The Critical Role of Annex III Bans in the F-Gas Regulation: The ENVI Report

On the 19th of June, the European Parliament's Environment Committee (ENVI) adopted a report on the revised F-Gas Regulation. The ENVI report advances a decidedly pro-European Union approach toward regulating fluorinated gases, one that mirrors the successful regulatory approach applied to ozone depleting substances, and at the same time advances European economic and environmental interests.

The crux of the ENVI report is the promotion of replacement technologies relying on natural refrigerants and other low-GWP technologies. Those replacement technologies are predominantly produced by European and EU-based companies within the European Union – due to early action by Member States on both HFCs and HCFCs. The promotion of low-GWP replacement technologies will only be achieved through the introduction of Annex III bans. For this reason, the HFC chemical industry, which is dominated by non-EU multinationals with production facilities located abroad, is heavily promoting an approach that relies on an over-allocated phase-down, in the knowledge that this will largely result in a transition to mid-GWP HFC chemicals and blends that they own and/or produce.

As shown below, the ENVI report advances a sensible and pragmatic approach to Annex III bans. This briefing note provides an overview and explains the merits of those amendments.

THE ABUNDANCE OF TECHNICAL SUPPORT FOR ANNEX III BANS

Every single Annex III ban in the ENVI report has a technical basis.

The Commission-published the ***Preparatory Study***, a multi-year analytical study led by Öko-Recherche comprising over 730 pages of in-depth analysis of over 26 subsectors and prepared with input from the HFC chemical industry, alternatives providers, institutes and other experts. The report found:

> "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.[1]"

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."[2] It incorporates safety constraints and costs considerations while factoring in the availability of materials and components, system complexity and know-how.[3] It also ensures, as its basic guiding principle, that abatement options achieve "at least the same level of efficiency as the existing refrigerants."[4] When penetration rates reach 100% for any given subsector, a ban on new equipment is feasible. These penetration rates served as the basis for the current proposal for bans in Annex III, and upon close scrutiny were also included in the ***Impact Assessment***.[5]

Some questions have arisen about the Annex III bans in the ENVI report given that the ***Impact Assessment*** lists the bans based on subsector and the ENVI report sometimes lists them more broadly. For example, instead of listing the individual subsectors within stationary refrigeration—i.e. stand-alone systems, condensing units, centralized systems, small industrial equipment and large industrial equipment—the ENVI report simply states "*stationary refrigeration equipment*."

The reason for this approach is that the ***Impact Assessment*** shows that all new equipment in each subsector falling under stationary refrigeration can convert to replacement technologies <u>on or before 2020</u> (the only exception being small industrial equipment below 100kW). With respect to small industrial equipment below 100kW, independent experts testified that this type of equipment can—and does—use replacement technologies found in commercial refrigeration because of the similar size and function of the equipment. Independent experts also testified that replacement technologies for equipment operating at extremely low temperatures (below -50°C) were not yet feasible. For these reasons, the ENVI report amends Annex III to ban "stationary refrigeration equipment *that contains fluorinated greenhouse gases, except equipment intended for use at operating temperatures of below -50°C*."

This straightforward approach was also taken for stationary air-conditioning. The ***Impact Assessment*** identifies each subsector as being capable of transitioning to alternatives in new equipment <u>on or before 2020,</u> with the exception of centrifugal chillers. Independent experts showed, however, that the conclusion on centrifugal chillers did not account for technologies already on the market and that this subsector can transition by 2020.[6] For these reasons, the ENVI report amends Annex III to ban "stationary air-conditioning equipment that contains fluorinated greenhouse gases." The same logic applies to mobile refrigeration.

When differentiation based on subsector was required, e.g. in the foam sector, the ENVI report lists the individual subsectors in Annex III.

Several studies from Member States, international bodies, NGOs and consultancies corroborate the findings in the *Preparatory Study* and *Impact Assessment*, including:

- ***Avoiding Fluorinated Greenhouse Gases: Prospects for Phasing Out*** (German Federal Environment Agency)[7]
- ***Étude d'Impact des Scénarios de Réduction de la Production et de la Consommation des Gaz à Effet de Serre Fluorés de Type Hydrofluorocarbures en France*** (Bureau Veritas)[8]
- ***Decision XXIV/7 Task Force Report: Additional Information to Alternatives on ODS*** (TEAP)[9]
- ***Phase Down of HFC Consumption in the EU – Assessment of Implications for the RAC Sector*** (SKM Enviros)[10]
- ***Natural Refrigerants Market Growth for Europe*** (Shecco)[11]
- ***Chilling Facts IV: HFC-Free Cooling Goes Mainstream*** (EIA)[12]

There is a general consensus on the availability of replacement technologies and, in fact, many studies even demonstrate that bans in some subsectors can occur earlier than recommended by the ***Preparatory Study*** and ***Impact Assessment*** (e.g. with respect to centrifugal chillers, commercial refrigeration, large industrial refrigeration). It is also important to note that the *Preparatory Study* only considered commercialised technologies, not prototypes that will surely develop rapidly with a clear regulatory signal. That Denmark took action to ban HFC chemicals a decade ago is further support. The question is not whether replacement technologies exist, but how to get them into the marketplace.

THE POLICY FRAMEWORK UNDERLYING ANNEX III BANS

The main issues confronting policymakers and the European companies producing alternatives are as follows:

(i) *Unlocking Investment in the European Union* -- how to unlock investment in replacement technologies to increase scale of production to capitalise on opportunities in the European and international marketplace;

(ii) *Overcoming Arbitrary Barriers to Market Entry* – how to overcome antiquated safety codes and standards, ones that have sometimes been specifically manipulated to prevent competition to HFC chemicals.

(iii) *Ensuring Emission Reductions When Using HFOs* – how to ensure emission reductions from replacement technologies using HFOs given their significant by-product emissions.

Policymakers will also need to create a structure that provides flexibility:

(iv) *Providing Flexibility for Discrete Applications* – how to craft a derogation procedure to allow continued use of HFC-based technologies if replacement technologies are not suitable for particular applications, something that has been done in successive ozone-depleting substance phase-outs.

The ENVI report tackles each of these issues with specific measures that, taken together, advance a holistic vision to transitioning to replacement technologies. It stands in contrast to the COM proposal, which actually seems designed to *prolong* dependency on HFC chemicals and bring about a transition to mid-GWP chemicals and blends through grandfathering of quotas and an over-allocated phase-down.

UNLOCKING INVESTMENT IN THE EUROPEAN UNION

Scale of production. Given that the replacement technologies are proven and commercialised, the primary question is one related to scale of production. Bans are needed to unlock investment in their production, which currently occurs predominantly in the European Union by European and EU-based companies and component manufacturers, many of which are SMEs. Over 250 have already been identified (this list is not exhaustive):[13]

- 45 in Germany
- 41 in UK
- 29 in Italy
- 20 in Denmark
- 13 in Netherlands
- 12 in Sweden
- 10 in Spain
- 9 in France
- 9 in Norway
- 8 in Belgium
- 6 in Ireland
- 5 in Finland
- 4 in Greece
- 4 in Austria
- 3 in Macedonia
- 2 in Romania
- 2 in Poland
- 2 in Hungary
- 2 in Bulgaria
- 2 in Serbia
- 1 in Cyprus
- 1 in Czech Republic
- 1 in Lithuania
- 1 in Luxembourg

From an economic perspective, the transition to replacement technologies is in European interests. The refrigeration market was worth $10.5 billion in 2012 and is expected to increase to $15.7 billion by 2018 – an annual growth rate of 6.9%.[14] The air-conditioning market is expected to grow by 7% a year through 2050 in developing countries—an increase by a factor of 12 from today's levels—and comparable growth rates are predicted for certain regions of Europe.[15]

From an environmental perspective, the transition to mid-GWP HFC chemicals like HFC-32,[16] is no guarantee of emission reductions. For example, in 2011, Indonesia agreed under the Montreal Protocol HCFC phase-out, to replace the use of HCFC-22 (GWP 1780) with HFC-32 (GWP 675) in the stationary air-conditioning manufacturing subsector. Despite this transition to an HFC chemical with less than half the GWP, Indonesia's CO_2-eq. emissions from this sector are expected to double by 2016 due to its annual growth rate.[17] Europe can lead the transition to truly low-GWP technologies which will also bring significant energy benefits.

Without Annex III bans, a phase-down simply promotes mid-GWP HFC chemicals and blends and will not generate an adequate reduction in CO_2-eq. consumption of HFCs as envisaged or required.

OVERCOMING ARTIFICIAL BARRIERS TO MARKET ENTRY

Safety Codes and Standards. Some replacement technologies rely upon hydrocarbons and ammonia, refrigerants with superior energetic performance that none the less have flammability or toxicity issues that need to be addressed. The technologies incorporating these refrigerants have been designed to resolve safety concerns—concerns that also once existed for gas-powered stoves and heaters in homes or gas tanks in vehicles—by reducing or dispersing charge sizes among other things. Despite overwhelming evidence that these refrigerants work safely and efficiently, many safety codes and trade standards prohibit or limit their use. The standards process has been clearly dominated by the HFC chemical industry in the past, resulting in a number of standards that have reduced the commercial viability of HFC-free replacement technologies in the marketplace. For example, a thriving SME market in

hydrocarbon domestic heat pumps in the 1990s was effectively killed by measures introduced by the HFC chemical lobby under the 1997 EU Pressure Equipment Directive.[18] To resolve these two issues, the ENVI report contains amendment 58:

Article 9

3b. Each Member State shall publish and notify to the Commission, by [1 January 2016], a report on codes, standards or legislation applied at the local, regional or national level that restrict the introduction of replacement technologies using flammable refrigerants, including hydrocarbons, in refrigeration and air-conditioning products and equipment and foams. The report shall propose actions to address these restrictions to allow the entry into force of the market prohibitions listed in Annex III or, where appropriate, detail areas of application where discrete exceptions may be needed for legitimate safety reasons.

The Commission shall publish a synthesis report by [1 January 2017], made available to the public, in electronic form, with a view to its active and systematic dissemination in accordance with Regulation (EC) No 1367/2006.

ENSURING EMISSIONS REDUCTIONS DURING HFO USE

Destruction of By-Product Emissions during the Manufacturing Process. The ENVI report does not attempt to include all HFC chemicals in Annex 1. Like the Commission proposal, the ENVI report considers two HFC chemicals referred to as "HFOs" in the basket of replacement technologies along with the natural refrigerants, namely HFC-1234yf (GWP 4) and HFC-1234ze (GWP 7). These HFOs, whose patents are owned by Honeywell and DuPont, suffer from the same disadvantages as other HFC chemicals (e.g. non-EU ownership and production outside Europe), but also raise additional concerns, such as those that have arisen in the context of the MAC Directive. In addition, replacing HFC chemicals in new equipment with HFOs does not ensure lifecycle greenhouse gas reductions due to potential significant by-product emissions during their production, the details of which are not open to public scrutiny. The ENVI report sought to address this final concern, in particular, by prohibiting the placement of any HFC chemical on the market unless by-product emissions have been destroyed.

In the ENVI report, the use of the term "fluorinated greenhouse gases" in Annex III does not prohibit HFOs—which are listed in Annex II, not Annex I—unless specifically stated (Amendment 16):

Article 1

(1) 'fluorinated greenhouse gases' means the hydrofluorocarbons ('HFCs'), perfluorocarbons ('PFCs'), sulphur hexafluoride ('SF_6') and other greenhouse gases that contain fluorine, as listed in ***Annexes I and II***, whether alone or in a mixture***, and they shall only refer to those fluorinated greenhouse gases listed in Annex I unless otherwise indicated***;

For this reason, the Annex III bans in the ENVI report that simply ban "fluorinated greenhouse gases" allow HFOs to still be placed in new equipment after the ban enters into effect – just as envisioned in the *Preparatory Study* and *Impact Assessment*.

But since the production of HFO (including its feedstocks and process agents) have by-product emissions that may undermine the emission reductions otherwise achieved from transitioning to HFOs in the first place, the ENVI report requires destruction of by-product emissions before those chemicals are allowed to be placed on the market (Amendment 49):

Article 6

-1a. Without prejudice to Article 9(1), producers and importers shall be prohibited from placing on the market fluorinated greenhouse gases listed in Annexes I and II unless any fluorinated greenhouse gases produced as a by-product during the manufacturing process, including during the manufacturing process of their feedstocks and process agents, are destroyed.

The practical implication of this provision is to require production facilities to install control devices to destroy by-product emissions if they wish to access the European marketplace, thus resolving a longstanding issue that has already cost the European Union billions of euros through CDM and ETS.

PROVIDING FLEXIBILITY FOR DISCRETE APPLICATIONS

Derogation Process for Discrete Applications. Some legitimate concerns about the availability of alternatives so exist in a limited number of subsectors, and at times in discrete applications there may be a need for continued HFC use, such as military applications and other critical uses. The F-Gas Regulation allows for derogations to be granted pursuant to Article 9(3) in these circumstances. This is a similar approach to the ODS Regulation, thereby allowing bans but also including a safety valve for unique circumstances. Many Member States report that the derogation process in the ODS Regulation is an educational exercise too, one that discourages illegitimate requests for derogations by requiring Member States to go before the other Member States with their request. In the past, those other Member States that have confronted the same issue are able to provide information on the replacement technologies used for that application in their country, making a derogation unnecessary.[*] In the current context, Council may elect to use the examination procedure rather than delegating authority to the Commission, or it may elect to craft a dual structure depending on whether the derogation sought is a categorical one (that applies across Member States) or an idiosyncratic one (that applies to only one Member State).

CONCLUSION

Contrary to the claims by the HFC chemical industry, the ENVI report advances a sensible and pragmatic approach toward transitioning to replacement technologies, one that draws on the successful experience of controlling ozone-depleting substances and is supported by an unparalleled body of technical evidence and real-world experiences.

The opposition against Annex III bans by the HFC chemical industry is driven by their understanding that Annex III bans are the most effective measure to swiftly transition the European market away from HFCs. The voice of those companies producing HFC-free replacement technologies is rarely heard, since they are predominantly SMEs that lack the huge lobbying budgets of multinational companies such as Honeywell, DuPont and Daikin, and the entities promoting their interests such as the American Chamber of Commerce, the Japanese Business Council of Europe and the HFC lobby group European Partnership for Energy and the Environment. It is noteworthy that the HFC chemical industry provides no evidential support for its claims, and its "scaremongering" is already a matter of public record.[19]

[*] Companies providing replacement technologies tend to be smaller. For this reason, many people are simply unaware of the replacement technologies. Online services have developed to overcome these marketing challenges facing smaller companies, such as R744.com, Hydrocarbons21.com and Ammonia21.com, which serve as industry platforms for cooling and heating components, systems and engineering services allowing end-users to search for specific products. In addition, Denmark provides free consulting services to end-users seeking to find a replacement technology for their specific need.

Annexes I and II to this briefing provide a summary of the conclusions in recent reports and studies for stationary refrigeration and air-conditioning, respectively, showing that Annex III bans are feasible.

ANNEX I
ALTERNATIVES IN STATIONARY REFRIGERATION

A ban on using HFC chemicals in new stationary refrigeration equipment in 2020 is feasible, according to the *Preparatory Study* and *Impact Assessment*, which looked at safe, energy-efficient and cost-effective replacement technologies on the market in 2010. Since 2010, several new replacement technologies have come onto the market further substantiating the feasibility of the 2020 ban date.

- ***Preparatory Study***: Bans were found feasible by 2020 (other than industrial refrigeration, however see UBA study below) and are recommended for inclusion, as shown from the following extract:

Ban the placing on the market of certain closed F-gas applications	Add. em. red. 2030	Abatement costs 2030	Effectiveness	Efficiency	technical feasibility / penetration rates	Other qualitative criteria	Final evaluation
	kt CO_2 eq	€/t CO_2 eq	Threshold: 1,000 kt CO_2 eq	Threshold: 50€/tCO_2 eq			
Domestic refrigeration	12	1.0	-	+	2015		exclude
Commercial hermetic systems	147	-0.8	--	++	2020		include
Condensing units	2,849	1.2	+	+	2020		include
Centralized systems	12,055	23.7	++	+	2020		include
Small industrial refrigeration	67	-0.9	+/-	++	95% in 2030	Exemptions need to be defined for small systems, e.g. <50 kg (similar to Sweden).	include
Large industrial refrigeration	202	-21.6	+	++	95% in 2030	Exemptions need to be defined. Combination of small + large ref. possible (threshold 50 kg)	include

- ***German Federal Environment Agency (UBA)***: Submitted comments to the public consultation proposing bands in 2020 or earlier, based on the findings in its report *Avoiding Fluorinated Greenhouse Gases: Prospects for Phasing Out*, as evidenced in the following extract:[20]

Fluorinated greenhouse gases	household and laboratory refrigerating/freezing appliances	01.01.2015
Fluorinated greenhouse gases	Stand-alone equipment in commercial refrigeration	01.01.2015
Fluorinated greenhouse gases	commercial refrigeration systems [containing more than [20] kg of refrigerant]	01.01.2020
Fluorinated greenhouse gases	refrigeration equipment containing less than [150] g of refrigerant	01.01.2020
Fluorinated greenhouse gases	industrial refrigeration systems exceeding a capacity of [100] kW	01.01.2020
Fluorinated greenhouse gases	refrigeration equipment for cold storage depots exceeding a capacity of [450] kW	01.01.2020

- ***SKM Enviros***: Only replacement technologies for single condensing units for low temperature (LT) were characterised as unsuitable on safety, efficiency or cost grounds (however note that at least one manufacturer is already producing such condensing units with CO_2 in Europe) whereas replacement technologies are available for hermetic units LT and medium temperature (MT), condensing units MT, and centralised systems LT and MT, as evidenced in the following extract:[21]

Main Sector	Sub-Sector		Group 1 Very low GWP (<10)
Domestic Refrigeration	Refrigerators	MT	🟢
	Freezers	LT	🟢
Commercial Refrigeration	Hermetic Units (Medium Temp)	MT	🟢
	Hermetic Units (Low Temp)	LT	🟢
	Single condensing units (MT)	MT	🟢
	Single condensing units (LT)	LT	🔴
	Multi-pack centralised systems (MT)	MT	🟢
	Multi-pack centralised systems (LT)	LT	🟢
Transport Refrigeration	Vans and light trucks	LT & MT	🟢
	Large Trucks and Iso-Containers	LT & MT	🟢
Industrial Refrigeration	Small DX LT (low temp.)	LT	🟡
	Small DX MT (medium temp.)	MT	🟢
	Medium DX LT (low temp.)	LT	🟡
	Medium DX MT (medium temp.)	MT	🟡
	Large DX LT (low temp.)	LT	🟢
	Large DX MT (medium temp.)	MT	🟢
	Medium-size Industrial Chillers	MT	🟢
	Large Industrial Chillers	MT	🟢
	Large Flooded LT (low temp.)	LT	🟢
	Large Flooded MT (medium temp.)	MT	🟢

SKM Enviros also produced a traffic light analysis specifically addressing when it considered bans were feasible in 2020:

	RAC Market	% 2010 HFC Emissions	Approximate GWP Threshold for New Product Ban by 2020				Comments
			150	700	1400	2500	
Refrigeration	Domestic refrigeration	0.2%	🟢				Already banned from 2015
	Commercial Small Hermetic	0.2%	🟢				Already banned from 2020. Needs new definition
	Commercial Condensing Units	4%	🔴	🟡	🟢	🟢	Use of mildly flammable refrigerants possible. Early R404A ban recommended
	Commercial Multipack	33%	🟢	🟢		🟢	CO_2 looking a good option on large packs. Smaller packs may need GWP 700
	Transport Refrigeration	1%	🟡	🟡		🟡	CO_2 being piloted. R404A ban from 2020
	Industrial Small / Medium DX	8%	🔴	🟡	🟢	🟢	Many variants. De facto R404A ban
	Industrial Large DX	3%	🟢			🟢	Ammonia and CO_2. May need exemptions
	Industrial chillers	1%	🟢	🟢			Large chillers < 150; small chillers < 700
	Industrial flooded	0.1%	🟢			🟢	Ammonia and CO_2. May need exemptions

ANNEX II
ALTERNATIVES IN STATIONARY AIR-CONDITIONING

A ban on using HFC chemicals in new stationary air-conditioning equipment in 2020 is feasible, according to the *Preparatory Study* and *Impact Assessment*, which looked at safe, energy-efficient and cost-effective replacement technologies on the market in 2010. Since 2010, several new replacement technologies have come onto the market further substantiating the feasibility of the 2020 ban date.

Indeed, bans on using these patented HFC chemicals were recommended for inclusion by the *Preparatory Study* and *Impact Assessment*, as shown from the following extracts:

Moveable AC	2,781	8.9	+	+	2020		include
Single split AC	22,970	19.0	++	+	2020		include

Multi split AC	2,172	13.1	+	++	2020		include
Rooftop AC systems	573	8.2	-	++	2020		include
Displacement chillers	1,989	5.9	+	++	2020		include
Centrifugal chillers	9	7.5	-	++	2030		exclude

Since publication of the *Preparatory Study*, as noted by MEP Chris Davies in amendment 350, "independent experts and advisors to industry state that the existence of sustainable alternatives means a ban in [centrifugal chillers] could be achieved by 2020."

Bans were not been proposed across the board, however, in the other studies and reports. In particular, while CO_2 is more efficient in colder climates, it is believed that energy-efficient hydrocarbons would be the predominant alternative in warmer climates. Hydrocarbons, however, are flammable and antiquated safety legislation often presents barriers to their market penetration, despite their energy-efficiency and cost-effectiveness. This was the basis for amendment 58 by MEP Jo Leinen, discussed above, which sets out to update safety legislation across Member States while providing a mechanism for determining those applications where legitimate safety concerns exist – something that is particularly important given the decades-long "scare" campaign waged by the HFC chemical industry. Air-conditioning manufacturers in China and India have already recognised the potential for highly efficient HFC-free air-conditioning using hydrocarbons. Indian company Godrej has already sold more than 25,000 5-star hydrocarbon split air-conditioning units that are saving 23% more energy than other 5-star products on the market.[22]

Other reasons for including a ban in stationary air-conditioning have been noted:

- **Bans in new air-conditioning equipment will lower costs for replacement technologies because smaller European companies will be able to invest in production**. There is nothing inherently more expensive about new air-conditioning equipment using hydrocarbons or CO_2. Hardware costs are higher simply because scale of production is lower. This is particularly relevant to consumer products,

such as moveable and split systems. Bans in new air-conditioning equipment allow the smaller European companies that produce the replacement technologies to invest in facilities and increase scale of production to reduce hardware costs to parity. Moreover, since hydrocarbons and CO_2 are not patented and are inexpensive, the costs for first fill and refill remain low. This contrasts to HFC chemicals, which will only increase in price as HFC quotas become increasingly scarce, meaning the costs for first fill in new HFC technologies and refills in existing HFC technologies that have already been placed on the market will increase over time.

- **Bans move production to Europe**. For example, the Commission estimates about 90% of current production of movable and split systems occurs in China.[23] If the market for new air-conditioning equipment using replacement technologies is Europe, then the smaller European companies producing them will invest in expanding existing production facilities already located in Europe and will also tend to favour building new production facilities in Member States with lower labour costs, i.e. Southern and Eastern Europe. The same production pattern holds true for refrigeration. In contrast, omitting bans will just preserve the status quo, i.e. continued dependency on patented chemicals and HFC technologies produced mostly abroad.

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1 Öko-Recherche *et al.*, *Preparatory Study for a Review of Regulation (EC) No 842/2006 on Certain Fluorinated Greenhouse Gases, Final Report* (September 2011), Executive Summary, p. XI.

2 Öko-Recherche *et al.*, *Preparatory Study for a Review of Regulation (EC) No 842/2006 on Certain Fluorinated Greenhouse Gases, Final Report* (September 2011), p. 195.

3 Öko-Recherche *et al.*, *Preparatory Study for a Review of Regulation (EC) No 842/2006 on Certain Fluorinated Greenhouse Gases, Final Report* (September 2011), pp. 195-198.

4 Öko-Recherche *et al.*, *Preparatory Study for a Review of Regulation (EC) No 842/2006 on Certain Fluorinated Greenhouse Gases, Final Report* (September 2011), pp. 196-197.

5 European Commission, *Impact Assessment: Review of Regulation (EC) No 842/2006 on certain fluorinated greenhouse gases* (Commission Staff Working Paper), SWD(2012)0364, p. 37.

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

7 Umweltbundesamt, *Avoiding Fluorinated Greenhouse Gases: Prospects for Phasing Out* (June 2011, English Version).

8 Bureau Veritas, *Étude d'Impact des Scénarios de Réduction de la Production et de la Consommation des Gaz à Effet de Serre Fluorés de Type Hydrofluorocarbures en France (2013, French Version).*

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14 Markets and Markets, *Refrigerant Market – Hydrochlorofluorocarbons (HCFC), Hydrofluorocarbon (HFC), Hydrocarbon (HC), Inorganic (Ammonia, Carbon Dioxide – Trends and Forecasts to 2018* (May 2013), *available at* http://www.marketsandmarkets.com/Market-Reports/refrigerant-market-1082.html; see also Sacramento Bee, *Refrigerant Market Worth $15.7 Billion by 2018* (published 16 May 2013), *available at* http://www.sacbee.com/2013/05/16/5425073/refrigerant-market-worth-157-billion.html.

15 GIZ Proklima, *PowerPoint Presentation: Proposed EU Regulation on F-Gases – Relevance for Developing Countries* (14 May 2013, European Parliament), p. 3.

16 United Nations Environment Programme, *Report of the Technology and Economic Assessment Panel: Decision XXIV/7 Task Force Report: Additional Information to Alternatives on ODS*, Volume 2 (May 2013, Draft Report), p. 11.

17 GIZ Proklima, *PowerPoint Presentation: Proposed EU Regulation on F-Gases – Relevance for Developing Countries* (14 May 2013, European Parliament), p. 8.

18 *See* http://r-22-refrigerants.blogspot.com.es/2013/06/renewed-interest-in-hc-heat-pumps-in.html; *and* http://www.earthcareproducts.co.uk/cms/uploads/108baf6d1cff2a17cdd7b7a228a20b8a/Low-Carbon%20Cooling%20Hydrocarbons%20RAC%20Oct%202009%20Pages%2036%2037.pdf

19 *See e.g.* 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* British Broadcasting Corporation, Radio 4, *Transcript of "File on 4" – European Commission* (Current Affairs Group, 22 November 2005).

20 German Federal Environment Agency, Options for Reducing Emissions of Fluorinated Greenhouse Gases (F-Gases) at European Level (December 2011), p. 4, *available at* http://www.umweltbundesamt.de/produkte/dokumente/options_for_reducing_emissions_of_fluorinated_greenhouse_gases_f_gases.pdf.

21 SKM Enviros, *Phase Down of HFC Consumption in the EU – Assessment of Implications for the RAC Sector* (Final Report, Version 11, September 2012), p. 35.

22 *See* "Conversion of the Production of Split and Window-Type Air Conditioners to Hydrocarbon Technology" *available at* www.Giz.de/themen/en/36794.htm and http://www.unep.fr/bangkoktechconference/docs/IIIA-1%20Dilip%20Rajadhyaksha%20Godrej%20Presentation.pdf

23 Testimony of *Bente Tranholm Schwarz*, *F-Gas Expert Hearings: Stationary AC and Pre-Charging Ban* (28 February 2013).