

NATIONALLY DETERMINED CONTRIBUTIONS: HOW REFRIGERATION SHOULD BE INCLUDED REFRIGERATION

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ABSTRACT

The impact of the refrigeration sector on climate change is important and growing. It is now recognised as a key challenge for successful climate change mitigation and adaptation. But the Paris agreement is based on Intended Nationally Determined Contributions (INDCs). The challenge is therefore at that level now. Introduction: refrigeration is at the heart of a sustainable development. The impact of refrigeration uses on climate change is huge and will increase due to the growing population, especially the urban population in developing countries, which will have increasing needs for food and health products, but also for air conditioning, information technologies and other traditional or new technologies requiring refrigeration systems. In other words: refrigeration is necessary for life. We will therefore present the impact of the refrigeration sector on climate change, and then the actions at international, regional, and national level to address these challenges. Refrigeration is now a global priority, but we still need to define and implement strategies for all refrigeration equipment at the country level.

Keywords: climate change

I. THE IMPACT OF THE REFRIGERATION SECTOR ON CLIMATE CHANGE

In our definition (it is also the whole IIR mission), refrigeration includes the cold chain, air conditioning, heat pumps and cryogenics.

1. The refrigerants issue

Everyone knows that most of the refrigerants used today are potent greenhouse gases. However, their impact is not the greatest. According to IIR estimates, they account for about 2.9% of global CO₂ equivalent emissions. The reason is that most refrigeration technologies used are vapour-compression systems and thus use fluids that contain mainly fluorine. Chlorofluorocarbons have a very high global warming potential (ex: R12: 10200 CO₂ eq), the hydrochlorofluorocarbons that have replaced them still have a relatively high GWP (ex: R22: 1760 CO₂ eq), as do hydrofluorocarbons (ex: HFC 134a: 1300 CO₂ eq). Chlorofluorocarbons are now banned everywhere. However, banks of CFCs are still huge, and emissions still exist. HCFCs will be phased out everywhere by 2030. HFCs will be phased down thanks to the Kigali amendment. With no leaks during operation or maintenance or at end of life, there are of course no emissions. Some fluorinated gases, such as HFOs, have a negligible GWP. So do natural refrigerants.

Measures have already been taken at the international level since 1987, when the Montreal Protocol was adopted. Regional and national regulations have also been put in place, reducing leakage, banning certain refrigerants, restricting the use of other ones in certain applications or imposing taxes. Despite the fact that the use of refrigeration is increasing dramatically, due to the need for a reliable cold chain for food and health products and the development of air conditioning, especially in developing countries, we could consider that we are already moving in the right direction to limit this kind of greenhouse gas emissions.

Table 2: List of GHGs emitted by the refrigeration sector.

Substance		GWP ₁₀₀ ^[6]	Lifetime (in years) ^[6]
Direct emissions			
CFC	CFC-11	4,660	45.0
	CFC12	10,200	100.0
	CFC-115	7,670	1,020.0
HCFC	HCFC-22	1,760	11.9
	HCFC-123	79	1.3
	HCFC-124	527	5.4
HFC	HFC-32	677	5.2
	HFC-125	3,170	28.2
	HFC-134a	1,300	13.4
	HFC-143a	4,800	47.1
	HFC-152a	138	1.5
Indirect emissions			
	CO ₂	1	there is no distinctive lifetime
	CH ₄	28	12.4
	N ₂ O	265	121

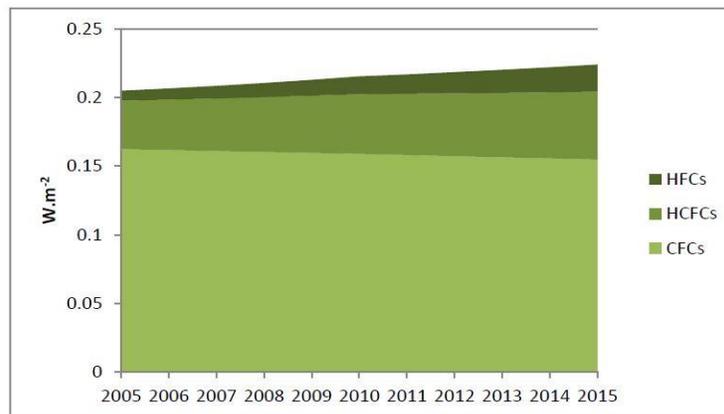


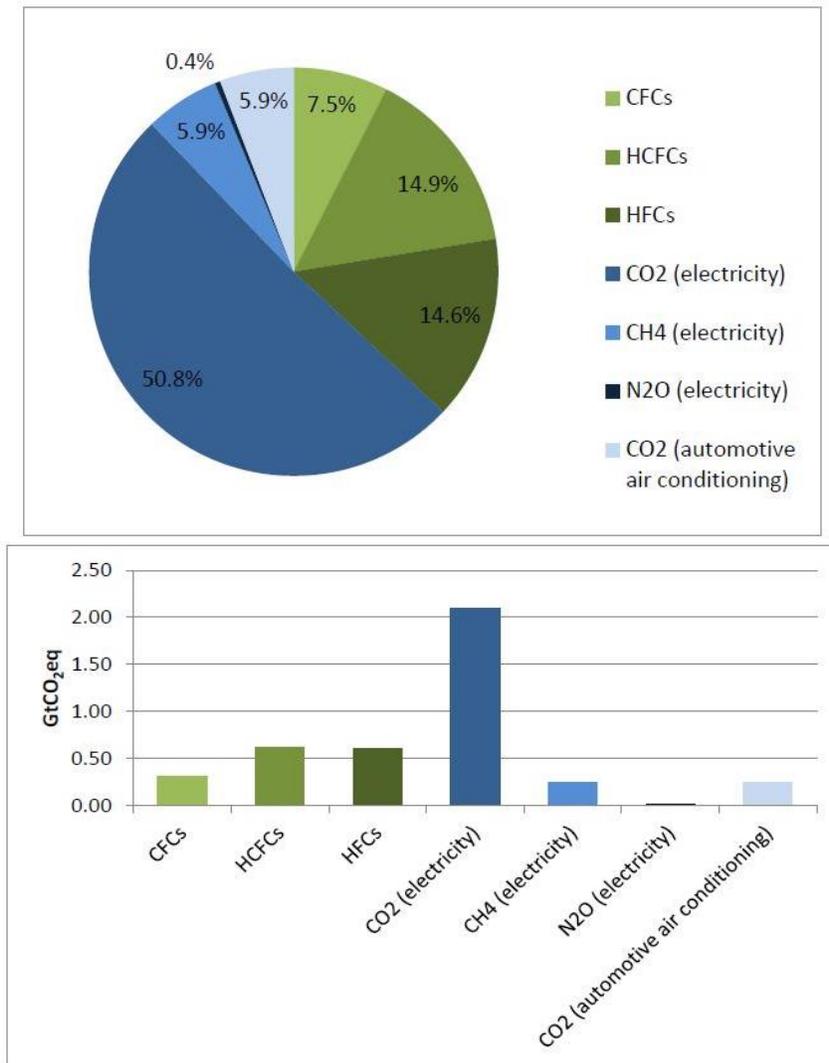
Figure 1: Changes in total radiative forcing of CFCs, HCFCs, and HFCs (refrigeration sector only) from 2005 to 2015. Sources: WMO^[4] and IPCC^[7]. (See [Annex A](#), [Annex B](#))

2. The energy issues

This is the main issue. According to IIR estimates, it accounts for about 4.9% of CO₂ equivalent emissions. All refrigeration systems need energy input.

The impact on climate change can be very different from one country to another: The energy input is generally electricity, and electricity can be produced without any carbon emissions (solar energy via photovoltaic panels, nuclear energy...) or with fossil fuels (coal, oil, gas). However, even if the electricity is produced from renewable energy sources, the impact on infrastructure (power grid, energy storage) can be huge. Refrigeration applications (including the cold chain, air conditioning, heat pumps, cryogenics...) represent 20% of global electricity consumption and this percentage is increasing. Thus, energy efficiency is a challenge, regardless of the origin of the electricity. The future of refrigeration is linked to the future of energy. Refrigeration equipment cannot be considered as a single system either, but as a part of a system (a building, a factory, a vehicle...), where the envelope plays a major role.

Figure 2: Emissions of different GHGs in 2014 and distribution of each (refrigeration sector only). These graphs represent emissions from the refrigeration sector only. (See [Annex A](#), [Annex C](#), [Annex D](#), [Annex E](#), [Annex F](#))



Increasing needs: food losses and air conditioning issues

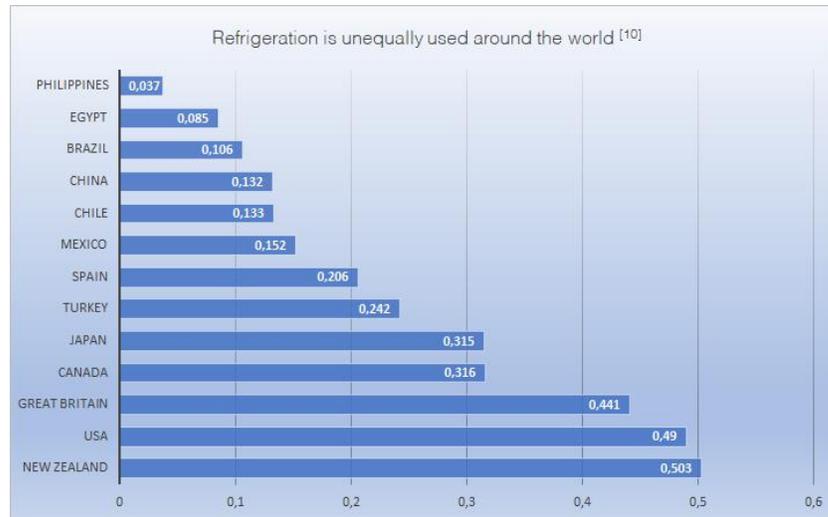
The cold chain is necessary for the preservation of food and health products. The preservation of these products thanks to a reliable cold chain is therefore a necessity for food safety and health. For instance, according to the World Health Organisation (WHO), about 40% of the world's vaccines are unusable due to a lack of reliable cold chain. The world's population is estimated to increase by 2 billion by 2050 and the elimination of food losses and waste could feed up to 950 million people. Other means could be used: deforestation, pumping more water from the ground... but with environmental consequences that could be worse than building or improving a cold chain, especially in developing countries.

All the food that is lost requires energy, water and soil, and the environmental consequences of this can be greater than the CO₂ equivalent emissions from refrigeration systems implemented in a cold chain.

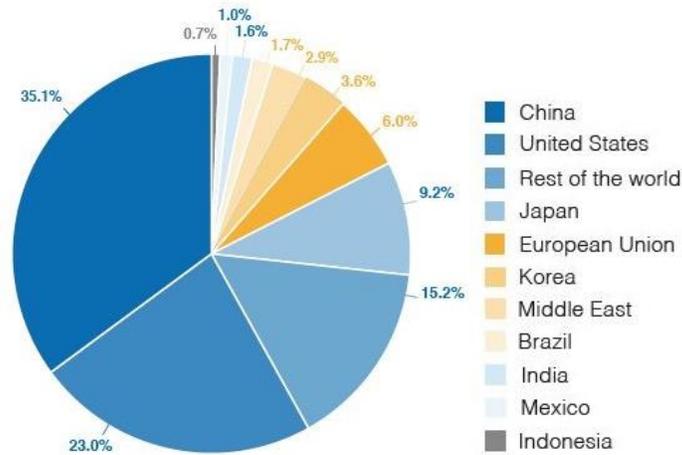
Refrigeration can thus have a positive environmental impact, provided that sustainable solutions are promoted. Moreover, refrigeration, in particular air conditioning, is a tool for adapting to global warming and it is necessary in any case. Even if the goals of the Paris agreement are achieved (no more than + 1.5°C or + 2°C during the 21st century), a temperature increase of 0.5°C or 1°C already represents risks of heat waves and

deaths that only the use of air conditioning can overcome. But the increase in refrigeration uses due to these needs, combined with a growing population, especially in developing countries urban areas, and its development needs, must be sustainable.

Solutions exist and actions are underway.



Stock of air conditioners by country/region, end 2016



II. ACTIONS AT AN INTERNATIONAL LEVEL

1. The Paris agreement

The global temperature today is about 1°C higher than in the pre-industrial period, about two centuries ago. The consequences are already visible: floods, storms, fires, heat waves, migration of plants and animals... The decision taken in Paris on December 2015 was to avoid an increase of more than + 2°C above the pre-industrial level (1°C more than today) and if possible, to avoid an increase of more than + 1.5°C (0.5°C more) during the century. Even with an increase of + 1.5°C, the consequences would be much worse than the current situation, according to the Intergovernmental Panel on Climate Change (IPCC). Although almost nothing has been done,

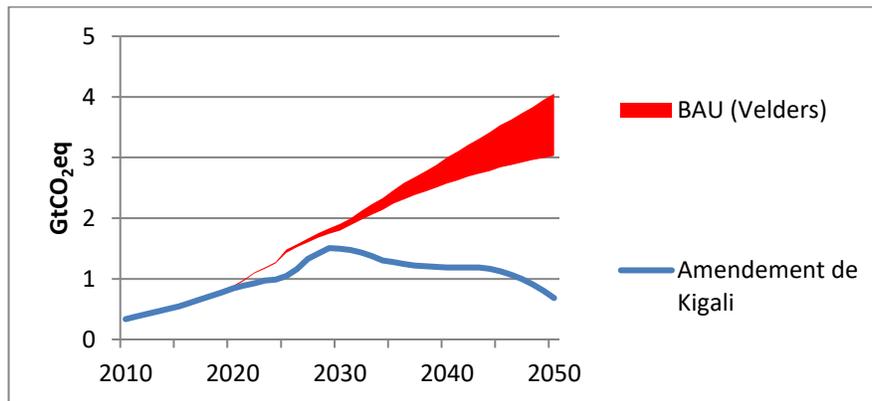
except in the European Union, since the Rio convention in 1992, the Paris agreement marked a new stage and a new method for mitigating climate change. There is no obligation at global level, each country must define its own goal and its own way of achieving its goals. But every country that accepts the Paris agreement must do so and the majority of countries (183 out of 197) ratified the Paris agreement.

Just before the adoption of the Paris agreement, each country was invited to present its “Intended Nationally Determined Contribution” (INDC). These NDCs are generally imprecise and are not sufficient to achieve the goals adopted in Paris. Even if countries had met their targets, the global result would have been about + 3.6°C above the pre-industrial level. Thus, each country was invited to submit revised NDCs in advance of the United Nations Conference of the parties on climate change planned to be held in Glasgow (UK) in 2020. As the conference was postponed to November 2021 due to the Covid 19 pandemic, few countries have so far sent their new INDCs. It is therefore difficult to predict what will happen. However, more and more developed countries are promising to achieve “carbon neutrality” by mid-century and China, the largest emitter, has also promised to achieve such a result: there is a clear movement towards more ambitious national targets in most countries and measures are already being taken. But these measures are different depending on the country.

2. The Kigali amendment to the Montreal Protocol

The Montreal Protocol, adopted in 1987, aimed to restore the stratospheric ozone layer in order to avoid cancers caused by UV radiation. CFCs were banned in 2000 in developed countries and in 2010 in developing countries. HCFCs were banned before 2020 in developed countries and will be banned in 2030 in developing countries. They have mainly been replaced by hydrofluorocarbons (HFCs) with high global warming potential (GWP)

Although the positive impact of climate change was also evident initially due to the phase out of CFCs, the increasing use of HFCs was a threat to the planet.



Thus, the Kigali amendment was adopted in 2016 and has already been ratified by 99 states. The main differences with the Paris agreement are the following:

The objectives are the same for each category of countries

The means to achieve the targets may be different, but regular reporting is mandatory and persons are designated in each developing country (ozone officers) to monitor and promote achievements. The Montreal Protocol is effective in phasing out CFCs and then HCFCs (the ozone layer will return to its original level within 40 to 50 years). It should be effective in phasing down HFCs.

However, “warm countries” (a list of countries in Africa, the Middle East and South-East has been established) may have a “tolerance” of 4 years for space cooling. Moreover, it was decided to consider energy efficiency as a key criterion for selecting and financing new projects in developing countries through the multilateral fund of the Montreal Protocol. But no agreement was reached on a concrete definition of energy efficiency in the decision-making process. And no link has been established with the tools of the Paris agreement, in particular the Green climate Fund.

	A2 countries	A5 countries (Group 1)**	A5 countries (Group 2)***
Baseline	2011-2013	2020-2022	2024-2026
Formula	Average HFC consumption	Average HFC consumption	Average HFC consumption
HCFC	15% or 25% baseline*	65% baseline	65% baseline
Freeze	-	2024	2028
1st step	2019 – 10%	2029 – 10%	2032 – 10%
2nd step	2024 – 40%	2035 – 30%	2037 – 20%
3rd step	2029 – 70%	2040 – 50%	2042 – 30%
4th step	2034 – 80%		
Plateau	2036 – 85%	2045 – 80%	2047 – 85%

* Belarus, Russia, Kazakhstan, Tajikistan, Uzbekistan

** Group 1: Article 5 parties not part of Group 2

*** Group 2: Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, United Arab Emirates, India, Iraq, Iran, Pakistan

In addition, plans to phase out HCFCs in developing countries have not been modified. Since they will continue to be implemented in the coming years before the phase down of HFCs that will begin in 2024 and 2028, HCFCs could be replaced by high-GWP HFCs that may be more harmful to the climate than previous HCFCs: for example, R22 could be replaced, via a drop-in solution, by R404A with a much higher GWP. Directly replacing HCFCs by low global warming alternatives remains a challenge.

3. The new involvement of the United Nations on the refrigeration sector

Before 2019, except of course among the teams in charge of the Montreal Protocol, the refrigeration sector was not a priority in United Nations bodies. Despite joint actions with the IIR in sub-Saharan Africa in 2012-2016, the FAO did not include food losses and the cold chain among its strategic priorities. The same is true with the World Bank. UNEP itself has not considered the refrigeration sector as a specific field within the UN Convention on Climate Change (UNFCCC).

Other important intergovernmental organisations had not really considered this sector. In 2018, the International Energy Agency (an OECD agency, thus involving developed countries and some emerging countries) published a report on air conditioning, with the help of the IIR. This document points out the dramatic increase in air conditioning, whose needs related to space cooling could triple by 2050. It was largely commented on and helped the United Nations to consider refrigeration as an environmental priority.

In 2019, we decided, together with UNEP and ASHRAE, to organise the “World Refrigeration Day”, which was a success. A new event was organised on June 26, 2020, dedicated to the cold chain and the series of events will continue. In August 2019, the G7 pointed out the issue of refrigeration. But the main sign was the speech by Antonio Gutierrez, Secretary General of the United Nations in September 2019:

“Implementation of the Kigali Amendment will be front and centre for climate action. We need all countries to develop national cooling action plans to deliver efficient and sustainable cooling and bring essential life-preserving services like vaccines and safe food to all people. We are calling for concrete and enhanced actions from industry. The leadership of global leading companies is essential to realize the vision into reality.”

Later, in November 2019, at the Conference of the Parties to the Montreal Protocol held in Rome, Italy, at FAO headquarters, the “Rome declaration” explaining the importance of the cold chain in avoiding food losses and the need for sustainable development was adopted, thanks to the joint efforts of FAO, UNEP, the Italian government and the IIR. Then, the General Assembly of the UNEP claimed the importance of the entire refrigeration sector for sustainable development. Just before, at the conference of the parties in Rome, a new partnership agreement was signed between UNEP and the IIR in order to implement a new policy; a practical

and immediate result was the translation into French and Spanish of the five Cold Chain Technology Briefs written by the IIR and UNEP in English in 2016.

At the same time, a new Intergovernmental Organisation, the International Solar Alliance (ISA), established in 2015, has launched an initiative on solar cooling. A partnership agreement between IIR and ISA was signed in 2020 in order to implement this new initiative. In October 2020, the World Bank decided to finance projects on cold storage for farmers in various countries of Africa and South Asia and asked the IIR for help in finding experts to help them... A new international policy is emerging, after years of efforts by the IIR in particular. This international priority was necessary to encourage countries to act. Since the NDCs of the Paris agreement are national, countries must now act.

III. ACTIONS AT REGIONAL AND NATIONAL LEVELS

The European Union

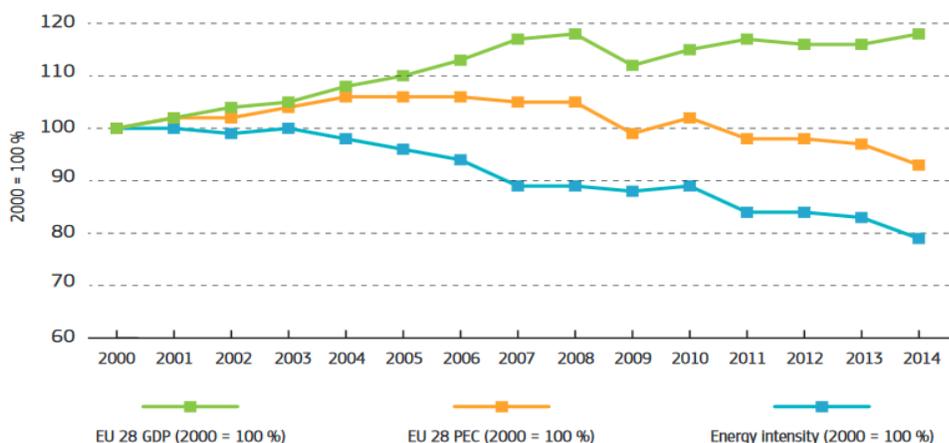
The European Union is a union of various countries with their own policies, but it also has its own policy obliging countries to implement certain measures that have important consequences on national policies, particularly in the economic and environmental fields, and therefore in the field of refrigeration.

The European Union is a precursor of many environmental policies that inspire other countries, even if its leadership is limited. It is thus interesting to examine how it has forced the refrigeration sector to move.

a.Regarding refrigerants

The first F-gas regulation in 2006 created obligations for the containment of fluorinated fluids through maintenance (certifications of technicians and companies, reports, etc.). In addition, it decided to ban refrigerants a GWP greater than 150 in mobile air conditioning since losses in this sector were huge. In 2014, the second F-gas regulation introduced a policy of decreasing the quotas of fluids in CO2 equivalent and banning them in certain applications. The general system could inspire the discussions for the implementation of the phase down of HFCs at international level in 2014-2016 and has been presented in numerous occasions at the UN meetings on the Montreal Protocol. The F-gas regulation is currently under revision and will probably strengthen the current regulation in order to achieve the EU climate goals in 2030. In addition, training for technicians is encouraged: see the Life programme, where a dedicated project is financed.

Figure 1: Gross Domestic Product (GDP), Primary Energy Consumption (PEC) and energy intensity in the European Union from 2000 to 2014



Source: Eurostat

(1) Energy intensity is the primary energy consumption divided by GDP.

b.Regarding energy policy

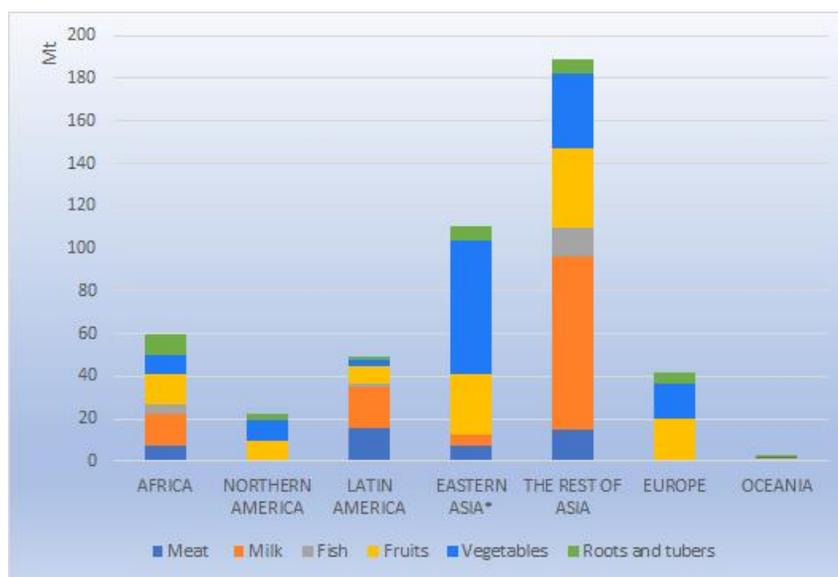
The European Union has for many years implemented various policies to promote renewable energies and energy efficiency, for instance the 20/20 in 2020 (20% renewable energies, 20% improvement in energy efficiency through labelling, the Ecodesign programme... and it works. The share of renewable energy has increased thanks to the development of solar energy, wind power, heat pumps and others. Energy intensity has also increased.

The aim of the European Union is to be carbon neutral in 2050, with a 40% or 50% reduction in emissions by 2030. This goal is currently under discussion. In any case, it forces all European Union countries to strengthen their climate policies.

Some actions are devoted to refrigeration, labelling of air-conditioning units, heat pumps, etc.

c.Food waste

Despite relatively good cold chains, food losses are relatively high due to wastage, especially at the consumer level.

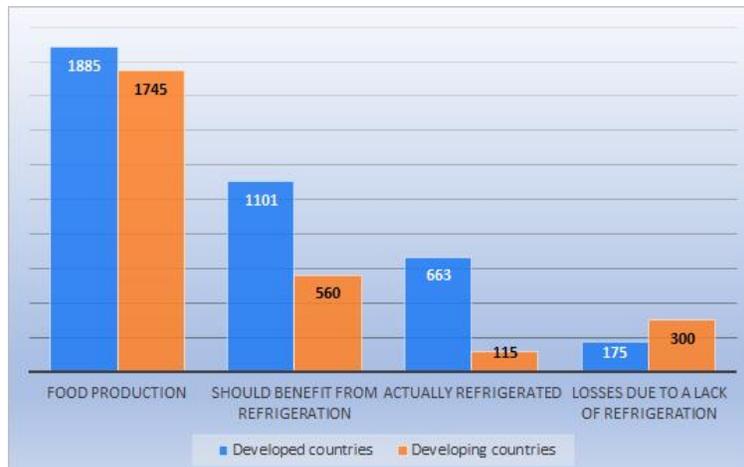


However, several European research projects dedicated to the cold chain have been financed in the past to improve the cold chain, including at the consumer level, such as Frisbee. Currently, several EU countries (France among others) are trying to reduce food waste, through voluntary programmes and some obligations for super and hypermarkets.

2.Developed countries

All developed countries have had to implement the phase-out of CFCs and HCFCs earlier than others and have already begun to phase down HFCs according to the Kigali amendment. Even in countries that have not ratified the Kigali amendment, such as the USA, various measures are being taken in order to promote HFOs or natural refrigerants such as hydrocarbons: changes to standards and regulations on fluorinated gases are being put in place. Others (Japan) are developing policies to reduce refrigerant losses.

Policies concerning energy consumption in buildings, vehicles and equipment are currently more complicated and unclear. The same is true for food losses, despite a real problem



3. Developing countries

Various policies are emerging in developing countries, without any general orientation. Regarding refrigerants, most countries are still in the process of phasing out HCFCs, and few are considering a simultaneous phase-down of HFCs. Some initiatives regarding hydrocarbons or CO2 are, however, put in place, thanks to national companies (India with Godrej...) or UNEP or UNIDO policies.

Solar energy seems to be the energy of the future in many countries and various initiatives, notably by ISA and IIR, are underway. But the main issue is to find the money for investment. Fortunately, the World Bank has very recently identified the cold chain as a good and necessary investment in Africa and South Asia and financed projects could emerge. Moreover, other public banks (especially regional banks) could follow this example. Few countries, but fortunately the major ones such as China or India, have started to implement national strategies in the refrigeration sector.

CONCLUSIONS

The importance of Revised Nationally Determined Contributions

The refrigeration sector is facing several major challenges around the world: the increase in refrigerating equipment, the phase-down of hydrofluorocarbons, energy consumption, food losses. Apart for the case of refrigerants, few clear policies are currently being implemented that directly or indirectly concern the refrigeration sector. The good thing is that the need for sustainable development is now clearly recognized at the international level and the policies of intergovernmental bodies will influence national actions.

But the key issue now for mitigation and adaptation to global warming is the future content of the Nationally Determined Contributions. At present, only a few small countries have elaborated them.

They will be drafted in 2021 for presentation at the next Conference of the Parties on climate change in Glasgow (UK) in early November 2021. It is our role to insist on the importance of the refrigeration sector for human life and a sustainable future. The IIR is now a partner of the various intergovernmental bodies in taking actions in this field. We need to convince everyone to convince the national governments to implement refrigeration policies in their national strategies outlined in their future NDCs.

¹ The impact of the refrigeration sector on climate change, IIR Informatory Note, November 2017

¹ The role of refrigeration in the global economy, IIR Informatory Note, June 2019

¹ The role of refrigeration in worldwide nutrition, IIR Informatory Note, Mars 2020

¹ IEA, The future of cooling. Opportunities for energy-efficient air-conditioning, 2018

