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PROHIBITING HFC TECHNOLOGIES IN THE EUROPEAN UNION: OBLIGATIONS IN THE F-GAS REGULATION

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RE: JOINT NGO SUBMISSION DURING PUBLIC CONSULTATION ON THE F-GAS REGULATION

On behalf of the Environmental Investigation Agency (EIA), European Environmental Bureau (EEB), Greenpeace European Unit, and World Wide Fund for Nature (WWF), we submit these comments on the public consultation on reducing fluorinated gases (F-gases) under the F-Gas Regulation. This review and resultant proposals to amend the F-Gas Regulation will have worldwide implications, and constitute much-needed action at the European Union (EU) level to curb climate change. Several recent studies show that the existing measures are underperforming. Adopting bans on marketing hydrofluorocarbons (HFC) in new systems and equipment are not only needed under the F-Gas Regulation to achieve the greenhouse gas (GHG) emission reduction target of 80-95% by 2050,[1] but are compelled under the current legislation.

Summary of Conclusions

- The F-Gas Regulation has proven more than twice as expensive as predicted—around €40.8/t CO_2-eq. instead of €18.32/t CO_2-eq.—which can be attributed to its reliance on containment and recovery measures to control HFC emissions over bans on HFC technologies where technically feasible, cost-effective, energy-efficient alternatives are available.
- The F-Gas Regulation suffers from a low level of ambition. When separating out emission reductions achieved under the MAC Directive, the F-Gas Regulation actually legislates an 82% increase in HFC emissions by 2050 when compared to levels that existed at the time of adoption, which if maintained will fatally undermine any efforts to meet the EU objective of 80-95% GHG-emission reductions by 2050 compared to 1990 levels.
- Parliament and Council, aware of these shortcomings, therefore required the Commission to "assess whether the inclusion of further products and equipment containing fluorinated greenhouse gases in Annex II is technically feasible and cost-effective, taking account of energy-efficiency, and, if appropriate, make proposals to amend Annex II in order to include such further products and equipment." The Commission must comply with these obligations.
- Recent reports and studies, including from the Commission, Öko-Recherche, and the German Federal Environment Agency, demonstrate that technically feasible, cost-effective, and energy efficient alternatives are available in almost all subsectors by 2020 – and in many cases earlier.
- The Commission should revise the F-Gas Regulation to prohibit the placement on the market of HFC technologies and products as soon as possible and at the latest by 2020.

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Background

In 2006, the European Union adopted the F-Gas Regulation with the "primary objective… to reduce the emissions of the fluorinated greenhouse gases covered by the Kyoto Protocol," namely HFCs, perfluorocarbons (PFC), and sulfur hexafluoride (SF_6), "and thus to protect the environment."[2] The F-Gas Regulation controls emissions of F-gases predominantly through containment and recovery measures that limit their release once placed on the market.[3] These measures set out obligations on operators to contain leakage of F-gases during use and, when at the end of their useful lifetime, to recycle, reclaim, or destroy them.

The HFC Time Bomb

The challenges presented by HFCs are unique. Whereas most greenhouse gases are byproducts produced unintentionally, HFCs are products themselves (with the exception of HFC-23). HFCs are purposefully produced for use as solvents and refrigerants, often in the compressed tubes of refrigerators, air conditioners and heat pumps, and in insulation foams. In larger systems HFCs are placed in canisters to fill or top up cooling mechanisms. This equipment is then sold on the market, making its way into homes, offices, schools, police stations, factories, warehouses, vehicles – everywhere

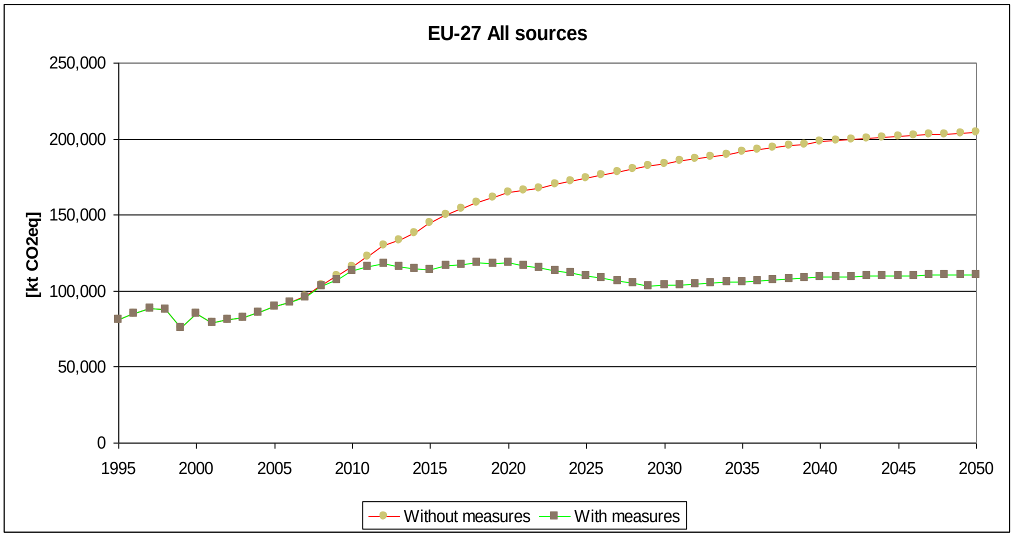
HFC emissions happen in three ways. During manufacture, and before the HFCs are placed in chemical stockpiles for later use, the HFC production process can generate unintentional GHG emissions, something that is often not regulated. Once placed on the market, HFCs proliferate throughout the economy and begin leaking from the equipment they are in. Large refrigerators and air conditioners leak more quickly, requiring periodic refills to maintain their cooling function. Although expensive containment measures can minimize this leakage, they cannot stop it. At the same time, many find it less burdensome and less expensive just to let the HFCs leak into the atmosphere than to prevent the leakage to begin with. When the equipment and foams reach the end of their useful lifetime—sometimes decades into the future—they are discarded along with any residual HFCs within. Those residual HFCs, located in every nook and cranny of our economy, then leak into the atmosphere over time unless captured and reclaimed or destroyed, which is referred to as "recovery," something that is also burdensome and expensive.

The HFCs found in chemical stockpiles, foams and equipment in use, and residual HFCs found in discarded foams and equipment, are called "HFC banks." They would be better referred to as HFC time bombs—economic and climate ones—that burden not only this generation but the next one too.

The F-Gas Regulation also prohibits placing on the market those HFC technologies listed in Annex II through operation of Article 9.[4] At present, only prohibitions for niche subsectors are included in Annex II, such as footwear, fire extinguishers and tyres.[5] This regulatory design was a well-documented result of an aggressive and effective industry lobby,[6] which had the practical implication of keeping open the lucrative European market to HFC producers despite the fact that many subsectors already had alternatives "commercially available within the EU... well beyond prototype applications."[7] The cost of these omissions to Annex II—both climate and economic—is now abundantly evident. Given the continued development of HFC-free alternatives, the value of which is particularly important in light of fundamental shortcomings in containment and recovery, revisions to amend Annex II are necessary.

I. Containment and Recovery Will Not Achieve Adequate Emission Reductions

It is now clear that the F-Gas Regulation suffers from a low level of ambition. The following figure shows emissions that would have occurred in the absence of the F-Gas Regulation *and* MAC Directive (without measures) and emissions that will occur as a result of the F-Gas Regulation *and* MAC Directive (with measures), assuming full implementation, something that we have not seen to date, which essentially provides a measure of the effectiveness of EU reliance on containment and recovery measures:[8]



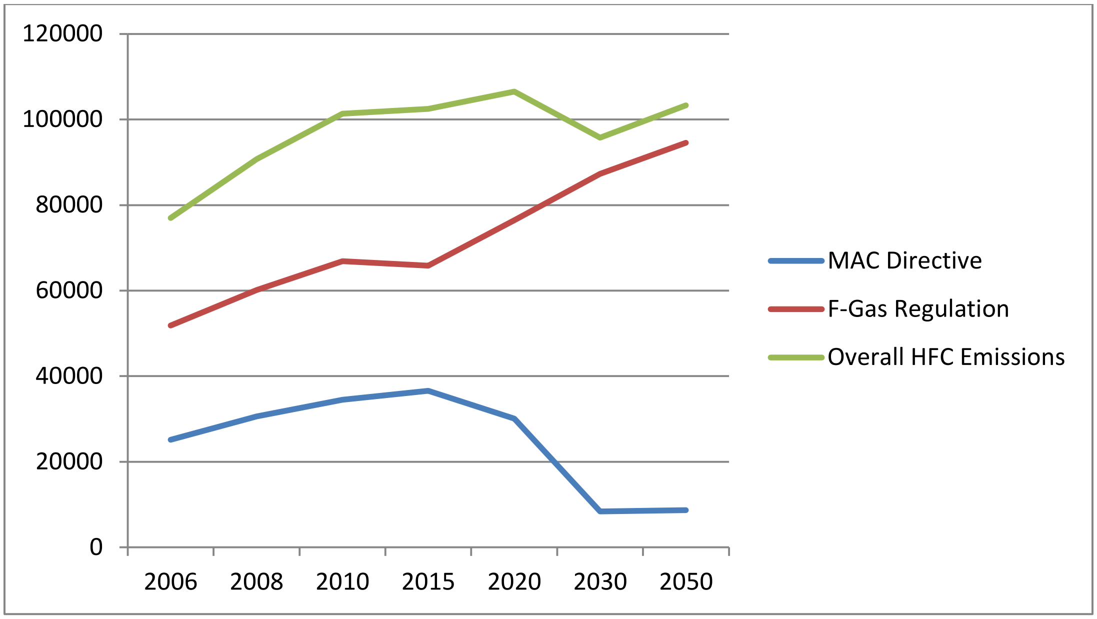
Notes: F-gas emissions in 1995-2050 in a scenario without measures (WOM) and a scenario with measures (WM) of EU F-gas legislation. The shape of the emission curves indicates the emission reduction potential for F-gas emissions. From 2008/2010 onwards the two curves distinctly split up. In the WM scenario, emissions will remain at a stable level from 2010 until 2050, while in the WOM scenario emissions continue to increase up to almost the double. It should be noted that even in the WM scenario absolute emissions in 2050 will be higher than in the WOM scenario in 2008 (by 6,400 kt CO_2 eq).

The majority of the avoided HFC emissions in the figure above are attributable to the MAC Directive, not the F-Gas Regulation.[9] The MAC Directive, which accounts for only around 30% of current HFC emissions, also prevents HFC emissions at a fraction of the cost by relying on marketing prohibitions.[10]

At a time when dramatic reductions are needed to avoid dangerous anthropogenic interference with the climate system, the F-Gas Regulation is underwhelming.[11] Even if fully implemented, the F-Gas Regulation and MAC Directive will only stabilize F-gas emissions at around today's level of 110 million tonnes (Mt) of carbon dioxide equivalent (CO_2-eq.) in 2050, an increase of 20% from 2006.[12] This is the same timeframe in which the Union committed to achieve overall GHG emission reductions of 80-95%. F-gas emissions would therefore represent around 39% of overall GHG emissions in the European Union in 2050, with HFC emissions comprising over 93% of those F-gas emissions, meaning over 36% of overall GHG emissions in 2050 will be HFC emissions.[13]

But looking deeper, the numbers are even more disconcerting. In just considering HFC emissions, when comparing those at the time of adoption with projected HFC emissions in 2050, the F-Gas Regulation and MAC Directive legislate a 34% increase in overall HFC emissions.[14] This increase is despite the fact that the MAC Directive legislates a 65% *decrease* in HFC emissions by 2050 through market prohibitions for passenger cars[15] – something that is even more impressive since other vehicles, such as trucks, buses, ships, and railcars, are effectively unaddressed.[16] The F-Gas Regulation, for its part, *actually* *legislates an 82% increase in HFC emissions by 2050* by focusing on containment and recovery for the remaining sectors.[17] Figure 1 depicts the relative contributions of the F-Gas Regulation and MAC Directive to overall HFC emissions in the European Union during the 2006-2050 timeframe:

Figure 1: Impact of F-Gas Regulation and MAC Directive on HFC Emissions in the European Union in 2006-2050 (kt CO_2-eq.)[18]



In order to bend the emissions curve significantly downward, the F-Gas Regulation must transition toward market prohibitions for those sectors under containment and recovery.

II. Containment and Recovery Have Proven Far More Costly Than Marketing Prohibitions

Containment and recovery measures also have significant costs. The one-off costs for these measures, such as certification of personnel and companies, "amount to €617 million."[19] The "[r]ecurring costs are estimated at €1,061 million in 2015 and €1,551 million in 2030"[20] with "containment measures account[ing] for high shares of these costs (leakage checks, records) and occur[ing] mostly in the stationary refrigeration, air conditioning and heat pump sector,"[21] as summarized below:[22]

	Article 5 annualised cost	Art 3-6 costs per year	Total annual cost	Emission reduction	Cost effectiveness
	million Euro	million Euro	million Euro	Mt CO_2 eq	€ /t CO_2 eq
2015	60	1,061	1,121	27.5	40.8
2030	60	1,551	1,611	39.3	41.0

As a result, the actual cost-effectiveness of the F-Gas Regulation is around €40.8/t CO_2-eq. and expected to increase in the future, which is more than double the estimated costs of €18.32/t CO_2-eq. at the time of adoption.[23] The costs of these measures are currently borne by Member States, taxpayers, and end users, not the HFC producers which are largely US and Japanese multinationals.[24] It flips the polluter-pays principle on its head: as drafted, it essentially promotes the polluter-gets-paid principle where HFC producers sell their products for profit and third parties are stuck financing damage control.[25]

In addition, once HFC technologies reach the end of their useful lifetime—sometimes up to decades in the future—the "share of recovery costs increases significantly over time."[26] This means, in looking at costs beyond the 2030 timeframe, HFCs found in existing equipment, chemical stockpiles, and other products that have yet to be released into the atmosphere—referred to as "HFC banks"—will leak unless expensive recovery measures are implemented and enforced at the Member-State level. In this way, the reliance on containment and recovery measures places an unfair burden on not only this generation but the next generation too, putting them in the no-win situation of either allowing a climate time bomb to go off or investing heavily to prevent it.

By comparison, Article 9 which prohibits HFC technologies for those subsectors listed in Annex II has been "applied to a large extent with minor administrative costs since conversion of production in these sectors largely took place so far, without significant needs for enforcement and control by authorities."[27] As will be seen below, the costs of prohibitions for subsectors currently outside Annex II are on average about half of those associated with containment and recovery – and in certain subsectors are even negative. The omission of subsectors in Annex II where technically feasible, cost-effective, and energy-efficient alternatives were already available was a mistake in the current F-Gas Regulation, and its repetition must be avoided this time around, especially during these times of fiscal austerity.

LEGISLATIVE MANDATE IN THE F-GAS REGULATION

Parliament and Council, aware of this omission when adopting the F-Gas Regulation, nevertheless provided an avenue to address it at a future date: a review-and-proposal clause.[28] In order to achieve climate objectives and commitments, the F-Gas Regulation acknowledges that prohibitions in other subsectors may be necessary.[29] It states that when placing HFC technologies on the market "is detrimental to the objectives and commitments of the [Union] and its Member States with regard to climate change," that it is necessary to ban them and, in addition to those bans already in Annex II, "[t]his could be the case concerning other applications containing fluorinated gases."[30] Parliament and Council concluded that "therefore the need for an extension of Annex II should be reviewed, taking account of the environmental benefits, the technical feasibility and cost effectiveness."[31] This is the justification for the review-and-proposal clause, found in the text of the F-Gas Regulation itself under Article 10(2)(j), which outlines the legislative mandate to the Commission:

> [A]ssess whether the inclusion of further products and equipment containing fluorinated greenhouse gases in Annex II is technically feasible and cost-effective, taking account of energy-efficiency, and, if appropriate, make proposals to amend Annex II in order to include such further products and equipment.[32]

The three criteria the Commission shall assess are: (i) technical feasibility, (ii) cost effectiveness, and (iii) energy efficiency. Technical feasibility means that, as a technical matter, if a ban on marketing HFC technologies in certain subsectors is to be included in Annex II, alternative technologies must be available in that same subsector to fulfill the same function. Cost effectiveness requires consideration of the costs in both absolute terms and in CO_2 equivalence relative to the status quo, i.e. allowing HFC technologies to be placed on the market but subject to existing containment and recovery measures. Energy efficiency, which is to be taken into account, requires consideration of whether equivalent energy savings can be achieved by alternative technologies to current HFC technologies on the market.

It may not always be the case that technical feasibility and cost-effectiveness are demonstrated. And when that happens, the Commission must balance various interests in determining the "appropriate" course of action. But when it is the case that each criterion is met for any given subsector, and energy efficiency is demonstrated, the presumption should be strongly in favor of inclusion in Annex II – indeed, inter-institutional cooperation on legislative and regulatory matters requires it. To the extent other considerations are relevant, those are best addressed with limited exceptions as done in the Montreal Protocol,[33] Member States,[34] MAC Directive[35] and ODS Regulation.[36]

The latest scientific and technical evidence—including a report by the German Federal Environment Agency and a study led by Öko-Recherche—removes any excuse for avoiding a more-robust Annex II this time around. The Commission should act to fulfill its legislative mandate, as it has been called upon by the Council and Parliament, and steer the European Union toward a low-carbon economy.

European Commission Report

In September 2011, the Commission published its report looking at these issues. In it, the Commission finds that alternative technologies "are today technically feasible in most relevant fields of application" and "have the potential to gradually replace technologies based on F-gases with high GWP, thereby contributing to a cost-effective transition to a climate-friendly, low-carbon economy."[37] With respect to energy efficiency, it further finds that "[i]n energy-consuming applications such as refrigeration, air conditioning and heat pumps and in energy-preserving applications such as building and appliance insulation foams, low-GWP technologies can potentially achieve an equivalent performance in most cases."[38] These conclusions, while pushing toward amendments to Annex II in several subsectors, are still curiously muted when compared to the underlying technical analysis that supports them.

German Federal Environment Agency Report

In June 2011, the German Federal Environment Agency (UBA) released a 262-page report titled *Avoiding Fluorinated Greenhouse Gases: Prospects for Phasing Out*. Based on an extensive literature and technical review, it assesses "whether the use of halogen-free substances or process is technically and economically possible and ecologically desirable."[39] It finds that "because of their high [GWP] and their persistence, fluorinated gases should be dispensed with where the use of halogen-free substances and/or processes is possible from a technical and safety point of view and does not result in environmentally harmful situations."[40] The report represented UBA's "contribution to the discussion about measures at European and international level."[41]

The UBA Report reaffirms that HFC technologies can be banned and replaced with non-HFC technologies, as summarized in Tables 1 and 2:

TABLE 1: Substitution Options in New Equipment and Systems in Closed Systems[42]

Sector	Subsector	Substitution Options in New Equipment
Domestic Refrigeration	Refrigerators / Freezers / Tumble Dryers	Isobutane
Commercial Refrigeration	Plug-In Appliances	Isobutane, Propene, Propane, CO_2, NH_3
	Condensing Unit Systems	
	Centralised Systems	
Industrial Refrigeration	Food Processing	Propane, Isobutane, NH_3, NH_3/CO_2
	Chemical / Pharmaceutical	
	Coldstores	
	Sports and Leisure Facilities	
	Metal Industry	
	Industrial Heat Pumps	CO_2

Stationary Air Conditioning	Room Air Conditioners	H_2O, NH_3, Hydrocarbons, NH_3/DME
	Building Air Conditioners / Chillers	
	Domestic Heat Pumps	Propane, CO_2
Fire Protection	Fire Extinguishing Agents	CO_2, N_2, Argon

TABLE 2: Substitution Options in New Equipment and Systems in Open Systems[43]

Sector	Subsector	Substitution Options in New Equipment
Aerosols	Technical Sprays	Propane, Isobutane, CO_2, N_2
	Freezer Sprays	
	Compressed Air Sprays	
	Other Technical Sprays	
	Medicinal Sprays	Powder Inhalers
Foams	Rigid Foams for Thermal Insulation (XPS, PUR)	CO_2, CO_2/Ethanol, Pentane
	Flexible PUR Foams	CO_2
	Integral PUR Foams	CO_2, Pentane
	Caulking Foams	290, Butane, DME

In addition to identifying substitution options, the UBA report offers an in-depth qualitative analysis of each subsector, including energy efficiency and cost-effectiveness, before providing its conclusions.[44] For example, when discussing industrial heat pumps, after listing industry practices and alternatives already in use, UBA then delivers its policy conclusion:

> In view of the considerable advances made in the development of industrial heat pumps with natural refrigerants, it is possible to dispense with systems using HFCs. The advantage of HFC-free systems lies not only in the substitution of the refrigerant, but also in the much improved energy yield of CO_2 systems in heat-pump mode. The resulting additional capital costs are thus more than made good by reduced operating costs. If operators want to avoid capital costs despite the short payback period, there is the possibility of 'heat contracting,' which is offered by system manufacturers.[45]

The UBA Report supports amending Annex II under the criteria set out in the legislative mandate. Indeed, UBA finds that "[h]alogen-free alternatives can be used as substitutes for fluorinated greenhouse gases (HFCs, PFCs, and SF_6) in nearly all fields of application."[46]

Öko-Recherche Study

The Commission Report draws upon a multi-year analytical study titled *Preparatory Study for a Review of Regulation (EC) No 842/2006 on Certain Fluorinated Greenhouse Gases*, released at the same time, by Öko-Recherche. The Öko-Recherche Study, comprising over 730 pages of in-depth analysis and prepared in association with industry, institutes, and experts, analyzes 26 subsectors, concluding:

> For each sector, technically feasible and cost-effective alternative technologies to sector-typical conventional F-gas technology were identified and are hereafter referred to as "alternative options." The selection of replacement technology was guided by three criteria including the reduction potential of CO_2-weighted use of F-gas and emissions, cost effectiveness (expressed in abatement cost of €/t CO_2 eq) and energy consumption. For each

> alternative option, the penetration rate, which is defined as maximum potential of each technical choice to replace new products or equipment relying upon F-gas, was estimated. Penetration rates are given for each alternative option based on technical feasibility to replace existing F-gas technology by a specific alternative technology, at least cost.[47]

The concept of penetration rate is an important one in the Öko-Recherche Study. 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."[48] It incorporates safety constraints and costs considerations while factoring in the availability of materials and components, system complexity and know-how.[49] It also ensures, as its basic guiding principle, that abatement options achieve "at least the same level of efficiency as the existing refrigerants."[50] The concept of penetration rate speaks directly to the criteria for consideration under the legislative mandate in Article 10(2)(j), and it addresses it in the clearest terms to date. The presumption should be strongly in favor of including subsectors that reach certain penetration rates in Annex II, not against. Given that the penetration rates represent conservative assessments—not precautionary ones—they should also serve as the latest date for which a prohibition should take effect. Earlier action is compelled under the precautionary principle, also bedrock European Union law under the Lisbon Treaty.[51]

The Öko-Recherche Study shows that HFC technologies in 18 subsectors can be banned by 2020 or earlier with no exceptions, i.e. the penetration rate is 100%, at equal or greater energy efficiency, as demonstrated in Tables 3 and 4:

TABLE 3: 100% Penetration Rates in Closed Systems and Energy Efficiency Savings

Sector	Subsectors	Penetration Rate Mix 100%[52]	Energy Efficiency Savings[53]
Domestic Refrigeration	Refrigerators/Freezers	2015	1.6%[54]
Commercial Refrigeration	Stand-Alone Systems	2020	4.5%[55]
	Condensing Units	2020	0% - 3%[56]
	Centralized Systems	2020	0% - 7.5%[57]
Transport Refrigeration	Refrigerated Vans	2020	0% - 7.5%[58]
Mobile Air Conditioning	Cargo Ship AC	2020	0% - 0.8%[59]
Stationary Air Conditioning	Moveable Systems	2020	0%[60]
	Split Systems	2020	0%[61]
	Multi-Split/VRF Systems	2020	0%[62]
	Rooftop Systems	2020	0%[63]
	Chillers (Displacement)	2020	0% - 7.5%[64]
	Heat Pumps	2020	0%[65]
Fire Protection	Fire Protection HFC-23	2015	N/A[66]

TABLE 4: 100% Penetration Rates in Open Systems and Energy Efficiency Savings

Sector	Subsectors	Penetration Rate Mix 100%[67]	Energy Efficiency Savings
Aerosols	Aerosols (sans non-medical)	2015	N/A[68]
Foams	XPS with HFC-134a	2015	N/A[69]
	XPS with HFC-152a	2015	N/A[70]
	Spray Foam	2015	N/A[71]
	Other PU	2015	N/A[72]

Switching to alternative technologies in the 18 subsectors in Tables 3 and 4 will result in additional emission reductions of 62 Mt CO_2-eq. per year by 2030, over and above reductions from the existing legislation.[73] This is more than 1.7 times the total avoided emissions projected for full implementation of the existing containment and recovery measures *for all sectors combined*, which are around 35.6 Mt CO_2-eq. in 2030 under a best-case scenario. This also assumes full implementation of containment and recovery measures that already suffer from serious implementation issues.[74] If containment and recovery measures continue to fail, the impact of bans on emissions will be even greater.

The average marginal emission abatement cost is €22/t CO_2-eq. for the 13 subsectors in Table 3 and €16.3/t CO_2-eq. for the 5 subsectors in Table 4, both of which are significantly less than the average emission abatement costs of containment and recovery measures, which are €41/t CO_2-eq. in 2030.[75] So not only do prohibitions lead to greater reductions in HFC emissions, they also cost less.[76]

When the penetration rate mix is less than 100% for any given date, say under a 2020 phase-out scenario, HFC technologies can still be banned even under the Öko-Recherche methodological approach. The EU has taken this precautionary approach toward F-gas technologies in the past. Indeed, setting prospective dates that transform the marketplace was the approach for the prohibitions currently listed in Annex II. There, HFC technologies were banned almost immediately even though many HFC-free alternatives in those subsectors had achieved only limited market share in the EU.[77] Those alternatives have since become the dominant technology with minimal, if any, additional cost to producers and consumers.[78] Nor has the EU hesitated to take a precautionary approach for HFC predecessor gases—chlorofluorcarbons (CFC) and hydrochlorofluorocarbons (HCFC)—as evidenced in the ODS Regulation.[79] European Union legislators typically craft climate policy to transform the marketplace, not let the marketplace transform climate policy.[80] This practice should continue.

The Öko-Recherche Study shows that another 5 subsectors have penetration rates sufficiently high—65% or above—to justify a 2020 phase-out under Annex II. Indeed, only three subsectors, namely centrifugal chillers, rail vehicle AC, and passenger ship AC, may require closer attention to monitor the market penetration when included under a 2020 phase-out under Annex II, as demonstrated in Table 5:

TABLE 5: Penetration Rates for Remaining Closed Systems in 2020 and Energy Efficiency Savings

Sector	Subsectors	Penetration Rate Mix in 2020	Energy Efficiency Savings
Industrial Refrigeration	Small Industrial Equipment	70%[81]	15%[82]
	Large Industrial Equipment	70%[83]	15%[84]
Transport Refrigeration	Refrigerated Trucks	65%[85]	2% - 4%[86]
	Fishing Vessels	90%[87]	6%[88]
Fire Protection	Fire Protection HFC-227ea	80%[89]	N/A[90]
Stationary Air Conditioning	Centrifugal Chillers	45%[91]	0%[92]
Mobile Air Conditioning	Rail Vehicle AC	25%[93]	0%[94]
	Passenger Ship AC	20%[95]	0%[96]

The Öko-Recherche Study shows that switching to alternative technologies in the 8 subsectors in Table 5 will result in additional emission reductions of 7.5 Mt CO_2-eq. per year by 2030.[97] The marginal emission abatement cost for these 8 subsectors is -€2.4/t CO_2-eq., which means the overall abatement options actually cost less than HFC technologies, largely because of the cost-effectiveness of industrial refrigeration. Even excluding industrial refrigeration, however, the marginal emission abatement cost is only €9.4/t CO_2-eq. for the remaining subsectors, which is also significantly less than the average emission abatement costs of containment and recovery measures of around €41/t CO_2-eq. in 2030.[98] In short, prohibitions again lead to greater HFC reductions and reduced costs.

For these sectors, limited exceptions may be needed. This issue, however, is not yet ripe for consideration. As previous experiences can attest to, including these sectors in Annex II will spur market transformation once the correct signals are established. Therefore, from a policy perspective, should some flexibility in these subsectors be desired, it is advisable to include these sectors in Annex II in tandem with a review-and-proposal clause—set for mid-2018, for example—that would ask the Commission to review the need for limited exceptions in these few subsectors following further market observation and review. This conforms to Commission obligations under the F-Gas Regulation, described above, and the Lisbon Treaty, which requires Union policy to "aim at a high level of protection... based on the precautionary principle and on the principles that preventive action should be taken, that environmental damage should as a priority be rectified at source and that the polluter should pay."[99]

CONCLUSION

The balance of evidence clearly demonstrates that technically feasible, cost-effective and energy-efficient alternatives to HFC technologies are currently available or will be available for all subsectors by 2020. The Commission should revise Annex II to include additional prohibitions in each sector to become applicable at the earliest date possible, and at the latest by 2020.

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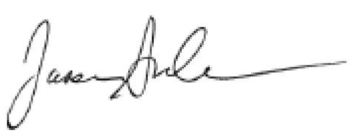

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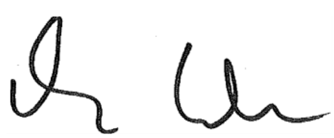

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[1] European Commission, *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee, and the Committee of the Regions: A Roadmap for moving to a competitive low carbon economy in 2050*, SEC(2011) 287 final (8 March 2011), pp. 3 and 6.
[2] Regulation (EC) No 842/2006 of the European Parliament and of the Council on Certain Fluorinated Gases, 17 May 2006, Off. J. Eur. Union L 161/1-10 [hereinafter "F-Gas Regulation"], Recital 6.
[3] *See* F-Gas Regulation, Articles 3 and 4.
[4] *See* F-Gas Regulation, Article 9.
[5] F-Gas Regulation, Annex II.
[6] *See e.g.* Corporate Europe Observatory, *Chilling Intent: The F-Gas Industry Plot to Subvert EU Climate Legislation* (October 2005), p. 3 *available at* http://archive.corporateeurope.org/docs/lobbycracy/chillingintent.pdf (last checked 18 November 2011); British Broadcasting Corporation, MEPs 'scaremongered to vote no' (22 November 2005) *available at* http://news.bbc.co.uk/2/hi/programmes/file_on_4/4459586.stm; *see also* 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 [hereinafter "IEEP Report"].
[7] EC DG Environment, *Final Report on the Costs and Impact on Emissions of Potential Regulatory Framework for Reducing Emissions of Hydrofluorocarbons, Perfluorocarbons and Sulfur Hexafluoride* (4 Feb. 2003), p. 8.
[8] 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 "Öko-Recherche Study"], p. 158.
[9] Öko-Recherche Study, Executive Summary, p. X; see Directive 2006/40/EC of the European Parliament and of the Council Relating to Emissions from Air-conditioning Systems in Motor Vehicles and Amending Council Directive 70/156/EEC, 17 May 2006, Off. J. Eur. Union L 161/12-18 [hereinafter MAC Directive].
[10] *Compare* European Commission, *Report from the Commission on the Application, Effects and Adequacy of the Regulation on Certain Fluorinated Greenhouse Gases (Regulation (EC) No 842/2006)* (September 2011) [hereinafter "Commission Report"], p. 6 *with* Öko-Recherche GmbH, *Preparatory study for the Review of Regulation (EC) No 842/2006 on certain fluorinated gases*, (Sept. 2010) [hereinafter "2010 EC F-Gas Preparatory Report"], pp. 10-11, 29.
[11] *See e.g.* V. Ramanathan & Y. Feng, *On Avoiding Dangerous Anthropogenic Interference with the Climate System: Formidable Challenges Ahead*, 105 Proc. Nat'l Acad. Sci. USA 14245, 14245 (2008); James Hansen et al., *Target Atmospheric CO_2: Where Should Humanity Aim?*, 2 Open Atmos. Sci. J. 217 (2008); Timothy Lenton, Hermann Held, Elmar Kriegler, Jim Hall, Wolfgang Lucht, Stefan Rahmstorf & Hans Joachim Schellnhuber, *Tipping Elements in the Earth's Climate System*, 105 Proc. Nat'l Acad. Sci. USA 1786, 1786 (2008).
[12] Öko-Recherche Study, Executive Summary, p. X.
[13] *Compare* European Commission, *Commission Staff Working Document – Impact Assessment – Accompanying Document to the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: A Roadmap for Moving to a Competitive Low Carbon Economy in 2050*, Sec(2011) 289 final (8 March 2011), p. 76 (total CO_2 and non-CO_2 emissions in 1990 was 5642 Mt CO_2-eq., which means an 80% and 95% reduction would yield total CO_2 and non-CO_2 emissions in 1990 of 1128.2 Mt CO_2-eq. and 282.1 Mt CO_2-eq., respectively) *with* Öko-Recherche Study, p. 159 (total F-gas emissions in 2050 with measures are 110.8 Mt CO_2-eq. and HFC emissions are around 103.3 Mt CO_2-eq.).
[14] Öko-Recherche Study, p. 159 (using the with-measures (WM) figures in Table 5-2, and excluding emissions attributed to "SF_6 users" and "PFC and Haloprod," HFC emissions in 2006 were 77,001 kt CO_2-eq. and are expected to be 103,306 kt CO_2-eq., which amounts to an 34% increase).
[15] Öko-Recherche Study, p. 159 (using the with-measures (WM) figures in Table 5-2, and excluding all other sectors except "Mobile A/C," HFC emissions in 2006 were 25,172 kt CO_2-eq. and are expected to be 8,736 kt CO_2-eq., which amounts to an 65% decrease).
[16] Öko-Recherche Study, pp. 159 and 163 (the MAC Directive covers AC systems in passenger cars but does cover mobile AC systems "in other subsectors, such as trucks, buses, ships, and railcars, which are not effectively addressed by current measures").
[17] Öko-Recherche Study, p. 159 (using the with-measures (WM) figures in Table 5-2, and excluding emissions attributed to "Mobile A/C," "SF_6 users," and "PFC and Haloprod," HFC emissions in 2006 were 51,829 kt CO_2-eq. and are expected to be 94,570 kt CO_2-eq., which amounts to an 82% increase).
[18] *See* Öko-Recherche Study, p. 159 (derived from Table 5-2 with-measures (WM) scenario with the MAC Directive comprising the "Mobile A/C" sector and the F-Gas Regulation comprising all other sectors minus "SF_6 users" and "PFC and Haloprod," which are assumed to include non-HFC emissions or those associated with halocarbon production, namely HFC-23).
[19] Öko-Recherche Study, p. 171.
[20] Öko-Recherche Study, p. 171.
[21] Öko-Recherche Study, Executive Summary, p. IX.
[22] Öko-Recherche Study, Executive Summary, p. 171.
[23] *Compare* Öko-Recherche Study, p. 171 *with* IEEP Report, pp. 11-12.
[24] European Partnership for Energy and the Environment, List of Members, available at http://www.epeeglobal.org/about-epee/members/ (last checked 28 November 2011).
[25] Lisbon Treaty, Article 191(2).
[26] Öko-Recherche Study, Executive Summary, p. IX.
[27] Öko-Recherche Study, Executive Summary, p. IX.
[28] F-Gas Regulation, Article 10(2)(j).

[29] F-Gas Regulation, Recital 10.
[30] F-Gas Regulation, Recital 10.
[31] F-Gas Regulation, Recital 10.
[32] F-Gas Regulation, Article 10(2)(j).
[33] UN Environment Programme, *Handbook for the Montreal Protocol on Substances that Deplete the Ozone Layer*, (8th ed. 2009), pp. 470-71 and 481-93 (decisions relevant to essential-use exemptions and critical-use exemptions).
[34] *See e.g.* European Commission, *Decision Concerning National Provisions Notified by Denmark on Certain Industrial Greenhouse Gases*, 2007/62/EC, 8 Dec. 2006, L32 Off. J. Eur. Union 130-134, at ¶14; *see also* Industriegas-Verodnung (HFKW-FKW-SF6-VO) Federal Law Gazette 447/2002.
[35] *See generally* MAC Directive.
[36] F-Gas Regulation, Article 8(1); *see also* Regulation (EC) No 1005/2009 of the European Parliament and of the Council ON Substances that Deplete the Ozone Layer (16 Sept. 2009) Off. J. Eur. Union L280/1-30 [hereinafter the "ODS Regulation"], Articles 7-10.
[37] Commission Report, pp. 73-74.
[38] Commission Report, p. 8.
[39] Umweltbundesamt, *Avoiding Fluorinated Greenhouse Gases: Prospects for Phasing Out* (June 2011, English Version) [hereinafter "UBA Report"], p. 3.
[40] UBA Report, p. 24.
[41] UBA Report, Foreward.
[42] UBA Report, p. 246.
[43] UBA Report, p. 247.
[44] *See e.g.* UBA Report, pp. 37-244.
[45] UBA Report, p. 71.
[46] UBA Report, p. 245.
[47] Öko-Recherche Study, Executive Summary, p. XI.
[48] Öko-Recherche Study, p. 195.
[49] Öko-Recherche Study, pp. 195-198.
[50] Öko-Recherche Study, pp. 196-197.
[51] *See* Lisbon Treaty, Article 191(2).
[52] Öko-Recherche Study, Annex V, p. 264.
[53] *See* Öko-Recherche Study, Annex V (derived from comparing the energy consumption of the predominant HFC technology on the market with the energy consumption of the various abatement options).
[54] Öko-Recherche Study, Annex V, p. 244 (rounded up from 1.58%).
[55] Öko-Recherche Study, Annex V, p. 245.
[56] Öko-Recherche Study, Annex V, p. 246.
[57] Öko-Recherche Study, Annex V, p. 247
[58] Öko-Recherche Study, Annex V, p. 250 (the 7.5% figure was rounded down from 7.51%).
[59] Öko-Recherche Study, Annex V, p. 260 (rounded up from 0.795%).
[60] Öko-Recherche Study, Annex V, p. 253.
[61] Öko-Recherche Study, Annex V, p. 254.
[62] Öko-Recherche Study, Annex V, p. 255.
[63] Öko-Recherche Study, Annex V, p. 256
[64] Öko-Recherche Study, Annex V, p. 257.
[65] Öko-Recherche Study, Annex V, p. 259.
[66] Öko-Recherche Study, Annex V, p. 264.
[67] Öko-Recherche Study, Annex V, pp. 260-261.
[68] Öko-Recherche Study, Annex V, p. 265.
[69] Öko-Recherche Study, Annex V, p. 266.
[70] Öko-Recherche Study, Annex V, p. 267.
[71] Öko-Recherche Study, Annex V, p. 268.
[72] Öko-Recherche Study, Annex V, p. 269.
[73] Öko-Recherche Study, pp. 260-262 (emission abatement potential)
[74] Öko-Recherche Study, Executive Summary, p. X.
[75] *Compare* Öko-Recherche Study, pp. 260-262 (alternative technology costs) *with* Öko-Recherche Study, p. 171 (containment and recovery costs).
[76] *See generally* Environmental Investigation Agency, *End in Sight: Phasing Out Fluorinated Greenhouse Gases in Europe* (November 2011).
[77] *See* EC 2003 Costs and Impacts Report, pp. 17, 25, 34.
[78] *See* EC 2003 Costs and Impacts Report, pp. 17, 25, 34.
[79] ODS Regulation, Article 11.
[80] *See e.g.* Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC, OJ L 275 (25 October

2003), as amended (EU ETS); Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC, OJ L 140, 5.6.2009, p. 16–62 (Renewable Energy Directive); MAC Directive; Directive 2009/30/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 98/70/EC as regards the specification of petrol, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions and amending Council Directive 1999/32/EC as regards the specification of fuel used by inland waterway vessels and repealing Directive 93/12/EEC (Fuel Quality Directive); *see also* 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/295/23 (EU Timber Regulation).

[81] Öko-Recherche Study, Annex V, p. 248.
[82] Öko-Recherche Study, Annex V, p. 248.
[83] Öko-Recherche Study, Annex V, p. 249.
[84] Öko-Recherche Study, Annex V, p. 249.
[85] Öko-Recherche Study, Annex V, p. 251.
[86] Öko-Recherche Study, Annex V, p. 251.
[87] Öko-Recherche Study, Annex V, p. 252.
[88] Öko-Recherche Study, Annex V, p. 252 (rounded up from 5.9%).
[89] Öko-Recherche Study, Annex V, p. 263.
[90] Öko-Recherche Study, Annex V, p. 263.
[91] Öko-Recherche Study, Annex V, p. 258.
[92] Öko-Recherche Study, Annex V, p. 258.
[93] Öko-Recherche Study, Annex V, p. 262.
[94] Öko-Recherche Study, Annex V, p. 262.
[95] Öko-Recherche Study, Annex V, p. 261.
[96] Öko-Recherche Study, Annex V, p. 261.
[97] *See* Öko-Recherche Study, pp. 262-264 (emission abatement potential).
[98] *Compare* Öko-Recherche Study, pp. 260-262 (alternative technology costs) *with* Öko-Recherche Study, p. 171 (containment and recovery costs).
[99] *See* Lisbon Treaty, Article 191(2).