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2021 ACTIVITY REPORT

THE IIR AT THE HEART OF SUSTAINABLE DEVELOPMENT

INTRODUCTION

The IIR is the only international organisation covering all refrigeration uses and technologies, such as refrigeration for food and health, air conditioning, cryogenics, heat pumps or heat recovery. Its purpose is to disseminate information, contribute to the intensification of scientific and technical exchanges and encourage research and development towards sustainability in this sector. The aim is to deploy these technologies around the world for the benefit of humanity, as well as to improve existing technologies to address the threats of environmental damage and resource depletion.

The IIR's structure ensures the quality and neutrality of its actions. It is basically composed of two entities:

- The Executive Committee (EC) composed of delegates from its 59 developed or developing member states, from all continents. The EC, expanded every four years in the form of a general conference, validates the allocated budgets, the activity reports and ensures the elections of the presidents and the director general;

- The Science and Technology Council (STC), composed of the presidents of five sections and ten commissions, covers the different uses and technologies of refrigeration:

  Section A: Cryogenics and liquefied gases
  Commission A1: Cryophysics, cryoengineering
  Commission A2: Liquefaction and separation of gases

  Section B: Thermodynamics, equipment, and systems
  Commission B1: Thermodynamics and transfer processes
  Commission B2: Refrigerating equipment

  Section C: Biology and food technology
  Commission C1: Cryobiology, cryomedicine and health products
  Commission C2: Food Science and engineering

  Section D: Storage and transport
  Commission D1: Refrigerated storage
  Commission D2: Refrigerated transport

  Section E: Air conditioning, heat pumps, energy recovery
  Commission E1: Air conditioning
  Commission E2: Heat pump, energy recovery

Each of these commissions comprises from 20 to 50 members. Each one has its own area of expertise, which it puts at the disposal of the IIR to write or review publications, organise conferences, launch studies, collect data, participate in projects.

The main actions of the IIR include:

- The creation of databases, in particular the FRIDOC database, with more than 100,000 referenced documents on all areas of refrigeration,

- Scientific publications such as the International Journal of Refrigeration, the most prestigious scientific journal in the refrigeration sector, as well as technical or techno-economic publications,

- Conferences, workshops, congresses and seminars organised by the IIR or with its participation.

These actions, carried out in particular within the framework of working groups and research, training and evaluation projects, make it possible to achieve the objectives below. They are carried out by the IIR network, made up of the experts of its commissions, its delegates, its corporate and individual members, alone or in partnership with United Nations agencies and programmes, other intergovernmental bodies, business or engineering associations, at the international, regional or national levels.

ACHIEVEMENTS

The IIR's work is intrinsically linked to the Sustainable Development Goals (SDGs), as refrigeration is present in most areas of human activity, past, present, and future, and is absolutely necessary for life. In fact, it now accounts for almost 20% of the world's electricity, and this figure is constantly rising: the IIR's note "The role of refrigeration in global economy" illustrates the importance of refrigeration in all areas.

BY SUSTAINABLE DEVELOPMENT GOAL (SDG)

The IIR has defined its strategic axes of action according to the main sustainable development goals and strives to carry out its actions in an ever more efficient way. The IIR's actions can be grouped according to the Sustainable Development Goals as follows:

1. Goals 1, 2, 3: Eradicating poverty and hunger, achieve good health and well-being

   Food security in each country is largely dependent on food losses throughout the food production and marketing chain. In developing countries, these losses are particularly important during the storage and transportation of foodstuffs. Refrigeration capacity for storage, transport, domestic equipment is on average ten times lower in developing countries than in developed ones. Overall, losses due to a deficient cold chain account for 13% of food production. If all these losses were eliminated, nearly one billion people could be fed, thus significantly meeting the future needs of humanity (IIR Informatory Note, 2020). In addition, wasted food has generated significant greenhouse gas emissions. If, for example, the cold chain in developing countries were as efficient as the cold chain in developed countries in its current (but improvable) condition, the greenhouse gas emissions of the current cold chain would be halved (IIR Informatory Note, 2021).
   Furthermore, maintaining food or health products (medicines, vaccines, etc.) at an adequate temperature is an absolute necessity for human health, avoiding bacterial diseases and deaths. The logistical challenges of distributing vaccines against the coronavirus pandemic in 2021 have proven the importance of refrigeration technologies. Here again, the situation of developing countries, which lack adequate refrigeration facilities, is a major source of health problems. Refrigeration is also increasingly used in surgery (cryosurgery), for diagnoses (scanners), for transplants and analyses (tissue, gametes banks, etc.).
   Air conditioning is a necessity for maintaining good health, or even survival, in hot climates or during heat waves.

The actions of the IIR on these topics in 2021 were the following:

- Preparation of a guide on cold storage in hot climate countries, funded by the World Bank;
- Ongoing update of the IIR guide on refrigerated perishables;
- Publication of an Informatory Note for policy makers on the carbon footprint of the cold chain in English, French, Spanish and Chinese;
- Publication of the Chinese and Russian versions of the Informatory Note on "The role of refrigeration in worldwide nutrition;
- Publication, with funding from the United Nations Environment Programme (UNEP), of an Informatory Note on the cold chain for vaccines, in English, French, Spanish and Russian;
- Completion of the European Community-funded programme (CryoHub) to develop a refrigerated food manufacturing plant and storage with renewable energy storage using cryogenics;
- Continuation of the project to develop efficient and environmentally friendly technologies for fishing vessels, with funding from Norway;
- Launch of another project with Norway to use carbon dioxide (CO_2) as a refrigerant in supermarkets, hotels and the fishing industry in India;
- Launch of two World Bank-funded projects in Bangladesh and India (West Bengal) to establish a sustainable cold chain;
- Launch of a European Community-funded project to develop food, water and medical equipment, powered by autonomous solar cooling, for pharmacies and hospitals in four sub-Saharan African countries;
- Active participation in various global events, such as the Food Systems Summit (FAO-UNEP-Italy), conferences and seminars to present cold chain issues, review of documents on these projects led by the UNEP and the United Nations Industrial Development Organisation (UNIDO), among others;
- Sponsorship of a conference on food and biotechnology with Russia.

2. <u>Goal 7: Clean energy at affordable cost</u>

Refrigeration technologies are increasingly used to produce energy. Heat pumps are cooling devices designed to use the heat produced or, when reversible, to produce both heat and cooling for air conditioning. They consume electricity but can convert it into energy with a coefficient of performance greater than 3 and in this case, can be considered as renewable energy. Their use is therefore steadily increasing. Natural gas is the cleanest fossil fuel and is expected to be used more and more in the coming decades. The liquefaction of gas allows it to be transported with greater flexibility than through a pipeline. Liquefied natural gas already accounts for more than 10% of gas consumption and is expected to account for nearly 90% of the growth in long-distance gas trade by 2040.
Liquefied hydrogen is being touted as an energy of the future and there are major national plans to develop it.
Renewable energies can also provide cooling: solar cooling, evaporative cooling, even if these technologies are still little used.
Solar refrigeration, which is currently produced from photovoltaic panels, is however likely to develop rapidly and very significantly in hot countries.

Saving energy, especially through energy recovery, is also an important issue today, because of the lack of energy infrastructure and the role of energy consumption in global warming.

The actions of the IIR in these areas during 2021 were the following:

- Publication of two Informatory Notes on heat pumps for policy makers: “Air-source heat pumps for space heating and cooling” and “High temperature heat pumps for industrial applications” released in English, French and Chinese;

- Publication of an Informatory Note for policy makers on “State of the art of new technologies applied to chillers”, in English, French, Chinese and Spanish;

- Publication of two Informatory Notes for policy makers on energy recovery: “Air-air energy recovery equipment” and “Heat recovery in mechanical ventilation systems”, in English, French and Spanish;

- Publication of the Chinese and Russian versions of the 2020 Informatory Note on “Solar cooling”;

- Participation in an energy saving project in air conditioning in the French overseas departments (Clim'Eco);

- Organisation of a seminar with the International Renewable Energy Agency (IRENA) and Italy on renewable energies in refrigeration;

- Sponsorship of the International Energy Agency (IEA) heat pump conference in Korea and the international conference on sorption heat pumps in Germany.

3. Goal 13: Measures to combat climate change

Refrigeration accounts for 7.8% of global greenhouse gas emissions, of which 37% are due to direct emissions (leakage) of fluorocarbons (CFCs, HCFCs and HFCs) used as refrigerants, and 63% to the production of electrical energy required to operate the installations (IIR Informatory Note, 2017). These emissions are increasing due to the growing need for refrigeration. It was therefore normal for the IIR to make a special, intense effort to reduce these emissions, firstly by developing the necessary analytical tools and disseminating information on the environmental impact of refrigeration, secondly by improving energy efficiency and using renewable energies (see 2), and thirdly by limiting refrigerant leakage and modifying current technologies to use refrigerants that are less harmful to the environment or no refrigerant at all.

Environmental issues related to energy consumption have been systematically and extensively addressed in the actions mentioned under Goal 7.

With regard to refrigerants, the actions of the IIR have been:

- Continuing to identify ways to ensure safety with flammable and toxic refrigerants used as alternatives to high greenhouse refrigerants, within the framework of the IIR working group composed of academics and industrialists subject to reinforced ethical rules;

- The organisation of several international scientific and technical conferences on refrigerants, organised online by the IIR:

    - 10th IIR Conference on Compressors and Refrigerants, in Slovakia;
    - 2nd IIR Conference on HFO Refrigerants and Low GWP Blends, in Japan;

- 6th IIR Conference on Thermophysical Properties and Transfer Processes of Refrigerants, in Italy;
- 13th IIR Conference on Phase-Change Materials and Slurries for Refrigeration and Air Conditioning, in Italy;
- 9th IIR Conference on Ammonia and CO_2 Refrigeration Technologies, in North Macedonia;

- The sponsorship and active participation in international videoconferences with the Purdue University (USA), in the 12th International Conference on Compressors and their Systems with the City University of London, in the International Congress of Serbia;

- The extension of training and certification on the use of low GHG refrigerants within the Real Alternatives for Life programme, with translation of the courses into national languages and inclusion in the programmes of new countries;

- The publication of new courses on vapour compression refrigeration systems and heat exchangers on the IIR website;

- Participation in virtual exhibitions on natural refrigerants, notably with Shecco.

The IIR has also continued to support research and development on refrigerant-free cooling systems:

- Organisation of the 3rd IIR International Conference on Caloric Cooling and Applications of Caloric Materials, with the University of Maryland (USA);

- Sponsorship of the International Conference on Sorption Heat Pumps in Germany.

Finally, the Director General of the IIR spoke at the Conference of the Parties on Climate Change in Glasgow (COP 26).

4. Goals 4 and 5: Quality Education and Gender Equality

The IIR has continued and expanded its training policy, with the introduction of new online courses on its website. The IIR website now features 38 course materials on a wide range of refrigeration technologies and uses, and 28 training programmes offered by the IIR and other organisations with which the IIR has an agreement, in various languages (Bulgarian, Danish, Dutch, English, Finnish, French, German, Greek, Hindi, Hungarian, Italian, Norwegian, Portuguese, Russian, Slovak, Spanish and Swedish).
It is not only necessary to better train refrigeration technicians and engineers in the use of new, more environmentally friendly technologies, but also to attract more young people, especially women, to these professions. The need for refrigeration will continue to grow in the coming decades, due to population growth, needs that are already insufficiently met in terms of health and food, and adaptation to climate change. However, staffing needs in companies and public bodies (research and development) are already not being met in most countries because of a probably somewhat outdated image of the profession: the challenges of sustainable development in refrigeration are not well known. Moreover, these professions are wrongly considered as male professions and the percentage of women, although variable from one country to another, does not exceed 30%. The IIR therefore set up a working group on careers in refrigeration several years ago, with a sub-group specifically dedicated to women.

Several actions were carried out in 2021:

- Organisation of events on International Women in Engineering Day and webinars on Refrigeration Days in 2021, in English, Chinese and Italian, to promote refrigeration and the careers opportunities in this very diverse sector;

- Articles in international journals and a survey of women working in refrigeration (their motivations, challenges and opportunities), carried out in partnership with many national and regional associations.

5. Goals 8 and 9: Decent work and economic growth, industry, innovation and infrastructure

All the actions described above contribute to achieving these goals, particularly the IIR's participation in online conferences and exhibitions. Other actions, related to the exploration and development of new technologies and new uses of refrigeration, in favour of a more sustainable development of solutions to the problems of humanity, should be associated with this.

Support to the research and development of refrigerant-free technologies has already been mentioned. But it is also in the various applications of cryogenics, i.e. ultra-low temperature refrigeration, that diverse promising innovations for uses in health (cryotherapy, cryosurgery, conservation of living materials), in the environment (liquefaction of gases such as CO_2), in industrial processes, in space technologies or in fundamental research in the infinitely small can be found.
This is the purpose of the conferences that the IIR organises on cryogenics. Its 16th conference was held online in 2021, with the support of the Dresden centres (Germany).

6. Goal 17: Partnerships for global goals

The IIR's actions have been largely co-ordinated with the various UN programmes and agencies with which the IIR has partnered. Projects have sometimes been funded by these programmes and agencies when they required budgets that exceeded the IIR's operating resources (the IIR does not currently have funds allocated to projects).

For example, the IIR was involved in the Food Systems Summit organised by FAO and Italy. The Director General of the IIR was one of the panellists at the cold chain dialogue "Sustainable Cold Chain and the Rome Declaration: Delivering Efficient Ozone and Climate-Friendly Cold Chains to Ensure Nutritious and Healthy Food for All", facilitated by the Cool Coalition (United Nations Environment Programme - UNEP).

The IIR also participated in a panel organised by UNEP at the Conference of the Parties to the Montreal Protocol on the theme "Turning the commitments of the Rome Declaration into action for sustainable cold chains".

With the support of UNEP, the IIR published an Informatory Note on vaccines (see 1) and participated in the drafting and review of various UNEP documents related to refrigeration and the environment. The IIR participated with UNEP in various webinars during the Refrigeration Days.

The IIR co-organised, at the request of UNIDO, a side event dedicated to cold chains during COP 26, at the Pakistan stand.

The IIR is responsible for a World Bank project launched in 2021 in Bangladesh and co-leads another World Bank project in West Bengal, dedicated to the establishment of sustainable cold chains and the necessary related infrastructure.

The IIR also cooperated with other intergovernmental bodies, such as the International Renewable Energy Agency (IRENA), for the organisation of a webinar on energies used in refrigeration; and the

International Energy Agency for its conference on heat pumps. The IIR also invited the International Centre for Advanced Mediterranean Agronomic Studies to speak in one of its webinars.

The IIR established partnerships with many professional organisations in the refrigeration sector, at international, regional and national levels and organised several events with them in 2021: GCCA, ASHRAE, REHVA, ISHRAE, AFF, JSRAE, CAR, AICARR, worldwide, in Asia, Europe, America. Cooperative actions with private industry allow for a better dissemination of information and a fruitful exchange of knowledge: they are complementary to the actions carried out with all the intergovernmental organisations interested in the subject of refrigeration, whether belonging to the United Nations system or independent.

CONCLUSION

The IIR has clearly set its strategy and actions within the framework of the sustainable development of the refrigeration sector. The actions outlined above clearly show this. The IIR has adapted its organisation accordingly: recruitment of a new project manager, division of labour, recruitment of trainees, regular improvement of its website functionalities, agreements with national and international organisations for the production of documents and events. Despite the impact of the pandemic on the staff, a new, flexible organisation, partly based on teleworking, made it possible to cope with the increased workload.

The actions of 2021 will continue along the same path in 2022, in line with the IIR's clear strategy: to be at the heart of the sustainable development of refrigeration in all countries.