SMARTER STANDARDS: VITAL FOR KIGALI AMENDMENT SUCCESS

EXECUTIVE SUMMARY

In 2016, EIA published "The Need for Smarter Standards in Cooling", a report introducing the issue of outdated safety standards limiting adoption of HFC-free technologies in major refrigeration and air conditioning (RAC) sectors. This report provides updates on the work of key standards bodies relevant to the cooling sector and expands on the climate imperative of modernizing standards for implementation of the Kigali Amendment and the ongoing HCFC phase-out.

Important efforts are underway to revise international and national safety standards. The Montreal Protocol and other policy venues have recently started recognizing updated standards as a critical step to implementing the transition away from HCFCs and HFCs. The pace at which this work continues will be a primary driver of the technology options available to countries in meeting their domestic and international climate commitments in the RAC sector. Enhancing focus on standards development work will depend on increasing awareness and understanding of relevant safety standards, capacity for active engagement from a broad set of stakeholders, and provision of sufficient resources for experts conducting core standards development work.

STANDARDS AND KIGALI AMENDMENT IMPLEMENTATION

Hydrofluorocarbons (HFCs), first introduced to replace ozone-depleting substances (ODS) in the cooling sector, are potent greenhouse gases that pose a significant threat to the global climate. In 2016, Parties to the Montreal Protocol reached the groundbreaking agreement to a global phase-down of HFCs under the Kigali Amendment.[1] As the Kigali Amendment was agreed, countries formally recognized the need for timely revision of safety standards, setting up a framework for the Montreal Protocol and individual countries to take steps to monitor and help facilitate these activities. If implemented successfully, the Kigali Amendment could avoid emissions of over 70 billion tonnes of carbon dioxide-equivalent (CO_2e) and half a degree Celsius of warming by 2050.[2] However, successful implementation of the Kigali Amendment hinges on the availability and cost-effectiveness of HFC-free, energy efficient, low-global warming potential (GWP) refrigeration and air conditioning technologies.

Without updated safety standards to enable broad global market acceptance of HFC-free energy-efficient refrigerants, countries will be faced with limited choices as they seek to meet compliance deadlines for phasing down HFCs, which begin in 2019 for developed (non-A5) Parties and in 2024 for most developing (A5) Parties. The restrictive nature of safety standards today is already impacting developing countries (A5 Parties) currently seeking to leapfrog or bypass HFCs through the HCFC phase-out, and will soon affect developed countries (non-A5 Parties) in meeting the first control measures of the Kigali Amendment or national legislation, such as in the case of the European Union (EU).

"Smart standards" should be based on valid assumptions backed by rigorous research and data and take into account the full range of modern safety technologies and warning systems to mitigate flammability risks.

Several important initiatives are underway to bring about the changes and updates needed to currently restrictive standards to make them 'smarter' in addressing the safety issues associated with low-GWP refrigerants. "Smart standards" should be based on valid assumptions backed by rigorous research and data and take into account the full range of modern safety technologies and warning systems to mitigate flammability risks. This work is taking place at the international, regional, and national levels in certain manufacturing and consuming countries. Rapid progress to change international standards and actions by individual countries to fast track changes to their national standards will contribute to increased opportunities to leapfrog HFCs under the

ongoing HCFC phase-out, and could encourage early action to phase-down HFCs under the Kigali Amendment. However, if the pace of progress of these initiatives is not maintained and expedited, then technology selection for certain refrigeration and air conditioning sectors will continue to be quite limited, possibly well past the beginning of early compliance dates for A5 countries in 2024. This could lead to an avoidable, costlier, and less climate-friendly transition to interim medium-GWP solutions.

Safety Standards and Energy Efficiency

The implications of restrictive safety standards also extend to the successful and cost effective maximization of energy efficiency benefits under the Kigali Amendment. Hydrocarbons, which face restrictive charge size limitations under many standards, are widely regarded as the most energy efficient low-GWP refrigerants for many applications.[3] When compared to HFCs and other fluorinated refrigerants, the performance of hydrocarbons is anywhere between 10 to 25% more efficient than HFCs and HFC-blends.[4] In the U.S., hydrocarbons have recently become an attractive way for equipment manufacturers to cost effectively meet more stringent energy efficiency regulations imposed by the U.S. Department of Energy with fewer expensive upgrades to equipment components.[5]

The efficiency benefits of hydrocarbons are particularly promising for countries with high-ambient climates. Due to their thermodynamic properties, hydrocarbons perform well at higher temperatures compared with other refrigerants.[6] Test results published by the Oak Ridge National Laboratory (ORNL) evaluated the performance of propane (HC-290) and four HFC and HFC blends as alternatives to HCfC-22 in mini-split air conditioners. Propane was the only refrigerant in the group that outperformed the energy efficiency of HCFC-22 under various high ambient conditions.[7] In chillers, hydrocarbons have achieved energy efficiency improvements under high ambient conditions of 15% compared with HCFC-22.[8]

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With standards moving towards allowing greater charge sizes, the efficiency margins of hydrocarbons would further increase. Current restrictions impose the need for potentially costly technical innovations in order to meet capacity requirements. Updated safety standards allowing greater charge sizes would therefore increase the efficiency as well as the market applicability of hydrocarbon technologies, and enable the maximum direct and indirect emission reductions to be achieved in a cost-effective manner.

MONTREAL PROTOCOL BEGINS TO ADDRESS STANDARDS

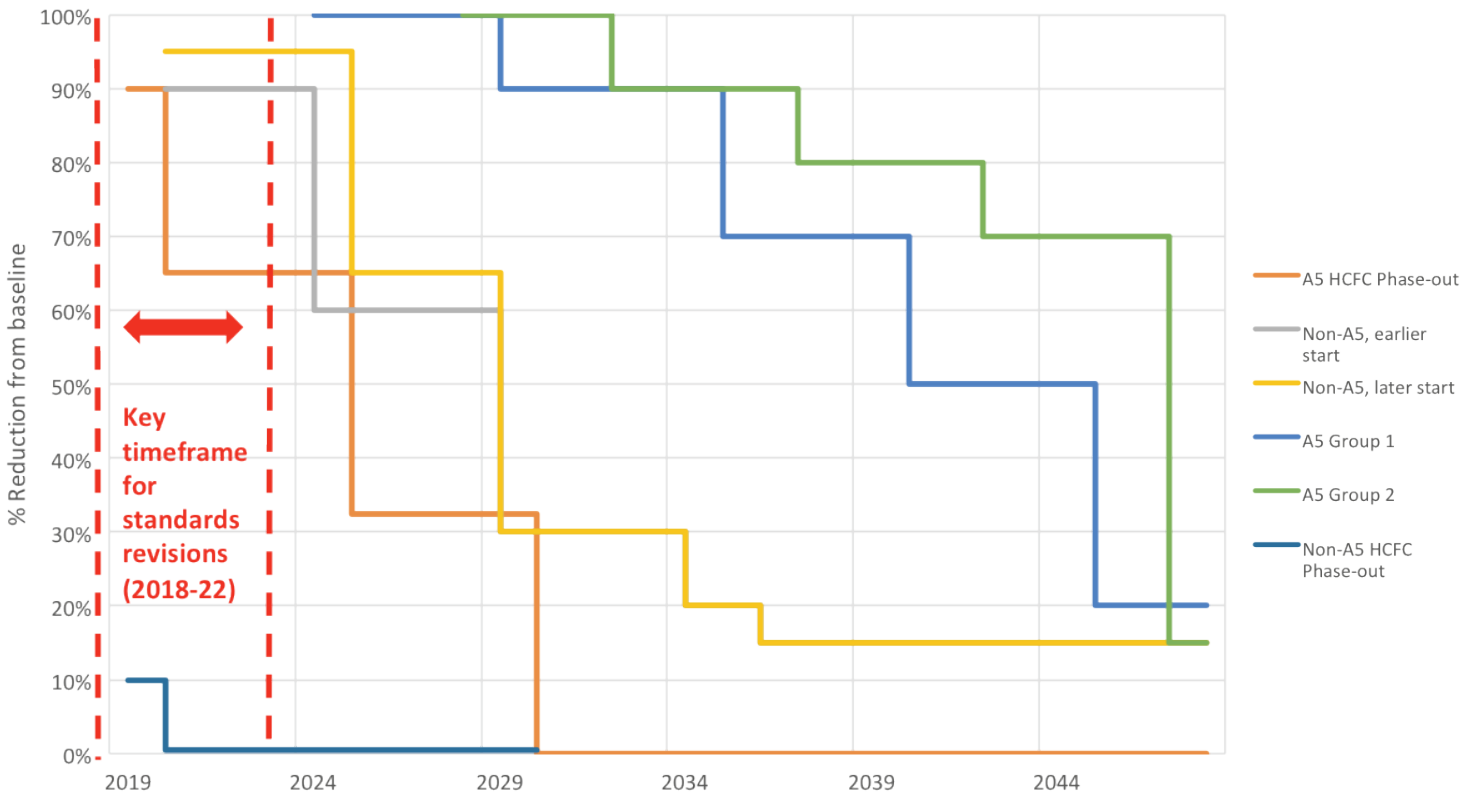
Kigali Standards Decision

Decision XXVIII/4 on safety standards, proposed by China, was adopted in Kigali at the 28th Meeting of the Parties (MOP 28). The decision aims to "support the timely revision of relevant standards in a manner that is technology neutral to enable safe use and market penetration of low-GWP alternatives."[9]

The decision:

1. Formed a task force of experts under the Technology and Economic Assessment Panel (TEAP) to submit a report to the 39th OEWG and to liaise and coordinate with standards organizations;
2. Requested a workshop be held on safety standards;
3. Urged Parties to work with their industries and standards bodies to support timely completion of processes for developing new standards, with the goal of completing such work by the end of 2018 and urged Parties to strengthen connections between national ozone units and national standards bodies;
4. Asked Parties to submit information on their domestic standards relevant to the use of low-GWP alternatives;
5. Asked the Executive Committee of the Multilateral Fund to consider maintaining or increasing capacity-building assistance with a view to improving cooperation between national authorities and standards committees;
6. Considered the need for regular consultations between the Ozone Secretariat and relevant international and national standards bodies, including IEC, ISO, UL, and ASHRAE.

Figure 1: Montreal Protocol HCFC Phase-out and HFC Phase-down Schedules



Standards and Codes in a Nutshell

- Standards are a set of technical criteria that establish quality and safety guidelines.
- With respect to refrigeration and air conditioning, there are different types of standards that apply to design, testing, and installation including refrigerant standards, equipment standards and building codes, among others. These different types of standards often overlap and reference each other.
- The most common technical aspect of safety tandards that restricts uptake of HFC-free refrigerants is a limit to the quantity (charge size) of flammable refrigerant that can be used in a given type of equipment or building type.
- Although standards are developed primarily by industry experts, most standards bodies are open to participation from non-industry stakeholders including government representatives, consumer groups and non-governmental organizations.
- Standards are voluntary unless specifically adopted into a national regulation or code that is legally mandated.

Refer to last year's report for a more in-depth introduction to standards bodies and information on the technical issues that require attention to allow broader safe uptake of HFC-free technologies: *https://eia-global.org/reports/the-need-for-smarter-standards-and-codes-in-cooling*

A full day workshop on cooling safety standards was held in July 2017 on the margins of the Open-Ended Working Group (OEWG) meeting of the Montreal Protocol. The Ozone Secretariat prepared several briefing notes to provide background information on relevant standards, the process for their revision, and how they apply at different points in the lifecycle of equipment for the workshop.[10] The TEAP task force on standards also submitted its draft report on this issue for discussion during the OEWG.[11]

The TEAP Report on standards acknowledges that current international standards are likely to result in a transition from HFCs to "medium GWP refrigerants in a first step and eventually to a low GWP refrigerant in a second step."[12] This two stage transition would be both extremely costly and could reduce the near-term climate benefits of the HFC phase-down. This is avoidable with enhanced efforts to expedite the work of updating standards. The TEAP Report also provides recommendations to Parties for practical measures that may be considered in the context of international standards bodies.

These recommendations include supporting national experts' participation and supporting technical research and data gathering activities. The TEAP report also notes that a country can introduce national modifications that enable broader and more cost effective use of alternative refrigerants of interest.[13]

Both the workshop and TEAP report acknowledge the limited participation of Article 5 (developing) countries in relevant standards bodies. The TEAP report highlights that while many international level activities are fairly open to nominated participants, only 30% of the participating members nominated in relevant IEC and ISO committees are experts from A5 countries.[14] It was agreed at the workshop that greater participation would be beneficial to the standards development process and that it would be meaningful for National Ozone Officers (NOUs) to gain an understanding of standards and the related processes and topics.[15] Building the capacity of NOUs with regard to standards could be a helpful step to encourage and enable participation of relevant experts to represent their countries.

Table I: Country Representation On Key International Standards Bodies

Working Group	Standard	Equipment Covered	No. of non-A5 Participants	No. of A5 Participants	Key issues under discussion	Estimated timeline for completion
International Electrotechnical Commission (IEC)						
IEC SC61C WG4	IEC 60335-2-89	Commercial Refrigeration	27	3	Developing requirements for increased refrigerant charge for all flammable refrigerants Draft proposals for 1kg and 500g.	>5 years
IEC SC61D WG9	IEC 60335-2-40	Air Conditioning and Heat Pumps	30	2	Requirements for expanding charge sizes of A2L refrigerants only Draft proposal enhanced tightness systems and other safety measures	1 year
IEC 61D WG16	IEC 60335-2-40	Air Conditioning and Heat Pumps	25	3	Requirements for expanding charge size of A2 and A3 refrigerants Draft proposal releasable charge and improved tightness	2-6 years
International Organization for Standardization (ISO)						
ISO TC86 SC1 WG1	ISO 5149	Refrigeration and Air Conditioning	51	1	Working on various aspects relating to new and revised requirements for alternative refrigerants for inclusion into ISO 5149.	>5 years

*Source: Information contained in this table comes from the TEAP Decision XXVIII/4 Task Force Report on Safety Standards for Flammable Low Global-Warming-Potential (GWP) Refrigerants, May 2017.

Twenty countries responded to paragraph 4 of Decision XXVIII/4, which invited Parties to submit information on domestic standards relevant to the use of low-GWP flammable refrigerants: Andorra, Armenia, Barbados, Brazil, Burkina Faso, Cabo Verde, European Union, Iran, Iraq, Italy, Jamaica, Japan, Malaysia, Maldives, Nigeria, Panama, Serbia, Singapore, the United States of America and Zimbabwe.[16] Most of these countries have adopted IEC standards in some form including IEC standards 60335-2-24, 60335-2-40, and 60335-2-89. Japan, Singapore, Armenia, EU, Malaysia, and Nigeria have all adopted key IEC standards either directly or with some form of national deviation.

The limited participation by A5 countries in the voluntary submission on standards further reflects a need for greater participation and understanding of these issues by NOUs and developing country experts. The submissions also show that while many countries have their own standards bodies, only a handful have adopted national versions of safety standards covering flammable refrigerants.

The Need for Continued International Cooperation and Capacity Building

Decision XXVIII/4 raised the issue of standards up the agenda for Montreal Protocol implementation. However, the discussions during OEWG-39 were just preliminary steps and there is a need to ensure that the issue continues to receive adequate attention and priority. The components of Decision XXVIII/4 that urge Parties to work with industry groups and instruct the Executive Committee of the Multilateral Fund to consider the necessity for additional capacity building to enable this cooperation and engagement still require further consideration and discussion. Given there is a lack of A5 country representation on key international standards committees and working groups, capacity building in this area should be considered and included in the discussions on Multilateral Fund resource use. There should also be a mechanism under the Montreal Protocol for informing A5 countries on the progress made by international standards bodies toward revision of important standards.

UPDATES ON KEY INTERNATIONAL STANDARDS

International safety standards governing refrigeration and air conditioning equipment are published primarily by two international standards organizations: the International Electrotechnical Commission (IEC) and the International Organization for Standardization (ISO). International standards are voluntary unless legally adopted via the national legislation of individual countries either directly, or with some slight national modifications. The most important role of international standards is to serve as a forum for setting international best practice and technical norms and thereby allow for greater harmonization of national standards.

International Electrotechnical Commission

IEC is the primary international standards organization that publishes safety standards relevant to factory built refrigeration and air conditioning equipment. The IEC standards development process is one that allows for wide participation from countries that maintain an IEC membership. Countries participate through membership of their national committee (NC), either as P-members, who must send experts to participate in all technical meetings and are able to vote, or as O-members with a lower level of participation required.[17] Each national committee has one vote on a given technical committee (TC) or sub-committee (SC). There are two main IEC working groups focused on examining the requirements for flammable refrigerants to determine the feasibility of safely expanding charge limits:

IEC 60335-2-40: Technical Sub-committee (SC) 61D on Air Conditioning - Working Group 16

Working Group (WG) 16 was formed in 2015 with a scope of work to address requirements for A2 and A3 refrigerants under IEC 60335-2-40. WG 16 released a draft proposal in early 2017 that received comments from the national committee members of SC61D and is undergoing further review and discussion by the WG16. The current proposal focuses on a method for determining maximum charge limits based on a calculation of the releasable charge. WG16 is also working toward additional draft proposals on a charge formula based on design features such as integral airflow and improved tightness. The publication of a revised IEC 60335-2-40 standard based on the outcome of WG 16 is expected to be within a 2019 to 2022 timeframe.[18]

IEC 60335-2-89: Technical Sub-committee (SC) 61C on Refrigeration – Working Group 4

WG4 was formed in 2014 to examine charge sizes of flammable refrigerants in commercial refrigeration equipment under IEC 60335-2-89. WG4 has looked at both air flow and specific design features to assess the safety of greater charge sizes ranging of up to 500 grams of A3 refrigerant. The draft proposal to expand charge sizes could be accepted into a revised standard as soon as 2018, but may take as long as 2020 to be finalized.[19]

International Organization for Standardization (ISO)

The International Organization for Standardization (ISO) is the second major international standards organization relevant to refrigeration and air conditioning safety. Similar to IEC, ISO has a process that allows for participation through a national standards body which is a member of ISO. There are three membership levels: Full members who participate and vote, Correspondent members who observe and comments, and Subscriber members who keep up to date but to not participate or adopt ISO standards nationally.[20]

ISO 5149: Technical Committee 86 - Working Group 1

The ISO 5149 standard is a 'horizontal' standard applying to all equipment not covered by the 'vertical' product standards under IEC, such as IEC 60335-2-40 and 60335-2-89. In 2014, a revision of ISO 5149 was published to incorporate the new classification of A2L refrigerants, allowing specific requirements for these refrigerants. ISO TC86 SC1 WG 1 was also asked in 2014 to continue improving the requirements related to flammability and other safety aspects. So far, there is no known timeframe for new revision proposals to be developed by WG1.

UPDATES ON NATIONAL AND REGIONAL STANDARDS

National and regional standards are those adopted by standardization organizations within a specific country or region. As with international standards, national standards are voluntary unless adopted in a mandated law or regulation, however national standards are much more likely to be enshrined in legal form in a given country. In some cases, national standards may be directly adopted in the exact form of the corresponding international standard under IEC or ISO. In many cases, however, IEC or ISO standards are adopted with some national differences. In other cases, a national standards body may choose to follow another national or regional standard. Finally, many countries may have no national standard in place. In these cases, equipment manufacturers producing in that country may choose to follow the guidance in an international or another national standard, as has been the case in India with the production of hydrocarbon air conditioners.

Harmonization of national standards with international standards carries many benefits by minimizing differences in products sold across different markets. However, it is important to note that direct adoption of an international standard with restrictive requirements on flammable low-GWP refrigerants may have a counterproductive impact on a facilitating a rapid transition to HFC-free alternatives. In these cases, national standards bodies may wish to examine the feasibility of adopting certain national modifications that may allow for a more rapid transition directly to the lowest-GWP and most energy efficient alternatives.

United States

Underwriters Laboratories (UL) is the primary organization that sets standards for specific RAC equipment in the United States. The charge size limits in UL standards are typically referenced in regulations under the U.S. Environmental Protection Agency's Significant New Alternatives Policy (SNAP) Program, and thereby are made legally mandatory for the U.S. market. UL is in the process of reforming its standards to harmonize with the format of corresponding IEC standards, however in some cases with national differences that diverge substantially from the corresponding IEC standard, particularly on treatment of flammable refrigerants.

UL 250, which covers domestic refrigeration equipment will expire in 2018, and is to be replaced by newly published UL 60335-2-24, which now fully harmonizes flammable charges sizes for hydrocarbon refrigerants with the 150-gram limit under IEC 60335-2-24.[21] This change is expected to result in a transition to hydrocarbon refrigerants in domestic refrigerators in freezers for the U.S. market, which for many years has lagged behind uptake of this technology in most other markets globally.[22] UL 471, which covers standalone commercial refrigeration will also be replaced with recently published UL 60335-2-89.[23] This standard fully harmonizes with IEC 60335-2-89 in terms of flammable charge size limits, allowing up to 150 grams of A3 refrigerant. Finally, UL 484 and UL 1995, which cover room and unitary air conditioning will be replaced with UL 60335-2-40. The second edition of UL 60335-2-40 was recently published and restricts use of A3 refrigerants based on a charge limit equation similar to that of UL 484, which allows only up to 116grams of propane.[24] Further proposals to revise the standard are expected in the near future, and the standard will fully replace legacy 484 and 1995 standards by 2022.

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) publishes ASHRAE 15, a standard which corresponds roughly with ISO 5149 and EN 378 at the international and European levels.

ASHRAE 15 currently places restrictive limits on the use of flammable refrigerants in many building types and particularly on A3 refrigerants which require approval from a local jurisdiction to install in amounts greater than 150 grams.[25] Changes to accommodate broader use of A2L refrigerants have been prioritized under this standard, while no proposed changes to accommodate greater use of A3 refrigerants have been submitted.[26] ASHRAE 15 is adopted into language for model building codes published by the International Code Council (ICC), which are in turn legally adopted my most states and local jurisdictions in the United States.[27]

China

In 2012, China released a revised national safely standard GB 4706.32.2012, equivalent to IEC 60335-2-40:2005. Compared with its previous version (GB 4706.32-2004) released in 2005, the new standard version discussed safety operation, which includes but is not limited to safety warning, transportation, installation, storage and charging of flammable refrigerants. The 2012 version also provided a formula to calculate the propane refrigerant charge quantity and security values for installation height, surrounded area and concentration.[28] GB 4706.32.2012 has allowed for early introduction of hydrocarbon air conditioners in China with manufacturers, Gree and Midea, beginning to introduce room air conditioners on the domestic market using propane. China may release a newer version of the national standard for air conditioners by the end of 2017 to incorporate more recent updates to IEC 60335-2-40.

In addition to updating the flammable refrigerant standard for air conditioning, China also updated its standards on domestic and commercial refrigeration in 2014 and 2016. GB4706.13-2014 - the equivalent standard of IEC 60335-2-24, covers the safety standards of household and similar electrical appliances and other requirements for refrigerating appliances, ice cream appliances and ice markers. It was published in 2014 to replace the previous 2008 version and was implemented in 2016.[29] Compared to the old version, the new version updated the definition of "household" and changed some technical terms.[30] In 2011, GB 4706.102.2010 (equivalent standard of IEC 60335-2-89) was published and implemented; the standard covers the safety standards of both household and similar electrical appliances as well as particular requirements for commercial refrigerating appliances with an incorporated or remote refrigerant condensing unit or compressor.[31]

India

The Bureau of Indian Standards (BIS) is the national standards body of India. BIS has published 37 standards

Prioritizing Work on All Low-GWP Refrigerants

The amount of resources and time made available by experts on specific technical issues needing to be addressed often drives the pace of the work to update standards. Due to this fact, work on synthetic patented refrigerants being developed by large chemical manufacturers, such as HFC-32 and HFC-HFO blends, which are more commonly classified as A2L or 'mildly' flammable, has often been addressed first and proceeded at a more rapid pace than work focused on natural refrigerants such as hydrocarbon which are classified as A3, or flammable.

For example, IEC SC61D WG9 was formed in2011 and the scope of work for this group was narrowly defined as dealing with flammability requirements for A2L refrigerants only, at the exclusion of A2 and A3 refrigerants, including hydrocarbons. It was not until 2015 that WG16 formed to perform the same analysis and apply similar concepts for the same types of equipment dealing with A3 refrigerants. Similarly, A2L refrigerants have been prioritized at the exclusion of A3 refrigerants in revisions completed or underway at the national and regional levels under EN 378, ISO 5149, and ASHRAE 15.

The prioritization of synthetic A2L refrigerants by industry stakeholders risks putting in place a standards framework that biases technology selection toward medium to high-GWP synthetic refrigerants. HFC-32 and other HFC-HFO blends have GWPs ranging from around 600 up to over 1,400. These refrigerants will not deliver the needed reductions in GWP to constitute a final solution under the Kigali Amendment. Therefore, this issue requires continued political attention by countries that seek to ensure the quickest transition to the lowest-GWP refrigerants. There is an important role for governments to play in ensuring that the scope of work defined for key standards bodies includes A3 refrigerants and that these are given equal priority in a technology neutral manner.

on refrigeration and air conditioning. However, most of these are product specifications, while only two of these classified as safety standards: IS 659:1964 (Safety Code for Air Conditioning) and IS 660:1963 (Safety Code for Mechanical Refrigeration).[32] These standards are outdated and do not contain provisions relevant to use of flammable refrigerants or charge size limit thresholds.

In the absence of a comprehensive and up to date national safety standard equivalent, BIS formed a sub-committee to consider national adoption of ISO 5149 as well other key international standards. The sub-committee was charged with looking at possible modifications to ISO 5149 in order to allow for wider use of hydrocarbons with added safety measures.[33] BIS adopted IS/ISO 51049 without national modifications on flammable refrigerants.

In conjunction with the adoption of ISO 5149, the technical committee is also examining IEC 60335-2-4- for air conditioning and a proposal is under consideration that includes critical concepts under development by IEC TC61D WG16 that would allow for much broader use of low-GWP alternatives. These technical concepts allow for additional safety measures that can allow for greater charges of flammable refrigerants and include improved tightness systems, systems with integral airflow, systems with limited releasable charge, and additional measures for systems connected via air ducts.

European Union

The two standardization organizations that publish the regional European standards (EN) with respect to refrigeration and air conditioning are the European Committee for Standardization (CEN) and the European Committee for Electrotechnical Standardization (CENELEC). The national standardization body of each country in Europe is a member of CEN and CENELEC, and is obliged to adopt each standard as a national standard in their country.

EN 378, published by CEN, is the parallel European standard for ISO 5149 at the international level, providing technical guidance on design, installation, operation, and maintenance for all refrigeration and air conditioning equipment not covered by a specific product standard. EN 378 was revised in 2016 (EN 378: 2016) and included a number of changes with respect to charge limits for flammable refrigerants. The revisions primarily addressed expanded charge sizes for A2L refrigerants used in human comfort cooling applications.[38]

EN 60335-2-24, EN 60335-2-40, and EN 60335-2-89 correspond with the equivalent IEC standards at the international level. These standards do not deviate from the equivalent IEC standards with regard to charge size limits and treatment of flammable refrigerants.

How Hydrocarbon Air Conditioners Came to India

Godrej & Boyce Manufacturing (Godrej), safely introduced hydrocarbon to the Indian room AC market in 2013 and has now sold over 350,000 AC units using propane on the retail market. This was possible because, in the absence of a mandatory standard dictating a certain flammable charge size limit in India, the company was able to follow requirements of another internationally recognized standard.

In 2008, the German development agency Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ) initiated a demonstration project to assist Godrej with safely introducing hydrocarbon ACs to the Indian market. Godrej already had experience with hydrocarbons as the first manufacturer to introduce hydrocarbon refrigerants in domestic refrigerators in 2001.[34] During the project, which ran from 2008 through 2012, Godrej received assistance from GIZ to research and develop the units as well as convert its manufacturing processes in one of its production lines, with the capacity to produce 180,000 units per year.[35]

In designing the propane split AC units, Godrej followed the charge limit standards contained in the European standard EN 60335-2-40, which for a typical 5kW split AC unit allowed a maximum charge of 361 grams.[36] Initial drop-in tests conducted by the company demonstrated that an ideal charge size of 585 grams would have been needed to achieve desired capacity and energy efficiency improvements of and 7% increase in COP.[37] However, using technology advancements in micro-channel heat exchangers using brazed aluminum allowed the company to reduce charge sizes to within the charge limit. Existing standards continue to pose challenges for companies like Godrej in that higher charge sizes are required to include heating mode on these units in order to export to markets with cooler climates, and to achieve higher capacities for larger room sizes.

European Commission Standards Mandate

In 2016, the European Commission (EC) published a report titled "Barriers posed by codes, standards and legislation to using climate-friendly technologies in the refrigeration air conditioning, heat pumps and foam sectors."[39] The report was included in it the EU submission on standards to the Montreal Protocol. The EC report recognized that although recent changes to European standards, such as EN 378, address challenges for refrigerants categorized as A2L such as HFOs and HFCs, significant barriers remain for the use of hydrocarbons as A3 refrigerants.[40] The EC report concluded that standards regarding the use of flammable refrigerants at all levels (international, European, and national) appear to be an important barrier to the uptake of climate-friendly alternatives to HFCs. The EC report also pointed toward a need for an international exchange of information on standards, their review and related processes between Parties to the Montreal Protocol, standardization bodies, industry as well as other stakeholders.[41]

The EC also began a consultation process in 2016 for issuing an official standardization request, or 'mandate' to the European standardization organizations CEN and CENELEC.[42] Under Regulation (EU) 1025/2012, the EC Standardization Committee is authorized to issue standardization requests or 'mandates' instructing European standards organizations to take on certain work considered essential to meet policy objectives. In this case, standards for flammable refrigerants are considered important to meeting the objectives of the EU F-Gas Regulation (Regulation (EU) No 517/2014).

The process of consultation on the draft standardization mandate involves input and approval by the standards organizations and other relevant stakeholders.[43] The mandate focuses specifically on A3 refrigerants requiring the standardization bodies to report regularly on progress and deliver a final report within 39 months of adoption of the mandate. The draft standardization request has reached the final stages and text has been approved by the standards organizations and EC standardization committee to be adopted as an official mandate by the European Commission.

ASSESSMENT OF AVAILABLE TECHNOLOGY UNDER KEY STANDARDS

The development of revised safety standards in the next two to five years will have a major impact on technology choices available in the context of the current HCFC phase-out and Kigali Amendment HFC phase-down schedules. As shown in Figure 1, A5 (developing) countries have committed to reducing consumption of HCFCs to 65% of their baseline in 2020, followed by a reduction to 32.5% in 2025. Under the Kigali Amendment, non-A5 (developed) countries are committed to reducing HFC consumption to 90% in 2019, followed by a reduction to 60% in 2024. Standards revisions must be completed well before key dates for consumption reductions in order to broaden the availability of low-GWP refrigerants and result in a smoother and more cost-effective direct transition to the most climate friendly alternatives.

2018 and 2022 are key dates when countries will be preparing and beginning to implement major strategies to meet consumption reductions. Low-GWP technologies available by the end of 2018 will drive strategies for meeting 2019 and 2020 reductions, while technologies available in 2022 will be even more important to meeting the larger consumption reductions required in 2024 and 2025. In some cases Parties may be able to meet earlier reductions by avoiding sectors impacted by standards and waiting to address these sectors until certain standards are updated within the next several years.

Standards revisions must be completed well before key dates for consumption reductions in order to broaden the availability of low-GWP refrigerants and result in a smoother, more cost-effective direct transition to the most climate friendly alternatives.

Table II: Assessment of Availability of Hydrocarbon (A3) Refrigerants under Key Standards

Equipment Type	Applicable Standards	Availability Under Current Standards	Availability of Hydrocarbons Based on Proposed Standard Revisions*	
			2018	2022
Domestic refrigeration	IEC 60335-2-24	Domestic refrigerators and freezers using hydrocarbons expected to be universally available. All standards now harmonized.	🟢	🟢
	UL 60335-2-24			
	EN 60335-2-24			
Standalone Commercial Refrigeration	IEC 60335-2-89	Current charge sizes limit use in larger standalone equipment. WG proposal for expanding charge to 500g expected approval in 2018-19.	🟡	🟢
	UL 60335-2-89	Current charge sizes limit use to smaller standalone equipment, preventing cost effective use in larger equipment. Adoption of IEC TC61C WG4 proposal feasible, however may be delayed for U.S. market adoption.	🟡	🟡
	EN 60335-2-89	Current charge sizes limit use to smaller standalone equipment, preventing cost effective use in larger equipment. Adoption of WG4 proposal likely given EC standards mandate.	🟡	🟡
Room AC (window units and mini-split)	IEC 60335-2-40	Hycrocarbons available only for small units. More widely available under optimistic scenario if WG 16 revisions complete by 2020.	🔴	🟡
	UL 60335-2-40	Currently not available. Adoption of IEC proposal feasible, however timeline uncertain.	🔴	🔴
	EN 60335-2-40	EN likely to adopt IEC revision per WG16. Potentially available in 2022 if WG16 complete by 2020 and adopted by EN.	🔴	🟡
Multi-split and Ducted AC	IEC 60335-2-40	Not available and not currently within the scope of current WG16 proposals	🔴	🔴
	UL 60335-2-40	Currently not available and not in current scope of WG16 proposal.	🔴	🔴
	EN 60335-2-40	Not currently within the scope of current WG16 proposals	🔴	🔴
Chillers	IEC 60335-2-40 / ISO 5149	Feasible to install chillers outside or on rooftop, however barriers to use in buildings.	🟡	🟡
	UL1995/UL 60335-2-40	Not allowed under UL1995. HCs limited to M1 charge under second revision of UL 60335-2-40.	🔴	🔴
	EN 378	Feasible to install chillers outside or on rooftop, however barriers to use in buildings.	🟡	🟡

*These dates (2018 and 2022) equate to the key timelines for countries preparing to meet reductions in baseline consumption of HCFCs and HFCs under the Montreal Protocol. Alternatives available due to standards changes by 2018 are likely to be available for the 2020 baseline consumption reductions to 65% HCFC for A5 countries and the first step down to 90% of HFCs for non-A5 countries under the Kigali Amendment. Alternatives available in 2022 due to standards changes can be used in preparing to meet 2024-2025 baseline reductions to 32.5% HCFCs for A5 countries and 60% HFCs for non-A5 countries. 2024 is also the date at which Group I A5 countries will freeze HFC consumption before beginning reductions in 2029.

🟢 = Available in all models under current standards.

🟡 = Available under optimistic standards scenario, however revisions still required.

🔴 = Not available without acceleration of current proposal or additional proposed revisions.

Table II shows the extent to which availability of key equipment types may be impacted, based on analysis of current progress of bodies discussed in this report. The table focuses on the international (IEC), European (EN), and U.S. (UL) standards bodies. Overall, the IEC standards are the most important for setting global norms, however UL and EN standards are also included, since failure of one of these major consuming markets to harmonize with IEC can have a substantial impact on the global market.

In domestic refrigeration, recent changes in the UL standard have brought charge sizes into harmonization across major markets, which will allow widespread availability of hydrocarbons in this sector. In commercial refrigeration, availability of hydrocarbons for larger capacity standalone equipment will depend on a pending proposal under IEC TC61C WG4, and the pace at which those changes are adopted into other national standards.

Air conditioning remains a sector of greatest concern, as the timeline for completion of current work by WG16 to propose a revision to IEC 60335-2-40 for expanding charge sizes in room air conditioning is uncertain. Furthermore, the scope of current WG16 proposals would need to be expanded to include multi-split and ducted air conditioning systems.

CONCLUSIONS AND RECOMMENDATIONS

Standards that enable widespread and safe application of HFC-free refrigerants are achievable, provided that the international community maintains a sense of urgency and a focus on this issue. Additional efforts to enhance progress on this issue are feasible both within the Montreal Protocol framework and by individual countries.

Broader participation by experts in A5 countries is vital, and will lead to more timely progress on critical technical issues affecting refrigerant choices in priority sectors and increased focus on the most cost-effective and efficient technologies. Participation in standards working groups will also contribute to greater country knowledge of technical aspects of ongoing discussions around proposed changes, allowing for more rapid adoption and deployment of international standards changes at the national level. Finally, a country or a group of countries wishing to accelerate the introduction of a standard or regulation nationally can do so independently from the international standards process, for instance by choosing to adopt a proposal that is still in a draft stage at the international level.

In order to enhance progress on this issue, EIA calls for the following additional actions within the Montreal Protocol framework, as provided for under Decision XXVIII/4:

- Continued consultation between the Ozone Secretariat and key standards bodies and a mechanism for continuing to regularly inform countries of the ongoing status of relevant standards working groups and committees.
- Additional resources for capacity building to allow National Ozone Units to coordinate with national standards bodies to assess need and feasibility of forming national committees to consider revisions to national standards or harmonization with international standards.

Outside of the Montreal Protocol, EIA also encourages individual countries to work proactively in coordination with national standards bodies to develop potential strategies for broadening safe use of HFC-free refrigerants. Such national actions may include:

- Developing a national standards request or mandate such as that under adoption by the EU
- Identifying experts to actively participate in representing national interests at international standards bodies, and
- Considering early adoption of a national standard containing country-level revisions adopting updated safety measures for low-GWP flammable refrigerants.

Completing necessary updates to key international standards in the next several years will be vital to maximizing direct and indirect emission reductions under the Montreal Protocol. Revisions that are finalized within this timeframe will have substantial impact on broadening the HFC-free technology options available to developing countries for leapfrogging medium-GWP HFCs in their HCFC phase-out plans, and to developed countries in meeting their first phase-down steps under the Kigali Amendment.

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