer responsibility for recovery in consideration of their unique attributes.

3. **Recovery should be extended to maritime and refrigerated trucks and trailers**. The *Impact Assessment* and *Preparatory Study* show that extending recovery to maritime is cost-effective and achieves reductions in HFC emissions.[54] The Commission declined to extend recovery to maritime, instead only requiring it "to the extent that it is practicable," because at the time it was considering a separate instrument to address GHG emissions in the maritime sector, but that instrument is no longer under immediate consideration or forthcoming.[55]

4. **Improve enforcement with mandatory reporting to competent authorities.** There is no uniform requirement for operators or certified personnel to forward records to competent authorities, only to maintain them.[56] This increases the administrative burden of enforcement and results in differential treatment across the Member States. Operators should be required to submit records to competent authorities with summaries of compliance for inclusion in a central electronic database.

5. **Improve enforcement with detailed rules on the nature and frequency of checks**. To ensure harmonized enforcement and compliance across the Union, the Commission should adopt detailed rules on the nature and frequency of checks by competent authorities, as in other Union legislation.[57]

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[1] Proposal for a Regulation of the European Parliament and of the Council on fluorinated greenhouse gases, COM(2012) 643 (hereinafter "Commission Proposal for Revised F-Gas Regulation").

[2] Commission Proposal for Revised F-Gas Regulation, Articles 12, 13-16 and Annexes III, V-VI.

[3] Regulation (EC) No 2037/2000 of the European Parliament and of the Council of 29 June 2000 on substances that deplete the ozone layer OJ L 244 29.9.2000, Articles 4-5.

[4] *See e.g.* Öko-Recherche *et al.*, *Preparatory Study for a Review of Regulation (EC) No 842/2006 on Certain Fluorinated Greenhouse Gases, Final Report* (September 2011)(hereinafter "*Preparatory Study*"); Umweltbundesamt, *Avoiding Fluorinated Greenhouse Gases: Prospects for Phasing Out* (June 2011, English Version) (hereinafter "*UBA Report*"); Bio Intelligence Service, *Preparatory Study for Eco-design Requirements of EuPs, Lot 1: Refrigerating and Freezing Equipment: Service Cabinets, Blast Cabinets, Walk-in Cold Rooms, Industrial Process Chillers, Water Dispensers, Ice-Makers, Dessert and Beverage Machines, Minibars, Wine Storage Appliances and Package Condensing Units*, (Final Report May 2011); Armines, *Sustainable Industrial Policy – Building on the Ecodesign Directive – Energy-Using Product Group Analysis/2, Lot 6: Air-Conditioning and Ventilation Systems: Air Conditioning Systems* (Final Report, 25 July 2012; Corrected Final Report, 5 September 2012); Shecco, *Guide 2012: Natural Refrigerants Market Growth for Europe* (2012).

[5] *Impact Assessment*, p. 115; *Preparatory Study*, p. 264.

[6] *Impact Assessment*, pp. 116-117; *Preparatory Study*, p. 264.

[7] *Impact Assessment*, pp. 243-248; *Preparatory Study*, pp. 195-199.

[8] *Impact Assessment*, p. 243; *see also Preparatory Study*, p. 195.

[9] *Impact Assessment*, pp. 244-246; *see also Preparatory Study*, pp. 195-198.

[10] *Impact Assessment*, pp. 243-245; *see also Preparatory Study*, pp. 196-197.

[11] *See* Lisbon Treaty, Article 191(2).

[12] *See e.g. Preparatory Study*; *UBA Report*; Bio Intelligence Service, *Preparatory Study for Eco-design Requirements of EuPs, Lot 1: Refrigerating and Freezing Equipment: Service Cabinets, Blast Cabinets, Walk-in Cold Rooms, Industrial Process Chillers, Water Dispensers, Ice-Makers, Dessert and Beverage Machines, Minibars, Wine Storage Appliances and Package Condensing Units*, (Final Report May 2011); Shecco, *Guide 2012: Natural Refrigerants Market Growth for Europe* (2012).

[13] Environmental Investigation Agency, *Chilling Facts IV: HFC-Free Cooling Goes Mainstream* (July 2012).

[14] *Impact Assessment*, pp. 115-116 (bans reduce 12 $ktCO_2eq$ at 1 €/tCO_2eq in domestic refrigeration; 147 $ktCO_2eq$ at -0.8 €/tCO_2eq in commercial hermitic systems; 2,849 $ktCO_2eq$ at 1.2 €/tCO_2eq in condensing units; and 12,055 $ktCO_2eq$ at 23.7 €/tCO_2eq in centralised systems); *Preparatory Study*, pp. 264, 292-294 and Annex V, pp. 244-249.

[15] Proposal for a Regulation of the European Parliament and of the Council on fluorinated greenhouse gases, […](2012) XXX draft, Annex IV (bans on "refrigerators and freezers for commercial use (hermitically sealed systems)" in 2017, "other refrigeration and freezing systems for commercial use" in 2020, and "industrial refrigeration and freezers capacity > 100kw" in 2020).

[16] *Impact Assessment*, p. 9.

[17] *Impact Assessment*, pp. 113-114 (ban of HFC-152a in XPS foam blowing reduces 460 $ktCO_2eq$ at -1.6 €/tCO_2eq; ban of HFC 134-a in XPS foam blowing reduces 1,553 $ktCO_2eq$ at 1.0 €/tCO_2eq; ban of HFCs in PU spray foam blowing reduces 1,369 $ktCO_2eq$ at 61.6

€/tCO_2eq; ban of HFC in other PU spray foam blowing reduces 587 ktCO_2eq at 3.5 €/tCO_2eq although a minor exemption may be needed for discrete applications since penetration rate in 2015 is only 95%); *Preparatory Study*, pp. 260-261, 290 and Annex V, pp. 266-269.

[18] SKM Enviros, *Further Assessment of Policy Options for the Management and destruction of Banks of ODS and F-gases in the EU* (Final Report, Revised Version 2, March 2012), *available at* http://ec.europa.eu/clima/policies/ozone/research/docs/ods_f-gas_destruction_report_2012_en.pdf

[19] *Impact Assessment*, p. 112 (ban of HFCs in technical aerosols reduces 3,637 ktCO_2eq at 10 €/tCO_2eq); *Preparatory Study*, pp. 260-261 and Annex V, p. 265.

[20] *See e.g. Preparatory Study*; *UBA Report*; Armines, *Sustainable Industrial Policy – Building on the Ecodesign Directive – Energy-Using Product Group Analysis/2, Lot 6: Air-Conditioning and Ventilation Systems: Air Conditioning Systems* (Final Report, 25 July 2012; Corrected Final Report, 5 September 2012); Shecco, *Guide 2012: Natural Refrigerants Market Growth for Europe* (2012).

[21] *Impact Assessment*, pp. 117-118 (bans reduce 22,970 ktCO_2eq at 19 €/tCO_2eq in single split; 2,172 ktCO_2eq at 13.1 €/tCO_2eq in multi split; 573 ktCO_2eq at 8.2 €/tCO_2eq in rooftop systems; 1,989 ktCO_2eq at 5.9 €/tCO_2eq in displacement chillers; 9 ktCO_2eq at 7.5 €/tCO_2eq in centrifugal chillers; and heat pumps, sometimes placed in this sector, have penetration rates reaching 100% in 2020 and a ban reduces 1,356 ktCO_2eq but alternatives are not considered cost-effective at 130.2 €/tCO_2eq); *Preparatory Study*, pp. 264, 292-294 and Annex V, pp. 253-259.

[22] *Impact Assessment*, pp. 118 and 120 (bans reduce 421 ktCO_2eq at 45.1 €/tCO_2eq in refrigerated vans; and 322 ktCO_2eq at 2.6 €/tCO_2eq in refrigerated trucks and trailers); *Preparatory Study*, 264, 292-294 and Annex V, pp. 250-251.

[23] *Impact Assessment*, p. 119 (bans reduce 232 ktCO_2eq at 16.7 €/tCO_2eq in cargo ship air-conditioning); *Preparatory Study*, pp. 264, 292-294 and Annex V, p. 260.

[24] Commission Proposal for Revised F-Gas Regulation, Annex V.

[25] *Impact Assessment*, Annex X, pp 156-163; *see also Preparatory Study*, pp. 9-30.

[26] *Impact Assessment*, Annex X, pp 157 (concluding that reporting system is still relatively new and an overestimation is possible).

[27] *See generally Preparatory Study*, pp. 104-126 (review of the application of containment and recovery measures).

[28] *Impact Assessment*, Annex X, pp 159-160; *see also* Commission Proposal for Revised F-Gas Regulation, Annex V.

[29] SKM Enviros, *Phase Down of HFC Consumption in the EU – Assessment of Implications for the RAC Sector* (Final Report, Version 11, September 2012), p. 20.

[30] SKM Enviros, *Phase Down of HFC Consumption in the EU – Assessment of Implications for the RAC Sector* (Final Report, Version 11, September 2012), pp. 60-63.

[31] SKM Enviros, *Phase Down of HFC Consumption in the EU – Assessment of Implications for the RAC Sector* (Final Report, Version 11, September 2012), p. 62.

[32] *See* Commission Proposal for Revised F-Gas Regulation, Annex X.

[33] Commission Proposal for Revised F-Gas Regulation, Articles 14-15 and Annex VI; *Impact Assessment*, Annex X, pp. 165-166.

[34] *Impact Assessment*, Annex X, pp. 164-165.

[35] *See* Lisbon Treaty, Article 191(2).

[36] Commission Proposal for Revised F-Gas Regulation, Article 8.

[37] Commission Proposal for Revised F-Gas Regulation, Article 18.

[38] *See* Institute for European Environmental Policy, *Is STEK as good as reported? – Uncertainties in the concept underlying the proposed European Regulation of fluorinated gases*, 14 June 2005, pp. 7, 41.

[39] *Preparatory Study*, p. 256.

[40] *Preparatory Study*, p. 256.

[41] *Preparatory Study*, pp. 256-257.

[42] Regulation (EC) No 842/2006 of the European Parliament and of the Council of 17 May 2006 on certain fluorinated greenhouse gases OJ L 161 14.6.2006, Article 3.

[43] *Preparatory Study*, pp. 252-255.

[44] Commission Proposal for Revised F-Gas Regulation, Article 3(2).

[45] *Impact Assessment*, pp. 108-109 (inclusion in containment and recovery reduces 273 $ktCO_2eq$ at 10.5 €/tCO_2eq in refrigerated cargo ships, 405 $ktCO_2eq$ at 8.5 €/tCO_2eq in refrigerated passenger ships, and 360 $ktCO_2eq$ at 0.5 €/tCO_2eq in fishing vessels); *Preparatory Study*, p. 293.

[46] *Impact Assessment*, p. 109; *Preparatory Study*, p. 293; *see also* European Commission, *Joint Statement on Emissions from Shipping* (1 October 2012)(statement from Commissioner Kallas and Commissioner Hedegaard announcing no new legislation).

[47] Commission Proposal for Revised F-Gas Regulation, Article 5.

[48] Regulation (EU) No 995/2010 of the European Parliament and of the Council of 20 October 2010 laying down the obligations of operators who place timber and timber products on the market, OJ L 295 12.11.2010.

[49] *Preparatory Study*, p. 50.

[50] *Preparatory Study*, pp. 52-53.

[51] *Impact Assessment*, pp. 103 and 110.

[52] Impact Assessment, p. 10.

[53] Commission Proposal for Revised F-Gas Regulation, Article 7.

[54] *Impact Assessment*, p. 109; *Preparatory Study*, p. 293.

[55] *Impact Assessment*, p. 109; *Preparatory Study*, p. 293; *see also* European Commission, *Joint Statement on Emissions from Shipping* (1 October 2012)(statement from Commissioner Kallas and Commissioner Hedegaard announcing no new legislation).

[56] Commission Proposal for Revised F-Gas Regulation, Article 5.

[57] Regulation (EU) No 995/2010 of the European Parliament and of the Council of 20 October 2010 laying down the obligations of operators who place timber and timber products on the market, OJ L 295 12.11.2010.