Final report on

Strategic considerations for the wider use of low-emission refrigeration and air-conditioning systems in Central and South America in April 2021

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IREES research for future.

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

On behalf of: Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety of the Federal Republic of Germany

Content

1 Executive Summary

1 The content of the webinar series focused on resource and energy efficiency of refrigeration systems as well as capacity building as a prerequisite for the demand-oriented construction of new and the refurbishment of existing refrigeration systems. The scope ranged from financing and planning to education and training as well as information, motivation and public relations. In addition, suggestions worthy of generalisation were presented based on concrete application examples of low-emission refrigeration and air conditioning technologies (best practices).

2 Refrigeration technology is ideally suited to address a high greenhouse gas potential with targeted, efficient measures and thus to counteract global warming. This applies both to the indirect CO_2 emissions from electricity generation and to the direct emissions of HFCs. The climate impact from indirect emissions is generally higher than from direct emissions.

3 Refrigeration and air conditioning systems already use 20 % of global electricity production. The share in absolute terms and in electricity consumption will continue to rise.

4 The subject of the 2016 Kigali Amendment to the Montreal Protocol is to limit the placing on the market of HFCs. This is intended to reduce direct HFC emissions with a time lag. The Kigali Cooling Efficiency Programme (K-CEP) of 2017 addresses the issue of energy efficiency and also aims to reduce indirect emissions from the operation of refrigeration and air-conditioning systems.

5 With a view to the targeted net zero emissions "carbon neutrality by 2050", it is more important to reduce not only HFC but also CO2 emissions. This is a huge task that can only be achieved with a combination of energy efficiency and renewable energies.

6 The implementation of the Kigali Amendment requires a legal framework in the individual countries to switch to the production of refrigeration without HFCs as refrigerants. This requires the use of refrigerants with no or only very low global warming potential or the use of other refrigeration processes such as absorption and adsorption, adiabatic evaporation and possibly magnetocaloric processes in the future.

7 A holistic, strategic approach to transforming the supply of technical refrigeration is needed.

8 Increasing the energy efficiency of refrigeration systems goes hand in hand with saving energy costs. This not only ensures the efficient use of subsidies, but also offers the opportunity to use market-based models such as energy performance contracting for the redesign of the refrigeration supply. Energy optimisation is therefore also the driving force behind the implementation of the Kigali Amendment.

9 In urban areas, the construction of heating and cooling networks is a particularly efficient and cost-effective solution. The cold can be generated from waste heat.

10 Appropriate support measures are essential for achieving climate policy goals. However, for the development and expansion of efficient refrigeration technology, it is not enough to simply provide state subsidies. What is also needed is a whole bundle of measures. In addition to a general legal framework, these include in particular the identification of suitable areas, spatial planning, action plans at national, regional and municipal level, the joint implementation of measures at various supply points, education and training, as well as campaigns to provide information, advice and motivation.

11 Lack of financial resources is often cited as a reason for not making investments. However, they do not have to be the main reason for not carrying out the intended investments. Market-based financing instruments such as contracting can also be used - this should include, among other things, guarantee or replacement services in case of default by contractual partners (e.g. district heating suppliers).

12 A lack of technical, economic and ecological knowledge as well as a lack of sufficiently qualified personnel in the companies also lead to the implementation of solutions that do not correspond to the state of the art and, due to the investment cycles, thus give away climate protection potential for decades.

13 Future measures should address these deficits. This is especially true with regard to the actors active in the market.

14 Such measures could include: Trade fairs accompanied by workshops, the establishment of working groups, steering committees and similar bodies, the strengthening of education and training or the regular exchange of information. The Chambers of Foreign Trade could support these actions.

15 It could be helpful to set up an online Latin American platform where interested parties can collaborate in a variety of ways, e.g. in the development of rulebooks or the design of projects.

16 The contributions from Latin America (Colombia) have shown impressive examples of the approach to creating appropriate infrastructure for the reduction of greenhouse gas emissions. They represent a good starting point for future, more far-reaching measures.

17 In Latin America, demand for energy services is expected to double by 2040.

18 This region is also characterised by significant inequality in terms of affordability of energy services, and many countries face financial and economic challenges due to their subsidy policies. National specificities need to be taken into account.

19 The webinar series on capacity building, resource and energy efficiency as well as on technologies and the state of the art has made clear the great need for action and the enormous interest of the actors involved. Further actions supported by Germany are seen as a helpful contribution.

20 The results from the webinar series can also be transferred to other regions (Africa, Asia).

21 The relevant actors (plant operators, planners, investors) should be provided with simple decision-making aids, preferably to be used online, which inform them about the impact of energy efficiency measures on the reduction of operating costs.

22 The starting point for assessing whether refrigeration systems are worthy of refurbishment could be energy audits, taking into account non-energy benefits such as comfort and air dehumidification of air conditioning systems.

23 In order to achieve the climate goals, specifications in energy law are necessary (priority for the feed-in of renewable energies, specifications for the permissible energy demand or energy savings),

24 Legal implementation of the Kigali Amendment (air pollution control, in particular gradual limitation of the use of HFCs) is also necessary.

25 Tax incentives are also suitable for achieving climate and energy policy goals.

26 About half of the emitted CO_2 is removed within a few decades, but the remaining part remains in the atmosphere for much longer; after 1,000 years it is still 15 to 40 %. Due to the associated increase in the CO_2 concentration in the atmosphere and the intensification of global warming, it will be essential to remove (this) CO2 over time at great technical and economic expense.

27 The 26th UN Conference, which has been postponed to 1-12 November 2021, could be used to deliver climate change messages in the field of refrigeration through a side event derived from the webinars. Other international conferences, such as the Meetings of the Parties to the Montreal Protocol (34th MOP from 31 October to 4 November 2022) and the Open-ended Working Group of the Parties to the Montreal Protocol (44th OEWG from 11 to 15 July 2022) could also be suitable for hosting side events.

Action is urgently needed.

2 Subject matter and objectives

Currently, about 20 % of the electrical energy consumed worldwide is used for air conditioning and refrigeration - mainly of food. The associated indirect emissions of carbon dioxide from electricity generation contribute significantly to global warming. The climate impact is amplified by the direct emissions of synthetic refrigerants that have a greenhouse effect due to leakage during their production, storage, transport and use in refrigeration plants, as well as disposal. In order to counter this, the extensive phase-out of the use of greenhouse-effective hydrofluorocarbons (HFCs) was agreed internationally in 2016 as part of the Kigali Amendment to the Montreal Protocol.

Assessing the behaviour of CO_2 in the atmosphere is complicated because it is removed from the atmosphere by multiple physical and biogeochemical processes in the ocean and on land, all of which occur on different time scales. After a pulse emission of about 1 000 PgC, about half is removed within a few decades, but the remaining part stays in the atmosphere much longer. After 1 000 years, 15 to 40 % of the CO_2 emitted in the pulse is still in the atmosphere. [1]

This inevitably leads to an increase in the CO_2 concentration in the atmosphere and thus to an intensification of the global greenhouse effect. It is therefore essential to extract (this) CO_2 at great technical and economic expense and to store it safely or recycle it. The narrow technical-technological framework of refrigeration technology offers good opportunities to initiate additional investments in modern, highly energy-efficient systems that operate with greenhouse-neutral refrigerants through targeted incentives and demanding standards.

In Central and South America, very diverse geographical, especially geomorphological, geological and economic conditions exist. It is challenging to identify the most appropriate technologies and generalisable pathways in each case and to apply them comprehensively. This applies both to ongoing investment and to stimulating additional investment.

The background information of 02.05 2021 provides comprehensive information on climate policy relevance, technical and technological aspects, state and market incentive systems, resource and energy efficiency, education and training as well as best practices.

In their respective introductions to the two webinars, **Wolfgang Müller** (for presentation see: https://www.renac.de/fileadmin/renac/media/Projects/Low-emission_cooling/Webinar_1/2021-04-13_A_Introduction_-_WMueller.pdf) and **Kerstin Martens** explained the aims of the event, based on an analysis of the current situation. They consisted in particular of elaborating:

- Who are the relevant actors (formally responsible, drivers, promoters)?
- What capacities can be used or need to be created (including technical advice, information, motivation and best practices)?
- Which existing funding instruments in the countries of application can be used?
- Are follow-up events useful, if so, in what framework?
- Creation of example objects, info on "best practices".

All presentations were of high quality and provided answers to the questions asked.

1 Source: https://www.deutsches-klima-konsortium.de/de/klimafaq-12-3.html

The above-mentioned goals have been achieved. The website https://www.renac.de/projects/current-projects/low-emission-cooling, which contains a wealth of information, has also contributed to this. The background paper prepared in the course of the preparation also contains an overview of the problems to be tackled.

3 Organisation

3.1 Organiser

The series of events was organised by the German Refrigeration and Air Conditioning Association (DKV) with its Refrigeration Working Group. (DKV) with its Refrigeration Working Group. The implementation was commissioned by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) and implemented by the Deutsche Gesellschaft für internationale Zusammenarbeit (GIZ) GmbH through the project "Strategic Environmental Dialogues".

3.2 Context

The original plan was to discuss the issue comprehensively with many relevant actors from the fields of politics, finance, governmental and non-governmental organisations as well as associations within the framework of a two-day strategic workshop in Panama City. Unfortunately, this was not possible due to the Corona pandemic. It was therefore decided to deal with selected topics in the context of three webinars, each held at a time interval of one week.

The number of individual topics and speakers had to be significantly reduced accordingly. They were focussed on different topics:

1st webinar on 13.04.2021: Capacity building, especially in the areas of

- Industry, Craft
- Financing concepts, contracting
- Planning, technical execution
- Education and training, training, information, motivation, public relations work
- Role of technical associations
- Funding programmes (national, international)

Guiding question: Which instruments can be used to enable a broader application of innovative technologies and which actions are useful for this?

2nd webinar on 20.04.2021: Resource and energy efficiency

- Overview of available technologies
- Kigali Amendment
- Resources (refrigerants, circular economy)
- Energy efficiency, renewable energies, sustainability
- Instruments

Key question: Which content-related priorities are to be set for a goal-oriented strategic orientation of the national measures, taking into account the internationally specified framework conditions?

3rd webinar on 27.04.2021: Technologies, state of the art (led by GIZ)

- Compression systems (especially propane refrigerant) and system combinations
- Sorption plants, combined heat, power and cooling (CHP)
- Solutions for areas without central (public) power supply
- Applications in supermarkets, commercial, buildings with central supply, air conditioning
- Reference to SPOTS project (Technology Roadshow)

Guiding theme: Best practices examples for broad application in Central and South America

The **3rd webinar** was also the kick-off for the **Digital Technology Roadshow** as part of the SPODS project (Sustainable and climate-friendly Phase out of Ozone Depleting Substances). It is implemented by the Gesellschaft für internationale Zusammenarbeit (GIZ) on behalf of the European Union (EU) and the German Federal Ministry for Economic Cooperation and Development (BMZ) and helps selected Latin American and Caribbean countries to fulfil their obligations under the Montreal Protocol to reduce ozone- and climate-damaging substances.

The schedule of the individual webinars is given in Appendix A.

3.3 Involvement of the participants

The webinar concept also aimed at specifically involving the participants and gaining input from the target countries. For interaction, a chat was therefore offered in addition to the moderation, which was supervised by the co-moderator. In addition, questions on specific topics were formulated for each of the first two webinars, which took place under the sole responsibility of DKV / ArGe Kälte. These were evaluated both statistically and in terms of content. A second co-moderation took place for this.

In addition, a survey of the participants was conducted after the webinars. The evaluation of the surveys can be found in Appendix C.

3.4 Partners

Two partners were involved for the necessary platforms for invitation, registration, information, contact exchange, online implementation and follow-up:

- **RENAC AG** prepared marketing materials, provided support with participant management and took over the simultaneous translation English - Spanish including coordination.
- **Jakobs Medien GmbH** implemented and supervised the two-part virtual event. The translation software Interactio was also used.

4 Participants

4.1 Participants

On 31.3.2021, about 150 potential participants in or related to Central and South America (professional and local politicians, NGOs, associations, manufacturers, service providers including financing) were invited by email.

A total of 136 participants registered, 95 for the first webinar and 104 for the second webinar. However, by far not all of those who registered logged in. 22 listeners took part in the first webinar and 19 in the second. Participation changed over the duration of the webinars.

4.2 Motivation

The reasons given for participation were very diverse and reflect the respective professional activity. Of general interest was the topic of energy efficiency; e.g. people who worked in an ozone unit wanted to gain additional knowledge about energy efficiency. In particular, there was a desire to gain additional know-how with regard to the latest technical-technological status of refrigeration technology as well as with regard to new challenges in its application. However, the will to give new impulses to one's company or to work in a more customer-oriented way or to expand one's network were also mentioned as motives.

4.3 Time

The first and second webinars both started at 15:00 CET. Due to the time difference to Central and South America, a later start, e.g. at 17:00, would very likely have resulted in a higher audience.

5 Situation in Central and South America

5.1 Political and economic situation

- The Corona pandemic has had a strong impact on the economic and political situation of some Latin American countries. Individual countries have been experiencing extreme unrest caused by the pandemic and other social, economic and political crises for several months. Five countries in this region (Mexico, Ecuador, Perú, Honduras and Chile) will elect new governments by the end of the year.
- The S&P agency's 2021 GDP growth forecasts for the six largest Latin American economies have been raised to 4.9% from 4.1% last quarter due t[2] better-than-expected performance in the fourth quarter of 2020 (see table below). The global growth outlook has improved thanks to progress on vaccines and other stimulus measures.
- An important reason for this change is the improvement in global growth forecasts to global GDP growth of 5.5% in 2021, an increase of 50 basis points from previous forecasts.
- Latin America had serious structural economic weaknesses even before the pandemic, and therefore the region will most likely not be able to recover economically from the pandemic effects so quickly.

Latin America: GDP Growth And S&P Global's Forecasts

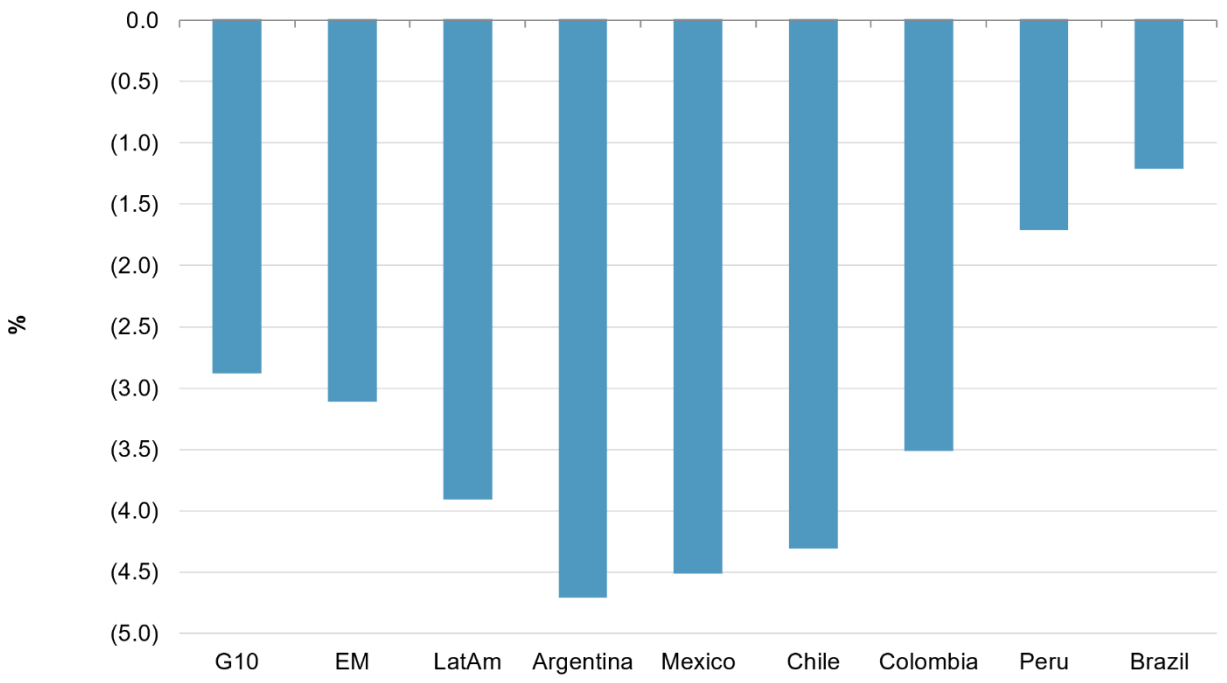
(%)	2019	2020	2021f	2022f	2023f	2024f
Argentina	(2.1)	(9.9)	6.1	2.5	2.0	1.9
Brazil	1.4	(4.4)	3.4	2.5	2.4	2.3
Chile	1.0	(6.1)	5.9	3.6	3.3	3.2
Colombia	3.3	(6.8)	6.0	3.5	3.3	3.1
Mexico	(0.0)	(8.5)	4.9	2.7	2.2	2.1
Peru	2.2	(11.1)	10.2	4.9	4.2	4.0
LatAm 5	0.7	(6.6)	4.5	2.7	2.4	2.3
LatAm 6	0.8	(6.8)	4.9	2.8	2.5	2.4

Note: The LatAm GDP aggregate forecasts are based on PPP GDP weights. LatAm 5 excludes Peru. f--S&P Global Ratings' forecast. Source: Oxford Economics.

2 Source 1: Economic Outlook Latin America,Source2:2021: Despite Growth Picking Up, Pre-Pandemic Weaknesses Remain | S&P Global Ratings (spglobal.com)

- Despite this improvement, projections suggest that Latin America will be among the slowest to recover from the COVID-19 downturn due to structural economic weaknesses that were already present before the pandemic.
- Experts in the region predict that the average economy in the region will not return to pre-pandemic GDP levels until mid-2022. Further economic consequences could arise from a further rise of authoritarian governments.
- The introduction of COVID-19 vaccines, especially in the US, stronger growth in China and additional stimulus measures in the US with positive spillover effects to Latin America are the main factors behind the higher global growth projections.
- The second reason is stronger than expected GDP growth in the fourth quarter of 2020 - the region grew by 17.5% on a quarterly basis. The improvement is due to the continued resilience of the commodity and manufacturing industries, as well as better-than-expected results in the services sector in the countries. The growth in the fourth quarter, compared to an average expansion of around 12% in the main emerging economies, leads to a strong statistical carryover for GDP in 2021.

GDP In Q4 2020 Versus Its Pre-Pandemic Level (Q4 2019)



Note: For Chile, we use Q3 2019 as a starting point, given the sizable impact of protests on Q4 2019 GDP. We then averaged out Q4 2019 and Q1 2020, and used that as the Q1 2020 value to smoothen out the volatility. Argentina is based on our estimates, as Q4 data is not available yet. G10, EM, and LatAm 6 calculations are based on median values. EM refers to 16 of the largest emerging markets. Sources: Oxford Economics and S&P Global Ratings.

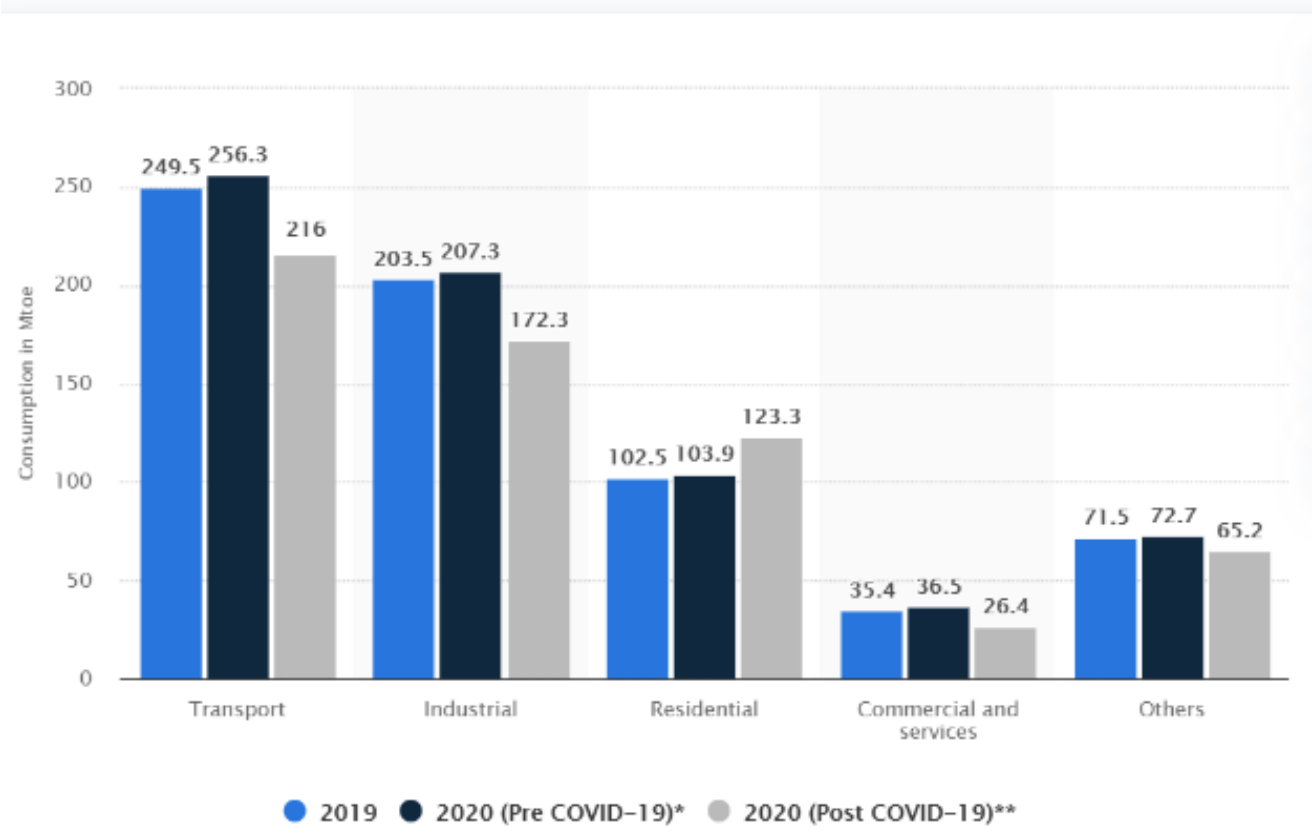
5.2 Energy consumption, energy efficiency and energy transition

Many countries in Latin America and the Caribbean are currently developing ambitious plans to revive the energy transition. The aim is to contribute to economic recovery and job creation in the post-pandemic period.

In addition, the unemployment rate and the informality (shadow economy) of labour are expected to increase in many countries in Latin America. To this end, many governments in the region are currently developing fiscal stimulus packages; the size of these stimulus packages depends on the respective scope and political decisions of the countries. Energy efficiency and energy transition programmes can create a win-win situation with job creation and greenhouse gas reduction.

Energy consumption in Latin America and the Caribbean decreased during the pandemic. For 2020, energy consumption is 603.2 million tonnes of oil equivalent (Mtoe or 25.246 EJ). This represents a decrease of almost 11% compared to consumption before the COVID-19 scenario.

The energy consumption of the trade and services sectors was the most affected by the pandemic, with a decrease of 28 % compared to the previous consumption. On the contrary, compared to the initial forecasts, consumption in the household sector was expected to increase by 19 %.



Source: - COVID-19 in Latin America: energy consumption 2020 | Statista

5.3 Trends in energy efficiency

The issue of energy efficiency is particularly relevant in Latin America and the Caribbean (LAC), where demand for energy services is expected to double by 2040. The region is also characterised by significant inequality in terms of affordability of energy services, and many countries face major financial and economic challenges due to their subsidy policies.

Energy intensity serves as the indicator to measure energy efficiency. Thus, it decreased globally at an average annual rate of 2.1 % in the period from 2010 to 2017. Latin America and the Caribbean saw the smallest decline at 0.9 %, lower than that of the Sub-Saharan Africa region at 1.7 %. The global rate of energy efficiency improvement is expected to double by 2030.

According to the Inter-American Development Bank, energy efficiency is the way to increase the affordability of electricity services while reducing emissions. Energy efficiency is a way in different dimensions to generate (positive) benefits for end-users and for society in a sustainable way. In addition, energy efficiency enables the increase of productivity and competitiveness of productive sectors; it helps public finances, especially in countries where funds are allocated to cover subsidies in the energy sector; and it creates jobs, so it plays a key role in the context of the current pandemic. Energy efficiency helps to improve the quality of life of the population.

Industrial refrigeration worldwide and in Latin America is showing a clear trend towards the efficient use of energy and water resources. Engineers, contractors and end users are being trained as well as increasingly informed and thus prepared to carry out design tasks for new plants or improvements to existing plants.

The spread of knowledge leads to safer plants and more efficient cooling systems that can generate data and even make decisions.

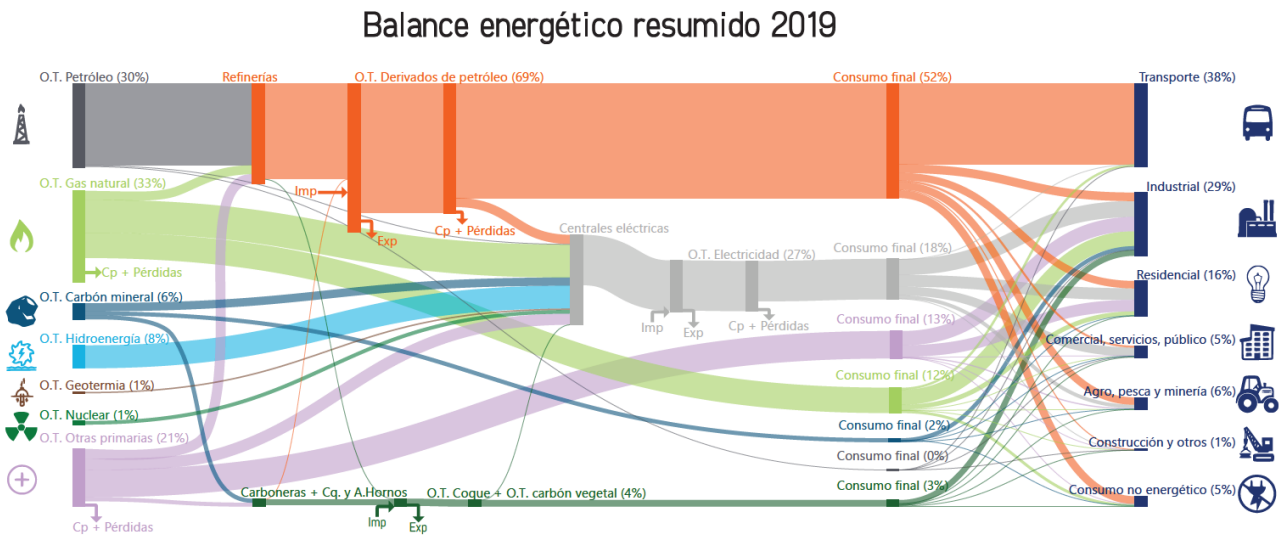
Awareness of sustainability is being raised and natural refrigerants that do not destroy the ozone layer or contribute to global warming are increasingly being used.

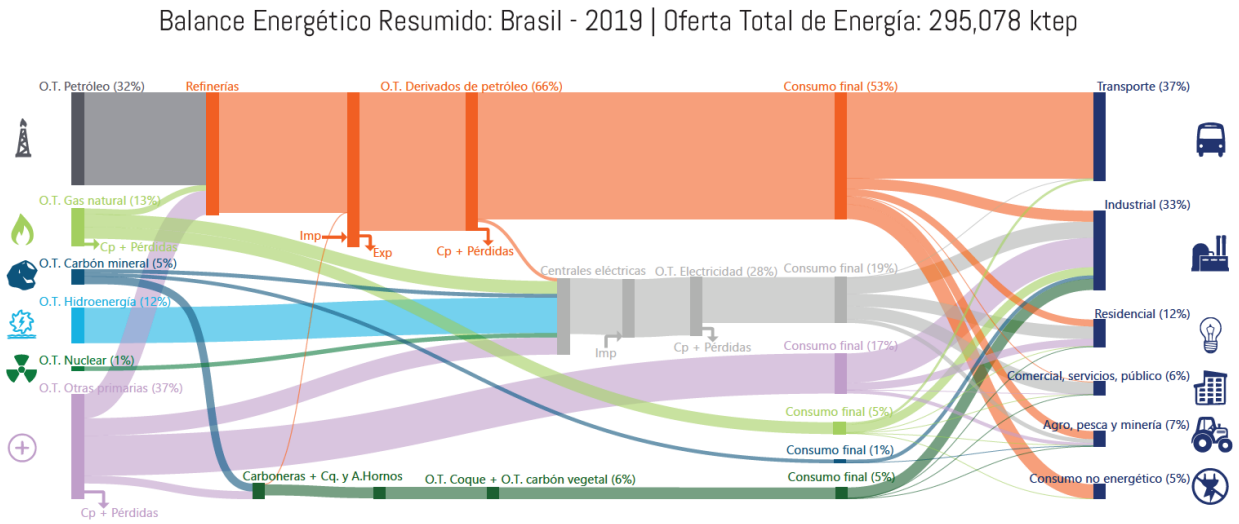
Engineers, planners and installers need to interact more with the authorities to create regulatory and safety frameworks that allow the continuity of "natural" solutions and reduce as much as possible the use of synthetic products with the risk of potential environmental damage.

The following aspects are important for sustainability:

- Selection of suitable refrigerants in relation to the application (use of ammonia, hydrocarbons such as propane, CO_2 and water) and also the refrigerant charge as an important activity,
- Energy consumption of refrigerant compressors,
- Water consumption and
- Optimisation through control technology.

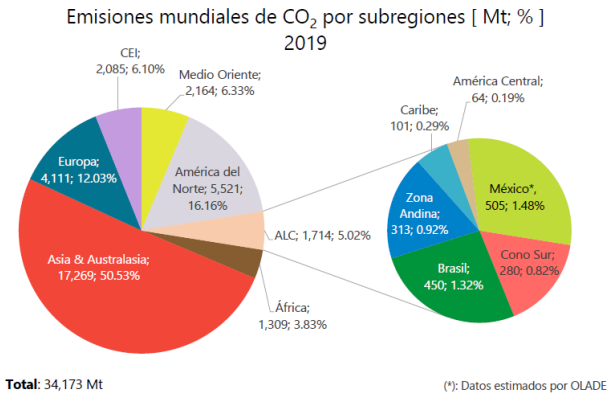
5.4 Final energy consumption and CO_2 emissions

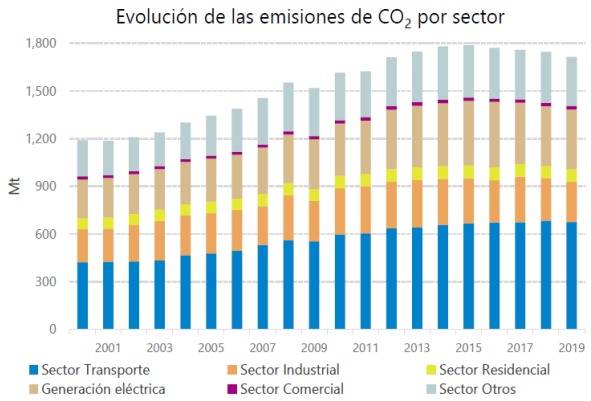




The graphs on the overall energy balance of Latin America and the Caribbean and Brazil show the high dependence on fossil fuels. Electricity generation is mainly based on natural gas, coal and hydropower, and to a lesser extent on other energy sources. The share of geothermal and nuclear power is low. This also shows that the climate impact can and must be significantly reduced through a rapid increase in energy efficiency.

To achieve the "netzero" target by 2050, the massive expansion of renewable energies is also necessary.





The pie charts show the global CO_2 emissions by region and below that, in the small circle, those for Latin America and the Caribbean. These countries have a share of 5.02 % or 1,714 million tonnes.

The bar chart shows the development of CO_2 emissions in Latin America and the Caribbean since 2020 by sector. It has been continuously decreasing slightly since 2016.

6 On individual topics

6.1 Funding

Mechthild Zumbusch, Berliner Energieagentur (BEA), reported on the financing of climate protection measures in an international context in her opening presentation on behalf of Michael Geißler.

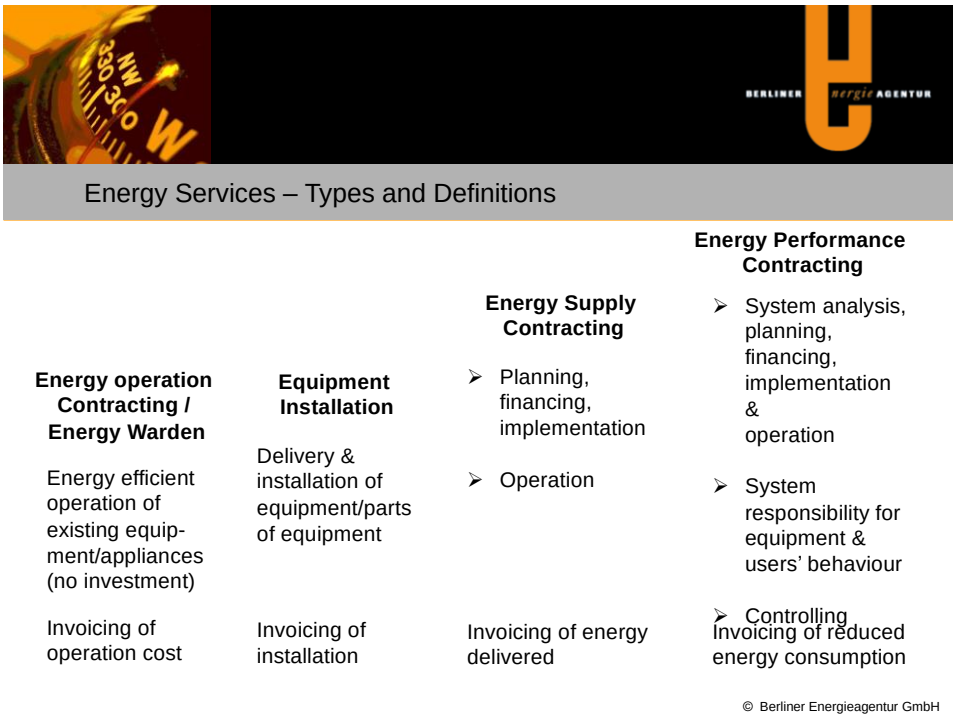
As a consultant, BEA is an international leader in energy service models and energy efficiency.

From the numerous international activities, she named the following as examples for South America

Buenos Aires**:** Introduction of a CHP system in a hospital

Chile: Feasibility study on CHP use in hospitals

Financing models play an important role in energy services (see also the following overview).



The market for energy performance contracting is substantial: USD 28.6 billion worldwide in 2017.

The advantages for potential **users** are:

- Guarantees for savings and operation
- Shifting the technical and economic risk to the contractor
- (Partial) repayment of future energy cost savings
- Saving investment costs by including third party financing

- Concentration on own core business
- Elimination of deficiencies and cash potential
- Permanent increase in comfort and value of the property.

Other ways of financing energy saving projects are:

- Equity
- Loan
- Public aid and subsidies
- Third party funding

Both the contractor and the customer can finance the energy service.

Using the example of Königstadt-Terrassen (combined heat, power and cooling), it was shown that energy consumption can be halved and CO2 emissions reduced by more than 60 %.

Further information can be found in their presentation (see: https://www.renac.de/fileadmin/renac/media/Projects/Low-emission_cooling/Webinar_1/2021-04-13_B_Financing_Clima_Protextion_-_Zumbusch.pdf).

Point 9 of the background paper (download at: https://www.renac.de/fileadmin/renac/media/Projects/Low-emission_cooling/2021-05-03_Backgroundpaper_-_en.pdf) also contains explanations on market-based financing models.

6.2 Energy efficiency, air pollution control, climate protection, resource efficiency

6.2.1 Stationary refrigeration

Refrigeration technology is of great importance for improving human living conditions as well as technical and industrial processes. It is indispensable for modern industrial societies, and demand continues to grow worldwide. The main areas of application are shown in Fig. 1, although the "trade, commerce, services" (GHD) sector as a whole is much more extensive.

Fig. 1: Areas of application for stationary refrigeration technology

The basic thermodynamic process of almost all refrigeration technologies is the vapour refrigeration process, which provides both heat and "cold":

- in 'refrigeration machines' for cooling foodstuffs, for air-conditioning rooms and for process cooling as well as
- in 'heat pumps' for space heating, domestic hot water and process heat.

The technical basis is substances known as "refrigerants", which alternately evaporate in a closed cycle, absorbing low-temperature heat (i.e. generating "cold"), and then liquefy, releasing high-temperature heat.

6.2.2 Commercial refrigeration

In the past, synthetic refrigerants (hydrofluorocarbons, HFCs), which had good thermodynamic and technical properties, were easy to handle, non-flammable and hardly toxic, were mainly used in GHD plants. However, they have a high greenhouse effect and can escape from the refrigeration systems into the environment in the event of accidents and due to leakages during operation and scrapping. Therefore, it was politically decided to phase out their use. In Europe, the gradual phase-out was stipulated in 2014 within the framework of the so-called F-Gas Regulation; globally, this took place in 2016 within the framework of the Kigali Amendment.

Central and South American countries belong to Group 1 of the Montreal Protocol's Article 5 countries, for which baseline actions start in 2024 and for which the first decrease in availability occurs in 2029 (see Figure 2). Thereafter, availability will be reduced to 20% of the baseline by 2045. As the synthetic refrigerants are produced by only a few manufacturers and distributed globally, there is no guarantee that HFC refrigerants will continue to be available at low cost and in sufficient quantities until the 2040s. Therefore, a transition to other refrigerants may be required earlier than envisaged under the Kigali Amendment.

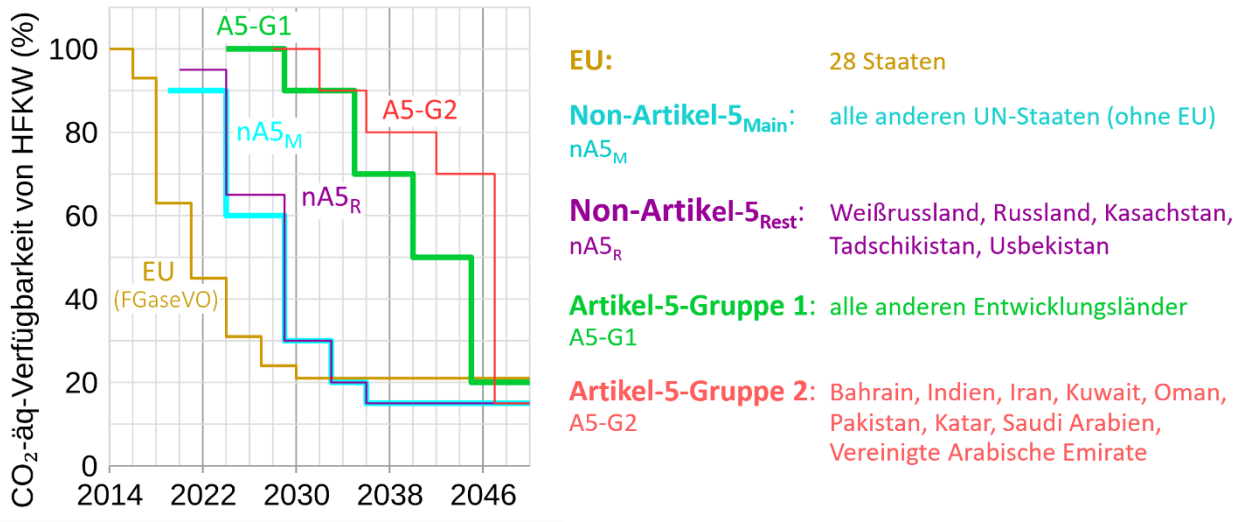


Fig. 2: Global decline in market availability of HFC refrigerants by 2047 due to the F-Gas Regulation and the Kigali Amendment for Montreal Protocol countries

6.2.3 Refrigerants for commercial refrigeration

Fig. 3shows the substance groups of the available refrigerants and their safety classes (which will not be discussed in detail here). As refrigerants with a global greenhouse effect will only be available until the early 2040s, the years will be available as refrigerants, a transition to other refrigerants must take place.
HFO refrigerants (hydrofluoroolefins), which have no significant greenhouse effect and are hardly flammable (safety class A2L), but whose degradation products have critical properties, are a possibility. Given this background, it is currently not certain that these HFO refrigerants will be available in the long term. The German Federal Environment Ministry therefore currently prefers "natural" refrigerants such as carbon dioxide, water (safety class A1) and hydrocarbons (safety class A3). and ammonia (safety class and B2L). Refrigerants of safety classes A2L, A3 and B2L require adapted refrigeration systems due to their flammability and increased toxicity.

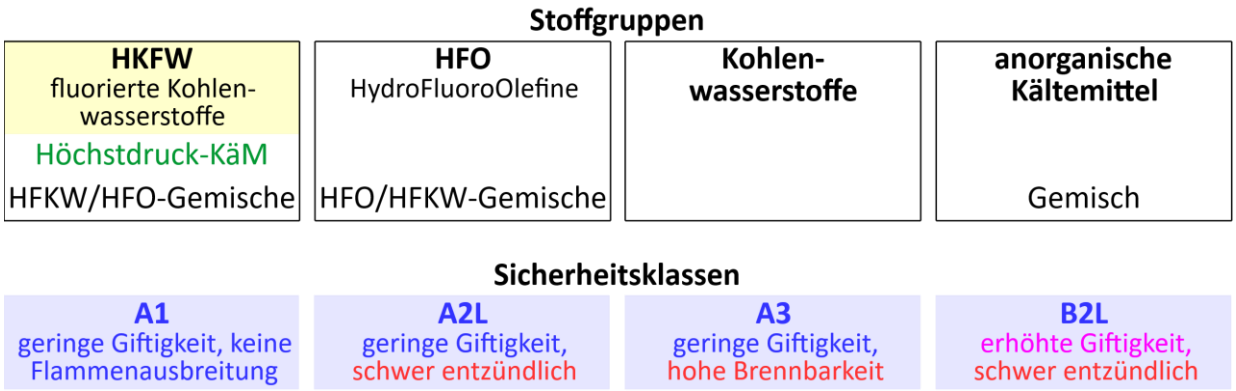


Fig. 3: Classification of refrigerants according to substance groups and safety classes

In industrial refrigeration with usually high cooling capacities, ammonia is mainly used as a refrigerant. In commercial refrigeration systems, carbon dioxide and hydrocarbons are increasingly used as refrigerants.

Water and ammonia are used, among other things, for air conditioning in buildings. What all natural refrigerants have in common is that they are not regulated under the Kigali Amendment because they are halogen-free.

6.2.4 Refrigeration systems with flammable refrigerants

Against the overall background shown in Fig. 1 use of hydrocarbons as refrigerants will become more intensive in the future in the area of application of trade, commerce and services, the so-called commercial refrigeration.

- In the case of small refrigerant charge quantities and large rooms, even if the entire charge quantity suddenly escapes from a refrigerant circuit, no ignitable mixture can develop, so that no fire can occur. Such micro and small refrigeration systems, e.g. with the refrigerant propane, have been used for many years in household and supermarket refrigeration. For a few years now, even individual sales refrigeration units in supermarkets have been equipped with such small refrigeration machines, whose waste heat is dissipated by means of cooling water circuits. Such systems are called "water-loop". Large central refrigeration machines in separate rooms of the supermarkets are superfluous with such systems.
- For larger refrigerant charges, encapsulated refrigeration systems are used in which the heat absorption and release is carried out via additional refrigerant circuits. The refrigerating machine is separated from the rest of the building by a housing and has a vent to the outside (likewise, the refrigerating machine can be housed outside the building). Heat from the cold room is absorbed via a coolant circuit (blue) (colloquially, "cold" is provided there), and the heat is released to the outside via a second coolant circuit (red). Such constructions are called "indirect" systems. - Such a design of a refrigeration system has the additional advantage of a very compact construction, whereby the refrigerant charge can be small and thus, even in the event of an accident, the risk of ignition is low.

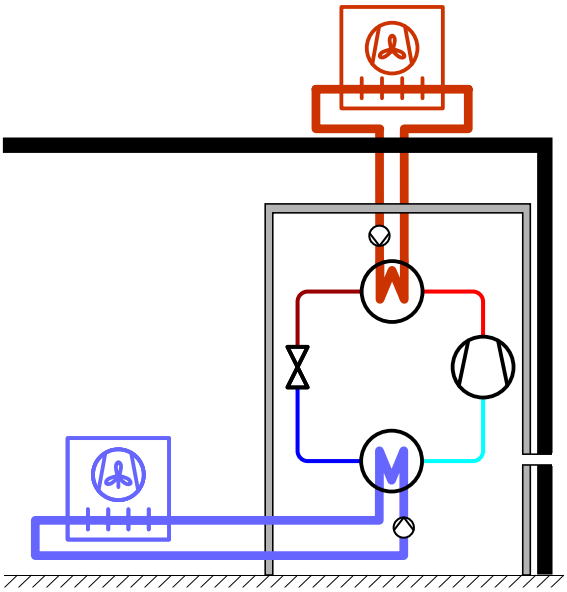


Fig. 4: Encapsulated refrigeration system for flammable refrigerants

6.2.5 Energy efficiency of commercial refrigeration systems

The topic of "energy efficiency" is important for two reasons. From the operator's point of view, high energy efficiency results in low operating costs, and from the point of view of environmental protection, it causes only low electrical energy-related CO_2 emissions.

Energy efficiency is influenced by the refrigerant used and the components of a refrigeration system. Roughly simplified, it can be said that high energy efficiency requires more cost-intensive components and control systems, but the additional costs are amortised in a short time and subsequently large savings are made due to lower operating costs. Fig. 4shows a comparison of the annual energy consumption of commercial refrigeration systems operated in Germany that provide "cold" at three different useful temperatures.

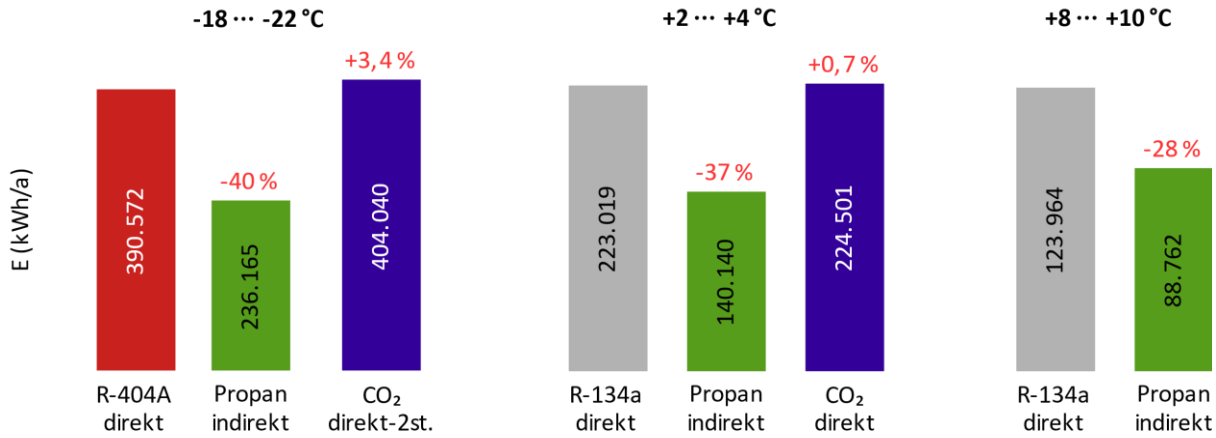


Fig. 4: Annual energy consumption of commercial refrigeration systems for low-temperature, normal and air-conditioning cooling using different refrigerants at a cooling capacity of 100 kW (R-404A, R-134a = greenhouse-effective synthetic refrigerants that will no longer be available in the medium term); CO_2 systems in supermarket refrigeration: more efficient with ejectors and parallel compression

The refrigeration systems with synthetic refrigerants are inexpensively constructed and therefore have a low energy efficiency, the systems with propane and CO_2 (carbon dioxide) as refrigerant are high-energy efficiency systems with large and therefore cost-intensive heat exchangers and a mechanical or electronic control of the refrigeration capacity.

Overall, it can be seen that the refrigerant propane offers the highest energy efficiency below the specified conditions. However, there are other applications and temperature ranges where other refrigerants with different properties are more advantageous. For each application and location, therefore, a design calculation should be made based on an annual temperature profile that gives the best environmental and economic benefit.

In the field of supermarket refrigeration technology, it is state of the art for the energy consumption of systems to be continuously monitored by service companies via remote data transmission. This makes it easy for specialists to detect malfunctions and defects in systems and arrange for service as quickly as possible. Operators are usually overwhelmed with the complexity of digitally controlled refrigeration systems.

6.2.6 Sorption technology

Sorption systems do not work with electrically but with thermally driven compressors in which solar or industrial or commercial waste heat or waste heat from electricity generation (combined heat and power) can be used. For their operation, electrical energy is then only required for circulation pumps and for the control system. Sorption systems are offered in the power range from a few watts, e.g. for vaccine cooling, to several megawatts, e.g. for process or air-conditioning cooling.

The dissemination and economic significance of sorption plants is currently still relatively low, and in addition the plants are technically demanding and require additional training for service personnel. However, the funding within the framework of the National Climate Protection Initiative in Germany, for example, has shown that such plants - also as complete combined heat, power and cooling plants - can be developed and established on the market in a short time. The German Refrigeration Award has also helped to publicise such solutions and thus promote their use.

6.2.7 Determining the worthiness of refurbishment of refrigeration systems

Energy audits are a proven method of assessing the energy status with the aim of increasing energy efficiency and saving energy costs. If this has not yet been done, a national framework for action should be established. This should contain both a legal and a funding component.

The relevant actors (operators of facilities using technical refrigeration, planners, investors) should be provided with simple decision-making aids that can be used online, if possible, to inform them about the impact of energy efficiency measures on the reduction of operating costs. Simple key figures such as specific energy costs per square metre of refrigerated shelving in normal or deep-freezing can also be used in relation to a benchmark.

6.2.8 In the contributions of the speakers, various aspects were explained in detail

Cristina Mariaca, Ministry of Environment and Sustainability (Ozone Unit) in Colombia followed up on Mechthild Zumbusch's presentation on energy services in her contribution on environmentally friendly district heating and cooling.

Thermal districts are networks of outsourced services that deliver heating or cooling to buildings and/or individual users within a locality or development district through a network of underground pipes from a central generation facility. Economies of scale allow for the connection of renewable energy sources, waste heat, thermal storage, power grids and heat pumps. The use of ozone depleting substances (ODS) in conventional air conditioning systems is avoided, energy efficiency is improved and variable operating costs are eliminated. Visual and noise pollution are reduced. There are financial savings for the end user. They are axes of urban regeneration and emblematic projects of territorial planning. However, they require long-term service contracts with the user. In buildings without central systems, the possibility of connection is also limited.

In Colombia, an ambitious infrastructure development strategy is being pursued with thermal districts. Until 2012, equipment was replaced 1 : 1 with more energy-efficient equipment. From 2013 to 2019, thermal districts were developed as an energy-efficient alternative with low environmental impact in air-conditioning the buildings. The plans anchor the territorial development with thermal districts (DT) in the cities of Colombia. From 2019 to 2023, the national regulatory framework will take, prepare and implement the measures necessary for sustainable air conditioning with efficient energetics and low environmental impact. From 2024, knowledge about the districts will then be integrated into the actions of market actors.

Institutionally, a bundle of measures was launched:

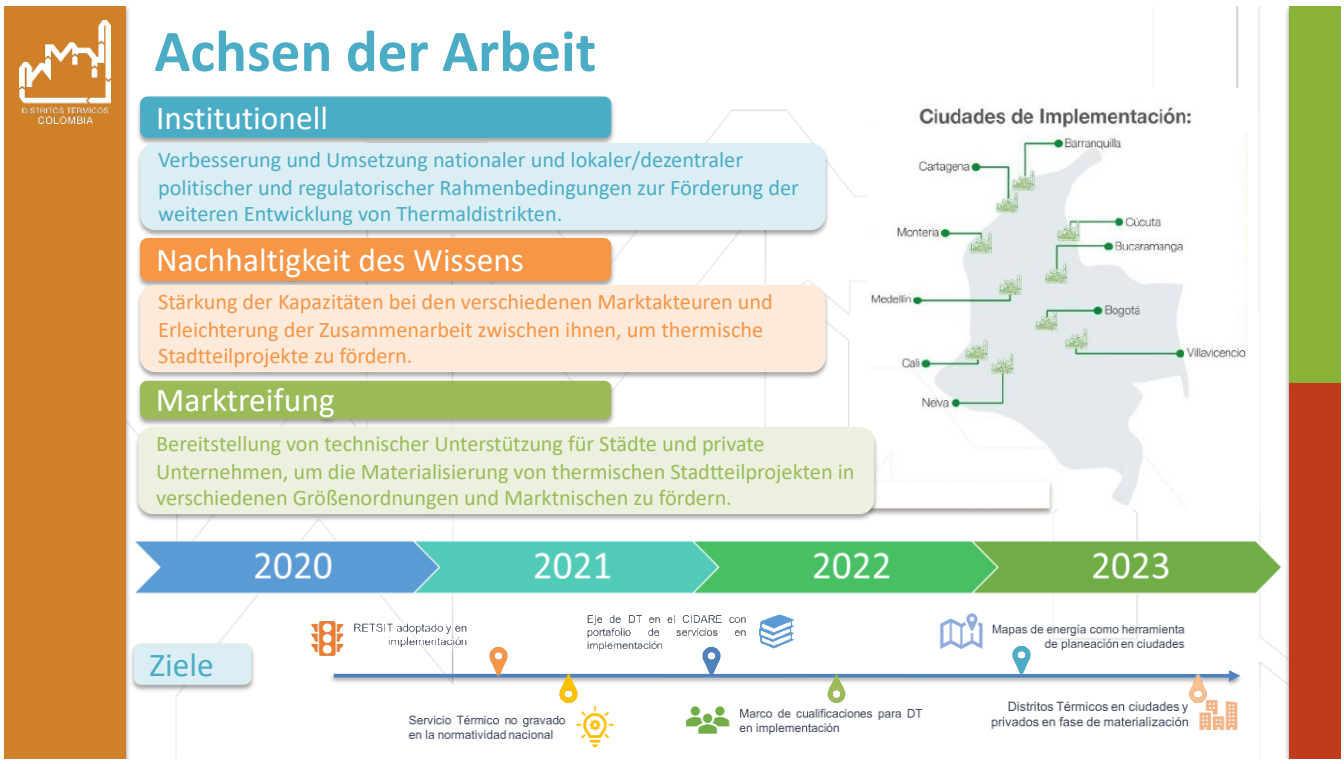
- Energy efficiency measure - PROURE.
- NDC of the Colombian Ministry of Environment.
- Technical regulation in thermal systems and plants - Minenergía.
- DT in sustainable public procurement.
- DT as part of climate change plans in cities.
- DT as part of land use planning in cities.
- Energy maps as a planning tool in land use planning.

Successes of the implementation of the thermal districts planning tool of the Alújarra in Medellín were:

- 100% elimination of ozone-depleting substances

- 25 % energy saving
- 35 % emission reduction
- 10-13 % reduction in thermal energy costs

An overview of the future goals is given in the following chart.



It became clear that the conversion to efficient, climate-friendly district heating and cooling systems cannot be successful with financial support alone. Rather, an accompanying bundle of measures is necessary, starting with spatial planning and the necessary technical regulations and ending with public procurement.

Further information can be found in their presentation (see: https://www.renac.de/fileadmin/renac/media/Projects/Low-emission_cooling/Webinar_2/2021-04-20_D_District_Cooling_-_CMOrozco_-_es.pdf).

Dr Lambert Kuijpers, UNEP, Montreal Protocol, explained:

- Refrigeration and air conditioning systems already use 20 % of global electricity production worldwide. The share of electricity consumption will continue to rise.
- The subject of the Kigali Amendment is not emissions, either direct (HFCs) or indirect (CO_2) from electricity generation. Nevertheless, the purpose is to reduce HFC emissions.
- To this end, the Kigali Amendment provides for the gradual limitation of HFC consumption and production.
- Energy efficiency itself is not part of the Kigali phase-down.
- With a view to the targeted net zero emissions by 2050 ("carbon neutrality by 2050"), it is particularly important to reduce not only HFC emissions but also CO_2 emissions. This is a huge task that can only be achieved through a combination of energy efficiency and renewable energies.

- Currently, a 50% reduction in emissions by 2030 is being discussed, followed by further steps in the next two decades towards net zero $_{CO2}$.
- In summary: possible solutions to address "netzero" by 2050 are strongly dependent on the use of renewable energies. However, they cannot rely on this alone. Rather, a complex system is needed that reduces or adjusts demand, using storage, combined heat, power and cooling and other efficiency technologies.
- This requires the establishment of a sustainable financing system.
- **And this must be done now! This is the** only way to set the necessary trends towards 2050.

Further details can be found in his presentation (see: https://www.renac.de/fileadmin/renac/media/Projects/Low-emission_cooling/Webinar_2/2021-04-20_A_Climate_related_emissions_-_LKuijpers.pdf).

Roland Handschuh, Cool-Expert GmbH, presented the "blue cool concept" with natural refrigerants as a complete solution for supermarkets. This also includes a control system for the stores. The company received the German Refrigeration Award in 2018 for this solution.

A detailed overview of the concept is contained in his presentation (see: https://www.renac.de/fileadmin/renac/media/Projects/Low-emission_cooling/Webinar_2/2021-04-20_C_Integral_system_-_RHandschuh.pdf).

In his contribution, **Jörn Schwarz**, Ice-TeX, gave an overview of technologies for generating technical refrigeration and evaluated their energy efficiency. Currently, technologies with propane (R 290) are increasingly gaining acceptance due to their energy efficiency and performance.

More detailed explanations can be found in his presentation (see: https://www.renac.de/fileadmin/renac/media/Projects/Low-emission_cooling/Webinar_2/2021-04-20_B_Technologies_and_efficiency_-_JSchwarz_-_en.pdf).

6.3 Education and training

Claudia Sanchez, ACAIRE (Asociación Colombiana de Acondicionamiento de Aire), Bogota, Colombia, presented Colombia's complex national strategy for combating climate change in connection with the development of the social sector. The framework for national qualifications: "Marco Nacional Cualificaciones" (MNC) is exemplary.

The corresponding National Catalogue of Education "NQC" is an overall document that becomes a tool to help reduce the gaps that currently exist between the manufacturing and academic sectors in order to strengthen the country's human capital through relevant and quality education and training provision. An important component is the National Catalogue of Qualifications (NQC). It ranks and assesses qualifications according to NQF level.

Gap identification takes place, for example, with regard to:

- number such as deficits or lack of training programmes.
- Quality as well as dissatisfaction of employers regarding the degree of attainment of the generic and specific competences of the available human capital.
- Relevance in education such as adaptation of education provision with regard to the needs of the productive sector in terms of competences and professional profiles.

Benefiting from the "Marco Nacional Cualificaciones

A. Students through

- Practice spaces with real working conditions at local, regional national and international level.
- enabling a system that has greater international comparability, mobility and progression in the education system.
- strengthening job placement and recognition of graduates.

B. Educational institutions

- the **productive**, **economic** and **social sectors**
- the **government** (local, national and international)

C. Craft workers

- In the refrigeration and air conditioning sector, the labour market is growing depending on the national economy and the development of hospital, residential, industrial, commercial, tourism and logistics infrastructure projects.
- The demand for labour has increased annually from at least 5 % to 18.3 % over the last three years.

Further information can be found in their presentation (see: https://www.renac.de/fileadmin/renac/media/Projects/Low-emission_cooling/Webinar_1/2021-04-13_C_ACAIRE_-_Claudia_Sanchez.pdf).

Karsten Beermann, IKKE - Informationszentrum für Kälte-, Klima- und Energietechnik gGmbH, Duisburg, informed about:

- dual vocational training in Germany.
- a seminar on "Planning and practice with propane refrigeration systems (natural refrigerants)" and
- the EU Life Programme "REAL Alternatives" with its various modules.

He explained the European Standard EN 13313 "competence of personnel". It contains the definitions for the required knowledge (e.g. for propane, ammonia or CO_2). This European standard will soon be transferred to the globally valid standard ISO 22712.

The IKKE is also available to interested parties in Central and South America as a contact for training and further education. Further information can be found in its presentation (see: https://www.renac.de/fileadmin/renac/media/Projects/Low-emission_cooling/Webinar_1/2021-04-13_E_Education_in_Germany_-_KBeermann.pdf).

Carolina Vélez and **Lara Teutsch,** GIZ Proklima, informed in their contribution Fit for Green Cooling about how Proklima supports the qualification, certification and registration of refrigeration technicians in Latin America in dealing with natural refrigerants.

They emphasised that targeted qualification minimises environmental and health risks, increases energy efficiency and ensures the creation of sustainable jobs.

- The certification sets the standards for the technicians' knowledge and skills.
- The registration provides the competent authorities of the Länder with a numerical overview of the trained personnel and their certification.

- Training on the safe handling of natural refrigerants includes comprehensive knowledge on standards, maintenance and operation. 30 % is theoretical and 70 % practical.

In general, the first step is to assess the need for education and training. In a second phase, the implementation of the designed training and certification measures takes place.

Further information can be found in their presentation (see: https://www.renac.de/fileadmin/renac/media/Projects/Low-emission_cooling/Webinar_1/2021-04-13_D_Proklima_-_CVelez.pdf).

6.4 Examples of concrete actions

Countries where exemplary actions - across LACs - can be organised include Colombia and Panama.

Possible actions are:

- "Refrigeration Week" (trade fair/exhibition; symposia on technology, financing, education and training; excursions)
- University Day
- Apprenticeship Training Day
- Efficiency competition
- Teaching module on climate protection / thermodynamics
- Carrying out campaigns to inform, advise and motivate
- Participation in "World Refrigeration Day", which takes place every year on 23 June.

Furthermore, the establishment of an internet-based platform for LAC could be a tool for initiating and coordinating projects and other activities.

6.5 Actors

Possible actors are at the level of

- Governments and governmental organisations: Ministries of Environment, Economy, Energy, Spatial Planning, Sustainability as well as regional and local institutions, embassies, chambers of foreign trade (AHK), in Germany also GIZ, UBA
- United Nations: UNEP including CCAC Initiative, UNDP, UNIDO (OLADE), UNFCCC, Cool Coalition
- Associations: Responsible for refrigeration, air conditioning and heat pump technology, e.g. ACAIRE (Colombia), ADEME, ASERCOM, DKV e. V. (Germany). (Germany); in Germany GIZ, UBA,
- Higher and technical education institutions
- Financing institutions: World Bank, ECB, KfW development bank

6.6 Use of events that are important for climate policy

26th UN Climate Change Conference

The conference was scheduled for November 2020 in Glasgow, Scotland, but was postponed to 1-12 November 2021 as a result of the COVID 19 pandemic.

Proposal:

Holding a side event entitled "Tapping enormous climate protection potential in the rapidly growing use of refrigeration systems worldwide".
It could be carried out jointly with the Ministerio de Ambiente y Desarrollo Sostenible and ACAIRE (Asociación Colombiana de Acondicionamiento de aire), Bogota, Colombia.

Meetings of the Parties to the Montreal Protocol

The 34th Meeting of the Parties to the Montreal Protocol (34thMOP) will take place from 31 October to 4 November 2022. The 44th Meeting of the Open-ended Working Group of the Parties to the Montreal Protocol (44thOEWG) is scheduled for 11-15 July 2022. No venues have yet been announced for either conference.
These two conferences are also suitable for holding comparable side events.

7 Results of the surveys

A survey of participants was conducted during the first two webinars (Appendix B) and in the follow-up to the event (Appendix C).

The event generally met with great approval. All participants described the event as very interesting and useful for their own work.

Follow-up events are desired. This includes holding the strategic workshop in Panama City as planned. In particular, decision-makers from supermarkets and hotels are to be involved. This should enable them to orient decisions on some issues more adequately to the necessities. The topic of electronics in refrigeration is also of particular interest. Information on control and regulation technology for refrigeration systems is desired.

Some issues, such as the disposal of refrigeration and air-conditioning systems, could not be dealt with due to time constraints. However, information on this can be found in the background information on the webinar series of 03.05.2021 (see: https://www.renac.de/fileadmin/renac/media/Projects/Low-emission_cooling/Concepto_Serie-Seminario-Web_es.pdf).

Appendix C shows the individual results.

The participants see the greatest need for action in the areas of information, motivation and engineering know-how **(**26 %), education and training capacities (26 %) and energy policy framework conditions including a lack of targeted, economic incentives (23 %).

The biggest barriers to the use of energy performance contracting are seen by participants as lack of financial resources (29%), uncertainty about future cost savings (19%) and (non-) recognition of non-energy benefits in terms of comfort or value enhancement (16%).

Appendix B shows the individual results.

8 Other

8.1

As of 27.05.2021, the English-language project page had 887 hits and the Spanish-language page had 478 hits. This shows that the information must have been disseminated far beyond the circle of invitees.

8.2

The contributions mentioned in each case can also be found under the respective webinars on the website:
https://www.renac.de/projects/current-projects/low-emission-cooling
can be called up.

Berlin, Rühlow, 28.06.2021

Contacts:

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ArGe.Kaelte@t-online.de

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☎ 0151 41919516
wolfgang_mueller@icl

Appendix

Appendix A "Procedure of the webinars

1st webinar on 13.04.2021: Capacity building

Welcome/Introduction

Wolfgang Müller (formerly BMU), ArGe Kälte,

Models and experiences in financing climate protection measures in an international context

Mechthild Zumbusch, Berlin Energy Agency

- Models, experiences in private financing of climate protection measures
- Refinancing of investments from energy savings
- Project examples (e.g. eE and CHP(K) in Chile)

Discussion

Occupations/Qualifications in Colombia in HVAC and Comparison with the World-wide State of the Art

Claudia Sanchez, ACAIRE (Asociación Colombiana de Acondicionamiento de Aire), Colombia

- Focal points of the association's work
- Capacity Building: Need for Action in Colombia (and Central and South America)
- Best practices, examples

Discussion

Further training offers - brief information

(1) Fit for Green Cooling

Carolina Vélez, Lara Teutsch, GIZ Proklima

- How Proklima supports qualification, certification and registration of RAC technicians in Latin America

(2) Training in the use of environmentally neutral refrigerants

Karsten Beermann, IKKE (Information Centre for Refrigeration, Air Conditioning and Energy Technology gGmbH)

- Education and institutions in Germany
- Courses in theory and practice

Discussion

Summary

Moderator, *Dr Felipe A. Toro Chacón, IREES*

2nd webinar on 20.04.2021: Resource and energy efficiency

Welcome

Kerstin Martens, UBA (Federal Environment Agency)

Relevant refrigeration and air conditioning technology

Jörn Schwarz, Ice-TeX

Cooling Emissions and need for action

Lambert Kuijpers, UNEP, Montreal Protocol

- Expected development worldwide for refrigeration systems
- Implementation of the Kigali Amendment
- Energy efficiency, an important pillar of implementation

Discussion

Energy-efficient technologies for the generation of technical refrigeration

Roland Handschuh, Cool-Expert GmbH

- Combined provision of cooling and heating
- Normal, low and climate cooling with heat pump function!

Discussion

District Cooling and Heating

Cristina Mariaca, Colombia (Ministry of Environment, Ozone Unit)

Discussion

Summary

Moderator*, Dr Felipe A. Toro Chacón, IREES*

3rd webinar on 27.04.2021: Technologies, state of the art (led by GIZ)

The refrigerant propane in commercial refrigeration

Vilim Mergl, CoolTool GmbH

- Theoretical energy efficiency
- Practical energy efficiency

Sustainable concepts for special operating conditions

Paul Kohlenbach, (Beuth University, Berlin)

- Solar drive of compression refrigeration systems
- Energy storage (thermal, electrical)

Appendix B "Surveys during the webinars".

Prepared questions

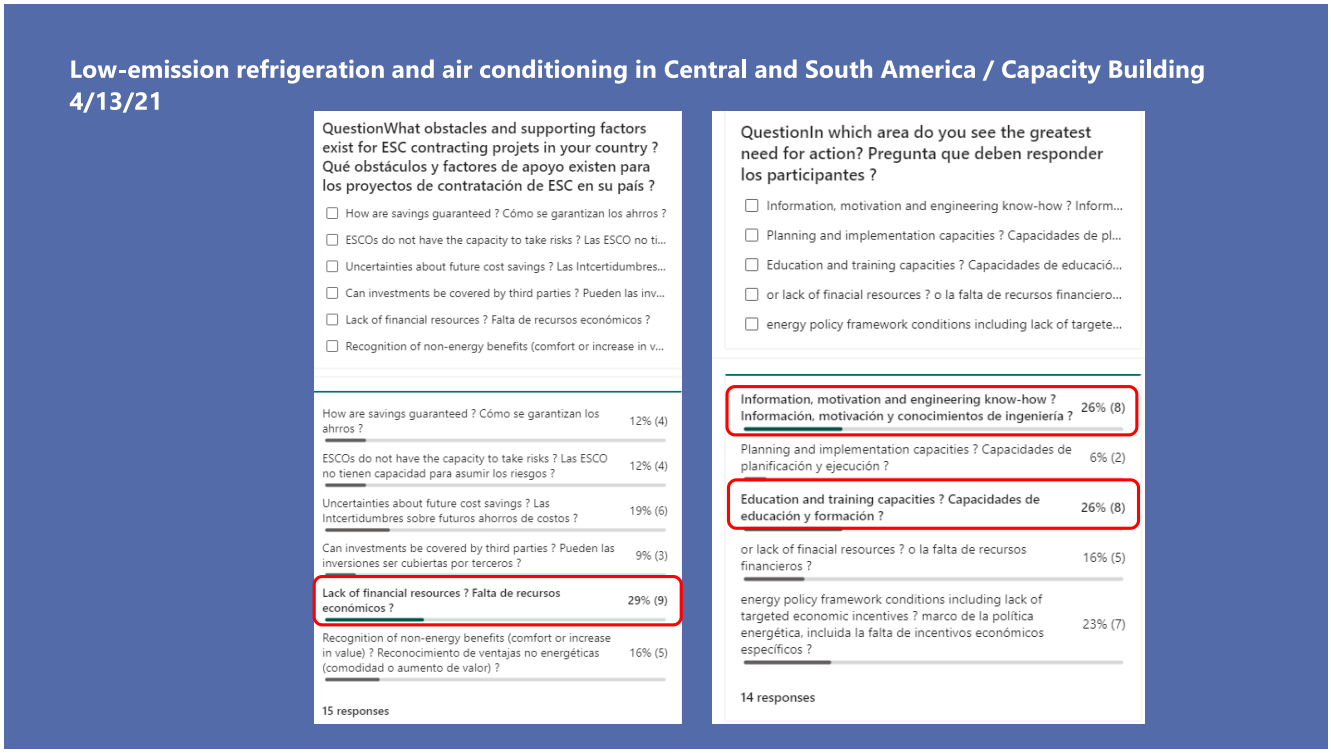
The question during the first webinar "In which area do you see the greatest need for action?" was answered by **14** participants as follows

- Information, motivation and engineering know-how 26 % (8)
- Planning and implementation capacities6 % (2)
- Education and training capacities26 % (8)
- or lack of financial resources16 % (5)
- Energy policy framework including lack of targeted, economic incentives 23 % (7)

In a second block of questions about the biggest obstacles to the application of energy performance contracting, the participants named:

- Lack of financial resources 29 % (9)
- Uncertainty about future cost savings19 % (6)
- Recognition of non-energy benefits (comfort or increase in value) 16 % (5)
- Are the savings guaranteed? 12 % (4)
- Can the risks be borne by the contractors? 12 % (4)
- Can investments be covered by third parties? 9 % (3)

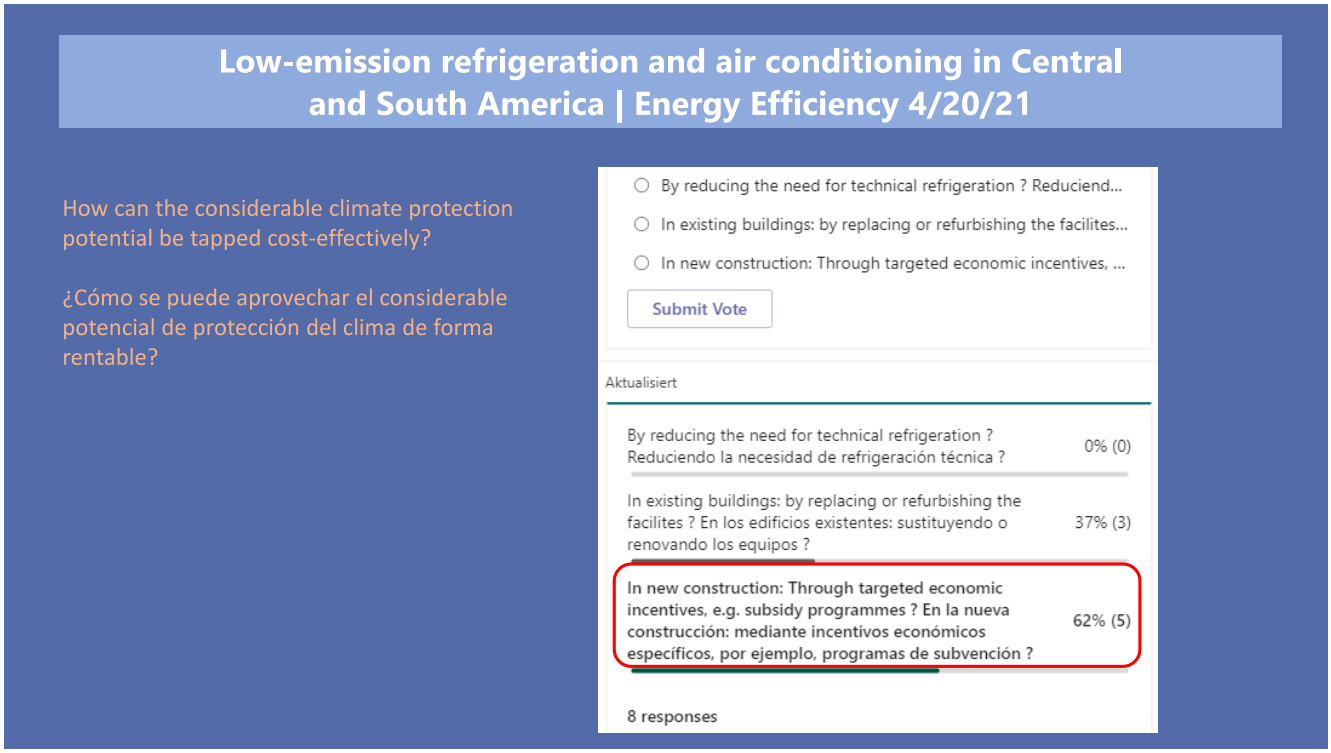
Overview see Annex 4/13/21



The question during the second webinar "Which way can the considerable climate protection potential be tapped cost-effectively?" was answered by 8 listeners as follows:

- By reducing the need for technical refrigeration? 0 % (0)
- In the existing stock: By replacing or refurbishing the facilities? 37 % (3)
- In new construction: Through targeted economic incentives, e.g. subsidy programmes? 62 % (5)

Overview see Annex 4/20/21



Appendix C " Survey after the webinars "

1. How did you like the event?

Very interesting13

less good0

2. What did you like best?

- Exhibitors' knowledge of the contents.
- The whole theme was very good.
- The timeliness of the information.
- The experiences made in other countries, the way the projects were developed.
- The technical solution possibilities, the resulting potentials for climate protection and air pollution. as well as possible models to support the diffusion of innovators, identify the necessary new skills, best practices and the best ways to improve the quality of life of the population.
- With the other innovative technical solutions that exist and are on the market today, it would be good to hold a seminar specifically on this topic with decision-makers from supermarkets and hotels.
- Motivation for the use of natural refrigerants, their energy efficiency. Electronics in refrigeration. New techniques, for pressurised connections.
- In general, anything that helps us get better at any aspect of refrigeration where we may be failing.

3. What could be improved?

- Communication of activities.
- Everything was fine.
- Adapt more to the Latin American context.
- I think everything is very good, maybe at the moment of translation the main idea is a bit lost, you could send the presentation in Spanish before.
- Organise the two-day strategic workshop in Panama City as planned.
- Explain the subject of electronics in refrigeration.
  Elements for the control of the refrigeration system, electromechanical and their equivalent elements in electronics.
- Involvement of decision-makers from supermarkets and hotels, which in some issues allows decisions to be more adequately oriented towards necessities.
- Our work schedule does not allow us to be present in all sections.

4. For possible future events: What content or issues should be addressed, e.g.

- Efficiency of energy systems, energy storage: 7.4
- Cogeneration, including district heating and cooling networks 6.1
- Construction: heating and cooling supply7 .3
- Refrigeration systems (size classes, efficiency, refrigerants, monitoring and control) 8.4
- Policy instruments (energy legislation, e.g. prioritisation of energy production types, state aid, market systems) 8.0

5. Which topics were you particularly interested in?

- Applied electronics
- HC Energy efficiency
- Use of HC in RAC
- Use of CO_2 in RAC
- Natural refrigerants, execution of welds
- Counselling practices
- Absorption cooling
- Ok, ok
- Applied electronics systems with CO_2
- New strategies

6. What topics did you miss?

- Training opportunities
- Equipment in HC Pictures of the HC cargo
- Treatment methods of scrap metal disposal
- none
- Specifics of the culture of concrete projects
- Mechatronics versus electromechanics

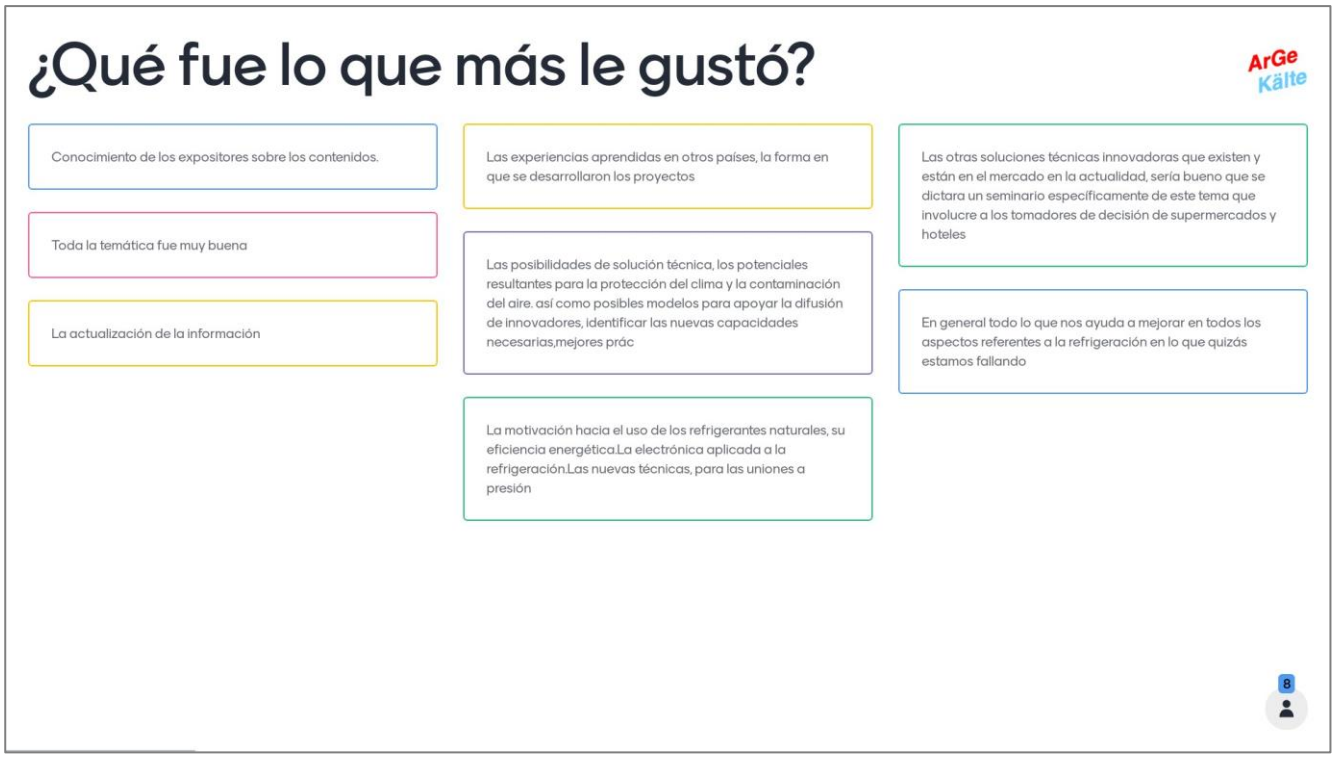
7. How would you rate the benefit of the event?

- excellent 5
- good 2
- Sufficient 0
- bad 0

8. Did you enjoy the event?

- Yes 7
- No 0

Attachments



¿Qué se podría mejorar?

ArGe Kälte

Comunicación de actividades.

todo estuvo bien

Más actualizadas al contesto Latinoamericano.

Creo que todo está muy bien, tal vez al momento de la traducción se pierde un poco la idea principal, se podría enviar antes la presentación en español

Organizar el taller estratégico de dos días en la ciudad de Panamá como se tenia planificado.

Exponer el tema de la electrónica aplicada a la refrigeración.Elementos para el control del sistema de refrigeración, electromecánicos y sus elementos equivalentes en la electrónica .

El involucrar a tomadores de decisión de supermercados y hoteles en algunos temas relevantes que les permitan tomar las decisiones más adecuadas dependiendo de sus necesidades

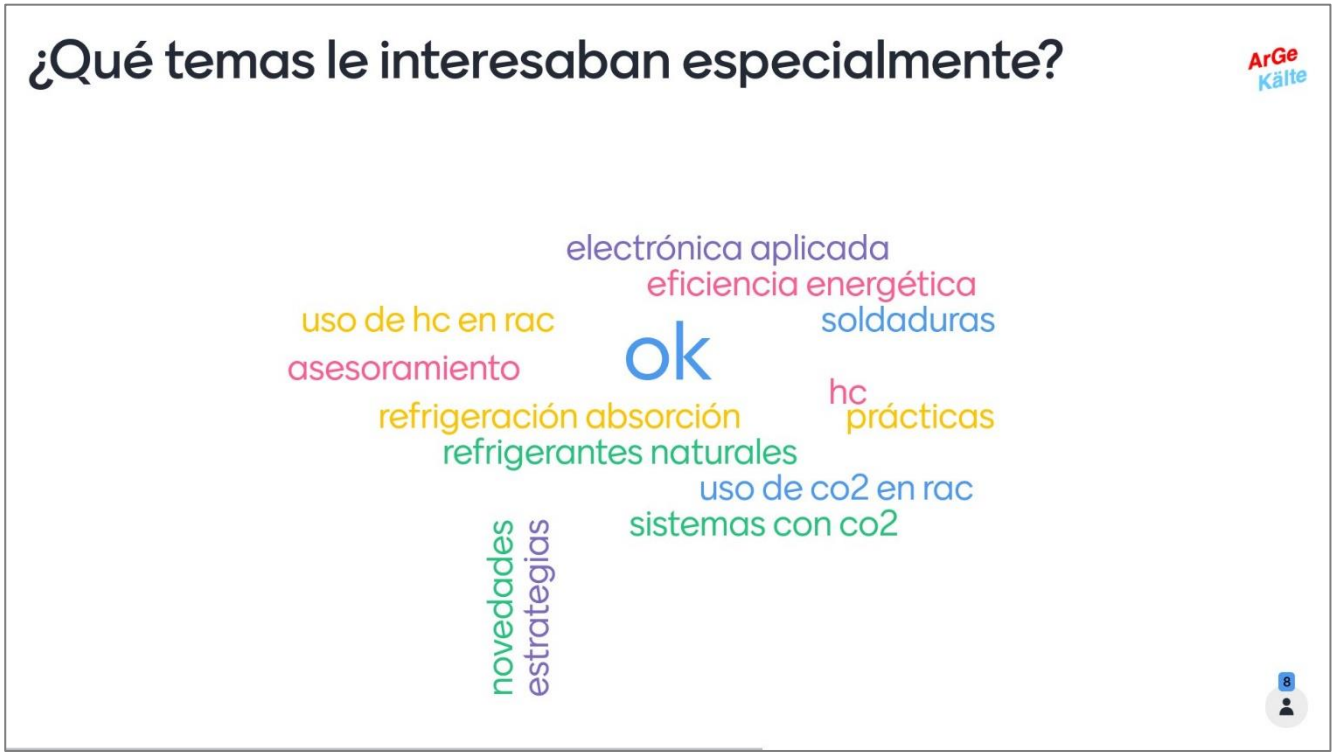
El horario un poco por el trabajo no nos permite estar presente en todas las secciones

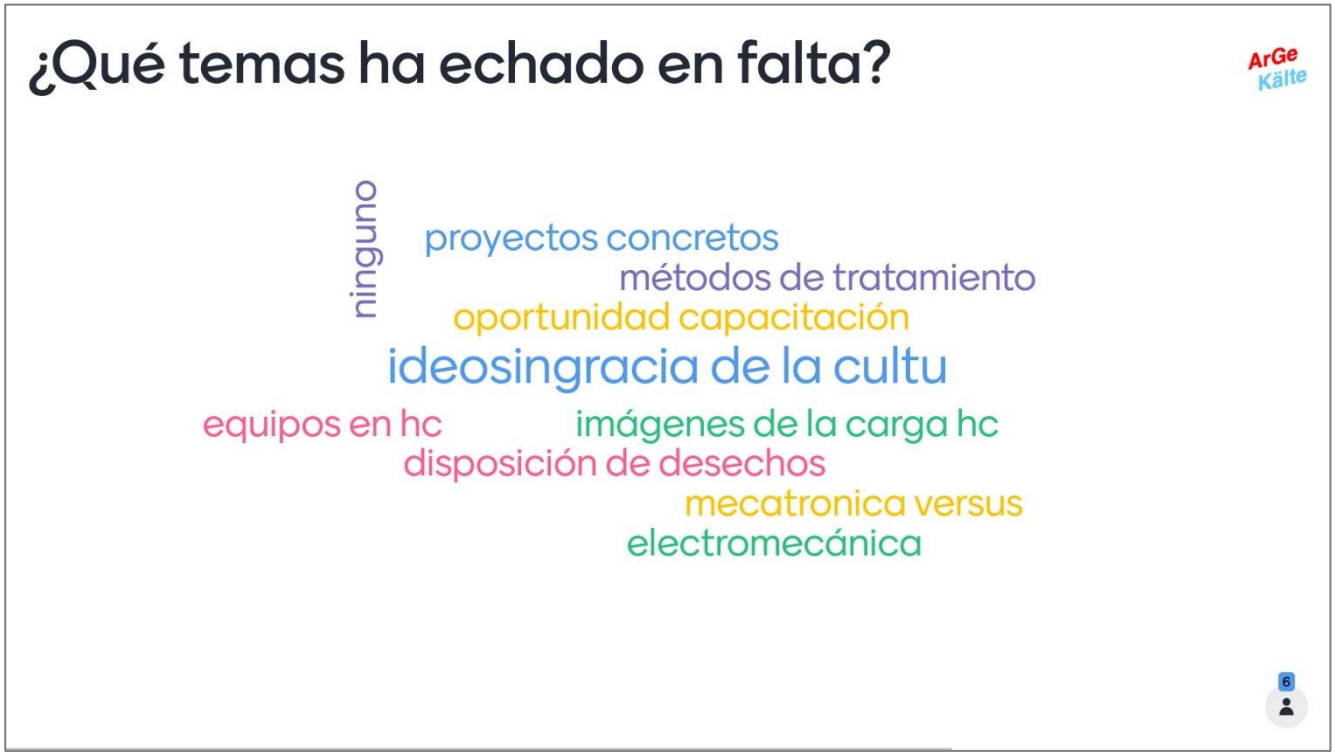
8

Para posibles eventos futuros: ¿Qué contenidos o temas deberían tratarse? Por ejemplo:

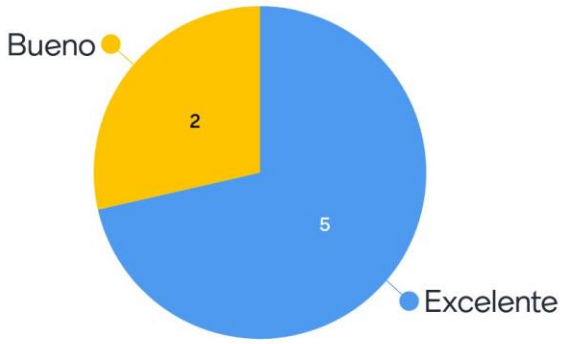
ArGe Kälte

7


¿Qué temas le interesaban especialmente?
ArGe Kälte
electrónica aplicada
eficiencia energética
uso de hc en rac
soldaduras
ok
asesoramiento
hc
refrigeración absorción
prácticas
refrigerantes naturales
uso de co2 en rac
sistemas con co2
novedades
estrategias
8


¿Qué temas ha echado en falta?
ArGe Kälte
ninguno
proyectos concretos
métodos de tratamiento
oportunidad capacitación
ideosingracia de la cultu
equipos en hc
imágenes de la carga hc
disposición de desechos
mecatronica versus
electromecánica
6

¿Cómo calificaría la utilidad del evento?



¿Participará nuevamente en un evento parecido?