35th Informatory Note on Refrigeration Technologies / November 2017
"The impact of the refrigeration sector on climate change"

SUMMARY FOR POLICYMAKERS

Refrigeration plays an essential and growing role in the global economy, with significant contributions made in food, health, thermal comfort and environmental protection areas.

The refrigeration sector includes all refrigeration systems (as well as cryogenic systems), air conditioning and heat pump systems. The total number of these systems in operation worldwide is roughly 3 billion.

The sector is expected to grow in the decades to come, particularly in developing countries, where demand for refrigeration is rising sharply. This growth must be sustainable, with limited impact on the environment, and Earth's climate in particular.

According to IIR estimates, **7.8% of global greenhouse gases (GHG) emissions are attributed to the refrigeration sector, or 4.14 $GtCO_2eq$ [(1)].** These emissions can be divided into two groups: direct emissions and indirect emissions.

- **Direct emissions**

Direct emissions of refrigerants occur during maintenance operations or when a refrigeration appliance has reached the end of its lifespan, but they can also be caused by leaks during operation. CFCs (chlorofluorocarbons), HCFCs (hydrochlorofluorocarbons), and HFCs (hydrofluorocarbons) are the refrigerants which contribute the most to global warming, as evidenced by their high Global Warming Potential (GWP), up to 15,000 times higher than that of an equal mass of carbon dioxide (CO_2).

Direct emissions are equal to 1.53 $GtCO_2eq$ [(1)], or 37% of the total GHG emissions of the refrigeration sector. The implementation of the Kigali Amendment — whose aim is to progressively reduce the production and consumption of HFCs — could result in the total of these emissions falling to 0.7 $GtCO_2eq$ by 2050. This drop would represent a 44% to 51% decline in cumulative HFC emissions over the 2015-2050 period.

The objective of the Paris Agreement is to "keep the increase of global average temperature to well below 2 °C above pre-industrial levels". In this context, it is important to underline the fact that **the Kigali Amendment would prevent a potential increase of average temperatures between 0.1 °C and 0.3 °C by 2100** (not the frequently referenced figure of 0.5 °C).

Today, there are many alternatives to high-GWP refrigerants with comparable or superior energy efficiencies that can help reduce direct emissions. Examples include ammonia, CO_2, hydrocarbons and HFOs. It should be taken into account, however, that these alternative refrigerants may present certain disadvantages such as safety hazards (flammability, toxicity), environmental risks (decomposition products), high workings pressures, or higher cost. Such disadvantages and risks should be considered, from the design of refrigeration facilities, to the training and certification of operators.

[(1)] In 2014 ; IIR estimates

• Indirect emissions

Indirect emissions are a by-product of the production of energy required to drive refrigeration systems. Three greenhouse gases are generated by energy production: CO_2 (90% of indirect emissions), CH_4 (9%), and N_2O (1%).

Indirect emissions are equal to 2.61 GtCO2eq [(1)] , or 63% of the total GHG emissions of the refrigeration sector.

The first way to reduce these emissions is by lowering the energy consumption of refrigeration systems. While the potential to improve energy efficiency in refrigeration technologies is ultimately limited by the laws of thermodynamics as well as cost-related constraints, it remains very important. Solutions to limit energy losses can still be implemented, such as energy recovery systems or better insulation. Another significant potential is in the rational use of air conditioning and smart control strategies, e.g. selecting comfortable temperatures that are not too low in summer, while avoiding unnecessarily cooling empty rooms.

Indirect emissions depend mostly on the primary source of energy used (fossil, nuclear or renewable). However, this choice is more linked to national energy policies than it is to the refrigeration sector. Electricity production from fossil fuels must be reduced.

The nature of the gases emitted means that the reduction of direct emissions and that of indirect emissions will have somewhat different consequences for climate change. Contrary to HFCs and HCFCs, which have an atmospheric lifetime of some twenty years, CO_2 has a lifetime of several centuries, and plays a role in many climate mechanisms. Consequently, reducing the direct emissions (HFCs and HCFCs) will have a substantial positive effect on the short and medium term while regulating CO_2 emissions would have an impact on a longer term.

• Recommendations

With a view to reducing direct emissions, the IIR encourages governments and the different actors in the sector to cooperate to make the Kigali Agreement a success. The IIR also recommends that HCFC and HFC refrigerants, which have a high impact on global warming, are replaced with refrigerants that have a low impact on global warming as soon as possible. Efforts are also needed in containment and recovery, particularly for refrigerants with a significant impact on global warming or presenting safety risks (flammability, toxicity).

The reduction of indirect emissions, whose impact on the climate is stronger than that of direct emissions, is essential. Governments must encourage the use of renewable energy and promote energy efficiency at all levels of the economy, as well as educational programs on the rational use of energy. It remains essential to continue research and development of alternative refrigerants and alternative refrigeration methods to achieve high energy efficiency and cost effectiveness of these novel technologies.

Thanks to its various scientific conferences, publications and international network of experts, the IIR will play a leading role in these initiatives to limit global warming and promote sustainable development.

[(1)] In 2014 ; IIR estimates